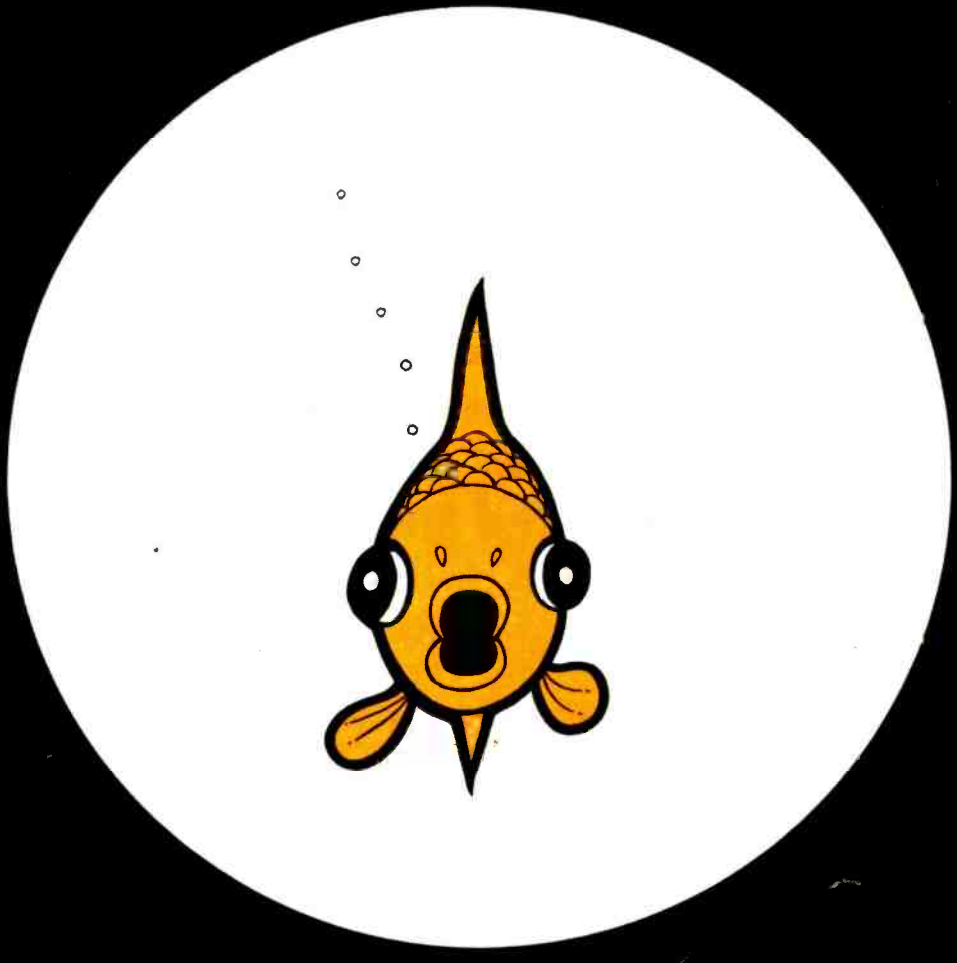
December 1975 35p

studio sound

AND BROADCAST ENGINEERING



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DECEMBER 1975 VOLUME 17 NUMBER 12

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COLUMNS

REVIEWS

DISTRIBUTION
STUDIO SOUND, published monthly, enables engineers and studio management to keep abreast of new technical and commercial developments in electronic communication. It is available without charge to qualified readers; these being directors, managers, executives and key personnel actively engaged in the sound recording, broadcasting and cinematograph industries in any part of the world. Non-qualifying readers can buy STUDIO SOUND at an annual subscription of £5.80 (UK) or £6.00 overseas.

BINDERS
Loose-leaf binders for annual volumes of STUDIO SOUND are available from Modern Bookbinders, Chadwick Street, Blackburn, Lancashire. Price is £1.50 (UK and overseas). Please quote the volume number or date when ordering.

Music criticism demands far more of both writer and reader than most other forms of comment. In our indulgent world of instant opinion, there is a constant babble of voices summarising the product of many hours' labour as 'good' or 'bad'. This tells us nothing except the primitive level of such a critic and his relationship with the work. However the criticism is dressed, it is of no more value than a light anecdote (despite the reverence of many to the printed word) unless it extends to an implication of the writer's own reference points. This may take the form of mentioning other areas of possible common experience with the reader, so that the latter is able to adjust the written attitudes to coincide with his own basic tenets. Also, steps and conclusions must be made apparent, even if they are intuitive and not easily rationalised.

At the other extreme, reviewing power amplifiers seems pretty straightforward. Measure the thing, compare those relatively simple figures with those obtained elsewhere and make the conclusions. But even that is far from straightforward by the time you worry about the speakers on the output and the sort of sound you *expect*. However, readers of such reviews, in this journal if not elsewhere, should be able to overlay their own personal requirements and act accordingly.

Somewhere between lie the traditionally vexed problems of speaker reviews, a medium in which more hot air has been expended than on the moral degeneration due to parametric equalisers. The problem is that the only method available is the discussion of subjective reactions, and even then it doesn't reduce to words like 'hot' and 'cold'. There is no absolute standard, because the monitor speaker is a tool reflecting the aural conditioning of the mixer from the time he started.

And there is little real tolerance of an opposite camp in personal terms; it isn't easy to change, nor is there much inclination to at the present time. While a church organist may acknowledge that there is something to rock and roll, and vice versa, he may prefer to stay on the musical lines along which he developed. There is about as much mutual tolerance between the BBC and the JBL monitor camps. Fine for all concerned, so long as one does not force its opinions on the others. But to present subjective speaker reviews to keep both schools of thought happy and provide them with something useful would need a parallel translation.

So we decided not to, until someone comes up with methods a bit better than those we have to rely on today.

STUDIO SOUND is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.

CORRESPONDENCE AND ARTICLES
All STUDIO SOUND correspondence should be sent to the address printed on this page. Technical queries should be concise and must include a stamped addressed envelope. Matters relating to more than one department should occupy separate sheets of paper or delay will occur in replying.

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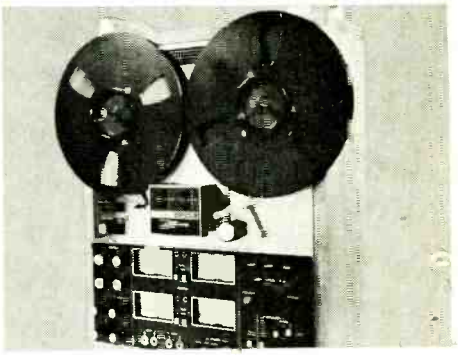

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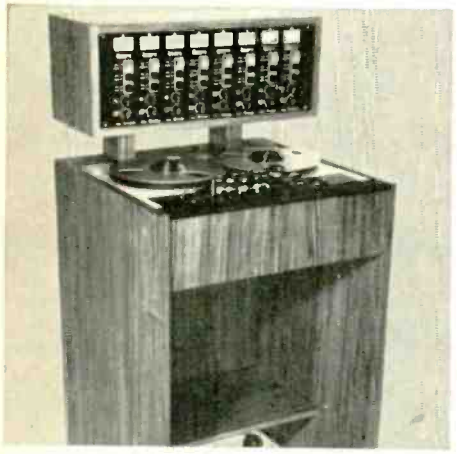

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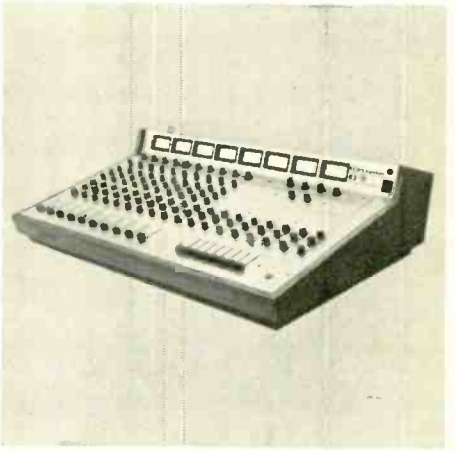

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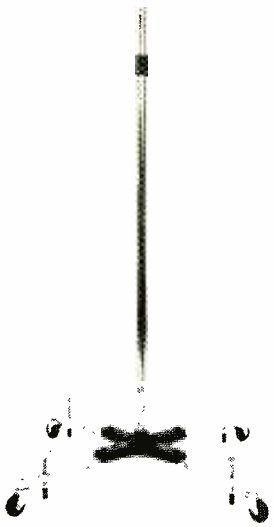

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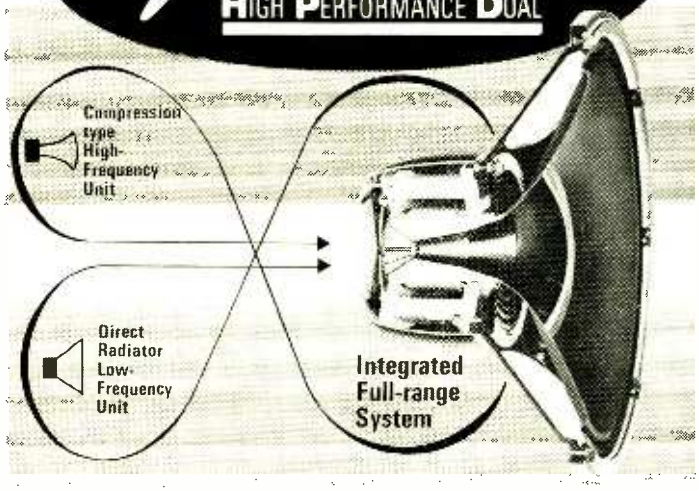

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Frequency Response	27-20,000 HZ	25-20,000 HZ	23-20,000 HZ
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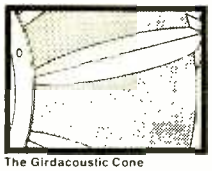
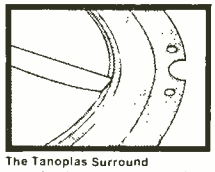
Impedance via Crossover network	8 ohms (5 ohms min.)	8 ohms (5 ohms min)	8 ohms (5 ohms min)

*INTEGRATED PROGRAMME MATERIAL

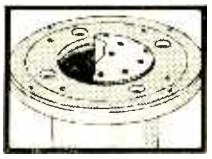


The Girdacoustic Cone improves frequency and transient response gives much increased power handling capacity and greater mechanical stability

The High Temperature Voice Coil assures absolute climatic stability and great mechanical strength together with much improved power handling capacity.



The Tanoplas Surround gives low bass resonance with excellent mechanical stability and freedom from edge reflections



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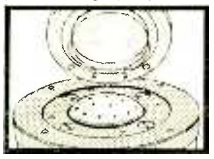

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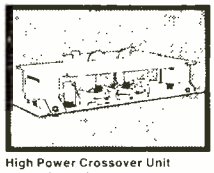

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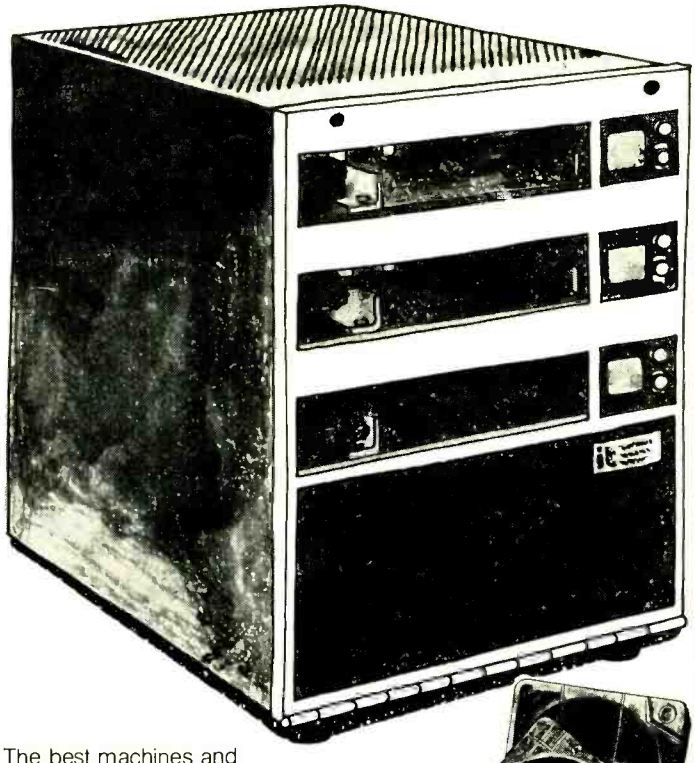

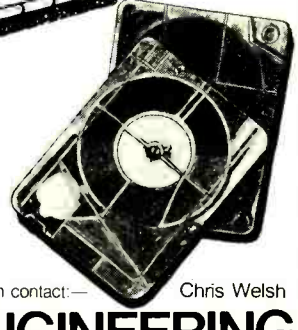

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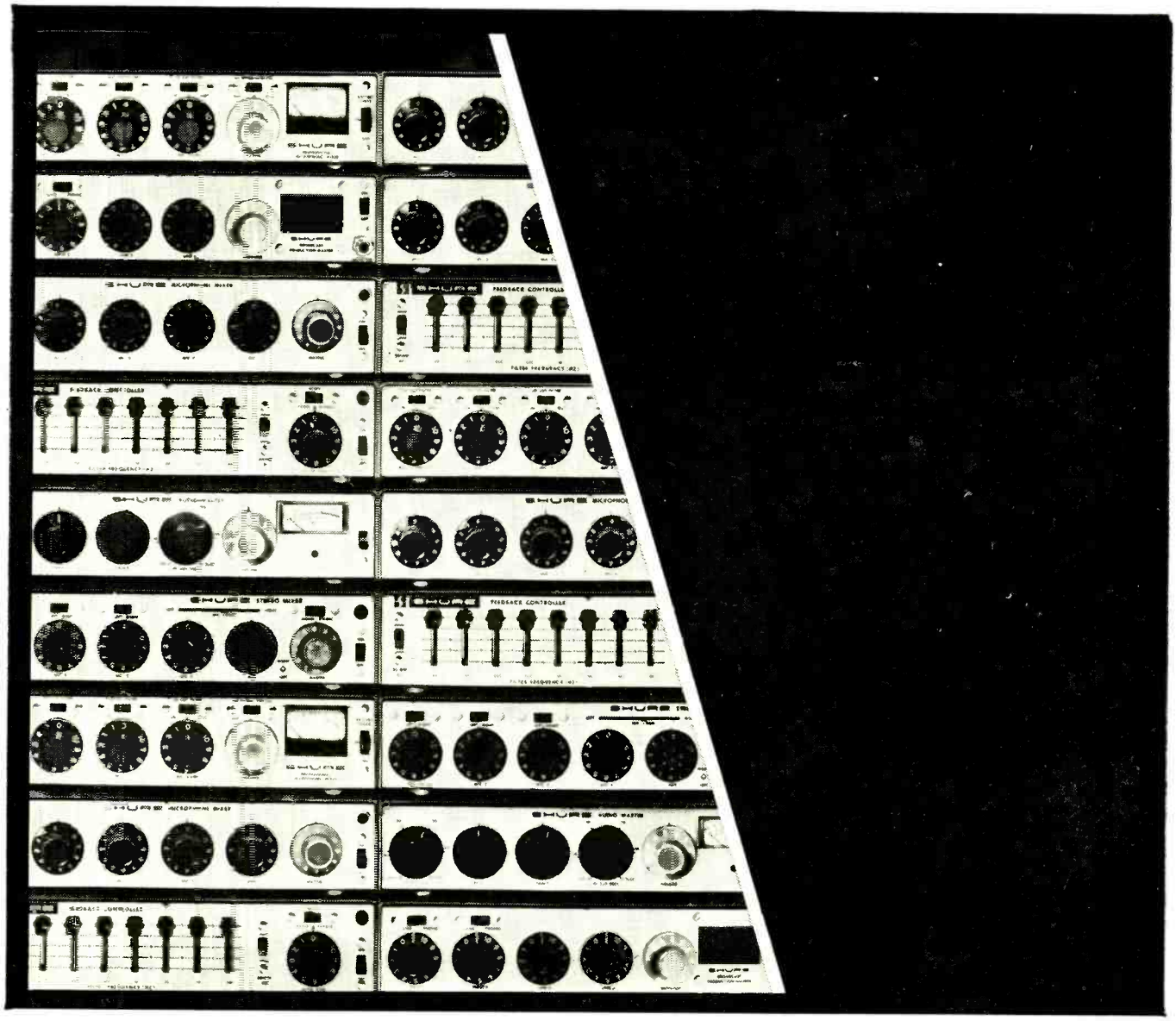

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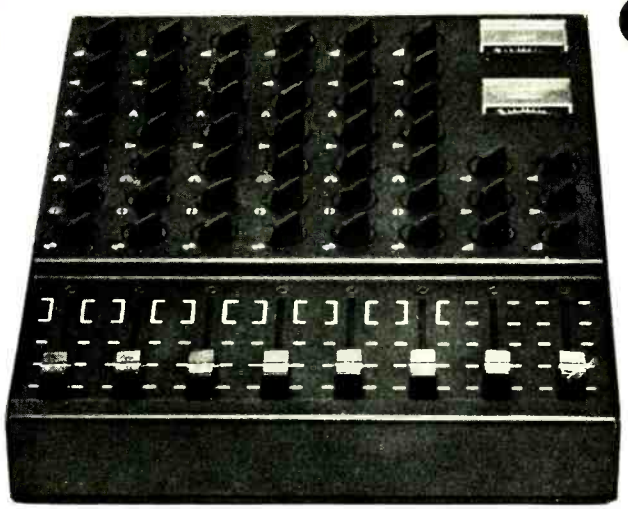

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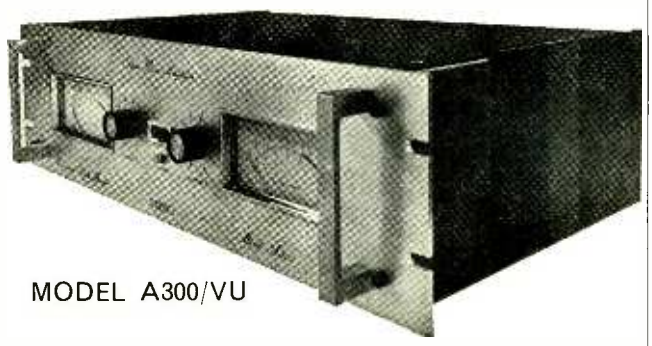

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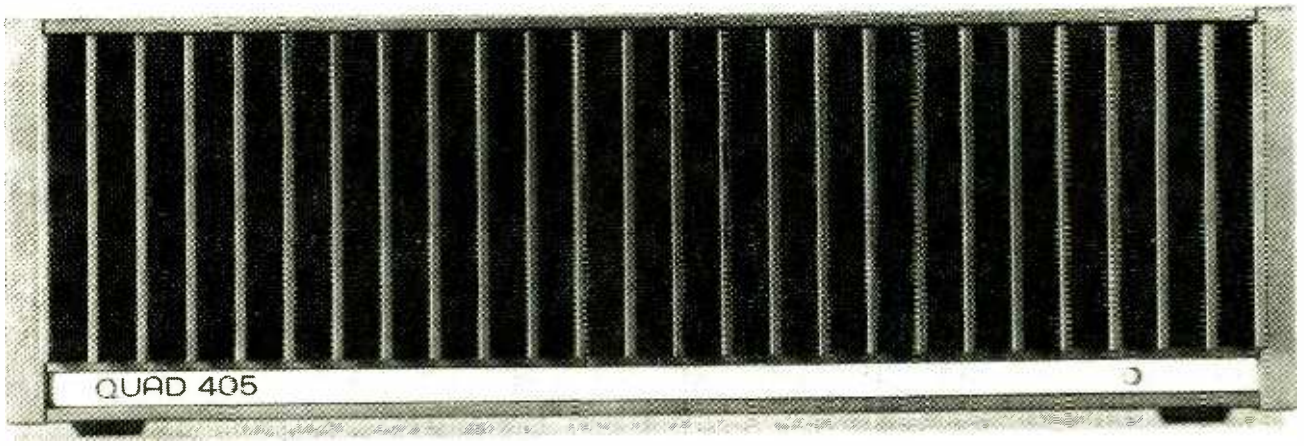

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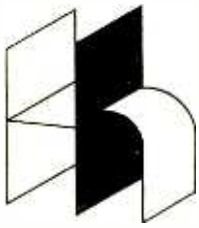

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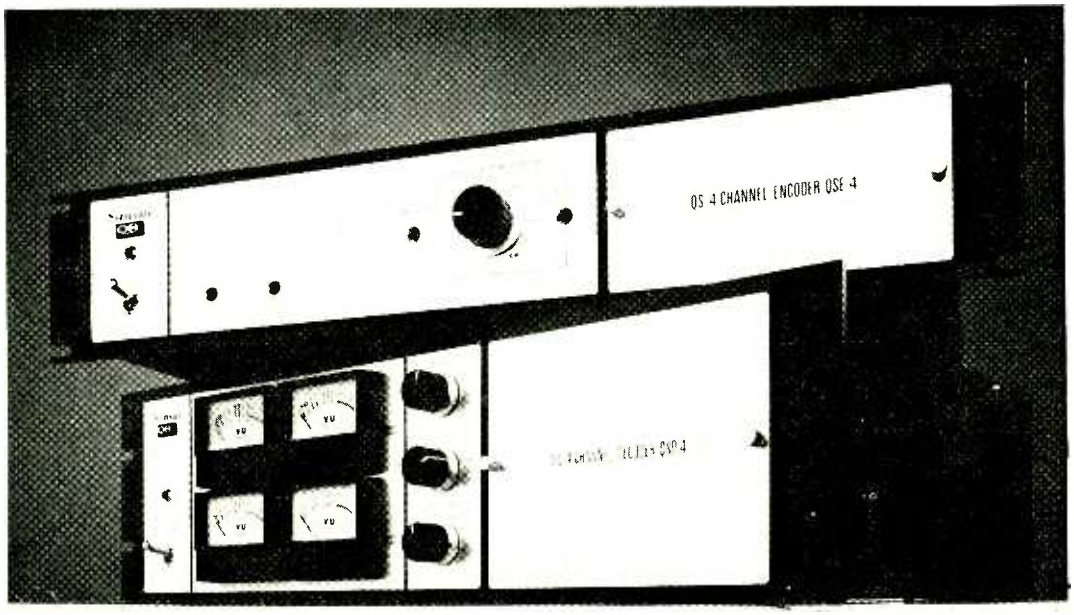

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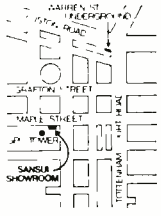

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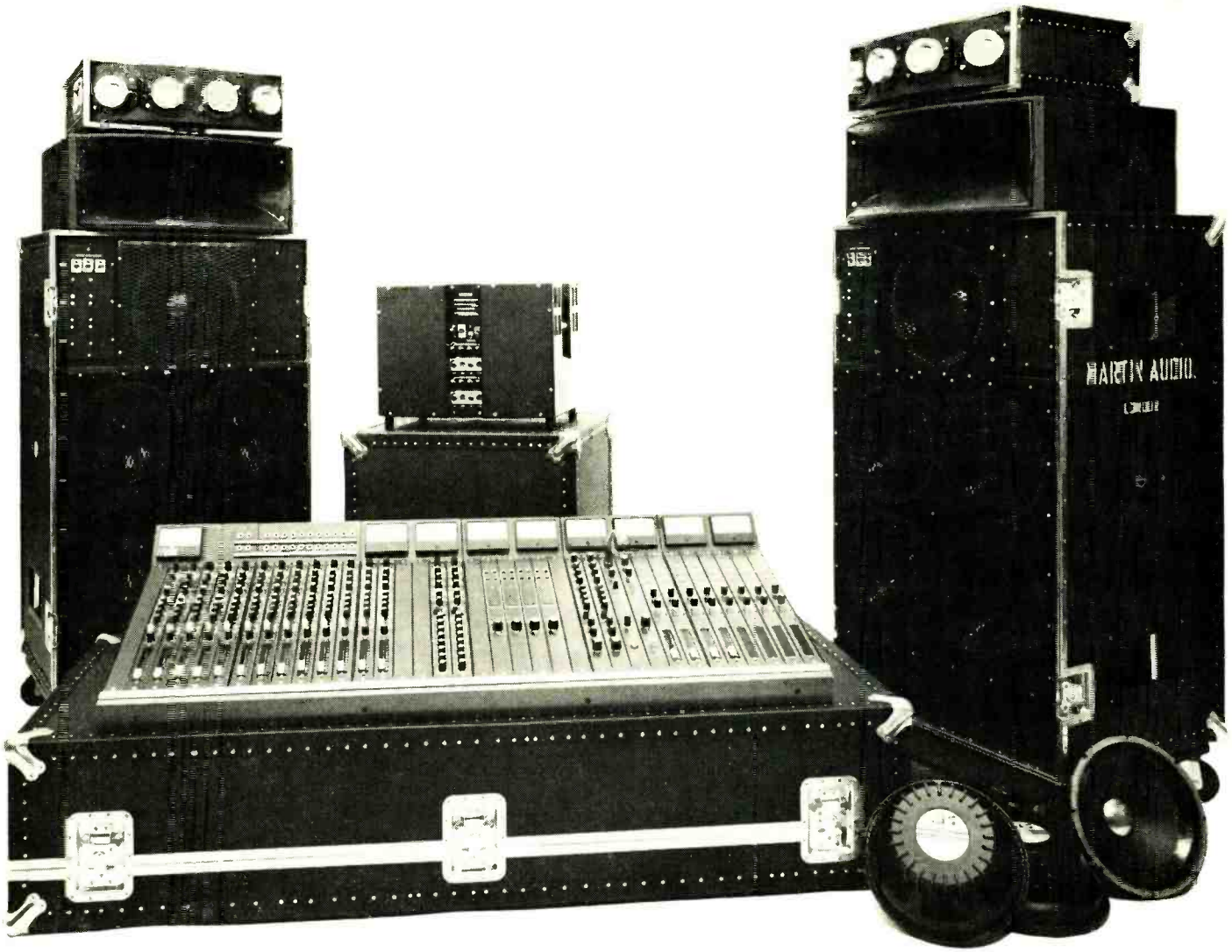


Developments in CD-4 cutting

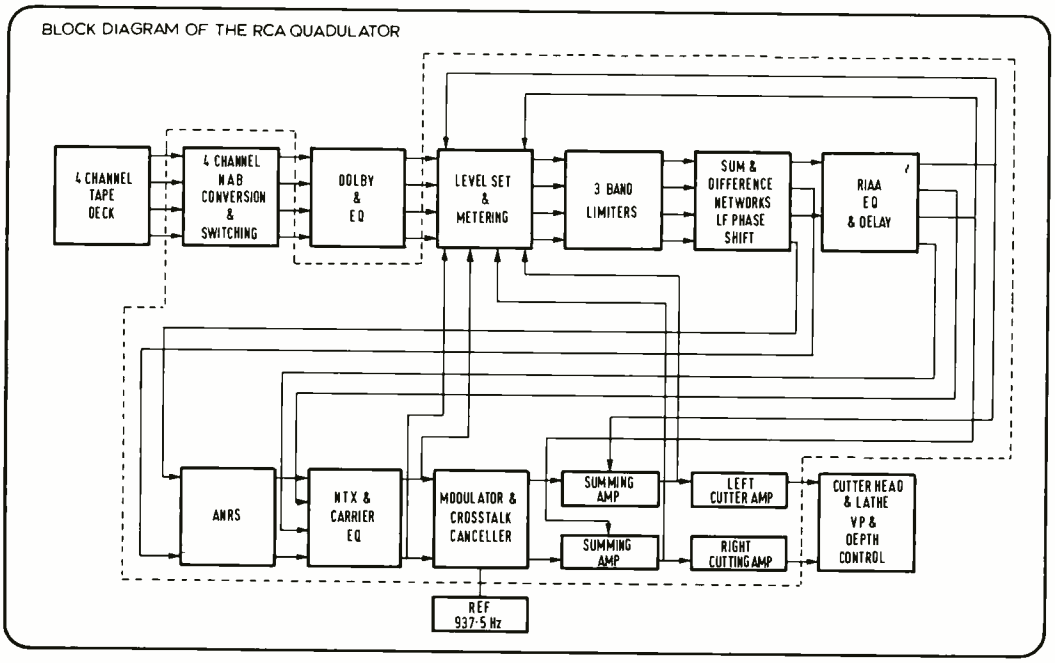
As a result of joint engineering efforts between RCA records, JVC and the Matsushita Electric and Industrial Company, a system of phase modulation for the difference signals (ie carrier) referenced by phase lock loop to a reference frequency was developed during 1973. It had the effect of stabilising the phase between the modulation systems under conditions of no signal. Since then research has been done to extend the dynamic range lacking in the basic system comprising essentially a reference generator, vco (this provides the modulation signal for the cutting head) phase comparator and feed back loop. The shortcoming shows up at low modulating frequencies where the modulation index of the vco exceeds the π or 2π radian capability of the widest range phase comparators.

Solutions to the problem were found with two different systems. The first approach was the Automatic Dynamic Range Expansion Circuit (ADREC). This makes use of the overload saw tooth output obtained from the comparator which has a period relating directly the number of times that its capacity has been exceeded. The saw tooth is differentiated to remove the vco carrier, then passed through a pulse forming network to an up/down counter. The counting direction is dependent on the polarity of the overload sawtooth coming from the comparator. The binary output from the counter is passed through a d/a converter producing a step error waveform. The addition of this to the sawtooth in a summing amplifier results, after filtering, in a correction signal for application to the vco thus restoring the dynamic range at low frequencies.

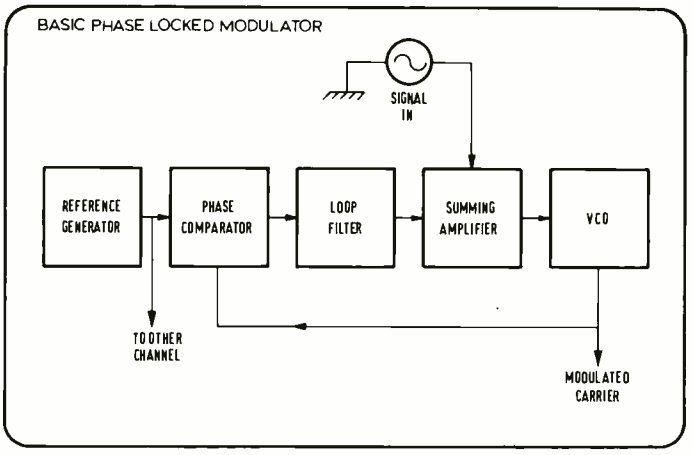
The other approach is the Selected Frequency Divider (SFD) which relies on frequency division of the feedback loop between vco and phase comparator to reduce the modulation index of the modulated signal applied to the phase comparator. The extension of dynamic range is directly proportional to the number of times the carrier frequency is divided before application to the phase comparator. Although this appears a simpler solution than ADREC, watertight procedures must be gone through to eliminate potential interference between the dividend and its harmonics, and the sidebands and harmonics of the modulating frequency. However, it is a relatively easy matter to predict when and where interference is likely to occur and design out by the use of filters. The SFD system has been adopted by RCA and JVC as the modulator used in their latest CD-4 disc cutting processors.

They also incorporate Neutrex which operates on the principle of providing anti-cross talk terms between the base band and carrier at the correct phase angle to result in the cancellation of those terms during playback. Previously, the system has been used in the composite signal, ie a carrier plus audio signal. The most recent version, Neutrex I, is used to improve the tracking in playback of the sum signal alone. This has the advantage of not degrading the frequency

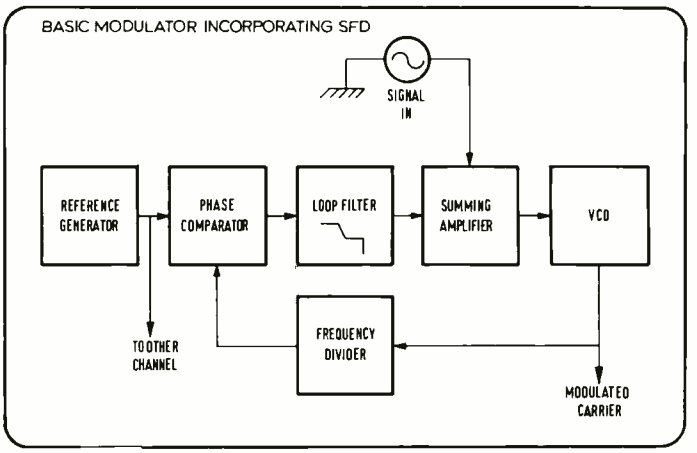
BLOCK DIAGRAM OF THE RCA QUADULATOR



BASIC PHASE LOCKED MODULATOR



BASIC MODULATOR INCORPORATING SFD



response of the difference signal which is caused by tracing delay in the sum signal.

A further processor, Neutrex 2, was designed for use in conjunction with *NTX 1*. This reduces phase distortion caused by interaction between the modulated carrier (difference signal) and the base band (sum signal) which should closely relate after demodulation. It is possible largely to cancel most of this phase distortion by applying a negative modulation derived from the sum signal. The amount of compensation which must be applied depends on the wavelength of the signal in the groove.

Generally, without altering the phase shifting characteristics of *NTX 2*, it is possible to compensate over the entire area of the disc by simply altering the Neutrex level during the cutting process.

Both the JVC *Mark 3* modulation system and the RCA *Quadalator* employ the various techniques outlined. The following is an extract from the specification of the *Mark 3*:

SUM SIGNAL
Frequency response (half-speed): 15 Hz-7.5 kHz (+0 dB/—1.0 dB).
Signal to noise: 70 dB.
Distortion: Less than 0.1%.
Dynamic range: 90 dB.

DIFFERENCE SIGNAL
Frequency response (half-speed): 15 Hz -7.5 kHz (+0 dB/—1.0 dB).
Signal to noise: 70 dB.
Distortion: Less than 0.1%.
Dynamic range: 90 dB.

MODULATOR
Carrier frequency (half-speed): 15 kHz.
Maximum deviation: 100 radians.
Frequency response (half-speed): 15 Hz-7.5 kHz (+0 dB/—0.5 dB).
Distortion: Less than 0.2%.
Dynamic range: 85 dB (500 Hz).

Bibliography

New Modulation Technique For CD-4. Recording by Yukinobu Ishigaki, Kiyotake Fukui and Gregory A. Bogantz. Preprint 1037 (A-4) AES 51st Convention.

Half Speed CD-4 Disc Cutting by Toshiya Inoue, Isao Owaki, Yukinobu Ishigaki and Katsuya Goh. AES Journal October 73.

Air clean up

The Scandair *SD-75* is said to be a small, quiet, light weight wall fitting electrostatic air cleaner with a disposable collecting cell. It claims to remove all airborne pollutants such as tobacco smoke, pollen, dust, ash etc and recirculate back into the room at up to $2m^3$ per minute.

While it would not be a full replacement for air conditioning, it might be cost effective in less demanding studio situations. Scandor say that the 'low cost' replaceable elements, average life six to nine months, are easily installed and require no electrical installation work. Power consumption is less than 25W. Scandor Company (Sales) Ltd The Distaff, Belmont Hill, Newport, Essex CB11 3RF. Phone: 0799-40218.

We boobed

Midas Amplification would like us to point out that the company's address, quoted in the mixer survey (Oct 75, p74) has been out of date for more than seven months. It should have been given as: 54/56 Stanhope Street, Euston, London NW1 3EX. The new phone number is 01-387 7679.

We apologise for any aggravation that this may have caused.

Broadcast mixer

The final addition to the Sparta *3000* range of broadcast mixers is the *3410*, the stereo version of the *3310* (see Nov 75, p22). Basically of 10/2 format, a solid state switching matrix allows up to 22 input lines, selected a dc remote signal. A multiple bridging input allows several cartridge playbacks to connect to a single channel without interaction. The mixer costs $3900. Sparta Division, Cetec Corporation, 5851 Florin Perkins Road, Sacramento, Ca 95828, USA. UK: CEC Ltd, Shaftesbury Street, High Wycombe, Bucks. Phone: 0494-37529.

Cartridge machine

The latest *5000* series incorporates updates over earlier models in the mechanical, electronic and maintenance departments. With either three or five bays, the series features fold down panel, slide out decks, flat wire harnesses and plug-in boards. The auto release decks have 'massive' machined deck plates, direct drive servo capstans and air damped solenoids. Both the mono and stereo versions are equipped with the *Phase Lok 3* head bracket claimed to give easy and accurate head adjustment.

Claimed to meet or better all NAB specifications, options include secondary and tertiary cue tones and remote control units. All machines accept 'A' or 'B' size cartridges. Broadcast Electronics Inc, 8810 Brookville Road, Silver Spring, Maryland 20910, USA. Phone: (301) 588 4983. UK: Broadcast Audio (Equipment) Ltd, PO Box 31, Isle of Man. Phone: 0624-4710.

Viewdata

The Post Office plans to introduce a service competing in the UK with Ceefax and Oracle. The service will differ only in that the information will be sent over telephone lines instead of by radio waves, and every telephone subscriber would potentially have access to the service. Viewdata could, say the Post Office, be available in three to four years' time if trials due to start next year are successful. Users would switch on the television set and then call up the service over the phone by pressing a button on the control unit. They would not even have to lift the receiver. Then they would press the button again and the Viewdata index would come up on the screen, listing the subjects available. The instructions for calling up those pages would appear on the index. The system could show sketches, and maps and up to seven colours would be available. Users could also send simple messages to one another, and these could be stored in the system until the receiver was available to receive it.

'Independent agencies would be responsible for providing the information displayed on viewdata,' said the Post Office in a statement. 'They would supply this information in a form suitable for direct use by the system.'

There are two very disturbing aspects to this development, both of them a threat to the Ceefax and Oracle systems. The first is that in order for the BBC and the IBA to transmit anything at all they have to rent lines from the Post Office, the same Post Office that is in direct competition with them in providing this service. The state of the PO's finances is apparent everytime we get a phone bill, and if the public were encouraged, by the more widely available and cheaper BBC and IBA systems, to develop a taste for digital data transmission systems the PO could then step in and say they would not make lines available for such a service. At the very least they could make the BBC and IBA accept limitations on the service they offered, providing the more comprehensive service themselves.

Secondly, the Post Office is not in the news gathering business. The paragraph quoted above about independent agencies indicates that the Post Office will be using the same news sources as the BBC and IBA use. In most cases this means the Press Association and Reuter, the first for home news and the second for foreign news. These, in any case, would seem likely to be among the few agencies able 'to supply this information in a form suitable for direct use by the system'.

In dealing with Reuter and PA the Post Office would in effect be dealing with one agency, since their ownerships are linked. The Post Office say they are 'still looking' at the possible sources of news.

John Dwyer

Annanagain

With the publication of two more memoranda to the Annan Committee on the future of Broadcasting the BBC has now submitted a total of 23 memos, including three from advisory committees, quite apart from the initial submission of its three volumes of evidence in March this year. The Annan committee's report, when it appears on the Home Secretary's desk a year next Christmas, looks like being quite hefty, with over 500 organisations having submitted evidence up to September and over 6000 letters arriving from the public.

The BBC's latest submissions are from the BBC's Central Agricultural Advisory Committee and from the Local Radio Councils. The first recommends that East Anglia, the North and the South West, with large rural populations should have regular weekly farming programmes on tv and radio, that specialist agricultural producers should be appointed in Norwich and Bristol, and that the Agricultural unit in Birmingham should be given more money so that it can produce, for general consumption, television programmes about food and the countryside.

Possibly of greater interest is the memorandum on local radio. The BBC has already submitted one memorandum on local radio, last April, but the latest is a summary of recommendations made by the councils appointed for each BBC local station.

All the stations felt that BBC local radio had 'woven itself into the country's sociological fabric,' and the memorandum stresses that it would be disastrous 'to curtail the activities of local radio in any rationalisation which might be envisaged'.

The local radio councils were also unanimous, says the memorandum, that local radio should retain its link with the BBC. Reasons given were varied. Radio Humberside felt 'This offers great advantages in

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being able to draw upon resources of the BBC for administrative help, financial backing, programme material and technical expertise'. Solent said that the link provided a high staff training standard, and Leicester said that it made available a free flow of ideas, talent and a full range of supporting services.' On the other hand it was 'widely felt' that the independence enjoyed by each station manager to run his own station should be maintained. Merseyside said 'The autonomy of Local Radio should be increased rather than the reverse, without separation from the rest of the BBC.'

If necessary all the stations would choose to sacrifice vhf rather than return to the high sound quality ghetto they found themselves in before they went on to mw. Nottingham was typical in saying, 'Faced with the quite appalling prospect of having to surrender one of these frequencies, we would choose to retain mw.' The reason, of course, is the greater coverage, particularly for those in motor cars. The Memo adds, however that all the councils would be bitterly opposed to any erosion of this kind.

The councils were strongly opposed, says the Memo, to financing local radio from local taxation. Carlisle submitted 'We consider there should be no erosion of the independence of the BBC. Such independence could only remain if licences continue to be the source of revenue.'

On the commercial stations the BBC says that although the competition has been welcomed 'there is a feeling among certain councils that there has been some squandering of resources. Thus in areas where local radio is already well-established it seems rather too prodigal at a time of national economic difficulty to introduce a second station'. Nothing could be done about existing stations, they say, but they urge that the matter should be carefully thought about before more are planned. The paragraph seems to amount to a bad attack of special pleading.

The memorandum also urges that all local radio stations should be given stereo as soon as possible and ends with the strange suggestion that 'Piped radio and tv to local authority houses should be under the control of a statutory body as with gas, electricity, etc.' This remark is so cryptic that it has even baffled some of the usual sources at Broadcasting House. One suggestion was that local radio stations should be available on the piped systems, but in new developments this is the case anyway. The older properties may have had only two or three channels but then most of the occupants will be using portable radios. Ten per cent of homes already get their radio and tv programmes from piped systems. A suggestion in Whitehall was that the paragraph was concerned with the bulk charges that the rental companies made to the local authorities for supplying these services, which was recouped out of a small increase in the rent. The BBC seem to be saying that a local authority piped broadcast body should replace the private companies who do it at the moment.

Whatever the BBC may think, another commercial radio station, the fourteenth, opened in Bradford on September 16th. Pennine Radio is run by Bradford Community Radio Ltd, under the chairmanship of Mr Richard Denby and backed mainly by the National Union of Dyers, Bleachers and Textile Workers, who hold 14 per cent of the shares, North East Industrial Securities Ltd (10 per cent), Standard Broadcasting Corporation (UK) Ltd (10 per cent), William Morrison Supermarkets Ltd (five per cent), Arnold Laver (Bradford) Ltd, and Illingworth Morris & Co Ltd (four per cent).

Pennine Radio broadcasts on 246m mw at 300W and 96.0 MHz at 0.5 kW. The nearest BBC local station is Radio Leeds, which used to suffer from such low transmitter power that the people of Leeds were as often as not better able to receive Radio Sheffield. That is no longer the case since the station's transmitter was moved to Holme Moss and Radio Leeds achieves almost regional coverage on 92.4 MHz at 5.2 kW and 217m mw at 1 kW. Pennine Radio managing director Stephen Whitehead agreed Leeds had better coverage than Pennine: 'They cover the whole of West Yorkshire.' But then local radio should be just that, and Mr Whitehead probably has enough problems in Bradford without trying to deal with a wider area.

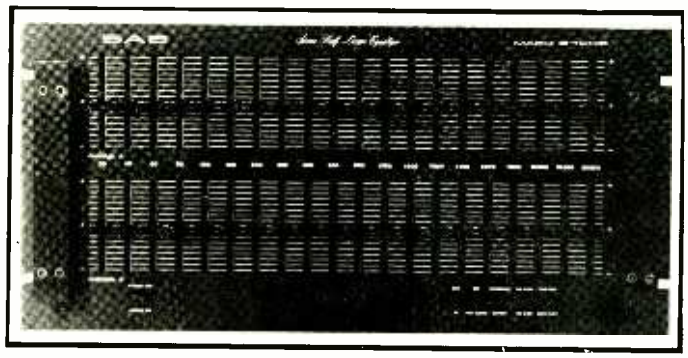
John Dwyer

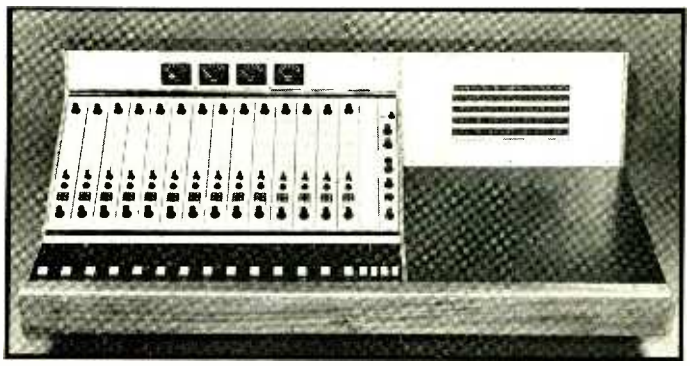
Half octave equaliser

Available for both the professional and domestic market, the SAE *2700B* (rack mounted, 600 ohms line) offers half octave eq on 20 centres between 20 and 20k Hz with spot control of ±16 dB. There is a built-in pink noise 'calibration' facility operated from a front panel pushbutton together with eq defeat and control range 8/16 dB max.

Quoted performance figures for the two channel unit include an intermodulation figure of .02% and a rather nebulous noise performance rating of better than 90 dB. The pro unit costs $600. The UK price is yet to be decided. Scientific Audio Electronics Inc, 701 East Macy Street, Los Angeles, Ca 90012, USA. UK: Gale Electronics & Design Ltd, 39 Upper Brook Street, London W1Y 1PE. Phone: 01-499 2996.

SAE Mk 2700B stereo half octave equaliser





This Raindirk mixing console was recently supplied to R. G. Jones (Morden) Ltd for installation at the Institute of Electrical Engineers, Savoy Place. Made up from channel modules and accessories from the Mini Mixer range, the mixer will interface with PO and satellite lines during lecture hook-ups

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Philips rebuild

Official confirmation of the rebuilding of the three Baarn studios of Phonogram talks in terms of 1976 completion, the contract having been awarded to Westlake. This represents their first European engagement by an 'establishment' record company, with the other three studios completed being Threshold, the Manor and Montreux Casino. Described as a 'no compromise' operation, it gives Westlake a more or less free hand in acoustic design and treatment, this in itself representing a significant departure from past Philips policy.

Studio One includes an isolation room, in which the mid and high frequency reverberation is variable between around 0.5 and 5 seconds, and can accommodate 18 strings or equivalent. Low end reverberation is expected to be less than 0.25s at 40 Hz. The irregular shape includes a 10 raked ceiling (low, due to the present building shell) and the floor will be of slate. Accommodation for 75 musicians with full separation extends to the largest drum cage ever tackled by Westlake, including variable frequency trapping.

Studio Two has a slightly smaller isolation room, approximate capacity 16 strings and three seconds upper limit to reverberation. The higher ceiling is trapped and the drum cage is normal; floor is partly of slate.

Studio Three, the smallest, is designed for band working, designed with as much emphasis on comfort as functional aspects. The stone fireplace, 'gas and/or wood fired', complements an oak floor with throw rugs. Anticipated capacity is a maximum of ten,

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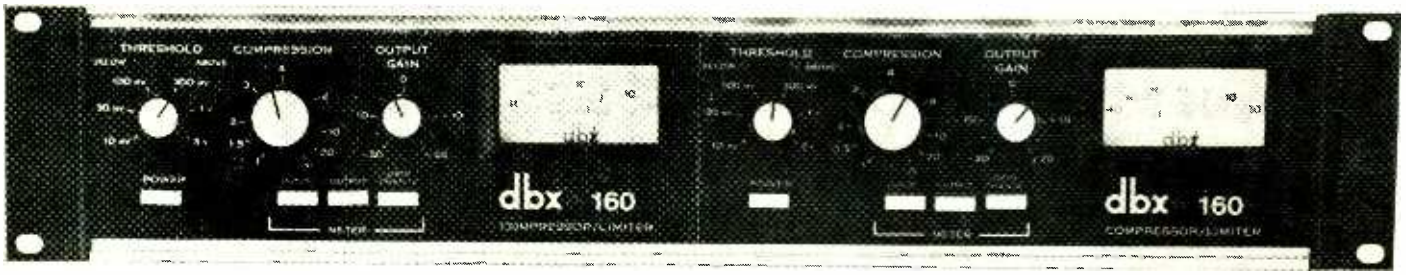
The Compressor that's seen but not heard. DBX 160.



DBX Inc. Waltham, Mass. USA

The dbx 160 compressor/limiter is the first in a new series of devices from the manufacturers of the dbx noise reduction system for the control *without degradation* of audio signals.

Unlike most conventional compressor/limiters which use peak detection and fast response characteristics, the dbx 160 employs true RMS level detection circuitry signal sensing coupled to a highly sophisticated voltage controlled amplifier gain control element.

As the human ear responds not to peak but to RMS signal values (defined as the sum of all frequencies/energies present), the dbx 160 produces listenable results *even at extreme levels of operation*.

Overall distortion on the dbx 160 is markedly low owing to the use of feed-forward control circuitry. This gives superior results to the level sensing feedback loop used in conventional compressor/limiters. Feedback circuitry results in increased distortion when progressively higher compression ratios are used—the feed-forward circuitry used in the dbx 160 eliminates noticeable distortion even at high compression ratios.

The dbx is a reasonably priced (under £200) professional studio product with balanced high impedance differential input stage and balanced low impedance output. Ground loop compensation is built in to electronically sense any ground loop at the output and attenuate it at least 40 db. Transient protection circuitry prevents turn-on turn-off thumps appearing at the output.

DBX 160 Features:

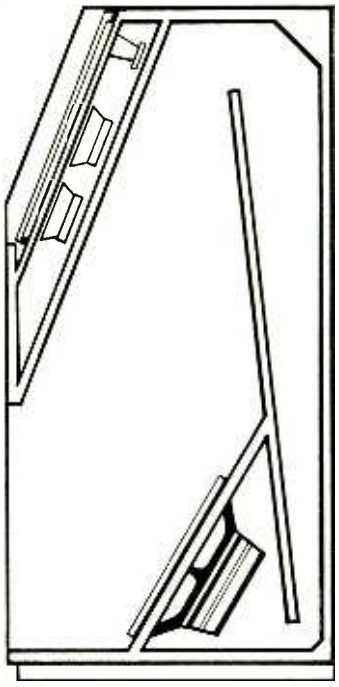
True RMS level detection
Low distortion at high compression ratios
1 :1 to infinity variable compression ratio
10 mV to 3V variable threshold point
LED indication of input signal above or below threshold
60 db range meter switchable to input, output or gain change
Ground loop compensated and transient protected
Available free-standing or in 19" rack mounting pairs

For full information on the model 160 contact:
Scenic Sounds Equipment 27–31 Bryanston St. London W1H 7AB Telephone: 01-935 0141

In France: 3M France SA 134 Blvd. Serurier, Paris 19E Telephone: 202 8080

although in practice this will not be reached.

The contract follows a visit to Westlake installations in LA by Philips representatives including Alex Bolster, during AES last May. See page 46 for a discussion of recording environment by Westlake president Tom Hidley, some of whose ideas will be realised for the first time in this project.



Brass horn studio monitor

Horn monitor

Although the manufacturers don't quote an spl for the folded horn bass, infinite baffle mid range and horn top loudspeaker, one of the claims made is that a 40 Hz blast at 200W will blow out a candle at one metre. Others include a ±3 dB response from 40 to 15k Hz, a power handling of 200W continuous rms and a three way variable attenuation crossover.

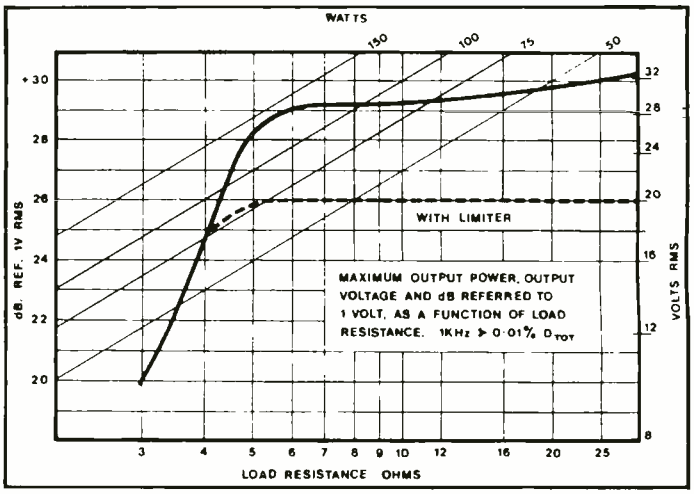
The cabinet comprises a 30.5 cm bass unit loaded backwards into the throat of the folded horn of length 2.5m, the radiation from the front of the cone emanating into the horn mouth. Eight 13 cm midrange units are mounted at the top loaded by infinite baffle into 32 litres. Four horn tweeters handle the top. Crossover is at 400 and 5k Hz. Overall dimensions are 60 x 60 x 130 cm. The speaker costs £425.

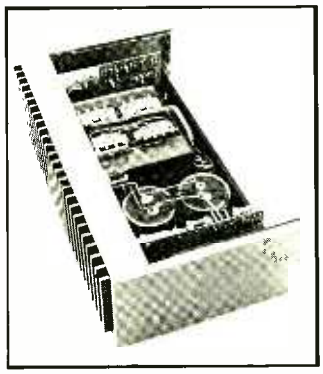
Harwell Instruments Ltd who produce the unit state that, in terms of quality, it finds applications in recording studio control rooms; equally, the high sensitivity enables use for 'high quality' pa.

The company manufacture other models using the same principle although these are only supplied as part of custom installations. Harwell Instruments Ltd, Spices Yard, South End, Croydon CR2 1GG.

Current dumping audio amplifier

The principles of operation were given in a paper presented to the AES 50th convention (see June 75, p26) by designers P J Walker and M P Albinson of Quad. Briefly, performance depends on the operation of a low power class 'A' amplifier, effectively paralleled with the output from a basic high power amp fitted with output current monitors. The error signal from the high power section is arranged as a feed foreward, ie positive current error correction signal independent of the conventional, overall voltage feedback loop, resulting in the characteristic low impedance voltage output.





Top: *Power output characteristics of Quad 405 current dumping amplifier*
Below: *What it looks like*

The resulting new product model *405* has the following specification:

No of channels: 2
Power output | see graph. Both
Load impedance | channels operating.
Output impedance: 0.03 Ω in series with 3.3 μH.
Frequency response: —1 dB at 20 Hz, —0.5 dB at 20 kHz, —3 dB at 50 kHz.
Input level: —4 dB.7V ± 0.5 dB for 100W into 8Ω.
Input impedance: 20 kΩ.
Input slew rate: 0.1 V/μs.
Crosstalk: 70 dB at 1 kHz.
Noise: —95 dB ref full power, 'A' weighting; unweighted (15.7 kHz bandwidth) —90 dB.
Protection: 'electrically protected by current limiters; 7 amps in phase current at peak voltage and 3½ amps at zero voltage. Shorting both outputs simultaneously on signal for an extended period (minutes) is not protected.'

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C.E. 4038 Bi-Directional Ribbon Microphone

A pressure-gradient transducer microphone designed after years of research sets a very high standard of fidelity for ribbon microphones. It is manufactured by agreement with the British Broadcasting Corporation, patent 738,864 and 742,006. It is ideal for orchestral and musical work, and is essentially a studio microphone. It has a smooth wide range frequency response, an absence of transient distortion, and relative high sensitivity comparable with that of superior moving coil microphones. The frequency response is exceptionally flat from 30 to 15,000 c/s and throughout this range the shape of the bi-directional polar response is maintained substantially constant both in the horizontal and vertical planes. The ribbon is of extremely low mass and is correctly damped so that the transient response is exceptionally good.

Non-linear distortion is practically non-existent at all levels which will be encountered in practice. The case is made of heavy gauge perforated brass, backed by finely woven monel wire mesh screen to exclude dust. The microphone can be either mounted on a stand or suspended from lugs to enable it to swivel and tilt.

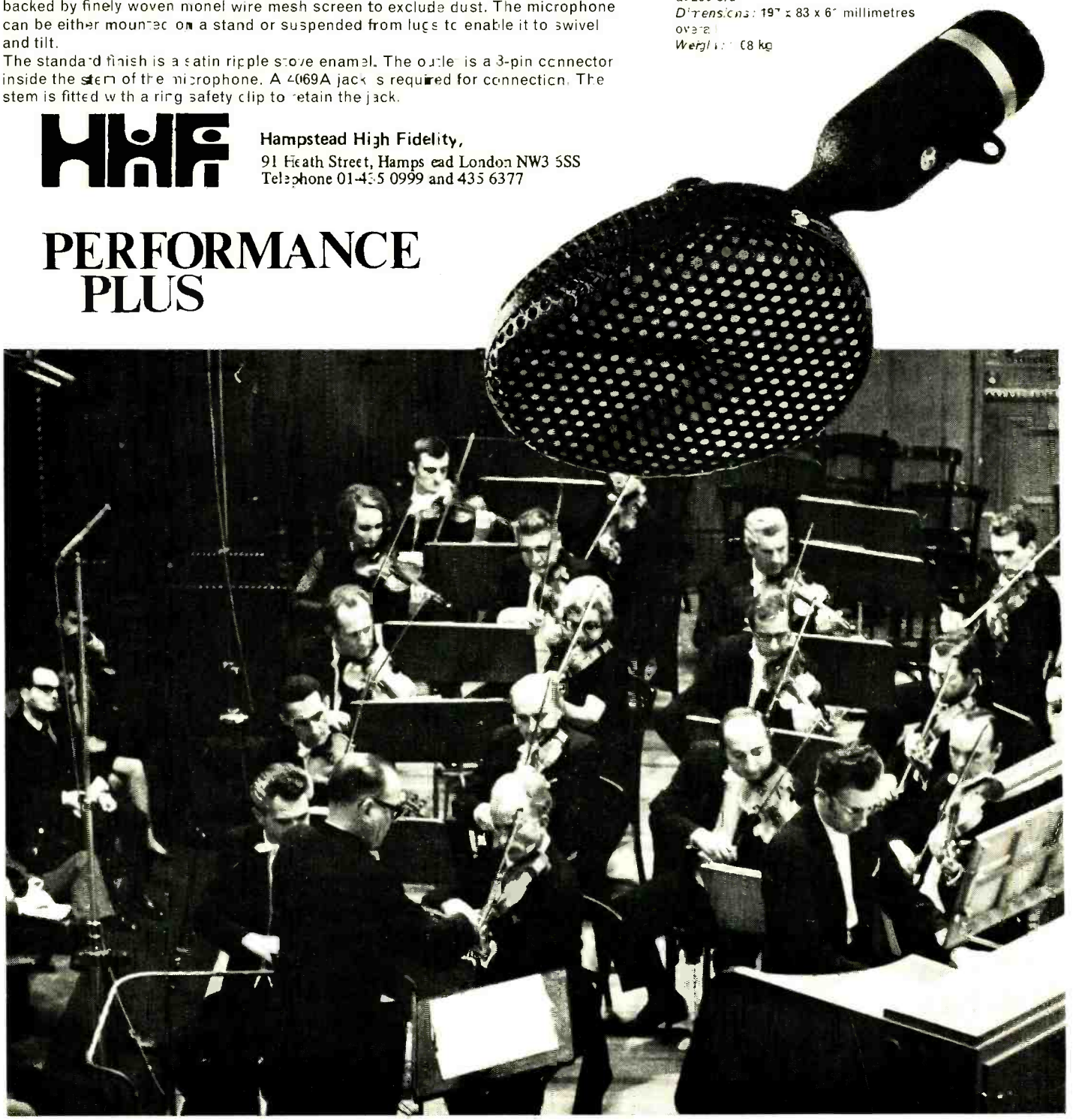
The standard finish is a satin ripple stove enamel. The outlet is a 3-pin connector inside the stem of the microphone. A 4069A jack is required for connection. The stem is fitted with a ring safety clip to retain the jack.

Technical Specification

Mean Sensitivity: Open circuit voltage per dyne/cm^2 (micro-bar) 0.06 mV
Open circuit voltage level per micro-bar ref. 1 volt—85 dB
Power delivered into 30 ohms for 1 micro-bar ref. 1 mW —76 dB
American ASA rating, ref. 1 mW —151 dB
Electrical Impedance: nominal value 30 ohms
Equivalent Electro-Magnetic Hum Pick-up:
Less than +5 dB on 0.0002 dynes/cm^2 for 1 milligauss at 50 c/s
Distortion (Non-Linear):
Less than 1% for a sound intensity of 125 dB above 0.0002 dynes/cm^2 (20 micro-Newtons per square metre) at 110 c/s and less than 0.1% for +125 dB at 250 c/s
Dimensions: 197 x 83 x 67 millimetres overall
Weight: 0.8 kg

Hampstead High Fidelity,
91 Heath Street, Hampstead London NW3 6SS
Telephone 01-435 0999 and 435 6377

PERFORMANCE PLUS



Survey: loudspeakers

ALTEC

Altec Lansing, 1515 South Manchester Avenue, Anaheim, Ca 92803, USA.
UK: Theatre Projects Services Ltd, 10 Long Acre London WC2E 9LN.
Phone: 01-240 5411.

604-8G chassis unit
Power handling: 65W rms.
Frequency response: 20 to 20kHz unspecified limits.
Sensitivity: 101 dB at 1.2m with 1W.
Polar response: 40° vertical, 90° horizontal.
Resonant frequency: 32 Hz.
Diameter: 39 cm.
Other: two way system with multicellular horn.
Price: £180.

601-8D
Power handling: 20W rms.
Frequency response: 30 to 20k Hz.
Diameter: 30.5 cm.
Other: two way system with multicellular horn.
Price: £100.

9846-8A speaker system
Power handling: 100W.
Frequency response: 30 to 15k Hz limit unspecified.
Sensitivity: 91.5 dB at 1.2m at 1W.
Polar response: 40° vertical, 90° horizontal.
Weight: 47.7 kg.
Dimensions: 79 x 67.5 x 60.3 cm.
Price: £460.

9848A speaker system
Power handling: 200W.
Frequency response: 20 to 15k Hz limit unspecified.
Sensitivity: 96 dB at 1.2m at 1W.
Polar response: 40° vertical, 90° horizontal.
Weight: 90.8 kg.
Dimensions: 124.5 x 86.4 x 59 cm.

9849A speaker system
Power handling: 60W.
Frequency response: 40 to 15k Hz limit unspecified.
Sensitivity: 93 dB at 1.2m at 1W.
Polar response: 40° vertical, 90° horizontal.
Weight: 27.3 kg.
Dimensions: 61 x 52 x 38.7 cm.
Price: £270.

9846B biamplified speaker system
Max spl: 112 dB at 1.2m 40 to 15k Hz pink noise.
Polar response: 40° vertical, 90° horizontal.
Input level: amplifier 771B compatible with standard line levels.
Noise: 80 dB below rated output, bandwidth unspecified.
Drivers: lf/horn arrangement.
Weight: 53.6 kg.
Dimensions: 67.3 x 78.7 x 59.7 cm.

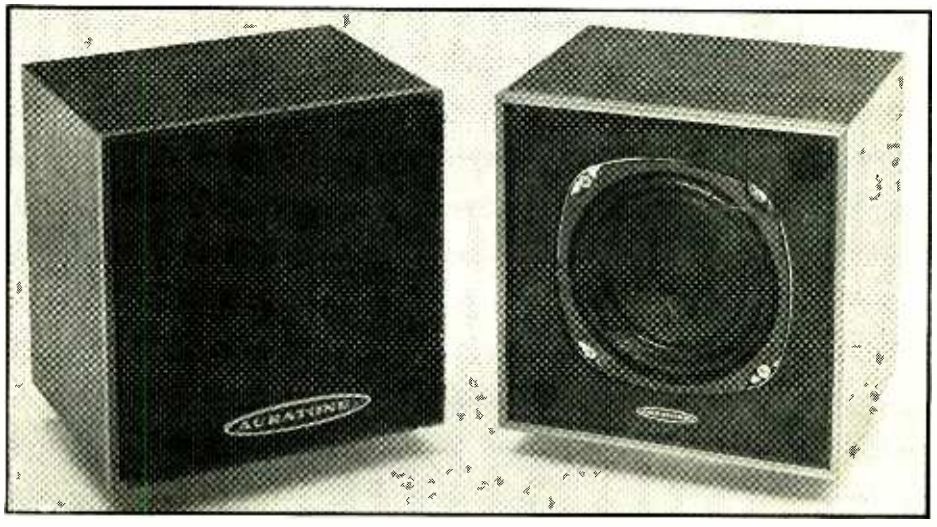
AUDIOTECHNIQUES

Audiotechniques Inc, 142 Hamilton Avenue, Stamford, Conn 06902, USA.
Phone: (203) 359 2312.
UK: Keith Monks Audio, 26/30 Reading Road, Fleet, nr Aldershot, Hampshire.
Phone: 025 14-7316.

Big Red/Super Red
'The red series of monitors provide the same great Altec *604* sound with extended bass response and ... a mid range with improved accuracy. The two mid and high frequency shelving controls of the Mastering Lab *frequency divider* allow fine tuning of control rooms without the additional phase distortion added by graphic equalisers.'
Big Reds use Altec *604E* drivers, Mastering Lab *dividers* and a ducted port reflex enclosure. Dimensions: 76.2 x 58.5 x 45.1 cm.
Super Reds for 'super bass response' and extended sound pressure level. They are fitted with an extra 38 cm lf unit, 110 Hz crossover to a *604E* and the Mastering Lab *frequency divider*. Enclosure volume is 12 ft^3. Dimensions: 76.2 x 121 x 45.1 cm. Price: *Frequency Divider* $165, *Big Red* $595, *Super Red* $745.

Left: *Altec 604-8G driver*

Below: *Auratone 5C super sound cube*



Forthcoming Surveys
Although we automatically send out a comprehensive circular requesting information, it cannot reach everyone. Therefore, manufacturers of the following products should let us know as soon as possible, and in any case not later than the date given in brackets.

February: *compressors and limiters (November 28).*

March: *sound reinforcement (January 2).*

April: *microphones (February 3).*

We need full address, phone, telex etc of manufacturer and all agents worldwide, in addition to product details.

AURATONE

Auratone, PO Box 580, Del Mar, Ca 92014, USA.

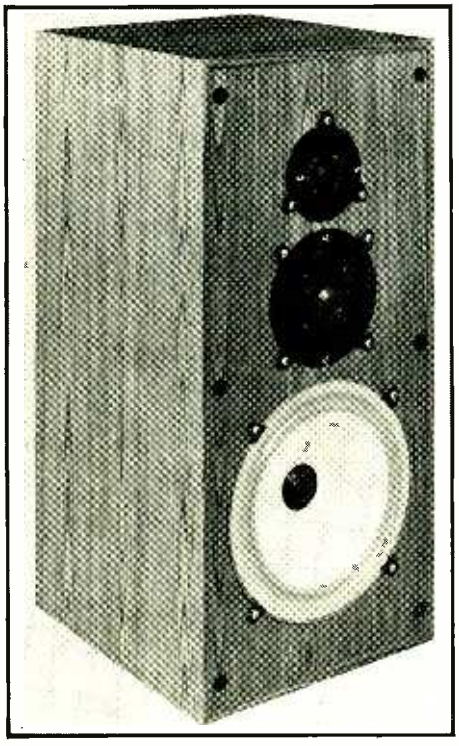
5C Super sound cube

Although not intended as the main reference source for monitoring applications, the manufacturers claim that the sound cube finds applications as squawk boxes in over 60 recording studios in the US.
Power handling: inputs of 30W peaking to 60W 'without blowing up'.
Frequency response: audible range is from 50 to 15k Hz. Within 3½ dB 200 to 12·5k Hz.
Drive unit: 1 x 11·5 cm full range.
Weight: 1·8 kg.
Dimensions: 16·5 x 16·5 x 14·6 cm.
Price: $49·95 fob San Diego, Ca 92121.

CADAC

Cadac (London) Ltd, 141 Lower Luton Road, Harpenden, Herts AL5 5EL.
Phone: 05827-64351.
US: Cara Pacific Sales Co, 41/45 Via Marina, Apartment 120, Marina del Rey, Ca 90291.
Phone: (213) 821 7898
Japan: Kawamura Electrical Laboratory, 34 Yaraicho, Shinjuku-ku, Tokyo 162.
Phone: (03) 260 0401
Cadac offer two models, large and small system, operating in the bi-amplified mode. They are supplied complete with electronic crossovers but without amplifiers.

Small System
Power handling: 45W continuous rms, 50% duty in 10s cycle 80W. Max transient power 120W.
Frequency response: 20 to 16k Hz, adjustable to ±2 dB 'under good monitoring conditions'.
Sensitivity: 116 dB spl at 2m from 45W.
Polar pattern: Horizontal 90°, vertical 40°.
Drive units: 1 x 46 cm lf, 1 x mf compression driver, 4 x 10 cm hf units.
Weight: 136 kg.
Large System
Power handling: 80W continuous rms, 50% duty in 10s cycle 100W. Max transient power: 120W.
Frequency response: 20 to 16k Hz, adjustable to ±2 dB 'under good monitoring conditions'.
Sensitivity: 120 dB at 2m from 80W.
Polar pattern: horizontal 90°, vertical 40°.
Drive units: 2 x 46 cm lf, 1 x mf compression driver, 4 x 10 cm hf units.
Weight: 250 kg.



CELESTION

Rola Celestion Ltd, Ditton Works, Foxall Road, Ipswich, Suffolk IP3 8JP.
Phone: 0473-73131.

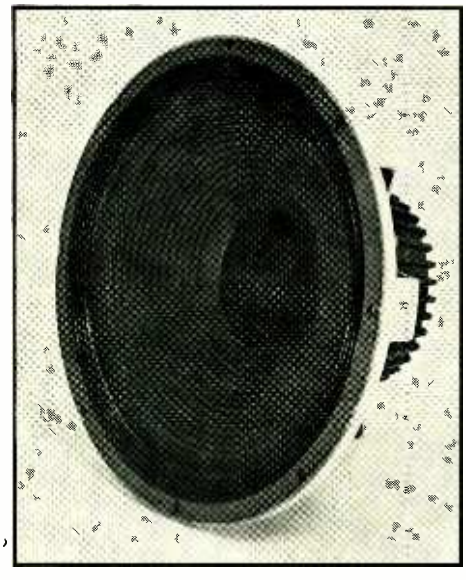
UL10
Power handling: 50W continuous rms.
Sensitivity: 96 dB at 1m from about 40W on pink noise.
Frequency response: ± 2 dB 40 to 20k Hz.
Impedance: 'to match 4 to 8 ohm amplifiers.'
Drive units: 1 x lf, 1 x mf, 1 x hf.
Weight: 23·5 kg.
Dimensions (hwd): 673 x 317 x 380 mm.

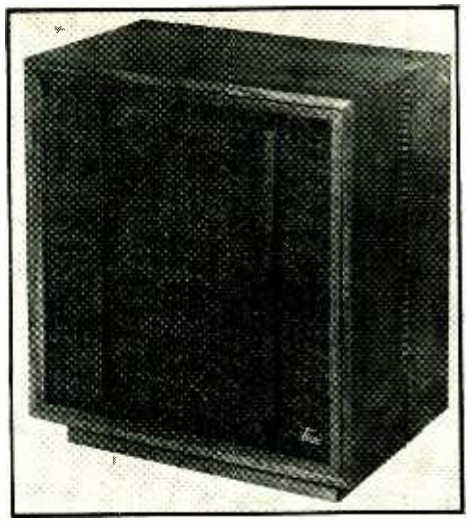
CETEC

Cetec Corporation, 13035 Saticoy Street, North Hollywood, Ca 91605, USA.
Phone: (213) 875 1900.
UK: Cetec Audio UK, 16 Uxbridge Road, Ealing, London W5.
Phone: 01-579 9145.
The company provide chassis units mainly for oem use, notably by Westlake Audio in their new range of monitors.

5831
Diameter: 38 cm.

Above: *Frazier Mk 6*
Left: *Celestion UL10*
Below: *Cetec 5831*





Nominal impedance: 8 ohms.
Power handling: 200W rms.
Recommended crossover frequency: 800 Hz.
Coil diameter: 10·5 cm.
Flux density: 12 000 gauss.
Depth: 18·5 cm.
Weight: 11·25 kg.
Recommended enclosure volume: 156 to 184 litres.
Recommended system: bass reflex.

CROWN

Crown International, 1718 West Mishawaka Road, Elkhart, Indiana 46514.
Phone: (219) 294 5571. Telex: 810-294-2160.
UK: Macinnes Laboratories Ltd, Macinnes House, Carlton Park Industrial Estate, Saxmundham, Suffolk IP17 2NL.
Phone: 0728-2262/2615.

ES-212
Max amplifier power: 75W.
Cone lf unit crosses over to electrostatic mf/hf tweeter at 350Hz. Tweeter self powered from 115V. Manufacturers claim frequency response from 22 to 30k Hz 'usable' in 114m³ room.

DAYTON WRIGHT ASSOCIATES

Dayton Wright Associates Ltd, PO Box 419, Thornhill, Ontario, Canada.
Phone: (416) 884 3422.
UK: Exposure Hi-Fi, Richardson Road, Hove, Sussex BN3 5RB.
Phone: 0273-777912.

XG8 Mk3
The basic building block is an electrostatic speaker, about 1m square, which stacks with others to form an array.
Power handling: to 500W.
Frequency response: 32 to 24k Hz ± 4 dB.
Nominal impedance: 4 ohms via *ST300A* control unit.
Max spl: 'as high as 115 dB' 1m on axis.
Sensitivity: 103 dB from 50W 1m on axis.
Distortion: total harmonic distortion less than 0·21% at 96 dB 1m on axis.
Weight: 25·5 kg/speaker. Power unit 50·9 kg.

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SURVEY: LOUDSPEAKERS

FRAZIER

Frazier Incorporated, PO Box 34216, 1930 Valley View Lane, Dallas, Texas 75234, USA.

F10W-37U-A capsule monitor
Power handling: 30W continuous peaking to 40W.
Frequency response: 30 to 15k Hz ± 5 dB.
Nominal impedance: 8 ohms.
Sensitivity: 94 dB at 1·2m from 1W.
Drive units: 1 x 25 cm lf, 1 x compression mf horn, 1 x piezo hf horn.
Dimensions: 48·25 x 40·5 x 40·5 cm.
Weight: 17·7 kg.
F12-8-WHA mark 6-A
Power handling: 30W continuous rms.
Nominal impedance: 8 ohms.
Sensitivity: 97 dB at 1m from 1W.
Drive units: 1 x 30·5 cm lf, 1x 20 cm pressure loaded mf, 1 x hf pressure horn, 1 x piezo hf super horn.
Weight: 46·76 kg.
Dimensions: 74·3 x 65·4 x 40·6 cm.
Price: $450.

GOODMANS

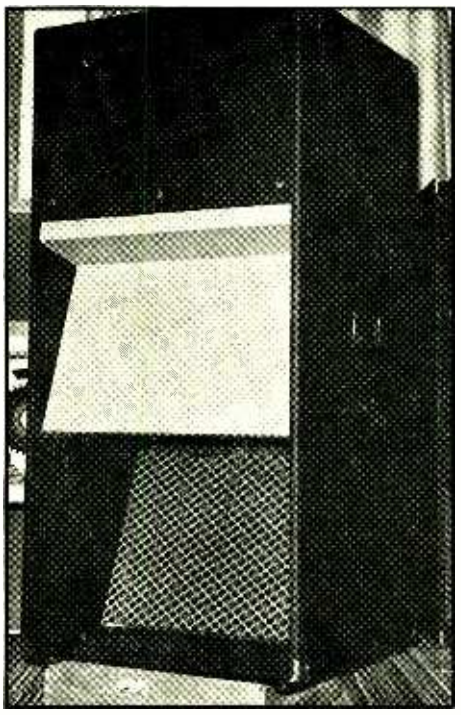
Goodmans Loudspeakers Ltd, Downley Road, Havant, Hants PO9 2NL.
Phone: 070-12 6344.

Achromat 400
Power handling: up to 75W 'music'.
Frequency response: 40 to 22k Hz ±5 dB.
Nominal impedance: 8 ohms.
Sensitivity: 12W for 96 dB at 1m.
Drive units: 1 x lf, 1 x mf, 1 x hf.
Enclosure volume: 39·5 litres.
Weight: 16·5 kg.

HARWELL

Harwell Instruments Ltd, Spices Yard, South End, Croydon CR2 1GG.

Bass horn studio monitor
Power handling: 200W rms.
Frequency response: ±3 dB 40 to 15k Hz.
Sensitivity: 'will blow out a candle at 1m.'
Nominal impedance: 8 ohms.
Drive units: 1 x 30·5 cm lf loaded into folded bass horn, 8 x 12·7 cm mf units loaded into 32 litres, 4 x hf horns.
Dimensions: 60 x 60 x 130 cm.
Price: £425.



KEF

KEF Electronics Ltd, Tovil, Maidstone, Kent ME15 6QP.
Phone: 0622-57258. Telex: 96140.

5/1AC
The basic unit has been built to BBC specification, with the addition of thermal overload and protection devices. The speaker also has its own internal power amplifier driven from a 0 dBm standard line source.
Frequency response: 30 to 15k Hz.
Max spl: 112 dB (ref ·00002N/m²) 2m on axis.
Harmonic distortion: less than 1% 50 to 15k Hz.
Input impedance: 10k ohms.
Signal to noise: 90 dB (wideband).
Weight: 45 kg.
Dimensions: 89 x 44 x 51 cm.
Price: £345.
Model 104
Power handling: 50W programme.
Frequency response: 50 to 20k Hz ± 2 dB.
Nominal impedance: 8 ohms.
Sensitivity: 12·5W for 96 dB at 1m.
Harmonic distortion: less than 1% 100 to 30k Hz ref 96 dB spl.
Internal volume: 35·5 litres.
Weight: 21 kg.
Dimensions: 63 x 33 x 23 cm.

K + H

Klein & Hummel, 7301 Kemnat, West Germany.
Phone: Stuttgart 25 32 46.
UK: F W O Bauch Ltd, 49 Theobald Street, Borehamwood, Herts WD6 4RZ.

OY
Bi-amplified three way speaker. Active crossovers and 2 x 30W amplifiers built in.
Frequency response: 40 to 16k Hz ± 2 dB.
Max spl: 107 dB at 1m.
Polar pattern: 30 .
Self generated noise: 10 dB spl.
Total harmonic distortion: less than 1% mid range.
Weight: 20 kg.
Dimensions: 483 x 305 x 227 mm.
Price: £337.

Below left: *Goodman's Achromat 400*

Left: *Harwell bass horn studio monitor*

Below right: *KEF 5/1AC with stand*

OZ
General specification as OY, but with max spl of 115 dB. Both models are fitted with Tuchel connectors and require standard line input levels and 220V mains.
Price: £795.

KLH

KLH Research and Development Co, 30 Corrse Street, Cambridge, Mass 02139, USA.
Phone: (617) 491 5060. Telex: 92-1427.
UK: Webland International Ltd, 117/121 Wandsworth Bridge Road, London SW6.

KLH offer a complete range of speakers from squawk boxes to first line monitors. The top of the range includes:

CB8
Power handling: 70W rms continuous.
Frequency response: 47 to 18k Hz.
Nominal impedance: 8 ohms.
Dimensions: 49.5 x 28 x 18.4 cm.
Price: £159.60, $170 pair.

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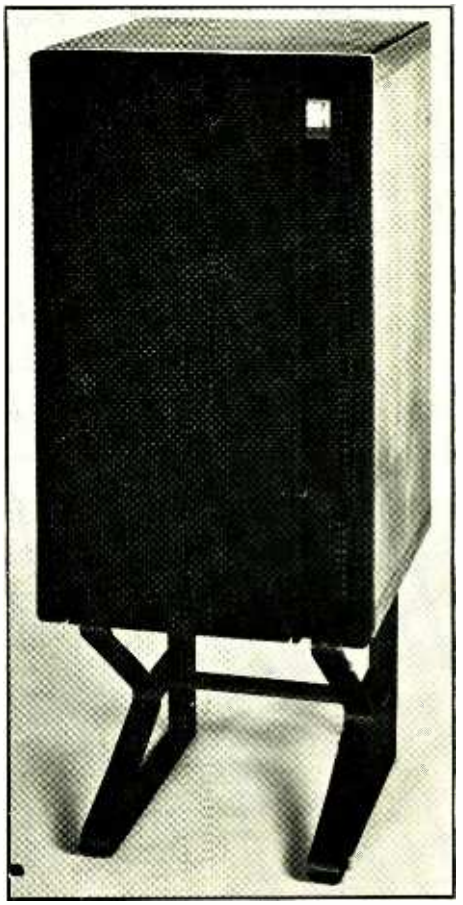


Five monitors. One sound. Five JBL studio monitors.
You could record with any one, play back on any other, and take your pick among the rest for mixing or mastering.
The only differences are acoustic output, size and cost.
No matter what size your studio is, you can cross reference with any other studio using JBL's.
But reading isn't knowing for sure. Come listen to one. Or two. Or five.

C.E.Hammond & Co Ltd Lamb House Church Street London W4 2PB Tel 01-995 4551

JBL

SURVEY: LOUDSPEAKERS

Power handling: for use with amplifiers up to 125W rms.
Nominal impedance: 8 ohms.
Drive units: 1 x 30.5 cm lf, 1 x 7.6 cm mf, 1 x 4.4 cm hf.
Weight: 20 kg.
Dimensions: 66 x 34.9 x 29.2 cm.
Price: £280, $470 pair.

CL4
Power handling: 100W rms at 30 Hz.
Frequency response: 30 to 22k Hz.
Nominal impedance: 8 ohm.
Drive units: 1 x 25.4 cm lf, 11.4 cm, 1 x 2.5 cm hf.
Weight: 26.8 kg.
Dimensions: 26.8 x 14.25 x 12.9 cm.
Price: £288, $378 pair.

KLH9
Electrostatic loudspeaker: maximum input voltage of 56V peak. Manufacturers state a requirement of 40W input minimum.
Nominal impedance: 16 ohms.
Weight: 36.3 kg.
Dimensions: 177.9 x 59.7 x 2.88 cm.
Price £1800, $ not available.

LESLIE
Electro Music/CBS Musical Instruments, Division of CBS Inc, 56 West Del Mar Boulevard, Pasadena, Ca 91105, USA.
Phone: (213) 681 6654.

DVX 580
Power handling: 50W continuous.
Frequency response: 20 to 20k Hz, no tolerance given.
Sensitivity: 90 dB from 1W at 1m.
Impedance: 4 ohms.
Drive units: 1 x lf, 1 x lmf, 1 x hmf, 2 x hf.
Polar pattern: adjustable.
Protection: slow blow fuse.
Weight: 49 kg.
Dimensions: 737 x 520 x 838 mm.

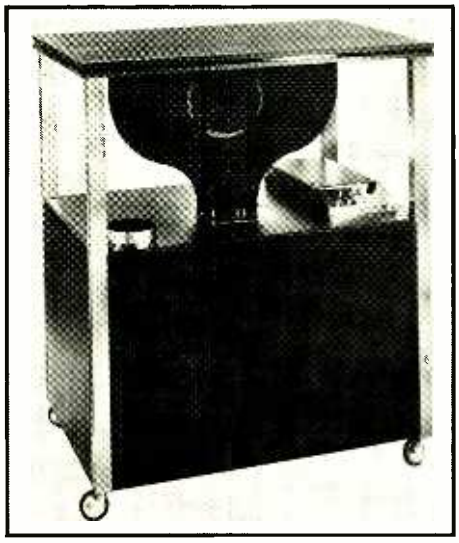
LOCKWOOD
Lowlands Road, Harrow, Middlesex HA1 3AW.
Phone: 01-422 3704/0768.
France: Quadra Universal, S.A., 56 Rue d'Auteuil, 75016, Paris.
Belgium: S.A. Delta Equipment N.V., 112 Rue de Calevoet, 1180, Bruxelles.
Spain: Mabel Sdad Ltda, Ripolles, 84, Barcelona 13.
Greece: Audiolab Hellas, 8 Enianos Street, Athens 104.
Portugal: Tecla Limitada, Rua Eca de Queiros 20.3.D. Lisbon.
USA: Roger Mayer Electronics Inc, 225 East 57th Street, New York, 10022.
Canada: Rupert Neve (Canada) Ltd, 2717 Rena Road, Malton, Toronto.
South Africa: Michael Bradbury, 2 York Road, Parktown, Johannesburg.
Japan: Shriro Tradlng Co Ltd, CPO, Box 572, Tokyo 100.91.
Norway: J. M. Feiring, A/S, Nils Hansens Vei.7, Oslo 6.

Major
Power handling: 85W 'integrated material'.
Frequency response: 23 to 20k Hz, limits unspecified.
Nominal impedance: 8 ohms.
Drive units: 38 cm Tannoy dual concentric *HPD*.
Weight: 58 kg without integral power amplifier (optional).
Dimensions: 114 x 71 x 44.5 cm.
Other: can be supplied built in power amplifiers such as the Quad *50E* or the H/H *50D*.
Price: £315.

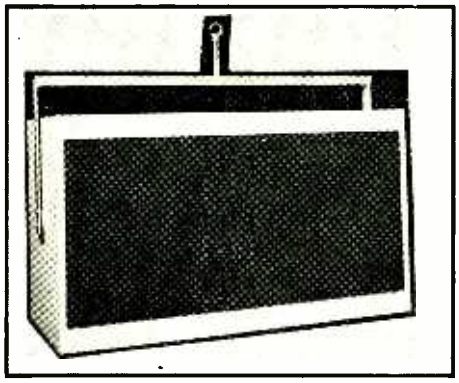
Universal Major
Performance spec as above, but cabinet supplied with fixtures and fittings for wall mounting.
Dimensions: 61 x 104 x 44.5 cm.
Price: basic model £300 with mounting bracket.

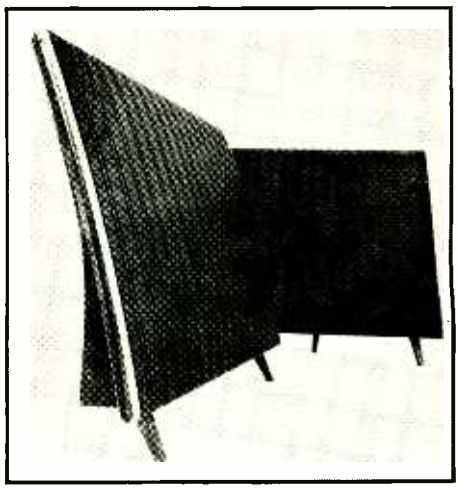
Miniature Monitor
Power handling: 50W 'integrated programme material'.
Frequency response: 25 Hz to 20k Hz, limits unspecified.
Nominal impedance: 8 ohms.
Drive units: Tannoy dual concentric 25.4 cm 295.
Weight: basic model 18.5 kg.
Dimensions: 56.5 x 38.5 x 32 cm.
Price: £120.

QUAD
The Acoustical Manufacturing Co Ltd, Huntingdon PE18 7DB.
Phone: 0480-52561/2.
Distribution by appointed dealer network in most countries.



Above: *Leslie DVX 580*
Below: *Lockwood universal major*
Above right: *Quad ELS electrostatic*





ELS electrostatic loudspeaker
Maximum peak input voltage: 33V.
Max spl: 93 dB 50 to 10k Hz. 100 dB 70 to 7k Hz.
Frequency response: within 5 dB 50 to 18k Hz (from graph).
Polar response: 70° horizontal, 15° vertical.
Impedance: 30 to 15 ohms depending on frequency.
Power unit: integral. 120/240V.
Weight: 18 kg.
Dimensions: 79 x 27 x 88 cm.

RANK
Rank Radio International, Bradford Road, Idle, Bradford BD10 8SF.
Phone: 0274-612552.
Belgium: RRI (BELGIUM) S.a.N.v. Avenue Vandenriessche 18,1150 Bruxelles.
W. Germany: Rank Audio Visual (Rank Arena A/S) Haldensteig 3, 2 Hamburg 61.
Netherlands: RRI NEDERLAND, Weverij 10, Postbus 555 Amstelveen.
Sweden: RRI RANK ARENA AB, Paternos ervagen 24, 121, 22 Johaneshov, 1, Stockholm.
Denmark: RRI Rank Arena A/S, PO Box 231, 8700 Horsens.
France: RRI SA, (Rank Radio International), 24 Rue Pierre Semard, 75009 Paris.

Airedale SP
Power handling: 100W DIN.
Frequency response: 27 to 20k Hz ±3 dB.
Sensitivity: 9¢ dB from 9W at 1m.
Impedance: 6 ohms nominal.
Drive units: 1 x lf, 1 x lmf, 1 x hmf, 1 x hf.
Internal volume: 100 litres.
System: bass reflex.
Dimensions: 880 x 468 x 415 mm.
Price: £274·10 pair.

Leak 2075
Power handling: 100W DIN.
Frequency response: 35 to 20k Hz ±3 dB.
Impedance: 6 ohms nominal.
Internal volume: 125 litres.
Weight: 51 kg.
Dimensions: 1192 x 500 x 375 mm.

ROGERS
Rogers Developments (Electronics) Ltd, 4/14 Barmeston Road, London SE6 3BN.
Phone: 01-697 8511.

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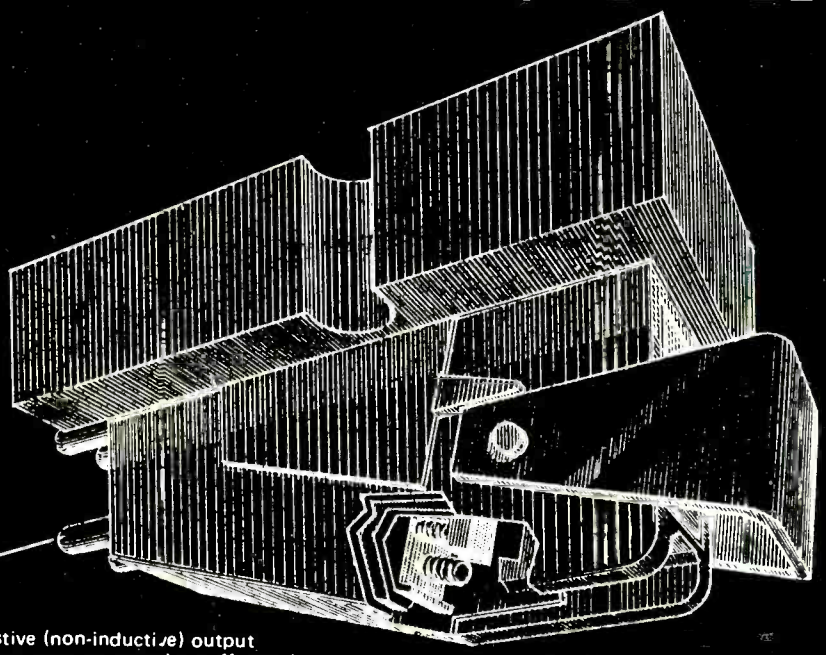
The new Micro-Acoustics QDC-1 Stereo Phono Cartridge:

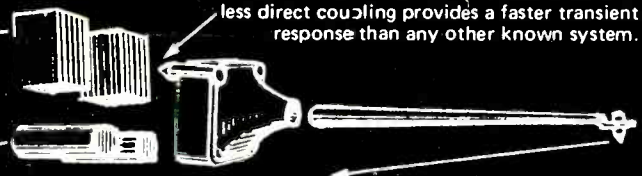


The QDC-1 has a low resistive (non-inductive) output impedance so that high frequency response is unaffected by cable capacitance. In addition the pre-amp input impedance is shunted, reducing thermal noise by 3-6 dB as compared to inductive type cartridges.

The QDC-1 electret transducer generates a perfectly linear signal from 5Hz to 50 kHz, without the phase shift normally associated with inductive transducers. Its reproduction of complex wave forms is equal to the best direct coupled amplifiers.

The QDC-1 stylus is balanced by two elastic bearings positioned to provide precise 45-45° signal resolution. These bearings are the exact mechanical analogue of a push-pull output circuit. The result is significantly lower phase and second harmonic distortion as compared to the conventional, loosely suspended, single bearing designs.

The QDC-1 stylus bar transmits the record groove modulation directly to the transducers by means of two coupler pins. This unique method of loss-less direct coupling provides a faster transient response than any other known system.



The CDC-1 Series 300 playback styli (QDC-1e, 1q) are shaped and polished with the same ultra precision as our world famous Micro-Point recording styli.

The record industry has for a long time known that a well recorded stereo disc is potentially every bit as good as its master tape. It has been our experience that there is no problem in getting the music onto the record; the problem has been in retrieving it. The cartridge is the culprit. Micro Acoustics, as manufacturers of ultra-precision cutting heads used to master the world's finest recordings, have had to contend with absolute standards of measurement. In the end, you should not have to choose between the "sound" of one cartridge or another. The fact is the cartridge should have no "sound" of its own. The objectivity of the QDC-1 makes it the one cartridge to judge other cartridges by.

Specifications	QDC-1e	QDC-1q
Stylus Configuration (User Replaceable)	.0002 x .0007 elliptical solid nude diamond	Quadra-Point (TM)—CD-4 solid nude diamond
Frequency Response	5 Hz to 20 kHz ± 2 dB	5 Hz to 50 kHz ± 3 dB
Tracking Force Range	0.75 to 1.5 grams	0.9 to 2 grams
Channel Separation	Nominally 30 dB at 1 kHz Nominally 20 dB at 10 kHz	Nominally 30 dB at 1 kHz Nominally 15 dB at 20 kHz
Output Voltage	3.5 mv each channel at 5 cm/sec peak recorded velocity	3 mv each channel at 5 cm/sec peak recorded velocity
Load recommendations	47 k ohms	47 k ohms
CD-4 Reproduction	Only replace stylus	Standard
Price	£39.60 (Ex VAT)	£47.60 (Ex VAT)

Webland Electronics

WEBLAND ELECTRONICS LTD. MIRABEL HOUSE 117-121 WANDSWORTH BRIDGE ROAD S.W.6. TEL: 01-736 0987 TELEX: 25570

SURVEY: LOUDSPEAKERS

LS3/5A
Manufactured to BBC specification.
Power handling: 25W speech and music.
Frequency response: 80 to 20k Hz ±3 dB.
Nominal impedance: 15 ohms.
Weight: 5·3 kg.
Dimensions: 19 x 16·2 x 30·5 cm.
LS3/6
No details received.

REVOX

Manufacturer: Willi Studer, CH-8105, Regensdorf-Zurich, Switzerland.
US Agent: Revox Corporation, 155 Michael Drive, Syosset, NY 11791.
UK: Industrial Tape Applications, 5 Pratt Street, Camden Town, London N1. Phone 01-485 6162.

AX 4-3
Power handling: 60W.
Frequency response: 30 to 20k Hz.
Sensitivity: 91 dB spl from 1·8W at 1m.
Nominal impedance: 4 ohm.
Harmonic distortion: less than 1% over 80 to 20k Hz bandwidth.
Drive units: 1 x 245 mm lf, 1 x dome 38 mm mf, 1 x dome hf.
Internal volume: 44·1 litres.
Weight: 14·1 kg.
Dimensions: 315 x 560 x 250 mm.
Price: £119.

SENNHEISER

Sennheiser Electronic, 3002 Bissendorf/Hann., West Germany.
Phone: (05130) 8011. Telex: 09 24623.
UK: Hayden Laboratories Ltd, Hayden House, 17 Chesham Road, Amersham, Bucks HP6 5AG.
Phone: 024 03-5511

The company manufactures two self powered amplifier speaker combinations operating from standard 0 dBm line.
VKL 304
Weight: 21 kg.
Dimensions: 650 x 400 x 250 mm.
Price: £270.
VKL 305-4
Max spl: 106 dB.
Weight: 22kg.
Dimensions: 240 x 400 x 650 mm.
Price: £493.

SMC

SMC loudspeakers, 76 Bedford Road, Kempston, Beds MK42 8BB.
Phone: 0234-65822.

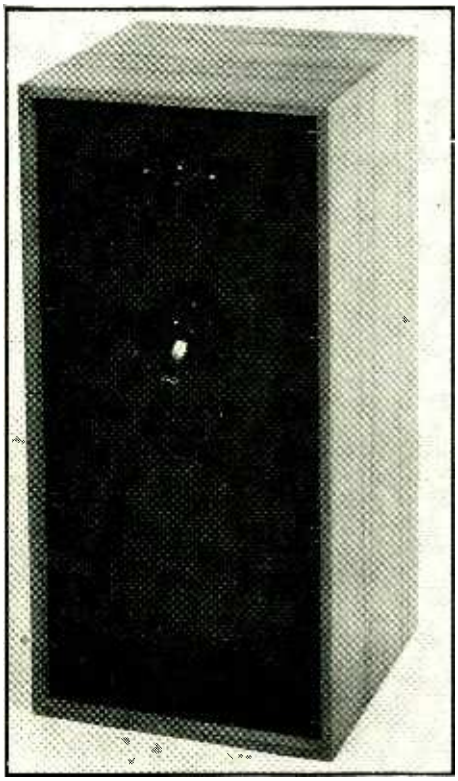
AL50 studio monitor
Power handling: 100W programme.
Frequency response: 55 to 25k Hz ±3 dB.
Sensitivity: maximum spl 104 dB at one metre, 15W gives 96 dB spl at one metre.
Impedance: 8 ohms nominal.
Drive units: 1 x lf 21/30 cm piston, 1 x 12cm pressure loaded mf, 1 x 1·9 cm dome hf.
Operating principle: transmission line.
Weight: 36 kg.
Dimensions: 38 x 74 x 43 cm.
Price: £475 pair.

TANGENT

Tangent Acoustics Ltd, 3 Kesters Close, Hardwick, Cambs CB3 7QY.
Phone: Madingley 658.

TM1
Power handling: 50W rms.
Frequency response: 40 to 30k Hz ±3 dB.
Nominal impedance: 8 ohms.
Drive units: 1 x 22 cm lf/mf, 1 x hf.
Internal volume: 42·5 litres.
Dimensions: 30·5 x 31·5 x 63 cm.
TM2
Power handling: 70W rms.
Frequency response: 38 to 30k Hz ± 3 dB.
Nominal impedance: 8 ohms.
Drive units: 1 x 23/33 cm lf piston, 1 x 22 cm mf, 1 x hf.
Internal volume: 71 litres.
Dimensions: 35·5 x 36·5 x 73·5 cm.

Tangent TM2 with grille material removed



TANNOY

Tannoy Products Ltd, West Norwood, London SE27 9AB.
Phone: 01-670 1131.

Tannoy manufacture a range of chassis units, each comprising a bass driver and high frequency horn in a dual gap arrangement. They are supplied with an adjustable crossover network. The company also market a range of enclosures fitted with the dual concentric drive units.

Chassis units:	385	315	295
Diameter:	38.1 cm	30.5 cm	25.4 cm
Power handling:	85W	60W	50W
Nominal impedance:	8 ohms	8 ohms	8 ohms
Spl—1m at 1W:	92 dB	90.5 dB	90.5 dB
Bass resonance:	20 Hz	20 Hz	22 Hz
Total weight:	14 kg	8.62 kg	8.17 kg
Price:	£89	£70	£68.50

Enclosures complete with drive units:
Chevening
Drive unit: 295.
System: bass reflex.
Dimensions: 38 x 58.5 x 26 cm.
Price: £92
Chatsworth
Drive unit: 315.
System: infinite baffle.
Dimensions: 84 x 39.5 x 26 cm.
Price: £100.50.
Mansfield
Drive unit: 315 or 385.
System: infinite baffle.
Dimensions: 84 x 53.5 x 32 cm.
Price: with 315, £107.50, with 385, £127.
Amesbury
Drive unit: 385.
System: bass reflex.
Dimensions: 107.5 x 60 x 38 cm.
Price: £151.

STOP PRESS—entries received after copy deadline.

ATC

Acoustic Transducer Company Ltd, Pier House Laundry, Strand on the Green, Chiswick, London W4.
Phone: 01-995 3654
The company manufacture a range of chassis units of 30 cm dia utilising edge wound 7.5 cm voice coils. Available in various cone weights according to application, the power rating is 75W rms.

B & W

B & W Loudspeakers Ltd, Meadow Road, Worthing, West Sussex BN11 2RX.
DM4
A three unit 20 litre reflex loudspeaker. For specification and review, see February 75, p56.
DM70
A two way 'large' speaker system using a moving coil bass unit and an electrostatic mid/treble constant charge driver unit.
DM6
This is the most recent model featuring 'linear phase' arrangement of the classic three way driver system. Power rating up to '350W under normal domestic conditions'.

JBL

James B Lansing Sound Inc, 3249 Casitas Avenue, Los Angeles, Ca 90039, USA.
Phone: (213) 665 4101.
UK: C E Hammond Ltd, Lamb House, Church Street, Chiswick, London W4 2PB.
Phone: 01-995 4551.

4311
This is a three-way system comprising a passive crossover and three-way drive system. Power handling: 75W 'programme'. Sensitivity: 42 dB at 9.1m with 1 mW from 500 to 2500 Hz, tone controls flat. (EIA sensitivity rating.) Frequency response: 45 to 15k Hz ±3 dB.
4315
Four-way system handling 60W rms steady state into 8 ohms. EIA sensitivity: 40 dB. Max output: about 101 dB spl at 120W. Frequency response: 35 to 20k Hz ±3 dB.
4330
Two-way system handling up to 75W steady state into 8 ohms. EIA sensitivity: 44 dB. Max output about 106 dB at 3m. Frequency response: 35 to 15k Hz ±3 dB. 4332 as above except fitted with super tweeter.
4340
Four-way system handling 75W steady state at 8 ohms. EIA sensitivity rating: 44 dB. Max output 107 dB spl at rated power at 3m. Frequency response: 35 to 20k Hz ±3 dB.
4350
Four-way system handling 200W steady state into 4 ohms. EIA sensitivity rating: 46.5 dB. Frequency response: 30 to 20k Hz ±3 dB.
Models *4330* upwards can be supplied without crossovers for bi-amplification.

BOOK REVIEWS

CLIVE—INSIDE THE RECORD BUSINESS

Clive Davis, with James Willwerth, 300pp, plus 12pp illus. William Morrow and Company, Inc, New York, 1975

Available in UK from Billboard Publications, 7 Carnaby Street, London W1

THIS is a marvellous book—the most important yet to appear on the record industry, required reading for both those people employed within the industry, and even more so for those whose activities require them to comment upon it from the outside.

Davis, now still only 43, was from 1965 until 1973 head of CBS Records (USA—Columbia) and steered that organisation as industry leaders through the rock explosion of the '60s, turning the profits from $5 million per year to $50 million in the process, and the Company from essentially a middle-of-the-road operation to that showing undisputed domination of contemporary music.

One can always justify one's own behaviour, and Davis' legal background makes him a formidable advocate for his own case but, although his dismissal from CBS was certainly unsavoury, his track record of unprecedented success needs no special pleading. However, there emerges occasionally more than the odd hint of self-righteousness, and some may feel that Davis claims almost too much as his own initiative, but it is a vastly impressive story, nonetheless.

Davis' blunt, straightforward taking of various lids off aspects of rock stars, characters will come as a surprise to those who blindly follow PR-pap, and his revelations of negotiations with Dylan, for example, throw considerable light upon that ultimately baffling genius. Those to whom Dylan is the quintessential anti-establishment figure (established, of course, long before the Beatles) may be surprised to find him committed to sell himself very dearly to the highest bidder—only to see a profound paradox in the process: Dylan, the free-wheeling hiker strolling down the freeway of '62 to visit the ailing Woody Guthrie in hospital, related perfectly to the immediate post-beat generation—a musical Jack Kerouac, whose *Lonesome Traveller* is a sonic equivalent of *On the Road*. Today, however, when Dylan travels in his own 4-million dollar jet, he's a lonesome traveller for very different reasons—precious few of the supertramp hitchers of the early '60s can relate to the millionaire with the Hefner trappings. So who has the identity (ie musical) crisis?

Through Davis' immediate predecessor, Goddard Lieberson, who had been responsible for some truly creative and imaginative company policy during the previous 15-20 years, the company image of CBS in the mid-60s was largely as an m-o-r operation. It says much for the creative genius of Davis that he was not only able to maintain artists such as Andy Williams, Ray Conniff, Tony Bennett, Barbra Streisand, Johnny Mathis (whom he re-signed to the label) at the same time as leading the Company into the rock explosion, but also to advise them brilliantly on how to appeal to a much wider audience while at the same time maintaining their individual artistic standards. As Davis frankly comments, he did not succeed with Tony Bennett, but his formula, certainly original but subtly simple, if applied to half-a-dozen English artists as of now, would remake their fortunes many times over within 18 months. It is startling that even today powerful record men do not follow Davis' example with this type of artist.

His most important early success was undoubtedly the major signings following the 1967 Monterey Pop Festival, especially those of Janis Joplin, Blood, Sweat and Tears, and Leonard Cohen. Davis undoubtedly had a special rapport with Joplin: through his rather clinical literary style, there emerges a genuine feeling, warmth and curious understanding—considering their totally different backgrounds—for this tragic and moving figure. Those who accuse Davis of lacking musical feeling should read his chapters on Joplin and his influence on her all-too-brief development. Furthermore, this book is full of the most profound truths about the record business, as his piece on BS and T and David Clayton-Thomas reveals. In a sense, just as Joplin broke away from Big Brother and the Holding Company and made it, so Clayton-Thomas doubtless felt he could do a similar thing with BS and T. This is where musical judgements came in—for Joplin was head and shoulders above BB when she left (people buying records and going to concerts because of *her*). Clayton-Thomas, for all his qualities as a singer was not quite the same—BS and T could survive his departure, but as so often, he couldn't make it on his own, needing the special qualities of the rest of the band as the catalyst for his own musicianship. With hindsight Clayton-Thomas could hardly have stayed with a band that has had so many public and publicised rows, but Davis' analysis of the situation is unerringly accurate.

There is no doubt that Davis had the special qualities that make a great record-man: not just the 'feel', the instinct, the ability to recognise raw talent (as the abovementioned signings prove conclusively) but also the mixture of ability to steer and mould artist's careers, to be sympathetic to the whole spectrum of music, and all this accomplished with a strong sense of business acumen. Nowhere is this more clearly shown than in his revealing insights into the internal running of CBS: although one should always remember Henry Ford's dictum: 'Don't tell me how many hours you work, just tell me what you do', there is a tremendous feel of the excitement of the long-filled-day-to-day running of CBS. His handling of Chicago, for example, is a superb case in point; a major band by any standards, at one time so much nto a manic-depressive ego-trip of packaging trash that the music threatened to be overwhelmed by an ecologically-unacceptable pile of waste-paper. Davis was right to resist Chicago's demands, for business, artistic, and image reasons. This comment reveals much of his qualities, when he speaks of those rock musicians who seem to equate social freedom with the unquestioning meeting of whatever demands they might make.

Being so close to the artists meant he was singularly well-placed to direct immediately what image the Company should be projecting through its advertising, and Davis probably spent more time at this than most record-company presidents. Part of this activity is also bound up with the total marketing concepts surrounding any launch—and here, I think, Davis' non-commercial background was a definite hindrance. As an example, the 'Rock Machine' concept comes in for criticism from him—unjustly I feel. In the UK the *Rock Machine Turns You On* and *Rock Machine I Love You* albums achieved much and were significant in putting across the new image of CBS. Although CBS learned another truth about record marketing from this operation—that buyers of cheap records rarely gravitate towards full price albums—there can be no doubt that the enormously wide exposure the vast sales of both these albums enjoyed meant that CBS' unparalleled array of contemporary artists were showcased in the best possible way. Ultimately, of course, each act has to make it on its own and not through some sort of external grafting but the imaginative concept was right to project, at the very least in terms of image, the new-found creativity of CBS.

There is no doubt, however, that Davis was again right to insist on the single-plus-album simultaneous release, especially for new acts. Inflation means no company can really survive on hit singles alone, especially in the States where a vast percentage of record buyers are fm-only listeners, where singles mean nothing. To hit the street with both the strongest single from the album and the album at the same time has been demonstrated so many times with success that the final bastion of singles-only acts—that of black soul—has even succumbed: and rightly, too. Another example of a definite rule of modern record company practice.

In spite of CBS's runaway success in the late '60s and early '70s, there was one area of music where CBS was almost totally absent: black soul. The acquisition of the Philadelphia label of Gamble/Huff was a move which, in simple terms, could not have been better. It was as important for CBS as Motown was to EMI and added the final large piece to Davis' jig-saw. As a postscript, although it took a little while for artists like Billy Paul, the O'Jays, Three Degrees, Harold Melvin and so on, to break out of the States, I feel Davis could have been more appreciative of the efforts of his gigantic International company, which is hardly mentioned in the book. But there is no doubt that it was Davis who did the deal in the first place.

Davis also gives a fascinating insight into Vladimir Horowitz, when he took the great concert pianist and his wife to a black soul disco in New York. Davis reports that Horowitz

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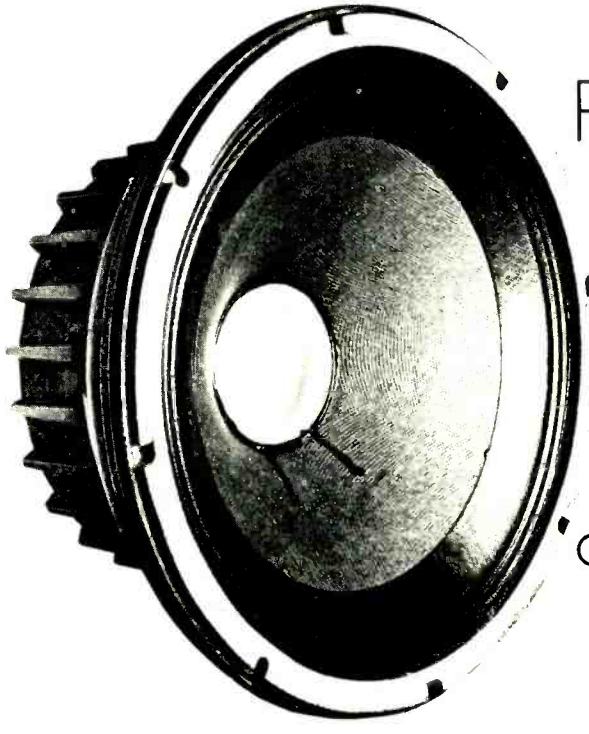
ATC

Acoustic Transducer Co. Ltd
(Acoustic engineers)



For the ultimate high quality, high power professional loud-speaker drive units

	12" STD	BASS	STUDIO BASS
Resonant Frequency	55Hz	35Hz	25Hz
Usable Frequency Response	up to 6Khz	up to 5Khz	up to 3Khz

Power Handling 75 watts nominal $\left[\frac{(\text{Input Voltage})^2}{\text{Nominal Impedance}} \text{ WATTS}\right]$

Pier House Laundry, Strand on the Green, Chiswick, London W4, Great Britain, Tel: 01-995 3654.

BOOK REVIEWS

was entranced, for apparently he listens to a great deal of soul and r-and-b. Although Davis was obviously weak in the classical area, not being quite so able to trust his instincts as in the pop field, he hits a few classical nails firmly on the head. His enthusiasm for Horowitz is obvious: the acquisition of the artist was a major event for CBS; he added lustre to the artists' roster; he was regarded (and still is, for that matter) by many as the greatest pianist of the 20th century; he won seven consecutive 'Grammy' awards. If Davis had still been at CBS, he would not have let Horowitz go to their traditional arch-rival RCA, as happened recently. The classical area, as I say, was Davis' weakest spot, and it shows. CBS did *not*, contrary to Davis' assertion, extensively record the major works of Hindemith in the '60s. It is a pity that many of the works they did record of Hindemith's were not issued outside of the USA, especially the *American Requiem* (with Hindemith conducting), the Symphony in E flat, and the Concert-Music for Strings and Brass, but it hardly adds up to extensive coverage, even so.

Nor did CBS allow Stravinsky to record practically everything he ever wrote: it is popularly supposed that they did, but a glance at Eric Walter White's most recent Stravinsky book shows that of Stravinsky's 100-plus compositions, he recorded only about half of them. This is not to criticise CBS work in this field, which will provide them with priceless valuable reissue material in the future, but to set the record straight.

Davis' background story to the decision to allow the Philadelphia orchestra to go to RCA is, like so much of this book, fascinating. Knowing the background, no-one could criticise him for allowing this: the money involved was just too much but, in relating the story, he makes the point (surely unintentionally) that had bugged CBS' classical operations during the '60s: Ormandy wanted to get into more important repertoire, away from the showpiece albums and kitsch which CBS was in danger of forcing him into. Yet this was resisted. Surely if Ormandy had been allowed that, then it is possible that the state of CBS's classical operations at that time might not have been so bad—after all, as Davis says (not realising the folly of it) CBS had embarked upon an extensive series of recordings of avant-garde music: a magnificent achievement, in image terms, and a strong public service (which was not taken up by CBS' companies around the world) but in record sales terms, absolutely meaningless.

Davis appeared to fail to grasp this essential difference between classical and pop. While he was enjoying unsurpassed success with the best of contemporary rock, he thought a similar approach in classical music would be successful. Well, at least he knows different now. A final word on classical: Davis was right to urge more opera on his Company and his instincts—to try and test-market Bernstein in an established war-horse, such as *Bohème* or *Butterfly*—were right. Yet he also grasped the essential feature of opera, which is that no matter how famous the conductor, people buy opera recordings because of the singers; and in that area CBS was not even past square one. It is surprising, but apparently true, that the idea for Bernstein's *Mass* came from a conversation between Davis and the maestro, so Davis' influence in the classical area was not insignificant.

A criticism of the book with which I think even Davis would agree is the book's lack of recognition towards the international companies. The phenomenal growth of CBS worldwide in the last decade has been achieved through the skill, energy and dedication of a number of truly remarkable men, especially Peter de Rougemont, head of European Operations; Dick Asher, now president of the International Company; Walter Yetnikoff, now holding Davis' job as head of CBS Records worldwide; and Maurice Oberstain, now Managing Director of CBS UK. The corporate future of CBS, even after both Davis and Lieberson have finally left, looks secure in the hands of these men but, as Davis often remarks, the strength of a record company lies in its artists and again, at present CBS seems well-placed indeed; waiting in the wings (it can only be a short matter of time) for international stardom are artists such as Bruce Springsteen, Earth, Wind and Fire, Alan Rich (Charlie's son—and a superb talent), Janis Ian, Herbie Hancock, Murray Perahia and Kansas. Many of these, Davis signed personally, and it is again a measure of his skill that one company under his direction could be seen to attract such talent.

However, Davis ought to have another look at the signing of Mott the Hoople (during the cheque-book raidings of 1972): Ian Hunter, quite clearly states, in *his* book 'Diary of a Rock and Roll Star' that it was Dan Loggins (brother of Kenny), the urbane and brilliant head of A and R for CBS UK, who signed Mott to CBS. Davis should have acknowledged this.

With hindsight, Davis' account of his sudden and traumatic leaving the Company seems true and his possible explanation of the step taken by the very board which only two weeks previously had invited him to join, appears right, but there can be no doubt that, in spite of his own personal qualities—the exact opposite of his predecessor Goddard Lieberson, a brilliant and truly great man himself—Davis' character was such that he could hardly have failed to make a number of enemies. Nothing succeeds like success, it is true, but it is also a fact that people envy success as well, and the stories which circulated after his dismissal—especially concerning payola and drugola—have all been investigated in depth and no prosecutions have followed. With the artistic talent CBS enjoys, no-one needs back-handers to play records.

There are many more things in the book than I have space to mention: Davis' rapport with Neil Diamond, his success with Miles Davis, and so on, but I think I have shown its importance. For, in spite of everything, in the mercurial business of running a record company, Davis divined a powerful truth: 'Planning is no substitute for judgement'. If any man in the United States had that tenet in the record business in the late '60s, it was Clive Davis.

Robert Walker

NEWS

Stability: unconditional.
Power requirements: 110 to 130V, 220 to 240V.
Size: h w d 115 x 341 x 195 mm.
Weight: 9 kg.
Price: £115.

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The performance of a session musician is often taken for granted. However, the help and consideration he is given reflects in the playing. Further, appreciation of the arranger's intentions must be linked with aspects such as layout and other fundamental studio techniques.

The other side of the glass

CHRISTOPHER GRADWELL

Aural capacity

What are ears? What is the memory inside a brain that actually makes people hear?

Musicians have various different sorts of hearing. Some people hear higher and some people hear lower than others—it's what we call a sharp ear or a flat ear. There are analogies with vision. If someone sees a brown a bit browner than someone else it might be just the musician hears something a bit louder or sharper or flatter than someone else. It's almost identical: the two things run together, as far as colour blindness.

But the principal asset, gained from training and experience, is aural capacity. Thus, you can listen in to a band or orchestra and hear the various parts. Take a trumpet section, and be able to hear what the thirds, fourths, fifths and all sorts of harmonies are doing, and be able to write them down afterwards. After years of training like this, one manages to be able to get hearing that really can tell you what it's all about.

Orchestral musicians have another problem too. They have to sit next to a player in an orchestra and play in tune. Intonation is one of the most difficult things a musician has to learn. He has to be able to play with an instrument which is imperfect; he has to learn to be able to play it in tune and not only that but to play it alongside another imperfect instrument. Most instruments are imperfect—you can't possibly get a true chromatic scale out of one tube or set of strings.

Now take the problem of the orchestral conductor or the musical md who stands in front of a score. The composer starts by writing the music and then scoring it out. Scoring it out for many instruments, many different sounds, which he hears and writes down on the page. He hears these sounds just as though listening to himself thinking.

So when you and he go into a recording studio, there is his score, with the musicians arranged in front of him. He's probably got some sort of layout of sounds in his head, so he'll start conducting the orchestra or group and they'll play that sound that he's got on the score. He will then go through rehearsals to balance the sound up; he'll go to the strings and get the various component parts of his harmonies worked out so that he gets a 'good' balance (or a balance that he wants—which can be a very different thing). He'll go to the other parts of the band or orchestra and do the same thing. Now, he can only do that with his ears. It's this that one has to transpose into the recording box, and it's this that the recording engineer must learn about. It's probably one of the most difficult tasks in all music, because he's got to insert himself inside the composer's brain and listen to what the composer wanted—a bit like an interpreter who interprets somebody else's composition.

It's essential for the recording engineer to be able to assess a score, so that he does not waste time arguing what's in it with the producer. It's also important for them to know what instruments there are and their musical functions, and thus which to bring out; just in the way that the conductor or composer has to. He's also got to be able to help the musicians themselves into talking about such problems as tuning, rhythm; things maybe are not quite together, particularly through a monitor speaker microscope.

Balance is the most important of all. Musicians, when they go back into the box to hear playback, often complain that they can't hear a solo which is a prominent part of the scoring. Often a recording engineer hasn't even known it's there in the first place.

I turned up at a studio session the other day and I had in front of me first a jazz tenor solo and then an obligato flute part. The microphone was probably six feet away from me and as the engineer came up I said, 'I doubt whether you'll be able to hear me with the microphone there, as I'm going to play in this direction.' It was very cramped in the studio and my instrument was pointing in another way, and I couldn't very well alter my position. He said, 'Oh I'll be all right—I'll be able to pick you up from that microphone.' I went into the box and could not hear a note.

This is one of the problems with which I am often faced but it's very difficult to help someone politely without seeming to tell them their own job. You couldn't possibly do that and neither would I want to, either.

Recording engineers, probably because many composers and writers have not furnished them with the necessary material or put the necessary pressures upon them, have learnt to busk their way through various studios without even such a thing as a lead sheet, sometimes not even understanding what instruments are in there. As long as they get a rough sound going then they're not really bothered. This happens particularly in the commercial field where the sounds have got to be doctored to that currently fashionable. An engineer who hasn't got a score in front of him and is just hearing the sound coming from the studio cannot possibly know what is going on in the score and in the composer's mind at the time, but if he had a score in front of him he could see the various parts of the studio ensemble which are supposed to be brought out.

Memory brings back a recording of rock music, which shall remain nameless, of a large brass section which was engaged to put a backing track on a rhythm track already existing. The brass section numbered 12, with an additional baritone sax. When the actual disc came out all anyone could hear was the lead trumpet. In fact it should have been a bit more than that. There was a large contrapuntal part written in fourteenth century style which was put to this particular rock music. This is an example of not looking at a score and thus missing what it can sound like. And if all that was heard of that 12 piece brass section with baritone sax was in fact the lead trumpet with diminishing sounds of trumpets underneath it, no trombones, no tuba, and no baritone sax, why spend all the money on it anyway?

Another difficulty is the sound heard by the player compared with that which an audience hears. Remember, the player is right on top of his instrument, and in the case of clarinet, oboe and bassoon, he actually has a reed or a mouthpiece inside his mouth, which is vibrating in his skull. He hears a totally different thing from an audience some distance away. By that time the sound has 'materialised' in the room and become a sound which is accepted as musical.

Trained musicians can anticipate that sound, and in playing to a hall try to materialise their

sounds so that the listener will hear what he wants them to hear. If you could actually record what a musician hears himself I'm sure you would be quite surprised. With flute, for example, many overtones buzz around while the player is playing, and they are an infernal nuisance. If any of you have ever played flute duets you know of this other racket going on simultaneously.

If a close microphone technique is employed with an instrument, the microphone is unlikely to pick up what the player or audience hears. But then usually the engineer produces the sound that *he* wants to from the flute, rather than that which the player is producing.

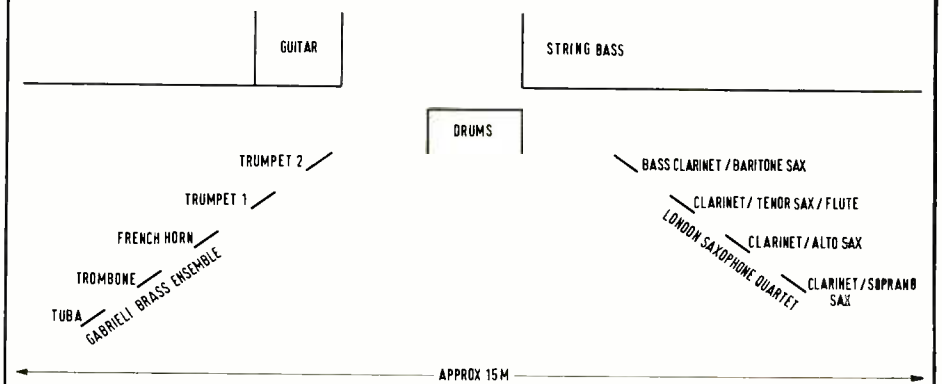
Layout

Orchestral recording is done traditionally using one pair of microphones in front of the orchestra with various ambience microphones around the room and over the orchestra to reinforce some of the softer instruments. As far as an orchestral musician is concerned this is generally a more satisfactory way of doing it, because the musician and the player has full control of the balance, and it is really his fault if it's wrong.

When an orchestral musician goes into a studio to record, say, a classical piece of music —a Haydn or Mozart symphony—he expects to sit next to a musician whose part is relevant to him. The second clarinet will sit next to the first clarinet, the bass clarinet next to the second clarinet. First clarinet will sit next to first bassoon and in front of him will be first flute, and so forth. If you put a secondary part miles away from a first part, the player will feel insecure, he won't be able to play in tune with the other person and he'll have a great deal of difficulty with the phrasing which the first player is about to form. Many times I have been put in awkward situations, where I have not been able to hear at all the instrument with whom I shared a part. With a saxophone player, one of what they call the 'novelties' of the orchestral profession, I'm sometimes put at one side of the studio and find that I've got to play with a trombone maybe five or even ten metres away from me. His sound may be covered up by a host of other instruments—or screens in between—how on earth am I going to listen to his sounds and play in tune with him? And if he's got the principal part, how am I going to copy his phrasing?

Recently, the Gabrieli Brass Ensemble and the London Saxophone Quartet made a record at Abbey Road. The recording engineer got a reasonable sound, but the layout made it extremely difficult for the musicians to perform at all. As shown in **fig. 1**, four saxophone players with their various clarinets and flutes and all sorts of instruments were put at one side of the studio 15m apart from the two trumpets, horn, trombone and tuba. Now you can imagine the difficulty that, say, the bass section of the saxophone quartet would have with the tuba, quite apart from the time lag of up to one twentieth of a second (which the musicians in fact got right). Because professional musicians are professional they pulled it through somehow and managed to get the thing to sound quite tight. But on the nth result the intonation suffered quite a bit. I might add that in the middle of these two groups was the rhythm section, at the back of the studio and

FIG.1 UNHELPFUL SESSION LAYOUT



all surrounded by boxes. How were we able to hear the rhythm section as well? You might say that all should wear cans. Sure—then you can't hear the noise you're making yourself properly.

Musicians have various unspoken rules; they don't talk about each other's playing very often, or at least they try not to. This is one of the professional things that keeps us from fighting. Another part of our etiquette is not to talk about intonation, and unless things are very bad indeed nobody will mention it. This may be counterproductive but it's one of those things which happen in music. These rules are generally productive, except when musicians are placed in awkward situations such as at Abbey Road that time, where no-one liked to say 'you're flat'.

The subject of musicians hearing others in the studio while they're playing and wearing cans is enormous and couldn't possibly be covered in detail here, but I might mention a couple of points. You wear cans —because you can't get the rhythm together with another part of the studio, which for recording purposes may be sectioned off. If you hear them in the room you're probably playing late behind them anyway. The general way with cans is putting one over one ear and having the other one half across the other. It keeps you on the beat all right, but the difficulty is that you don't actually hear the correct sound coming out of your instrument, and you are not able to adjust the appropriate phrasings and sounds that you wish to produce from your instrument—this can be most disconcerting. Another way of doing it is by putting a speaker behind the musician, which feels one of the best ways of doing it.

There is another thing which does help musicians a great deal, putting an artificial ambience inside the studio with speakers. It gives the musician a false sense of ambience, and it makes him feel slightly more at home. He feels he's making a better sound than he really is. In some recording studios that have no ambience at all, covered in carpets and polystyrene tiles, it helps the musician feel a little bit more secure, therefore he is able to give a better performance. There's not much point in putting ambience through the cans to make the musician feel more at home, for he simply cannot hear his own instrument while he is playing.

Frank Cordell, the composer, often provokes me to ask him: 'Why are recordings of your arrangements all so good?' His technique is to place a stereo pair right on the score paper when he writes a piece of music. He scores the music for those microphones. Then if he wants to get a certain balance normally only associated with close microphone technique, such as alto flutes playing the main theme balanced with, say, 12 brass players in a room, you'd never be able to hear the alto flutes. But Frank juggles with the positioning of the players in the studio until he gets the sound that he wants to hear, transcribes it on to tape with the stereo pair over his score. In other words, he wants what he *hears* to go on to the tape and he spends a lot of time juggling the players around in the studio until he gets that sound.

Worries

I wonder how many people know what a musician actually feels like when he goes along to a recording session. In the train on the way, or in the car on the way to the studio, he's thinking 'goodness I wonder what on earth I'm going to be asked to play this time'. He could be asked to play absolutely anything. People never realise some of the technical problems of what orchestral, or jazz, or any musician is asked to do. A clarinet player once went along to a film session and found the whole of the *Galanta Dances* by Kodály spread out on his stand. This is a piece of music which needs quite a bit of study. Even though he probably knew the thing already that did not matter; he would have liked to practise beforehand. And he got lumbered into playing it right on the red light.

Now what on earth do you think he felt like? He probably felt quite nervous and when this conductor put his baton down, here were the *Galanta Dances* sailing away into the most hideously difficult clarinet part. After the session the musician was quite justified in going up to the conductor and saying 'Look I think you should have let me know about this first.'

On the other hand you get a lot of times when you're incredibly bored, with practically nothing to do and just eggs (long notes) to play and you have to spend your time concentrating on getting these long notes correct every single time maybe for some singer who wants to do it 30

44 ▶

THE OTHER SIDE OF THE GLASS

times and you have to play it 30 times without a single mistake. I find this very difficult to do and also extremely boring. And at the back of your mind is always the dread of turning that page over and finding some frighteningly difficult part.

There are a few simple things to make musicians feel more at home in the studio: a place where they can have coffee, sit, talk with each other, catch up on gossip and so forth—it does make a considerable contribution to a happy session; having a room or studio that has a little bit of ambience in it, has something to make the musicians' confidence a little stronger; having seats that don't have angular constructions or arm rests at the side of them (because I'm a saxophone player and I find it extremely difficult to play with these complicated things).

To be perfectly honest I'm splitting too many hairs here because really and truly the musicians would far rather know where the pub is than know anything else, because there is such a strong social atmosphere existing in the freelance world in London and other cities.

In Britain because of the lack of money and the lack of support for musicians, London has produced the most remarkable session industry, a number of musicians who know and work with each other in both the pop and the straight sides. And it's really rather amazing that you might go along to a session and there are a few names that you know very well indeed. You can sit next to them and play almost identically with them; you know their intonation, you know their sound and you know their phrasing so that everything is really taken care of almost straight away. This is one of the peculiarities of London and we're very very lucky to have such a cosmopolitan collection of musicians who vary through all different styles and all instruments.

May I paint rather a fantastic picture to you of the sort of recording engineer that a musician, composer or md likes? First of all, he must be a musician, somebody that doesn't necessarily have to play an instrument but certainly with a good aural capacity. He's then immediately in tune with the musician, who knows he's got a pair of ears and he can actually hear; so they are talking about the same thing. He certainly should have an electronics side to him, but it needn't be particularly great providing there is an engineer there. All that he needs to know is what is available to him in the techniques of recording. He needs to know what sounds he can get out of which microphones, which machines. How it will help to use artificial ambience in the studio, how it will help to use cans and all these various techniques. How to use 16 track, how to balance something up quickly afterwards. All this gives the musician an immense amount of confidence that his stock-in-trade is not being ruined by someone else. Because remember, you cannot measure music in anything else's terms; it just wafts out of someone's instrument. Someone may have recorded it anyway they want, changed the sound, and altered it completely from what the original musicians thought of in the first place. It can be rather unfair.

Cautionary tales

The London Saxophone Quartet has made many recordings of all sorts of different shapes and sizes. In particular we have been asked to do several films. One of the very first films we ever did was a commercial, in which the composer wrote the music to be very tuneful. We turned up in the studio, to be forced to have a microphone each inserted in the bell of the instrument. The saxophone sound doesn't happen there, but happens many feet away from the instrument and not down its bell. In any case, the sound doesn't come out of the bell but from all over the tone holes—all over the instrument. As a result the sound was extremely hard and edgy, from picking up impure partials of harmonics which were rushing up and down the instrument as it was played. Balance was reasonable, given four different tracks at the same meter reading level but that's just about it. When it finally made it to the film it lost even more.

Another film we did was recorded in several different ways, with the film up in the studio at the time. Recording was with a stereo pair on the outside of the quartet and using some other microphones to help the engineer balance the sounds. But unfortunately he didn't have the score and didn't know what was in the parts; so therefore some of the balance was pretty bad, because he brought out instruments which were secondary and not of primary interest in the score.

Two of the most successful recordings the quartet has done were for James Archibald, who runs his own film company and is rather a special man in that when he asks the composer to write the film, he has generally shot too much film; he edits it together and then shows it to the composer. The composer then writes a piece of music which has continuity (a very important word). And the composer writes his piece more or less to the times given by the composer, but not exactly. The film is then cut by the film editor to the music and you get a very accurate view of film music this way.

What we wanted also was a microphone system that would simply pick up what we did, given the composition from a concert-hall oriented musician. We didn't want any balancing from the recording engineer at all. It was purely a matter of his obtaining a sound on his recording equipment. We thus had a stereo pair put above the four players, who sat looking at each other in a star shape and playing various instruments ranging through flutes, clarinets and saxophones. At the side of this setting was a screen around a percussion player. Now we were close enough to be able to hear everything that he did, for his own microphones. We found that this was by far the easiest balance because we could go to the box, listen to what we did and maybe find out that we needed a little more flute here, a little less bass clarinet there, and so forth. It was easy for us to balance as necessary. Remember, *we* were playing the instruments and not the recording engineer. The person who is playing the instrument is directly connected to it and can alter the sound *instantly* and not three seconds or even a split second later. It is best done by the player himself, if practical. There is a well-known film producer who simply demands that the recording engineer records what he hears; it is very important for him to do that. If he does not know that he can do that, how can he write his music, how can he score it out in the recording studio itself? It's completely impossible if he doesn't know what's going to go on to the tape, for he's got no control over it.

Perhaps it might be better if composers did learn a bit about recording techniques. It helps a great number of composers that way, and they must learn a bit as they go on. People learn in various different degrees, some more than others. But I think it's more important, because the recording engineer has more control over the processes we have been discussing, that he learns more about music. It's very difficult to get the two together—the musician and the recording engineer. This is why the recording engineer should be a musician.

AGONY COLUMN

■The cut was going well, the tape aligned as best it could be in the circumstances and the customer reasonably happy. But maybe a little more boost in the bass would be nice. OK. And could you add a little more top? Sure. The client was a bit slow on the uptake, but eventually he realised that something was missing in the middle; so he asked for a little boost in the mid region to help. 'But it's probably better to take the top and bottom down a bit'. But the producer was really into it now. 'Oh, why don't you just go and boost at all frequencies . . . '

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Modern recording environment

TOM HIDLEY*

Studio

WE should open a discussion of modern recording environment with some ideas about the type of music and what the recording studio was asked to record in earlier times. What was required of the records when they finally made the street. What was acceptable and what was not.

In the dance band era, working mono and sometimes direct stereo, we might see anywhere from one to five microphones involved with an 18 to 20 piece orchestra. The general sound pressure level 1.5m or so in front of the Basie or Woody Herman bands, five saxes, four trumpets, four trombones, and four rhythm or so, I have read to be around 105 to 107 dB spl at *ff*.

The rhythm was light in intensity in comparison with brass and reeds. Isolation problems were neither as prevalent nor as pressing as today. We were monitoring a direct master, and so everyone heard just what acoustical summing was taking place in the control room. In most cases we didn't worry about overdubbing. Music that came across the microphones into the control room desk was, indeed, what finished on tape with very little alteration.

As time moved on, we got into the idea of tighter miking; and suddenly more were needed. Instead of two rhythm mics, one bass, one piano and possibly a third on acoustic guitar, we now found need to mic bass and piano, with possibly two mics on drums, and balancing it. Then there might be two on brass, two on reeds, maybe a solo mic for a sideman to come up front during a particular song, and a vocal mic.

So then we were up to eight, nine or ten, but still putting them direct on two tracks. Everything seemed to be working reasonably well and the industry was not suffering from any acoustical disadvantages of which those on the other side of the glass were aware at that time. Inevitably, though, the more microphones that are put into a given playing environment, the better that environment must be in order to handle them correctly.

We are now talking about an environment that must present ten to fifteen microphones to a console, and a monitoring system in a control room with the same or less amount of inherent acoustical cancellations and distortions. There was a time when use of one or two microphones to an orchestra would gel, or you would adjust the microphones to get a better balance. Or you could move the orchestral sections. But suddenly, now arrives today's music with many microphones: up to eight on drums, perhaps four on 8-2-2 strings. Brass and woodwind sections are not as large but still need two or three each. Thus, separation becomes a problem.

Old studio design utilised diaphragmatic walls built to attenuate the low end. It would dissipate it a bit but the musical energies were weaker than they are today. In contrast with the Herman band at up to 108, rock bands now can generate to 114 dB spl in the studio.

Suddenly, the walls that were working with very few mics in earlier recording days, are not absorbing or attenuating the low ends as much as is needed for today's sounds. They are not 'controlling' the room from high intensity standing waves. The result is leakage. On a session you begin to open faders and might have thought, 'there's a great rhythm sound'. Then you opened the string faders and suddenly your drum sound changed from very tight to very open and roomy. Leakage from the drum set into the string mics augments the leakage problem existing in the room. That drum set sound is unwanted in the string mics.

As those things began to happen and as we developed through mixdown techniques instead of the direct two track or whatever, techniques had to change. We might have at the live date new music coming across the monitors in all of its excitement and high spls and everybody very happy about it all. But on mixdown you might open the strings and find rhythm presence decreases. Now you open woodwinds and hear a bit more rhythm sound change, and if you have french horns or something you open them and, suddenly, another change. All of these things become uncontrolled in the mix session to some extent, for you cannot pull acoustical phase distortion or leakage out of a track very conveniently. The instrument is moving across quite a bandwidth with its fundamental and harmonics and you really don't have that much you can eliminate. So you accepted the balance of previous times and say 'That's about as good as we can go'. Perhaps you've played a lot with equalisation, compression, and all the black boxes to get as good a sound balance as you can get. But when done it's sometimes a kind of disappointment by comparison with the sound on the studio floor during the recording.

Then comes 16 track with still more microphones and still more demands on the studio. Many acoustical design arrangements of old are no longer acceptable because the low end energies are so loud today that the floor begins to move. Coming up the mic stands is this 20 Hz rumbling along on the floor. The console then sees all of this low end garbage going on while it's trying to handle the music at the same time. So you must look closer at the instruments of today and ask what has changed in *musical* demands.

People are very picky about the drum sound today. Bass drum must have a certain definition —attack and release—and it must have a round body sound. This is what you want to hear from that monitor. The snare has to have a certain snap and yet it can't be tinny: it has got to be full within itself, and you still want the rim shot with its hard transient response.

Drums must not leak into string mics if you can help it. But a rock drummer generates bass drum energies of 124 dB spl average at the mic. Peak power is well in excess of this. This means enormous energy is being presented to the studio floor. If you are not on a decoupled platform the studio floor may move and cause acoustical mud. The bass drum mic also must handle this acoustical energy without collapsing or it will muddy the sound. In general, if isolation is desired, the drum must be surrounded in a room or cage that will enhance its sound, and help by having better isolation in the mix at a later date.

A stick on the cymbal will generate higher energy around 7 kHz than it will at its fundamental. The energies off a drum set, where microphone would sit over the cymbal, will be in the neighbourhood of 114 dB spl with a hard driving drummer. These have a tendency to ricochet around parallel walled studios. Yet

*Westlake Audio

this drummer is presented to the studio environment with other players who have an output of perhaps 90. Immediately, you have leakage. So, you consider the drummer as one of the challenges in your session, one to work on quite hard. The engineer usually welcomes any help that he can get in containment of the drummer, while at the same time the player be within the studio *environment* and not off in some closed room somewhere.

Isolation level

Suppose you must have piano, bass, drums and guitars not only seeing each other, but working in the same general area and still retaining separation? It can be done and they can relate musically. The rhythm has to be together if the record is to be, for patterns and balance within that section are fundamental. If they work, you are on the right start as a producer. Producers frequently start working on the rhythm, often with hours spent in balance. Along with this the acoustic piano sits there at about 90, very calmly working along at some 30 odd dB less power than the drummer. Yet you want them close together. And you want isolation of that piano track of at least 20 dB from anything else. So this would say you want 45-50 dB of attenuation between the drums and piano to effect 20 dB of piano isolation.

Now in comes the bass which puts up possibly even 108 with energy centred between 40-50 Hz on the bottom to, maybe, 160 Hz on the top, plus the usual harmonics. This can start wall motion at low frequencies, potentially leaking into everything and anybody in the room. And then, comes the electric guitar and similar energies at higher frequencies which can stimulate audible ricochets.

It would be nice from a designer's point of view if all instruments played at the same intensity. Unfortunately, this does not happen. Net result is that you have to look at these instruments as mutual problems, whether a cellist at 70 or drummer at 120. They have to be matched.

Booths?

You want them playing at the same time on the studio floor. Even though it's often done, you don't want anyone having to overdub to get the basics down. In 1967-68 when eight-track was here and 16 just around the corner, what did we do with the increased quantity of microphones with associated acoustical phase shift, leakage developing in the studio, with more tracks, and everybody wanting to record more tracks simultaneously? All this became a strain on the acoustical environment of the performing room, the studio. The only approach that I could see in 1968 was one of isolation of these problem instruments, some physical brute force isolation which still allowed them to work in the same general room.

Now, the first drum cage that we built was a total disaster—sounded like a tunnel, was dead, had everything wrong with it: helped the isolation problem a little bit but ruined the drum sound. It took three or four years of experimentation with what drummers wanted, how they wanted to sit within the group, to see the piano players' face, to see the guitar and the bass player's faces; and everybody wanted to look at and hear each other, and everybody wanted to sit at the same end of the room. The balance engineer meanwhile wanted all the isolation as if they were in five different rooms. Quite a problem!

We have found, for example, that a drumkit should not fit directly on a studio floor, but should be, in fact, an isolated platform such as a floating concrete slab on the studio floor, or a rigid floating wood platform packed with sand. You want stability and yet isolation from the floor and really do not want the floor of the drumkit to resonate but for it to be a stable device, such that the drummer hears what *he* wants. Both sides have to be equally happy or it is not a good marriage.

It *is* possible to achieve separation and still maintain a large open sound musically. From the other side, the piano player has to have vision and feel like he is part of the rhythm section, but his output is going to average between 80-95 dB spl. Back to the drummer: in his cage he will be attenuated at least 24 dB (sometimes as much as 30). The energy coming from that drumkit comes out in the open area at 100 or less where you don't have it glassed in for three feet; you have him looking right out at the studio and yet just outside of the drum cage you will be down 25 dB from that basic energy source, but still 10 dB louder than the piano.

We now want to see a distance of 3m attenuate between 25 and 40 dB depending on the room acoustics in general, but not attenuating to the pianist's ears. He still has to be able to be conscious that he is working with a man right in the room and that he could throw a rock and hit him on the head if he wanted to. So 3m away sits the piano microphones with the lid open but looking straight at a trap. The piano microphone then sees approximately 30 dB of attenuation from that 100 dB spl point just outside the drum cage. Now drums are at 70 entering the piano mic (approximately 20 dB spl under piano output). Bass and guitar trapping is handled in the same general way. If you have got 3m between any one of the sources sitting around in a circle you can have in excess of 20 dB of isolation from instrument to instrument, no matter what their output is. You want people to work without headphones. They can do it with this type of trapping, but it does mean control and attack of specific instrument's outputs: drums, piano, bass, and so forth.

A word about the subjective feelings of a room. When people say 'that is a very dead room' they are generally finding mid high end as being dead, because they relate to the timbre, the brightness or the liveness, or the deadness of the room to how their voice sounds when they walk in, and the general ambient feeling they get in their ears. This, for the most part, is describing frequencies that are 400 Hz and above. Below that, it becomes 'that's a really loose bass sound'. Or, 'that's a very tight bass sound'. They are really talking about live and dead low end rooms. If a room is very dead in the mid band it takes away the *ss* and anything that relates to continuing high frequency. Your *ss* come out of your mouth and go straight to the floor. That type of room is sometimes very uncomfortable to work in.

The main thing people don't consider when they talk about live and dead rooms is what the low end is doing. You can't hear that in your voice. If the room is live at the low end, the net result will be one of concert hall sound. Such conditions for the most part are unhelpful in studios; when people are looking for a live playing environment they are relating to mid band and its comfortable sounding condition with its decay time. They really do not want to hear the loose bass sound.

In design you want control of the low end for a cleaner product; even if you are designing an echo chamber that has three seconds in the mid band you want a quarter second or less at 40 Hz. Nobody considers this, generally speaking, when they design an echo chamber.

Supposing you had a studio that was considered to be very dead and you had a twelve strings to overdub. You show the players in and they say 'oh what a dead room'—unhappy to play. They get their three hour thing done—know they are going to get paid for it, get the job done and get the hell out of there. The opposite is 'Isn't this a marvellous place to play', 'doesn't this feel good' and they get into what they are doing. Environment affects the performance. So if you're going to be doing a lot of legit or pop work or work where strings, french horns, or light woodwinds or soloists are involved, give them a large concert hall sound in their ears. They will work for you and *with* you.

Supposing you sat in your remix room and you looked through your control room glass on the studio floor you could look through a pair of sliding glass doors that were floor to ceiling; and behind them you saw a speaker and a microphone. You called it an echo chamber. The next recording session coming in is a string overdub with some simultaneous brass and maybe a couple of french horns and now you want a roomy environment, even though your studio really is designed for rock and roll. If that room was properly designed, within one minute, it can be converted to a live string room—suitable for recording.

Your producer says 'I'd like a little more echo'. Fine. Don't reach for the echo send; go change the drapery, pull it back a bit and develop the reverberation acoustically in the room. Get the timbre in its pure condition. Pull it through quality microphones into your console and there is your string section: pretty and musical, with no eq or echo needing to be added. This is really what an acoustical tool is. This is what your room should be. You can develop entire studios to this flexibility. And completely in parallel with this process is the provision for the musicians of a positive environment.

Beyond this, the studio development is getting into what might be called a two dimensional environment. Three dimensions means four walls, a ceiling and a floor. Resonant conditions will develop that will be a room character: 'I like the string sound in that room.' 'I hate the rhythm sound in that room.' 'The brass are fair, but I get a better brass sound over at Jim Does down the street.' They are talking about room character which is a function of the finished material, the cubic volume, and the general size. But, if you had a room that was adjustable to this whole attitude, everyone would be happy.

Beyond this, suppose you take the three dimensional property and you cut it down to two. You still have four walls and a floor—but no ceiling. You look up and you have stars and moon and the breeze; and all the other things that you can't live with like aeroplanes and street noises and so on. But acoustically it presents far less coloration or likes and dislikes than does a three dimensional room. That room can also be moulded and shaped artificially as we have just discussed.

Studio design seems to be moving further this way and that the liberties that the designer is allowed to take in design to get certain performance in rooms are getting greater; he is allowed a greater flexibility when the third room dimension is minimised. In practice we have gone in to what we call active ceiling trappings to tune frequencies to present rooms with a two dimensional property down to a given frequency. 40 Hz is the point we start our attack because that's getting very close to the bottom frequency that is going to be presented with any kind of energy to the studio.

We can then indulge in niceties such as control of mid band decay while maintaining extremely tight low end; this relates musically to the balance engineer and the producer being able to develop the amount of highs in the room or harmonic structures within the room

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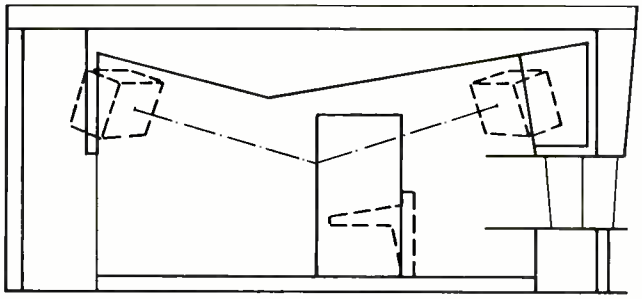
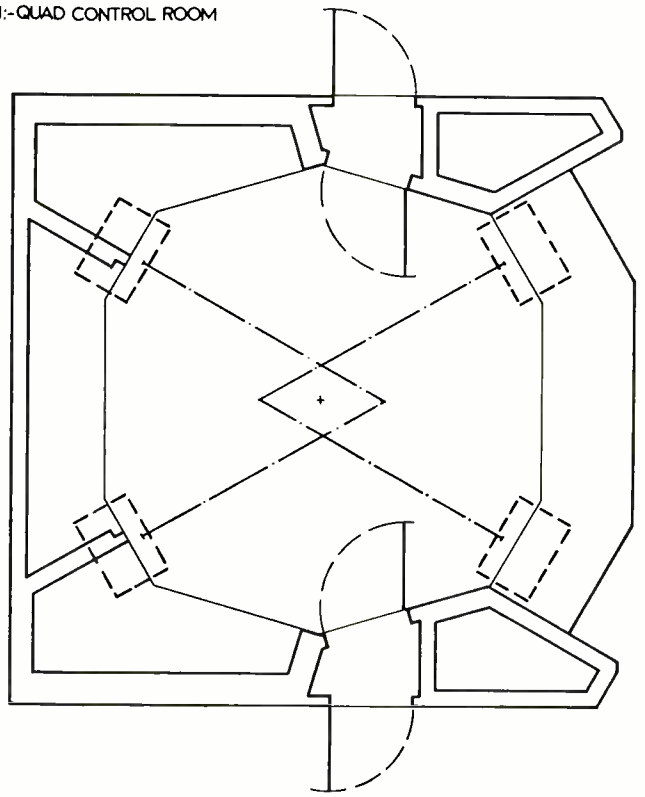
SECTION-ELEVATION:-QUAD CONTROL ROOM



FLOOR PLAN:-QUAD CONTROL ROOM



Soundcraft-Series II

Since first introducing the "Twelve into Four" range of mixing consoles over a year ago, customer feedback from all over the world has enabled us to assess the desirability of certain modifications and extensions to the facilities offered. The new Series 2 incorporates the most popular optional extras as standard, thus saving costly customising.

Particular attention has been paid to increasing the dynamic range and nature of the inputs that can be handled by the console, and complete elimination of additional patching at any time during the recording or mixing process – even when using the console at its full 8-track capability.

The new construction and styling of the console gives considerable ergonomic improvement, and enables us to offer more economically the option between the 66 mm. Ruwido carbon track faders or 105 mm. Waters conductive plastic faders (for which we are the U.K. distributor).

All the items for possible improvements discussed by Angus McKenzie in his review (Studio Sound, October 1975) of the Series 1 12/4 have been incorporated in the Series 2, plus many features which were not normally available in the original design.

1. INPUT FACILITIES. Continuously variable mic/line gain over a 60 dB range. Switchable 20 dB mic pad before input transformer. Max. mic handling using pad + 15 dB at 20 Hz, + 25 dB above 50 Hz. Mic/line switch, max. line input handling + 35dBm. Insertion point pre-equalisation. Four band equaliser. Foldback and echo sends. Switch for pre-fade listen/channel on/channel mute. LED peak indicator, fast attack, slow release, full wave detection set at 5 dB below clipping level. Slider fader – choice of 66 mm. carbon track (standard) or 105 mm. conductive plastic. Panoramic potentiometer, stereo-mono compatible. Routing push-buttons to: Monitors, Groups 1 and 2, Groups 3 and 4.

2. OUTPUT FACILITIES. Slider fader. Tape/Line monitoring with rotary fader, cue sends and panoramic control. The four output groups and monitor returns are selectable by track switches to 8 output sockets and tape return sockets, the latter being normalised through to the first 8 line inputs. Sockets are provided for foldback and echo send outputs at line level and 2 echo return inputs mixing into one return channel with identical facilities to the mic/line inputs.

3. MONITORING FACILITIES, allow push-button selection of PFL, foldback or normal monitoring. Outputs are provided for both headphones and line.

4. TALKBACK is provided with level control and lever switch to give momentary/off/hold and automatic muting of monitors by 20 dB.

5. LINE-UP OSCILLATOR continuously variable from 100 Hz-12 kHz with level control, output socket and switch for slate/off.

6. Choice of Bell spec. VU (standard) or BBC spec. PPM meters. Output capability, + 22 dBm into 600Ω. Relative input noise, –128 dBm with 200Ω source. Output noise better than –90 dBm (faders down). T.H.D. less than .02%. Power supply internal (standard), external option.

SOUNDCRAFT ELECTRONICS LIMITED

5-8 Gt Sutton Street London EC1V 0BX Tel: 01-251-3631/2/3 Telegrams: Soundcraft LDN EC1
Systems & Technology in Music Inc., 2025 Factory Street Kalamazoo Michigan 49001 USA Tel: (616) 382 6300

without hitting the equaliser, which is not a totally musical device. If that entrance and exit curve of the equaliser were replaced by an acoustical change of environment then it's natural—and really isn't that what you are looking for? You can also 'fold back' the eq as well, because they're playing in it.

Control room

Discussion of control room environment is equally important as that of the studio, but control rooms are harder to develop into a controlled environment. Studio work has certain design criteria philosophy involved, deriving from the musicians and their needs. These are reasonably easy to handle, develop and alter to taste. The control room, in comparison, is a listening or evaluating environment.

The microphone is placed at a point. The balance engineer ought to be able to walk out and put his ear where that microphone is and listen to the parent sound with the random field of the room. Then he should be able to walk back into the control room and hear the same tonal balance. Fidelity between one side of the glass and the other is the only true way to evaluate what is happening in the studio before you start equalising, compressing and so on. To handle the signal you want to know what you have to start with on the multitrack. So you need to be able to move left and right across the entire width of the mixing desk, to be able to stand up or sit down and yet hear no appreciable change across the tonal balance.

We found in going back to the first room in which we were involved and measuring that you could only move left and right by 1m before you were into a change of condition. Later came improvements doubling that, and we publicised a guarantee that said 3m. But the vertical problem has been the greatest to beat. The solution seems to be to removing the third dimension mentioned earlier from the control room so that as the frequencies climb we look for control and handling of the mid and high frequencies by the control room material. So the signal passes you once and does not come back to you after the first reflection with any significant energy. The human ear does not seem to be conscious of this acoustic change, it doesn't seem to reject it. It seems to say 'this is really quite pleasant'.

And now we have rooms which are just that: truly two dimensional at low frequency. It is trapped in the front, the back, the two sides and the top; it is a two dimensional room at 40 Hz. In the mid band, the decay slope is one that presents the second and third order reflection in a minimum power condition. This seems to minimize standing waves to such a point that the frequency peaks and dips in the room are minimal.

This was the same type of control that we would use in a non-focal room. But we have had trouble with focusing sound from 400 Hz up. If you come in with the lava rock wall there is no way that 10 kHz is going to give you any force at all. But 400 can. Unfortunately, its wavelength is such that it sees a rock wall and says 'that is rigid'. Turns around and walks right back. So as it comes back right across to the centre of the room where you are sitting in 'focusing' rooms makes trouble again. So what you are looking to do is adequate broad frequency band random field. Effectively you are taking a random field of 14 focusing room angles and working for additions so that they become a net uniform dispersion condition to the human ear.

Arrangements of control room is crucial, as is shown typically in the above diagrams. On the top is the section and below is the floor plan. The angles of the line shown off here are the vertical convergents of the sound path. There sits the ear 30 cm above it. That is just the tolerance that it can work within. The window system is three fold, with trapping under it. There is trapping behind the rock. Let us take it from the front section back.

What we have here are three different windows. These window systems are above a trap, which is in essence this whole distance coming back. The low end will pick up its easiest path of rigidity. If the walls are rigid it will pick it up and it will walk them; it will run with the floor and it will run with the ceiling.

It walks down the window to the floor and heads forward to the console; hits it and says 'that's rigid I can't handle you'. And suddenly back in this area, phase problems begin to develop as the energy builds up in this cavity. From the monitor comes the direct sound same frequency with a shifted wavelength. The net result is 'loosening', just like taking one side of a bass note and putting it through a ddl. Slow it down, and suddenly the definition of the bass washes out. You only have a big round thump going for you (and this problem is being developed in the control room, when actually it may not be on your tape if the studio low end is tight). Now, a window trap really is not large enough to do a 100% job, particularly when we are talking about sources of 115 dB spl. So the trap fills up, and finally throws the sound out; but at the leading edges of the console on the front side wall is an opening that comes up about 1m and then continues up in rock. Behind that opening are hanging blankets vertically tuned to 40 Hz. These blankets are behind the rock veneer which is shown for the mid band horn to work against, artificially developing mid band dispersion and random field.

From these and many other technical reasons we now find a situation where you can move around the room and find enormous accuracy in power balance: suddenly the tenor saxophone up in left front of the strings up in the right front, or the split of any given instruments in the room. You can now get up from the console, move back, left, right, and everything subjectively seems to sound the same. If anything the corners of the room, such as they are in a circular or symmetrical environment, are really lighter by a dB or so at 40 Hz than the centre of the room, unlike the usual past conditions.

Design problem

Quad has always been a design problem, particularly in designing for the side wall image. We would find as we would complete quad rooms and measure the centre image in front stereo that we would have an energy build up between the two monitors. And when you went to left and right rear, you found about the same build up, with everything quite uniform. But left front and left rear together is a different story, because quad implies to the designer that all pair-wise energies and all dispersion patterns between the four monitors should be similar, that the side centre control room image should be as strong as the front or the back.

On the basis of pure physics, given a pink noise energy source in a control room, you should see a central image reading relative to the speaker levels of +6 dB. Control rooms that I have read around the world, some of which we have done, have seen additive conditions to 2 dB in the front. We have, with very recent rooms now seen 5½ dB pushing 6. I have now also seen energies on the side wall up to 5½ dB, pushing 6. But what this requires is complete pair-wise symmetry. Those speaker energies will develop a 6 dB summation only when there is a completely symmetrical environment for those monitors to work within.

Build-up of energies

Several things happen when these energies build up which might interest the producer, balance engineer, maintenance engineer or designer. The subjective comments from producers that work within an environment of, let's say 110 dB spl average day in day out, is one of ear fatigue after six or seven hours; after eight hours they are really tired.

One Stateside producer working in a room with a 3½ to 4 dB build-up condition and complained about ear fatigue at 112 spl in eight hours. He proceeded to do a mixing project there because he couldn't get in his normal mixing room; time was booked. The additive condition of the room that he went into was 5½ dB across the centres, sides and back, a completely symmetrical environment. His comment was two fold. 'First of all, I just did a 16 hour session in such-and-such a room. Why is that? Also, I noticed a distinct difference of the tonal quality of the material on tape coming back from my mix; it doesn't sound like I have a glass. It sounds free, open and transparent. Things that I have never heard before, subtleties, are suddenly there.' That is interesting. So, I contacted other producers that were using this room, just starting; it was a new room and I said I want your harsh and honest opinions of the mixing conditions.

The two other producers that were kind enough to come back to me reflected the same thing—transparency, reduction in ear fatigue after high levels. We read this as an additive condition of higher nature than we had ever had before, especially on the side wall, up to 5½ dB in contrast with a former 3½.

Ear fatigue is not only a result of sound pressure level, but is companion with 'acoustical phase distortion', or lack of acoustical additive condition of the random field of the control room; that is, not only the parent sound but also what else is splashing around the room. The ear wants to hear purity and will take more level when it hears it. These conclusions are

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"...tion for producing these speakers ...re that no changes of any sort ... the design without prior per... ...tained from the BBC. Each ...er produced must satisfy a rigid specification. Rogers have sensibly taken great care over the production of the BBC monitors and have even had a special anechoic chamber built so that each unit can be tested on completion.

They felt, however, that the response at the upper end, though perfectly adequate for BBC the BBC tolerances, the latter give improved performance on listening tests.

The Rogers BBC Monitor is extremely well made from high quality material, and care has been taken to see that it is pleasing to the eye as well as to the ear. The cabinet work is of a very high standard, and the unit would fit happily into domestic surroundings as well as into studios, thus making it suitable for Hi Fi enthusiasts who want and can afford the best. The speakers are supplied complete with metal stands, the stands being in matt black and of

cracking, and it was difficult to say whether the amplifier or the speakers ran into overload first. The sound level produced before cracking occurred was very high, showing the Rogers to be excellent speakers in this respect and considerably better than most larger and more expensive systems given the same rather vicious test.

Comments on other sections of the usual test tape were as follows:

Choir: Very natural sound with excellent tonal balance.

Musical Box: Excellent transient response—very smooth and pleasant.

Organ: The bright stops had the correct bite and the bass end a full pleasant tone.

Folk singer (with guitar): A more natural sound on this section than any speakers tested so far.

Dance Band: Very natural with excellent percussion.

Piano Concerto: Silky tone to strings—the piano sung as it did in performance.

Wind Quintet: Very natural.

Speech: Very natural with no excessive sibilants or chestiness.

Full Orchestra: Excellent stereo picture with a good sound and climaxes handled well.

Organ and Percussion: The percussion instruments were pinpointed accurately and the whole section handled very well.

The units were so good on all the tests using the tape that it was no surprise to find that they performed equally well on the live v recorded tests. The most important of these, and fortunately the easiest to do, is the one on male speech and on this test the speaker was one of the best tested so far.

This is not surprising as the engineers at the BBC Research Dept are very conscious of the expected that any speaker designed by them should excel in this respect.

Comparison with other sources including various types of music showed how well the designers had used their facilities in the studios, and how closely Rogers had kept to the standard laid down.

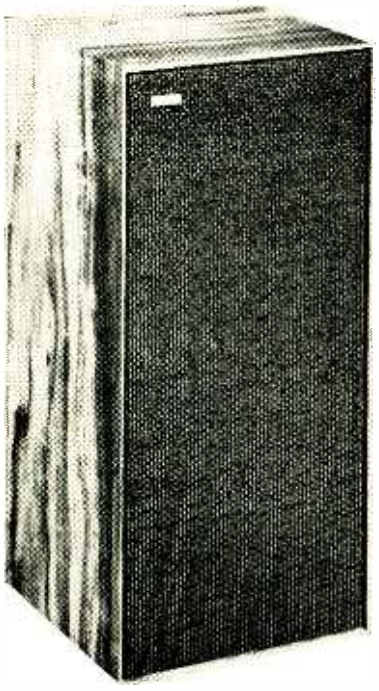
The speaker, although able to handle quite high levels of power, will not give the large sound output favoured by many engineers, and therefore is not suitable for monitoring loud pop in a large control room. For moderate levels it takes its place among the very few excellent monitor speakers that can be relied upon to give an accurate sound and as such it is highly recommended for use where normal listening levels are adequate and quality matters most.

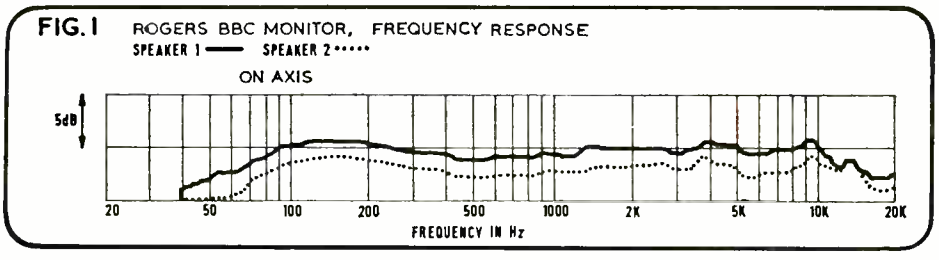
Frequency response curves were taken in an anechoic room one metre on axis, and are given for both review models. The remarkably close similarity between both sets of curves shows how closely the two speakers match—a tribute to the Rogers production team. The impedance curve shows that the speaker will not cause trouble with any decent amplifier, and the response curves are excellent by any standards though, after listening to the test tape and using the speakers on live v recorded tests, they come as no surprise.

Rogers are to be congratulated on having the courage to undertake the production of this speaker, the integrity to take such care over it, and the skill to do it so successfully.

An industrial version of the BB... available from Rogers. Price to... excluding stand. This version ... follows the BBC design by om... the ear-"

(*The above extracts are taken from a Studio Sound review by John Shuttleworth*)





Brief Specification: Overall Frequency Response: 40Hz-25kHz. +3dB 50Hz-14kHz. Power Handling Capacity: 25 watts, speech and music. Impedance: 15 ohms. Drive Units: Three. Overall Dimensions: Enclosure 12″ x 12″ x 25″. Height, including stand 37″. Weight: 34 lb. Finish: Teak. (Rosewood and other finishes available to order at extra cost.)

Distribution restricted to a limited number of carefully selected specialist high fidelity dealers and professional users.

Recommended U.K. Retail Price: £228.50 per pair including stands + V.A.T.

STOP PRESS ! ! The newly announced Rogers Export Monitor utilises the design technology of the LS3/6 with the added advantage of increased power handling. Price £214 per pair including stands + VAT.

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SS12

drawn from the rooms that we have done of this nature, all of which have provided the same type of comment.

Such things point to the acoustic environment of random field and additive sum conditioning as equally important, possibly more so, as the frequency response developed by that monitor system. Possibly it is more important than the horizontal, vertical and front-to-back dispersion that we have been talking about for so long.

Comfort

There is more than acoustics in a good life. The human body really does not like to relate to grey walls, hard floors, platforms that rumble beneath your feet and tape machines that sit there and squeal at you.

Equally important is the environment that designer and studio owner present to people that work within this studio. Take lighting; if you have to sit in an area such that you squint up from your music stand right into a light, you might accept it and not think much about it; but you will tire before you really should. The five senses have to be tended to equally and whatever we do to develop environments for performing, listening or just general humanising, we have to consider the human element. Lighting is an enormous factor, it must never be hospital bright but adequate, with control to effect mood along with the acoustics.

Air conditioning and humidity should be similarly flexible, able to be handled in a 'professional' manner to make the people feel comfortable. They shouldn't have to have 72° and sit there and perspire because you have 80% humidity living in an area by the coast. Also if you sit up in the mountains with 5° above zero outside, then pipe heat into your studio you shouldn't make things so dry that when you touch the console you get a big arc off your finger. You may like to dim the lights; but perhaps you would want them dimmed in front of you and not behind. Any combination of lighting characteristics, both in colour and intensity should be available within the control room on an adjustable basis, as should temperature and humidity. You really shouldn't have to sit in a control room and feel a draft on the back of your neck at four am when you are feeling pretty tired if you have been working from eight the previous morning and are pushing a 24 hour stretch. You shouldn't have to put a shawl or coat around you because someone has designed a dumb air conditioning system that blows on the back of your neck. It is liable to cost your studio time. If you present an environment of that nature the producer will say 'Oh to hell with it'. He is tired and he doesn't want to fight the environment around him. He may not be able to pin it down to lighting or air-conditioning; but it will cost you money.

It is also most distracting to have noise of tape reel scraping and most distracting to have fans on tape machines. Yet most tape machines have fans. Line up four or five, turn them on, and it sounds like the Colorado river rushing by your front door. You shouldn't have to hear this; you should be able to operate at 60 or 110 spl and not be influenced by extraneous noise. It is a small matter to build tape machines into an acoustic well and make them part of the geometry of the control room. It is quite easy to install a tinted glass door that will allow perfect vision of the machine and yet eliminate hearing the machine. You don't need another man to run the tape machines because they are in another room that you can't see, and you have to get up from the console to see if the damn thing is running. These things should not be your problem as a balance engineer or as a producer. Things should be comfortable.

When you go into your home, amongst other things that make you like or dislike, it is going to be the appearance of the place that counts. It can be very comfortable and very pleasant with greenery and plants growing; there is nothing wrong with having plants in your control room or in your studio. We have done drum cage huts that look as if they are out of the south seas, with palm tree branches on the outside directly in the studio. We have had raft support posts with nautical rope and we have taken pillars that hold the second floor up that go right through the middle of the studio; put tree bark around and branches that are at the top and even developed artificial ones that match the ones that are already in there to make it look like a palm tree grove within your studio. So what, if it is comfortable and pleasantly lit? If you go down to the Caribbean or wherever, and see a tropical environment, how often do you admire the palm trees, the beaches, the water and so forth; that is appearance and environment that you choose. Anything that you can do to your studio or control room to effect a relaxed, pleasant environment, will both sell time and develop a better record. Not necessarily in that order; but they are things that directly relate to people's reaction to your facilities.

If, for example, you happen to be one of the fortunate ones that can build your facility out in groves of trees (as I recently have seen out there in Holland in a beautiful setting), don't chop the trees down. Put the building there in the middle of the trees and develop a studio environment to the point where you can actually look out of windows. You look out and see this beautiful green foliage and the wind going through the leaves. If you have a control room that happens to be one that you want to make particularly attractive, supposing you were to incorporate in the trap system an actual wood burning fireplace, built out of rock with a rock hearth, the chimney acting as a partial trap system of the control room or studio. You can work it in acoustically and almost have a living room, and a very luxurious living room at that.

These things are nice. People like them. They work. Supposing you are developing a master disc cutting room and you have no window to look through at the front. You can do several things. For example, you can start with putting a stained glass window and exhaust the heat out the normal air-conditioning air-ducts above it. You can put back-lighting on a dimmer and get any intensity or colour that you want in there, depending on what you choose in lighting and glass.

Tony Clarke (a very inventive guy) suggested that a studio might be built with a dome appearance, using moon rock lunar landscape to cover the studio floor, with behind it coming up the rising sun. The entire dome should be done in black fabric with iridescent stars and moon; and the degree of intensity of lighting one would want in the room would be directly proportionate to the amount of lighting put behind the moon rock which, in turn, would come up on the dome and come down into the room.

Ideas of this nature, I believe, are important. If you are going to build your studio by the seashore, take advantage of it. If you are putting it in the mountains take advantage of that. Carry the outdoor context and outdoor environment into your studio, make it part of it; the people love it. Most would like to be out in a grove of trees in the woods, or on the sand at a beach rather than in a building. So bring nature back into the room and develop it.

Go one more thought back to the mastering room. Even more exotic than the stained glass and not too costly, is taking 3-5m of wrap-around glass that would follow the geometry of the monitors above and present it as a tropical fish aquarium. That may sound a little far out and indulgent, but think a moment. Here you have a glass system in front of you which drapes over it. If you are doing quad, you present the same acoustical environment to the front of the room that you have from the back of the room. For stereo, supposing you pull the drapes back, to show an enormous tropical fish aquarium, variably back-lit to develop the mood you want. Your clients will sit there engrossed. And yet it is totally sealed, totally a part of the acoustical environment of the rigid hard surface of the front of the room.

There is nothing to say that these things are out of line or irresponsible. Departure from convention is something that we can call progress; in many cases it means getting back to what people want to see—nature and environment. If you can develop this within your complex you will sell more time because people will be comfortable; they will like what they see, their eyes will not be blinded by bright lighting, they won't be run out of the room by cold drafts or air or humidity that makes their instruments run out of tune every three hours. You won't be plagued by the normal problems that studios have had for 20 years. Clean up the act in environment. It is part of and just as important as the acoustical conditions.

Working

One of the things that producers have jumped on is the telephone in a control room. This can be a constant annoyance when they are trying to create. They have almost got what they want and the damn thing rings, interrupting the thought. The phone could be just a low light somewhere that would be seen by the balance engineer, perhaps the producer, something that wouldn't make any sound. You could, at your own choice, switch that light off or turn it on as the client may request. But, built in to the geometry of the control room back in the tape machine area, out of the line of sight of the producer (who is concentrating on what is going on through the glass and doesn't want anything up front) is a telephone booth. When the light lit you could go over and have it open when you stepped on a certain place. Or you could just touch the wall and the door would open and you walk into the isolated phone

booth; the door closes behind you, you talk on the telephone without interrupting the control room. It doesn't cost much in comparison with the disturbance to the producer's thoughts.

And then the hangers-on: supposing the producer says: 'I don't want the people in front of me because it distracts me. They turn around and talk, they jump up and down . . .' You must sit dead centre of a quad room as a starting power reference. You can mix stereo or quad in any 90° position you like. You have four positions in that room by turning your head 90° you can mix off the side wall 180° you can mix off the back wall and still another 90° you can be off the other side wall, or you can flip around totally and you have done a 360° and you are mixing off the front wall. That is what a symmetrical control room is all about. Aside from its uniform performance it allows you that kind of flexibility of positioning of your console.

Basic listening area

If you are sitting centre and the console is forward of you with a depth of maybe a metre, forward of that is an area that you might put pillows down for people to lay down or sit on below the console and out of the viewing area of the producer. But the basic listening area, because the high end is shooting over the head, is behind the engineer. Now you have got a control room where you can sit in the centre and move back in the room in a sit down position and not much will change. This means that the hangers-on can now sit behind you and hear the same thing as in the mixers chair.

There is then a problem with them sitting behind you: they will want to look out of the window, or look forward. Some of them will be looking forward and the *ss* from their voice will carry forward and disturb the producer. You don't want to hear reflections off the console amplifying voices, murmur and garbage coming from the back. Supposing your control room had a little excavation of maybe 1½m in depth, given 4m from the centre of the room to the back. Put a rope around it so nobody falls and breaks their neck. Take old brick and line it around the carpet for maybe one or two layers. Then you build the floor of concrete, brick-face or carpeted so that it is attractive and natural looking; line it with rope and pillars of colour corresponding to drapes and so forth in the room. Say to the listeners 'There is your pit, get down there and you will hear everything that we hear in here'. Remember, too, the low end is not necessarily stronger on the floor than it is in the middle or the top of the room with this type of two-dimensional room. So the balance is essentially good on the floor behind you. Now their mouths are at floor level below the ear level of producer and engineer's. This means that their conversation is going to be attenuated.

Another thought in working environment. Elevator people have for years been taking ropes and cables carrying electricity for lighting, telephone, emergency access for the outside world in the event of car stall. They have been hoisting these electrical lines up and down for years over 80 and 90 storey buildings. Why not try a hydraulic lift under your console that would hold it at normal position but would allow you to drop it down so that you could lay out cushions in front and you could really lay down and mix; you could sit or kneel depending on inclination. It doesn't cost much to put in that sort of a system.

These are typical things that can be done to make your environment pleasant, both acoustically and aesthetically, from a human point of view. Given more and wider thought, you can produce a more acceptable, liveable, pleasant and desirable place to go. Naturally, this means that you are going to sell more studio time. And you are going to turn out a better product as a studio owner, and as balance engineer.

Think for a moment about your objectives as a studio owner in selling time, as well as in turning out a good product. Incorporation of other things within the studio complex, not necessarily in your control room or studio, will sell more time. Typically, people book from let us say, two in the afternoon open ended or four in the afternoon open ended. As a studio owner, you know that you are pretty safe up to midnight but it becomes grey from midnight on. Come two in the morning they are a little tired, after 12 hours. Supposing they were able to walk out and take a jacuzzi, a bubble whirlpool at maybe 105-108°. They have got a stiff neck, bad back or whatever. They get into the jacuzzi in their bathing or birthday suit and relax, then out of that into a cold shower. You provide them with shaving equipment. Suddenly they have got their second wind and it's just two or three in the morning and they are ready to go on. They really want to get back and hit at it. Instead of going home they are going on with your facility. They go back into the studio, you are still selling them time and when your maintenance crew arrives at eight in the morning, they are still going to be there working at whatever your rates happen to be. Now *that* is marketing. Laugh if you like. but you can put this sauna and jacuzzi and shower in for $5,000, £2,500.

As head of maintenance at the LA Record Plant, I have walked in at ten in the morning and said hello to that group that started at two the afternoon preceding. The man that originally thought of this is Gary Kellgrun. When he presented it to me and I said, 'Gary you are out of your head.' We did it, it made money and it helped our environment. Helping your environment is helping your pocket book, and it is also helping the product. You want also to give them some other action? Give them a pinball machine, a one armed bandit, give them a refrigerator stocked with tomatoes, lettuce, mayonnaise, some cold cuts, cheeses and that sort of thing. They will make their own sandwiches. They are not going out to get dinner, get tired and say, 'Let's call this session and go home.' They are going to make their sandwiches and keep working. Because it is right in your canteen facility. Maybe those sandwiches have cost you about $25 for the evening, but if you have sold another 15 minute's time, which you will do while they are making the sandwiches, it pays for itself. If you sell an extra eight hours of time when they don't feel hungry because they have eaten and taken their bath, sauna, shower and shave, that is real money in your pocket. Jacuzzi and shower will pay for themselves within six months or less. The producer will go home content, and will want to return because it is coming home—*it is comfortable.*

Zoom

'Audio visual', whatever that may actually mean to you, persists in the basket left on the doorstep of the mass media industry, whatever that actually means. On one side is the establishment of large tv conglomerates and corporations, with massive investments in a proven and domestically accepted field. At the other extreme is the video cassette revolution. yawn, after which every household will play their own selected items from a wide library of software or be able to repeat 'Crossroads' until it gets boring. There are fewer optimists along those lines now. In the middle is an acknowledged grey area inhabited by a very small number of video studio operations, existing to serve business applications for inhouse documentary programmes such as company reports, sales pitches or instructional tracts. Or to produce tv programmes for normal distribution, as far as the union rulings will permit.

Zoom Television is one of just four or five such in London and among the most successful and well-spoken of those, although existing on a basis far from as tenuous or as lacking in colour as the intro might suggest. The strength and dominance of the film industry in the a-v side at present is one reason why plants have to be very strong to survive in an all-video climate, but another is the considerable amount of hardware investment which in Zoom's case turns out around £¼M. Ally that with a total staff of just 64, of whom only 16 are located at their Holborn studio, and you get a better idea of the production demands.

Although their orientation now is completely professional and industrial, there was the *de rigueur* opportunist beginning. One of the growth points was in providing an instant record/replay service for pro golfers and flush amateurs concerned with improving their swing. Such applications are still served by others, and parallel video applications include soccer clubs and racehorse trainers, for their own analysis purposes.

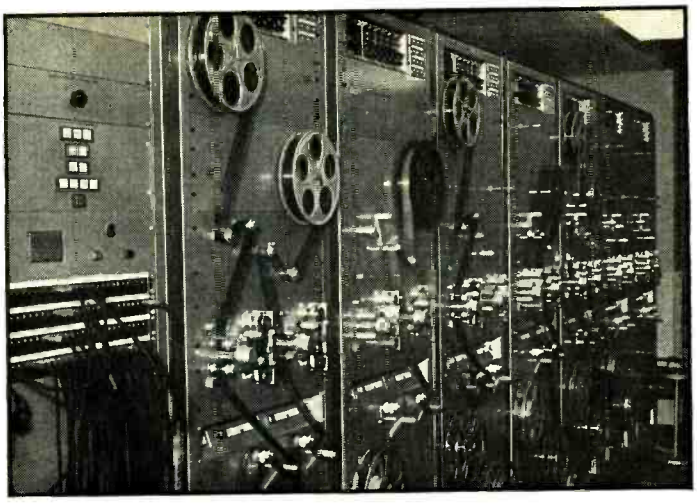
But golf is many years past. The staple diet of Zoom now is the commercial information and propaganda mentioned above, with a particular emphasis on speed of dissemination. Thus, an urgent presentation such as a company report may be recorded in a morning and / or afternoon, edited immediately and copied through the night as many times as required; and the studio reports that the demand for this type of service, far from slackening with the all pervading crisis, is actually increasing. The mechanism suggested is that of companies realising the need for an information flow, perhaps instituting it on a traditional film basis, and then calculating that costs could be cut and processing speeded by moving to video production.

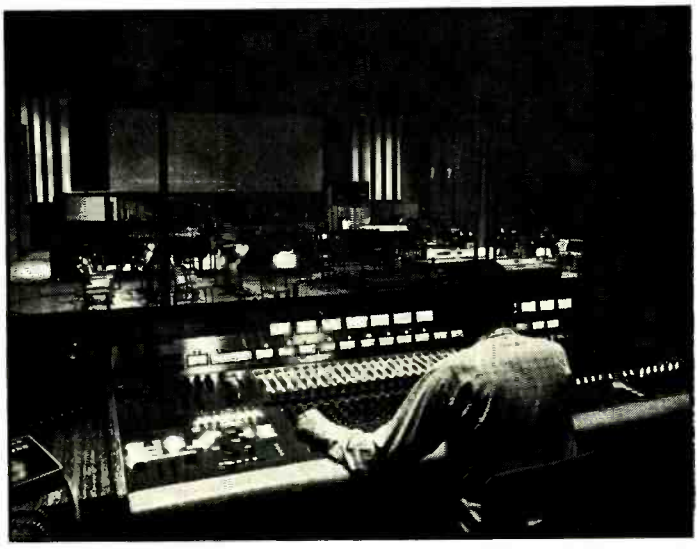
In-house production is of video master, with facility for limited cassette copying. For large runs, PO tie lines are used to the more extensive duplicating facilities of Specialist Duplicating Houses, about a mile away. If their description of the installation procedure for the tie line terminals is anything to judge from, their actual initiation must have been a triumph of sorts after many months and more Post Office departmental gentlemen had come and gone. But now, all is past and the terminals are in constant use.

The link is not just used for outgoing signals. Remote facilities can be offered if a sighting of a microwave link is possible, a reasonable expectation in the London area, where the Post Office Tower is visible from most places. Such an exercise was a recent Intervision promotion of Showaddywaddy playing and performing at the Penthouse Club, across the other side of town. For this, the production team were on location, the signal being beamed at the Post Office Tower and thence collected and fed down the land line to Holborn. Once collected and recorded, everything became as normal, in so far as any correlation of video and music is ever predictable or easily worked out. Jon Hocking, technical director, wonders about the compatibility of stereo and the screen: not entirely the usual domestic limitation of Carnegie Hall live in your sardine can, but more a problem of sorting out camera/mic shots such that the two images, audio and vision, correlate.

These are problems that certainly

Top left: *General view of control room, including audio and vision mixing equipment.* **Below left:** *Master video tape recorders. Rank Cintel 9000s.* **Below:** *Telecine area including Sony and Philips video cassette equipment and 35 mm flying spot scanner.*





Above: *Dubbing console, dubbing room 5.* **Top right:** *Magnetic film duplicators. Machine room for dubbing room 5.* **Below right:** *Recording as seen from the control booth, which houses the music mixing console.*

need solving if those trite dreams of music plus vision cassettes are to be realised, although the main requirement may end up in music promotion. Already, the company has produced sales pitches for Phonogram, although these remain as yet effective documentaries with background music of particular interest. Still, the sound quality in mono remains appalling out of three inch speakers, so unless the application is specialised there won't be too much demand from the hi-fi freaks. Which leads on to the usual discussions. 'But you're producing to a budget, and the sound is secondary, unfortunately. Certainly, you can have good sound, but no-one wants it, when they realise what it costs.' At the production end, however, Zoom provide a high-quality audio master automatically.

In comparison with the banks of video screens and recorders, which include two Rank Cintel 50 mm machines, the sound equipment dithers a bit: an early Midas 8/1 desk takes the largely capacitor (eg AKG *451* and Sony *ECM 50*) mic feeds from the single studio. An elderly Studer ('maybe, but it's never broken down') complements a TRD ('horrible machine, we've had to cannibalise the other one for spares since they went out of business'). Audio is dwarfed technically and visually by the simple but useful special effects function generator custom built for them by Michael Cox Electronics and offering the necessary shaping and auto-fades and blends. The main vision mixing is in the room behind that facing the studio, the control room effectively split into two concentrated halves.

But the overall impression always seems to be of a neatness and fastidiousness: this judged on the feeling when you walk through the front door of a studio and which, if it isn't there, no amount of great production will create. There is also a comfortable immediacy about the place—another quality also very precarious in the visual world and which, in some areas, is patently non-existent. Perhaps this reflects their position in the forefront of innovatory technique; whatever, it's hard to believe that things will go other than well for them, even if only on extrapolation of the present rate of expansion.

Michael Thorne

Another Star is Born

I've had the opportunity on some occasions to lean over to a friend during a film screening and say 'how do you like the music?'. A lot of times I'm met with a curious 'what music?' response. And then, other times the raving about the music track overshadows the fact that even a film is on the screen. Music, or the role of music in films is a funny one. When used properly it complements and heightens the action on the screen; when used as an obligatory afterthought, it's mushy and awkward.

The process by which the music makes itself apparent is a long and sometimes laborious one. I say sometimes because the excitement surrounding film-scoring sessions gets fever-pitched. However, with all the excitement the air is mixed with nervous apprehension that the track will undoubtedly never sound the same on the big screen as it did in the studio, and the end results are somewhat anti-climactic. The frustrations and hopes of the soundtrack came into realization one day during a planning session for the upcoming remake of *A Star Is Born*. This marks the third revamping of the film since 1934 with Janet Gaynor and Frederic March. This time, the movie takes on a new air by becoming a full musical.

The man in charge of putting the music together, arranging and co-producing it is Rupert Holmes. He is no stranger to film scoring, but this is his first really major project. Together with Jeffrey Lesser, his long-time co-producer, engineer and friend they are poring over the ideas for the score, and most importantly, the arrangements for the recording itself.

'A lot of people never realize that most of the music in a movie is faked in the recording,' Holmes' past experience with film scoring was primarily with low budget features and last minute races with the release date of a film where one musician assumes the role of four and where double tracking turns a four-piece unit into a dubious substitute for the Vienna Philharmonic.

Anyone who has remotely worked with the film medium has realized the limitations of the quality of the soundtrack itself. The major complaint was a release print with a mushy track. Fortunately in recent years many drastic changes have taken place, and with the forefront of these change. seems to be the Burbank Studios' Opened in November of 1973 and headed up by Jim Winfree, TBS Record Recording Administrator and Al Green, TBS Post Production Sound Director, it boasts to be the best equipped studio in the world. The initial scoring console comprises no less than 50 microphone inputs, 32 line inputs, automated mixdown capabilities and logic systems, 32 direct outputs and 32 quad (yes, quad) pan pots. In essence everything you need to cut an album is sitting there, only the end result winds up on screen. The sound is notoriously clean, and even though it may eventually suffer from the inevitable transfer to optical track with its ever present 7-10 kHz ceiling it main-

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tains a better-than-average overall quality. Subsequently, the Burbank Studios are constantly being used by the other studios because of their great sound, most recently and most popular at the moment is *Jaws*, and you *know* how good the sound is on that one.

The hard part of this whole session is realizing that with 50 mic inputs, 32 line inputs and 24 track recording, it's all going to wind up in mono. For the old-line Hollywood engineer who got his start mixing during the 'Golden Days at Metro' where everything centred around one microphone to be fed to an inside-outside 16in transcription cutter whizzing away at 78 rpm, the transition to this multiple mic setup causes no problems. Even the engineer of the pre-stereo days has no difficulties putting everything in perspective for the one-dimensional eventuality. But the engineer whose been fed a strict diet of stereo and quad will find himself in a rather precarious position, but as is the case of the Hollywood sound stage there are *very* few young sound mixers, and the older ones never divulge their secrets.

Back to the movie. When the production gets under way, and when it finally comes down to the scoring, which is the last item on the production schedule, Holmes and his crew will have roughly three weeks to assemble a working track. This three weeks constitutes the work of about six months worth of composing and rehearsals (this *is* a musical by the way).

The vocals will be recorded before the scenes themselves are shot; this way they serve as a playback for the lip-syncing that will take place during those scenes. The rest of the music will be recorded at the tail end. The other interesting point about the scoring session is the exactness that must take place, many times at the cost of umpteen takes. Recurring themes throughout the picture help heighten whatever suspense or emotion that particular scene is projecting; they all have to be recorded. And if one passage is 5.9 seconds long, it has to be 5.9 seconds long or else the effectiveness of the track is lost, so as a result the track must be gone over again and again to arrive at perfection. Of course all the conveniences of film playback during recording and digital countdown clocks make the job a little easier, but more than often is the case when a composer has physically to delete passages during the recording due to errors in timing.

Back to the anti-climactic part. Since sound movies began there has always been trouble of getting an adequate sounding mix on the screen. The optical track on a movie has never had a 'state of the art' status to boast of, and even though the magnetic track has been widely used the problem inherent with this system is purely in its breakdown in the individual theatre. Magnetic playback systems are simply not maintained enough to make them certainties. A projectionist is more likely to replace a burned out sound lamp because an audience is yelling at him than he would clean or replace a magnetic head. So with that problem in mind a new system has been devised using one of the new household words in the recording industry: Dolby, as mentioned in the discussion of Elstree Studios (August). So far with its initial premiere with the movie *Steppenwolf* and its howling success with the film *Janis* which the audience swore was a stereophonic track, the Dolby system is being used more and more frequently in the industry.

With this nuance walking in the door it is very likely that *A Star Is Born* will be recorded using this process and it would only seem logical as the movie is a musical therefore relying heavily on the cleanest possible track both in record and optical playback. Although the system is in its embryonic stages, with many engineers and directors giving it more than the average once over, the Dolby system of theatre playback is a major breakthrough on the market at this moment. It is relatively inexpensive for the average theatre to adjust to, more so than the magnetic-track system which requires a complete conversion rendering it incompatible with an optical track. The other problem with the mag-track playback system is the high cost of duplication of the film itself; many labs are not equipped to process 35 or 70 mm magnetic release prints.

So, for the time being, the optical track is the standard of the industry. The scoring session has become more sophisticated now than it ever has been, but the end result is largely the same with 100 Hz on the low end and 7 kHz on the high. Both the engineer and the composer have to be increasingly aware of whatever losses a particular instrument might incur. Of course, a weak instrument can be mixed higher to bring it out, but if the final transfer leaves it without the tonal colour that was intended the effect is lost, therefore then instrument goes through a preliminary eq check of how it will eventually sound. If the sound isn't what is needed the track is equalized until it does achieve that colour that is needed.

The process is laborious and not free of sweat, but if half the stimulus of a movie is the use of sound and music, there is no way around it. Face it, *Jaws* wouldn't be very much if it was a silent movie; there again neither would *The Exorcist* or *Psycho*. Nobody takes sound as an afterthought any more, fortunately, for it too has the power to make or break a movie. If they play their cards right, Rupert Holmes, Jeffrey Lesser and the Burbank Studios can add a third classic revamping of an already classic film to their credits. And that's worth the price of admission alone.

Gordon Skene

Round House

The Round House recording studio isn't actually in the Round House or run by the Round House. Instead it's in a large new office block next to the Round House, at 100 Chalk Farm Road. This will come as something of a relief to anyone who has encountered the somewhat halfhearted and casual babies-nappies-in-the-box-office organisation that pervades the old engine shed.

There is certainly nothing halfhearted or casual about the way the Round House Recording Studio has been put together and is being run. There are close links with the Bron Organisation, whose offices occupy the floor above the studio, and it is obvious from the start that Gerry Bron and studio manager, Peter Gallen, are in business to run a tight but comfortable ship. The original idea was to build a studio that took into account all their own likes and dislikes; they reasoned that if the result satisfied them it was likely to satisfy others. One very obvious mutual like is space, and another is comfort. The single studio is spacious and deep-pile carpeted, with the clever idea of sections of the carpet tailor-made for removal to expose a hard floor underneath and so provide acoustic bright spots. The control room, which is several feet above the studio, must be one of the largest in the world. On split level, it has 24, 16, 4 and 2 track decks at the high rear, a Cadac 32 in, 24 out desk in the centre and a large free area at the low front which is dominated by a pair of Cadac monster monitors. This control room can easily hold 30 people and 40 were in at one time during the APRS exhibition.

But all this space had to be hard won. The original basement was far too shallow for a spacious studio, so the original concrete floor was dug out to a depth of around five feet. The bulges round the walls are pillars, which couldn't be dug out because they were holding up the rest of the building. Likewise, Gerry Bron kept on pushing out the walls of the studio control room into the corridors outside, until finally the GLC Fire Inspector said 'stop'.

Starting from the premise that anyone with money and premises can create a studio of sorts simply by running through the standard shopping list of equipment, only a note of the extraordinary now makes interesting reading. In this context, it is well worth mentioning the foldback system worked out by Peter Gallen, Cadac and Eddie Veale. Spaced around the studio walls there are four panels, each with a multipoint cable connector for a custom-built foldback junction box. There are six of these boxes, which can be plugged separately into the wall sockets or one into the other. Each foldback box has jacks for six pairs of cans, and an output for a matching loudspeaker on which it can stand. The foldback feed from the wall provides four separate channels of sound from the desk and each junction box has four separate controls, each operable on one of the four channels. In this way each junction box can provide its speaker or cans with its own individual foldback mix. Take, for instance, the simplest possibility, of a four-piece group. The four-channel foldback feed would carry each instrument separately on its own channel, and a musician with a junction box could control the relative mix of those four instruments into his own cans or speaker. More realistically, the four foldback channels can, for instance, carry voice, rhythm section, strings and brass, so that the musician can kill or boost voice or strings or brass as he wishes. It's a nice idea that saves everyone time and it keeps the musicians happy by giving them a hand in the mix they want.

Other interesting points are the provision of earth leakage circuit breakers on all the mains supply, so no one can get a fatal shock through a belt from a live connection running down or across them to earth. The tape storage room, being relatively cramped, has its storage racks on runners, so that anyone looking for a tape makes his own passages through the store. There is also a direct audio and video feed to and from the Round House proper, so that recordings can be made of Round House stage events under the eye of a remote controlled cctv. Although the cctv

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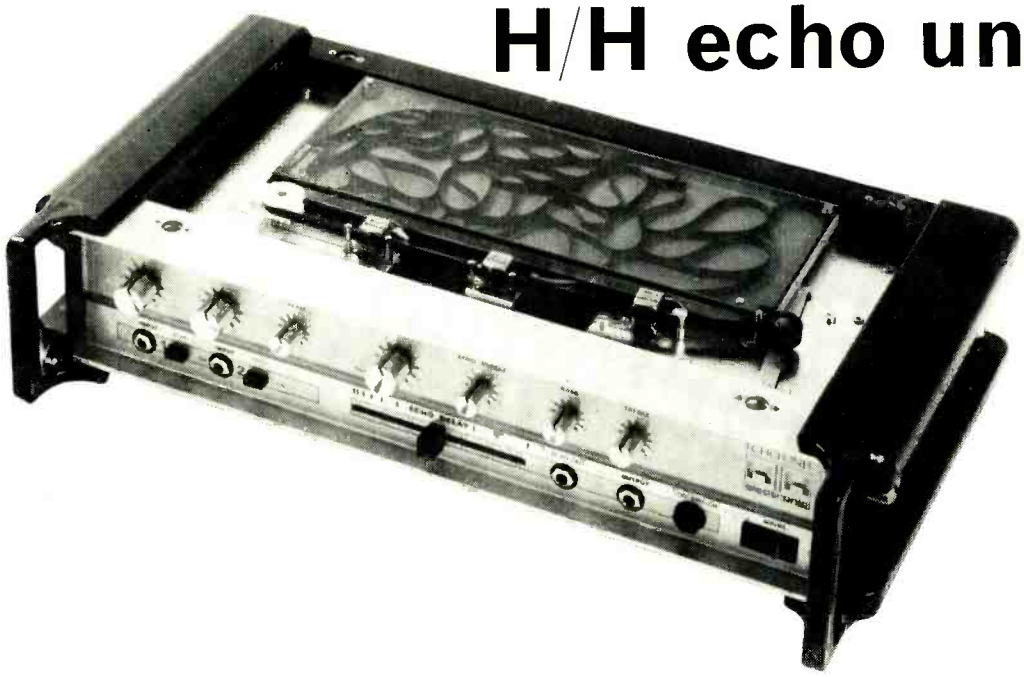

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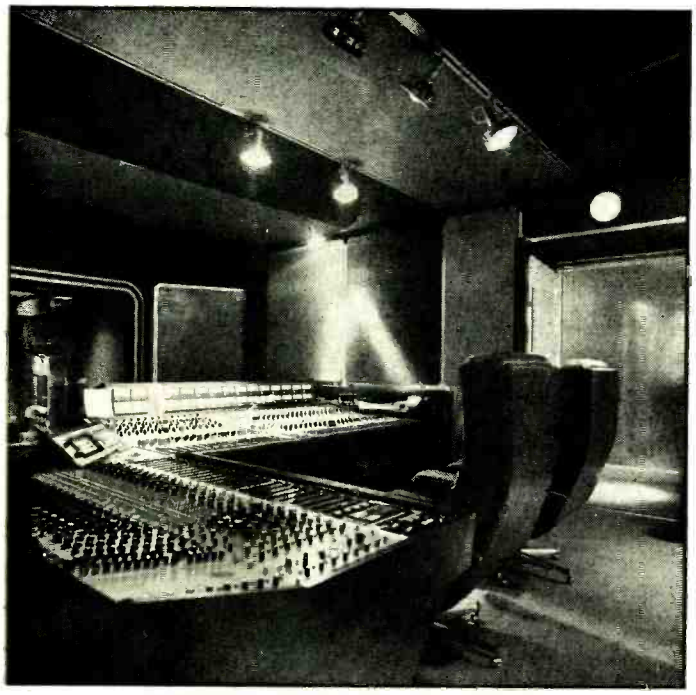
isn't fully operational yet, the audio lines have already proved themselves on a live recording of Richard and Linda Thompson. The system may also provide pa for the Round House stage.

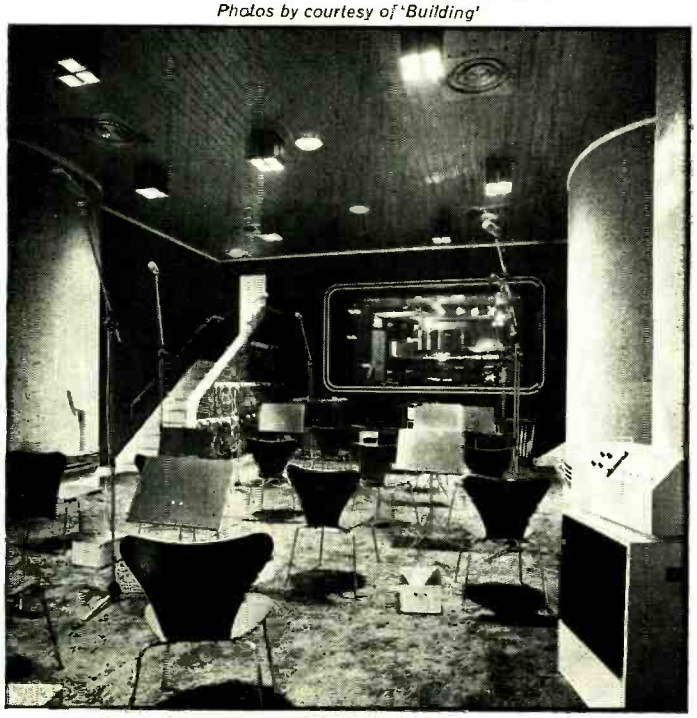
Although the studio has at the time of writing officially only been open for a couple of months, it is already fully booked up a couple of months ahead. As is currently a familiar story from new studios, all the equipment has the now obligatory full quadraphonic capability, but no record producer as yet has asked to use it.

Adrian Hope



Round House—Phantom of the Opera mid take

Photos by courtesy of 'Building'



De Lane Lea politics again

After one of the messiest episodes in their history, staff and management at De Lane Lea's Dean Street Sound Centre have reached what both seem to regard as a new spirit of co-operation. In a statement issued on October 1 announcing that agreement had at last been reached on the redundancies the management had wanted, Mr George Philips, Chairman of De Lane Lea Ltd and joint managing director of Humphries Holdings, De Lane Lea's parent company, said 'I am delighted that management and unions have been able to sit down together and reach this very sensible first step. We hope it will be the last step—and if the industry picks up significantly and the various measures we are taking to obtain more business are successful, it will be'. The statement went on to say that the redundancies, which had been reached voluntarily, had reduced the staff to a more compact unit and certain promotions had been made internally with the full agreement of the trade unions. 'The unions and the management are looking forward to a spirit of co-operation.'

The statement was issued about a fortnight after the resignation of Roy Sonnex as chief executive of De Lane Lea and the appointment of Adrian ('Andy') Worker in his place a year almost to the day after the staff and unions had reached a previous agreement to consult about the future running of the studios.

Last year's agreement followed a series of protests and demonstrations after the publication of the annual report of the Humphries Group for the year to March 31 1974 in July that year. A paragraph in the report of the Humphries chairman, Mr William Dravers, had said that discussions were in progress for 'the possible disposal of all or part of De Lane Lea'. The De Lane Lea Board had not been consulted. During the subsequent furore, Humphries' managing director, Mr John Nutman, described press reports about the sale of the Dean Street premises as having 'no bearing on the truth' (STUDIO SOUND November 1974).

In September 1974, agreement was reached at a meeting between the Humphries chairman Mr Dravers, the managing director Mr Nutman, General Secretary of the ACTT Alan Sapper, ACTT and NATKE shop stewards Swanscott and Amos, and the chairman of the joint NATKE and ACTT shop, Ernest Cousins. The meeting set up a joint consultative committee between management and staff, and the management agreed to keep Dean Street open with the same staff for a year.

It's been a troubled year. To begin with there have been constant management changes. The first, reported in the Financial Times on St Valentine's Day, was that of Roy Sonnex as director and chief executive of De Lane Lea. A few days later it was announced that the managing director of British Electric Traction, Mr Hugh S. L. Dundas, had taken over from the retiring Dravers as chairman of Humphries. These two appointments were, for different reasons, responsible for a great deal of what followed. Mr George Philips was appointed to the Humphries Board with effect from March 1, joining Nutman as managing director shortly afterwards. Nutman moved into the background, taking over responsibility for the manufacturing parts of the group.

It was widely thought that Andy Worker would immediately succeed Jacques De Lane Lea, who had resigned as managing director of De Lane Lea in October 1974, but the appointment of Roy Sonnex as chief executive came as a surprise. To begin with, his previous experience had been in television, and this aroused fears for the future of De Lane Lea as a film centre. The bread and butter of the film business has been in advertising and promotional films, but in recent years two things have chipped away at these sources of revenue, causing severe hardships not just for De Lane Lea but for other film studios in Wardour Street. One has been the economic decline. This has meant not that the public has been subjected to fewer television advertisements but that that fewer are made, each having a longer life. More repeats cut advertising costs for the equally economy-hit manufacturer while keeping his product before the public, yet mean less business for the film studios.

The second has been the introduction and growing use of videotape, which has meant the young turks in new-fangled companies like Zoom have been taking an increasing proportion of what the economy leaves. To introduce a proselytiser of the value and importance of videotape in this atmosphere, aggravated by poor industrial relations, was a gross error of tact.

In a sense, though, this might have been overcome if it had not been for two additional factors. The first was that the staff were, until very recently, sceptical of the effectiveness of whoever was in charge of Dean Street. They didn't think it mattered who had the job because he would simply be at the mercy of BET, the conglomerate that owns Humphries, and the appointment of Dundas as chairman of Humphries seemed to confirm this. This suspicion on the part of the staff has probably been the biggest obstacle to co-operation between them and management.

That is not to underestimate the

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Evaluating loudspeakers by way of listening tests seems thoroughly logical. After all what better way is there to appreciate food than by eating it? The straightforward comparative listening test is simple to arrange. One only needs a programme of favourite recordings, an adequate amplifier and the test loudspeakers. This procedure is in daily use all over the world by high fidelity enthusiasts, studio engineers, magazine reviewers and dealers. The only drawback is that the results are not consistent. Studios are at variance in their choice of monitoring speakers and few audio magazines agree on their recommendations. There appear to be some sizeable pitfalls which require illumination.

Loudspeaker Listening Tests —useful or misleading?

RAYMOND E. COOKE*

LOUDSPEAKER listening is a three dimensional experience. A functioning loudspeaker radiates sound in all directions due partly to diffraction round the front face of the enclosure and also by vibration of the supposedly dead cabinet walls. These effects are of course frequency dependent because the enclosure is of negligible size compared with the wavelengths of low frequency sounds and yet represents a considerable obstacle at high frequencies. Panel vibrations are likewise frequency dependent resonance effects. In normal listening rooms, part of the sound is perceived by direct transmission, but substantial contributions to the overall effect are heard after reflection from the walls of the room and any large objects present. These contributions vary according to the distance between the listeners and the loudspeakers and the distance between the loudspeakers and the nearest reflecting surfaces.

Let us consider for a moment a very bad situation which is frequently encountered in dealer's demonstration rooms up and down the world. It is the so-called 'speaker wall' in which perhaps as many as twenty pairs of loudspeakers are stacked one on top of another. The sound quality of each loudspeaker will be modified by one or more of the following factors:

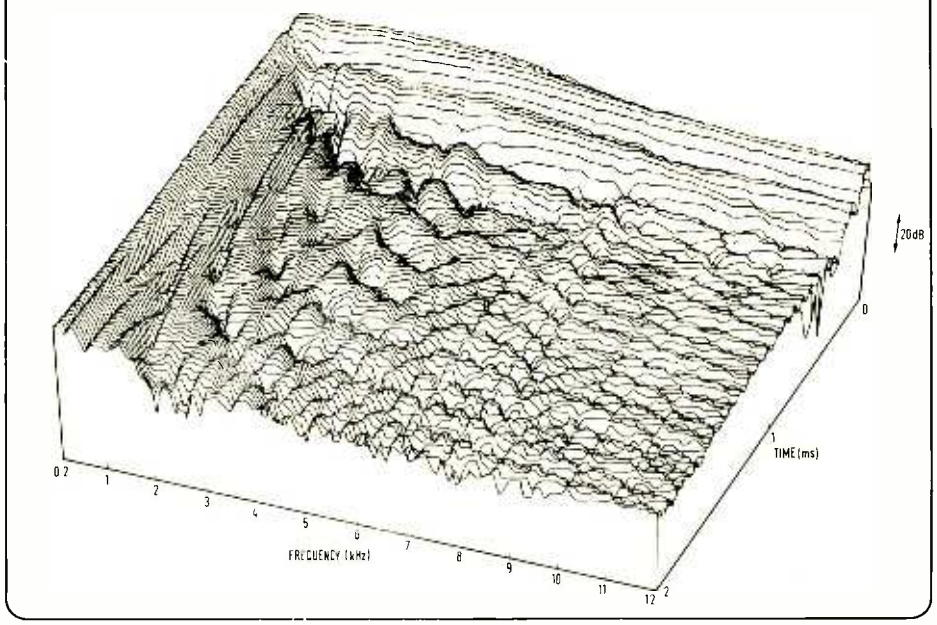
1. Cabinet panels which are touching each other, or touching the walls of the room, will be damped and therefore will not vibrate in the same way as when free standing.
2. Diffraction effects will be modified appreciably by the presence of adjacent speakers.
3. Sympathetic vibrations will be induced in all the other loudspeakers by the pair which is actually performing. The effect is similar to standing the speaker on a grand piano with the dampers off.
4. The degree of low frequency reinforcement contributed by floor or ceiling reflections will vary considerably with speaker location.
5. Widely separated speakers will excite different groups of eigentones.
6. Cavities between speakers will tend to resonate.

This kind of test or demonstration is in fact so hopeless that it should never be attempted on a serious level, notwithstanding the fact that it is so widely used.

It is of course possible to refine listening test procedure in such a way as to remove many of the serious objections outlined above. The most important refinement is to reduce the number of speakers under test to two pairs. The speakers are arranged out of contact with each other and free of obstructions. All other loudspeakers not included in the test must be outside the listening room to obviate sympathetic vibrations. The speakers under test are then located at their correct design heights using stands or bricks as suggested by the manufacturer. This is most important because not only is the low frequency performance affected by mounting height, but the general character of the mid-range response is also liable to change round the vertical axis. The left and right hand speakers should be grouped close together two to three metres apart and as far away from the room boundaries as possible.

So far so good, but we are still left with the acoustics of the listening room and its interface with the loudspeakers. The object is an impartial assessment of speaker performance and this requires an impartial listening room. There are few of these in existence. Certainly, no domestic room can be considered to be neutral in acoustic ambience. Structural resonances, lumpy absorption characteristics and inadequate sound diffusion are inevitable except in specially constructed listening rooms. One such room was built twenty five years ago in the BBC's Research Department at Kingswood Warren. It measures 6.5 x 3.8 x 3.2 metres high and is equipped with specially designed broad band absorbers which give the room a reverberation characteristic which varies smoothly from 0.35s to 0.30s over the range 62 Hz to 8 kHz. There are various protuberances to assist diffusion. The excellent characteristics of this listening room have probably had a greater influence on the quality achieved by BBC

FIG.1 CULMULATIVE DECAY SPECTRA FOR HIGH QUALITY 110mm PLASTIC DIAPHRAGM MID-RANGE LOUDSPEAKER



*KEF Electronics Ltd, Maidstone, UK

designed monitoring loudspeakers than any other single factor.

A frequent false assumption in listening test procedures is that peculiarities in listening room acoustics will affect all loudspeakers to an equal extent and may therefore be overlooked. Nothing could be further from the truth. Speakers which sound nearly alike in one room may sound wildly different in another. There can be many reasons, but the most general cause is the way the room deals with the diffuse sound radiated to the back and sides of the loudspeaker. We listen not to the loudspeaker alone, but to a combination of speaker and room. No matter how hard we try, it is impossible to dissociate the speaker from the enormous influence of the listening room and rooms which have characteristic acoustic effects can completely alter the order of preference for loudspeakers in listening tests. A recent paper by Henning Moller[1] gives some interesting sidelights on listening tests and shows that results are strongly dependent upon the room.

Having located two pairs of speakers correctly in a neutral listening room, another problem area has to be considered in choosing a test programme of music and other sounds. There is a strong temptation to use familiar recordings of favourite music on the grounds that repeated playing impresses a kind of standard performance on the memory. Experience shows that this is not a safe basis of procedure. Commercially recorded sounds are rarely natural these days. Varying amounts of frequency distortion, reverberation and even non-linear distortion are deliberately injected in pursuit of special effects and to achieve a sound quality which is 'different'. This is not a criticism, for it is well understood that touches of added ambience contribute to the success of a record, but such artificial sounds are useless for testing purposes since there is no basis for comparison. Classical or light music remains a safer choice of programme material for listening tests especially if it has been recorded using very simple microphone arrangements. By far and away the most reliable test is to compare the reproduced sound with the original live sound. This can only be done effectively in recording and broadcasting studios where there is easy access to a variety of live source material. Male speech also reveals a wide range of loudspeaker faults and is relatively easy to record for comparison purposes. However it is essential to use a high quality mic, preferably an omnidirectional type, and to record in an anechoic chamber or out of doors in a quite location.

Without the safeguard of reliable source material and a live standard of comparison, listeners will tend to prefer those loudspeakers which most nearly compensate recording faults or reproduce the programme with some arbitrarily preferred balance.

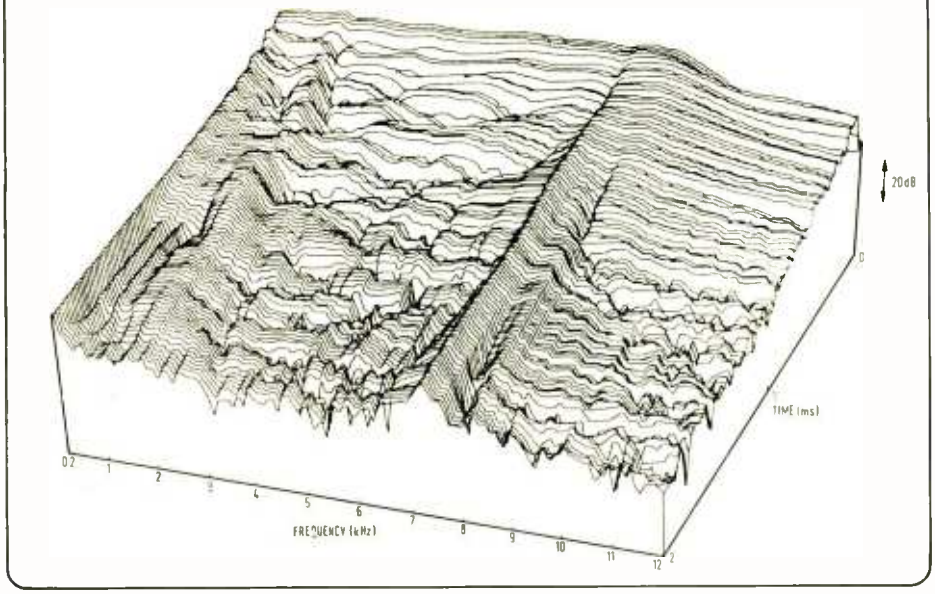
Even when highly refined listening procedures are adopted there is plenty of scope for error if comparison with live sounds is impossible. An example recently demonstrated by Harwood[2] indicated that listeners could be persuaded to believe that a high quality loudspeaker suffered severe mid-range colouration by comparing it with another which had a sizeable mid-band crevasse in its amplitude-frequency characteristic.

To summarise so far: loudspeaker listening tests are greatly influenced by local acoustics. Speaker preferences are strictly related to specific surroundings and particular programme material and may not necessarily apply in other circumstances unless very great care is taken to achieve neutral acoustics and naturally balanced programme signals. It is also worth emphasising at this stage that listening tests are strictly limited in what they reveal. Important aspects such as non-linearity, power handling capacity, reliability and consistency of performance are not touched upon.

Studio Monitoring

The selection of monitoring loudspeakers for sound balancing and quality control in professional recording and broadcasting studios presents an interesting extension to this discussion about listening tests. There are two schools of thought here.

FIG 2 CULMULATIVE DECAY SPECTRA FOR 110mm PLASTIC DIAPHRAGM MID-RANGE UNIT AS FIG 1 BUT WITH INDUCED FAULT



The BBC in England has for nearly 50 years advocated a policy of natural sound reproduction at realistic volume levels and championed a breed of loudspeaker developed especially for this purpose. Both policy and speaker technique have been widely accepted with the result that British sound and British loudspeakers have become world famous for their naturalness, transparency and neutrality. Nevertheless, many people find this approach rather dull and prefer to improve on nature by raising the volume level and peaking up the mid-range to give a more forward sound. Producers of pop music and hard rock are increasingly of this persuasion and justify their attitude by claiming that faults are more readily detected at high volume levels and that boosted mid-range reveals more detail in the music. The results are contrary because prolonged exposure to high level sound actually reduces the acuity of the ear, making low level faults relatively less likely to be detected. The only exception is that of background noise which is of course revealed when the gain is increased. Boosted mid-range, or for that matter, any frequency distortion in the loudspeaker, may result in a balance which is generally unsatisfactory when the programme is subsequently heard on high quality equipment.

A common feature of almost all so-called high level monitoring speakers is that mid range efficiency is obtained at the expense of low frequency extension. Such speakers are generally over-damped and the bass rolls off from as high up as 80 Hz. In this condition it is impossible to reveal rumble and other low frequency faults and the use of such speakers probably accounts for the considerable number of records which are faulty in these respects.

A disturbing aspect of pop music monitoring is that there is no point of reference since even the studio sound is either electronically amplified or close miked and electronically mixed. Adrian Hope[3] has recently written a thought-provoking article on this subject in which he questions the value of an accurate approach to an original which does not exist. But there must be some point of reference otherwise we are in danger of drifting further from reality and our audio world will become as distorted as Alice's Wonderland. Perhaps an acceptable solution would be the use of 'flat' high level monitoring speakers, as technically perfect as human knowledge can make them, but fitted with electronic curve benders to simulate currently used models which are probably more fortuitous than scientific. At least by this means we could keep our feet on the ground and still be able to enjoy the excitement of a 'souped up' performance.

Digital Measuring Techniques

The notion of a technically perfect loudspeaker naturally leads to concepts of measurement and recent attempts to correlate subjective assessments of sound quality with objective measurements. For many years objective investigations have been confined to simple steady state frequency response measurements. Earlier attempts to investigate performance in the time domain have been thwarted by poor signal-to-noise ratio. Advances in digital techniques have made it possible to obtain high definition impulse responses for loudspeakers

Last August, the author discussed methods available for sound level measurement, together with areas of doubt. But the actual institution of level restrictions, already confused with scientific and moral difficulties, has been further complicated by ill-advised legislation which, in retrospect, may appear as inadequate as that for prohibition in the 1930s.

Hearing damage again: politics and persuasions

ADRIAN HOPE

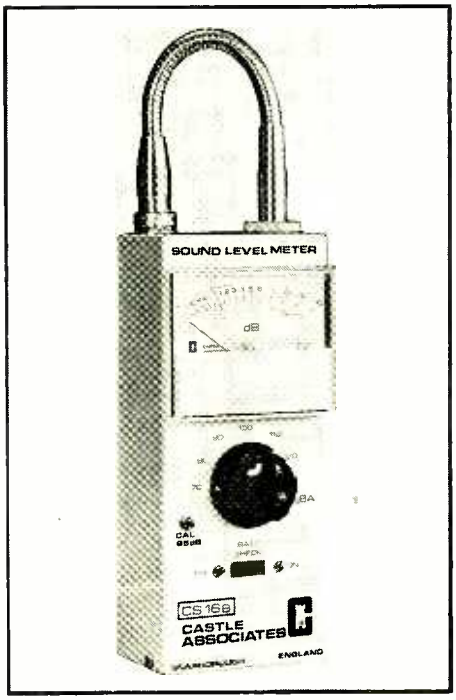
EVERY time I pass through Leeds, Yorkshire (population around half a million), I make a point of buying the local newspaper. I turn immediately to the entertainments page, and find always the same thing—not a single advert for a pop concert. Despite hopes and hints to the contrary, Leeds still sticks to the sound level limit imposed a few years ago, which makes any musical sound with a maximum level of over 96 dBA illegal. Any day now the Greater London Council may formally impose slightly higher but equally unrealistic limits on the eight million people living in London. In years to come it is likely that these initial attempts by Leeds and the GLC to legislate on the sound of music will be compared to the American attempt at prohibition —well intentioned but absurd. Well how else would you describe legislation that, in seeking to protect the public's ears from the obvious risk of excessive exposure to dangerously high levels of sound, at the same time unwittingly outlaws an unamplified trumpet heard from the second row of a jazz club, or a Covent Garden singer as heard by her colleagues on stage?

Until recently, I made a very definite point of referring to the Leeds situation in predominantly neutral terms, giving the reasons and arguments behind the decision to make anything above 96 dBA illegal and balancing them against the mass of criticism (both uninformed and informed) levelled against the Council. I felt obliged to try and remain impartial, because it seemed that everyone else had taken sides and that at least someone should try and stay on the fence. Both Ron Millett, the Chairman of the Environmental Health and Control Committee that had engineered the legislation, and R. W. Fearn, Lecturer at the Department of Agricultural Studies at Leeds Polytechnic, on whose figures much of Millett's campaign was based, have at one time talked frankly to me. Also the Leeds Council Health Department did once show me how it takes measurements to determine whether a pop group or disco playing locally is infringing the ban or not. But co-operation from Leeds soon ceased and gradually I have become convinced that the Council's action, and more to the point its reaction to criticism, constitutes a gross infringement on human rights in the city. Moreover, if the GLC do not put a brake on their own legislators, the rights of Londoners will be similarly infringed. And because the Control of Pollution Act, 1974, gives sweeping powers to all local authorities, there is a very real risk that the whole of England might come under a blanket of over-protective legislation.

Any discussion on the pros and cons of recommendations or laws to limit sound levels must start from the premise that the prolonged exposure of the human ear to excessively loud sounds will cause, first, temporary hearing loss (temporary threshold shift) and eventually, permanent hearing damage (permanent threshold shift). The Government-funded research work and recommendations referred to in the last article (STUDIO SOUND, August, 1975) had the laudable aim of protecting industrial workers from the dangerous effects of excessively loud noise during the course of their daily work. To cut a very long story short, the borderline between safe and dangerous (inevitably an arbitrary boundary) is in the UK placed at an exposure to generally continuous noise levels of 90 dBA for eight hours a day, 93 dBA for four hours a day, 96dBA for two hours a day, 99 dBA for one hour a day, 102 dBA for half an hour a day, and 105 dBA for a quarter-hour a day.

The situation in the USA seems less well defined, and, as one observer put it, 'the whole country's in the dark, because there are both State and Federal recommendations'. Also, whereas in the UK only A scale readings are relied on, in the USA there is some reliance on linear scale readings. But some American meters are sold with engraved reference to the provisions of the US Occupational Safety & Health Act of 1970, which is somewhat less strict than the comparable British recommendations quoted above. Thus, according to the OSHA scale, employees should not be exposed to steady ambient noise in excess of 90 dBA for eight hours, 95 dBA for four hours, 100 dBA for two hours, 105 dBA for one hour and 110 dBA for half-hour and 115 dBA for a quarter-hour a day.

Although it would be easy for engineering firms to redesign many machines to run quieter, industry pinches pennies in this direction and prefers to provide earmuffs for workers instead. But, just as road workmen often leave their drill muffs lying idle on the pavement, so many factory workers eschew the use of earmuffs, sometimes because they feel it is a sign of weakness. Even though the 1972 British court case, Berry-v-Stone Manganese Marine Ltd, opened the way to the award of damages to workers deafened through no fault of their own, many firms still do not provide earmuffs to their employees. Recently, when a large international firm came to insulate the cavities in the walls of my flat, I noticed that the worker drilling the holes in the walls for injection of the insulant was wearing muffs. But they were his own muffs, because when he had



The photos show two sound level meters capable of reading maximum levels on the A scale to BS3489 and IEC 123. They are available from B&K and Castle Associates. Also available are dose meters, which integrate time and sound level to a percentage read-out of the safe daily dose as recommended by the Department of Employment.

asked the firm for a pair they had laughed at him. By coincidence, I had a Castle Associates CS17A precision sound meter on loan at the time, and measured the noise at his ear during drilling. It was around 105 dBA, which put his maximum safe daily dose under UK limits at a quarter hour. In fact, he reckoned to be drilling three hours a day on some days of the week.

That worker, along with anyone else who subjects their ears to continuous sounds of that level for that long without protection, will almost inevitably suffer some noise-induced hearing loss during the course of his working life. All this is generally agreed. What is not agreed is the extent to which musical and other entertainment sound can be compared to industrial noise. If any noise (musical, industrial or otherwise) fluctuates by more than 8 dBA, then it is no longer regarded as continuous. An integration of time and level must then be adopted to produce an Leq or equivalent continuous sound level which can be used for risk calculation purposes in exactly the same manner as a direct reading of a continuous sound. It is because virtually all music fluctuates in level by more than 8 dBA that there is a danger in applying anything other than Leq limits to music. But Leeds always has, and still does, apply a maximum, rather than an Leq level.

Earlier this year the GLC published a Draft Code of Practice for pop concerts, which seeks to control everything, from sanitation to sound levels, at any musical event in the London area. Sound control, according to the Code of Practice, is to be under several heads. At an outdoor concert, at a distance of 50 metres and beyond from the loudspeakers, the industrial limit Leq of 90 dBA for eight hours must not be exceeded. Thus for a four-hour concert, someone sitting fifty metres from the loudspeakers may not be exposed to a sound level greater than the equivalent of a continuous 93 dBA. There is also the overriding provision that the maximum should never exceed 105 dBA. At an indoor concert the 50 metre clause is dropped and the 90 dBA for eight hours limit applies to any member of the audience—anywhere. Also, the maximum level can never exceed 102 dBA.

As mentioned briefly in the postscript to the last article, I wore a B & K Type *4424* sound dose meter round several musical events in the London area. This meter integrates sound and time, to provide a digital readout of the percentage of the full daily dose notched up. Thus when the meter reads one hundred per cent it (and the wearer) has been dosed with the equivalent of 90 dBA continuous sound for eight hours. A fifty per cent read-out denotes half the safe daily dose, and a two hundred per cent read-out denotes twice the daily dose. Of course one hundred per cent can be notched up in a very few minutes by very loud sound, or may take days under quiet conditions. At the Round House, the rock group Fumble, not a particularly loud group, notched up 334 per cent (over three times the safe daily dose) in a fifty-five minute concert performance. The group also smashed the peak limit permitted by at least a dozen dBA, so by one token (Leq) the whole concert could have lasted only seventeen minutes and by another taken (maximum level) it was illegal from the first

note peaking over 102 dBA. Other checks, at discotheques and even a pub with a jazz piano trio, produced enough readings to convince me that formal adoption and enforcement by the GLC of their Draft Code would kill music in London as stone dead as in Leeds, even though the London limits are somewhat less restrictive than those in Leeds.

I suggested above that the Leeds and London legislation would outlaw a trumpet and Covent Garden singer, both without amplification. Here are the facts. I measured the sound level at around 1 metre from a Covent Garden dramatic mezzo soprano; the reading was 104-105 dBA and she wasn't even trying! Thus, on stage during a performance, her colleagues will be subjected to sound pressure levels nearly 10 dBA above the Leeds legal limit (twice the subjective volume of sound) and 3 dBA above the GLC maximum level limit. It is likely that at least some members of the orchestra in the pit and the front few rows of the stalls may be likewise receiving an illegal dose during a Covent Garden performance. I also took a level meter along with me to a small club performance by a jazz quintet. The group was only partly amplified, by no stretch of imagination particularly loud, and certainly quieter than plenty of other jazz groups of similar size which have given pleasure over the last half century. When the trumpet player (a London session musician playing jazz on his day off) blew unmuted in my direction, the meter often read 105 dBA. So he, and the group, were illegal not only by Leeds standard (96 dBA maximum) but also under the GLC Code (102 dBA maximum). If all the legends about how Buddy Bolden could be heard for miles around when he blew his trumpet out of the window and how Caruso cracked glasses are true, they are lucky not to be alive today—because they would have Ron Millett, Ron Fearn, the GLC, Uncle Tom Cobley and All after them with a sound level meter.

Currently, the GLC is still debating whether or not formally to adopt the Code. But in many respects this is a charade. The Code is already being used and by the GLC's own admission it can go on being used, even if it is not adopted. The long and short of it is that when the GLC grants a music licence, either for a concert or a club, it can impose any licensing conditions it wishes. If the GLC wants the girl at the door to have green hair, it can put that in the licence. Likewise, the Council can put into the licence any guideline for sound levels, and already it is clear that the Code is being used both as a yardstick and as a big stick. Take, for instance, the extraordinary situation of the open air pop concert which was to have been held at the Chelsea Football Club ground earlier this year. Objections were lodged to the grant of a licence for the concert by the GLC, and the matter was debated at an extraordinary all-day marathon session at County Hall. The licence for the concert was finally refused, and the event was thus cancelled. The grounds of refusal are not available to the public, nor is any official comment, because any such comment might be taken as a hint to the grounds of refusal. The reasons for this silence are understandable, although frustrating. Any debate can (and in this case certainly did) last for many hours, and the GLC believes it is impossible to *precis* accurately several hours of debate. Moreover it is argued that the hearings are open to the public. But with respect to the GLC I would remind them that only those members of the public who have actively lodged an objection are likely to hear about the debate until after it is over.

One fact which the GLC did confirm, however, was that Hammersmith Council were the main objectors. I approached Hammersmith Council and found the Public Relations Officers helpful. Yes, of course I could talk to someone about why Hammersmith had objected and on what grounds. But finding someone to talk, even when authorised by the PRs, was another matter which took two solid days of phoning. At one stage I was even shunted through to the Legal Department, who had their own, novel way of trying to get rid of me. 'Write in with a request to talk to someone and we will consider it and let you know,' they suggested. I didn't, but finally I did get to talk with someone in the Health Department. He read me over the phone figures from a report which Hammersmith had used at the GLC licence hearing to get the Chelsea concert killed. I was so astounded by the figures that I asked to see a copy of the report, but, despite reminders, a copy has never turned up. Doubtless Hammersmith by then realised exactly what they had done by releasing their grounds for objection. It emerged that at a previous pop concert at the Queen's Park Rangers football ground, Hammersmith Health officials had measured both the sound levels inside the ground and outside. (Incidentally inside the ground one official was reputedly measuring on C scale by mistake!) They did this because, apart from the previously discussed Leq and maximum levels laid down for inside and outside concert venues, the GLC Code also specifies that 'to minimise possible annoyance to occupiers of premises within the vicinity of a venue at which a concert is staged, the noise level, measured at a distance of one metre outside the window of such premises should not exceed the ambient 10% level by more than 5 dBA (and) between

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the hours of 8 p.m. and 7 a.m. the ambient 10% level should not be exceeded'.

I doubt that many people, other than Hammersmith Council, had spotted just what blockbuster powers this gives the GLC if they choose to use them. Put in simpler words, this section of the Code says that a concert is beyond the legal pale if it produces a 5 dBA rise in sound level just outside the window of any residential property outside the concert venue. It takes a 10 dBA increase of sound level to produce a subjective doubling of loudness, so the 5 dBA maximum leakage from a concert is a very tight restriction; and the zero leak which is specified for after 8 pm is a very tall order indeed. But when Hammersmith took measures *outside* the QPR ground for the previous concert, they also took reference measurements not only on a day when the ground was empty but also on a day when there was a football match in progress. Sure enough, although the pop concert exceeded the ambient noise level of the quiet day by well over the permissible 5 dBA, so did the football match. Thus, when the GLC took note of Hammersmith's objection to the grant of a licence for a pop concert on the Chelsea ground, they effectively admitted that their Code of Practice also outlaws a football match held in the same ground. Small wonder that Hammersmith chickened out when it came to giving me a written copy of that crucial report.

I talked, soon after this discovery, to Dave Martin, of Martin Audio, who at the last minute had been brought in to handle the sound at the Reading pop festival. His brief was to produce a reasonable sound inside the open air festival site while preventing spillover into the residential areas nearby. To provide a 14 kW pa system he brought together five separate Martin pa rigs owned by groups and organisations and ended up by keeping the festival audience reasonably happy and the residents round the site almost entirely happy (there were only three complaints). This he did by stacking the speakers high and angling them down into the crowd. I asked Dave Martin his views on concert levels in general.

'The loudest I ever monitored was 130 dBA at head level at a Slade concert. I had to wear muffs, and it was loud even through them, but I took that reading at the ears of someone who was standing on a box to get a better view—and was thus full in line with the stacks. That is clearly ridiculous. But equally ridiculous are the kind of level limits being adopted by Leeds and GLC. It's analogous to the early days of motoring, where the law said a man had to walk ahead of a car with a red flag.'

Following on from the Slade comment I raised what, over the last year, I have come to think of as the most important areas where legislation is needed—that of correctly stacking speakers. At the Round House concert mentioned earlier, for instance, I noticed several of the audience sitting with their heads virtually inside the bass bins and receiving what must have been well in excess of the sound levels quoted by specialists as instantaneously damaging on the human ear.

'The problem with any regulations covering stacking is that different systems have different dispersions,' Martin remarked. 'At Reading we stacked the left and right banks of speakers 26ft high, but take a club like the Marquee and there just isn't room for it. The first few rows are going to get hit with something like 2.5 kW of energy, and there is no doubt in my mind that that must be damaging. Around 110 dBA is as loud as I ever want to listen.'

By coincidence, around the time that I interviewed Martin, I received a letter from a pop fan who had scared himself stiff with a trip to the Marquee Club. After a set by a loud band he felt a strong pain and aching in his ears and head. An ear specialist diagnosed 'severe temporary threshold shift', and although the shift disappeared I doubt that the writer of that letter will ever subject himself to levels of that order again. So before banning any more open air concerts because they may put the ambient noise level up a few dB, like a football match, the GLC might spare a thought for the very real risks that some people must be running if they are regular attenders to the front few rows of some London clubs.

Dave Martin also reiterated the by now familiar (to all but Leeds) observation that the kind of levels employed by Leeds must inevitably outlaw some classical concerts, where peaks of well over 96 dBA are an integral part of the music. Presumably the Leeds Health Department do not bother to check these concerts. Indeed, this perhaps sums up where the problem lies. Although we all agree that there are now dangerous sounds in abundance, many of the attempts at restricting them are being made by people who do not like the music which will be subject to the restriction enforced. As a result they show a complete lack of understanding of the problems involved. To quote Dave Martin again: 'At one concert we took some readings and found that when the Bay City Rollers came on stage the noise that the *audience* made when it screamed, before even the band had started to play, was up in the region of 120 dBA. So what is going to happen? Is the group going to be legal if it plays quietly, but the audience illegal because it screams too loud?'

With this in mind, I visited Dr John Knight, Senior Consultant Physicist at the Royal National Throat, Nose and Ear Hospital, in Gray's Inn Road, London. Dr Knight has done considerable work on the area of hearing loss, especially as a result of impulsive noise, and is for instance anxious to see pop music put in perspective with respect to the far greater risks from gunfire. He showed me audiograms for service personnel who have suffered hearing losses of up to 80 dB above 1 kHz through exposure to gunfire sounds without protection. In one case a 17 year old serviceman, who had fired only 250 rounds from a rifle, had a permanent hearing loss of 60 dB at 4 kHz and above in both ears.

Particularly interesting in the present context is what Knight says about the techniques of measurement used. The audiometric equipment used routinely in Hospital measures hearing in 5 dB steps. Thus no measurement taken can ever be more accurate than by 5 dB. Despite the fact that the Hospital has some of the most modern equipment available. Knight points out that the repeatability of audiometry is notoriously poor and a subject under test will produce different results for the same tests as he becomes more familiar with the test technique. The variations can be ±10 dB!

'The subjects simply perform better, even during a single test,' says Knight, 'and for this reason we often find that on average the ear tested first shows up worse than the ear tested second.' Inevitably this invites extreme scepticism over the way that Leeds have taken decisions based on extrapolations from measured losses in the order of a couple of dB.

Leeds' legislation followed an audiometric survey of young people carried out by R. W. Fearn in Yorkshire three years ago. The survey compared average hearing loss of regular attenders to pop concerts with those who did not attend. Extrapolation from the results can produce alarming predictions for the future—but is extrapolation from such small loss figures justified when other audiometric surveys do not even attempt to work in steps of less than 5 dB?

Average hearing loss of 102 attenders compared to 53 non-attenders

Frequency (kHz)	1	2	3	4	6
Hearing loss (dB)	1.4	3.3	3.1	2.0	2.1

To quote Knight further: 'The average person won't even notice a 10 dB loss, let alone a 3 or 5 dB loss. All this talk of a deaf generation coming out of the current pop craze is an exaggeration. What's a few dB between friends? Let's acknowledge that some young people will be going to pop concerts and hearing too much loud music for a few years. So what? After that they will get married and settle down and be none the worse for it.'

I wanted to put these points to Leeds, but still no one was talking. I wrote, and received a very disturbing reply. 'I can perhaps inform you,' wrote the Chief Environmental Health Officer, 'that the enforced silence from this Department over the past twelve months or so in connection with our activities to control entertainment noise has been on the direct instruction of the then Chairman of the Environmental Health and Control Committee.' I phoned and asked for more details of this odd situation. It seems that Ron Millett, the chairman who pushed through the 96 dBA limit and who, now, by the Leeds Council's admission, subsequently forbade them to talk to anyone about the limits, lost his place on the Council during the May local elections. He has now been replaced by a Mrs Christine Thomas. It also seems that there has now been set up a working party on sound levels, and this, although 'somewhat slow in considering the problem' will presumably eventually produce a report. Surely the report must recommend immediate relaxation of the 96 dBA limit. Even so Leeds cannot now escape a place in history as the public body that took a far-reaching decision on the strength of scientific data that is at best questionable and then, on the instructions of a part-time councillor, refused to discuss the resultant situation which was not only affecting everyone in the area who likes to listen to

66 ▶

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DM6
How B&W pioneered the measurement of phase/impulse response

These measurements and oscillograms are, as far as we know, the first to be published anywhere in the world. They relate to two vital aspects of loudspeaker performance that have not been previously assessed: phase response and impulse response.

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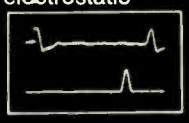
It is well known that 'square' or impulse waves are made up of a fundamental sine wave plus a harmonic series. Equally well known is the fact that the amplitude of these harmonies must not only be correct but must also arrive in the correct phase or time if the desired wave shape is to be reproduced. It is this correction for phase or time in the design of the units, the crossover network and the physical placement of the units which enables the DM6 to dramatically improve the square or impulse waveform performance as set out below.

The 'third octave' room measurement is yet another meaningful method in assessing how well the balance of the DM6 conforms to the idealized curve shown.

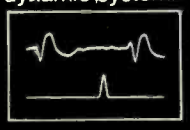
Response to $\sin^2$ pulse of 0.33 ms half-amplitude duration.

DM6

Full range electrostatic



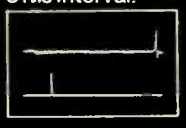
Normal 3-way dynamic system.



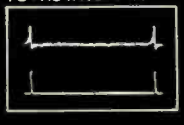
Impulse response of DM6.

Mid-frequency Squarewave

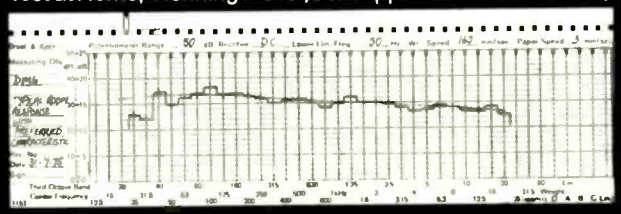
50 μs pulse at 5 ms interval.



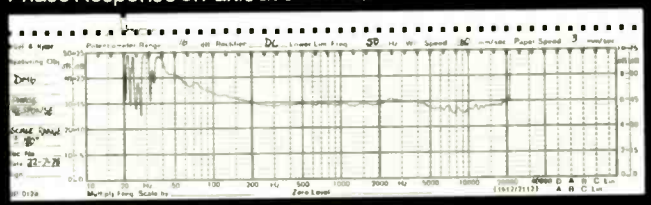
50 μs pulse at 10 ms interval.



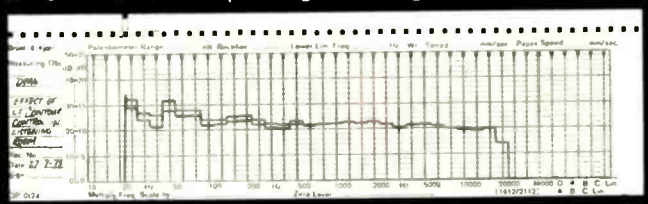
⅓rd Octave room response of system and optimum characteristic (from recommendation of "Relevant Hi-Fi Test at Home," Henning Møller, B&K Application Note 14–114).



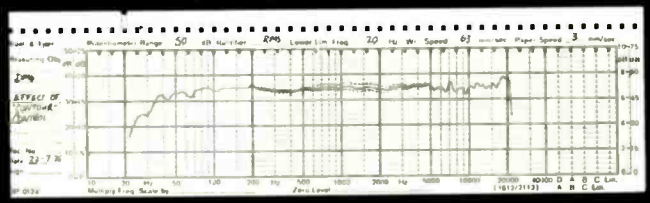
Phase Response on-axis at 3 metres.



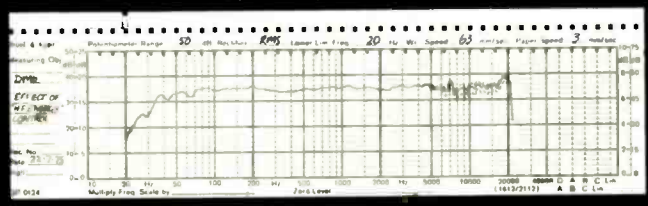
L.F. Contour Control Operating in listening environment.



Contour Control operating between 500 Hz and 5 kHz.



H.F. Energy Control operating at frequencies above 5 kHz.



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HEARING DAMAGE

pop music but also doubtless damaging the livelihood of a good many people involved in its promotion. The good intentions which sparked the original action pale into insignificance in the light of what has followed. One can only hope that the GLC, which is far more open minded and willing to discuss points with the press, will curb any internal over-enthusiasm before it stumbles into a Leeds-like situation without even realising it.

Forgetting now about the political intrigues at Leeds and the anomalies generated by the GLC Code we are left with the indisputable facts that loud industrial noise is dangerous and ridiculously loud music must also be a risk. But there also remains that one crucial question still unanswered—is it reasonable to equate industrial noise with musical noise for the purpose of establishing whether anyone regularly exposed to fairly loud music, for instance as part of their work, is running a long-term risk?

In the previous piece I hinted at the possibility of a difference between the damaging effects of 'nasty' industrial noise on the one hand and 'nice' musical noise on the other. Alex Burd, of Sandy Brown Associates, still has an open mind on the point but finds it difficult to see how there can be a difference in effect. John Knight gave the matter thought but also feels there can be no difference in effect. In a radio programme Ron Fearn categorically dismissed the possibility of there being any difference in damaging effects of nice and nasty noise on the ear. J. S. Ratcliff, Lecturer in Sound at Ravensbourne College of Art (a mine of information and references on the whole subject of noise-induced hearing loss), remarks on the similarity of curves between the 'spectral band of measurements of sound levels for rock music and fortissimo symphonic music' measured by Lebo and Oliphant (Calif. Med. No 107) and similar types of measurement applied to diesel engine noise.

Set against this weight of obviously informed opinion, generally suggesting that there should be no difference in effect between nice and nasty noise, is the apparently unanswerable fact that jazz (especially big band jazz), musicians have been making very loud sounds now for at least fifty years. And I have never yet heard a report of any jazz or big band musician suffering from hearing loss. Charlie Watkins, of Watkins Electric Music Ltd, has measured levels of up to 125 dBA from the orchestras of Duke Ellington and Ted Heath in full flight. Likewise, my dose meter tests showed that a largely unamplified piano trio could notch up a hundred per cent safe dose in just over two hours' playing time (probably due mainly to the drum kit and cymbals sound). So it is on the cards that any musician playing or near the drums of a big band must continually be notching up grossly over the safe daily dose.

Of course, even though there are no reports of deafened musicians, this is not to say that there have been none. In other medical fields (such as risk due to exposure to asbestos dust or PVC components) the correlation between cause and effect has emerged only when the possibility has been publicised and those involved have had their attention drawn to the possibility of a correlation. This is, of course, what should worry studio engineers. They, even more than professional musicians, are subjecting themselves to large doses of loud sound. Whereas young people attending pop concerts are doing so for, at the most, only a few days a week (and probably only a few days a month) a studio engineer is dosing himself daily. The Leeds and GLC limits can be written off as grossly over-protective for all but the very small, and perhaps even non-existent, minority who can afford to hear loud sound for pleasure daily. But could those limits be applicable to studio engineers (and for that matter discotheque engineers and jockeys) who are being paid, rather than paying, to listen to loud sounds?

In an effort to establish just what kind of risk studio and discotheque engineers are running, I carried out more tests with the B & K and Castle meters. At a London discotheque attached to a pub I sat at the side of the dance floor and out of direct line of the loudspeakers which were beamed to fire down onto the dancers. At the end of one hour the reading was 86 per cent of a full daily dose, and thus the full allowed Leq of 90 dBA for an eight-hour period would have been reached in only a little over an hour by the side of the dance floor and probably in under the hour in direct line of fire of the speakers. The disco was open for four-and-a-half hours with virtually non-stop music, so the disc jockey must have been receiving about four times his safe daily dose during the course of just one evening. Even at the bar, the percentage was notching up at about the rate of about one per minute, so the bar staff were receiving a full daily dose in about one hour forty minutes, and two or three times the safe daily dose during the course of the whole evening.

I have found London studios not unnaturally cagey about letting me in with a meter, but I found the BBC's attitude particularly surprising. I talked to several engineers and they agreed that the BBC was probably the best place of all to do an extensive check on control room levels. Because the BBC puts out not only commercially recorded music but also internally prerecorded live sessions with classical, rock, jazz and light pop musicians, a series of readings taken in various control rooms during various sessions would have given a very comprehensive picture of studio sound levels in general. It would also have shown how some BBC engineers prefer to listen at loud levels while others are prone to don a tin helmet or run and hide if anyone turns up the wick. According to BBC protocol I was referred upwards to the Assistant Head of Engineering Information. Instead of the hoped-for official OK for a visit with my dose meter, I was told that the BBC already had their own Engineering Department on the job of measuring, so there was no point in my doing anything similar. I pointed out that there was every point in my doing something similar, because my measurements would be of what I wanted to measure, and they would in any case be independent. But the Assistant Head was not to be budged, and finally came out with his ace. 'Studios are small places, you know,' he told me, 'and there just isn't room for an extra person in there

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with a meter.' I learned subsequently that the real reason for the ban was that the BBC is worried over possible union action, the Corporation envisaging one day either a down-tools or a claim for damages from an internal troublemaker taking sound levels as a peg on which to hang a grievance.

It is also interesting to note that when, a few days later, I was invited by a BBC news programme to go on air in a discussion on sound levels, I was asked to take a dose meter into the studio. (Presumably the BBC had by then found a studio that was large enough to cope with us.) As my dose meter had by then gone back to B & K and I suggested to the programme production staff that they borrow one from Engineering for the programme. But after a morning's fruitless phone calls, the programmers gave up trying to borrow the meter from down the corridor, and found it easier to send a runner out to Hounslow to borrow one direct from B & K.

Talking generally with engineers about levels in England, it seems likely that the low hundreds in dBA is the average maximum monitoring level. But there are certainly plenty of instances when 110 dBA and even 120 dBA is likely to be notched up. Even the lower levels could easily account for the notionally safe daily dose being notched up in an hour or so's hard work. And obviously most studio engineers work hard for much longer than this period during any given day. So equally obviously an engineer can, without undue difficulty, exceed the safe daily dose several times over during the course of a day's work.

But of course, we are immediately back again to the question of whether exceeding the British 'safe' dose really is unsafe.

With this in mind I talked to Tom Hidley, of Westlake Audio, while he was in England recently, and asked for his views on USA levels and their safety or otherwise. Immediately an interesting point arose. Hidley was quoting levels on the linear, rather than the A scale, and maintains that it is misleading to use the A scale for pop music. He points to the fact that in many modern rock recordings there is a considerable amount of bass energy that will be discounted by the low frequency roll-off of the A scale. Hidley instanced the results obtainable from spectral analysis of most Stevie Wonder recordings: there is almost as much energy in the 30 to 50 Hz range as there is in the 200 or 300 Hz area, and only a linear scale reading can accurately represent this.

Hidley divides the problem into three separate areas. In the concert hall, where rock bands must play sometimes to around 25 000 people, there will inevitably be dangerous readings up front. Then, contrary to what some observers believe, there may also be a risk on the studio floor itself. Some rock bands insist on bringing their full pa rigs into the studio for recording, and work, as Hidley puts it, 'on an emotional reaction', to levels of around 110 dB linear. Of course it makes sense. A rock band that plays loud music on stage will not feel or sound right playing quiet on the studio floor. Finally, there is the area of the control room. Even if the balance engineer wants to protect his ears, the producer will as likely as not issue the ultimatum 'turn it up or I go'.

Hidley is convinced that some engineers really are now going deaf. I suggested that perhaps they should protect themselves with annual audiometric checks. 'More likely every three months or even less', countered Hidley.

When Westlake install potentially dangerous equipment, they slap a warning notice to that effect on it. 'I want to feel my stomach pump before I hear everything break up in the system,' said one potential client to Westlake. What he wanted was well over 110 dB linear, from 30 Hz to 16 kHz, plus or minus 3 dB all the way. 'I can die,' says Hidley, 'if I am close to a sound like that, especially in a small room with standing waves.'

In any discussion in this area, interesting new points keep arising. In the context of his comments on preferred linear weighting, Hidley points at the very high energy content in the bass drum of a kit. On the other hand, at a recent TDK tape press conference, George Tsutsumi suggested that his company's spectral analysis of modern rock music shows there to be more high frequency energy in the programme material than others have generally acknowledged. And work by speaker manufacturers on voice coil overheating suggests that there are two pronounced energy peaks in the lower mid-range. Perhaps the real answer is that every rock recording has a different energy content; so whereas in one case an A scale reading is more realistic than a linear measurement, the opposite can equally well apply for another recording. Also, no one yet seems to have given much thought to the possibility that the transients in some rock music may be comparable to impulsive noise. Certainly, a snare drum track played alone at high level can resemble the sound of gunfire — I know from bitter experience, for I once had a headache for hours after listening to the mix-down of a snare track with Kepex.

There is of course always outstanding the ethical question of whether it is reasonable to try and prevent an engineer from listening to unsafe levels on speakers if he chooses to do so. After all, in the August issue of STUDIO SOUND, the last article on hearing damage faces a survey of headphones, some of which could easily produce an spl at the ear of over 120 dBA. One of the checks I wanted to run at the BBC was to check the level of sound at dj Rosko's ears when he was listening on headphones during his programme.

The editorial that preceded the previous article emphasised the need for education in this area. Rather than legislate, it is far better to educate the engineer over the problems and leave it to him to decide. After all, there are other disadvantages of monitoring at high level. It may give a microscopic appreciation of the sound, but it can also play havoc with internal frequency balance in the final product, when played on domestic equipment. What sound like a reasonable bass level monitored at over 100 dBA may, without compensation, sounds bass thin in someone's living room on even a reasonable record player played at a listening level of around 80 dBA. In 1972 the Association of Professional Recording Studios produced a pamphlet on 'High sound levels and the impairment of hearing' and marked on the front cover 'It is important that everyone in your studio should read this'. Underneath was a table, where everyone who had seen and read the publication was asked to write his initials and the date. I wonder how many studios actually have ensured that everyone at possible risk has read the APRS booklet?

Reading a booklet, and worrying about likely personal risk is one thing, but knowing what to do about it is another. So far there is really only one thing that an engineer can do, and that is have his hearing checked now (not next month or the month after, but now), to provide a permanent, positive record of its current state. This will provide a base line for future reference. A comparison between this base line and the results of any checks taken in future months or years will show up quite unambiguously any deterioration. A hearing specialist will then be able to advise on what is to be expected through natural ageing and what is left over and therefore probably the result of monitoring at excessively high levels. Perhaps studios could organise an audiometric test for all their staff involved in high level monitoring at least once a year. It would cost little, provide peace of mind for all concerned, and perhaps save the studio a nasty claim for damages in years to come.

But as Hidley rightly observes, simply knowing that they really are losing their hearing will not deter some studio engineers, just as the threat of bone necrosis does not deter North Sea divers. Also, how does one cope with the situation when an engineer, although worried about his hearing, is faced with a producer who refuses to monitor at a lower level? The answer, put forward by Tom Hidley, is really only commonsense. 'What we need,' he says, 'Is a frequency linear earplug with variable attenuation. You wear it when you want to and it does nothing to alter the frequency response. It has built-in pads, rather like the pads you use in desks, to put a 5, 10, 20 or 30 dB cut into the sound transmitted. That way, everyone can have their own freedom to do what they want with their own hearing without involving anyone else; just as anyone can smoke if they want to. If we can put a man on the moon we can, sure as hell, develop such a device.'

He's right, of course. We could. The question now is, will we?

AGONY COLUMN

In the good old days, the major London record company used to take on any house producer who looked like he might make it with one fab hit. Some came from boutiques, one from a restaurant. Being a complete natural was in. So one of this school was preparing to go into the studio to cut his artist's first single, and being smart he enquired of an old timer what was the best thing to say to impress the engineer and show him who was boss. 'What you need to do is to ask him for a bit of r^2 echo, that'll really do it.'

So the session starts reasonably non-haphazardly, but isn't really anything special. So the producer hits him with a special request. 'Certainly, it's a pleasure. Don't get many people asking for *that*.' Which at least shows how a good grapevine can give everyone all they want.

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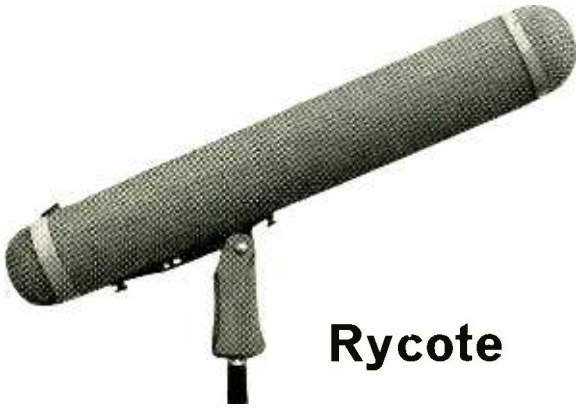

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WORK

second factor which was the character and personality of Roy Sonnex. He felt, very sincerely, that he would be doing his best for Dean Street and the people who worked there if he exerted a little discipline over what he regarded as a clique of politically-motivated trouble-makers unrepresentative of the general run of staff. His interpretation of the word 'consultative' was different from the interpretation put on it by the staff's negotiators, who unfortunately were the same people whom he regarded as the unrepresentative clique of troublemakers. By April this year the workers were claiming gross breaches of the September agreement, but a situation was reached where neither of the consultative committee's two factions could agree on what constituted such a breach.

A few weeks before Sonnex resigned he explained the difficulty to me over lunch at the Hilton: 'There are two ways you can look at this, depending on your point of view. I take consultation very seriously, and there are a number of problems that have been considered at great length. Everything has been done to agree with the agreement and so far as I am concerned it has been honoured. But', he added vehemently, 'I regard it as a sensible agreement, not an agreement designed to make the management of the company a matter of consensus. If you do interpret it as a matter of consensus then, no, it hasn't been honoured.' He confirmed without any prompting that there had been occasions when the consultative committee had been informed rather than consulted.

One such occasion was the announcement of an increase in the studio rates. This, it is reported, had been opposed by other members of the De Lane Lea board, and so might have been considered an item upon which consultation might be needed. An increase made earlier this year had been discussed, but the second increase, which took effect from July 28, was a surprise. The feeling was that the price increase was a deliberate attempt to sabotage De Lane Lea preliminary to closing it down. Such a misapprehension should not, perhaps, have gone uncorrected.

The reason for Sonnex's apparent intransigence was his opinion that the agreement of the previous September had been reached under duress. At second hand he had received reports of the demonstrations outside the BET offices in Piccadilly and had also been told of the use of a loudhailer to shout obscenities at the window of John Nutman's office in Wardour Street. He felt growing distaste for a battle conducted in a flurry of memos, the wording of which grew saltier and more terse with each exchange, and it may be true that his stance was determined as much by the bruising of middle class sensibilities on receiving these less than politely worded missives as by the points at issue. Feeling as he did it doesn't seem all that strange that he should not have felt bound by the agreement.

The breaking point was a statement from George Philips to the joint workers' committee to the effect that unless 12 redundancies, including five unfilled vacancies, took effect from the end of September the company would close. Other conditions were attached, but even if all were complied with the company could only be certain of survival to the end of March next year.

The staff immediately fired back that they could not agree to the redundancies unless they were voluntary and not, as he had intended, nominated by Mr Philips. The subsequent bargaining culminated in the replacement of Roy Sonnex with Andy Worker, whose manner and background met with a greater degree of staff approval. The tension visibly lifted. All the redundancies were made voluntarily. Worker is a manager; he has no more intention of managing by consensus than did his predecessor, but his approach seems to have been a great deal more conciliatory. The staff prefer to forget what happened before Worker was appointed, and as a result may accept more than would have been thought possible a year ago. The looking round for other jobs has stopped, I understand, and there is a widespread determination to make De Lane Lea viable, despite the odds.

The atmosphere at the press reception on October 1, attended by many of the staff and management, was decidely cordial. Most of the staff seemed to feel that Andy Worker, a film man, could be trusted. Worker himself told me he had no intention of helping to close the company. Joint managing director George Philips said the company had a good future because they had behind them all the resources of BET, which he said he regarded as a humane organisation, and the companies of the Humphries group, which could offer every service the film maker could want. One of Worker's special tasks would be to put total packages together for clients involving these.

The signs look at least as good, compared with the irretrievable situation of a month or so ago, as for the other studios in struggling Wardour Street. It is possible that more gear will be bought, including Dolby equipment. A three year contract for production and post production work may be signed with a government department and up to 12 commercials a day, they say, are being dubbed in Theatre Two. A Twentieth Century Fox feature, *The Adventure of Sherlock Holmes's Smarter Brother* with Gene Wilder, has been dubbed, cut, post-synched and effects-shot at De Lane Lea and another Fox film, is going through.

The March 31 ultimatum has disappeared. Bookings have been accepted into April or May of 1976 and guarantees have been given to customers that the company will carry out any work they undertake. This would seem to guarantee also the jobs of the staff.

Andy Worker stresses that he has no intention of re-engaging staff on a free lance basis after large-scale redundancies, which had been one of the staff's major worries. Ernie Cousins, chairman of the joint shop committee, said that one or two of the staff weren't convinced that this was a new start but he felt sure that after they had seen what would happen over the next few months 'they'll come round'.

There are problems remaining, such as the poor return from Studio One. Four or so proposals for its future use are now under discussion. An outsider would hope, too, that the boardroom musical chairs had slowed down sufficiently to allow a little separation between the members of the group, so creating a clear chain of command. Ernie Cousins knew it wouldn't be easy over the next few months, but equally he knew Andy Worker, and thought that his record at Shepperton had been misrepresented. 'All I can say is that I'm very optimistic.'

John Dwyer

LOUDSPEAKER LISTENING

using low energy input signals. Such impulse responses have revealed defects of performance which could not be readily seen from frequency domain displays. By further combining frequency and time information, cumulative decay spectra can be produced showing transient decay phenomena in three dimensions. This powerful display technique is adding rapidly to our knowledge of loudspeaker behaviour and in many cases can reveal in a dramatic way effects which were formerly only detectable audibly.

Fig. 1 shows typical cumulative decay spectra for a high quality mid-range loudspeaker which is free from significant coloration effects. The decay of sound from the unit after excitation is comparatively smooth and devoid of characteristic formations. By contrast a similar type of speaker fitted with a different experimental diaphragm and coil assembly is depicted in fig. 2. The decay characteristics are not nearly so smooth and there is a submerged high Q resonance at 7 kHz which becomes sharply revealed after a few hundred microseconds into the decay. It is interesting to note that the delayed resonance is scarcely observable in the steady state response at the rear of the display (time=0).

The speaker depicted in fig. 1 sounds smooth and quite neutral in tone colour whereas the other corresponding to fig. 2 has a hard, bright quality which is more hi than fi.

Cumulative decay spectra do not reveal everything we need to know about loudspeakers, but they certainly provide a wealth of new information which correlates well with subjectively perceived aspects of reproduced sound quality. These computer techniques can be adapted to simulate loudspeaker listening tests and are helping to establish audible thresholds for various kinds of distortion.

Conclusions

We are of course a long way from abandoning listening tests altogether. Loudspeaker reproduction remains a three dimensional experience in time and frequency and any process of evaluation must take all the factors into account. However, the best loudspeakers are now so much improved that unless listening tests are brought to a new standard of sophistication, misleading results will be obtained.

References

1 *Relevent Hi-Fi Tests at Heme* Henning Moller
Proceedings of the 47th Convention of the Audio Engineering Society.

2 Some of the Factors affecting Sound Quality in Loudspeakers H. D. Harwood
Proceedings of the 50th Convention of the Audio Engineering Society.

3 High Fidelity to What? Adrian Hope
Hi-Fi News and Record Review, September 1975.

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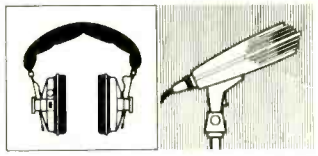

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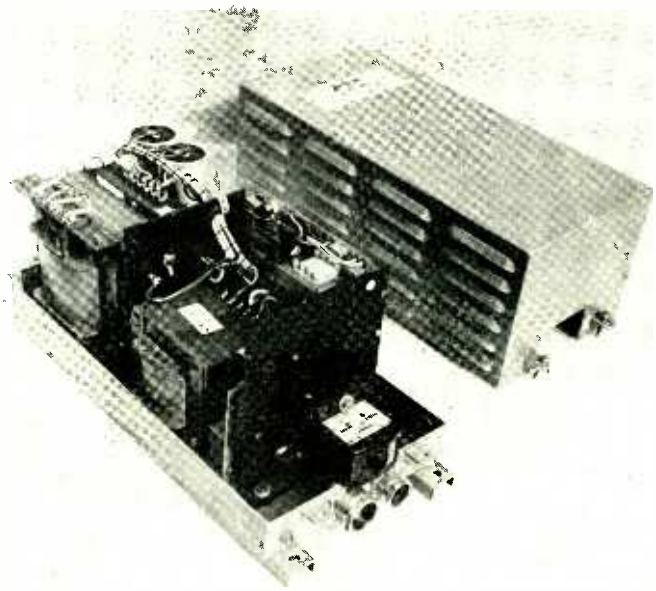
NEA LINDBERG MP3-24 STATIC INVERTER

Hugh Ford



MANUFACTURERS' SPECIFICATION
Input voltage
Nominal rating: 24V dc.
Service range: 20 to 30V dc.
Dc power supply: Battery. When using other power supplies, connect a parallel capacitor, e.g. of 5000 μF. The circuit breaker protexts against reverse polarity and serves also as a main switch.
Output voltage
Nominal rating: 220V ac (may be connected for 240V ac).
Guaranteed output: Min 217.5V ac-max 227.5V ac at nominal dc voltage and 200W.
Stabilisation: As per curves provided.
Response time: 50 ms after start the deviation from stationary rating is less than 3% at 0W, and less than 1% at 200W.
50 ms after load changes from 200W to 0W the deviation from stationary rating is less than 10%.
Load: 0 to 200 VA, cos ø $\geqq$ 0.9 inductive.
Frequency: 50 Hz ±1%. The deviation from 50 Hz is almost exclusively dependent on the temperature.
Waveform: Sinusoidal.
Distortion: Approx 6% at nominal dc voltage.
No-load consumption: Approx 2.4A at 24V dc.
Efficiency: > 70% at nominal dc voltage, 200W.
Radio noise: The radio noise will not exceed the n-limit in VDE 0875/9.65. The k-limit can be achieved except at a few isolated frequencies.
Ambient temperature: —10°C to +60°C.

Casing: Epoxy-enamelled, ventilated steel case.
Outside dimensions: 190 x 195 x 375 mm.
Weight: 18 kg.
Price: £208.

Manufacturers: Nea Lindberg, Industriparkn, 39-43 BK 2750, Ballerup, Denmark. (01) 972200.
UK agents: Avel-Lindberg Ltd, South Ockendon, Essex 01-700 3444 Telex: 897106

THE TYPE *MP3-24* static inverter is one of a range of static inverters manufactured by Nea Lindberg for both marine and aeronautical applications where reliability is of prime importance. Furthermore, the *MP3* range, which includes four different inverters giving a mains voltage 50 Hz output, is specifically designed for driving electronic equipment with a maximum power requirement of 200W.

The choice of a 200W inverter for review was based on the premise that the vast majority of studio equipment does not exceed this power requirement. While it may appear incongruous to choose an inverter with a 24V dc input requirement, a little thought shows that a normal 12V car battery of 40 Ah or so capacity has little to offer when it is being discharged at in excess of 20A, even when its internal resistance becomes a significant factor.

Mechanical construction of the inverter is very substantial, the main chassis of the unit being a welded steel tray on to which all the major components are fixed by means of nuts, bolts and lockwashers, this making the replacement of components a simple matter. Two steel sections are secured to the underneath of the chassis tray and extend beyond the ends to provide four fixing holes for mounting the inverter in any position. The inverter's cover is also of welded steel and is secured to the chassis tray by screws threaded into steel angles on the chassis tray. Within the inverter the remainder of the components are mounted on either two black heatsinks, or on a high quality printed board which is bolted to the chassis, and wired in. However, replacement of the board only involves four screws and five wires which are soldered to pins on the printed board —a sensible and reliable arrangement.

All the electronic components are of good quality and all transformers are impregnated; the standard of wiring is first class. Furthermore, the instruction book supplied gives very good servicing information as well as including oscillograms of the more important waveforms within the inverter.

The principle of operation

The ac output originates from a magnetic voltage stabiliser transformer which is tuned to 50 Hz and the output of which is passed through filters to minimise radio frequency interference. This is generated by the two switching thyristors which drive the stabiliser transformer. While the transformer is tuned to 50 Hz, the output frequency of the inverter is not controlled by the tuning, but originates from the thyristor drive system.

The 50 Hz standard is a free running multivibrator, the rail voltage for which is stabilised by a zener diode which itself is fed from a constant current source. The output from this multivibrator is then buffered and is used to trigger a second multivibrator which drives the thyristor firing transformer.

From this description it can be seen that while the basic inverter section is conventional, considerable care has been exercised to maintain frequency stability. Also, in addition to the filtering on the inverter's output, radio frequency filtering is fitted to the dc input lines which include a fast-acting overcurrent circuit breaker which is of the type that also functions as an on/off switch.

Stability

While the inverter is supplied ready for use with a nominal output voltage of 220V ac, it is a simple matter of moving one soldered connection to convert the unit for nominal 240V ac operation, and because this is the most common requirement in Great Britain all testing was undertaken with the inverter set for a nominal 240V output.

Fig. 1 shows the relation between output voltage and current with a constant 24V dc input voltage and shows an excellent voltage stability with a change in output of less than 3 per cent from no load to the rated load of 200W; it is also to be seen that the efficiency remains above the specified 70 per cent from half load to full load.

The output frequency remained at 49.90 Hz throughout the load changes and also remained constant with dc input voltage variations from 20V to 30V with the inverter delivering a full

200W output.

Fig. 2 furthermore shows that the output voltage is well stabilised against input voltage changes, remaining within ±3 per cent of a nominal 240V over the input voltage range 22V to 30V dc, which is somewhat better than the local electricity boards manage to achieve most of the time!

Waveform distortion

The predominant harmonics in the output of the inverter were the odd harmonics of 50 Hz, any even harmonic output being greater than 50 dB below the fundamental, at an output loading of 100W. However, the second harmonic at 100 Hz appeared some 47 dB below the fundamental when the loading was increased to 200W.

Individual harmonic levels are shown in **fig. 3** with the inverter loaded at 100W, and the associated waveform is shown in **fig. 4.** At a loading of 200W the higher harmonics showed a marked decrease, but there was little change in the level of the third harmonic at 150 Hz. The harmonic contents measured are substantially higher than those associated with the public electricity supply, and some caution must be observed in this direction—however, there are many types of inverter that have far higher harmonic contents, and also some independent electricity supplies that suffer from the same complaint.

The transient performance

Investigations into the switch-on and switch-off transients when switching the incoming dc supply did not reveal any other voltage transients in excess of 4 per cent of the nominal output voltage, and any such transients only occurred within 200 ms of switch-on independent of the loading applied.

It was also found that the sudden application of loading, to the extent of going from no load to full load, produced little disturbance in the waveform, and that which did occur was fully recovered within 20 ms. The only operation that did have any potentially unhappy consequence on the inverter was removing the full 200W loading, which gave a voltage overshoot of up to 20 per cent with about 200 ms being required to regain full stability as shown in **fig. 5.**

Short circuiting the output did not produce any unhappy effects, the protective circuit breaker in the inverter operating within 10 ms of the short circuit being applied to the output.

Other aspects

While the measurements made were directed at exploring the performance within the rated specification, on the suggestion of the agents the inverter was subjected to severe overload, lowered supply voltage, and to capacitive and inductive loading without any malfunction being apparent.

One potential problem which must be mentioned is that the acoustic noise level, the form of harmonics of the mains frequency, was high. Measurement of the noise with the inverter mounted on thick sheet rubber on the bench, the noise level meter being located one metre from the inverter, produced a sound level indication of some 48 dB(A), which is a very high level by the standards of normal

FIG.1
EFFICIENCY AND STABILITY AT 24V DC INPUT

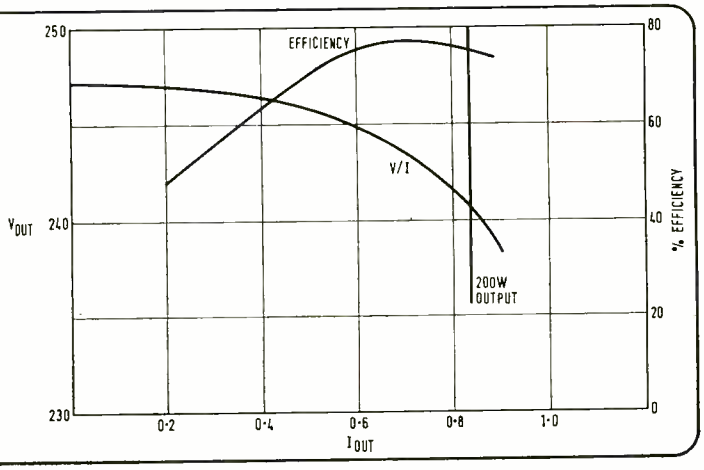


FIG. 2
FULL LOAD OUTPUT AND EFFICIENCY VERSUS INPUT VOLTAGE

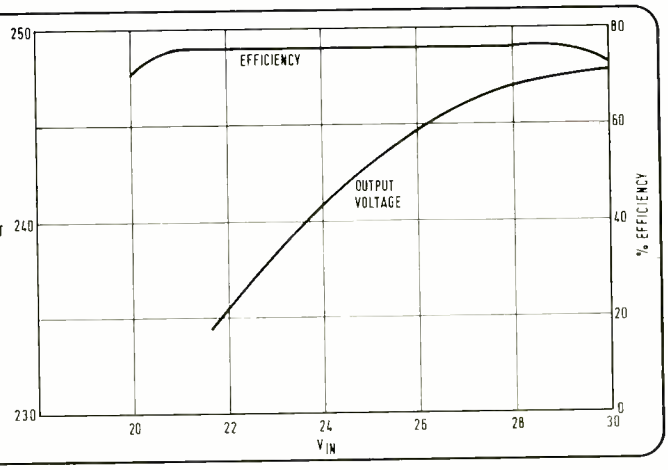


FIG. 3
HARMONIC CONTENT OF OUTPUT. 10Hz ANALYSER BANDWIDTH

PEN: 200mm/S
PAPER: 1mm/S

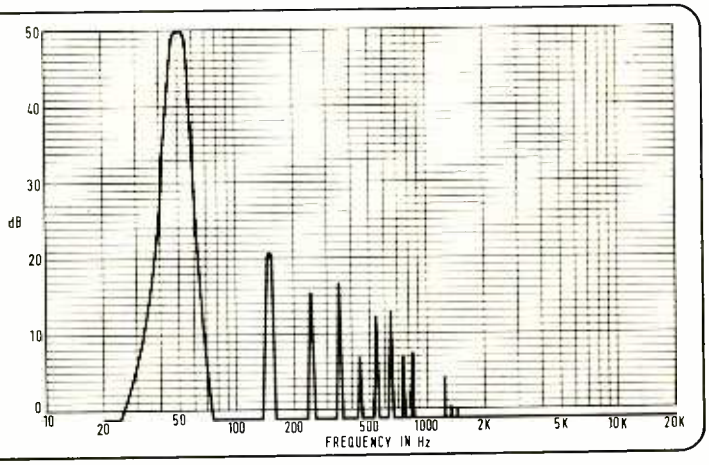
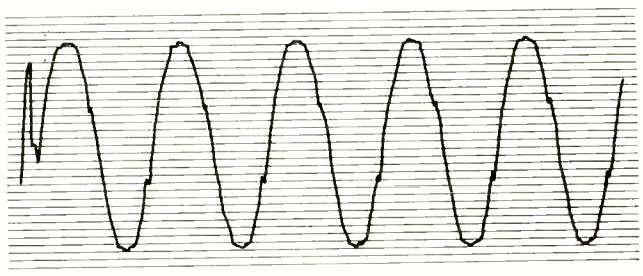


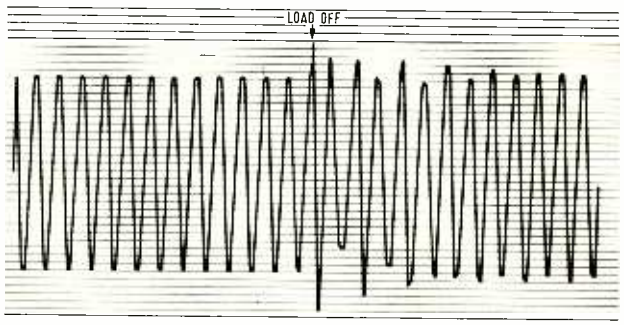
FIG. 4
OUTPUT WAVEFORM



audio equipment. The presence of the inverter in a control room, or a similar environment, would therefore be quite unacceptable.

Another aspect which also deserves mention is that there is a fairly large stray magnetic field generated by the inverter's transformers, and while I do not have the equipment necessary to measure this field, there is no doubt that it could cause trouble if the inverter was mounted near magnetic tape transports—simple trials proved this, and by 'near' I mean less than two metres.

FIG. 5
EFFECT OF REMOVING 200W LOAD 20% OVER VOLTAGE SPIKE



Summary

The performance of this inverter is fully to the manufacturers' specification, and in fact far better than the specification would suggest. In particular, the frequency stability and voltage regulation are better than that which one might expect from the public electricity supply.

On the other hand, as is the case with most auxiliary power supplies, the harmonic content of the output is fairly high. While this is unlikely to produce malfunctioning with most types of mains-powered electronic equipment, it is a factor which must be borne in mind when purchasing any auxiliary power supply.

Provided that the Lindberg inverter can be located where its acoustic noise is not troublesome, and likewise where its stray magnetic field is out of harm's way, it offers very good performance from an unusually substantial unit which will withstand rough handling.

PATENTS

Three new approaches to reverb control

In BPI 399 846, AKG of Austria explains how a conventional spring reverb system with feedback suffers from the disadvantages that the echo characteristics tend to be periodic. The new suggestion is that this unwanted periodicity can be avoided by building a balanced bridge of symmetrical construction with four component ohmic resistors, of which two have transducers in series. The transducers are mechanically interconnected in conventional manner by a helical spring. The voltage tapped off across the bridge will be nil while the bridge remains balanced by all its symmetrical components. But a differential voltage will be created as soon as the bridge goes out of balance, for instance due to randomly distributed irregularities in the spring. When audio signals are fed into the spring all the unwanted periodic signal components, which appear in phase and with the same amplitude in both transducers, are eliminated from the bridge output.

In BPI 400 275, the BBC tackles the same problem in a different way. A feedback loop, for instance for a tape system, contains a series of time delay elements. Although effective in producing prolonged reverberation effects this also produces undesirable periodicity coloration in the output. To mask this periodicity, the BBC engineers suggest adding a random delay circuit to the feedback loop, thereby to cause a continually and randomly varying delay in the system. One ideal way of providing random delay is to use a variable delay circuit, of which the time constant is controlled by a random noise generator. Although the time constants of the remaining delay elements in the feedback loop remain fixed, the constant of the variable delay circuit is as unpredictable as the output of the random noise generator, and this in turn causes a random change in the overall characteristics of the loop. It appears that in practice the variable delay need only have two values for the successful obliteration of coloration.

The BBC suggest that the system is applicable to both digital and analogue signals, and may be used both for stereophonic and quadraphonic processing.

Yet another different approach to reverberation control is patented in BPI 398 330, again by the BBC. In this case the suggestion is that the reverb time of the studio may be varied, for instance between one and two seconds, by simple mechanical means. The studio walls and ceiling are clad with sound absorbent panels of the perforated or cavity type. These panels are covered by further panels which have a pattern of simple through-perforations matching the pattern of perforations on the wall panels. The inner panels are fixed, the outer panels are slideable. Thus by moving an outer panel over a fixed inner panel it is possible to move continuously between two extreme positions, in one of which the holes of both panels are aligned and in the other of which the holes of the lower panel are totally covered. In the halfway positions some holes are aligned and some are covered, and some holes are partly covered. In this way there can be a fairly smooth mechanical change between the dead and live acoustics. An alternative approach suggested is to use venetian blind slats as the outer panel, the slat angle being varied to change the effective open area of the inner panels. It is envisaged that the moveable parts can be motor-driven for automated master control.

Adrian Hope

FIG 1

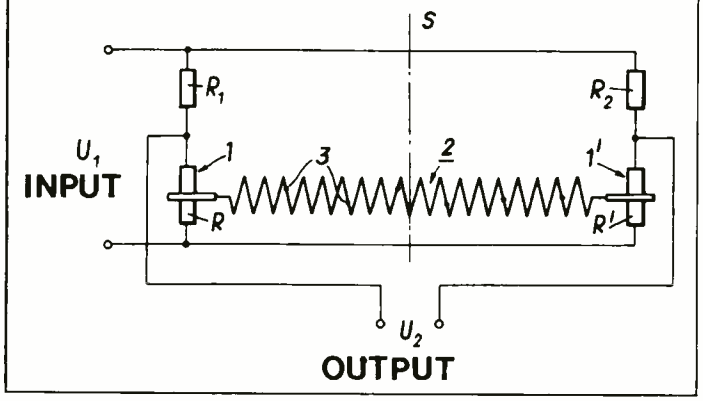
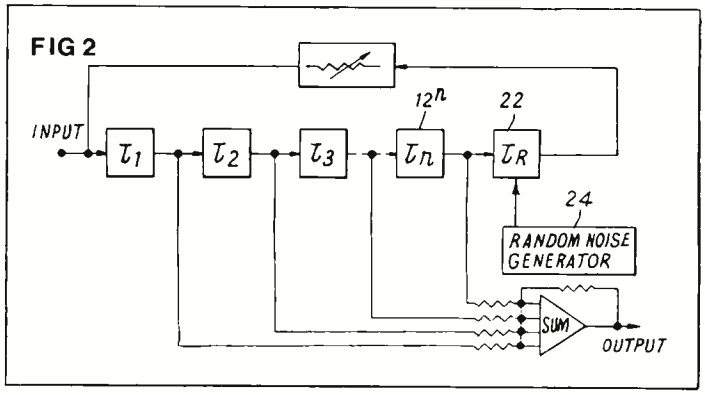


FIG 2



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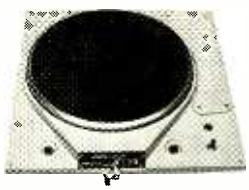

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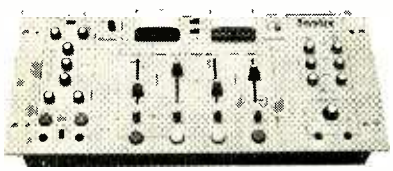

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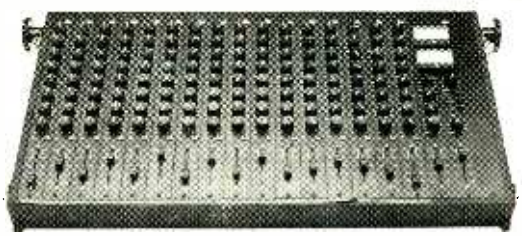

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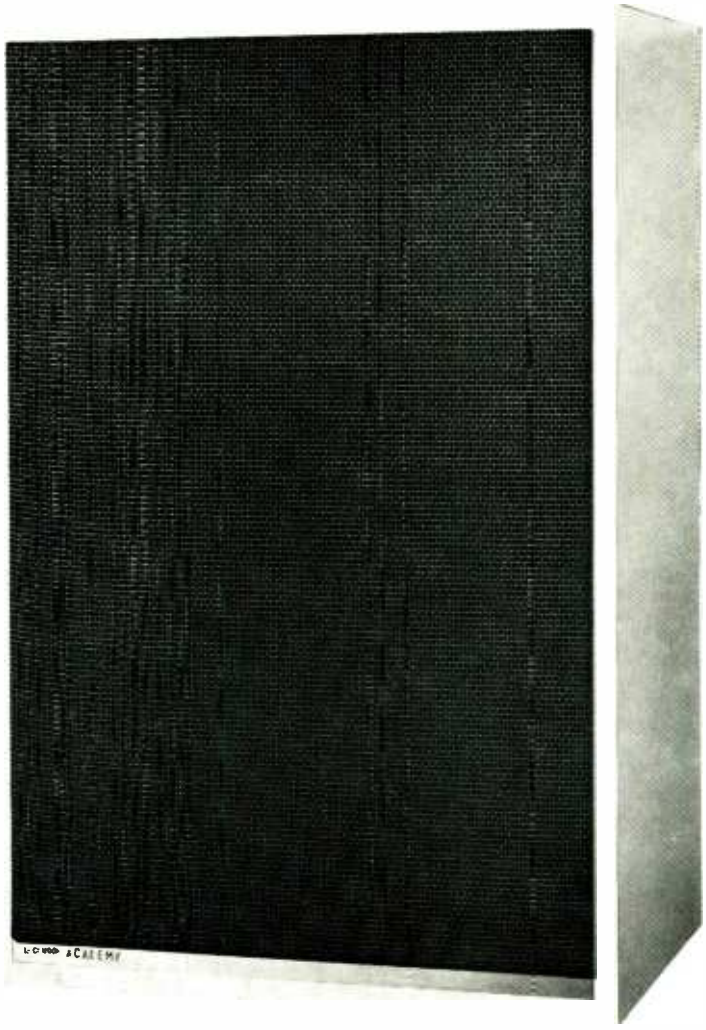

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