March 1975 25p

studio sound

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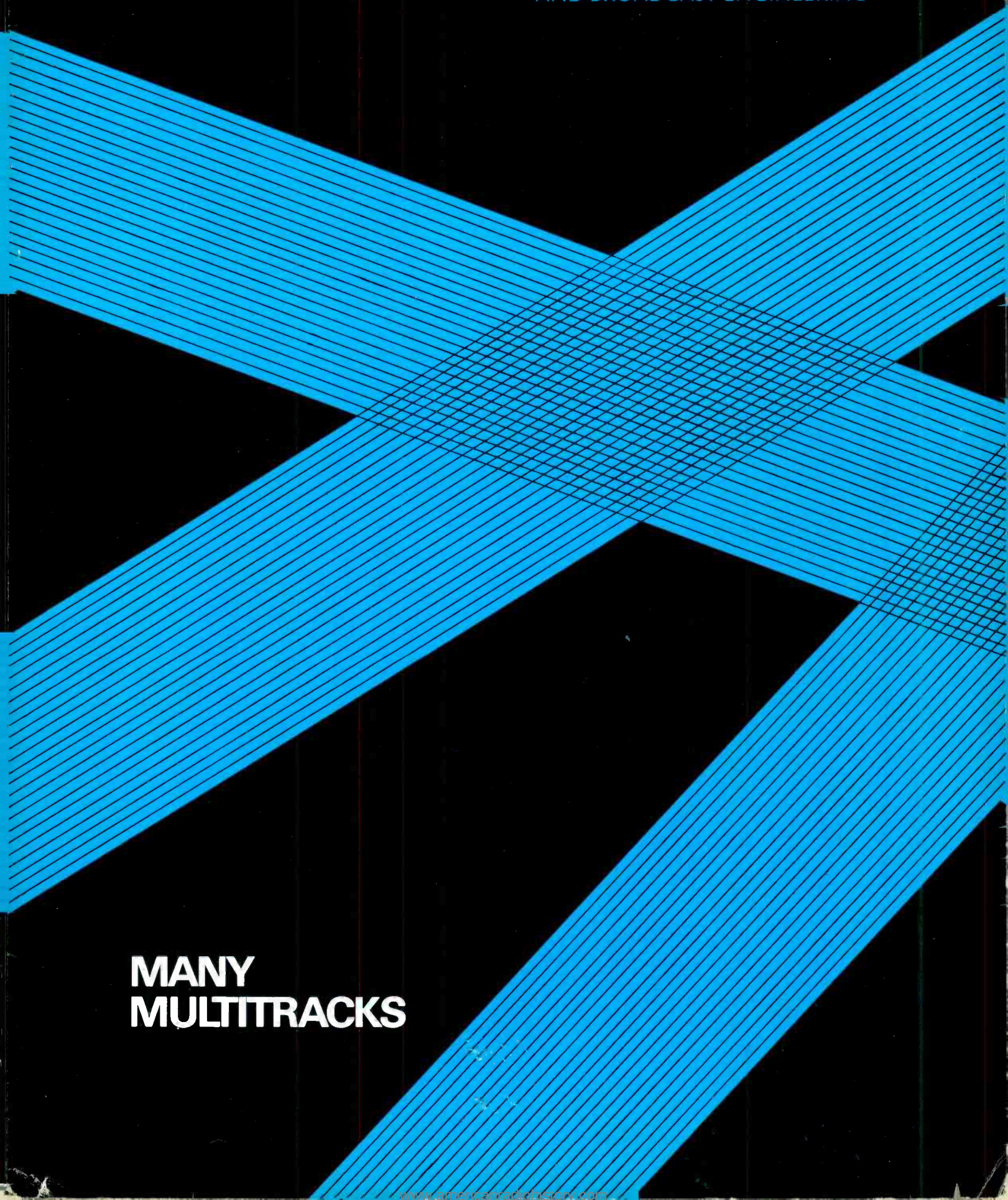

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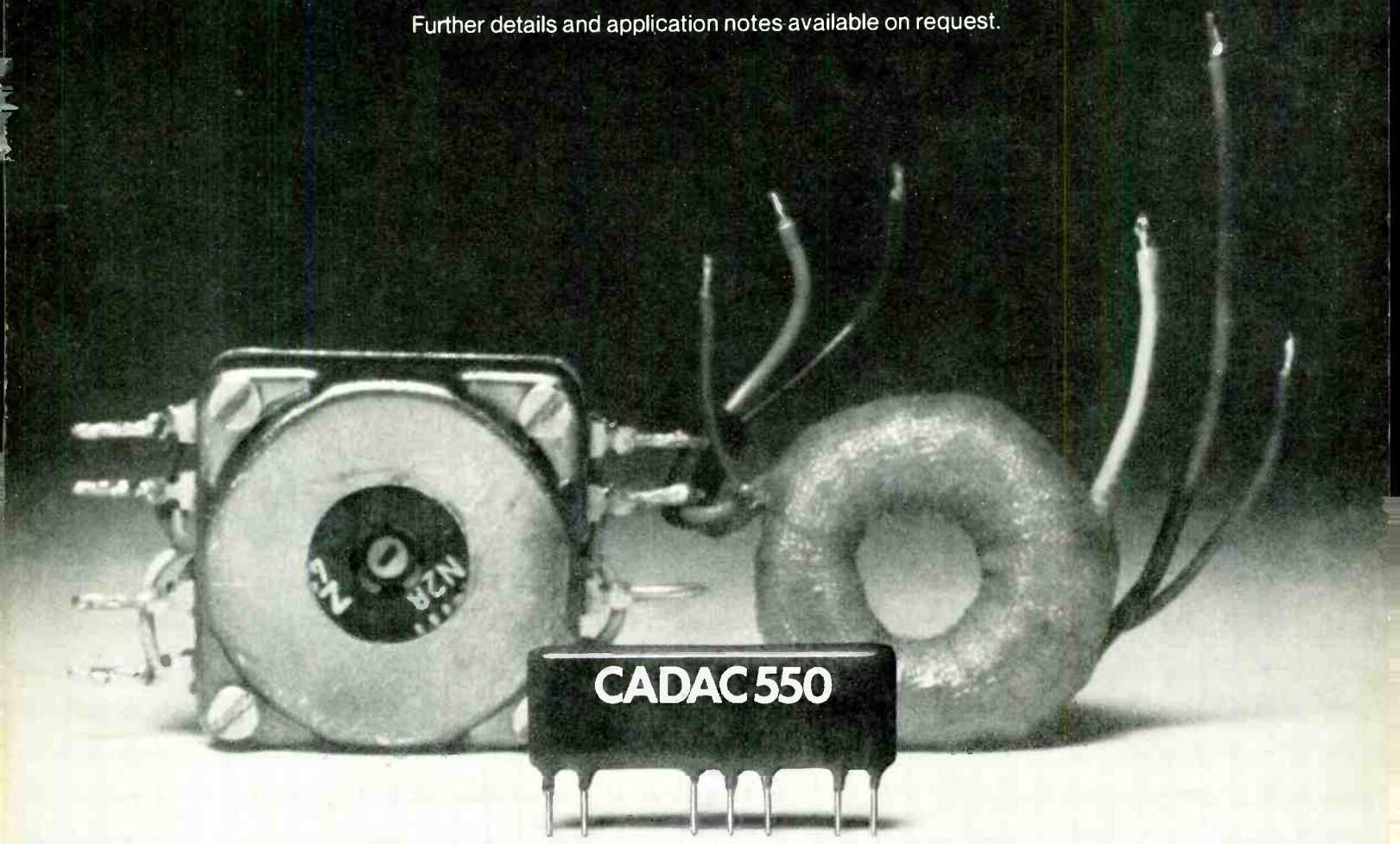

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THE LINK HOUSE GROUP

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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. Non-qualifying readers can buy STUDIO SOUND at an annual subscription of £4·17 (UK) or £4·20 overseas.

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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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MARCH 1975 VOLUME 17 NUMBER 3

IN MARCH, WE welcome the AES 50th convention to London. Since its establishment in 1948, it has evolved as the major clearing house for ideas and developments in audio and related technologies. Such conventions occur three times a year: one on each USA coast and one in Europe; March's is the first London visit, all previous being on the continent. Associated with it is an exhibition of particular interest to the commercial sound industry. The benefits of a centralised display of equipment and manufacturing companies are obvious, but less apparent is the function as a place where everyone can meet everybody else and exchange business, ideas and gossip.

Because of their prime position, AES conventions attract delegates from many parts of the world, making them truly international. The recording business, by virtue of the scale of its equipment, and as a reflection in turn of the record business, is similarly wide-ranging. The only UK shows of relevance to our sector are those of the APAE and the APRS and are relatively local. Nevertheless, for many visitors there is an overlap with consumer shows, of which there are several.

Because of the proliferation of consumer exhibitions, which are profitable business for the organisers, the last few years have seen a decline in importance and credibility which reaches its nadir with the farce of the Sonex split shows. Fortunately, the recording industry does not suffer from such frivolities, and the two shows mentioned are generally well run and considered to be worthwhile. Nevertheless, as the third London exhibition of this year, AES provoked a few comments about the difficulty of visiting all three. Studios and similar organisations do not work regulated nine till five and it is not always easy to set aside time. If manufacturers who felt involved with all three were unable to attend all for time or money reasons, this in turn discourages visitors who might wish to meet them.

On this basis, the obvious course is to unite all shows under one roof at the same time. This has been proposed, particularly with regard to the APAE and their exhibition which falls close to AES, that a separate exhibition be mounted but at the same time. A difficulty is the reluctance of any thriving small organisation to become lost in a larger operation; depending on reaction, this could be labelled as protecting a minority interest or, simply, parochial.

Another proposition floating around is of a unified exhibition time, with professional and consumer shows mounted simultaneously at different London venues. Apart from the alarming organisational difficulties, the self-protective instinct of organisations involved has been important and understandable. However, thinking internationally, people have only so much time available for travelling around. This holds for Londoners too. Perhaps this is the right time to consider such suggestions. We would not make any trite recommendations, for it is a complex subject. But it would be reassuring if ideas about rationalisation of trade shows at least were discussed thoroughly; they may be dropped after due consideration, but that is preferable to their being rejected by default.

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

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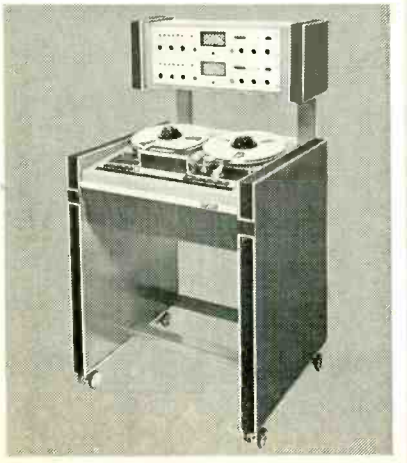

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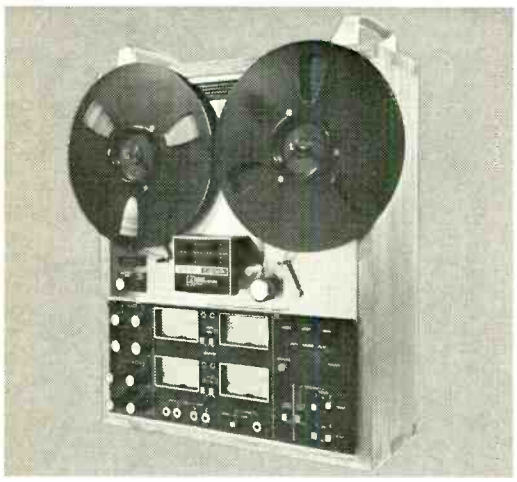

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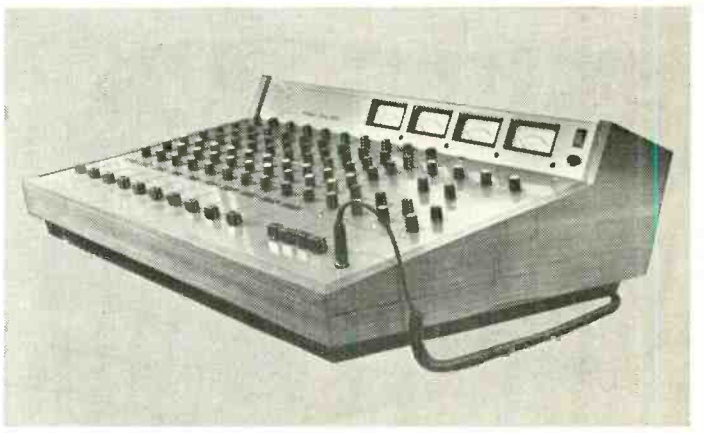

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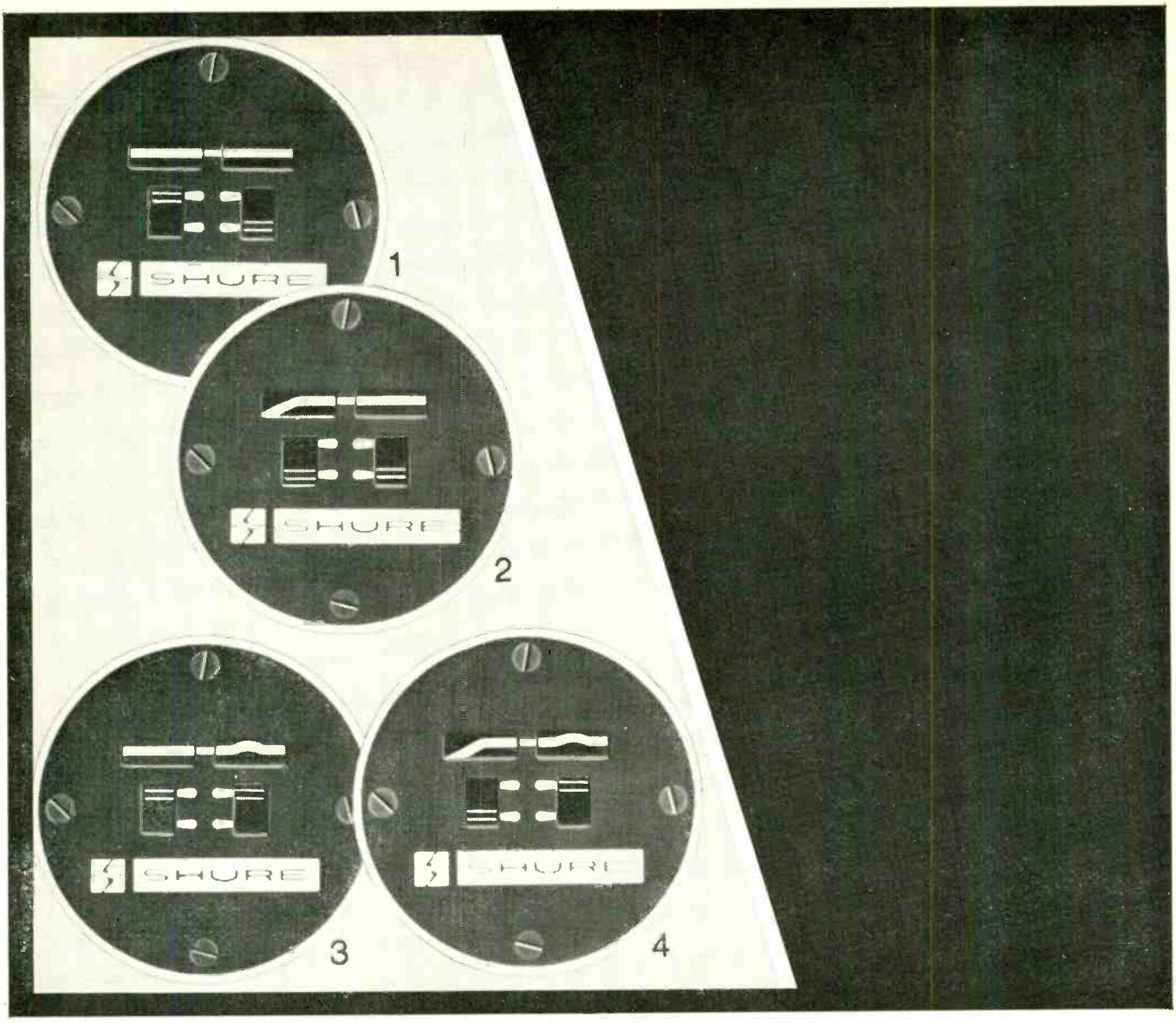

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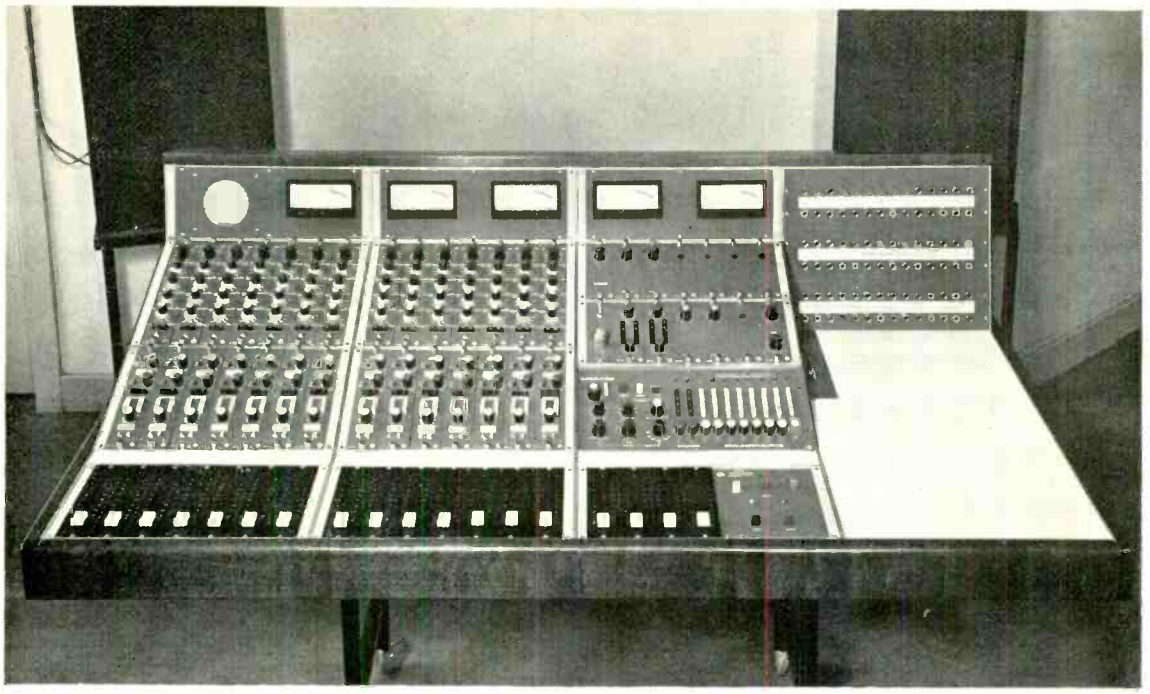

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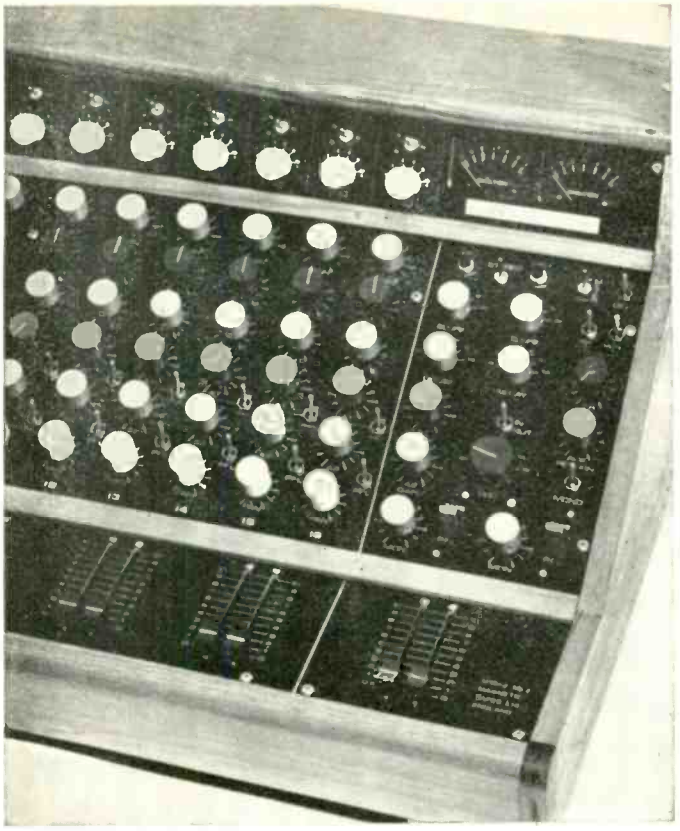

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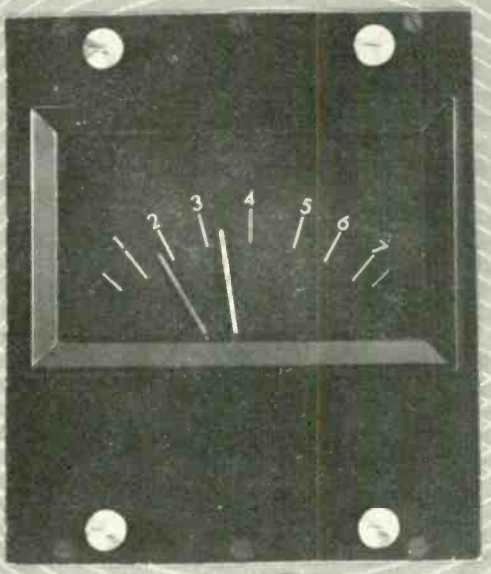

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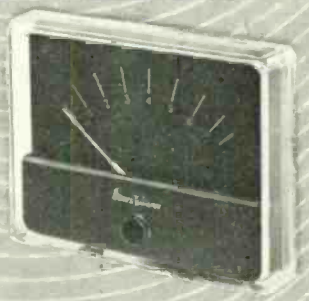

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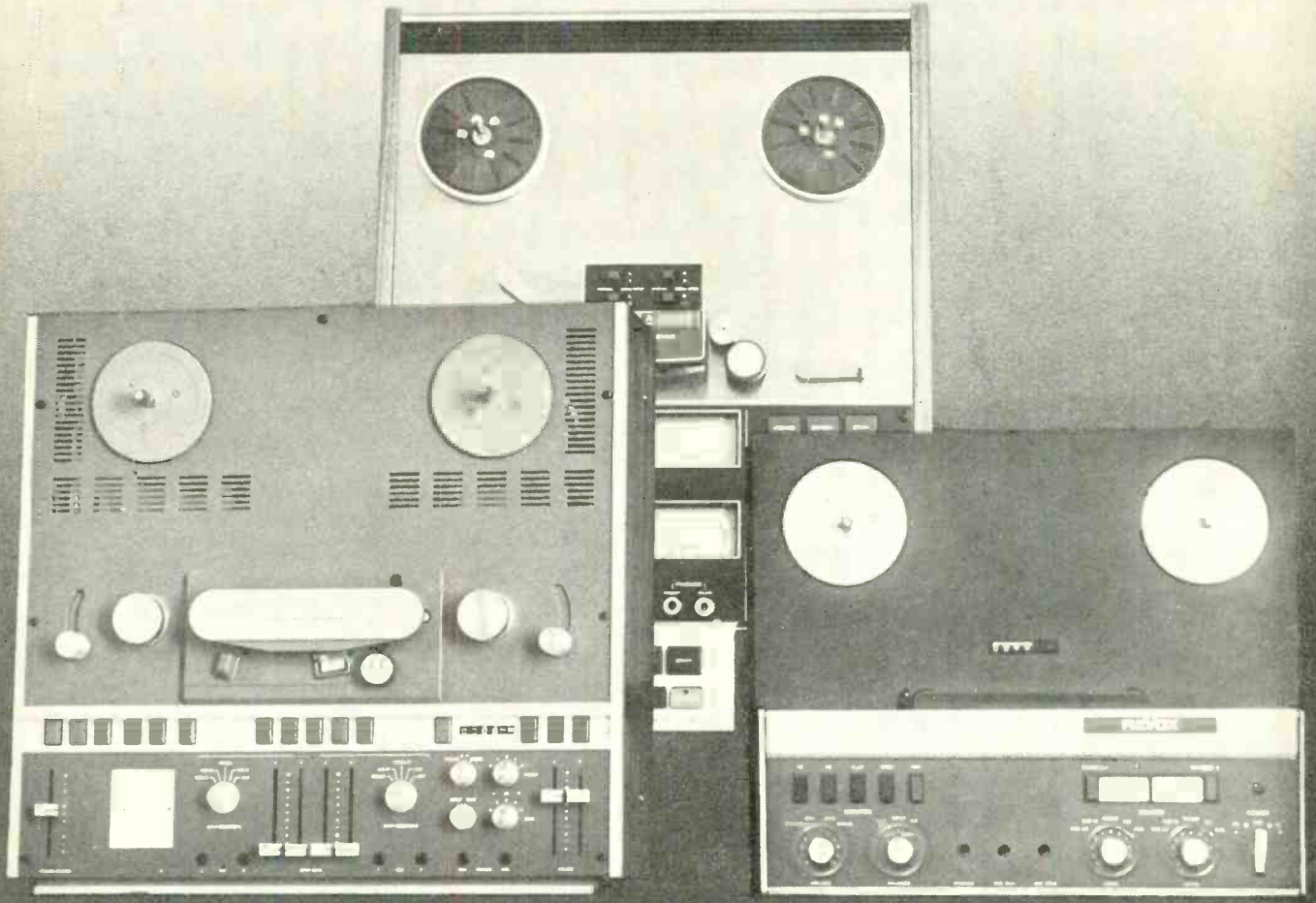

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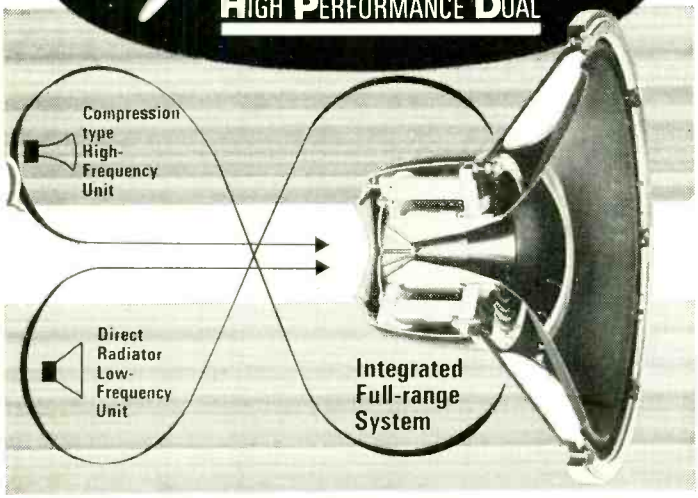

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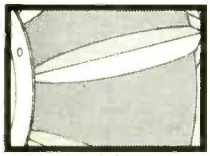

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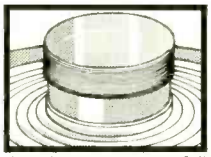

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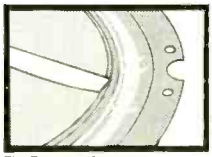

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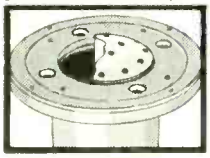

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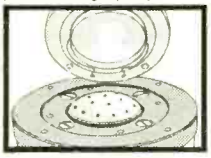

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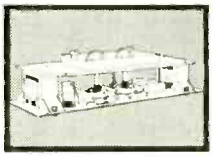

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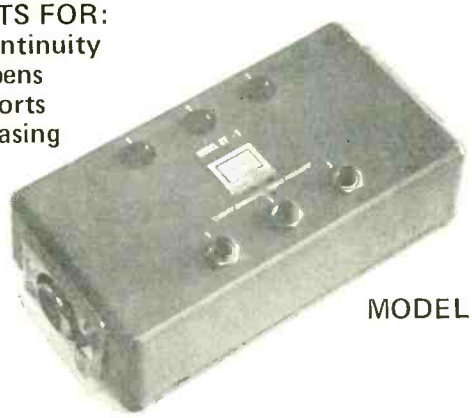

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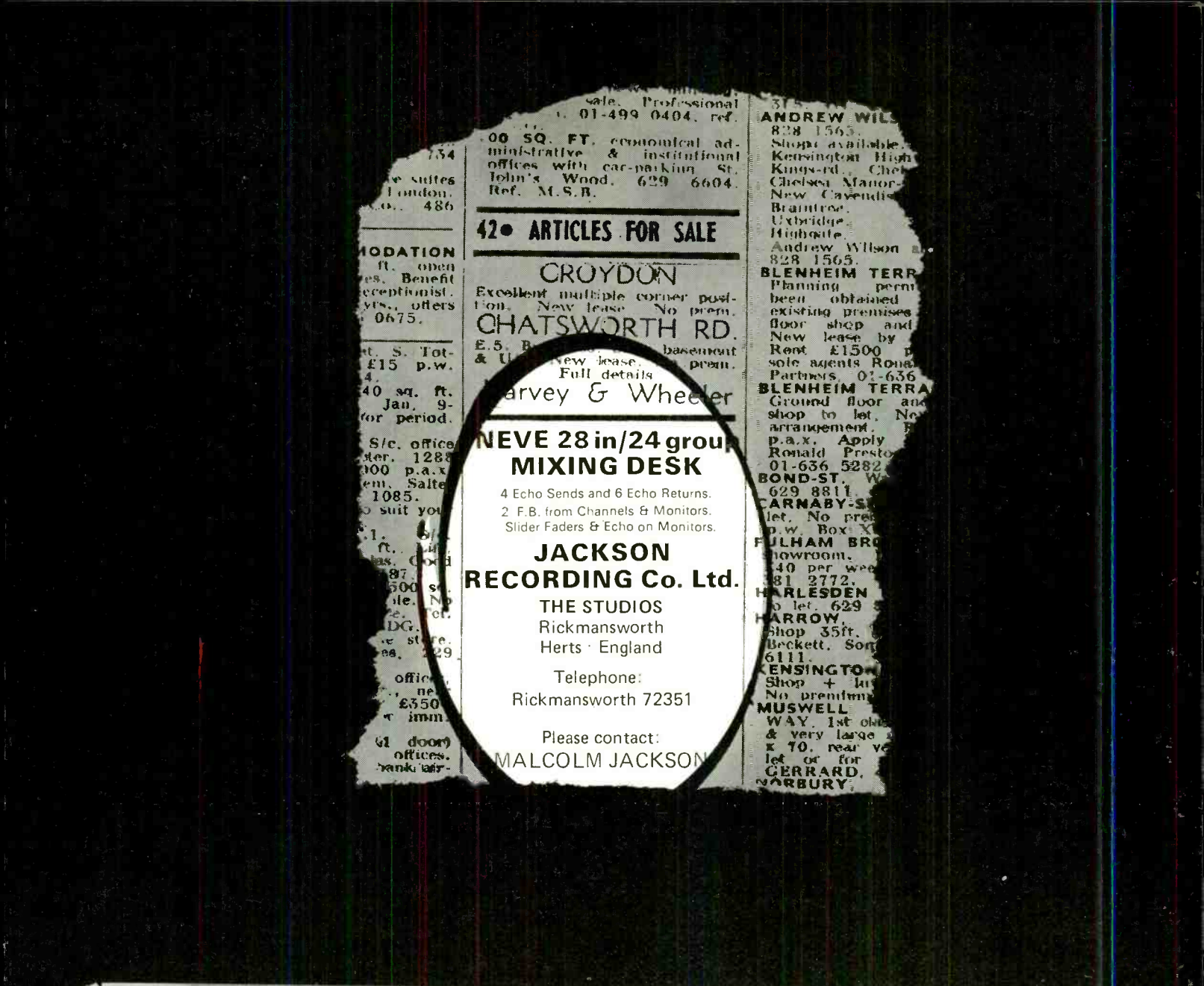
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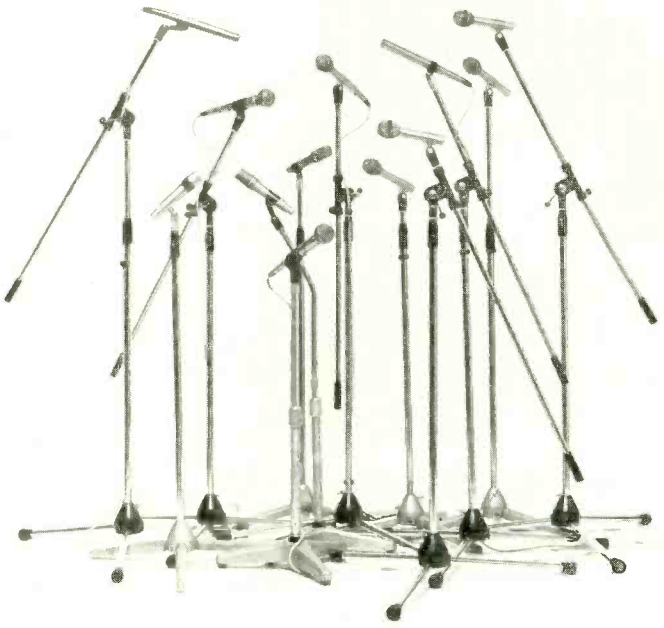

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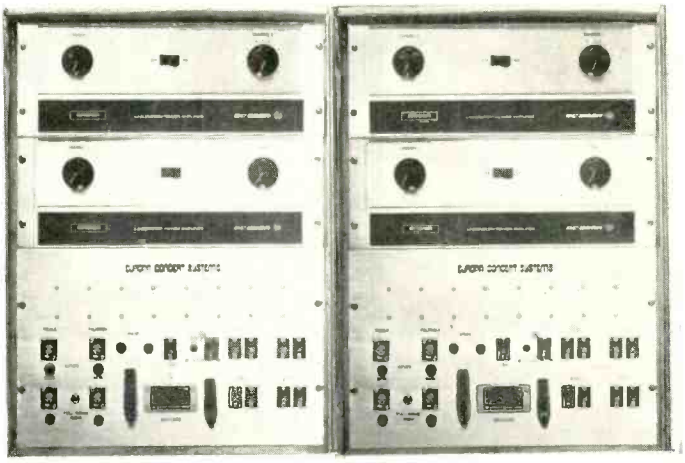

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NEWS

Wide range frequency shifter

BASED ON THE ORIGINAL design by Dr M Hartley Jones, a new shifter from Surrey Electronics claims to provide shifts in the range of 0.1 Hz to 1 kHz. At the lowest shifting frequencies, a unity gain mixing facility provides phasing effects brought about by interaction of the modified and straight through signal paths. The mix is hooked up by front panel switch, the shifting frequency being controlled by a slider through four switched ranges.

At slightly higher frequencies (about four to five cycles) the spectrum shifter may be used for howlround reduction in the conventional manner. At the highest frequencies, the shift destroys the harmonic relationships between musical notes—each note undergoes the same frequency displacement—producing unusual sound effects.

The specification for the unit claims less than 0.1 per cent thd up to +12 dBm output with −1 dB points at 50 Hz and 20 kHz. The shifter is 230V ac powered and uses *XLRs* for all signal connections. Price is £150. Surrey Electronics, The Forge, Lucks Green, Cranleigh, Surrey GU6 7BG. Phone: 04866-5997.

Smart start

IN THE MANUFACTURER'S specification for the Series *2000* jingle machines are noise figures of −57 dB and start/stop times of under 80 ms. The new range, produced under the 'Spotmaster' banner, is available in all the usual mounting arrangements with 150 and 1000 Hz cue tones standard. The new design claims to possess low power consumption resulting in a cool running machine that's easier on tape. Prices for the series start at $465 (mono playback). Broadcast Electronics Ltd, 8810 Brookville Road, Silver Spring, Maryland 20910, USA. Phone: 301-588 4983 UK agents: CRS (World) Productions Ltd, 24/30 Park Lane, Cheshire. Phone: 099 67-6401.

Power converter

500 WATTS OF EMERGENCY ac power can be provided from two 12V car batteries using the latest power converter from Tower Flue Components Ltd, Morely Rd, Tonbridge, Kent TN9 1RA. The unit is air cooled and measures only 16 x 24 x 10 cm. In addition, it has the facility to recharge the batteries on restoration of the supply. Supplied with 'jump leads' for connection to the batteries, the unit costs £80.

Next APAE show

THIS WILL BE the Sound '75 International Exhibition, to be held from March 11 to 13 at the Bloomsbury Centre Hotel, Coram Street, London WC1. This annual event has attracted considerable interest in the past and promises to do the same again this year. The organisers report that stand bookings have been quite brisk and they estimate that all available space will be taken at this year's show. Association of Public Address Engineers Ltd, 47 Windsor Rd, Slough, Berks. Phone: Slough 39455.

Didn't they do well

PYE TVT ANNOUNCE the delivery of two ob vans to African countries—Nigeria and Sierra Leone. The vans are equipped with tape recorders, six way sound mixers, uhf/vhf broadcast and radio telephone links and full air conditioning. The Nigeria bound vehicle, for Radio Television Kaduna, has been built on a long wheelbase Land-Rover chassis while the Sierra Leone mobile is constructed from a Bedford van.

Further news from Pye TVT concerns the appointment of Peter Lance as marketing director. Since joining the group in 1959, he has been the man mostly responsible for the successful export drive. Pye TVT Ltd, Coldhams Lane, Cambridge. Phone: 0223-45115.

Performing Right Society

MR ALAN FRANK has been elected chairman of the General and Executive Councils of the Performing Right Society. The appointment took effect from new year. Mr Frank, husband of composer Phyllis Tate, is an erstwhile head of the Music Department at Oxford University Press and has served on many public committees concerned with the propagation of music.

He succeeds Mr Laurence Swinyard, the chairman since 1968.

Above: *Pye TVT's OB van*

Left: *Spotmaster 2000 jingle machine*

Watergate re-visited

THE REPORT of the panel of experts on the 18½ minute buzz section of the tape of June 20 1972 which was recorded in the White House makes some interesting reading. This report which is officially titled 'The EOB Tape of June 20, 1972, Report on a Technical Investigation Conducted for the US District Court for the District of Columbia by the Advisory Panel on White House Tapes May 31, 1974' was compiled by the six appointed experts.

It may be recalled that the experts were Richard H. Bolt, Franklin S. Cooper, James L. Flanagan, John G. McKnight, Thomas G. Stockham Jr, and Mark R. Weiss, all of whom are well known figures in their appropriate disciplines which cover the field of audio recording, speech synthesis and digital techniques as applied to the synthesis and analysis of audio information.

The task of the panel of experts was to investigate the authenticity of the recording and to determine the cause of the 18½ minute buzz section of the tape, as well as attempting to recover any speech recording which might exist underneath the buzzing noise. The recorder said to have been used to make the original recording was a Sony type *800B* running at 2.38 cm/s to which was connected 'several miniature microphones in the President's office'. The signal from the microphones operated a voice actuated switch which started the recorder. In fact, two recorders were used on alternate days (except at weekends!). The machine used for transcribing the tape was a Uher *5000* recorder equipped with a Fidelitape foot-pedal control.

Various pieces of recording equipment from the White House were given to the panel of experts, and the original tape was made available only in the presence of two or more Deputy US Marshals who acted as guardians of the tape and observers during examination of the tape. It is perhaps surprising

that listening tests were restricted to the buzz section of the tape and the adjacent speech sections, while only measurements were permitted outside this section of the tape and these were done at four times normal tape speed in order to preserve the privacy of the recorded conversation.

The investigators used copies of the buzz section for some of the investigation, but reverted to the original tape whenever copies might be unsuitable. Likewise, the original recording equipment was under the supervision of the US Marshals and in order to save time during the investigation similar new equipment was used for parts of the investigation where this would be meaningful. It is perhaps interesting to quote in full the conclusions drawn in the 51 page report, and then to mention briefly the methods used in examining the tape, which are detailed in the subsequent sections of the report and occupy a further 150 pages or so: '**1** The erasing and recording operations that produced the buzz sections were done directly on the Evidence Tape. **2** The Uher *5000* recorder designated Government Exhibit No 60 probably produced the entire buzz section. **3** The erasures and buzz recordings were done in at least five and perhaps as many as nine, separate and contiguous segments. **4** Erasure and recording in at least five places on the tape required hand operation of the keyboard controls on the Uher *5000* machine. **5** Erased portions of the tape probably contained speech originally. **6** Recovery of the speech is not possible by any method known to us. **7** The Evidence Tape, insofar as we have determined, is an original and not a copy.'

These conclusions were based on a number of different methods of studying the tape, some of which I will outline here. I thoroughly recommend anyone interested in the detailed techniques to obtain a copy of the report and also to refer to my paper 'The Legal Aspects of Magnetic Recordings' to be found in the JAES Vol 22 No 4 May 1974 and reprinted in STUDIO SOUND and elsewhere. The two completely independent works share a number of common techniques, and so far as I am aware are the only works on magnetic recordings as evidence.

Of primary interest were the click patterns recorded on tape by the record and erase heads when recorders are switched out of the record mode. From the nature of the waveform of the click patterns it was possible to decide whether the Sony or Uher recorder were used to record various sections of the tape. Furthermore, by applying finely divided iron particles in a volatile solution to the tape surface, the click patterns were made visible, and it was then possible to measure the width of the heads which produced the various click patterns — this information was vital if any possible copying was to be detected, for while it is possible to copy click patterns it is not possible to copy the exact track width. Using this technique the panel also determined the head alignment used to record the evidence tape, and then compared this alignment with the alignment of the other recorders which could have been used.

Several sets of click patterns were found in the buzz section of the tape, and the characteristics of these patterns suggested that they had been made by the Uher recorder which was used for transcription as opposed to the Sony recorder used for the original recording. Studying the original Sony recorders from the White House, together with the voice actuation devices, failed to show how click patterns of the type found could have been produced during the original recording process. Further studies were therefore initiated to determine if the Uher recorder (or other Uher recorders) could produce a similar series of click patterns as a result of a malfunction during the transcription processes.

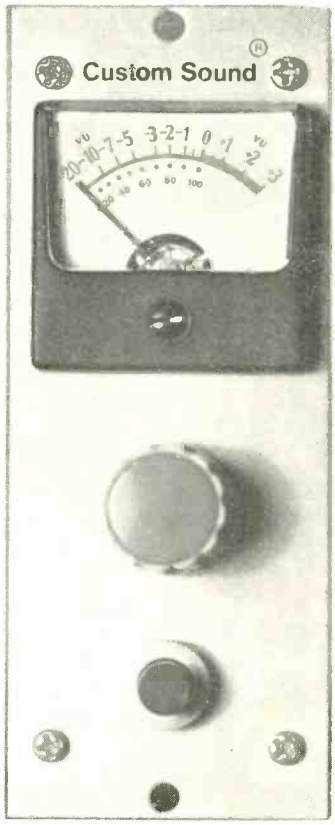
Fortunately for the investigating panel the recorded section of primary interest was the buzz section of the tape, which was shown by spectrum analysis to be in the form of a 60 Hz tone (US mains frequency) and many of its harmonics. A study of the phase of the buzz section was made by re-recording the buzz section on one track of a four track machine and recording a continuous tone of the same frequency on a second track, the phase between the two tracks then being compared. This study revealed phase discontinuities at the points of the aforementioned click patterns: thus confirming the suspicions that the buzz section was a series of separate recordings. Further study of these areas of the tape with a spectrogram (voice print) showed that in some cases there was evidence of a previous speech recording, which had been suspected from listening tests.

Attempts were made to recover the original speech recording by means of filtering, the use of very narrow edge track replay heads (with the hope that the erasure might be poor at the edge of the tape) and by various other more complex means. However, it was not possible to reveal the original speech.

Other tests included the checking of the tape speed of the original recorder and also flutter analysis. Both these checks were possible as a result of the 60 Hz buzz recording which provided a constant (and known) frequency reference tone. In these fortuitous circumstances it was a straightforward operation to verify the original tape speed, which was then compared with the tape speed of the various available recorders. The flutter checking was done by narrow band spectrum analysis and this particular check provided most valuable results, as individual recorders of the same type give differing flutter spectrograms according to the tolerances of the mechanical components in the tape path. A further check of some particular interest is that of the azimuth of the recorders used. This check was done by means of a azimuth angle adjustment tape manufactured by Magnetic Reference Laboratory which was used to determine the azimuth angle of the various recorders from the White House. These results were compared with the azimuth angle of the evidence tape which was determined from the high frequency response during listening tests.

In concluding this note it is important to mention that the time investigating this 18½ minute buzz section of the White House tape amounted to hundreds of man days, I am currently working on evidence tapes of about 29 hours duration—pro rata this investigation would occupy almost 30 man years—is it right that magnetic recordings should be used as evidence? **H.F.**

Mic preamp from Custom Sound Productions



Mic front end

A CONSOLE MOUNTED mic pre-amp unit is now available from Custom Sound Productions of NYC. Using an *LM 381AN* ic, the manufacturers quote equivalent noise input voltage of 0.55 μV—about −63 dB ref. 0 dBm. The overload point into the 600 ohms balanced input is 0.3V; below this level, the quoted distortion factor is less than 0.1 per cent. The unit offers a supply rejection ratio of 120 dB at an optimum working voltage of 40V.

The pre-amp uses a Bach-Simpson *1214* vu meter to indicate headroom. Custom state that tantalum capacitors and other quality components are used throughout to provide a professional mixer building block. The price for individual units is $175 with a delivery of four to eight weeks. Custom Sound Productions, 119 Bank St, New York City 10014, USA. Phone: 212-691 8754.

Cause for expansion

ALLEN AND HEATH announce that they have doubled their production capacity to cope with a rising demand for their products. Included in the new programme is a mini mixer providing low cost studio facilities when complemented by auxiliary equipment modules. In addition, they plan to manufacture a pa console and a 16 track modular recording system. Andrew Stirling, Allen and Heath Ltd, Pembroke House, Campsbourne Rd, London N8. Phone: 01-340 3291.

Getting canned

GUESS THE PRODUCT with the help of a few extracts from a current press release: 'To start with, he can expand the centre channel of each of the four channels by simply flipping the Ambience Expander switches to the E position. Like a recording engineer, the listener will be able to add a dimension to his favourite recordings never before possible.' This release continues: 'When he flips the Binauralators to the ON position, the Phase/2+2 listener will zoom into a panorama of performing musicians.' On and on . . . 'Suddenly, he'll be completely immersed in a totally new experience, amazed at the added presence and dimention that exist in his source material.'

20 ▶

NEWS

Answers, please, on a postcard only to the Quadraphonic Headphone Dept, Koss Corporation, 4129 N' Port Washington Avenue, Milwaukee, Wisconsin 53212, USA.

Emergency light

PROVIDING ILLUMINATION when the power's turned off, the Lab-Craft *9000* series are said to comply with the latest GLC regulations. The company claims their *9033* Teak Light is 'the first emergency light specifically designed with decor in mind'. The units are powered in the emergency mode by Ni-Cd batteries which recharge on restoration of the mains supply. Under these conditions, the lights provide three hours of operation between charges. Lab-Craft Ltd, Church Road, Harold Wood, Essex RM3 0HT. Phone: Ingrebourne 49241.

Mini mic equaliser

NOW AVAILABLE IN THE UK, the *502* Microphone Programme Equaliser from Spectra Sonics offers three band parametric equalisation and switchable shelves at 50 Hz and 10 kHz. Control range extends from −12 to +12 dB with overall unity gain in the flat position. The unit, intended for rack mounting, measures 4 x 19 x 7 cm and is available from the UK agents, Sun Recording Services Ltd. 35 Edgecumbe Park Drive, Crowthorne, Berks. Phone: 034 46 4363.

On the recording side of the business, Sun state that their new studio, opened in December, is doing great things in the world of jingles and demos. Operational studio hardware includes four channel Teacs and Revoxes sourced through an Allen and Heath 16/8 mixing console. A piano, synthesiser and other instruments are on hand for visiting musicians. Studio charges range from £6.50/hour to £250/week. Studio 6, 34 Crown St, Reading, Berks.

Good for e/s speakers?

COULD BE USEFUL for making electrostatic speakers, a new lightweight plastic sheeting from 3M offers electrical conductivities of 32k ohms/sq. The soft, flexible and impervious material claims to be mouldable and heat sealable while enjoying resistance to tearing and abrasion. The trade name of the plastic is Velostat and was designed to remove static from critical operating areas. The material feels like soft 'polythene' and is black in colour. 3M UK Ltd, 380/384 Harrow Rd, London W9 2HU. Phone: 01-286 6044.

Radio London?

THE GO AHEAD has been given for BBC Radio London to raise its medium wave power levels from 20 to 50 kW. This means that the effective service area now includes Guildford, Godalming, Cranleigh, Horsham, Cuckfield, Haywards Heath and Crowborough (BBC estimates). Although some of these towns are 40 miles away from the centre of London, a BBC spokesman insisted that the new transmitters didn't herald another national network.

Quadfest at IEE

ABOUT ONE HUNDRED and fifty AES/IEE members were present at the exposition of quadraphony held at the Savoy Place headquarters of the Institute of Electrical Engineers on December 16 last. Organised by John Gilbert of the AES in co-operation with the IEE, five contrasting quad systems were on demonstration and the indefatigable Doctor Keith Barker lectured twice on the current state of the art. Not quite a repetition of the same lecture; the version delivered before the tea interval was phrased for a strictly professional audience, that after tea having the more obscure and controversial technicalities tactfully omitted to suit the ear of the informed layman.

The demonstrations included the well-known *QS*, *SQ* and *CD-4* systems with the addition of a new one called the *UD-4* system. The BBC showed a system of their own. The marbled magnificence of the IEE building is not acoustically ideal for such demonstrations but, it can be argued, neither is the average living room. While the technical achievement of the competing systems cannot be denied the question whether they improve the music remained unanswered. One wag was overheard to declare enthusiastically that an operatic overture sounded exactly as it did at the back of the stage during rehearsals at Covent Garden. Now, there's realism for you!

Dr Barker's lecture was admirably delivered and illustrated both audibly and visually. Aided by an assistant of great dexterity and a rent-a-van load of equipment brought down from Sheffield University he described and commented upon the design philosophies of the more practical systems available demonstrating musical values with the aid of commercial recordings. Rather than the generally accepted quadrilateral placing of loudspeakers he favours a trapezium with the audience facing loudspeakers placed at the ends of the short side. The virtues of this arrangement were impossible to evaluate in the acoustics of the Council Chamber but the effectiveness of it was most impressive. This was particularly so in an identical musical arrangement recorded by Mr Enoch Light and his Orchestra and released in *SQ*, *QS* and *CD-4* giving possibly a unique opportunity directly to compare the three systems. In fact, on just the one hearing, there seemed nothing to choose between them. But, notwithstanding the merits and shortcomings of the competitive systems, the major obstacle to successful marketing, overall compatibility, remains as immovable as ever.

The success of the exposition reflects great credit on all concerned. However, the answer to the question whether quadraphony will sell more records is still firmly in the negative, apparently.

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ALAN CORBETH:
Sound Supervisor.
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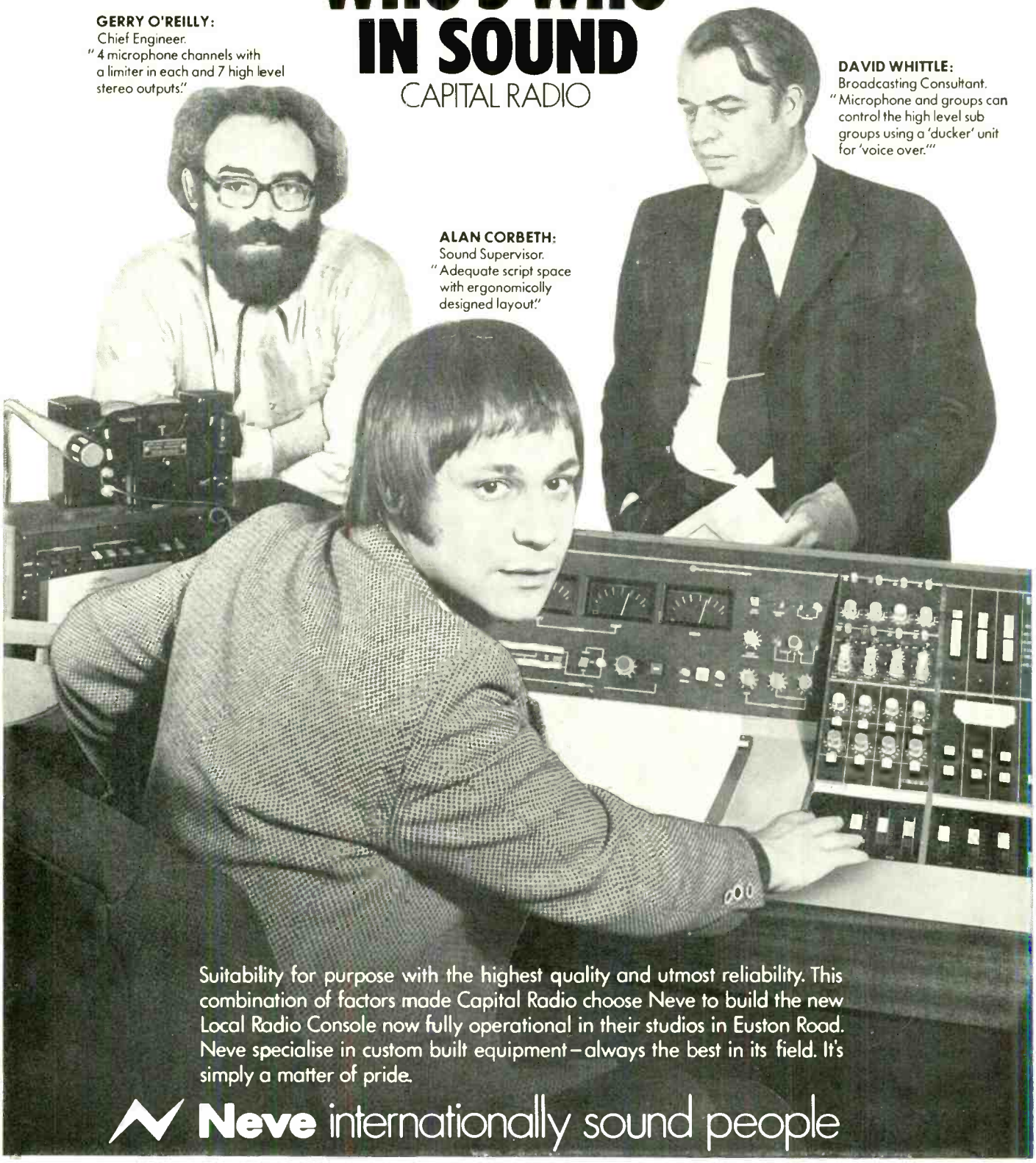

Suitability for purpose with the highest quality and utmost reliability. This combination of factors made Capital Radio choose Neve to build the new Local Radio Console now fully operational in their studios in Euston Road. Neve specialise in custom built equipment – always the best in its field. It's simply a matter of pride.

Neve internationally sound people

Rupert Neve, Cambridge House, Melbourn, Royston, Herts. Telephone: Royston (0763) 60776. Or Cambridge (0223) 53454. Telex 81381. Cables Neve Cambridge.
2719 Rena Road, Malton, Ontario L4T 3K1, Canada. Telephone: 416 677 6611. Telex 0696 8753.
Berkshire Industrial Park, Bethel, Connecticut 06801, U.S.A. Telephone: (203) 7446230. Telex 969638. Hollywood Office: Telephone: (213) 465 4822.

PATENTS

THE FOLLOWING list of Complete Specifications Accepted is quoted from the weekly *Official Journal* (Patents). Copies of specifications may be purchased (25p) from the Patent Office, Orpington, Kent BR5 3RD.

December 4

1380944 Nippon Electric Co Ltd.
Echo canceller having two echo path models.
1380945 Nippon Electric Co Ltd.
Multiplex echo canceller system.
1381094 Bosch Fernsehanlagen GmbH
Robert.
Television camera.
1381143 Philips Electronic & Associated Industries Ltd.
Driving device for the linear positioning of magnetic heads.
1381223 Wurlitzer Co.
Electronic musical instrument circuit.
1381348 British Broadcasting Corporation.
Retrieval of information in the form of phase or frequency modulation.
1381376 Philips Electronic & Associated Industries Ltd.
Method of manufacturing a diaphragm for a transducer.
1381459 Axelrod, H. R.
Arrangement for recording and playing music.
1381490 Staar SA.
Cassette recording and/or reproduction apparatus.
1381554 Standard Telephones & Cables Ltd.
Transmission systems.
1381597 Marconi Co Ltd.
High frequency amplifier arrangements.

December 11

1381808 Kimbell, W. L., and Edlund, R. P.
Portable amplifier and speaker.
1381862 Masson Scott Thrissell Eng Ltd.
Phonograph records.
1381888 Matsushita Electric Industrial Co Ltd.
Pickup cartridge.
1381895 Marconi Co Ltd.
Crystal oscillators.
1381901 Kokusai Denshin Denwa KK.
Coaxial cable including at least one repeater
1381903 Optical Systems Corporation.
Encoding and decoding system for CATV.
1382018 Westinghouse Electric Corporation.
Dual frequency array.
1381065 LRW Electronics Ltd, and Poynter, J. H.
Telescopic aerials.
1382094 Husband, H. C.
Method of maintaining the required shape of a structure.
1382096 Matsushita Electric Industrial Co Ltd.
Automatic noise reduction system.
1382166 McDonald, D. M.
Tape playing apparatus.
1382176 Western Electric Co Inc.
Branching networks for electromagnetic waves.
1382224 Lanier Electronic Laboratory Inc.
Adapter apparatus for use with a tape record-playback apparatus and to tape record-playback apparatus incorporating such an adapter.
1382257 Westinghouse Electric Corporation.
Communication system.
1382324 Soc Italiana Telecomunicazioni Siemens Spa.
Digital voice interpolation system for PCM, systems.
1382334 Thomson-CSF.
Passive limiter for high frequency waves.
1382371 Thomson-CSF.
Device for locally positioning a flexible rotating disc.
1382381 Compur-Werk GmbH & Co.
Tape recording and reproducing apparatus.
1382382 Compur-Werk GmbH & Co.
Tape recording and reproducing apparatus.
1382432 Powerdrive Drum Co Ltd.
Instruments of percussion.
1382437 Industrial Nucleonics Corporation.
Single frequency moisture gauge with logarithmic feedback.
1382447 Philips Electronic Associated Industries Ltd.
Colour television convergence unit.

December 18

1382523 Vockenhuber, K., and Hauser, R.
Holographic method and apparatus.
1382524 Hasler Ag.
Process and apparatus for the recognition of a predetermined frequency in a mixture of frequencies.
1382532 CBS Inc.
Film scanning system having vertical stability.
1382533 Mitsubishi Denki KK.
Colour television receiver.
1382548 Thomson-CSF.
Waveguide assembly.
1382558 Mullard Ltd.
Privacy transmission system.
1382590 Pioneer Electronic Corporation.
Record-changer.
1382598 International Business Machines Corporation
Recording apparatus.
1382680 Eastman Kodak Co.
Motion picture projectors.
1382711 Saba Schwarzwalder Apparate-Bau-Anstalt August Schwer Sohne GmbH.
Circuit arrangement for producing a line-frequency parabolic potential having an amplitude and phase varying at raster-frequency.
1382747 Picker Corporation.
Automatic limit switch system for scintillation device and method of operation.
1382862 Soc Italiana Telecomunicazioni Siemens Spa.
Apparatus for positioning variable equalizers for wideband telecommunication systems.
1382892 Westinghouse Electric Corporation.
Digitally controlled wave analyzer.
1382923 Canon KK.
Colour resolving optical system.
1382924 Optical Systems Corporation.
Method and apparatus for making animated cartoons.
1382927 International Business Machines Corporation.
Electroacoustic transducer.
1382929 Philips Electronic & Associated Industries Ltd.
Radio systems.
1382990 Knox, J. H.
Intercommunication systems.
1383066 Western Electric Co Inc.
Apparatus for selecting video signal samples.
1383075 Micro Consultants Ltd.
Signal transmission system.
1383126 International Standard Electric Corporation.
Non-rotating antenna.
1383131 Clark, S.
Audio-visual display unit.
1383238 Nippon Victor KK.
Phonograph pickup stylus.

December 27

1383336 RCA Corporation.
Velocity adjusting system
1383356 Staar SA.
Switching device for recording/playback heads in tape recorders.
1383374 Duplison SRL.
Cartridge loading apparatus.
1383416 Eastman Kodak Co.
Web handling apparatus, eg self-threading motion picture projector.
1383435 Ricoh, KK.
Magnetic recording and reproducing arrangements.
1383449 Philips Electronic & Associated Industries Ltd.
Recording and/or playback apparatus.
1383458 Hitachi Ltd.
Dynamic convergence correction device.
1383539 Philips Electronic & Associated Industries Ltd.
Mode selector for scan laser.
1383590 RCA Corporation.
Automatic registration of colour television cameras.
1383621 International Business Machines Corporation.
Apparatus for detecting the fundamental frequency of a speech sound.
1383710 Philips Electronic & Associated Industries Ltd.
Change spindle for records having large centre holes.
1383736 Motorola Inc.
Cartridge locking mechanism for a tape player.
1383969 Commissariat A L'Energy Atomique.
Device for deflecting a light beam.
1383976 Licentia Patent-Verwaltungs-GmbH.
Direction finder antennae system comprising a plurality of individual antennae.
1384013 ITT Industries Inc.
Electronic musical scale generator.

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In addition to machine performance, operational convenience is crucial to the selection and subsequent running of a multitrack tape recorder. Field problems are discussed broadly, together with a few speculations about future developments and usage.

Multi-track and studio practice

TERRY YEADON*

STRICTLY, THE TERM 'multi-track' could be applied to any machine which records and replays more than one piece of information on magnetic tape separately and simultaneously. This definition would then include all domestic half- and quarter-track equipment, cassette and cartridge units as well as the 'monsters' the professional industry associates with the term. However, those machines using 12.5, 8, 25 and 50 mm wide tape are all that this article is intended to cover. It is not the intention to delve too deeply into purely technical spects or theory of tape transports and electronics, this article being written hopefully to assist the studio staff responsible for the purchasing of new multi-track equipment and those who may be involved in front-line repairs.

The dramatic advances in electronic and mechanical design and techniques during the past few years have resulted in tape machines employing a greater number of tracks and many more facilities being physically no larger than the early professional full track mono and two track stereo machines. These advances have also embraced the incorporation of tape transport control logic on one or more plug-in printed circuit boards. This has drastically improved reliability over the older units employing rows of heavy-duty relays. Also, in the event of a breakdown in the control circuits, the simple replacement of a pcb will usually restore working order. In the majority of cases, however, this refinement in techniques has resulted in the mechanical components in the transport becoming more delicate in comparison with the huge motors, solenoids and levers in earlier transports, and this has placed a different emphasis on the job of the maintenance department. Now, more than ever, a good knowledge of fault-finding and servicing of mechanical components has become essential. An example of this is the critical adjustment necessary to the components concerned with the setting of the tape tensions in various modes of operation. It is clear that should the mechanical operation of these parts be incorrectly set, the chances of correct electronic adjustments are pretty remote.

Reliability

It is essential that the studio involved in replacing equipment, or marching down the seemingly never-ending road of increasing the number of tracks offered to clients, ought really to give a great deal of thought to the subject of reliability. Probably most people reading this will have their own ideas on this subject, based on stories they have heard within the industry about particular faults and shortcomings. It is as well to remember, however, that with any complex electromechanical equipment it is possible to have a 'roguc' machine which always seems to suffer from one problem or another, and naturally it is this machine which will receive most publicity (especially by people who dislike the equipment anyway for one reason or another). What is less obvious is that many studios will be operating with the same equipment, from which may have come trouble-free operation for many years. Obviously, a very important factor is the standard of the work carried out by the members of the studio's maintenance department.

Very closely connected with machine reliability is the ability of the manufacturer or distributor to supply the necessary spare parts should trouble arise. It is of no use to a busy studio to be fobbed off with excuses such as 'Oh that part never goes wrong, so we don't keep it,' or 'We have had a run on those recently.' Fortunately in my own experience this rarely occurs in the UK and the major suppliers can be relied upon to give every assistance. My knowledge of distributors outside the UK, however, is very limited so I would suggest any prospective buyer checks for himself that a reliable after-sales service is available for the equipment he chooses.

It may seem wrong to discuss the reliability of a machine before mentioning such things as performance, specifications, facilities and options which could initially be the deciding factors in your choice of equipment. But to operate a successful commercial studio, equipment reliability is of prime importance. It is imperative that equipment should do all that is expected of it without fuss or drama and should continue to do so reliably with little attention outside routine servicing.

How many?

Of obvious importance when deciding on a multi-track machine is the number of tracks required now and in the future. As far as the major studios are concerned, eight track work now appears a little thin on the ground, and the purchase of a head block and deck conversion kit may be considered unnccessary. To the smaller studio, however, a machine which will handle eight track 25 mm format and yet be easily and quickly converted to 16 track 50 mm and also have the capability of being made up to 24 track as and when required would seem the wisest move. Machines are now readily available which are wired for 24 track operation and supplied either eight or 16 (or both) and the increase to full capacity is a simple job which may be carried out in the control room.

Most machines available today have very complex tape tension control arrangements ensuring careful handling of master tapes. When you consider that the width of one track on a two-inch 24 track master is only 1 mm you begin to appreciate that careless handling of tapes can have very serious consequences. Take the opportunity of operating the various machines yourself to get the 'feel' of the controls generally. Test the rewind and fast forward response especially at the ends of the reel. Run the tape up to high speed and press the stop button to make sure the braking system stops the tape with no snatch or loop formation. If you can try this test with a partially empty reel (as often happens in practice with a valuable reel of extracted masters) all the better. Some tension sensing arrangements are set up on a full reel and may show problems when tested this way.

Whilc using the equipment, have a look at the general standard of engineering and attention to detail. For instance, is there any noticeable play in the bearings of guides, capstan spindle, spooling motor shafts etc? (It has happened.) Is there clear access to the head faces for cleaning, demagnetising and especially editing? Is it an easy, foolproof job to change the headblock?

Look at the mechanics of the unit to assess its 'botch-ability'. I am not suggesting that a

*Kingsway Recorders Ltd
Terry Yeadon (Services) Ltd

Heath Robinson cure for a fault become a permanent one, but if a fault does develop it will invariably be in the middle of a large and expensive session and if the mechanics are held together with screws rather than rivets, and if the levers and springs look fairly simple things, it may enable an emergency repair to be carried out. Indeed, some time ago I repaired a machine by replacing a lever with a hair clip and a spring with a piece of elastic from a suspender belt. (Those were the days.) All these points may seem to be very personal and not really scientific, but then spending in the region of 15 grand is perhaps something to be taken personally.

While discussing transport facilities, a point worth mentioning is that of azimuth adjustment of the record and replay heads. Here there is some disagreement. One school of thought is to provide a means of adjustment so that azimuth discrepancies can be corrected. On the other side, a headblock manufactured to the tolerances required should not go off azimuth and so no provision is made for its correction. My own experience is that equipment handled with a fair amount of respect seems not to suffer in this area but I do like the security of knowing that if one day I should find an off-azimuth head I could easily overcome the problem.

It is as well also to remember that should tape guides mounted on the deck plate proper move slightly up or down at any time (perhaps after replacement due to bearing troubles), this could affect the azimuth setting of the heads. Another point to bear in mind is the possibility of receiving a tape for remixing from a studio with a less than thorough maintenance department, only to find that it was recorded off azimuth. It is good to know that by a simple adjustment you can get the best results from the tape, but it's as well to remember to re-align after the session. All professional multi-track transports will accept 268 mm diameter spools, but machines are available which will accommodate larger sizes. This could be very useful to anyone carrying out mobile or live recording work, where fewer changes of reel would be required during the session. Of course it is possible to obtain long play tape in 25 mm and 50 mm formats which will effectively give more running time on a similar diameter of reel. The problem here is that of possible print-through which is more likely than with standard play tape. For this reason some studios prefer not to use it.

Electronics

It is usual for multi-track tape machine electronics to be built as a modular system where each channel is separate and may be removed as a unit. The majority of active components are built on to one or more printed circuit boards usually plugging into a mother board which carries the power busses, input, output signal leads etc to the sockets on the rear of the console. One popular American machine employs one board to hold all the electronics for one channel, while most others divide each channel into sections, with one board being record, another reproduce, and so on. The problem with the former is that should a fault develop, say, in the record amplifier or bias circuitry, the whole card must be removed to effect a repair. This means that, while only the record side is down, no reproduce exists on this track so the machine cannot be used for a remix session in the meantime unless a spare card is carried by the studio. My experience has been that the machine's supplier will quickly forward a replacement but, should your studio be situated some distance from his service department, with the best will in the world this may still take quite some time.

Probably the most important figure to investigate in the specifications of the electronics is that of crosstalk on the record (sync) head. This becomes critical when attempting track-jumping on 24 track (and this happens more often than some might imagine). On certain machines it is not possible to jump adjacent tracks because of 'crosstalk feedback' across the record head. So long as this is remembered on recording all is fine, but all too often in the middle of a long and complicated overdub session it is so easy to end up with 22 tracks recorded, some of which need to be mixed down to the two available tracks. Indeed I have seen 22 tracks mixed and jumped on to the two empty tracks when building up a complex chord sequence for the intro to a number using a synthesiser.

Most professional machines will meet the required standards for signal/noise ratio, distortion, frequency response and efficiency of erasure, but it is important when comparing the manufacturers' published specifications to ascertain the various levels at which the measurements were made. For instance, a statement such as 'signal/noise ratio: 60 dB' is meaningless if no mention is made of the operating level to which it is referred. The majority of manufacturers quote the signal/noise ratio at 6 dB above normal operating level. When NAB equalisation is used, normal level on tape is 185 or 200 nW/m (185 is the recognised standard, though 200 is becoming more popular. The difference is less than 1 dB and so can be ignored for the purpose of comparison.). The distortion figure will normally be given at 1 kHz and at operating level (which should again be specified). This figure is typically in the region of 1% maximum. An erase of 75 dB at 1 kHz is normal.

Machines generally have only one line output socket per track and during operation in the safe or record modes the normal output from the reproduce head is available at this socket. When the electronics are switched to 'sync' or 'ready', the output then available from this socket is derived from the record head. This is necessary to facilitate overdubbing of material in synchronisation with the original track. It should be checked that the frequency response of the sync signal is as good as or at worst only a little inferior to the reproduce response. This is important when undertaking track-jumping, to minimise deterioration of quality.

Machines are available with two line outputs per channel, one being reproduce output and operating as previously described, and the other being a sync output. This second socket is fed by its own line amplifier and provides a sync signal at all times except in the record mode. This output can prove useful when re-mixing, in the following way; if the signal from the sync (record head) is taken to and recorded on a machine of the same type (ie

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with the same distance between record and reproduce heads) and the output from this machine is fed to a spare channel on the mixing console (via a noise reduction unit switched to 'play' if one was used on the original multitrack recording), this signal can be mixed with the original signal from the reproduce head of the multi-track machine. If the two machines are running at the same speed (and the sync output is not inverted) the result should in principle be an in-phase signal on the mix. If a varispeed facility is available on the second machine, slight variation of speed up and down will produce the effect known as phasing. A greater difference in speed will give a definite echo which can be made to occur after or before the main signal by simply running the delay machine slower or faster than the master machine. Although this may sound long and complicated it is in practice very simple to achieve the effects described.

Options and accessories

Often, methods of remote control provided by the manufacturer for operating electronics status as well as transport functions are overlooked, as if these are some sort of luxury. There are studios with basically very well designed control rooms spoiled by a collection of thick multicore cables crossing the floor from machine to mixer and terminating in a large, unwieldy box perched precariously on the edge of the desk (invariably covering some important controls). This turns out to be 'the remotes'. Surely a neat, well designed remote unit built into the console must be essential. Such a system can be designed to give visual indication of the state of the electronics of each track. This will not only lessen the possibility of accidental erasure of a master, but also save a great deal of time (and therefore money) over a period of several years.

A second tape timer slaved off the machine and mounted in front of the engineer can prove a boon in assisting the speedy location of a particular take or other point on the tape when 'dropping in' or re-mixing. Obviously the best method of achieving this is to invest in an auto locate unit which manufacturers are now offering. The cost of such a unit does at first glance seem rather high. If, however, your studio operates without the assistance of a tape operator the cost of such a unit can be quickly recovered by reducing operating time and relieving the engineer of the chore of constant overseeing of the machine's functions, leaving him to concentrate on more difficult things.

A feature of master recorders which has increased in importance recently is that of reliable, consistent, repeatable vari-speed of the capstan. Each manufacturer has his own method of achieving this and each has its own virtues. Studios will find that a variation of plus or minus 30 per cent at each set speed will suffice for typical applications. Regarding the choice of standard tape speeds, most machines offer two switched speeds; either 19/38 or 38/76 cm/s. It is usual for the transport to be easily converted from one combination of speeds to the other, although the difficulty here is the usual provision of equalisation for only two tape speeds in the electronics. It is by no means automatic to choose 38/76 for eight to 24 track machines. But it seems very unlikely that 19 cm/s will ever be used seriously on multitrack work; 76 cm/s could be. Indeed there is a move at the moment in America towards the use of the highest speed. One reason for this could be to facilitate easy editing on complex album recording. Granted, the top response and signal/noise ratio are slightly improved at 76 cm/s compared with 38 cm/s, but the increase in speed sometimes adversely affects the frequency response at the lower frequencies (below 250 Hz). All things considered it looks as if 38 cm/s with some form of noise reduction system will be the accepted standard in the UK at least for some time to come.

Problem solved

A problem which was a very great one in some early multitrack machines has been improved and in some cases completely eliminated in the latest series of equipment. I refer to the click, pop or crackle (or any combination) that occurred when dropping into or out of record. All the same, it would be worth checking their absence, especially if you are considering designing your own system of electronics remote control rather than using the one supplied by the manufacturer.

Future

Any prospective buyer of multi-track equipment would be wise to formulate some ideas on the subject of future trends in recording. This is, naturally, very difficult. 24 feels as if it will be the maximum number of tracks used in commercial studios for perhaps four to five years; however, rumour has it that several manufacturers are presently developing machines offering greater than 24 track capability. I could obtain confirmation of only one such equipment after approaches to the people concerned. Indeed the manufacturer now has 32 and 40 track machines using 50 mm tape on the market. The published specifications indicate the performance to be only a little inferior to present 24 track machines. I await an opportunity to acquire first-hand experience of these machines.

What seems to be much more likely to increase is the locking together of two or more machines to boost the number of usable tracks. Systems are already available and, fortunately, adherence to the SMPTE time code seems widespread. Such standardisation will be necessary in order to allow interchange of tapes between studios using different makes of synchronising equipment. This method of locking machines in sync does mean that one track per machine must be given over to the sync signal and therefore cannot be used for programme material. This makes the use of two 16 track machines yield a total of 30 tracks which is so few more than a standard 24 that it seems likely it will gain no favour, remembering that two expensive reels of 50 mm tape would be necessary instead of only one on 24 track. It seems more likely that a 24 track locked to a 16 track (38 tracks) or even two 24 track machines (46 tracks) will be the normal combinations. This immediately raises the worries about noise levels. With modern tape and machines plus the use of one of the accepted noise reduction systems the results obtained are really very good indeed. I cannot help but feel, however, that 46 track operation will really begin to put the equipment at full stretch. Possibly with this in mind two major manufacturers of recording tape have recently introduced a new type claiming, among other things, to give an improvement in noise level of some 4 dB compared with presently-accepted tape. This improved performance is only realised when the record sections of the machine are optimised to the new tape. This means that changing over from one tape type to the other in the short break between sessions would call for a re-alignment of the tape machine electronics.

The cost for the improved tape is up approximately 30 per cent compared with normal types and this increase will have to be passed on to the client. This is only the beginning of cost increases when a 46 track capability is contemplated. Very few studios are capable of handling 46 track mixing with present equipment, and to make it an operation which can be handled by even the most experienced balance engineers some form of computerised mixing console will be essential.

Anyone who is aware of the cost of equipment will be able to see that the amount of money required to fit out a studio to operate as described will be very high indeed. All this outlay must be recovered by increased studio charges. This may bring us up against the economic state of this country, which perhaps does not allow UK clients to increase their budgets much above the present level; in some cases possibly even a lowering of expenditure will be called for. This, above any technical considerations, must keep 24 track operation with us as standard for some time to come.

This must not suggest that work on synchronising units will not find a place in sound recording studios. With the increased number of video cassette recorder/reproducers becoming available at a cost which puts them within the reach of the general public, I can see a move in the future towards albums (probably with four channel sound) complete with video to be reproduced on home colour television and hi-fi combinations. This will appeal to producers more for location work in the beginning, but I see no reason why the system should not come to the major studios initially for remixing work. Again equipment is available to do just this.

Whatever actually does happen in the future it is clear that the cost of equipment will continue to rise. Because of this, it is vital that a studio purchase the type of equipment whose eventual disposal is due to its wearing out and not because it becomes outdated. For this reason it may be considered good economy to purchase a 24 track console fitted with, say, 16 track facilities even if you feel now that your maximum requirement will not exceed 16 track. If the cost of equipment is of primary importance it may be worth your while shopping around for used gear. Some good examples do come on to the market from time to time. Here, it's naturally essential to check the performance against the published specifications, with discrepancies reflected in the price.

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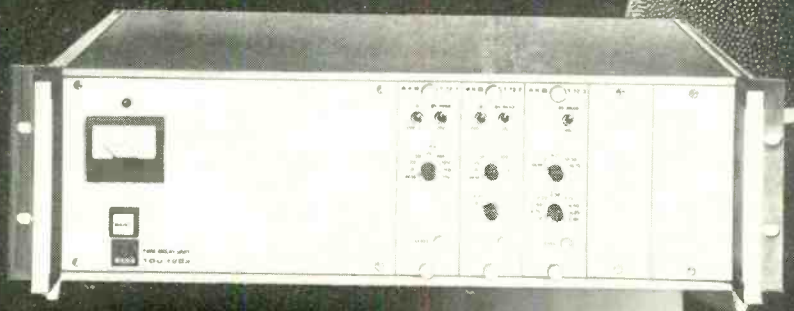

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BOOK REVIEWS

ADVANCED COMMUNICATIONS SYSTEMS—An STC Monograph. Editor: B. J. Halliwell. Authors: K. G. Hodgson, G. C. Hartley, H. B. Wood, O. G. Williams, C. Kao. Published July 1974 by Newnes-Butterworths, 88 Kingsway, London WC2B 6AB. ISBN 0 408 00124 0 276 pp. Price (cased) £8.20.

WHETHER ONE IS a non-technical citizen, someone involved in broadcasting, or an engineer working in telecommunications, one can hardly be totally unaware of the great advances that are taking place, or indeed have already taken place, in the realm of telecommunications in its broadest sense. The increasing numbers of direct-dialling international telephone links, television relays by satellite, stereo radio by PCM links—these are almost commonplace instances of the advances and improvements going on in this field which affect the daily lives of almost everyone.

Advanced Communications Systems is a monograph, or collection of individual monographs, by research engineers in the STC group. It deals primarily with the long-distance transmission systems which form the arteries of the world-wide telecommunications network as we know it today, with its hierarchy of national, international and intercontinental transmission/reception, switching and signalling systems. The authors of the various chapters have spent much of their research careers with STC, are experts in their particular fields, and have gereneral experience of the various aspects of overall network planning. The aim of the book is to assist the younger engineer or one not directly involved with this field to understand the complex relationships involved, at least superficially if not in depth, and to give readers with greater experience or expertise in some part of the field a clearer understanding of the whole and their part in it. The monograph is one of a series, produced by Newnes-Butterworths in collaboration with STC, dealing with various aspects of telecommunications and electronics including relays, transducers and microminiaturisation.

Chapter One of *Advanced Communications Systems*, by K. G. Hodgson and G. C. Hartley, deals with the growth of telecommunications from Bell's invention of telephony about a century ago. It reviews the earliest stages of manually-operated telephone systems, the development of exchanges, repeater amplifiers and multi-channel coaxial links, and prospects offered by microwave radio links and optical fibre links. The chapter goes on to deal with the cost of bandwidth, access to wide-band media, the effect of introducing digital techniques, the inclusion of telex and wide-band signals, network organization, the balancing of costs, the functions of the CCITT and CCIR, and systems economics. The Chapter concludes with an appendix on costing, specifically the calculation of Present Value of Annual Charges (PVAC).

Chapter Two (by K. G. Hodgson) deals with Frequency Division Multiplex (FDM) systems, covering the history and basic principles of FDM, line frequency allocations, cable sizes and costs, repeaters, system performance objectives, terminal equipment, channel modulation and demodulation, pregroup systems, line equipment and submarine cable systems; and includes an extensive list of references and further papers.

Chapter Three (by G. C. Hartley) deals with Pulse Code Modulation (PCM) and digital networks, noise cancelling aspects of digital transmission, theoretical considerations of PCM, PCM junction systems, the ATT, BPO and CEPT systems, switching with PCM, the encoding of various kinds of information such as high-quality sound and colour video signals, facsimile and data signals, line transmission and multiplexing, and the evolution of an integrated digital network, including long-distance and local transmission considerations.

Chapter Four (by H. B. Wood) deals with microwave radio systems. It covers the history of microwave communications, basic kinds of analogue radio repeaters, available frequency bands, path loss and fading, performance requirements, radio equipment required for a microwave replay system, use of phase-locked loops, use of frequencies above 10 GHz, and long-haul waveguides.

Chapter Five on communications satellite systems is by O. G. Williams. In it he covers the early satellites and passive balloons, the INTELSAT satellites, Russian satellites, the performance objectives and design factors for satellite systems, transmission delay, choice of orbit, system design and evaluation, design of the satellite communication package, economic considerations, future developments including regional and domestic systems, and increased sophistication in the relay chain.

Chapter Six (by C. Kao) is on what the editor of the book aptly describes as perhaps the most futuristic of the technologies covered by the book—optical communications. It covers the basic optical considerations of propagation, optical systems and lenses, waveguides, fibres, light sources, laser sources, detectors and modulators, electroacoustic effects, and the development of optical systems.

The book is extremely well produced and printed; it has an adequately detailed index. Whether or not it will be bedside reading is very much a matter of temperament. It contains some fascinating and informative insights into current research and technology in this field which will prove interesting to anyone involved with the engineering aspects of modern broadcasting and telecommunications, while possibly being of less immediate interest to the studio manager or balance engineer. It will stand reading at both the superficial level, to get an overall picture, and at the more detailed mathematical and physical level required for closer study; this successful combination is something of a tribute to the authors and editor. Ample references are given for further reading on details. Despite the many hands which have stirred this particular pudding there is a surprising uniformity of style throughout, which is helpful; only the last chapter left me feeling that perhaps a little more could have been given.

If you are interested in this field this is probably a book to add to your list of essential reading. It is unfortunate that the price of the cased edition may tend to confine it to specialists and libraries rather than attracting a wider readership.

John Fisher

PLAYING IN THE FM BAND—A personal account of free radio. Author: Steve Post. Published by Viking Press, New York. Price $10.

WHEN HRH THE Duke of Kent opened IBC 74, he observed, in the context of radio, that 'there are many advantages in a cheap, protable receiver which does not depend for its effectiveness on one having to sit down and look at it'. This may be true, but it more-or-less sums up what WBAI-FM, the New York radio station about which Steve Post writes, is not all about. BAI has become a legend in New York, because it is listener-sponsored on a voluntary basis and as such it is not a radio station that you can treat as aural wallpaper. You either listen to BAI or you turn it off.

It is certainly no ordinary station. The manager recently spent some time in jail for refusing to turn over logging tapes of telephone calls broadcast from prisoners rioting in a New York jail. Because the station is listener-sponsored it is chronically short of cash and when I visited it a few years ago for *Hi Fi News* they had just finished a marathon appeal which involved playing Mario Lanza and similar records by way of a threat. 'That is what you will get if you don't send us some money,' snarled the announcer. And, yes, the announcers do quite often snarl. Whereas Capital's Everett and Cash have made a success of happy morning sounds, Larry Josephson of BAI always used to do his morning show in the foulest of moods. He would continually moan openly over the air about having to be up so goddam early and insult callers.

The phone-in programmes are censored only where they risk losing the station its FCC licence to stay on the air, and in consequence they are sometimes boring and sometimes

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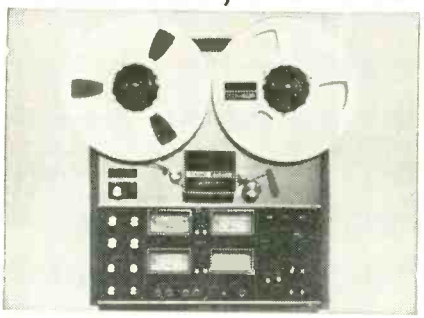

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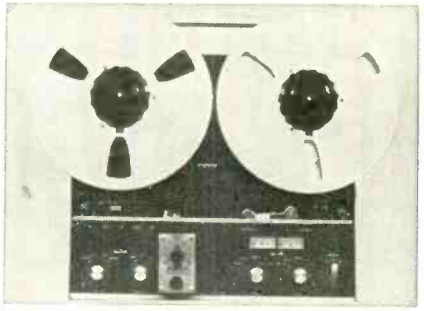

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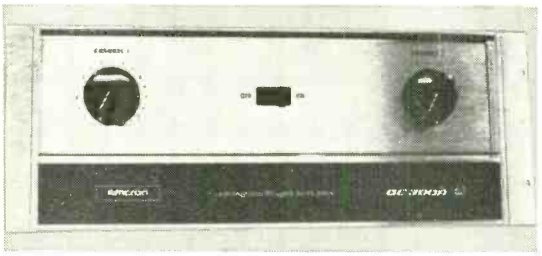

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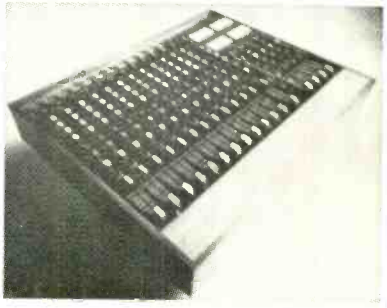

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Survey: Industrial tape recorders

ABE

ABE Apparatebau und Elektronik, Becker GmbH & Co, Kommanditgesellschaft, D-7750 Konstanz, Otto-Raggenbassstrasse 5, Switzerland. Phone: 075-31-21536.

8/16 track

Construction: console.
Tape width: 25/50 mm.
Tracks: 8/16 half track
Transport control: logic interlock.
Equalisation: NAB or CCIR switchable.
Spool type and size: up to 26.7 cm.
Tape position indicator: digital timer.
Noise: ref 510 nW/m unweighted better than 54 dB at 38 cm/s, and 52 dB at 19 cm/s to DIN 45 405.
Tape speed and wow and flutter: to DIN 45 507 38 cm/s 0.05%, 19 cm/s 0.08%.
Input level @ impedance: } 0 dBm at 600Ω
Output level @ impedance: } nominal.
Spooling time: 120s for 750m.

24 track

Construction: console.
Tape width: 50 mm.
Tracks: 24.
Transport control: logic interlock.
Equalisation: NAB/CCIR switchable.
Spool type and size: NAB.
Tape position indicator: digital timer.
Noise: ref 510 nW/m unweighted better than 52 dB at 38 cm/s, and 50 dB at 19 cm/s to DIN 45 405.
Tape speed and wow and flutter: as for 8/16 track.
Input level @ impedance: } 0 dBm at 600 Ω
Output level @ impedance } nominal.
Spooling time: 120s for 750m.

AKAI

Akai Trading Co Ltd, Tokyo, Japan.
UK Agents: Rank Audio Products, PO Box 70, Great West Road, Brentford, Middlesex TW8 9HR. Phone: 01-568 9222.

GX 400D

Construction: free standing.
Tape width: 6.25 mm.
Tracks: two.
Track width: quarter track.
Spool type and size: to 26.6 cm NAB.
Tape position indicator: mechanical counter.
Head type: glass ferrite.
Noise: no baseline 54 dB.
Tape speed and wow and flutter: 38 cm/s 0.035%, 19 cm/s 0.05%, 9.5 cm/s 0.08% rms.
Input level @ impedance: from 0.5m V to 0.6V at high Z.
Output level @ impedance: 1.23V into 100Ω.
Spooling time: 90s for 366m.
Other features: double capstan, auto reverse.
Weight: 30.5 kg.

AMCRON

Amcron International, 1718 West Mishakawa Road, Elkhart, Indiana 46514, USA. Phone: 219-294 5571.
UK Agents: Macinnes Laboratories Ltd, Macinnes House, Carlton Park Industrial Estate, Saxmundham, Suffolk IP17 2NL. Phone: 0728-2262 2615.

SPECIFICATION DEPENDS on purchaser. Amcron offer a basic choice of transports in the *700* and *800* series, the latter offering full logic control of mechanism. 38 cm/s wow and flutter figures are 0.08% rms. 19 cm/s 0.09% rms.

Electronics available for various mic inputs, high Z or 0 dBm line level. Track format full, half, quarter and stereo. Four channel facilities available on 6.25 mm tape width. Complete machines from about £500 up.

AMPEX

Ampex Corporation, Audio-Video Systems Division, 401 Broadway, Redwood City, Calif 94063, USA. Phone: 213-240 5000.
UK Agents: Ampex (Great Britain) Ltd, 72 Berkeley Avenue, Reading RG1 6HZ. Phone: 0734-55341.

AG 440C

Construction: console.
Tape width: 6.25, 12.5 mm.
Tracks: two or four.
Track width: stereo 1.9 mm/4 channel 1.8 mm.
Transport control: logic interlock.
Equalisation: NAB/AES/IEC by speed switch.
Spool type and size: up to 30 cm all standards.
Head type: interchangeable head block assembly.
Noise: 2T 6.25 mm/4T 12.5 mm ref 520 nW/m unweighted 76 cm/s AES 65 dB, 38 cm/s NAB 63 dB 19 cm/s NAB 64 dB, 9.5 cm/s NAB 62 dB.
Tape speed and wow and flutter: measured to DIN 45 507 or ANSI S 4.3 peak weighted for servo capstan 76 cm/s 0.04%, 38 cm/s 0.06%, 19 cm/s 0.06%, 9.5 cm/s 0.1%.
Input level @ impedance: } 0 dBm at 600 Ω
Output level @ impedance: } nominal.
Input overload point: +28 dBm.
Spooling time: 60s for 732m.
Optional extras: servo capstan, remote control.

MM1100

Construction: console.
Tape width: 25/50 mm.
Tracks: 8/16/24.
Spool type and size: to 40 cm NAB centre.
Tape position indicator: digital timer; parity register.
Noise: ref 520 nW/m unweighted 76 and 38 cm/s 8/16T 63 dB, 24T 58 dB.
Tape speed and wow and flutter: 76 and 38 cm/s to DIN 45 507 0.08% peak weighted.
Input level @ impedance } 0 dBm at 600 Ω
Output level @ impedance: } nominal.
Optional extras: search/cue, sync lock code generator.
Dimensions: 74 x 69 x 114 cm.
Weight: 8/16/24T 188/210/240 kg.

BIAS

Bias Electronics Ltd, 572 Kingston Road, London SW20 8DR. Phone: 01-540 8808.

BE 1000, 2000

Construction: console.
Tape width: 6.25 and 12.5 mm.
Tracks: full, half and stereo.
Track width: 6.25, 2.2 and 2.75 mm.
Transport control: logic interlock.
Equalisation: NAB, CCIR switchable.
Spool type and size: cine, NAB.
Tape position indicator: digital, min sec.
Head type: laminated or ferrite.
Noise: ref 320 nW/m mono 60 dB } overall
ref 510 nW/m stereo 60 dB } unweighted.
Tape speed and wow and flutter: 76 cm/s 0.06%, 38 cm/s 0.06%, 19 cm/s 0.08%, 9.5 cm/s 0.1%. All values total rms.
Input level @ impedance: 0 dBm nominal at 10 kΩ.
Output level @ impedance: 0 dBm nominal at 600 Ω.
Spooling time: 100s for 732m.
Optional extras: available in transportable form.
Price: BE 1000 from £699.
BE 2000 from £1298.

BRENELL

Brenell Engineering Co Ltd, 231/235 Liverpool Road, London N1 1LY. Phone: 01-607 8271.

Mark 6 Tape Deck

Construction: tape transport only.
Tape width: 6.25 mm.
Tracks: mono, stereo.
Track width: quarter or half track.
Transport control: mechanical.
Spool type and size: max 21.6 mm cine.
Tape position indicator: mechanical counter.
Head type: 3 micron r/p. Erase 5 mH, 22 mA.
Tape speed and wow and flutter: 38 cm/s 0.05%, 19 cm/s 0.1%, 9.5 cm/s 0.15%, 4.75 cm/s 0.25%.
Spooling time: 60s for 366m.
Optional extras: NAB centres available for 25 cm spools.
Dimensions: 38 x 29 x 13 cm.
Weight: 8.2 kg.

Type 19

Construction: tape transport only.
Tape width: usually 6.25 to 25 mm.
Tracks: one, two, four, eight.
Track width: full or half track.
Transport control: full interlock.
Spool type and size: NAB, cine and European to 29 cm.
Tape position indicator: mechanical counter.
Head type: Bogen 6.25 mm. Branch & Appleby 12.5/5.25 mm.
Tape speed and wow and flutter: 38 cm/s 0.05%, 19 cm/s 0.08%, 9.5 cm/s 0.12%, 4.75 cm/s 0.2%. All values rms.
Spooling time: 100s for 730m.
Other features: pause/play control.
Optional extras: Non standard speeds-two or four options.
Dimensions: 48.3 x 35.6 x 16 cm.
Weight: 16 kg.

FERROGRAPH

Ferrograph Professional Recorder Company Ltd, Auriema House, 443 Bath Road, Cippenham, Slough, Bucks SL1 6BB. Phone: 062 86-62511.

Studio 8

Construction: portable or console.
Tape width: 6.25 mm.
Tracks: full, half track or stereo.
Track width: 6.25/2/2.75 mm.
Transport control: full logic interlock.

Equalisation: NAB or IEC by plug in units.
Spool type and size: NAB, European or cine to 26.6 cm.
Tape position indicator: digital, accuracy 0.1%.
Head type: interchangeable block.
Noise: ref 514 nW/m IEC eq weighted to DIN 45 405 38 cm/s 62 dB 19 cm/s 59 dB.
Tape speed and wow and flutter: 38 cm/s 0.06%, 19 cm/s 0.08%, 9.5 cm/s 0.1% peak weighted to DIN 45 507.
Input level @ impedance: } 0 dBm at 600 Ω
Output level @ impedance: } nominal.
Input overload point: +24 dBm.
Spooling time: less than 60s for 366m.
Other features: monitor amplifiers.
Price: from £1353.

Series 'Y' and 'P'
Construction: free standing.
Tape width: 6.25 mm.
Tracks: mono or stereo.
Track width: full, half or quarter.
Transport control: mechanical.
Equalisation: IEC.
Spool type and size: to 21 cm.
Noise: above 9.5 cm/s, ref level producing 2% distortion unweighted 55 dB for half track.
Tape speed and wow and flutter: 38 cm/s 0.08%, 19 cm/s 0.1%, 9.5 cm/s 0.15%, 4.75 cm/s 0.2%, 2.37 cm/s, 0.4% rms.
Input level @ impedance: } 'P' series 0 dBm
Output level @ impedance: } operating level.
Other features: internal amplifiers sel-sync.
Optional extras: signal switching from tape.

ITAM
Industrial Tape Applications, 5 Pratt Street, London NW1 0AE. Phone: 01-485 6162/7833.

ITAM 805
Tape width: 25 mm.
Tracks: 8.
Track width: half track.
Noise: ref 640 nW/m weighted ASA 63 dB.
Tape speed and wow and flutter: 38 cm/s 0.08%.
Input level @ impedance: } 0 dBm operating
Output level @ impedance: } level.

Ferrograph Studio 8

Other features: sel-sync.
Optional extras: varispeed, remote control.
Price: £1790.

LEEVERS-RICH
Leevers-Rich Equipment Ltd, 319 Trinity Road, London SW18 3SL. Phone: 01-874 9054.

E200
Construction: console or free standing.
Tape width: 6.25 mm.
Tracks: mono or stereo.
Track width: full, stereo or half track.
Equalisation: NAB/CCIR by plug in modules.
Spool type and size: NAB, cine and European to 30 cm.
Tape position indicator: digital, min sec.
Noise: ref 320 nW/m 38 cm/s full track 62 dB, stereo 60 dB, half track 58 dB.
Tape speed and wow and flutter: 76 cm/s 0.06%, 38 cm/s 0.06%, 19 cm/s 0.08%, 9.5 cm/s 0.1%.
Input level @ impedance: —14 dBm at 10 kΩ.
Output level @ impedance: +22 dBm at 600Ω.
Spooling time: 90s for 732m.
Optional extras: remote control unit. Headblocks.
Dimensions: 48 x 35 x 28 cm (48.3 cm standard rack).
Weight: 120 kg.

LYREC
A/S LYREC, Electro-Acoustic Equipment, 12 Hollandsvej, DK 2800 Lyngby, Denmark. Phone: 01-87 63 22.

NOT MUCH information available. Lyrec offer 25 and 50 mm tape machines providing up to 32 channels of simultaneous recording in addition to the standard 8/16/24 format. Capstan drive by brushless dc motor servo controlled through photo strobe disc. The company will provide complete recording installations including desks, sync, vus etc. Enquiries to Friis Larsen at the above address.

MCI
MCI, 4007 NE 6th Avenue, Ft Lauderdale, Florida 33308, USA. Phone: 305-566 2853. UK Agents: Feldon Audio Ltd, 126 Great Portland Street, London W1N 5PH. Phone: 01-580 4314.

JH-100
Construction: tape transport only.
Tape width: 25/50 mm.
Tracks: 8/16/24.
Transport control: full interlock.
Spool type and size: to 12.7 cm NAB hubs.
Tape position indicator: real time tachometer.
Tape speed and wow and flutter: 76 and 38 cm/s 0.05% peak DIN weighted.
Spooling time: 85s for 732m.
Other features: servo controlled spooling motors.
Optional extras: auto locator.

JH-16 (electronics)
Tracks: 16.
Equalisation: NAB.
Noise: less than 3 dB over bulk erase noise for record/playback.
Input level @ impedance: —20 dBm (min) into 20 kΩ.
Output level @ impedance: up to 24 dBm.

JH-110 series
Construction: console.
Tape width: 6.25/12.5 mm.
Tracks: mono, two and four.
Transport control: full logic interlock.
Equalisation: NAB internally switchable to CCIR.
Spool type and size: to 30 cm.
Tape position indicator: tacho wheel.
Noise: 2 track unweighted 62 dB. Record/playback noise 4 dB above bulk erase noise.
Tape speed and wow and flutter: 38 cm/s 0.05% DIN weighted.
Input level @ impedance: } 0 dBm operating
Output level @ impedance: } level.
Input overload point: +18 dBm.
Spooling time: 85s for 732m.
Other features: phase locked capstan drive.
Optional extras: auto locator.
Weight: 95.5 kg.
Price: JH-110 £1925, JH-120 £2154, JH-140 £2960.

3M
3M Mincom Division, 3M Centre, Saint Paul, Minnesota 55101.
UK Agents: 3M, Mincom Products, Witley Works, Witley Gardens, Southall, Middlesex. Phone: 01-574 5929/6045.

Series M79
Construction: console.
Tape width: 6.25/12.5 mm.
Tracks: mono, two and four.
Equalisation: normally NAB. Ampex standard for 76 cm/s.
Spool type and size: up to 26.7 cm NAB hub.
Tape position indicator: digital, accuracy 0.1%.
Noise: ref 3% thd 206 tape 64 dB.
Tape speed and wow and flutter: NAB unweighted rms 76 cm/s 0.06%, 38 cm/s 0.06%, 19 cm/s 0.08%.
Input level @ impedance: } 0 dBm operating
Output level @ impedance: } level.
Spooling time: 90s for 750m.
Optional extras: remote control, synchroniser, edit code.
Dimensions: 117 x 68.6 x 60 cm.
Weight: 91 kg.

Series M79
Construction: console.
Tape width: 25/50 mm.
Tracks: 8/16/24.
Transport control: full logic interlock.
Equalisation: normally NAB. Ampex master on 76 cm/s.
Spool type and size: to 26.7 cm NAB hub.
Noise: ref 3% thd 206 tape 8/16T 64 dB. 24T 60 dB.
Input level @ impedance: } 0 dBm operating
Output level @ impedance: } level.
Spooling speed: 760 cm/s.
Optional extras: as for 1/2/4 track.

NAGRA
Kudelski SA, CA 1033 Cheseaux, Lausanne, Switzerland.
UK Agents: Hayden Laboratories Ltd, Hayden House, 17 Chesham Road, Amersham, Bucks HP6 5AG. Phone: 02403 5511.

IV-S and IV-SL
Construction: portable.
Tape width: 6.25 mm.
Tracks: two or two + pilot (IV-SL).
Track width: half track.
Equalisation: NAB/IEC/Nagramaster (38 cm/s only).
Spool type and size: to 12.7 cm.
Noise: with 206 tape, better than 69 dB with IEC eq to ASA 'A' weighting.
Tape speed and wow and flutter: 38 cm/s 0.05%, 19 cm/s 0.07%, 9.5 cm/s 0.15%, 4.75 cm/s 0.25%. Measured to DIN 45 507.
Input level @ impedance: most dynamic and phantom condenser mics.

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SURVEY TAPE RECORDERS

Output level @ impedance: standard 0 dBm level.
Other features: Dolby connection, modulation meter 10 ms.
Optional extras: 26.7 cm spool adaptors, pilot (IV-SL).
Dimensions: 33 x 24 x 11.5 cm.
Weight: 5.3 kg.

4.2L, 4.21LSP, IV-SJ and IV-SJS

THESE MACHINES include the same transport as the models *IV-S* and *IV-SL* and thus offer a similar standard of mechanical performance.

The first two machines are intended for use as mono report machines, the *4.2L* being a pilottone version which provides a sync signal for sound on vision cameras. Both models feature a wide range of input filters; a suitable combination can improve the intelligibility of the human voice in noisy surroundings. Switchable automatic level control is standard.

The *IV-SJ* and *IV-SJS* are intended for noise and vibration recording for analysis at a later date. Both conform to the appropriate IEC recommendations for sound level meters through use of the integral modulation meter when used with an instrumentation condenser mic. Both versions are two track; the *SJ* machine features an fm (cue) track of bandwidth 3.5 kHz for dc and low frequency vibration measurements or a voice track. In addition, the *SJ* model is fitted with switchable input filters appropriate to the relevant ASA weighting networks.

SN series

Construction: miniature portable.
Tape width: 3.81 mm.
Tracks: one.
Track width: SNN2 full track, SNS2 half track.
Equalisation: 50+3 180 µs.
Spool type and size: 68 mm special.
Noise: better than 60 dB to 'A' weighting.
Tape speed and wow and flutter: 0.1% peak weighted to DIN 45 507.
Input level @ impedance: 3 µA input from 200Ω.
Input overload point: 100 µA.
Spooling time: hand crank.
Other features: automatic level control.

OTARI

Otari Corporation, 981 Industrial Road, San Carlos, California 94070, USA. Phone: 415-593 1648.
UK Agents: Industrial Tape Applications, 5 Pratt Street, London NW1 0AE. Phone: 01-485 6162.

MX-700

Construction: console.
Tape width: 6.25/12.5/25 mm.
Tracks: 1/2/4/8.
Track width: full (6.25 mm only), half track.
Transport control: full control interlock.
Spool type and size: NAB to 26.7 cm.
Tape position indicator: mechanical counter.
Head type: interchangeable headblock.
Noise: better than 65 dB peak NAB.
Tape speed and wow and flutter: 38 cm/s 0.06%, 19 cm/s 0.09%, 9.5 cm/s 0.12% peak weighted.
Input level @ impedance: —55 dBm and nominal 0 dBm.
Output level @ impedance: 0 dBm nominal.
Spooling time: 80s for 760m.
Other features: 700 and 10 kHz test oscillator.
Optional extras: rack version available.
Dimensions: 111 x 66 x 58.4 cm.
Weight: to 79 kg.

REVOX

Willi Studer, CH-8105 Regensdorf, Zurich, Switzerland.
UK Agents: C E Hammond & Co Ltd, Lamb House, Church Street, Chiswick, London W4 2PB. Phone: 01-995 4551.

A77 Mk III

Construction: free standing.
Tape width: 6.25 mm.
Tracks: stereo.
Track width: quarter or half track version.
Transport control: electromechanical interlock.
Equalisation: record NAB. NAB/IEC playback switchable.
Spool type and size: cine to 26.3 cm/NAB adaptor.
Tape position indicator: driven from spool.
Head type: laminated alloy.
Noise: no baseline, 19 cm/s quarter track 62 dB, half track 66 dB weighted ASA 'A'.
Tape speed and wow and flutter: 19 cm/s 0.04%, 9.5 cm/s 0.05% rms.
Input level @ impedance: 0.15 to 35 mV.
Output level @ impedance: 2.5V at 600Ω.
Input overload point: +40 dB on any input.
Other features: headphone outputs.
Optional extras: internal power amplifiers.
Price: from £329.

A700

Construction: free standing.
Tape width: 6.25 mm.
Tracks: two.
Transport control: full logic control.
Equalisation: NAB/CCIR switchable.
Spool type and size: up to 26.7 cm cine of NAB.
Tape position indicator: digital, accuracy 0.5%.
Head type: laminated alloy.
Noise: ref 514 nW/m ASA 'A' weighted 38 cm/s 65 dB, 19 cm/s 66 dB, 9.5 cm/s 63 dB.
Tape speed and wow and flutter: 38 cm/s 0.06%, 19 cm/s 0.08%, 9.5 cm/s 0.1%.
Input level @ impedance: 0.15 to 40 mV at 600 and 6 kΩ. RIAA input.
Output level @ impedance: up to 4.9V into 100Ω.
Input overload point: +40 dB on any input.
Other features: three speeds.
Optional extras: remote control.
Price: from £693.

SCULLY/METROTECH

Scully/Metrotech, 475 Ellis Street, Mountain View, California 94040, USA. Phone: 415-968 8389.

Scully 400L

UK Agents: Lee Engineering Ltd, Ashley House, Ashley Road, Walton on Thames, Surrey KT12 1JE. Phone: Walton on Thames 28783/4.

270

Construction: rack mount reproducer only.
Tape width: 6.25 mm.
Tracks: mono or stereo.
Track width: full, half, quarter or stereo.
Equalisation: front panel switch.
Spool type and size: all hubs to 35 cm.
Tape position indicator: accuracy to 99.7% over 30 mins
Noise: (no baseline) stereo half track at 38/19 cm/s 60 dB.
Tape speed and wow and flutter: 38 cm/s 0.08%, 19 cm/s 0.1%, 9.5 cm/s 0.2%. All rms.
Input level @ impedance:
Output level @ impedance: +18 dBm.
Spooling time: 105s for 1464m.
Dimensions: 43 x 63 x 23.
Weight: 45.5 kg.

100 series

Construction: console.
Tape width: 25/50 mm.
Tracks: 8/12 on 25 mm, 16 on 50 mm.
Transport control: full digital control.
Equalisation: NAB/CCIR.
Spool type and size: NAB to 28.25 cm.
Tape position indicator: accuracy to 99.9%.
Noise: ref +10 dBm 206 tape 16 track 63 dB unweighted.
Wow and flutter: unweighted to ASA Z57.1 0.06% 0.5 to 200 Hz.
Input level @ impedance: } 0 dBm operating
Output level @ impedance: } level.
Spooling time: 75s for 732m
Other features: single speed 38 cm/s (76 on request).

280-B

Construction: console.
Tape width: 6.25/12.5/25 mm.
Tracks: 1/2/4/8.
Track width: full, half or stereo.
Transport control: full control interlock motion sensing.
Equalisation: plug in NAB/IEC.
Spool type and size: to 29.2 cm.
Tape position indicator: 0.2% accuracy.
Head type: interchangeable headblock assembly.
Noise: ref 500 nW/m NAB eq 206 tape NAB weighted—half track 38 cm/s 68 dB, 19 cm/s 68 dB.
Tape speed and wow and flutter: ANSI 4.3 1972 38 cm/s 0.08%, 19 cm/s 0.1%, 9.5 cm/s 0.2%.
Input level @ impedance: } 0 dBm operating
Output level @ impedance: } level.
Spooling time: 60s for 732m.
Optional extras: remote control.
Dimensions: 128 x 64 x 73 cm.
Weight: 64 kg.

500 series

Construction: console or panel mount.
Tape width: 6.25 mm.
Tracks: mono or stereo.
Track width: full, half and quarter.
Transport control: logic interlock.
Equalisation: NAB/CCIR plug in.
Spool type and size: NAB to 26.7 cm.
Tape position indicator: counter optional extra.
Noise: ref 500 nW/m 38 cm/s 206 tape NAB eq half track 60 dB.
Tape speed and wow and flutter: to ANSI 54.3 1972 38 cm/s 0.09%, 19 cm/s 0.12%, 9.5 cm/s 0.2%. 4.75 cm/s 0.3%.
Input level @ impedance: 140 mV into 100 kΩ (min).

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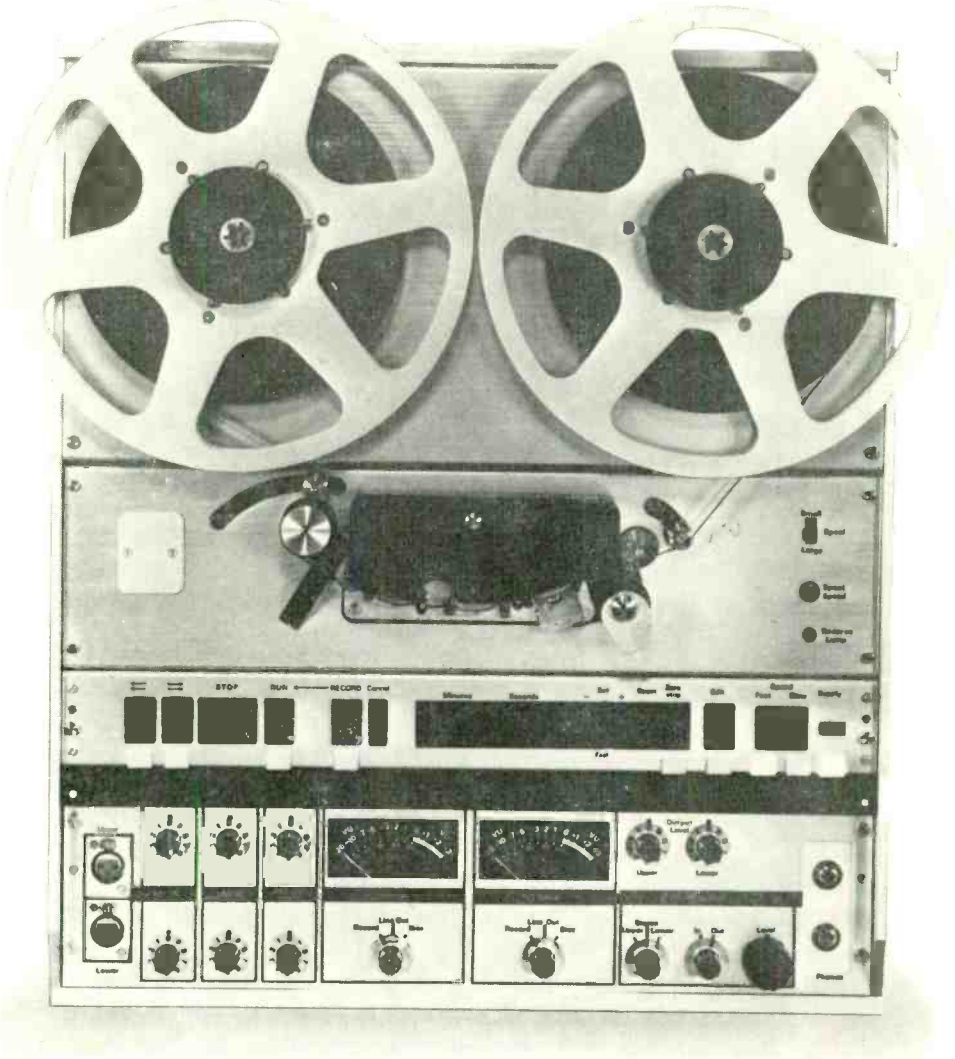
Studio 8
The new recorder from Ferrograph Professional



Console, rack-mounted, trolley-mounted or transportable.
Parts needing routine servicing are immediately accessible.
Uses ¼" tape: standard, long-play, double-play.
Two speeds: 15/7½ or 7½/3¾ in/s.
Servo-controlled run and spooling.
Available as line in/line out, or with full metering/monitoring.
Models for stereo, twin track, full or half-track mono.

Real-time indicator is direct reading at both speeds.
Auto-stop at counter zero can be set for any point on tape.
Provision for remote control and remote display panel.
Tape motion sensing and TTL/MOS logic gives fastest possible response to all valid commands.
Electronic interlocks give total protection against misuse.
Internal speakers, twin 10-watt amplifiers, phone outputs.

Ferrograph Professional Recorder Co. Ltd. Auriema House, 442 Bath Road, Cippenham, Slough, Bucks. SL1 6BB, England. Telephone: Burnham (062 86) 62511. Telex 847297.

Ferrograph Professional

A member of the Wilmot Breeden Group of companies.

SURVEY TAPE RECORDERS

Output level @ impedance: to +24 dBm 600Ω.
Spooling time: 90s for 732m.
Optional extras: mic preamps, remote control.
Dimensions: 49 x 40 x 23 cm.
Weight: 17.2 kg.

400L series logging recorders

These recorders provide up to 153 hours of single channel logging by sequential operation at a tape speed as low as 7.9 mm/s (2 kHz bandwidth). The series has optional speeds to 2.37 cm/s giving a corresponding increase in bandwidth. The loggers feature auto reverse of direction with a time code generator available as an optional extra. Reel types are NAB 26.7 cm normally filled with 1 mil tape. For critical applications, there is a tandem 'fail safe' machine in the range.

Studer 24 track

Tandberg 10XD

STELLAVOX

Stellavox, Georges Quellet, Engineer EPZ, 2068 Hauterive/Ne, Switzerland.
UK Agents: AV Distributors (London) Ltd, 26 Park Road, Baker Street, London NW1 4SH. Phone: 01-935 8161.

SP 7

Construction: portable.
Tape width: 6.25 mm.
Tracks: mono or stereo.
Track width: full or half track.
Transport control: interlocked to capstan.
Equalisation: 35 μs DIN.
Spool type and size: 12.7 cm.
Head type: interchangeable inc pilottone.
Noise: ref 500 nW/m 'A' weighted mono 70 dB, stereo 65 dB.
Tape speed and wow and flutter: 38 cm/s 0.1%, 19 cm/s 0.12%, 9.5 cm/s 0.25%.
Input level @ impedance: mics 0.2 to 75 mV mixer 1.55V at 820k.
Output level @ impedance: various, nominal 0 dBm.
Spooling speed: 406 cm/s.
Other features: film sync (pilottone) facility.
Optional extras: many inc large spool adaptors.
Price: from £924.

Stellamaster

Construction: portable.
Tape width: 6.25 mm.
Tracks: stereo.
Track width: 2.6 mm.
Equalisation: 35 μs DIN.
Spool type and size: to 12.7 cm.
Head type: Bogen.
Noise: ref 800 nW/m 'A' weighted 70 dB.
Tape speed and wow and flutter: 38 cm/s 0.05%.
Other features: 25 Hz —28 kHz ±2 dB.
Optional extras: as for SP 7.

STUDER

Studer Franz AG, CH-5430 Wettingen, Switzerland.
UK Agents: FWO Bauch Ltd, 49 Theobald Street, Borehamwood, Herts. Phone: 01-953 0091.

B62

Construction: portable, free standing.
Tape width: 6.25 mm.
Tracks: full track mono, half track stereo.
Track width: 2 and 0.75 mm guard band available.
Transport control: full interlock.
Equalisation: NAB or CCIR.
Spool type and size: to 26.7 cm NAB.
Tape position indicator: digital, 0.5% accuracy.
Noise: ref 510 nW/m unweighted. 38 cm/s stereo 61 dB, half track 56 dB.
Tape speed and wow and flutter: 38 cm/s 0.05%, 19 cm/s 0.08%.
Input level @ impedance: nominal 0 dBm at
Output level @ impedance: 600Ω.
Input overload point: +22 dBm.
Spooling time: 120s for 730m.
Optional extras: vus, pilottone, mounting options.
Dimensions: 482 x 356 x 220 mm.
Weight: 28 kg.

A80/R

Construction: console.
Tape width: 6.25 mm.
Tracks: full, half and stereo.
Track width: 2 and 2.75 mm.
Transport control: logic interlock.
Equalisation: plug in CCIR or NAB.
Spool type and size: up to 26.7 cm NAB.
Tape position indicator: digital, 0.2% accuracy.
Noise: ref 320 nW/m stereo 38 cm/s CCIR 61 dB, two track 56 dB.
Tape speed and wow and flutter: 38 cm/s 0.04%, 19 cm/s 0.06%.
Input level @ impedance: 0 dBm at 600Ω
Output level @ impedance: nominal.
Input overload point: +22 dBm.
Spooling time: 120s for 1000m.
Optional extras: chassis and vu available.

A80/VU 24 track

Construction: console.
Tape width: 50 mm.
Tracks: 24.
Transport control: logic interlock.
Equalisation: CCIR or NAB.
Spool type and size: up to 26.7 cm NAB.
Tape position indicator: 0.2% accuracy.
Noise: ref +6 dB above 200 nW/m NAB at 38 and 19 cm/s.
Tape speed and wow and flutter: 38 cm/s 0.04%, 19 cm/s 0.06%.
Input level @ impedance:
Output level @ impedance
Input overload point:
Spooling time:
as for A80/R.

TANDBERG

Tandbergs Radiofabrikk A/S, Kjelsas, Norway.
UK Agents: Farnell-Tandberg Ltd, Farnell House, 81 Kirkstall Road, Leeds LS3 1HR. Phone: 0532-35111.

10XD

Construction: free standing.
Tape width: 6.25 mm.
Tracks: stereo.
Track width: quarter and half track.
Transport control: logic interlock.
Spool type and size: NAB or cine to 26.6 cm.
Tape position indicator: mechanical counter.
Head type: crossfield four head.
Noise: half track, 38 cm/s without Dolby 'B' unweighted 58 dB. DIN 45 511 56 dB.
Tape speed and wow and flutter: 38 cm/s 0.04%, 19 cm/s 0.06%, 9.5 cm/s 0.11%.
Input level @ impedance: 0.23 mV to5Vat high Z.
Output level @ impedance: +6 dBm at 150Ω.
Input overload point: 5V.
Other features: Dolby 'B'.
Optional extras: remote control unit.

9100X

Construction: free standing.
Tape width: 6.25 mm.
Tracks: stereo.
Track width: quarter or half track.
Transport control: logic interlock.
Spool type and size: cine to 17.8 cm.
Tape position indicator: mechanical counter.
Head type: Crossfield four head.
Noise: 19 cm/s unweighted 58 dB. DIN 45 511 56 dB.
Tape speed and wow and flutter: 19 cm/s 0.06%, 9.5 cm/s 0.11%, 4.75 cm/s 0.21%.
Input level @ impedance: 0.23 mV to 5V at high Z.
Output level @ impedance: +6 dBm at 150Ω.
Input overload point: 5V.

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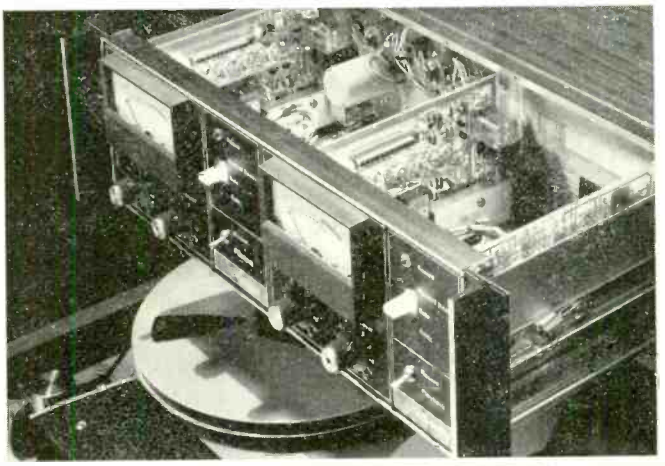
Now There's An Easier Way To Get The Perfect Tape. Scully's 280-B.



Why make the job of recording tougher than it has to be? Operating a recorder/reproducer is so easy with solid state control switching, plus straight line threading for fast editing. A motion sensing system like OPTAC™ which helps prevent tape spill or damage. And you don't even have to use the stop button when changing transport modes.

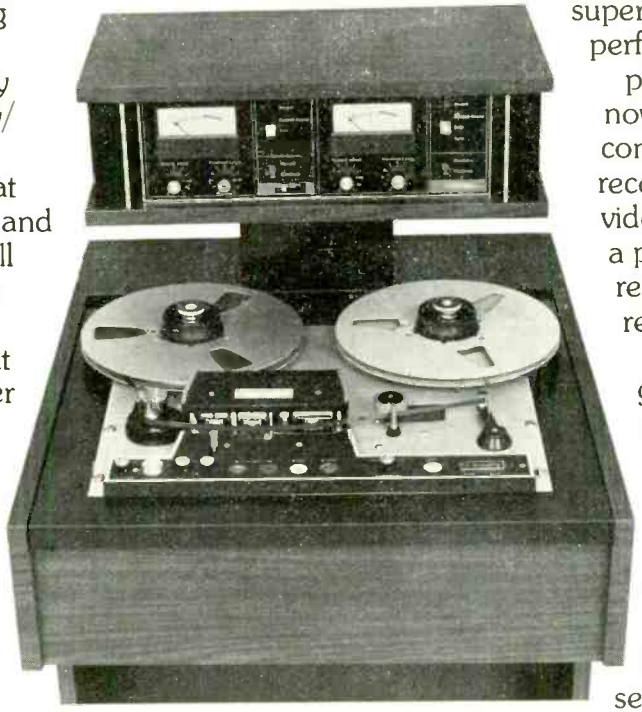
That's the kind of easy operation you get in Scully/Metrotech's 280-B.

And why be an acrobat when it comes to adjusting and maintaining equipment? All that bending and reaching can be eliminated with a pull-out control drawer that houses the mother-daughter boards to give full access to all set-up and equalizer adjustments. Would you believe no extender boards needed?

You enjoy this convenience in the 280-B, too.

But to really take it easy on the job, you need assurance that sound is being recorded to perfection. So we made sure that the efficient, clean-looking electronics of the 280-B deliver the goods — and then some.

An outstanding S/N ratio assures cleaner sound in progressive generations.



Up to 72dB on full track .25" tape at mastering speed. And 68dB on two-track .25" and four-track .50".

Flat frequency response usually exceeds published specifications: ±2dB, 30Hz to 18kHz. You'll find reliable selective sync switching in the 280-B, with sync response equal to normal play response. But you won't find noisy push-buttons in the audio circuits. For easy insert, our function switch provides the ability to punch "in and out" of the record mode on any channel without disturbing tape motion.

The payoff is a superior end product — the perfect tape. And for long-playing tapes, the 280-B is now available in a 14" configuration. Clearly, this recorder/reproducer provides your transmitter with a perfect recording. When recording masters, the result is just as outstanding.

So get the facts. Then get the best — at a reasonable price. Contact your Scully/Metrotech field office in Los Angeles (213) 387-4252, Nashville (615) 244-1546, New York (212) 354-0623 or Chicago (312) 583-7878 for details on the 280-B series with up to 4 channels, or write: Scully-Metrotech, 475 Ellis Street, Mountain View, California 94040. Telephone (415) 968-8389. TLX 345524.

Scully|Metrotech
Division of Dictaphone

Designers and manufacturers of a full line of tape recorders, reproducers for broadcast and master recordings, super slow speed voice logging recorders with time generators and readers.

SURVEY TAPE RECORDERS

TEAC

Teac Corporation, 3-7-3 Maka Cho, Musashino, Tokyo, Japan. Phone: 03-343 5151.
UK Agents: Acoustic Research, High Street, Houghton Regis, Bedfordshire. Phone: 0582 603151. ITA, 5 Pratt Street, London, NW1 0AE. Phone: 01-485 6162.

A-3340

Construction: free standing.
Tape width: 6.25 mm.
Tracks: 4.
Track width: quarter track.
Transport control:
Equalisation: NAB.
Spool type and size: to 26.7 cm NAB.
Tape position indicator: mechanical counter.
Head type: hyperbolic ground.
Noise: 64 dB weighted to ASA curve.
Tape speed and wow and flutter: 38 cm/s 0.04%, 19 cm/s 0.06%. All rms.
Input level @ impedance: 0.25 mV. 100 mV/100 kΩ.
Output level @ impedance: 0.77V into more than 10 kΩ.
Spooling time: 180s for 1281m.
Other features: sel-sync.
Dimensions: 58.5 x 46 x 23 cm.
Weight: 27.5 kg.
Price: £486.

TECHNIK

Klark-Technik, MOS Industrial Site, Kidderminster, Worcs DY11 7RE. Phone: 0562-64027.

SM2 and 2000 series (four to 24 track range)

Construction: free standing.
Tape width: 6.25 mm to 50 mm.
Tracks: 2 to 24.
Track width: 2 mm and 2.75 mm (SM2 stereo only).
Transport control: full logic interlock.
Equalisation: NAB or CCIR switchable.
Spool type and size: up to 30 cm NAB/cine.
Tape position indicator: digital min sec display.
Noise: better than —62 dB below operating level and —68 dB below peak record level.
Tape speed and wow and flutter: DIN peak weighted 0.05% at 38 and 19 cm/s.
Other features: logic controlled tape tension.

TELEFUNKEN

AEG-Telefunken, 775 Konstanz, Buchlestrasse 1-5, West Germany.
UK Agents: Hayden Laboratories, Hayden House, 17 Chesham Road, Amersham, Bucks. Phone: 02403-5511.

Magnetophon 12

Construction: rack mounting.
Tape width: 6.25 mm.
Tracks: mono, stereo or two track.
Track width: 0.75 and 2 mm guard bands.
Transport control: logic interlock.
Equalisation: NAB or CCIR.
Spool and type size: most types to 26.7 cm.
Tape position indicator: min, 1/10 min.
Head type: ferrite interchangeable headblock.
Noise: ref 510 nW/m to DIN 45 405 38 cm/s stereo 58 dB, 19 cm/s stereo 56 dB, 9.5 cm/s stereo 54 dB.
Tape speed and wow and flutter: 38 cm/s 0.08%, 19 cm/s 0.1%, 9.5 cm/s 0.2% rms weighted.
Input level @ impedance: } 0 dBm operating
Output level @ impedance: } level.
Input overload point: +12 dBm.
Spooling time: 180s for 1000m.
Optional extras: mixer, pilottone.
Dimensions: chassis 208 x 483 x 444 mm.
Weight: 25 kg.

Magnetophon 15

Tape width: 6.25 mm.
Tracks: mono, stereo and two track.
Track width: 0.75 and 2 mm guard bands.
Transport control: logic interlock.
Equalisation: switchable CCIR/NAB.
Spool type and size: all standards.
Tape position indicator: min sec 0.2% accuracy.
Head type: interchangeable headblocks.
Noise: ref 510 nW/m to DIN 45 405 38 cm/s stereo unweighted 47 dB, 19 cm/s 54 dB.
Tape speed and wow and flutter: 38 cm/s 0.05% 19 cm/s 0.08% measured to DIN 45 507.
Input level @ impedance: } 0 dBm operating
Output level @ impedance: } level.
Input overload point: +15 dBm.
Spooling time: 150s for 1 000m.
Optional extras: remote control.
Dimensions: chassis 30.8 x 64.5 x 52.5 cm.
Weight: 53 kg.

UHER

Uher Werke Munchen, 8 Munchen 71, Postfach 71 10 20, West Germany.
UK Agents: Uher (UK) Ltd, PO Box 30, Braintree, Essex CM7 7RG. Phone:

SG 560 Royal

Construction: free standing.
Tape width: 6.25 mm.
Tracks: two.
Track width: half track or quarter track.
Spool type and size: cine 17.78 cm.
Tape position indicator: mechanical counter.
Noise: no baseline 19 cm/s DIN—?—58 dB rms half track.
Tape speed and wow and flutter: 19 cm/s 0.04%, 9.5 cm/s 0.1%, 4.75 cm/s 0.2%. To DIN standards.
Input level @ impedance: 0.12 mV upwards by various inputs.
Output level @ impedance: 0.6V across 15 kΩ.
Other features: internal amplifiers, echo.
Dimensions: 46 x 19.2 x 35.5 cm.
Weight: 13.1 kg.
Price: about £400.

4000 series

Construction: portable.
Tape width: 6.25 mm.
Tracks: mono (4000), stereo (4200 and 4400).
Track width: half track (4000, 4200) quarter track 4400).
Transport control: piano key.
Spool type and size: cine to 13 cm.
Tape position indicator: mechanical counter.
Noise: weighted to 'A' curve two track 19 cm/s 64 dB, 9.5 cm/s 63 dB, 4.75 cm/s 61 dB. ¼T about 2 dB lower.
Tape speed and wow and flutter: 19 cm/s 0.15%, 9.5 cm/s 0.18%, 4.75 cm/s 0.25%. All rms.
Input level @ impedance: 0.12 mV, 200Ω source.
Output level @ impedance: 1V at 15 kΩ.
Input overload point: 40 mV.
Other features: remote control, internal loudspeakers, automatic level control.
Optional extras: mics, Ni-Cd packs, chargers etc.
Dimensions: 28.5 x 9.5 x 22.7 cm.
Weight: 3.8 kg.

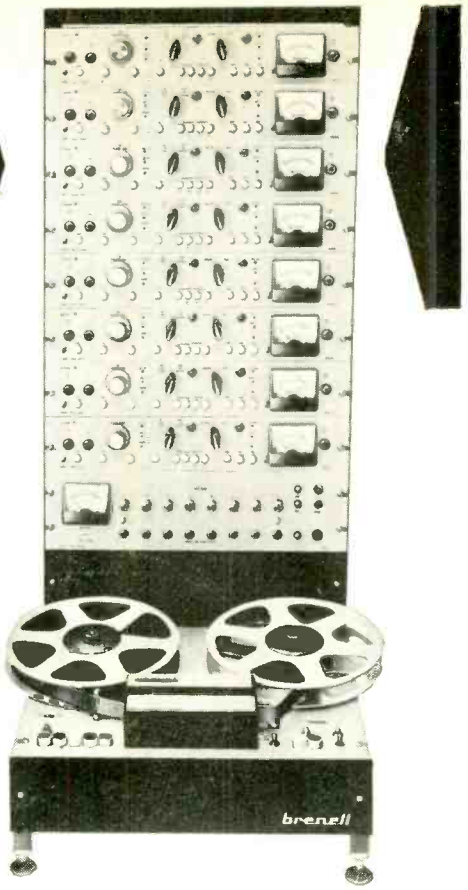
1200 Report Syncro

This machine offers a similar performance to the *4000* series but with the addition of a pilot track and relevant electronics. The *1200* is intended for use with the *W352* Syncroniser which provides a suitable interface for film sound sync. Both units are powered by their own internal rechargeable batteries.

Telefunken M15

SG 560 Royal Uher

NEW equipment for the professional sound-recording studio from brenell



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We have set a new price/performance standard with our 4, 8 and 16 channel studio recorders offering full facilities for the production of master recordings. PPM or VU meters on each channel. Equalisation to CCIR, NAB and IEC characteristics. Remote control for tape transport and record functions. The equipment is in full production and studio use in both U.K. and overseas.

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for 2-channel reducing, field recording and full track mastering.

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We offer a widened range of 2 speed and 4 speed modules from 15/16 to 60 IPS, $\frac{1}{8}$" to 1" tape width, with heavy duty solenoid operation and remote control facilities.

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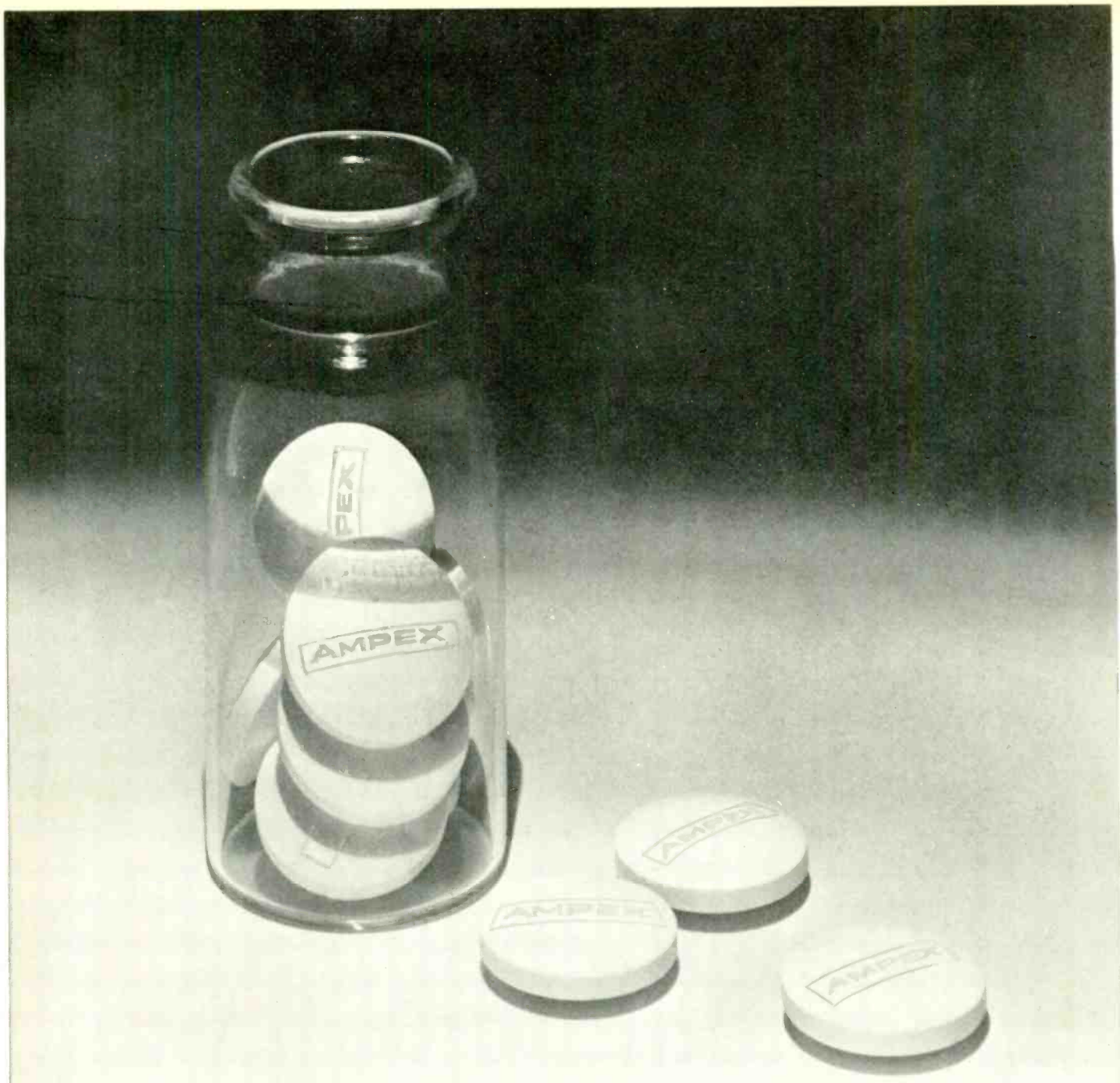
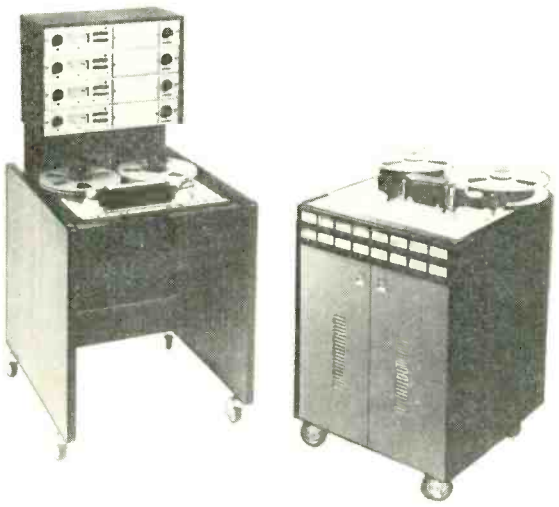


Take two of these and kiss your

Take a look at the MM–1100. The tape transport is probably the most advanced ever for multi-track purposes. Low tape tension – phase loop capstan servo. Used in conjunction with the VS–10 Vary Speed Accy the MM–1100 offers absolute repeatability. It will even pull tape backwards in record/plug mode. Connect to the Ampex ultra flexible 3 card electronics system and the finest multi-track tape machine results.

Throughout the world the AG–440 series has long been the standard of the industry in both mastering and broadcasting. Now the AG–440C offering many new features continues its role as true professional.



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A preview of the activities and exhibitions associated with the Convention scheduled for the week Monday March 3 to Friday March 7 at the Cunard International Hotel, London.

AES 50th Convention London

MICHAEL THORNE

THE CONVENTION will be held at the new Cunard International Hotel, 1 Shortlands, Hammersmith, London W6 8DR. This is five minutes' walk from Hammersmith Underground stations and Hammersmith Broadway, with its numerous bus services. Parking for 400 cars is available at the hotel.

Although the larger part of this preview of the forthcoming London AES Convention is concerned with the exhibition and the plans of manufacturers, this should be seen in the context of the overall convention. The activities scheduled for the five days March 3 to March 7 inclusive are listed.

The convention registration office at the Cunard Hotel will be open on Monday 3rd March until 22.00 and from 08.30 on Tuesday. Advance booking is advised, to save delay, forms available from AES Convention, Ecclestone Road, Maidstone, Kent ME15 6AU. Phone Maidstone (0622) 672538, telex 96121. Included in the information pack, to be available from the Convention Registration Desk at the hotel, are identification and admission badge, a complete set of preprints of the papers due for presentation, convention programme, exhibition catalogue, banquet tickets (if previously ordered and paid for), full details of all special visits and other travel and miscellaneous information. Charges are as follows: AES fellows, members and associates (including members of APAE, APRS and the Acoustical Society) £4; AES student members £1; non-members £8; student non-members £2. The charge for the banquet is £12 per head.

All registration forms are to be returned to the address above. UK applications should include remittance payable to AES Ltd; applications from outside the UK may pay in any of the 13 currencies to the Brussels AES account, details of which are with the registration form.

Hotel reservations should be made directly with the hotel, address above.

At the heart of the convention are the technical sessions, a list of which is given. These will be read in two parallel sessions in the hotel's Queen Mary Suite, and are grouped under the following headings: loudspeakers; transducers other than loudspeakers; recording and reproducing media and machines; digital and measurement techniques; psychoacoustics; noise reduction, gain changing and studio equipment; educational and economic topics; architectural and studio acoustics; multichannel and directional listening. All delegates receive a complete set of preprints at no extra charge.

The majority of the papers will be given in English. Breakdown of authors by country is as follows: Belgium 3, Denmark 3, Germany 5, Holland 2, Hungary 3, Italy 2, Japan 2, Norway 1, USA 5, Finland 1, UK 30.

The special meeting at the Royal Society is on Wednesday evening, at 6 Carlton House Terrace, London SW1Y 5AG, and is a programme titled 'A. G. Blumlein: Inventor Extraordinary', and is a commemoration of his life and work. The presentations will cover his work in electronics, audio and tv, and various demonstrations will include one of his stereo recordings made in the early thirties. Transport between here and the hotel is available for delegates registering for the session.

During the day on Wednesday, visits have been arranged, the choice being between Emitape Ltd at Hayes, Middlesex, Post Office Research Station at Dollis Hill, London NW2, BBC Research Establishment at Kingswood Warren, Surrey, Building Research Station at Garston, Hertfordshire, and EMI's Abbey Road studios at St John's Wood, London NW8. It is hoped that further visits will be available by the time of the convention, and full details will be given to delegates on arrival at the hotel. The cost of the visits includes transport to and from the establishment.

On Thursday at 19.00, a private visit will be made to the Science Museum, with a reception. The museum will be displaying exhibits of particular interest and historical significance to audio engineering, recording and broadcasting. Full details in programme of visits.

A 'ladies' programme' is being organised, to provide a variety of visits and tours for ladies accompanying delegates to the convention. A reception suite will be available, together with an information and advice service covering anything from reservations to restaurant selection. Full details will be included in the information pack.

The Awards Banquet, prominent feature of any AES convention, will be held on Tuesday in the Great Hall of Guildhall, which dates from the fifteenth century. Guests of Honour will be Lord Hill and Henry E. Mattox, Director of Higher Technology at the US Embassy in London. A chamber recital in the Church of St Lawrence Jewry next Guildhall will precede the banquet, and music before and during the festivities will be by the Orchestra and Fanfare Trumpeters of the Royal Marine School of Music. After speeches and award presentation, entertainment will be provided by 'a distinguished group of singers'. The £12 per head cost of the banquet covers all entertainments, as well as wines, spirits and the transport to and from the hotel.

The exhibition incorporates some 37 companies, although as usual many are agents for a number of foreign manufacturers. Opening hours are shown in the list of events, and admission is open only to delegates to the convention.

LIST OF PAPERS

2. H. A. O. Wilms, Levels in basic room acoustics —or the new dB(m) (20)
3. Percy Wilson, Contributions to audio from Britain in the past 50 years
4. M. J. Hawksford, A multiplex stereo decoder with automatic phase error correction (20)
5. D. A. Barlow, Performance of pickups at low frequency and isolation from external shock (20)
6. D. A. Barlow, Sound output from loudspeaker cabinet walls (20)
7. D. A. Barlow, Instability in moving coil loudspeakers (20)
9. M. C. Morton, Current hearing aid performance and requirements of hearing of impaired persons(20)
10. J. M. Eagle, Improvements in cutting styli for CD 4 discs (20)
11. E. J. Volker, Pop studio in German Radio (45)
12. H. D. Harwood, Influence of loudspeaker cabinet walls (20)
13. B. Lane, Compatibility of magnetic tape cassette recording
14. H. D. Clark, New electronic music studio in Norway
15. R. H. Campbell, Electroacoustic properties of noise attenuating headsets (20)
16. P. J. Walker, Current dumping audio amplifier
17. W. R. Stevens, Sound radiation from loudspeaker cabinets (45)
18. J. Moir, Crossover distortion (20)
19. J. Moir, Frequency response in rooms (20)
20. J. Moir, Phase shift in a monaural channel (20)
21. K. Ridler, Direct drive turntable with a parallel tracking arm (45)
22. A. V. Garner, Theoretical and practical aspects of bass unit designs (45)
23. P. A. Fryer, Delayed resonance measurements and their significance (20)
24. P. A. Fryer, Im distortion tests (20)
25. P. A. Fryer, Holographic investigations of speaker cone vibration (2)
26. G. P. Millward, The isodynamic principle (20)
27. G. Häder, New method of loudspeaker measurement with reference to the listening environment (20)
28. P. R. Wall, Active and passive loudspeaker crossover networks without transient distortion (20)
29. R. C. Whelan, A novel planiform loudspeaker system (45)
31. J. M. Berman, Loudspeaker evaluation using digital techniques (45)
32. L. R. Fincham, Loudspeaker system simulation using digital techniques
33. J. E. Lay, Walsh functions in audio education and electronic music (20)
34. P. J. Baxandall, Bidirectional line source loudspeakers (45)
35. P. J. Baxandall, Musical instrument rc oscillator with .005% accuracy (45)

36. P. J. Baxandall, Converter and dc stabilising circuits for capacitor microphones (45)
37. D. Comper, Taking the strain
38. D. Aldous, Record care and cleaning devices (20)
39. E. J. Veale, Earthing arrangements for audio systems(20)
40. E. Baekgaard, Loudspeakers—the missing link
41. V. Nosselt, Electroacoustical music production and the standardisation of audio percepts
42. R. C. Driscoll. Harrow-band transient test function.
43. W. L. Hetrich, ACCU-Peak level indicator (45)
44. R. C. Wallace, A new kind of headphone receiver (45)
45. K. Baeder/B. Blessar, Digital on line audio processing
46. B. Bernfeld, Simple equations for multichannel stereophonic sound localisation
47. R. Sorensen/M. Jensen, Automatic tape recorders: the requirements, solutions and applications (20)
48. A. Defossez, Stereophony: a physiologically adapted microphone arrangement theory
49. D. J. Mears/P. A. Ratcliff, Broadcasting of quadraphony (45)
50. S. Takahashi/R. Ito, Technical background of QS system and its latest encoding technique (20)
51. P. E. Bown, Contribution to pop forum
52. G. Háli, How many control rooms for a studio (20)
53. M. Gerzon, The elimination of scratch noise from 78 rpm records (20)
54. M. Gerzon, The design of precisely coincident microphone arrays for stereo and surround sound 4(5/20)
55. V. Tamor, The lower limit of detectable sound pressures
56. R. D. Weyer, Characteristics of initial sounding in piano and harpsichord sounds
57. A. R. Rangabe, A new method of arm/cartridge damping (20)
58. D. Gaol, Theory and apparatus of the sound travel effect
59. S. Kálmán, The measurement and interpretation of cross power spectra and physical application of coherence function analysis
60. H. Tendeloo, Twin tone tape testing (20)
61: M. Mezzalama, The influence of phase and windowing in pitch synchronous analysis of speech
62. J. Mantel. Optimum multiphony
63. G. Plenge, Cocktail party effect with and without conflicting auditory and visual cues
64. S. Rivoira, A computer program for inferring the grammar of speech
65. L. Antal, Subjective tests on discrete and matrix quadraphonics
66. P. Karjalainen, A state of the art audio oscillator
67. B. G. Wachner/M. S. Robbins, The new stringent federal standard for amplifier testing—its impact and importance
68. G. H. R. Taylor and P. Watson, Improvement in Sound Quality of High Speed Duplication of Music Cassettes.
69. B. B. Bauer, Recent Advances in SQ Quadrophony.
70. E. Rusconi and others, A Formal Method to Describe Pitch.
71. A. Rakowski, Auditory Tests of Timbre Sensitivity in Candidates for Tonmeister Courses.
72. H. L. Feldgen, Musikaufnahmen in Kunstkopf Stereophonie.
73. J. Sotscheck, Identification of Fricative Consonants in Analogue transmission systems.

Note: Numbers in brackets denote the duration in minutes of each paper

PRELIMINARY PROGRAMME

Monday March 3
14.00-22.00 Registration desk open
19.00 Informal meeting of delegates and exhibitors

Tuesday March 4
09.00-12.30 Technical sessions
11.00-18.00 Exhibition open
12.30-14.00 Lunch
14.00-17.00 Technical sessions
18.30-19.30 Recital, St Lawrence Jewry next Guildhall
19.30-23.00 Banquet, Guildhall

Wednesday March 5
09.00-12.00 Technical sessions
10.00-20.00 Exhibition open
12.30-14.00 Lunch
13.00-18.00 Visits
19.00-21.00 Special meeting (Blumlein), Royal Society

Thursday March 6
09.00-12.30 Technical sessions
10.00-20.00 Exhibition open
12.30-14.00 Lunch
14.00-17.00 Technical sessions
19.00-21.00 Visit and reception, Science Muscum

Friday March 7
09.00-09.30 AES European Section AGM
10.00-14.00 Exhibition open
09.30-12.30 Final technical sessions

PROVISIONAL SESSION LAYOUT

P = Port Room, S = Starboard Room

		AM	PM
March 4 Tuesday	P	Loudspeakers I 6, 7, 12, 17, 22, 25, 26	Loudspeakers II 27, 28, 29, 31, 32, 34, 40
	S	Psychoacoustics 9, 20, 24, 63	
March 5 Wednesday	P	Digital and measurement techniques 4, 45, 55, 59, 61, 64	Technical visits
	S	Multichannel listening I 49, 41, 46, 48, 58	
March 6 Thursday	P	Pop forum 51	Education, economics and studio acoustics 11, 37, 14, 2
	S	Multichannel listening II and recording media 62, 65, 13, 38, 53, 60	Studio equipment I 43, 16, 18, 66, 67
March 7 Friday	P	Other transducers 21, 44, 5, 10, 15	
	S	Studio equipment II 35, 39, 47, 50, 52	

Acoustical Manufacturing Company, better known by their Quad trade mark, will have on display the Quad *303* stereo power amplifier and the *50E* professional power amplifier. In addition, special versions which are made for commercial users will be shown. Peter Walker will present a paper entitled 'Current dumping audio amplifier'.

AKG will be showing the full range of products. This includes the new digital delay unit, ntroduced to the UK at the APRS exhibition ast summer, and the *BX20* reverberation unit. A new lightweight dynamic headset is the *K140*. The *C414* capacitor microphone will be on display, as will the entire modular *C451* range and the extensive line up of dynamics.

Allen & Heath will be showing their latest range of mixers, which is a redesigned range based on the Minimixer with new complementary accessories. The Monmix unit is a simple monitor mixer and the Auxbox provides for subroutings such as talkback and foldback. For the combination of two Minimixers and one each of the accessories, total cost is less than £400; this configuration will work for a basic four track studio. Their new 16-2 fully modular pa mixer is just 38 mm thick and includes balanced microphone inputs. The new studio console is 16-8 and provides for 16 track monitoring. To accommodate demand, the manufacturer has doubled the workshop facility, with a production line working on 100; price is £1700. Also on view will be 10-2

Allen and Heath's new mini mixer

42 ▶

and 8-4 formats together with the modular 16-8 range.

Allotrope. No information received.

Ampex will show units from their wide range of recording and reproducing equipment. The *AVR-2* is a high band video tape recorder/player for studio or mobile use and is of modular design. At tape speeds of 19 cm/s or 38 cm/s, single standard operation is provided with alternatives provided by module interchange. Dual or stereo audio is available as a plug-in option. The *AG-440C* audio recorder will be shown together with the *MM-1100* multichannel recorder which is available in eight, 16 and 24 track versions (24 track model reviewed elsewhere in this issue). Frame by frame synchronisation between two audio recorders or one audio and one video recorder is provided by the Ampex time code synchronisation system. A fast search and cue is enabled by recording an exact frame count for any length of magnetic tape, together with the elapsed time in hours, minutes and seconds.

BASF are displaying and discussing their varied tape products, in particular their *SPR 50LH* standard play tape and the polyester long play *LPR 35LH;* both are matt-backed. An innovation is the Unisette, a 'professional' cassette based on 6.5 mm tape. This is intended for high quality convenience applications. In contrast with the Philips-type cassette, the tape guidance is carried out by the playing machine, with subsequent improvement in wow and flutter performance. When not on the machine, the hubs are automatically locked to prevent looping. The Unisette can be recorded from both sides, and if necessary locking pins can prevent accidental erasure. With lp tape, maximum playing time at 9.5 cm/s is 30 minutes. BASF will also exhibit magnetic film, cassette tape pancakes for *C60* and *C90* cassette duplication, and calibration tapes,

Ampex edit code recorder

calibration cassettes and test films.

FWO Bauch occupy a group of stands subdivided among the manufacturers who they represent in the UK. There are five displays: the first is the Gotham Export Corporation representing various American manufacturers including United Recording Electronic Industries, whose products include the Universal Audio Limiter *1176LN*, digital metronome, 'Little Dipper' filter set, graphic equalisers, Sonipulse acoustic analyser, Cooper Time Cube delay line, electronic crossover systems, Teletronix limiters *LA3A* and Modulimiter *BL-40*. Allison Research is responsible for the 'Kepex' keyable program expander and 'Gain Brain' limiters, and Lexicon's varispeech tape time expander and compressor will be shown. Also on this stand: Gotham electronic audio delay systems, ITI parametric equalisers, MRL test tapes and Switchcraft audio connectors.

The separate Neumann stand will show the familiar range of microphones, including the dummy head, and also the cutter head *SX74*, associated cutter drive logic *SAL74*, and various console modules.

The FWO Bauch stand serves as reception area and also to feature Klein & Hummel monitor loudspeakers and equalisers, ARP music synthesisers, Danner faders and Albrecht magnetic film recording equipment.

Studer also has an independent stand, showing the ubiquitous *A80* machines in multitrack, disc-mastering, pilot tone with resolver and mono/stereo versions. The *B62* master recorders will be exhibited along with the new quadraphonic mixing console *189-Q*.

Franz Vertriebsgesellschaft MBH is better known for EMT and will fill a separate stand with a wide range. On show will be the *240* reverberation foil, the *928* and *930* turntables, the *156 PDM* compressor and its compact version *256*, the *258* limiter, the noise filter (*259*), electronic delay system (*440*), wow and flutter analyser *424-HE16*, magnetic logging recorder (*803*), polarity tester (*160*), Loopmatic cassette recorder and an electronic tuning fork.

Beyer Dynamic (GB) will be showing the entire range of Beyer microphones and will particularly feature the ubiquitous *M201* and the *M260* ribbon. In addition the wide range of accessories will be on view. The new low price headphones, working on the open ear principle are the *DT 302*, with the *DT 100* closed ear studio cans also. Beyer (GB) are now agents for the entire range of König and Meyer microphone stands, and other accessories such as a further range of loudspeaker stands.

BGW Systems. No information available.

Bias Electronics will show a new version of the established 6.25 mm *BE1000* tape recorder in transportable format. Available in mono or stereo with selective erase, the machine features a tape transport suitable for horizontal or vertical operation together with a re-styled control panel. Bias offer a choice of metering; vu and ppm are available. The console version

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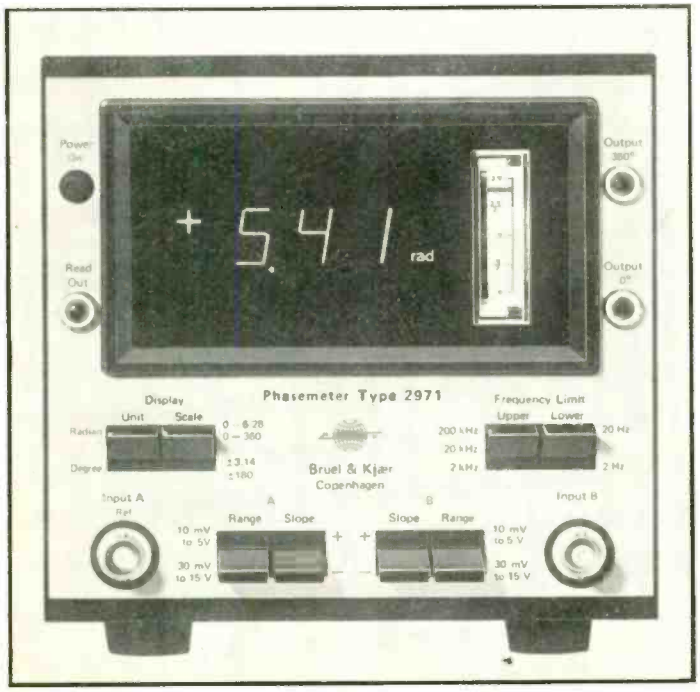
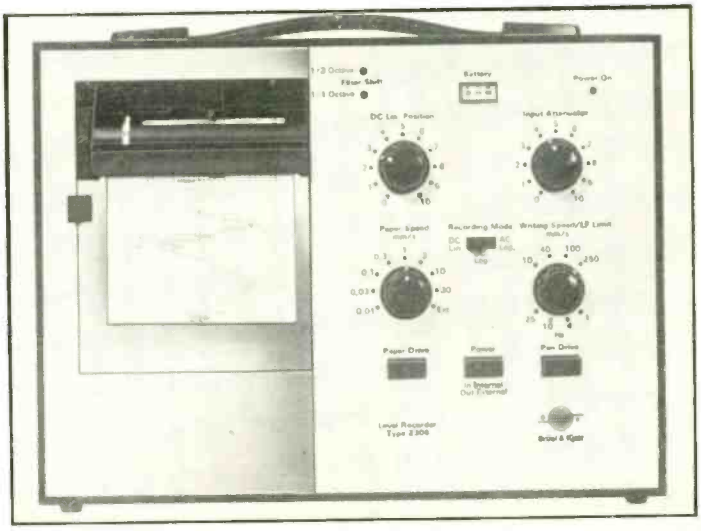


Left: *Bruel & Kjaer 2971*

Below: *Bruel & Kjaer 2306*



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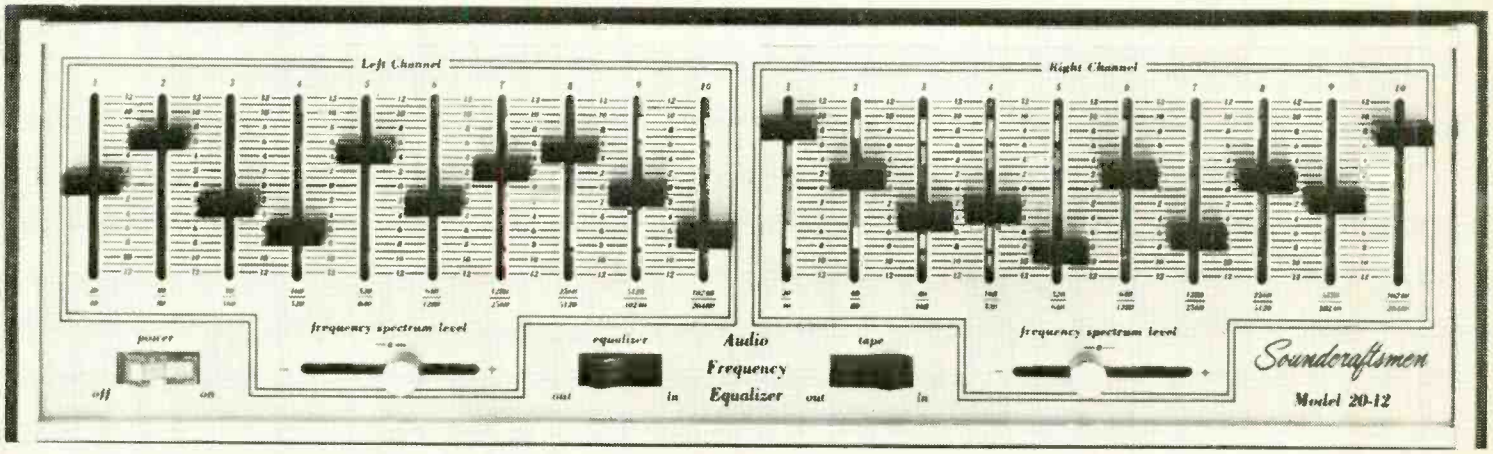

ROOM EQUALIZATION, SPECIAL EFFECTS, PLAYBACK and RECORDING

EQUALIZING FOR ROOM CHANGES: For example, here are some factors that would call for definite changes in your Equalizer settings: (1) Draperies open or closed. (2) Sliding glass door open or closed. (3) Room full of people. (4) Seating arrangements changed. (5) Major changes in furniture arrangement. (6) Relocation of speakers.... **EQUALIZATION OF RECORDS:** You can compensate for old 78 record deficiencies (surface noise, absence of highs or lows, etc.) or favorite recordings that have never sounded quite the way you felt they should sound.... **COMPENSATING FOR RADIO STATIONS:** Some stations are noted for excesses in either low or high frequencies. Make out a Computone Chart for each of your favorite stations so that you can easily achieve the ideal tonal response each time you change stations.... **EQUALIZING TAPES:** Compensating for pre-recorded, or home-recorded, tapes that are under or overemphasized in certain frequency areas.... **CHANGING OVERALL BALANCE:** You can make up for many deficiencies in recordings to more accurately duplicate the sounds of the original performance, or shape each curve to your own listening interests to greatly enhance your enjoyment of your recordings.... **SPECIAL EFFECTS:** You can boost or cut the loudness of a specific instrument or groups of instruments to obtain more pleasing instrumental balance or to add presence to a solo.... **IMPROVING RECORDING OF TAPES:** Use the Equalizer for tape dubbing, to create a near-perfect tape out of one that may have serious deficiencies. (Make your own corrected recording of records, station programming, or other tapes, and no further adjustment of the Equalizer will be needed for playback.) (See Operating Instructions).... **COMPUTONE CHARTS:** After you have achieved the equalization of sound that you prefer use the Computone Charts, supplied with each Equalizer, to mark the settings, so that you can duplicate the settings easily.

SPECIFICATIONS and SPECIAL FEATURES

TOROIDAL and ferrite-core inductors, ten octave-bands per channel.
FREQUENCY response: ±½ db from 20-20, 480 Hz at zero setting.
HARMONIC DISTORTION: Less than .1% THD @ 2 v., Typ: .05% @ 1 v.
IM DISTORTION: Less than .1% @ 2 v., Typ: .05% @ 1 v.
SIGNAL-TO-NOISE RATIO: Better than 90 db @ 2v. input.
INPUT IMPEDANCE: Operable from any source 100K ohms or less — (any Hi-Fi Pre-amp, Receiver or Tape Recorder.)
OUTPUT IMPEDANCE: Operable into 3K ohms or greater — (any Hi-Fi Amp, Receiver or Tape Recorder.)
CIRCUIT BOARDS: Military grade G-10 glass epoxy.
RESISTORS: Low-noise selected carbon-film.
RANGE: 12 db boost and 12 db cut, each octave.
MASTER OUTPUT LEVEL: "Frequency-spectrum-level" controls for left and right channels, continuously variable 18 db range, for unity gain compensation from minus 12 db to plus 6 db.
MAXIMUM OUTPUT SIGNAL: variable Master "frequency spectrum level" Controls allow adjustment of optimum output voltage for each channel, to exactly match amplifier capability, up to 7 v.
SIZE: designed to coordinate with receivers, comes installed in handsome walnut-grained wood receiver-size case, 5¼" x 18" x 11", or rack-mount
WARRANTY: 2-year parts and labor.

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of the *BE1000*—and its 12.5 mm counterpart the *BE2000*—will be shown unchanged in specification.

Bruel and Kjaer show their huge range of test and measuring equipment, and there will be several new additions to their range. The Type *1027* sine/random generator provides outputs of sine, narrow band noise, white noise and pink noise. Frequency range 2 to 200 kHz, distortion rate ±.015%. The *2306* fiortable level recorder combines with the *1621* filter set for field measurements. The tracking frequency multiplier Type *1901* enables measurement of both total harmonic distortion and individual harmonics as a function of frequency, and output can be plotted on a level recorder. A new digital voltmeter is the *2427*, which provides for voltage readout, dB readout with respect to 1 μV or 1V, and readout in dBm. Although the gating system type *4440* is primarily designed for calibrating hydrophones, it can also be used for free-field loudspeaker measurements in typical rooms, and as such offers an alternative to the anechoic chamber. An operating demonstration will consist of the *2971* phase meter and the *5675* delay unit to demonstrate automatic phase measurements on loudspeakers, such as might be required for assessment of transient performance. Another feature will be the demonstration of various ways of performing third octave measurements with B&K equipment. Systems range from the real time analyser *3347* to the combination of *QR 2011* test record and portable sound level meter *2206*.

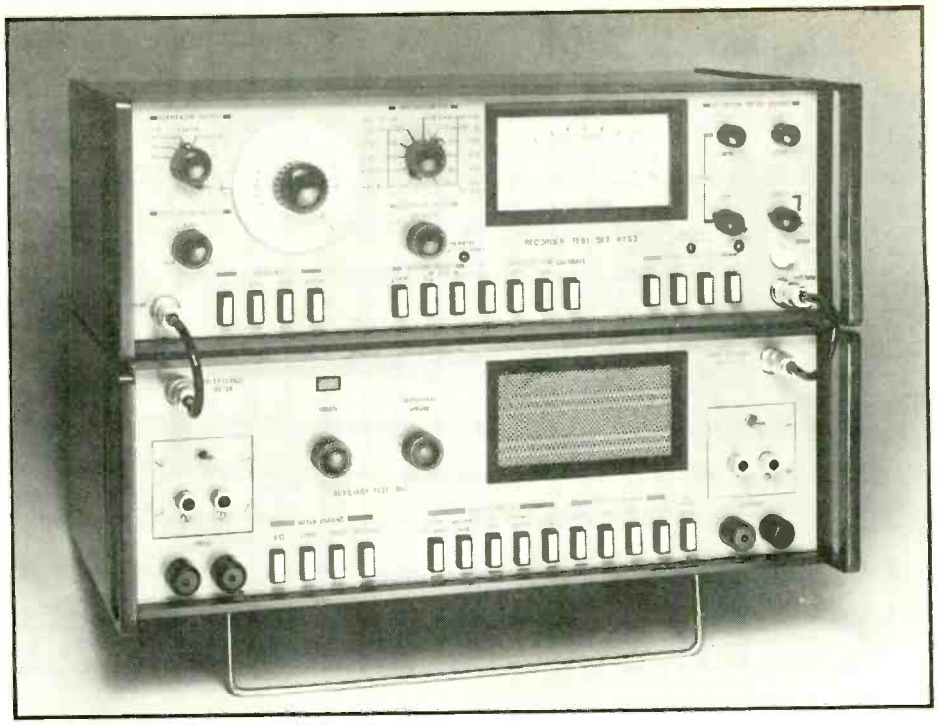
Cetec (UK) Ltd. No information received.

Cadac were uncertain of final plans, but expected to show their large monitoring loudspeakers. In addition, they expected to show a version of a new portable mixer, perhaps in 10-4 configuration. Details of their ic gyrator for filter applications will be available.

Dolby Laboratories will be showing equipment from their wide and increasing range of A and B type noise reduction systems. The single channels *360* and *361* will appear, as will the M series multitrack versions. Future Film Developments' portable A pack for film location work will be exhibited, and other equipment for cinema use are the *364* noise reduction unit for decoding optical or magnetic sound tracks and the *E2* cinema equaliser which assists reproduction of high quality, wide range sound tracks. B type encoding is incorporated in the *330* unit, used for preparing duplicating masters, and the *334* which is used for fm broadcast encoding with B characteristic and 25 μs pre-emphasis. Reflecting its approval by the US FCC, such broadcasting has found wide application there, and evaluation is proceeding for European applications.

Emitape will show their familiar range of studio tapes. It was expected that visitors would be able to listen to a before / after demonstration of the tapes, although final details were not fixed.

Feldon Audio are the English agents for a wide variety of foreign equipment, of which the major manufacturers will have separate displays. From MCI will be shown their 24 track tape machine (reviewed this issue), together with a 24 in, 24 out console. In a separate demonstration room, JBL speakers will include the new family of *4340* models and the *4333*, which supersedes the ubiquitous *4320*. A new two channel power amplifier is claimed to give 300W rms per channel into eight ohms. Another active demonstration may be of Quad/Eight Electronics' Compumix automated mixdown system. The recently introduced Ortofon *731* cutter head and cutter amplifier are with *CD-4* in mind, and can handle 2 x 500W. Also on display will be the Pandora delay line and phase and delay units from Eventide.



Ferrograph audio test set RTS2

Ferrograph will show their recently introduced *Studio 8* tape recorder in both console and transportable versions. Construction features electronic logic switching and interlock, with an open head arrangement conducive to easy editing. These machines, described as 'designed for modern broadcast applications', are available with mixing and monitoring modules incorporated, or for basic line in/out work. Head blocks and equalisation boards are readily interchangeable, and an led display shows tape position up to 199 minutes 59 seconds. The Audio test set *RTS2* has as companion unit the *ATU1* for more critical applications and together they provide for a wide variety of convenient measurement.

Grampian Reproducers will have a wide range of commercial products represented; it extends right across amplifiers, mixers, microphones, loudspeakers and reverberation units. Prominence will go to the *Series 7* range of modular sound systems, the *730* input control system, a preamp with comprehensive input selection, the *7301* mixer unit, with up to five inputs, peak reading meters and two levels of mixing and the *700* solid state logic unit, which provides for low-level switching of the *730* unit. Using these basic units, a complex system may be developed to a particular requirement. In addition, monitoring may be through the *Series 7* power amplifier.

Gulton Europe, as agents for Electrovoice, will take a separate demonstration room. The Sentry *III* studio monitor, the Interface 'A' system, and various microphones from the professional range will be joined by the new *LR7B* line radiator speaker for outdoor applications and the *CS15* electret cardioid microphone.

Hayden Laboratories take a stand to exhibit three companies for whom they are the exclusive UK agents. From Kudelski in Switzerland comes the Nagra *IS*, which will be exhibited in this country for the first time. Light in weight, it features easy push-button controls and high speed spooling. Another first showing here is for the *QGB* adaptor for the Nagra *IV* recorders which enables them to take NAB spools. Tape machines also from AEG Telefunken in Konstanz, including the *M12* stereo machine, a review of which we will publish shortly. Various items associated with cassette and cartridge production from the Milan factory will be shown. The complete Sennheiser range of microphones and headphones will be exhibited.

JVC will take a demonstration in the hotel as well as the stand, to demonstrate and discuss the *CD-1* four-channel disc system, with their newest demodulator the professional *CD-1000* improved. Demos will be with recent release records, and a *Mark 3* modulator may be discussed. John Eargle will present a paper for JVC, and other technical representatives from Japan and the USA will be available for questioning about hard and soft ware.

KEF Electronics expect to be exhibiting monitor speakers and amplifiers in the main exhibition area. In addition, they intend to take a separate room to demonstrate pulse

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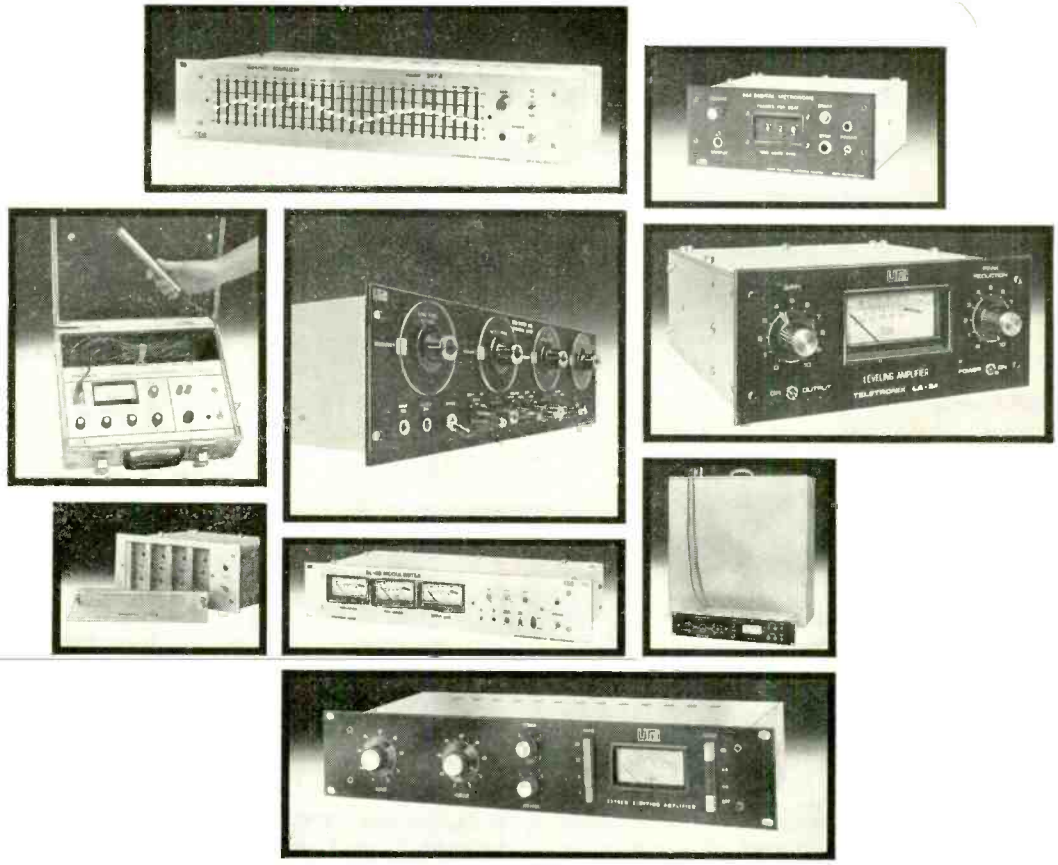

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techniques for loudspeaker evaluation, on which the company has been working extensively. The most recent work will be covered in two complementary papers given by L. R. Fincham and J. M. Berman and titled 'Loudspeaker system simulation using digital techniques' and 'Loudspeaker evaluation using digital techniques' respectively.

Klark Teknik introduce a new stereo recorder, the *SM-2*, intended for studio and broadcast mastering. Full production is underway on the model, which is essentially a smaller version of the previous twin-capstan model. Control of all functions is fully electronic; reel motion is subject to digital servo controlled tension sensing, which is the subject of a patent application. The machine is available in two different guises: one for the BBC in a metal console with sloping front panel, the other in a wooden console such as normally required in recording studios. Price, including varispeed, is given as £1690. The extensive range of graphic equalisers will be on show. A new model is the *27S*, which is a single channel, 27 band, third octave module.

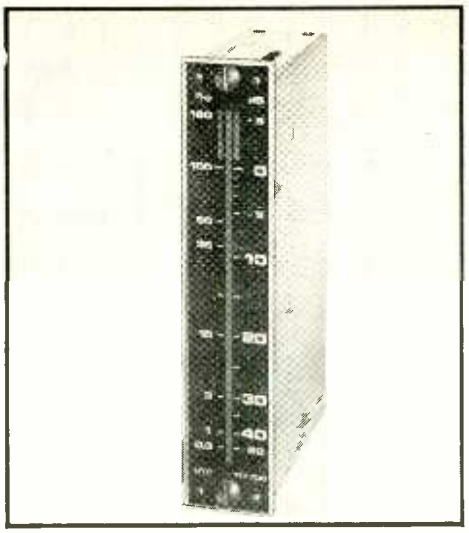
Lennard Developments will show the Woelke range of wow and flutter meters, the *ME102C*, the *ME104C* and the *ME105*.

Macinnes will have on display the full range of Amcron amplifiers. Of particular interest is the new *M600*, appearing in the UK for the first time, which is the latest and largest. Dc coupled throughout, it is claimed as delivering 1350W rms into four ohms, and is claimed stable down to two ohms where output is around 1700W. Output can be capacitor coupled if desired, and also there is optional overload protection. The peak reading meter has an adjustable threshold. The whole weighs 35 Kg, incorporates two cooling fans, and costs £830. We hope to publish a review in April. After a four-year lapse, the Amcron *CX 844* four track 6.5 mm recorder is back in production, and will be on display. Speeds are 9.5/19/38 cm/s, and price is £2200. Mic and line inputs are provided, and there are sync facilities. The Maclab speakers are shown, Macinnes' own brand, but are dwarfed by a range of speakers from the American RTR company which goes up to a 63 cm version with a 15 cm voice coil. Power handling is not given, other than an indication that it is 'several hundred watts'. Free air resonance is 12 Hz. In addition to the obvious application in cinemas, some have gone to RAI, Farnborough, for use in noise simulation where high output at low frequencies is essential.

Mercury Electronics. No information received.

Midland Sound have their disc-cutting equipment, principally the *MSR 2000* lathe for mastering lacquer production. In addition to normal stereo facilities, a version is available with comprehensive phase comparison for critical cutting such as phase encoded disc. Half-speed cutting option utilises the Ortofon 2 x 500W head and amplifier. Also on show: their cutting console incorporating lathe, control desk and Leevers-Rich *E200* with advance head.

Keith Monks Audio introduce a heavy duty wheeled studio boom stand, in contrast with their range which has not included anything of this weight before. At the other extreme,



NTP's 177-700 sound level meter

they introduce very lightweight floor stands with folding legs to extend the current range. Two varieties of record cleaning machine are on show, the 'double' version differing from the 'single' in its faster speed of operation. The mercury contact pickup arm will be shown on as many turntables and with as many cartridges as feasible to demonstrate its versatility, along with other consumer hi-fi equipment.

Rupert Neve and Company intend to show a newly-designed 24 group output desk. Designed with limited space requirements in mind, it is intended to provide such recording facilities at an economical rate and in a smaller space than normal. Also on display will be the new 12-2 portable console type *5302*. It can be fitted with a wide variety of input equalisation and is suggested for general purpose broadcast or location work. Finally, on show will be one of a number of consoles designed for Radio Trent, to be installed in the month following the AES convention. The Neve Radio B is specifically designed for operation by a disc jockey in typical applications.

NTP Elektronik, of Copenhagen, will show their wide range of peak programme meters. This has by now become quite extensive, with moving coil instruments, light spot meters, led type displays (with green leds now available as an option) and the compact multichannel display unit. The latter, type *377-100*, may indicate up to 28 channels on one small screen, with the usual advantages. The channels are represented by vertical bars grouped in fours, and for reference purposes the colour may be controlled from the desk itself. In the overload range, bar colour changes to red. Since the video signal is based on the 625 line standard, a standard colour tv monitor may be used. System may be initiated with eight channels and four masters and expanded later to the full 24+4. NTP expect to introduce a new model of ppm. Other control modules include limiter/compressors, a filter unit, and communications systems modules and operational amplifiers.

Peak Radio Productions. No information received.

Pye TVT will represent themselves and also the Broadcasting Division of Philips from Eindhoven. Their own sound mixers, audio matrices and communications systems are as used in systems packages for radio and tv stations, particularly for ob work. The *SM-8* mixer is a redesigned eight channel desk with additional options to the basic format. Philips equipment will include the ELA *MM2* mixer, with narrow modules enabling compact system construction for critical ob work, and the *MD* range with standard module fixing centres.

Radford will be showing their familiar range of test equipment, and in particular the *Series 3* low distortion oscillator, a transistorised version. The *HD 250* is a stereo integrated amplifier delivering up to 250W rms per channel.

Sansui, protagonists of the *QS* quadraphonic matrix system, will be taking a separate demonstration room in addition to the display of professional encode/decode equipment. The conveniently arranged demonstration setup uses two Studer tape machines and an Automated Processes desk, and easy switching is provided between four channel master tape and the end of an encode-decode array. Similarly, stereo and mono compatibility can easily be demonstrated at the turn of a switch and without any replugging. The desk, which was built specifically for this purpose, has already had a public airing at the Audio Fair last year. Sansui will welcome anyone with a four channel, 12.5 mm master under his arm for demonstration of their system, which means the demo will be on material familiar to the engineer listening.

Shure Electronics. No information received.

SNS Communications. No information received.

Scenic Sound's display will centre on the DBX noise reduction systems and a continuous demonstration room will be showing the *216* unit (16 channel simultaneous line in/out), the *187* (four channel switchable for disc mastering and other applications) and the *150* range of semi-professional equivalents. A new and as yet undesignated introduction is a selective frequency compressor/limiter for disc and tape mastering. Tunable hi and lo filters can either come together or open out, giving gain control over a few cycles or the whole bandwidth. This will be demonstrated in conjunction with the Amber real time analyser. This reads octave energy bands on a 10 x 10 led display. Highest peak information can be stored. Use is expected to be in critical disc, tape and programme monitoring. The Audio Design and Manufacturing *301* noise gate is available in frame with integral power supply, at £112 for the unit and £50 the power supply. Also to be exhibited: Aengus equaliser and Master Room echo units of two and five seconds.

Schlumberger Corporation. No information received.

Schoeps, manufacturers of microphones which have not made a wide appearance in the UK, will show the Collette range of mics, with standard preamp and range of seven interchangeable heads. An extension cable assembly shown by them enables the mic to be controlled from 5m from the body—the active extension lead has a mini preamp at the connector with the capsule, which helps in applications where the mic has to maintain a low profile. Also shown will be the pop range of performers capacitor mics and a complete range of holders, stands and accessories.

50 ▶

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'The time is coming when I'll have to put a studio where my mouth is, and I'm not looking forward to it a bit'.

Gimme that old-tyme recording

BILL LEADER*

FOR YEARS I'VE been a wandering producer, making records for the crankier end of the market, sometimes in conventional studios, sometimes in pubs, but most times in people's living rooms. Recording traditional music, as I do, the engineer must nearly always go to the performer rather than try to transport a 90-year-old born and bred in the country man into a world where jargon-ladened communications are spoken through dalek-type talk-backs, while the singer wonders why, if they want him to sing well, did they put him in this room where his voice sounds lifeless.

One of the most sparkling facets of music-making in London, to my ears, is the little-known but highly skilled playing of Irish traditional musicians who play in some North- and West-London pubs. In these pubs fiddle players, flute players and other instrumentalists, who in their own musical convention are of the highest order, play to a bar full of their fellow countrymen, who while not appearing to give the players their undivided attention, certainly prefer to drink in that particular pub, than to down their stout to the accompaniment of piped non-music. From a record producer's point of view, the lure of recording these fine musicians is to try to capture on disc music being created rather than being interpreted. Rather like having a recording machine in New Orleans at the turn of the century or St Thomas's, Leipzig in the 1720's.

Now if I try to remove these musicians from their noisy natural home to the controlled convenience of a studio, the shortcomings of studio techniques start to become obvious. To get separation the engineer wants the musicians to sit far apart, maybe have screens round them. Now for musicians who spend their playing lives cramped on to a small dais in a pub, happy to be in constant danger of the fiddle player poking out the accordionist's eye with his bow, to be moved apart is to drive a wedge through their music. 'Give 'em cans,' says the engineer. But if you take a group of Irish building workers who are probably making the one and only recording of their lives, and ask them to play with cans as well as adjust to the strangenesses of a studio, the chance of achieving a good performance is pretty small. Then the engineer says: 'Would you mind not tapping your feet, the mike stand is picking it up'. Which is the equivalent of asking a flutist not to exhale because the mike is picking up his breath. These lads would be happier clustered round a recording horn in Maiden Lane than in a modern studio.

So as producer, I have to persuade the engineer that there are more ways of recording an ensemble than close-miking it, that he should take advantage of the natural balance of the group and put a stereo pair on them and let them sit how they like. But as you start moving the mikes back, the shortcomings of the studio and its acoustics become obvious. For instance, one studio set up a stereo pair that was out of phase, and because the engineer had never got into the habit of checking his mix in mono, he just sat there congratulating himself on his stereo spread. I remember one Denmark Street studio where my attempts to record a solo unaccompanied voice were frustrated by the sound of young hopefuls tramping up to the music publisher above. Or there are aeroplanes, or trains, or lorries.

The point is that although it is easy to make what old-time record reviewers used to call 'a good clear recording' in a studio, it is not necessarily the place to get a recording of a good performance. So if I am faced with a compromise between technical and musical standards, I opt to keep the musical standard as high as possible, solve the technical problems as best I can, and tend to record the music where it is normally being made. After all I am trying to document the country's traditional music, not produce hi-fi samplers.

Fortunately, the sessions I'm faced with do not require sophisticated equipment. Folk-rock has not hit the farm labourer yet. But the sessions do require a certain amount of tact and some expertise. To draw up in front of a country cottage with Rolling Stones' mobile unit would be a fast way to make the most vociferous old boy dumb. Once the equipment is set up it should be fiddled with as little as possible. The occasions are song-collecting expeditions as much as anything and the singer or player will remember more and perform it better the less I muck about with mike positions and draw his attention to the paraphernalia of my trade. I've got to do things right fast and with no fuss.

At the moment I'm doing a series of recordings with a farm carpenter in a tiny Norfolk village. From the folklore point of view, he is one of the most important discoveries of the last 20 years. The only time he can record is on Saturday afternoons. So about once a month I head for deepest Norfolk and spend just three hours each visit recording him. In those three short hours he will record upwards of 20 songs, each a perfectly performed gem. This productivity is quite overfacing. When a performer so knows his songs (after all he's probably been singing them since he was a child) that one take is virtually identical to another, the singer resents repeating a song several times while you sort out mike positions and levels. So you're challenged into being as quick and accurate as he, and you soon learn to assess the acoustics of a room and the correct mike placing by eye.

One thing all these informal living room sessions has taught me is that if you can cut out the red lights, the squawking talkback, the layers of plate glass between you and the performer, you can get on with the music. You can build up a rapport with a performer if you are sitting there in the room with him. The concentration of both of you is maximum throughout the take and there is a better chance that the take will be a good one—rapport is all too often in short supply in a studio.

'*I'm getting nothing through the cans*,' says the lead guitarist. '*I say, I'm getting nothing—can you hear me? Can* he *hear me? Is there anybody in there? Have they all gone off for a drink and left us here? Hallo*!'

In the control room the tape op says to the producer, who is on the phone trying to book a session musician for another job: '*I think the guitarist is saying something*'.

The producer says to the engineer, who is at the other side of the studio trying to find the fault: '*Where's your talkback button?*'.

'*What's wrong?*' says the engineer.

'*The guitarist, Fred, is it Fred? Fred I think his name is, is trying to say something.*'

'*Whip up his fader*,' says the engineer. '*It's the*

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* Leader Sound Ltd.

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MODEL DM2A

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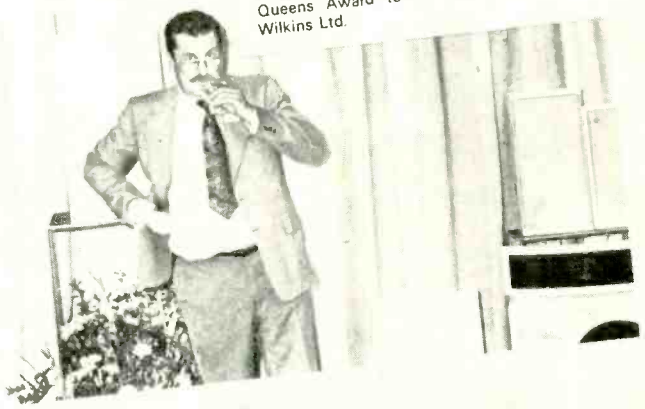
B&W



Broadcaster Peter King pulls off the audio trick of the year before a distinguished audience watching the presentation of the Queens Award to Industry to Bowers & Wilkins Ltd.

'YOUR Grace, Your Worship, Mr Minister, Gentlemen, you have been good enough to inspect our research and production complex here at B & W, and now we offer for your consideration the end product, which has won for us not only world-wide acclaim, but also the honour which Her Majesty the Queen has been graciously pleased to approve. You may, or may not have noticed that I stopped speaking to you in person some time ago, and my voice is now being reproduced on a B & W DM2 loudspeaker . . .'

It was at this point that broadcaster Peter King, who was producing the demonstration, pulled the trick of the year. While his voice went on to describe the B & W range, with no perceptible change whatsoever, he took a glass of water from behind the DM2 and pulled the old ventriloquist trick of drinking while speaking and *then*, he slowly walked away, to the delight of the audience.

AUDIO was there, having been warned in confidence that the attempt would be made—so we were listening for the switch—and missed it! We heard it again and missed it again. 'A tribute indeed', as Peter King's ghost voice hammered home, 'to the fidelity of the DM2.'

Just for the record, it happened fifteen times that afternoon and, although no-one really likes to be fooled that often, it is just possible he was right. In fact, he told us later that the tape took over after the word 'acclaim'.

Reprinted from 'Audio' October 1973

". . . a most impressive demonstration of the B & W range; an object lesson to anyone who ever plans to demonstrate loudspeakers."

from 'Hi-Fi News & Record Review' September 1973

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OLD-TYME RECORDING

third on the . . .'

'*I can't hear a bloody thing through these crappy cans*,' screams the voice of the of the guitarist, already not in the best of moods.

'*Tell him I'm trying to fix it*,' says the engineer.

'*Where's your talkback button?*' says the producer.

You've seen it haven't you. Time and tempers wasting. Animosity growing. Now if in some way that barrier, that wall between the control room and studio, that double layer of fish-tank glass could be removed, communication between the performer and the technician would be simplified and the session would flow.

There's me, sitting in my living room studio, sitting-in with a bunch of musicians. They're half way through a take and it's not going well, the singer thinks. He raises his eyebrows questioningly to me. I frown. He nods. He raises his arms so that the others can see. They stop. He takes a breath and off they go again. Just like that. No need for words. No need for long breaks in the continuity of the performance. You all just get on with the job of recording.

Transfer that scene to a studio.

The engineer says to the producer: '*They've stopped*'. He presses the talkback. '*Fred, do you want another take?*'

This comes through the bingo callers talkback as: '*On the red number eight*'.

'*Yer wat?*' says Fred. '*Er yes. I didn't think we were going too well. What did you think?*'

'*What do you think?*' the engineer asks the producer.

'*Er—yes well er—I think we might as well do another take*,' says the producer, who hadn't been taking notice because he had been on the phone to another session musician.

'*Okay*,' says the engineer, with his finger on the button. '*We'll do it again. This will be take eight*.'

'*No it's seven*,' says the producer.

'*No it's eight*,' says the tape op. '*Seven was a false start*.'

Meanwhile Fred in the studio has been explaining something to the producer, but because the talkback button was down, nobody heard him. So he has to repeat it all over again. And so on. It happens every day. Sometimes you could get the impression that a studio is a carefully constructed device to prevent musicians making music.

But now, as I said, I'm going to have to put a studio where my mouth is. I'm about to build a small studio from scratch. Do I dare throw convention out of the window and build an open-plan studio, designed to help the session move along at the pace set by the musicians rather than the technicians. Designed so that there will be the maximum communication between desk and mike. After all, I'm in the handy position of being producer, engineer and tape op, so that cuts down the number of technical people milling around. I'll monitor the actual take on cans and play back through speakers that both the musicians and I can hear because we're in the same room. That would avoid the scene that goes:

Musician (from the studio): '*Can we hear that back?*'

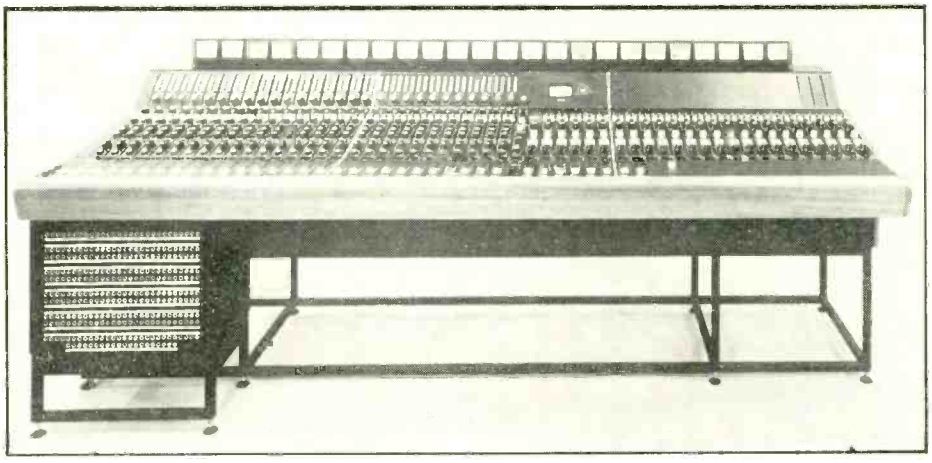
Engineer (finger on button): '*Well the speakers in the studio aren't really working well today. Would you like to come in hear. That's right, come right through. Mind the mike leads. That's right, if you could all squeeze in here. Fred, you'd better sit in my chair, and perhaps the rest of you could just line up round the wall. Try not to stand in front of the speakers it spoils it for the rest of us. That's right. Are we all in? Maybe we'd better not try to close the control room door.*' Did you ever see *A night at the opera*, where the Marx brothers were in that cabin? It seemed funny at the time.

I'll admit that an open-plan studio is difficult for heavy sessions, because the cans can't exclude enough ambient sound. But I don't get involved in heavy sessions. So I say to myself: 'It would be worth trying to set up an open-plan studio just to prove that it is musically a better way of recording'. Then I say to myself: 'Supposing I got a chance to do a lot of heavy sessions with lots of lovely lolly rolling in'. And say to myself: 'Don't be daft, who is going to come to a tiny studio in the Pennines to do a rock buster'. And I reply: 'You never know'. 'You know damn well,' I say. 'Come on, put the studio where you're mouth is and get your teeth into it.'

AES PREVIEW

Sescom. No information received.

Soundcraft are by now well known for their unit mixer systems. The main feature of their exhibit will be their new *Mark 5* modular mixing system. A 24-16 console will be on show with all the available module types incorporated. Input includes comprehensive quasi-parametric equalisation, three cue sends, 105 mm plastic faders, and direct post fade line out. The output can include adjustable limiting, monitor return with three cue sends and vu or ppm metering fitted as standard. In addition, the display will include two models from the fixed format range, the familiar 12 into 4 and the more recent 16 into 8. Both feature adjustable group limiting, full monitor routing, and four band channel equalisation. The 16-8 unit will cost less than £2000. Soundcraft also announce their sole UK agency for Waters potentiometer products and will exhibit samples from the range.



Triad desk

Triad consoles of Trident Audio Developments need little introduction. It is expected that the 'A' and 'B' series desks will be shown. The former is oriented towards large multitrack studios requiring wide and flexible facilities: among the modules available are 16 frequency graphic channel equalisation, four independent headphone foldback circuits, six echo send groups, selected by push button, and dual-scaled vu/ppm metering selection. The 'B' series offers the same performance at lower cost, the compromise coming in system facilities. The range is fully modular, enabling prewiring to accommodate possible later expansion or initial budget restrictions. Power supplies are external to the console, and for the microphone lines 45V phantom powering is available. Triad expects to introduce shortly a compact limiter/compressor module as a unit complementary to both ranges of console.

Edward J. Veale and Associates is a firm of consultants who offer advisory services relevant to sound recording, film, tv and broadcasting. Aspects covered include 'design, planning, systems design, engineering and project engineering at building works and installations'.

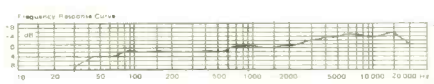
Speaking to the professionals

M88 Dynamic Moving Coil Microphone

With hypercardioid characteristics and unusually high sensitivity. Due to its very good front to back ratio it is less subject to feedback and provides excellent elimination against unwanted sound. It is used by broadcasting and TV-studios, recording artists, bands and instrumentalists.

Specification:

Frequency response 30-20 000 Hz
Polar Pattern: Hypercardioid
Output Level: 2,5mV/Pa≙-51 dbm
EIA Sensitivity Rating: - 144 dbm
Electrical Impedance: 200 ohms
Load Impedance: > 1000 ohms
Hum Pickup Level (50 Hz):
4Ω V/5Ω Tesla
Available DIN or Cannon connectors.



Terry Yeadon of Kingsway says *'of course we use Beyer Dynamic, we get the sound, the service and the price.'*

DT 100 Dynamic Stereo Headphone

Brilliance of sound and high wearing comfort distinguish this BEYER DYNAMIC product which is popular with studios.

Specification:

Frequency Response:	30 – 20 000Hz
Output Level at 400 HZ and 1 mW input power:	110dB over 2×10^{-5}Pa
Impedance available:	2x400ohms (standard) (2x8, 2x50, 2x200, 2x800, 2x2000ohms upon request). DT 100RR only with 2x400ohms
Rated Input/Cartridge:	600 mV
Peak Power Limit/Cartridge:	1W or 20V (400 ohms version)

DT 100RR model has individual volume controls

Cord & termination:

Available at choice either with 10ft. (3m) detachable straight (K) or coiled cord (WK).

K/WK 100.0	open end
K/WK 100.4	fitted with Standard DIN-Loudspeaker Plugs
K/WK 100.7	3 conductor jack plug
K/WK 100.10	standard 5-pin DIN Headphone plug

BEYER DYNAMIC

BEYER DYNAMIC (GB) LTD
1 Clair Road, Haywards Heath, Sussex. Tel: Haywards Heath 51003

Three 24 track recorders on test. Shown in Hugh Ford's laboratory are; left, 3M 79; back right Ampex MM-1100 and front right MCI JH 24

3M 79 RECORDER

By Hugh Ford

MANUFACTURERS' SPECIFICATION

NAB-CCIR-AES 76 cm/s characteristic: The electronics can be set up for all NAB, all CCIR or combination: NAB at low speed, machine will automatically switch to CCIR or new 76 cm/s 17.5μs characteristic at high speed. Terminals can be linked on the electronics boards to obtain required function.

Number of channels: 8, 16 or 24.

Signal-to-noise ratio: 8 and 16 channel models in normal or sync 68 dB on standby, 64 dB with biased tape. 24 channel model in normal mode 64 bB on standby, 60 dB with biased tape. Figures relate 3% third harmonic distortion at 700 Hz with 3M *206* or *207* tape to noise over the bandwidth 20 Hz to 20 kHz.

Equalisation: Machines are normally equalised for NAB 38 cm/s and 17.5 μs at 76 cm/s. Equalisers automatically switch electronically when tape speed is changed. When variable speed is used, LO or HI equalisers may be selected.

Capstan drive: Dc servo control with following switched selection: VAR LO, VAR HI, LO, HI, and external. A local control is provided to vary the speed from 12.7 to 114 cm/s. External control is available from a single variable resistor or voltage source Fixed speeds 19 and 38 cm/s, or 38 and 76 cm/s by plug-in selector.

Reel drive: Contains solid state power switching with three rate response modules. Nominal winding velocity 7.62 m/s. Maximum capacity 267 mm reel, NAB hub.

Frequency response: 19 cm/s reproduce, ±2 dB 40 Hz to 12 kHz; 19 cm/s rec/repro, ±2 dB 40 Hz to 12 kHz; 38 cm/s reproduce, +1, —2 dB 50 Hz to 15 kHz; 38 cm/s rec/repro, +1, —2 dB 50 Hz to 15 kHz; 76 cm/s reproduce, +1, —2 dB 50 Hz to 15 kHz; 76 cm/s rec/repro, +1, —2 50 Hz to 15 kHz. Sync response the same as normal reproduce (separate equalisers and amplifier).

Phasing: On all channels, input to output polarity is maintained. 25.3 micron wavelength error is less than 90° between a centre track and any other track.

Channel separation: Better than 55 dB at 500 Hz for 8 and 16 track machines. Better than 50 dB for 24 track machines.

Electronics input: 2.5k ohms single ended input. Optional input transformers yielding a 20k ohm, fully floating or unbalanced line. —6 to +16 dBm range on 600 ohm bus.

Electronics output: +4 dBm reference level into 600 ohm load, termination switches provided. +26 dBm maximum output.

Bias and erase oscillator: Master oscillator on tape transport supplies 234 kHz low impedance bus feeding individual bias and erase power amplifiers for each channel.

Degree of erasure: A 1 kHz signal at 3% distortion level is reduced 75 dB or more by erase head.

Power input: 105 to 125 or 210 to 250 volts, ac 50 or 60 Hz. All power to machine is electronically regulated within the power supply unit. 8 track unit 400 VA maximum, 16 track unit, 450 VA maximum, 24 track unit 500 VA maximum.

Mechanical: Weight 136 kg. Height, 8 track 1.17m, 16 track 1.28m, 24 track 1.40m. Width 686 mm. Depth 597 mm.

Flutter: NAB unweighted in the band 0.5—200 Hz:— 76 cm/s and 38 cm/s less than 0.06% rms. 19 cm/s less than 0.08% rms. DIN weighted peak: 76 cm/s and 38 cm/s 0.04% maximum, 19 cm/s 0.05% maximum. NB. All measurements of flutter made by recording a tone on machine under test, rewinding and measuring flutter on replay. Flutter measurement is maximum cumulative.

Timing accuracy: ±0.2%.

Remote control: A control unit is provided and provides full control for all functions excepting speed selection. Positive indication of erase current flow is provided for each channel.

Start time: Less than 0.5 seconds to reach play speed.

Stop time: Less than 0.5 seconds from play mode. Less than 4.0 seconds from fast forward or rewind.

Rewind time: Less than 1.5 minutes for 2,500 ft (762m).

Optional extras: A Selectake Counter Locator unit can be supplied. Optional input transformers as above.

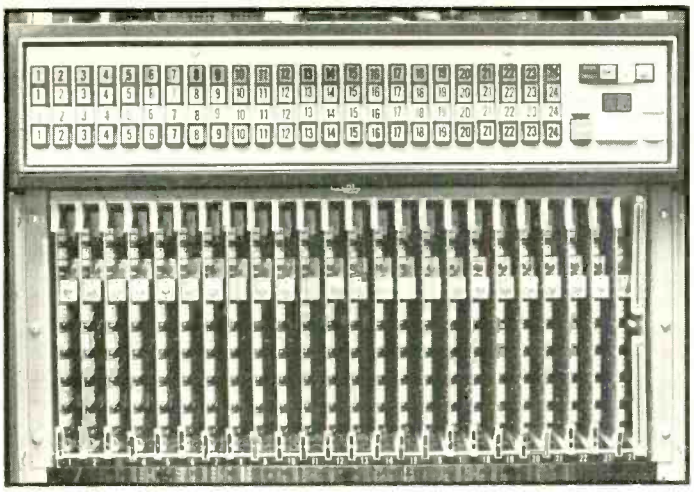
Price: £12,850 + VAT, with input transformers and Dolby switching.

Manufacturers: 3M Company, Mincom Division, 300 S. Lewis Road, Camarillo, California 93010, USA.

UK agents: 3M United Kingdom Ltd, Witley Gardens, Southall, Middlesex.

THE 3M TYPE 79 recorder may be considered as a number of separate units which are supplied in a handsome 'wood look' cabinet. The 24 vu meters are arrayed at the top rear of the cabinet, the upper surface being occupied by the tape transport to which are attached the tape control electronics. Below the tape transport section is the remote control assembly which not only duplicates the tape control functions, but also contains the signal switching functions for individual tracks. This remote control unit can be readily detached from the main cabinet and mounted on the studio console, some 10m of cable being supplied with the remote control unit.The bottom front of the cabinet is occupied by the signal electronics which are located behind two doors in the cabinet front. Finally, the power supplies are located in the bottom of the cabinet to the rear, where the *XLR* type signal connectors are also to be found.

Inspection of the various units revealed an extremely high standard of construction in all respects, the finish of the mechanical parts being to the best of standards and all the electronic components being mounted on fibreglass printed boards with clear component identifications. Furthermore, access to all the parts is very good, and individual sections all have



Above: *3M function indicator and tape electronics board*
Right: *3M 79 tape transport*

plugs or sockets for easy maintenance. In this respect, the instruction manual is also to a very high standard, but it does lack exploded diagrams of the mechanical assemblies.

The tape transport itself is rather interesting, in that the tape path is based on instrumentation transport techniques which 3M call the 'Isoloop Tape Drive' (see fig. 1). Starting at the pay-off spool the tape passes over two fixed guides and then to the capstan, from where it passes over the erase and record heads. There is then a rotating idler with a 180° wrap angle, followed by the replay head, the other side of the capstan, two fixed guides and the take-up spool. Pinch rollers are located at both points where the tape passes the capstan, such that when the pinch rollers are engaged there is a short closed loop of tape which contains the heads and the rotating idler. The cunning of this system is that not only is there an extremely short length of free tape between the heads and the idler (which of course acts as a flutter roller) but also that the tape tension over the heads is kept under accurate control—this is achieved by two different capstan diameters being used at the input and output of the closed loop, such that the tape is very slightly stretched within the loop.

Also within the tape loop are tape lifting pins which lift the tape from the heads in the fast modes of tape winding. However, the tape may be lowered on to the heads in the fast modes by means of a rocker switch on the remote control panel. When recording or playing two head shields are lowered over the heads in 'butterfly' formation. These shields are also arranged to be lowered when the transport is switched off, thus protecting the heads from possible accidental damage.

The controls on the tape transport include the on/off switch, a reel balance switch for adjusting the tape tension for any combination of large or small reels and the speed selection switch to the left of the heads. To the right of the heads there are the usual tape transport functions, all properly interlocked, a mute defeat switch which controls muting in the fast modes, a high/low tape tension switch and finally a 'mode' switch which selects three delay times when entering the fast winding modes—I do not see the use for this facility. The tape speed switch offers the selection of the two fixed speeds of 76 and 38 cm/s which may be accurately set by using the strobe marks on the capstan in conjunction with pre-set controls, as well as the facility to vary the speed over the range 7.6 cm/s to 96 cm/s with a multi-turn potentiometer on the tape transport. In the variable mode either of the two replay equalisations may be selected with the mode switch, but in the 'external' position where the tape speed is controlled from an external source, the equalisation is fixed. When the machine is set for the variable speed mode a bright yellow warning lamp is illuminated on the tape transport, there is not however any warning signal on the remote control unit.

All the tape control functions were properly interlocked, and the overall quality of tape handling with 3M type *206* tape or EMI *815* or *816* was beyond reproach. However, it was found that a mains power failure when the machine was in either of the fast winding modes led to some tape loop slinging. 54 ▶

FIG.1 3M DIFFERENTIAL CAPSTAN

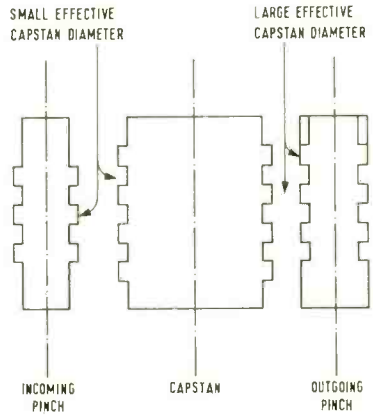
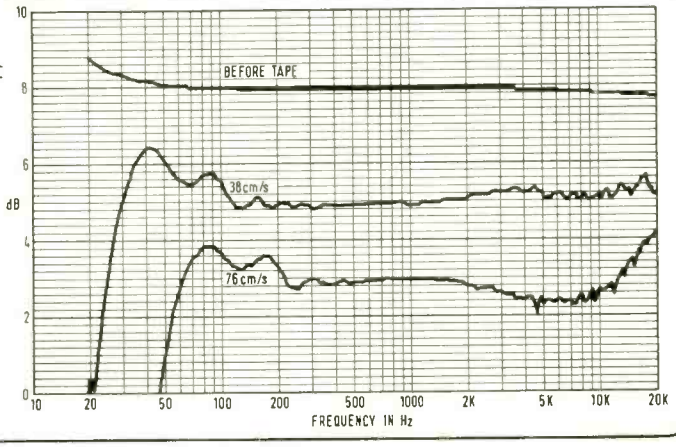


FIG. 2
3M OVERALL FREQUENCY RESPONSE IN NORMAL MODES AT OVU

PEN.... 200mm/s
PAPER... 3mm/s



3M 79 RECORDER

As I already mentioned, main tape control functions: play, record and the two fast wind commands are duplicated on the remote control unit; this also contains the switch which de-energies the tape lifter. In addition to these master functions there is a master cue (sync) switch and master in and out (A/B) switches. These illuminated master function switches operate in conjunction with four illuminated status switches per channel, which are layed out in 24 vertical rows of four switches on the remote control unit.

The upper record switch is dimly illuminated when it is actuated, and becomes a bright red in the record mode. The actuation of any individual record switch when the machine is in the record status immediately put the individual track into record and automatically selects the desired monitor output in accordance with other switch settings. A further function of the illuminated record switch is that it emits a red flashing light if the high frequency bias and erase input to any individual channel falls below a certain level.

In the record mode the cue (sync) button is dimly illuminated (presumably as a further safety factor should the record lamp fail). When the master cue button is actuated, the switch on any individual channel will display a bright green light if it is actuated; reverting to a dim green if the record function for that channel is actuated.

The two further illuminated switches for each channel are concerned with source/tape switching and give the indication of the source/tape signal status which is arrived at in accordance with the master source/tape switches in conjunction with the individual channel switches and the play or record functions. The logic of these switching functions is very complicated and difficult to comprehend. In short, I do not propose to describe the possibilities and feel that the logic is unnecessarily complicated.

Turning now to the signal electronics department, this is quite a different story with the 24 individual electronics boards being plugged into a card rack such that all the pre-set controls are accessible from the front of the machine. Each control is not only identified on its printed board, which is itself identified with the channel number, but also a large clear control layout is shown on the inside of one of the cabinet doors. An extender board is provided in a spare slot in the card frame, but this extender board is not required for the normal alignment of the machine. The basic alignment adjustments are multi-turn potentiometers (with the exception of the record high frequency boost) which are numerous as a result of separate replay amplifiers being used for the normal replay and cue (sync) replay modes, and separate equalisers being used for each tape speed.

However, there are only three controls for for each condition, giving control of low frequency, high frequency slope and high frequency peaking—accounting for twelve potentiometers. The remaining potentiometers set gain in the record, monitor, play and sync modes of operation and the erase and bias current.

FIG. 3
3M OVERALL FREQUENCY RESPONSE IN SYNC (CUE) MODE

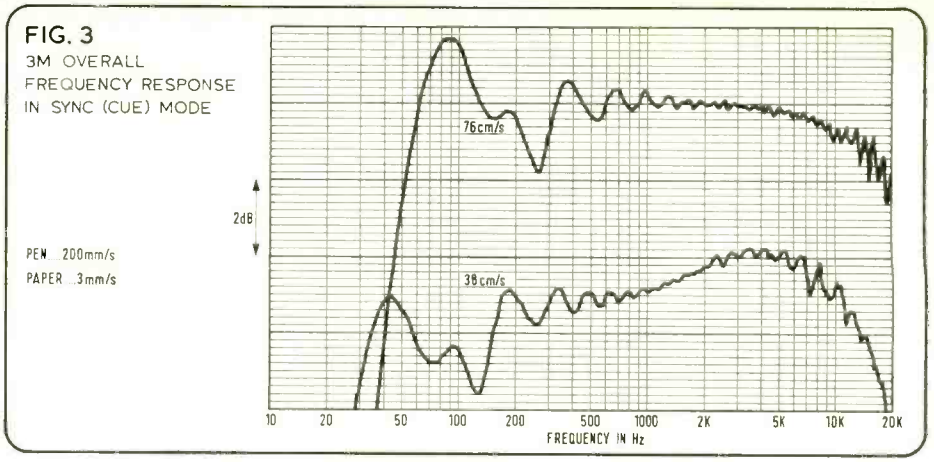


FIG. 4
3M DISTORTION OF ELECTRONICS ONLY AT OVU

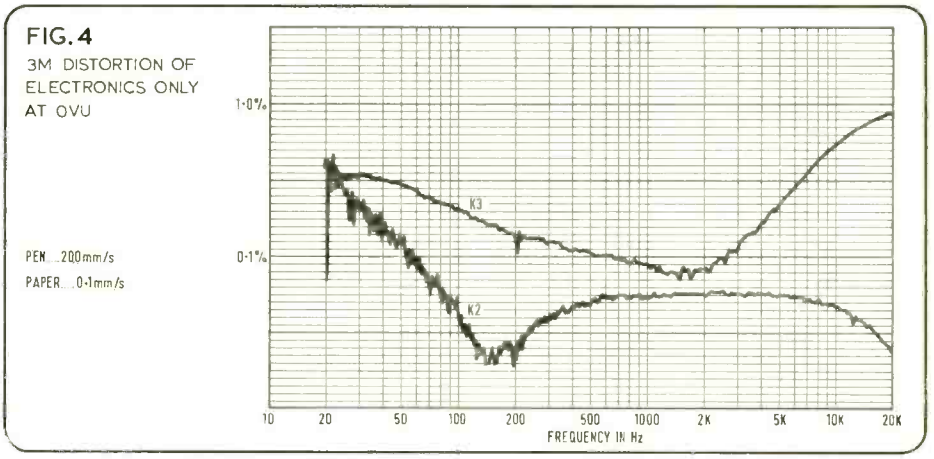
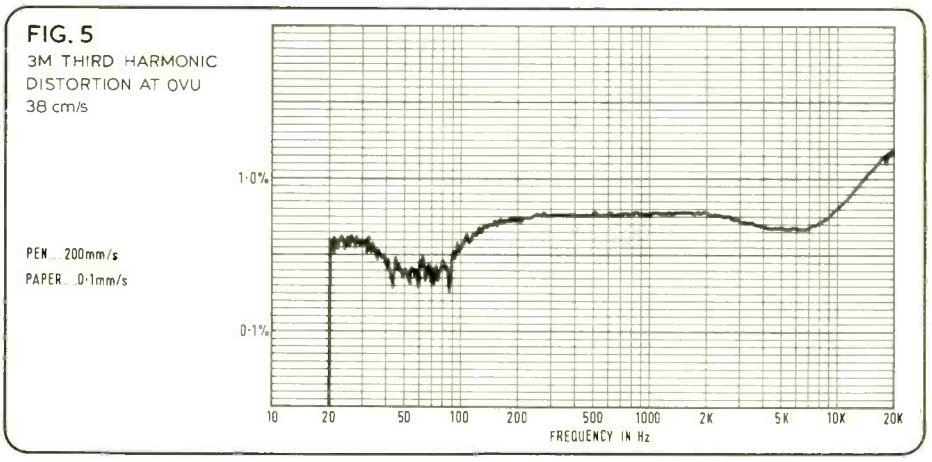


FIG. 5
3M THIRD HARMONIC DISTORTION AT OVU 38 cm/s



In practice the machine alignment was found to be extremely quick and simple, although it was found that the high frequency record boost capacitor (trimmer) ended up at its minimum capacitance on some channels when using 3M type *206* tape, and it is felt that some modification to the machine is required to change this situation.

Another modification which, I feel, might be wise would be to eliminate a real woofer-shaker of a click which occurs when the machine is switched on—as things stand it could be disastrous to have a channel open to a monitor speaker when the machine is turned on at the mains. While on this subject, I would mention that the hum induced in the replay (and record head when in sync) is really terrible when the head screens are not in place and far from good when they are in place. Also the machine can hardly be described as a quiet runner, as it makes a noise rather like a transverse video tape recorder.

FIG. 6
3M THIRD HARMONIC DISTORTION AT OVU 38cm/s

PEN 200mm/s
PAPER 0·1mm/s

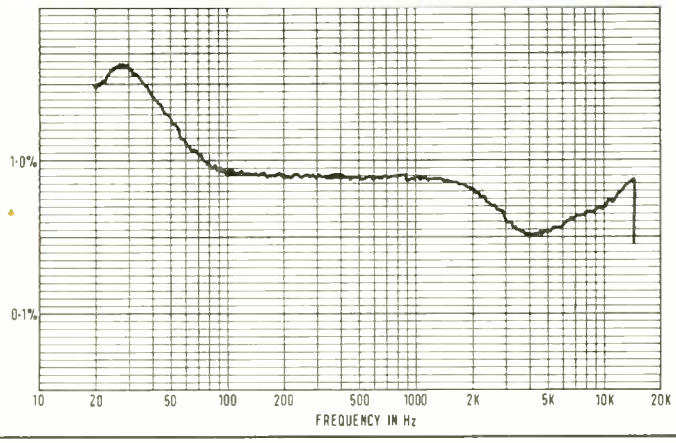


FIG. 7 AMPEX UNIFORMITY OF REPRODUCTION

RECT . RMS
LLF. ..20Hz
PEN ... 500mm/s
PAPER 1mm/s

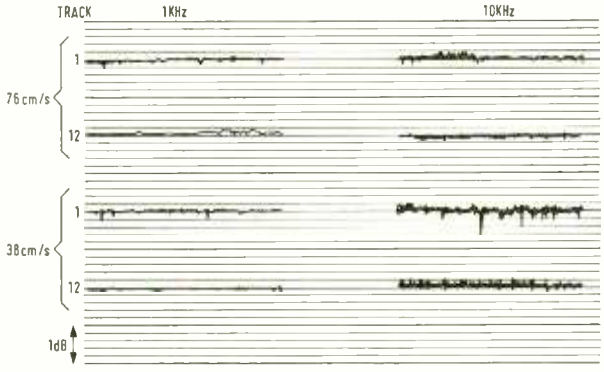
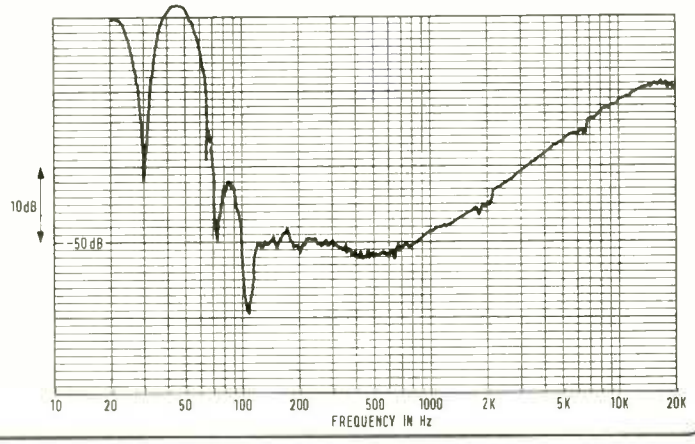


FIG. 8
3M CROSSTALK RECORDING TONE ON TRACKS 1 AND 3 AND TRACK 2 INPUT SHORTER AND BIAS RECORD

PEN 200mm/s
PAPER 1mm/s



Condition and speed	Operating level to noise ratio			
	Unweighted rms 20 Hz-20 kHz	'A' weighted rms	CCIR weighted reference 1 kHz rms	DIN peak meter
Replay 76 cm/s	—51·5 dB	57·5 dB(A)	49 dB	44·5 dB
Machine 76 cm/s	55 dB	69 dB(A)	62·5 dB	58 dB
Replay 38 cm/s	52 dB	57 dB(A)	48·5 dB	43 dB
Machine 38 cm/s	57·5 dB	68 dB(A)	61 dB	56·5 dB
Cue replay 38 cm/s	54 dB	57 dB(A)	44 dB	42·5 dB
Cue machine 38 cm/s	60 dB	65·5 dB(A)	57 dB	52·5 dB

Replay performance

Initial investigation into the replay frequency response showed that the equalisation at the lower speed of 38 cm/s was accurately set to the NAB standard of 50 μs and 3180 μs, and the high speed equalisation set to the 17.5 μs standard. I certainly do not have any reason for complaint in this department, and the available replay equalisation adjustment is more than adequate. It should however be noted that the bass response at a tape speed of 76 cm/s is such that the response falls rapidly below 50 Hz.

Replay noise was investigated on a number of randomly selected tracks and showed very little variation between them, the following 'operating level' to noise ratios being measured in terms of machine only and with 3M type *206* tape erased on the machine and recorded with bias only.

It is to be seen from the above that the machine offers a very good margin between tape noise and machine noise when weighted noise is measured, but that the unweighted noise levels do not change to any appreciable extent; furthermore the unweighted noise in the lower tape speed is degraded so far as the machine noise is concerned. This effect is caused by the hum introduced into the replay heads which is worse at the higher tape speed setting as a result of the infinite equalisation time constant at this speed. With the machine set for 76 cm/s operation the hum at the output was found to be between 54 dB and 57 dB below operating level which can hardly be called a good performance standard. Subsequent investigation showed that the hum levels were the result of extreme sensitivity to extraneous hum fields and not a result of hum generation within the machine. Investigating the overload margin of the replay amplifiers showed that provided that the output level was adjusted in an appropriate manner the potential fluxivity that could be replayed before pre-amplifier clipping was extremely high. A quick check showed that at least +24 dB above operating level could be accommodated, which is of course far above the potential of any current tape types.

Record/replay performance

The majority of the record/replay parameters were measured using 3M type *206* tape, but the performance was also checked using EMI types *815* and *816*, the review performance being the average performance of a number of randomly selected channels unless otherwise stated.

The record/replay frequency response is shown in **fig. 2,** from which it is to be observed that at both tape speeds the response is flat within better than ±1 dB from 55 Hz to 20 kHz and that at the lower tape speed the bass response descends within these limits to about 27 Hz. At the higher tape speed of 76 cm/s I would have preferred to have seen the bass response extended, as a −3 dB point at 50 Hz cannot be regarded as the highest standard of performance. Also shown in fig. 2 is the before-tape frequency response which is within ±0.4 dB from input to output—no complaint in this area!

As is only to be expected the cue replay mode

56 ▶

shows a degraded frequency response as is illustrated in **fig. 3,** but the degree of degradation is really minimal bearing in mind the normal applications of this mode of operation.

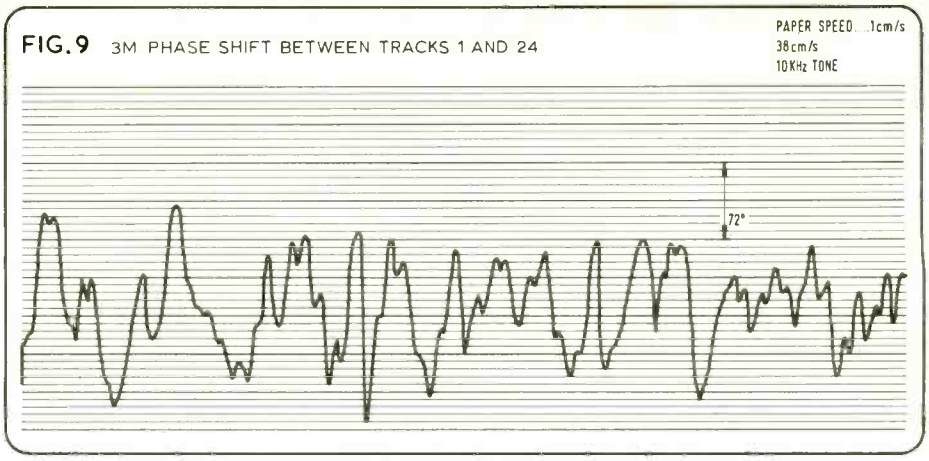
Harmonic distortion of the electronics section without tape was measured before investigating the distortion via tape. It is to be seen from **fig. 4** that in particular the third harmonic distortion from the input to the output of the electronics section alone is not to a particularly high standard. The high frequency characteristic in fig. 4 is reflected in the distortion characteristic via tape as is shown in **figs. 5** and **6,** the latter plot also demonstrating the shortcoming of the bass boost in the NAB equalisation characteristic which is used at the lower tape speed of 38 cm/s. However, the mid frequency distortion at the level of +4 dB on operating level at which the plots were made is to a completely satisfactory standard. Three percent third harmonic was found to occur at some 11 dB above operating level at both tape speeds when measuring the performance at either 1 kHz or 700 Hz. Adding this margin to the operating level to noise ratios shows that the machine is within the manufacturers specification and confirms that the overall signal to noise performance is tape limited.

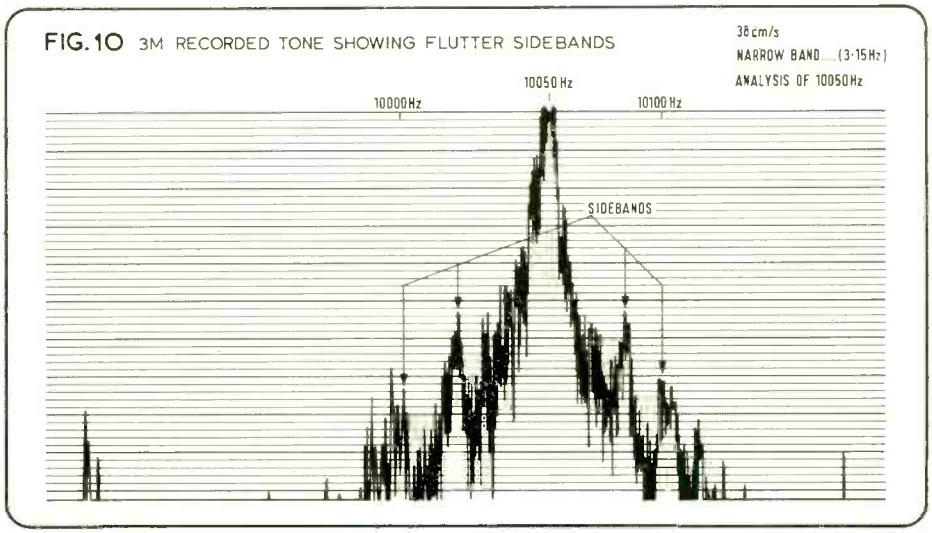
Measurement of the intermodulation distortion to the SMPTE method using 50 Hz and 7 kHz tones in the amplitude ratio 4:1 gave the following results for the amplifiers alone and with the tape.

In fact the uniformity of reproduction, which is shown in **fig. 7,** is very reasonable at mid frequencies, but at short wavelengths the performance is considerably degraded and far worse than good quality 6.35 mm tape recorders; however, the track width is, of course, much narrower on the 24 track machine.

Crosstalk is also related to the track configuration, and the worst case crosstalk is shown in **fig. 8** which is the result of recording tone on tracks 1 and 3 and recording bias only on track 2 which is then replayed. The resulting crosstalk of more than 50 dB down between 100 Hz and 1 kHz is a good standard, but about 18 dB separation at 50 Hz may well be cause for concern. A further interesting matter came to light during these measurements: it was found that a better crosstalk performance was measured if the unmodulated track was not in the record mode when the adjacent tracks were recorded, in fact the mid frequency performance was better by 8 or 10 dB. It was eventually decided that this inconsistency resulted from crosstalk in the electronics, and was not related to the head configuration.

A final matter under the heading of record/replay performance is the dynamic phase shift between tracks, and here the worst case is the two outer tracks at the lower tape speed and at high frequencies. **Fig. 9** is a plot of the phase shift of a 10 kHz recording at 38 cm/s as seen by a B&K phase meter. A similar pattern was obtained at a tape speed of 76 cm/s, but as is to be anticipated the total excursions in phase are approximately halved.





Level reference operating level equivalent peak sinewave	Amplifiers	Tape 38 cm/s	Tape 76 cm/s
+4 dB	0·26%	3·0%	1·4%
0 dB	0·34%	1·6%	0·8%
—10 dB	0·36%	<1·2%*	<0·7%*

**These figures are limited by uniformity of reproduction

Wow, flutter and speed

The wow and flutter as measured by the DIN weighted method and taking the measurement by first recording a track and then rewinding and reproducing was consistent throughout a reel of tape, with very slight degradation at the end of the reel. The excellent results of 0.02% at 76 cm/s and 0.03% at 38 cm/s do justice to the closed loop capstan system. The time from the start command to the rated wow and flutter was found to be just over 0.5s and the speed consistency throughout a full reel of tape was within 0.25%.

Fig. 10 shows the result of doing a narrow band spectrum analysis on a 10050 Hz recorded tone, and demonstrates that flutter sidebands occur about 32 Hz either side of the carrier at about 30 dB down; in terms of 6.35 mm machines I would not regard this performance as being particularly good.

Inputs and outputs

Each channel is provided with *XLR* input and output connectors. The outputs each have an internal 600 ohm load which can be inserted by means of a slide switch adjacent to the output connector. The outputs are fully floating with a measured source impedance of 55.4 ohms which is adequately low for any normal line impedances. The available replay gain is such that operating level can be set for up to +16 dBm at the output, which has the capability of delivering +24 dBm at 1 kHz before the onset of clipping.

The standard machine has an unbalanced input with a maximum sensitivity of −24 dBm for recording operating level and no upper limit on the input voltage, which is fed directly to the gain control. The measured input impedance at 1592 Hz was found to be 2,560 ohms falling to 1,250 ohms at 15 kHz. When the optional input transformers are fitted the input becomes a floating input with a sensitivity of -18 dBm for recording operating level and an

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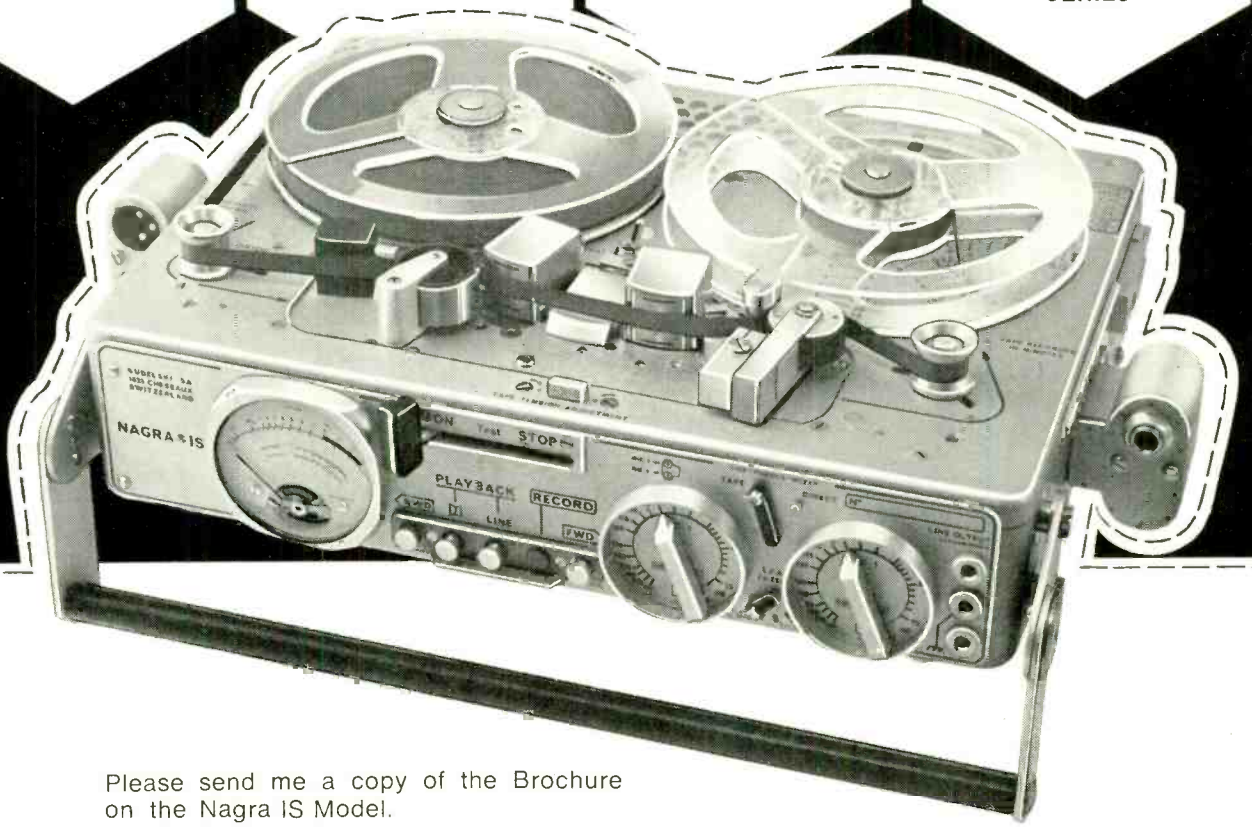

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input impedance of 22,700 ohms at 1592 Hz. However, the impedance falls to about 10,000 ohms at 15 kHz, so some caution is required to make sure that this rather large change in impedance does not cause frequency response errors.

A further optional output which was not included in the review machine is a 10V dc output for automatically switching Dolby noise reduction units from the reproduce mode to the record mode when individual channels are put into record. There is also a further output for the 3M 'Selectake' timing unit which was not provided with the machine for review.

Level meters

Examination of the illuminated vu meters showed that the 0 vu calibration corresponded to 3.5 dB above operating level, thus giving a margin of nearly 8 dB between 0 vu and 3% third harmonic distortion. This follows the NAB recommendations for the setting of vu meters.

Checking of the ballistics of the meters showed that the rise time was correct, but the return time was 1.4s to the steady state condition—far in excess of the specification which calls for the rise and fall times to be similar.

Other matters

A large number of other parameters were checked both by measurement and by listening tests, and such matters as bias breakthrough on the outputs, clicks from switching functions and other spurious noises were found to be absent for all practical purposes.

All the manufacturer's specified parameters were found to be met, and with the exception of the complex source/tape switching arrangements the machine was a pleasure to use.

Summary

The overall standard of construction of this machine is beyond reproach, and clearly much thought has been given to ease of maintenance and adjustment.

In many respects the performance is really excellent, but reading through this review shows that there are some rather suprising shortcomings such as the poor hum shielding of the heads and the variation in input impedance of virtually 2:1.

I leave it to the reader to study the reviews of the other 24 track machines, rather than make further comment upon the performance of individual makes of machine.

AMPEX MM1100

By Hugh Ford

Weight: 8, 188 kg; 16, 210 kg; 24, 240 kg.
Price: £15,300 + VAT as reviewed.
Manufacturers: Ampex Corporation, 401 Broadway, Redwood City, California, USA.
UK agents: Ampex Great Britain Ltd, Acre Road, Reading, Berkshire.

MANUFACTURERS' SPECIFICATION

Tape width: 25.4 mm for 8 track systems, 50.8 mm for 16 or 24 track systems.
Tape speeds: 38.1 and 76.2 cm/s.
Reel size: NAB hub up to 406 mm diameter (specifications apply up to 356 mm only).
Inputs: 20k ohms balanced input. Accepts line levels from —17 dBm to produce recommended operating level.
Output: Nominal output of +4 dBm; maximum output of +27 dBm at 600 ohm load, balanced or unbalanced.
Overall frequency response, sel-sync and reproduce modes: 76 cm/s: ±2 dB from 50 Hz to 18 kHz; 38 cm/s: ±2 dB from 30 Hz to 15 kHz.
Signal-to-noise ratio, using Ampex 406 tape or equivalent at 76 or 38 cm/s: 8 or 16 channels 63 dB; 24 channels 58 dB; peak record level to unweighted (30 Hz to 18 kHz) noise, includes bias, erase, and reproduce amplifier noise. (Peak record level corresponds to a tape flux of 520 nWb/m).
Signal-to-noise ratio using Ampex 404 tape or equivalent at 76 or 38 cm/s: 8 or 16 channels 60 dB; 24 channels 55 dB; peak record level to unweighted (30 Hz to 18 kHz) noise, includes bias, erase, and reproduce amplifier noise. (Peak record level corresponds to a tape flux of 370 nW/m.)
Erasure: At 1 kHz, peak record level erased to—75 dB minimum on channel(s) selected.
Flutter: 38 and 76 cm/s: 0.08% peak weighted per ANSI S4.3/DIN 45507 in a band 0.5 to 200 Hz, while reproducing a 3150 Hz signal. (0.08% NAB unweighted; peak NAB unweighted.)
Crosstalk: —50 dB minimum for 8 or 16 channels at 500 Hz —45 dB minimum for 24 channels at 500 Hz.
Tape speed accuracy: Within ±0.05% from beginning to end of a reel. Tape speed unaffected by line voltage or line frequency fluctuations (per NAB standard on Magnetic Recording and Reproduction, 1965, Section 2.02.01).
Heads: 8, 16, and 24-track head stacks are non-adjustable precision mounted.
Start time: Full speed within 0.5 seconds at 38 cm/s.
Power requirements: 105 to 125V ac, 48 to 62 Hz.
Power consumption: MM-1100-8 0.8 kW maximum; MM-1100-16 1.0 kW maximum; MM-1100-24 1.2 kW maximum. All without accessories.
Size: 8 and 16, 74 cm W x 69 cm D x 107 cm H. 24 74 cm W x 69 cm D x 114 cm H.

AS REVIEWED, THE Ampex *MM1100* is the basic machine which includes the remote control panel and a simple mechanical tape position indicator calibrated in hours, minutes and seconds. However, various accessories are available, including a search and cue unit which replaces the mechanical position indicator, an SMPTE time code synchroniser and a sync lock device which not only gives the facility of locking to video or film sources but embodies variable speed facilities.

The 24 track version of the machine has a somewhat bulky appearance, which is largely a result of its height, as unlike many machines the metering is below the tape transport which together with a very compact remote control unit occupies the top surface of the machine. The 24 vu meters are arrayed in three rows of eight at the top front of the machine on a hinged panel, such that the complete meter panel may be tilted downwards to make life easier when aligning the electronics or tilted upwards to improve the visibility of the meters in normal use. All the record/replay electronics are mounted in card frames below the meter panel, with clearly labelled channel identification and control functions.

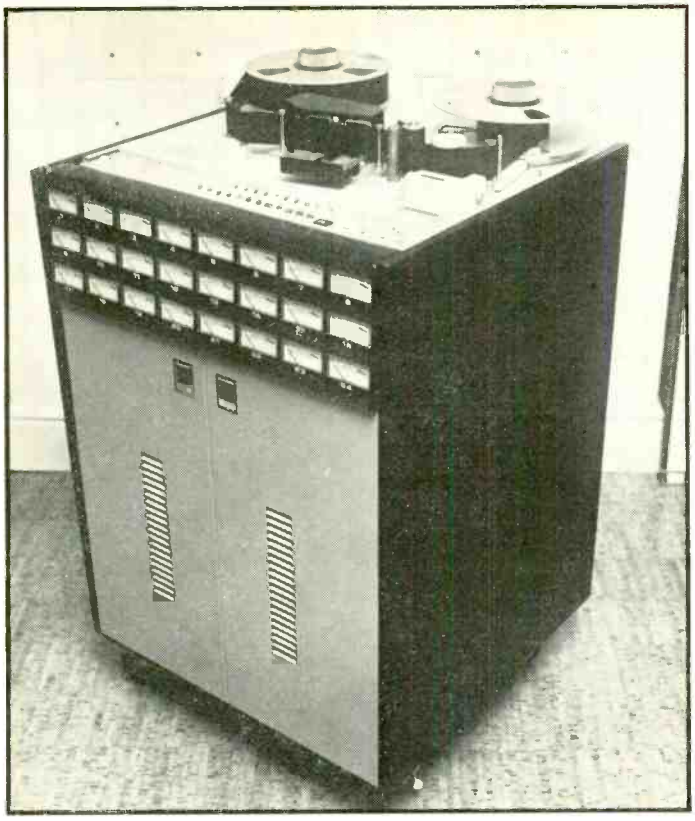
The capstan and spooling motor servo electronics are mounted in a pocket on the upper surface of the machine next to the remote control unit, which is of course a most convenient position when one is setting tape tensions etc. Furthermore, all the capstan control electronics are arranged on a single printed board and all the spooling motor control electronics on a second adjacent board, both boards having the variable controls clearly identified and readily accessible without the use of the extender board which is supplied in a spare slot next to the servo boards.

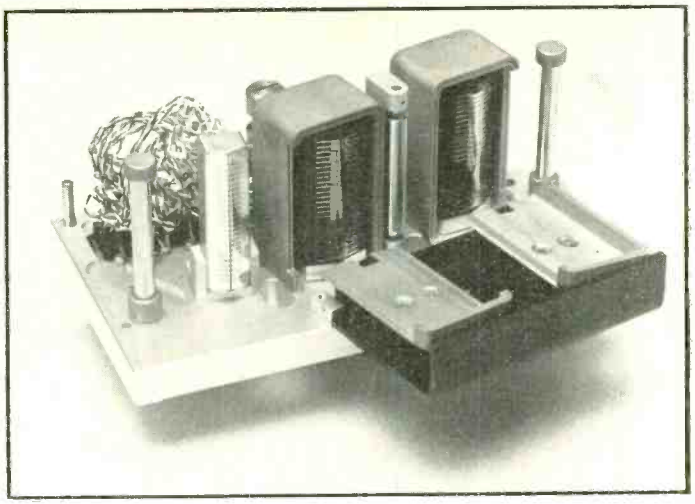
The rear of the machine houses the *XLR* input and output sockets and various other connectors for auxiliary equipment, as well as the power supplies and three cooling fans. With one exception, the sel-sync connector, all the rear panel functions are fully recessed—it would however be all too easy to damage the sel-sync connector and its associated dummy plug.

Reverting to the tape transport, this is of fairly conventional design. Its basis is a heavy section alloy plate to which flanges are welded in order to provide a really stable platform for the various transport components. The tape path begins at the pay-off spool which like the take-up spool has a direct drive servo controlled ac motor to which is attached the NAB spool clamp which gives positive locking of spools up to a maximum diameter of 406 mm. The tape passes from the pay-off spool to a fixed guide and from there over a tension sensing arm to the headblock. The tension sensing arm is coupled to an optical transducer, which in conjunction with a pre-set potentiometer affects constant tension pay-off. The headblock itself is a self contained subassembly which consists of a precision machined plate. To this are attached two fixed guides, one each at the entrance and exit of the tape, the three heads and a flutter roller between the record and replay heads. There is no adjustment of head position or azimuth or of guide height—all of which are factory aligned and positively fixed.

Changing headblocks is simplicity itself, as all that is required is to undo a single screw and lift the headblock complete with the audio connectors over the two tape lifting pins. The headblock then comes away complete with the impressive hum screens which are manually operated.

From the headblock, the tape passes to the large diameter capstan which is driven by a servo controlled dc motor which in conjunction with a tachometer is normally referenced to a crystal oscillator but may also be referenced to an external frequency source; this gives a potential tape speed range from 7.4 cm/s up to 229 cm/s. From the capstan the tape passes to the roller which normally drives the tape counter, but this section is replaced when the search and cue option is used. After this there

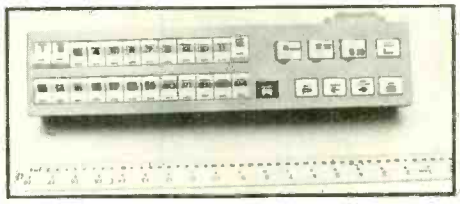




Above: *Ampex 24 track head assembly*

Left: *Ampex MM 1100 console*

Right: *Ampex remote control*



is a further fixed guide, a tape sensing pin and the take-up spool.

Any of the components in the tape path are easily replaced without any mechanical adjustment, as they either screw onto a reference face, or are equipped with slide-on sleeves which may be manually rotated when wear occurs. In contrast to this ease of servicing, while the spooling motors may be replaced from the top surface of the transport, access to the underside is rather poor should it be necessary to replace the capstan motor and some other less likely components.

Adjustment of tape tension in the various modes of operation is accomplished by means of potentiometers on the servo boards which have individual adjustments for tension in the fast, play and stop modes. While the behaviour of the transport was first class with the tape in motion, even with 356 mm diameter spools of tape, I feel that tape handling in the stop mode is rather a compromise which, together with the large physical dimensions of the machine, is not conducive to easy editing—particularly for the smaller species of the human race. Furthermore, there is no edit mode provided for running-out tape without the take-up spool in action.

The remote control unit is normally supplied mounted in the machine on the operator's side of the tape transport. However, the complete remote control unit lifts out of the machine and unplugs—it may then be remotely mounted and fed from an accessory cable which plugs into the rear of the machine. In addition to the normal tape motion functions the remote unit has a tape lifter defeat switch which is a spring loaded pushbutton; this lifts the tape from the heads in the record or play modes, or drops the

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FIG.1
AMPEX OVERALL FREQUENCY RESPONSE IN NORMAL MODE

PEN.. 200mm/s
PAPER.. 3mm/s

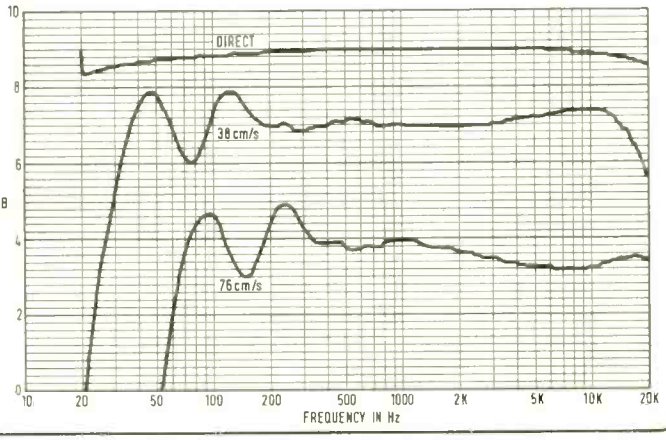
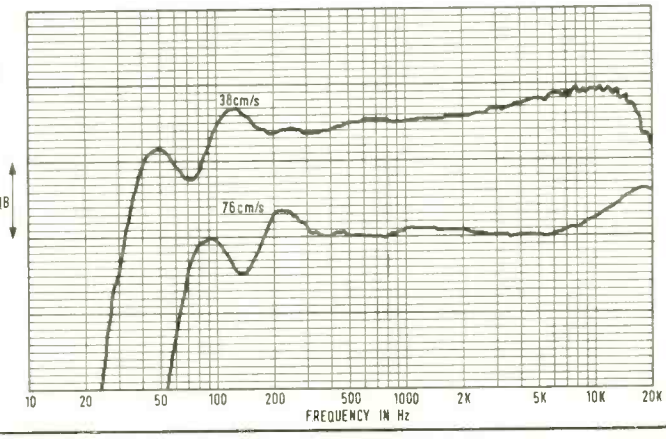


FIG. 2
AMPEX FREQUENCY RESPONSE IN SYNC MODE AT OPERATING LEVEL

PEN..200mm/s
PAPER.. 3mm/s



tape on to the heads in the fast modes—the head clearance being adjustable to meet individual requirements.

Tape speed is selected by a rocker switch which normally selects both speed and equalisation—it is however possible to play swings and roundabouts with the combinations.

Two further rocker switches select input/normal monitor and the sel sync/reproduce modes and are interlocked with the individual channel function switches. The channel switches are arrayed in two banks of 12 rocker switches which are illuminated and clearly identified, the layout being excellent for quick setting of groups of channels or individual channels. The two positions are identified as 'safe' and ready' —the 'safe' position completely inhibiting the record function, and the 'ready' position being a pre-selected record position. In order to actuate the record function it is necessary to press simultaneously the record and play functions, which may be done without stopping the tape; any channel may be reverted to the play function by resetting its selector to the 'safe' position. The interlocking of all functions is excellent and could not be fooled—even by a mains power failure, when the tape comes to a controlled stop. However, I personally do not like the layout of the tape motion control buttons which appears to be different from the logic of other machines with the record button on the left and the stop button on the right.

The input/normal monitor switch function depends upon the setting of a three position switch which is associated with the electronics section of each channel—this switch has three positions, a bias monitor position, a 'normal' position and a 'set up' position. In the latter position the input/normal switch acts as an input/tape switch in both record and play modes, while with the three position switch in the 'normal' position the input/normal switch acts as an A/B switch only when a channel is set ready to record or recording.

Turning now to the audio electronics, these are contained on six plug-in card frames, each frame dealing with four record/replay channels each of which is associated with three printed circuit boards and three separate level setting potentiometers for the record, play and sync levels. These three controls are 270° potentiometers which are rather difficult to set with great accuracy, as they suffer to a slight extent from the 'rubber shaft' effect and are rather coarse in action.

The three printed boards are clearly identified with component references and have their variable controls accessible through the front panels which are identified with the control functions.

The record board has three controls which cope with record level and high and low speed record equalisation—it is felt that the range of the equalisers is marginal for modern tapes which have such good sensitivity at short wavelengths. In fact the record and replay equalisers are mounted on piggyback boards which plug into printed board sockets behind the appropriate front panels—equalisation may thus be changed by inserting alternative pre-adjusted equalisation boards. As is conventional in good quality machines, there are separate high and low frequency equaliser controls for the two tape speeds. The third board for each channel is the bias amplifier, which has bias adjust controls, able to be set in conjunction with the vu meters and the bias calibrate control, and an erase peak control.

Each type of electronics board is mechanically keyed so that it cannot be inserted in an incorrect socket in the card frame. However, the mother board of the card frame is somewhat inaccessible and contains a relatively large number of components which would not be easy to service.

While the overall standard of construction of both the electronics and mechanics is to the very highest standards and engineering principles, I do feel that certain aspects of servicing could have received more attention.

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FIG. 3
AMPEX DISTORTION OF ELECTRONICS ONLY AT OVU

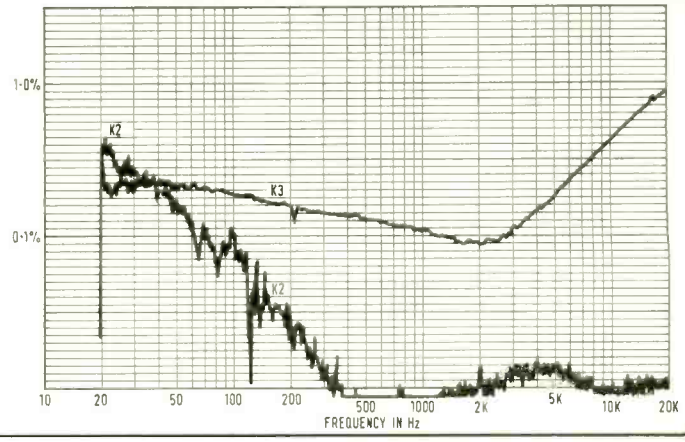


FIG. 4
AMPEX THIRD HARMONIC DISTORTION AT OPERATING LEVEL AT 76 cm/s

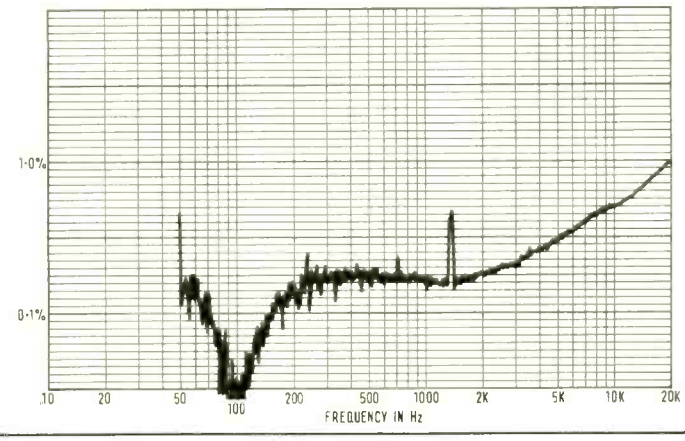
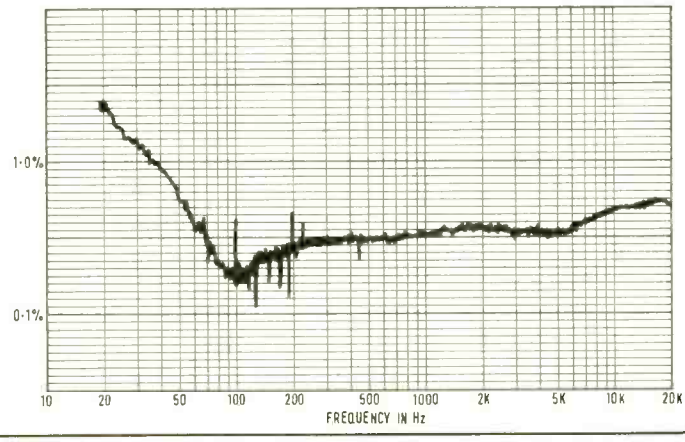


FIG. 5
AMPEX THIRD HARMONIC DISTORTION AT OPERATING LEVEL AT 38 cm/s



Replay performance

The replay frequency response in both the normal and sync modes was found to be to all intents and purposes identical, this being brought about by the use of the same type of head for both record and replay. The range of the replay equalisers was also found to be quite satisfactory.

In common with the evaluation of many parameters, the replay noise was measured on a number of randomly selected channels and showed good consistency between them. The quoted operating level (185 nW/m) to noise ratios averaged over a number of channels were measured with 3M type *206* tape. (For comparison with other machines 3M *206* was used where appropriate.) In fact many measurements were made with not only 3M type *206*, but also Ampex *406* and EMI *815* and *816*, but so far as *machines themselves* are concerned performance was found not to be affected by tape type.

The following figures relate operating level to replay noise after 3M type *206* had been recorded on the machine without any audio input, and also operating level to the basic machine noise without tape (see below).

Mains hum in the output was found to consist largely of the 50 Hz fundamental and varied according to the location of the 240/117V transformer which needed to be kept a reasonable distance from the machine. Provided that this precaution was observed, the hum levels were between 60 dB and 70 dB below operating level in both the normal and sync modes.

Record replay performance

With the machine adjusted to the manufacturer's recommendation with 3M type *206* tape the overall frequency response as is shown in **fig. 1** was most impressive, being within ±1 dB from 33 Hz to 18 kHz at a tape speed of 38 cm/s and within ±1 dB from 70 Hz to above 20 kHz at a tape speed of 76 cm/s. Furthermore, when in the sync mode the performance as shown in **fig. 2** is not far from identical. However, it has been noted that the record equaliser is near its limit when using modern tapes with a good short wavelength sensitivity.

Fig. 1 also shows the overall frequency response of the electronics only, which is to a high standard. The distortion of the electronics only is shown in **fig. 3**, from which it is to be seen that while the second harmonic products are at a very low level, it would have been nice to have seen a lower third harmonic content; there is not, however, any real cause for complaint.

The three percent third harmonic distortion point was found to occur at +8.5 dB on operating level which, for some unexplained reason, was rather on the low side. While this measurement was re-checked, there was unfortunately no time to investigate this matter further. It should, though, be noted that the measured performance was in close agreement with the manufacturer's specification and also with the original machine alignment, and may be the result of using identical heads for both replay and record which are understood to have a gap of about 8 μm.

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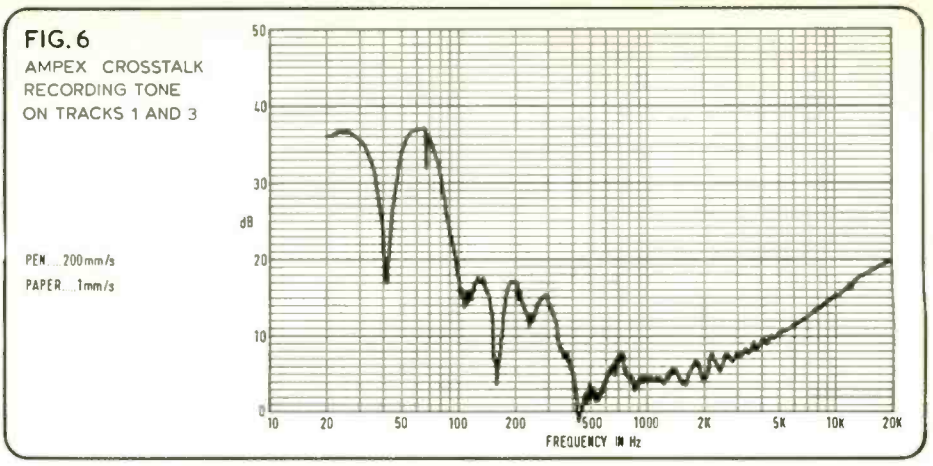
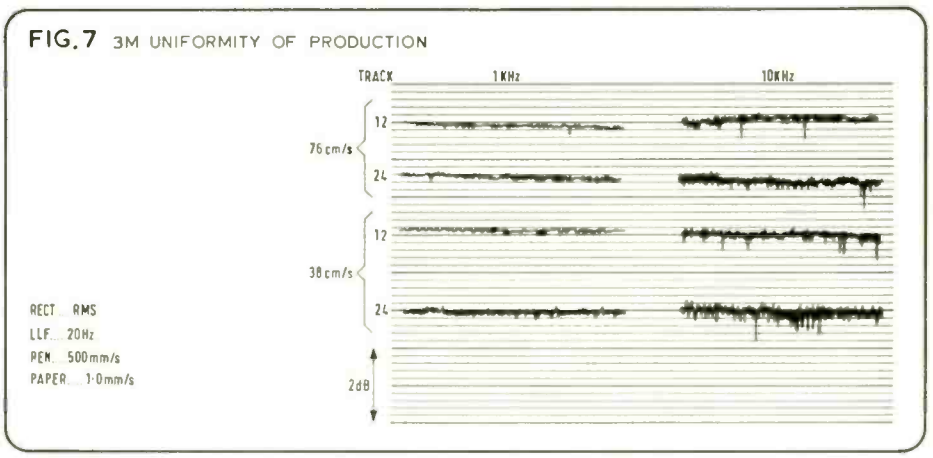
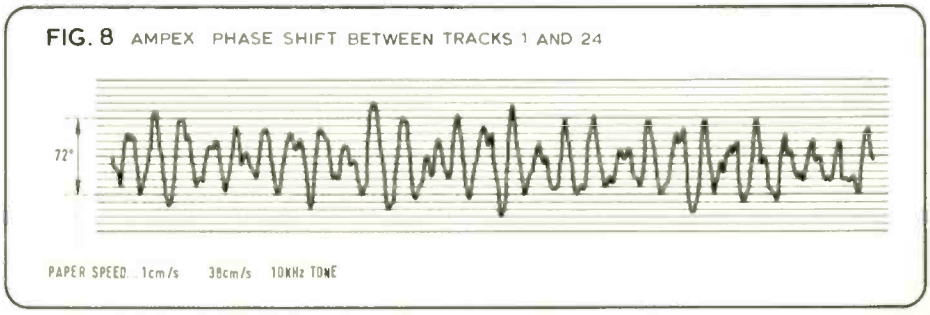




Condition and Speed	Operating level to noise ratio: Unweighted rms 20 Hz to 20 kHz	'A' weighted rms	CCIR weighted reference 1 kHz rms	DIN peak meter
Replay 76 cm/s	50 dB	57·5 dB(A)	52 dB	47·5 dB
Machine 76 cm/s	57 dB	68·5 dB(A)	62 dB	57·5 dB
Replay 38 cm/s	50 dB	59 dB(A)	49 dB	44 dB
Machine 38 cm/s	56 dB	64·5 dB(A)	59 dB	54·5 dB
Sync replay 38 cm/s	50 dB	55 dB(A)	47 dB	42 dB
Sync machine 38 cm/s	55 dB	65 dB(A)	58·5 dB	54 dB



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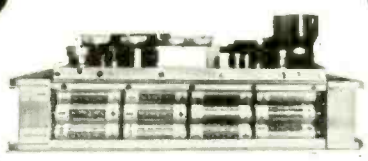

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■ AMPEX MM 1100

Checking the third harmonic distortion at operating level produced **figs. 4** and **5** at the tape speeds of 76 cm/s and 38 cm/s respectively; other than the usual sharp rise in distortion at low frequencies resulting from the NAB equalisation curve I have no complaint in this direction. However, it should be explained that these plots are not compensated for the fall off in frequency response below 50 Hz or so, and therefore do not give a true plot of the harmonic distortion at low frequencies which is, of course, considerably worse than that shown.

The measurement of intermodulation distortion to the SMPTE method using 50 Hz and 7 kHz tones in the amplitude ratio 4:1 gave the following figures which also suggest that something is awry in the maximum level that could be recorded.

The above figures were obtained using 3M type *206*, and similar figures were produced with Ampex type *406* tape, but the two samples of EMI *815* and *816* gave far worse results—these findings are currently being investigated by EMI who are making every effort to look into my findings, which were confirmed by using machines other than the Ampex *MM1100*.

Measurement of the crosstalk between adjacent channels was performed under what are probably worst case conditions; that is, while recording tone on channels 1 and 3 and replaying channel 2—the resulting crosstalk is shown in **fig. 6,** far better than the implied specification.

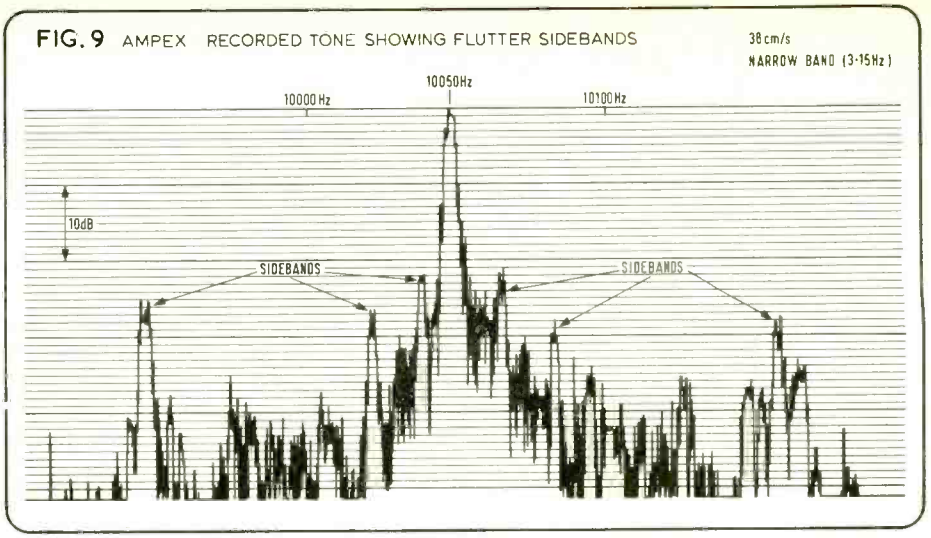
Fig. 7, which shows the uniformity of reproduction, illustrates that the head to tape contact is superb; it was quite hard to believe that I was not in the 'line in' monitoring mode when measuring at 1 kHz, even using an edge track! Similarly, the dynamic phase shift measured as a result of recording and replaying tracks 1 and 24 at 38 cm/s does very great justice not only to the control of the tape path but also to the precise manufacture of the fixed headblock. A rapid calculation on the results suggested a maximum positional error of only 19 μm between tracks 1 and 24 when comparing the record and replay azimuths.

Wow, flutter and speed

Checking wow and flutter to the DIN method gave close results at the beginning, middle and end of both 263 mm diameter and 356 mm diameter spools of tape. At a speed of 38 cm/s the wow and flutter was on average 0.033%, while at a speed of 76 cm/s this excellent performance was further improved to an average of 0.024% throughout a reel.

Even when using a full 356 mm reel of tape the start time to the rated wow and flutter was no more than 600 ms with no evidence of tape snatch and everything well under control. It was further noted that the speed stability between the beginning and end of a full 356 mm reel of tape was better than 0.03% and that the relation between the two tape speeds was within better than 0.01%.

However, while the performance shown above is to a very high standard, things came somewhat unstuck when I did my flutter test using a narrow band spectrum analysis of a replayed high frequency tone. A typical result is shown in fig. 9 which is one of the many plots obtained while trying to understand



Level reference operating level equivalent peak sinewave	Amplifiers only	Tape	
		38 cm/s	76 cm/s
+4 dB	0·022%	3·0%	1·4%
0 dB	0·029%	1·5%	1·5%
−10 dB	0·36%	1·0%	0·9%

the reason for the somewhat mediocre performance. Unfortunately, time available for writing this review limited the investigation into this shortcoming. (This factor has not stopped Ampex from taking a very serious attitude to my findings, and only this Bank Holiday morning I spent several hours with an Ampex engineer looking into this shortcoming, which neither of us could explain in terms of tape transport design. I hope that Ampex in the United States will resolve this matter within the next few days; but, unfortunately their findings will be too late to accompany my review.)

Inputs and outputs

Both the inputs and outputs are fully floating with logically selected impedance, the input impedance being substantially constant at something just over 20k ohms and the output impedance being of the order of 120 ohms—both are compatible with the common line impedances.

The input sensitivity could be varied from a maximum of −16 dBm (with 3M *206*) for recording operating level; the available output when replaying operating level was a maximum of +14 dBm with a potential output of +26 dBm before output clipping occured.

Level meters

The initial setting of the vu meters corresponded to the NAB recommendations for the setting of vu meters, but there was considerable variation in level setting available.

Investigation into the rectifier characteristics and the ballistics of the meters revealed performance consistent with the correct rectifier characteristics and rise time, but it may be considered that the fall time is a little in excess of specification at around 800 ms.

Other matters

While tape handling performance was very

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AMPEX MM 1100

good, it is (as previously explained) not the easiest of machines to handle because of the height of the transport; furthermore, it is possible to load the tape while omitting the tension sensing arm adjacent to the pay-off spool. If this is done the machine may apparently run in a normal fashion but with disastrous results in the way of wow and flutter.

A further matter for some concern is the erasing capability of the machine: using Ampex type *406* tape a 1 kHz tone at 38 cm/s could be erased to −68 dB, but 3M type *206* could only be erased to −63 dB. With the current vogue for higher coercivity tapes it is felt that some modification is required in this direction.

While users may have noted that the time to rewind a full reel of tape may be longer than some machines, it is my feeling that waiting just over two minutes is little hardship for a length of 730m of tape—after all, it is much kinder to the expensive tape to have a little patience!

Summary

The Ampex *MM1100* with the exception of the matters raised, is a really excellent performer. It does however lack a certain amount of consideration for maintenance—in particular in the region of the mother board at the rear of the card frames.

Overall, the standard of engineering is really excellent, and the design of the tape transport complies with my ideals of a flat rigid structure upon which are mounted the various sub-assemblies which are toleranced such that no shimming or other adjustment is necessary.

Whilst the physical layout of the machine may be open to criticism, the performance of the electronics is good, and subject to the outcome of the investigation into the flutter problem the mechanical performance is also to a very high standard.

MCI JH 24

By Hugh Ford

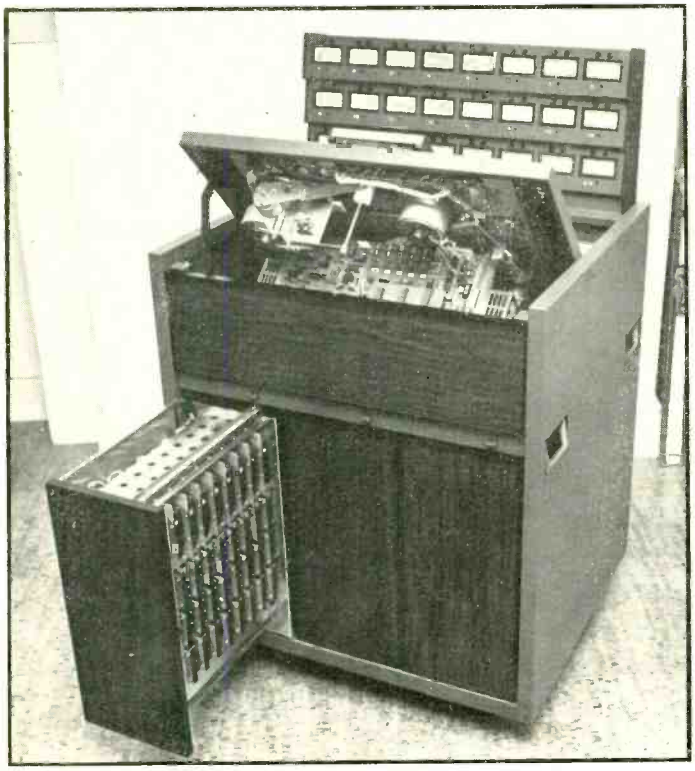
MANUFACTURERS' SPECIFICATION

Tape width and head configuration: 25.4 mm—8 tracks, 50.8 mm—16 tracks, 50.8 mm—24 tracks.
Tape tension: 170 gms at all play speeds ±2% for line variations from 105 to 140V.
Tape speeds: 38 cm/s, 76 cm/s.
Long term speed stability: Less than 10 Hz change of 15 kHz recorded tone. (0.07%).
Flutter and wow: Weighted—less than 0.05% peak (DIN. Unweighted—less than 0.1% peak (DIN).
Start time: 0.3s at 38 cm/s, 0.6s at 76 cm/s.
Reel sizes: 152 mm to 267 mm—NAB hubs.
Rewind time (for 732m): 85s.
Frequency response (38 and 76 cm/s): Reproduce —30 Hz to 16 kHz ±2 dB. Cue—30 Hz to 16 kHz ±3 dB.
Signal-to-noise (unweighted): Reproduce—64 dB below +4 dBm. Cue—60 dB below +4 dBm. Record and erase—less than 3 dB increase over bulk erased tape.
Input: Level 20 dBm (minimum). Impedance 20K (nominal) balanced.
Output: Level 0 VU = +4 dBm. Impedance 600 ohm balanced. Line amp clipping +24 dBm.
Equalisation: NAB automatically switched by deck speed switch.
Bias oscillator: Frequency 120 kHz.
IM distortion: At standard record level 3%.
Size—24 track: 1194 mm W x 813 mm D x 1143 mm H.
Weight—24 track: 261 kg (shipped).
Size—remote unit: 292 mm W x 127 mm D x 229 mm H.
Price: £13,915 + VAT.
Manufacturers: MCI Incorporated, 4007 N.E. 6th Avenue, Fort Lauderdale, Florida 33308, USA.
UK agents: Feldon Audio Ltd, 126 Great Portland Street, London W1.

BEFORE ENTERING INTO the review proper of the MCI 24 track machine, it is only fair to point out that the machine was delivered direct to my laboratory from London Airport. Feldon Audio arrived the same evening to put together the six packages containing various parts of the machine, and by the early hours of the next morning all was operational.

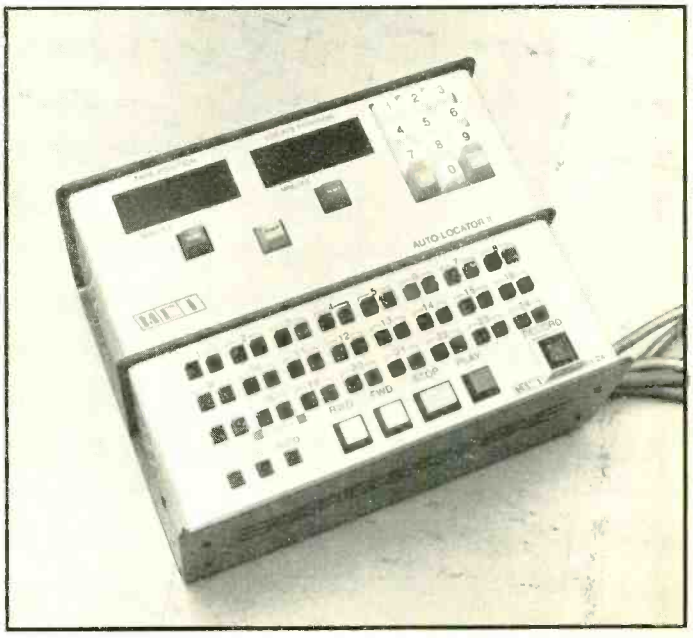
It follows that not only was the machine delivered in a great hurry for this review, and that it had not been checked-out to any great extent, but also it is unfortunate that the machine was only available to my laboratory for a relatively short time. My normal practice is to use equipment over a period of a few weeks, and to raise any queries with the manufacturer after at least double checking my findings—in the case of this review neither of these actions has been possible.

The MCI machine is to my way of thinking a very practical looking machine, with no attempt being made to enhance its appearance with wood trim, chrome escutcheons or other artistic devices. A brown sheet metal cabinet



Left: *MCI JH 24, showing transport and electronics access*

Below: *MCI remote control*



contains the tape transport and the associated electronics and power supplies, the latter comprising two units which rest in the rear of the cabinet and in the case of the review machine required a 117V mains supply.

The top surface of the cabinet contains the tape transport which is hinged so that access may be gained to its underside, where the servo electronics are mounted on fibre glass printed boards which include led status indicators. At first sight the servicing of these boards would appear to be a nightmare, in spite of clear components identification, because the boards are three layers mounted upon each other. However, the boards just un-plug from each other and buried within the pack one finds an elapsed time indicator for total hours run!

Layout of the tape transport is in many ways conventional, but there are some unusual features in the tape path which proceeds from the 267 mm maximum diameter pay-off spool to a flanged roller guide which is, in turn, followed by a second roller (not a guide). This roller is unusual because it is associated with a flywheel of relatively large inertia; the flywheel only being attached to the roller in the record and play modes. The (flywheel) guide is followed by a fixed guide pin which in turn is followed by the headblock. There is a fixed guide at the entrance to and exit from the headblock, which itself has two tape lifting pins; these are actuated in the fast modes, but may be manually operated by a lever in any mode. The headblock itself is of the most fundamental type, being fabricated from alloy plate and attached to the machine by four screws—the head leads being plug-in flying leads. Screening of the heads is achieved by two screening plates which emerge from the transport in the record and play modes, but may be withdrawn for editing by means of a pushbutton switch.

This head arrangement is followed by the capstan and pinch roller, the former being made of ceramic. Certainly this should have excellent wear properties and it is said that it is no more fragile than a metal capstan—it breaks when a metal capstan would bend. Finally, the tape path terminates with a roller guide followed by the take-up spool. I would not at first sight expect this transport design to be conducive to minimal flutter, as not only is there no flutter roller near the heads, but also the undamped length of tape in the area of the heads is rather long.

The main tape transport functions, play, record and the fast modes are available on both the transport and the remote control unit, but the following facilities are only available on the transport. A three position rotary switch selects the reference source for the capstan servo from either the internal fixed reference, from an external source or from a multiturn potentiometer on the transport. When either external or variable sources are selected the status is indicated by a red warning lamp on the transport, but this lamp could well be easier to see. The internal reference is selected by a two position rotary switch which selects either 76 cm/s or 38 cm/s (on the review machine), the absolute speed being referenced to a crystal oscillator. Operation of the speed change switch stops the transport, which is a sensible safeguard. I have already mentioned the head shield switch, and the remaining controls are an edit switch which enables the tape to be run with the take-up spool drive inoperative and a joystick control labelled MVC. This control is a particularly nice function as it provides for a number of variable speed spooling conditions. When in the stop mode, touching the MVC joystick initiates variable speed playback in either direction, the direction and speed being controlled by the position of the MVC control, and the machine reverting to the stop mode when the control is no longer touched. In either of the fast wind modes, touching the MVC control initiates variable (constant) speed spooling, the direction and speed depending upon the position of the MVC control and a light in the end of the MVC control being illuminated when the tape speed is under its control. To revert to high speed winding one just actuates the appropriate fast wind control. This control is therefore a valuable editing facility, eliminating much manual tape rocking.

As should be expected, all the transport controls are fully interlocked and a power failure in any mode of operation leads to a con-

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FIG. 1
MCI OVERALL FREQUENCY RESPONSE IN NORMAL MODES

PEN...200mm/s
PAPER...3mm/s

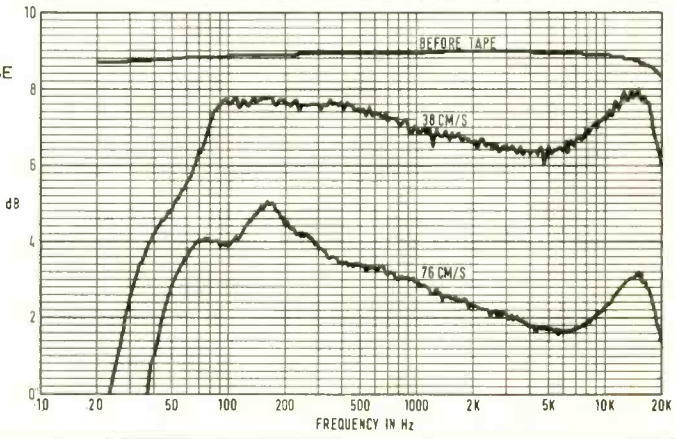


FIG. 2
MCI OVERALL FREQUENCY RESPONSE IN CUE (SYNC) MODE

PEN...200mm/s
PAPER...3mm/s

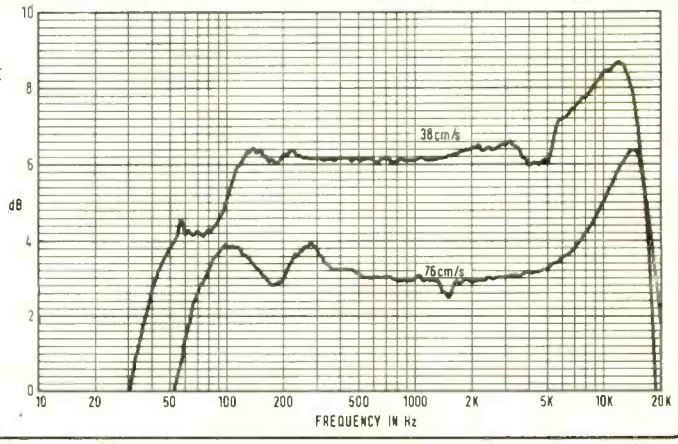
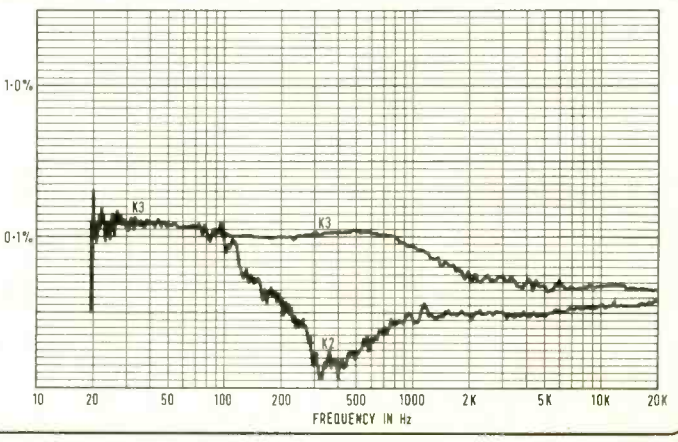


FIG. 3
MCI DISTORTION OF ELECTRONICS ONLY AT OVU

PEN...200mm/s
PAPER...1mm/s



trolled stop. However, I do not like the behaviour on tape run-out in the fast modes, when the take-up spool requires a very long time to come to rest, meanwhile flaying the free end of the tape all over the place even catching under the spool. Other than this defect, there was no tendency to any form of loop slinging and the transport was well behaved.

The 24 vu meters are mounted above and behind the tape transport, each being associated with two indicator lamps; a red lamp indicating record on the particular channel and a blue lamp indicating before tape monitoring—these lamps work in conjunction with the remote control unit which will be described later.

All the record/replay electronics are contained in three drawers below the tape transport, each drawer containing the electronics for eight channels and running on rollers such that it is pulled out of the main cabinet. Each channel has its electronics accommodated on four plug-in printed boards which are arranged in vertical array for easy channel identification. Other than bias and equalisation trimmers, all the variable controls are normal 270° potentiometers, some of which cover a large range with the result that the setting accuracy is rather coarse.

All the boards, which are fibreglass with printed component identification, are provided with printed front panels giving the preset identification; also, the majority of pre-set controls are accessible through the front panels. As a further protection the board connectors are keyed so that boards cannot be placed in an incorrect socket.

The upper board contains three level settings for play, cue (sync) and record. In addition there is a pushbutton switch which feeds bias to the appropriate vu meter for a quick calibration check. The next board is the replay amplifier which has compensation control for high and low frequency curves at both the high and low tape speeds. These controls and the equalisation components are contained on a piggyback board behind the front panel; thus, the replay equalisation standard may be altered by changing the piggyback board for another pre-calibrated board.

The same principle also applies to the record amplifier board, which has high frequency boost controls for both tape speeds and a single level calibration pre-set. The final electronics board is the bias and erase board which contains bias adjustment and erase peak controls as well as a bias calibration control for adjusting the sensitivity of the appropriate vu meter when monitoring bias.

All the separate sections of the electronics are plug-in parts, such that it is simple to replace any particular section should the need arise. The remote control unit and tape position 'auto locator II' are also plug-in units supplied with very long leads for remote mounting on a console.

To start with the remote control unit, this duplicates the play, record and fast controls on the tape transport as well as providing mode control for each individual channel and master mode controls. Each channel is associated with two illuminated pushbuttons identified as

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FIG. 8 MCI PHASE SHIFT BETWEEN TRACKS 1 AND 24

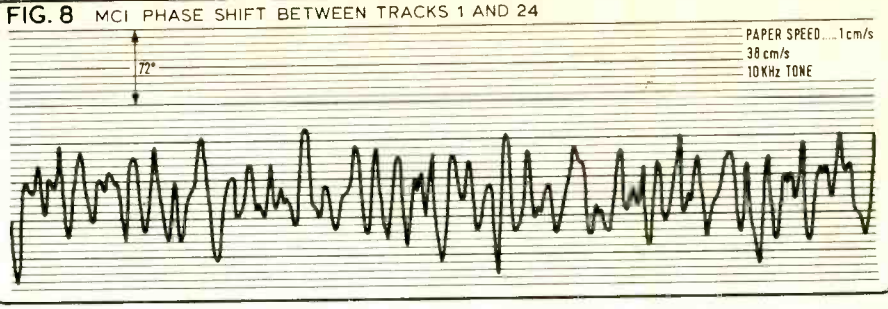
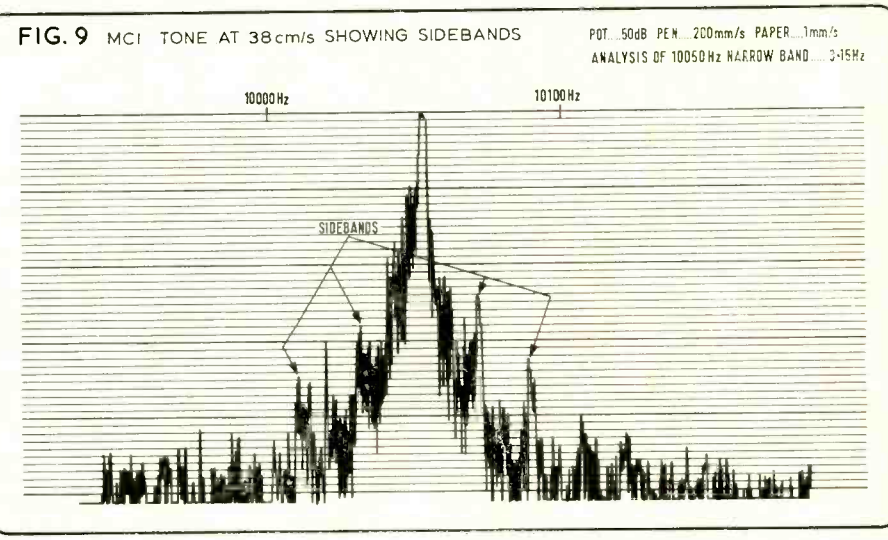


FIG. 9 MCI TONE AT 38cm/s SHOWING SIDEBANDS



Condition and speed	Unweighted rms 30 Hz to 20 kHz	'A' weighted rms	CCIR weighted rms	Operating level to noise ratio reference 1 kHz DIN peak meter
Replay 76 cm/s	44 to 58 dB	61 dB	52 dB	47 dB
Machine 76 cm/s	as above	71 dB(A)	63 dB	59 dB
Replay 38 cm/s	47 to 58 dB	58 dB(A)	49 dB	44 dB
Machine 38 cm/s	as above	68 dB(A)	60 dB	56·5 dB
Cue replay 38 cm/s	54 dB	57 dB(A)	46·5 dB	41·5 dB
Cue machine 38 cm/s	58 dB	67 dB(A)	61 dB	56 dB

Level reference operating level equivalent peak sinewave	Amplifiers only	Tape 38 cm/s	Tape 76 cm/s
+6 dB	0·025%	1·3%	1·3%
0 dB	0·028%	1·3%	1·1%
−10 dB	0·022%	<1·1%*	<0·8%*

*These figures were limited by tape uniformity; both EMI samples produced far worse figures.

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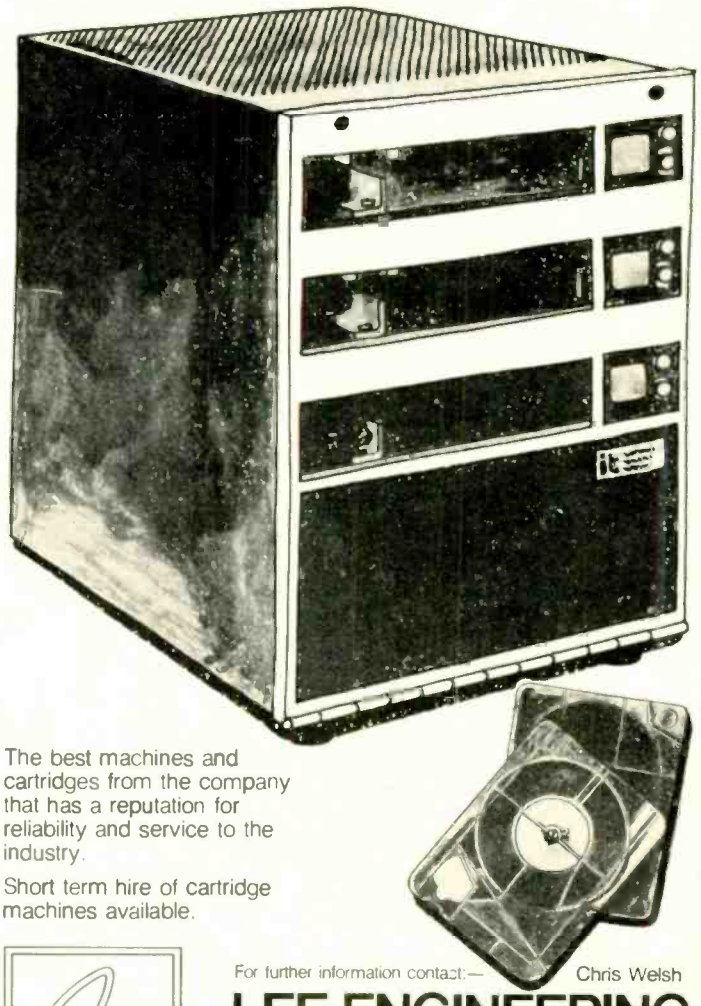

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'record' (coloured red) and 'cue' (coloured green). To enter the record mode, the desired channels are pre-selected and the machine set into the play mode with or without the master record button pressed. As soon as the record button is pressed, the pre-selected channels go into record and the red indicators on the individual channel selectors and adjacent to the associated vu meters are illuminated. An exit from the record mode is accomplished by pressing the play button when the tape will continue in motion, or by releasing the individual channel record button, or by initiating any other tape motion control—this action being properly interlocked.

The source of the monitoring output is controlled by the combination of the master mode controls and the individual channel cue (sync) button. There are three mechanically interlocked master mode controls identified as 'tape' 'in' and 'auto'. When the 'in' button is pressed the output is before tape irrespective of other controls. When 'tape' is selected the monitor output is from the replay head in the record mode, but depends upon the individual cue (sync) buttons in the replay mode for any individual channel. When the master 'auto' button is pressed all channels monitor the sync head in the replay mode and automatically monitor the replay head when inserted into record. It follows from the above that in conjunction with the remote control indicator lamps it is very easy to select any desired configuration. My only real complaint about the remote control unit is that the type of push-button used has two disadvantages: firstly, I found that the latching mechanism was not positive and sometimes failed to catch, and secondly the square headed pushbuttons are uncomfortable even for my horny hands.

The tape position locator is a different kettle of fish as it uses calculator keyboard type buttons of the non-latching type. The unit comprises two numerical displays in minutes, tenths and hundredths of a minute (automatically corrected for tape speed), one giving the current position from the start and the other indicating the required position. Both displays have reset buttons, and the required position display remains at position zero unless otherwise set. A keyboard is used for setting any desired location in either display, and once the desired location is set all that is required is to press to locate button and the tape proceeds to that position within about 2cm over a full 1000m of tape. If the play button has been pressed the machine automatically proceeds into the replay mode instead of stopping. While it would have been more civilised if the displays were in minutes and seconds, instead of decimals of a minute, this is an excellent device which is extremely simple to operate and also very accurate.

Both alignment of the complete electronics and operation of the machine were quick and simple, and the important functions of the machine were free of clicks and other nasty possibilities. The replay/sync switching did however produce clicks in the monitor output which might be irritating, and there was also some delay between actuating to sync (cue) button and the switching in the electronics.

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FIG. 4
MCI THIRD HARMONIC DISTORTION AT OPERATING LEVEL
76 cm/s

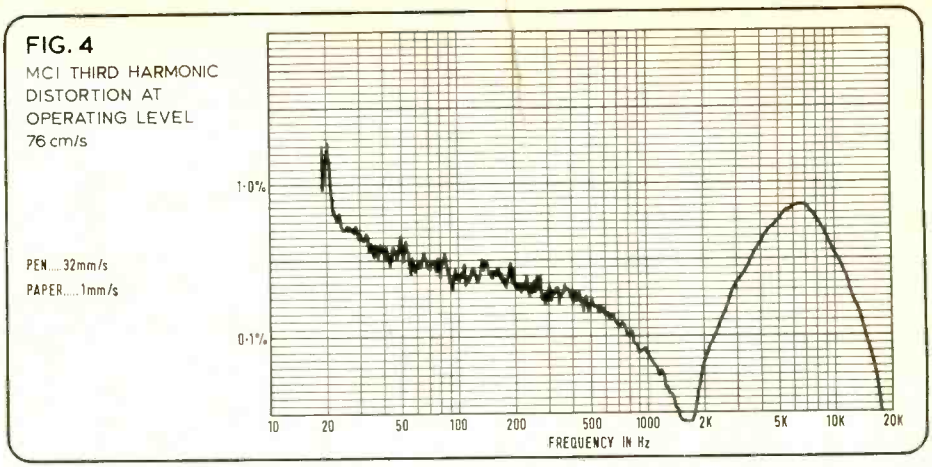


FIG. 5
MCI THIRD HARMONIC DISTORTION AT OPERATING LEVEL
38 cm/s

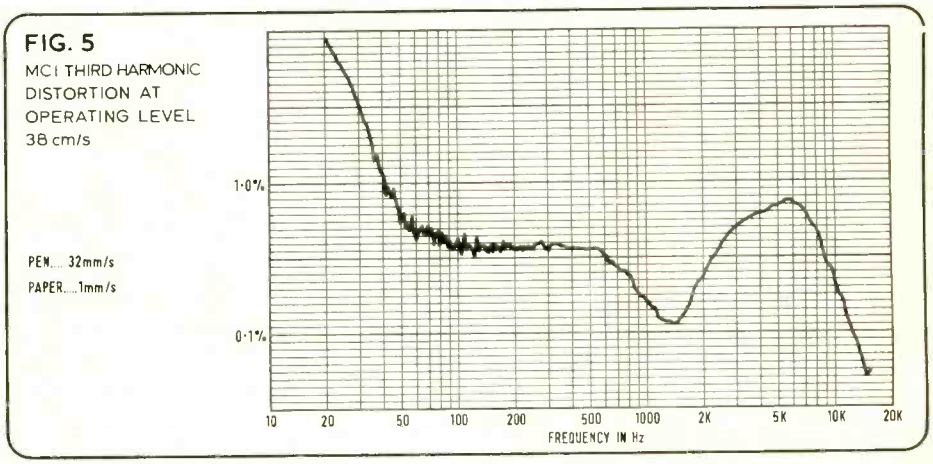


FIG. 6
MCI CROSSTALK RECORDING TONE ON TRACKS 1 AND 3 REPLAY TRACK 2

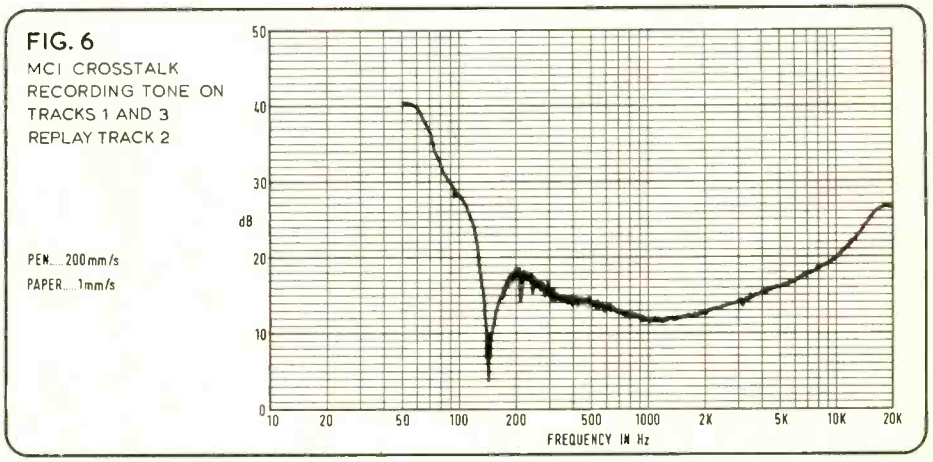
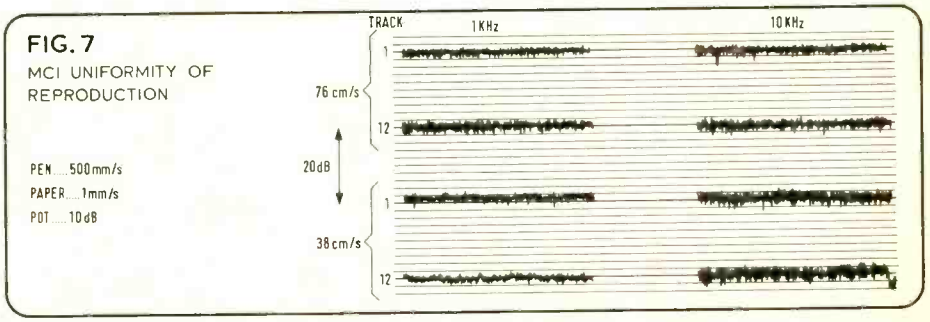


FIG. 7
MCI UNIFORMITY OF REPRODUCTION



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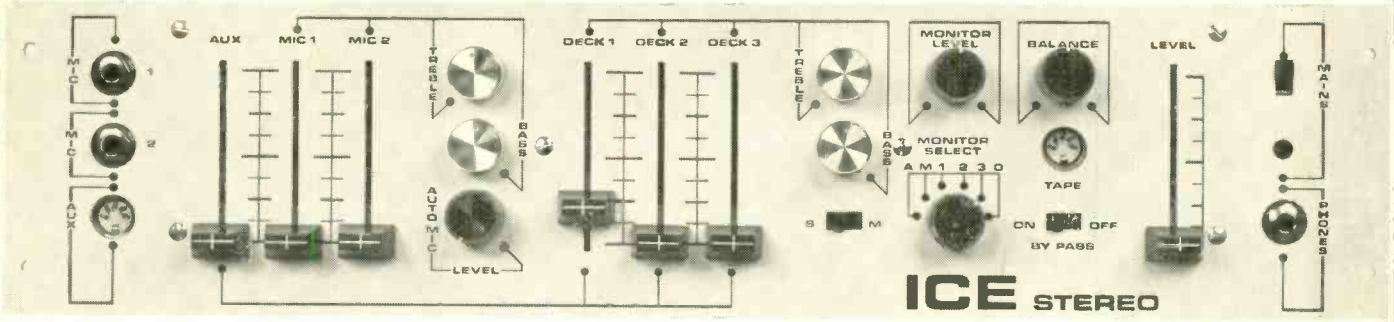

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MCI JH 24

The machine was particularly quiet in operation for a 50 mm machine, the major noise source being the tape running over the guides rather than the cooling fans on the power supplies.

Replay performance

Initial checking of the replay frequency response at 38 cm/s with an Ampex calibration tape showed that the machine had been accurately set at the MCI factory, and checking the degree of available correction on the machine showed that this was quite adequate.

The replay noise performance was checked on a number of randomly selected tracks (as were other parameters) and showed large variations between tracks when unweighted measurements were made, the weighted measurements being with close limits from one track to another. The following operating level (185 nW/m) to noise ratios were measured using 3M type *206* tape where appropriate, the quoted replay figures relating to this tape after it had been recorded without any signal input on the MCI machine, and the machine figures relating to the replay section of the machine without tape (see p 68).

The variable, and sometimes very poor, unweighted figures were found to be due to hum pickup in the cabling at the rear of the electronics drawers. The variation from track to track was large, and it is likely that the 'A' weighted figures may be degraded by hum. Hum induction into the heads was at a low level, and quite acceptable even when the headshield was withdrawn. Ignoring hum, the subjective noise from the machine was low; however, it is suspected that the bias waveform distortion was on the high side as the noise increase over bulk erase noise when recording on tape was found to be 5 dB(A) and the subjective character of the noise was rather 'ploppy'.

Record/replay performance

Both 3M type *206* and EMI types *815* and *816* tapes were used for the evaluation of the record/replay performance, the quoted results being an illustration of the typical performance found over a number of channels. The overall frequency response is shown for the electronics only and overall for both tape speeds in **fig.1**, from which it is to be seen within ±1 dB from 70 Hz to 20 kHz at a tape speed of 38 cm/s and within ±1.5 dB from 45 Hz to 20 kHz at 76 cm/s. The performance when replaying from the sync head is shown in **fig. 2** which illustrates a degree of high frequency peaking at both tape speeds, but to no serious degree. As the same replay electronics are used for both the normal and sync modes it is not surprising to find this difference in replay response.

Both the frequency response of the electronics only (as in **fig. 1**) and the distortion as shown in **fig. 3** are to a very high standard of performance and are such that no degradation of the record/replay processes could arise from the electronics in this respect.

The third harmonic distortion plots via tape are shown in **figs. 4 and 5** for the two tape speeds which exhibit common and interesting characteristics, other than the NAB bass boost disease at 38 cm/s. It is to be seen that at both speeds there is a minimum distortion notch between 1 kHz and 2 kHz, and that the overall distortion performance is excellent at mid frequencies. This is brought about by the inclusion of a pre-distortion circuit in the later MCI machines, and which I believe can be added to earlier machines. As will be seen, the inclusion of this modification also has a very good effect upon intermodulation distortion. The three per cent third harmonic distortion point with 3M *206* tape was found to be 11.5 dB above operating level at 38 cm/s or 12 dB above operating level at 76 cm/s at a measuring frequency of 1 kHz, both figures being satisfactory. Adding these figures to the weighted operating level to noise ratios offers a good overall dynamic range.

Reverting to intermodulation distortion, the following figures were obtained with 3M *206* tape (where appropriate) using the SMPTE method of measurement using an Amcron meter with 50 Hz and 7 kHz tones in the amplitude ratio 4:1.

Investigations into the crosstalk performance was undertaken by recording tone on tracks 1 and 3 and no signal on track 2, the crosstalk introduced on to track 2 being measured and probably giving the worst case result. This result is shown in **fig. 6** from which it is to be seen that mid frequency crosstalk is around −48 dB and that crosstalk is at least 40 dB down between 130 Hz and 10 kHz.

Two matters relating to the quality of tape transport across the heads are the overall uniformity of reproduction and also phase shift effects. **Fig. 7** shows the uniformity of 1 kHz and 10 kHz tones recorded and replayed at the two tape speeds, and illustrated a first class performance in this respect; it was also found that the dynamic phase shift between tracks 1 and 24 as shown in **fig. 8** was to a good standard, this plot being made with separate record and replay tape passes.

Wow, flutter and speed

Wow and flutter was measured to the DIN method using a quasi-peak meter, the quoted figures being the result of record and replay processes with a full 267 mm diameter spool of tape. At both tape speeds the wow and flutter at the beginning and middle of the reels was around 0.025 per cent increasing to 0.035 per cent at the end of the reel—a very high standard of performance. The time from the start command to stabilisation of the wow and flutter performance was found to be of the order of 550 ms when running at 76 cm/s and with a full pay-off spool and the speed stability within a reel of tape was better than ±0.01 per cent.

A narrow band analysis of a 10 050 Hz recorded tone is shown in **fig. 9** which shows that fairly substantial flutter sidebands occur about 12 Hz and 24 Hz from the 10050 Hz

74 ▶

MCI JH 24

carrier and that much out of band noise occurs. It is probable that the inclusion of a flutter roller adjacent to the record and replay heads would considerably improve this situation.

The available speed variation in the internal variable speed mode was found to be +26.3 per cent to −21.5 per cent on nominal speed, which is more than adequate for correcting typical material.

Inputs and outputs

Each channel is fed from an *XLR* connector on the rear of the machine, the input being a floating input with a measured impedance of just over 18k ohms at 1592 Hz and substantially constant with frequency. The input sensitivity was found to be around -6 dBm for recording operating level (depending on tape type) at maximum gain which, while it is a rather low sensitivity, will cope with most situations.

The outputs are again *XLR* rear panel connectors, and provide a fully floating output with an impedance of 65 ohms which is adequately low and a maximum output clipping point of +22.5 dBm into a high impedance. The output voltage for an operating level recording could be adjusted to a maximum of +9 dBm in the normal mode or +12 dBm in the sync mode and should cope with any normal requirements.

Level meters

The initial setting of the vu meter sensitivity was correct, in that 0 vu was found to correspond to +4 dB on the operating level of 185 nW/m and was close to 8 dB below the 3 per cent third harmonic distortion point on tape.

Checking the ballistics and rectifier characteristics of a number of the meters showed that they complied with the proper ASA standard for vu meters and that there was no significant difference between individual meters.

Other matters

I have already mentioned that the increase in basic tape noise resulting from the record process is rather high at 5 dB(A) which, together with two other factors, makes me feel that something may have been wrong in the oscillator department of the review machine. The other two matters are that the maximum degree of erasure of a 1 kHz tone was found to be 67 dB after peaking the erase head, and also that a substantial amount of bias was present in the line outputs. The one channel which I measured was giving out 140 mV rms of bias.

At the time of writing this review no full manufacturer's machine specification was available, and some of the information that I was given was clearly incorrect, and other pieces of information were difficult to interpret.

Summary

It is most unfortunate that this machine was only made available to my laboratory for a few days around the Christmas holidays, for I am sure that some of the shortcomings that I have mentioned may be simple matters to correct.

Ignoring the replay hum problem for the time being, I have the impression that the performance of the electronics could well be first class subject to the bias oscillator being put right. From a mechanical point of view the machine is rather basic in design, and definitely could do with the incorporation of a flutter roller—a simple component to add.

The tape locator and the remote control facilities were excellent, but here a better quality switch should be used in the remote control unit.

In conclusion I feel from my short acquaintance with the MCI machine that it offers great potential, but while some of the shortcomings that I have found may be quirks of the review machine, others are matters which could benefit from attention at the factory.

BOOK REVIEWS

extraordinary. For example, one night Marshall Efron rang up impersonating Spiro T. Agnew and talked about how he yearned to slit the throats of America's long-haired youth. And one day I heard Mel Brooks telling Carl Reiner anecdotes ('His father wanted the east river to be his final resting place. So we took his ashes down to the river and threw them in. But the wind turned at the wrong moment and his final resting place turned out to be the dry-cleaners on East 34th Street.'). Then Steve Post did one of his shows from a call box outside the city because he was stuck in a traffic jam and couldn't get to the studio.

Can you imagine any of that on BBC radio? Or any of the IBA stations doing as BAI did and giving out a hire car firm's phone number when their driver refused to carry a reporter? Not on your life.

It's all here in Steve Post's book, and a lot more besides. For instance, the way you get a job at BAI—you hang around the studio until no one thinks of you as a stranger any more, and then one day someone asks you to do something.

Realistically, I doubt that the book will ever be published in the UK, but as many STUDIO SOUND readers will have friends in the States they should write and hint for a copy. This is exactly what I did. My only irritation with the book is a little bit of self-indulgence by Steve Post once in a while, and a whole lot of self-indulgence by someone called Ira Epstein, who, for some reason which is beyond me, is allowed to contribute several chaotically boring passages.

Adrian Hope

AGONY COLUMN

■ Yet another 'new boy' had learned how to operate the buttons on the front of the tape machine, and was heavily into simple editing. So he was pleased and honoured to have 'the new Frank Sinatra single' passed casually his way for mastering prior to despatch to the cutting room and rush release. Having been flown in from the States, it was simply wound on a centre, so he took extra care in the rewinding. Unfortunately, not even the delicate charm of an old three-ton Ampex was able to bring a typewriter ribbon to rest without stretching it out to a long thin strip, and the operator was completely unable to get any sound out of it, let alone Old Blue Eyes. Two hours locked tearfully on the loo produced a resolve to tell the Studio Manager the sad tale; he, needless to say, was quite bemused since the single had long since passed through and was heading for the pressing plant. The unfortunate operator was finally rescued from his coffee in Grotties and restored to former mental health.

■ At one time, it was considered by record companies that singles over 3.00 minutes never got air time on account of their length. It was reported that a record producer presented a promising master, clearly labelled 3.05 mins, to his parent record company. Under the three-minute rule, the tape was duly thrown out. Undeterred, the producer went back to the editing room and re-labelled the tape as being of 2.65 mins duration. It was accepted.

■ The engineer was tired and thirsty; he needed a break from editing a protracted ob recording of an indifferent pipe band. Gratefully, on the arrival of an assistant to carry on the good work, he left for the sanctuary of the canteen leaving the Nagra IV machine with an equal amount of tape on each spool. No one will ever know what happened during that coffee break. It is known, however, that there appeared to be something wrong with one of the tracks of the resulting lp. Nobody could put their finger on it until a northern pipe band addict pointed out that one of the tracks had been recorded backwards.

■ A 'new boy' session pianist was booked for a fairly straightforward recording of several backing tracks. The md had given everyone a pile of numbered but untitled scores and the break was 'accidentally' timed to come after No. 3 and before No. 4. So, as the break was called, the pianist had No. 4 up for immediately afterwards and of course he had to have a quick look out of curiosity before going out with the rest of the band for a drink. The first scores had all been a piece of cake but No. 4 was something else. Making his excuses about 'not being thirsty', the pianist spent the break desperately trying to get his fingers round the part. But to no avail; musically it made sense but, as he miserably told the md when they all trooped back after the break, he just couldn't make it. Which wasn't unduly surprising, because few if any pianists can sight read a transcription of an Art Tatum ballad solo, laboriously re-copied by a prankster md, re-titled 'No. 4' and marked up 'play very fast'.

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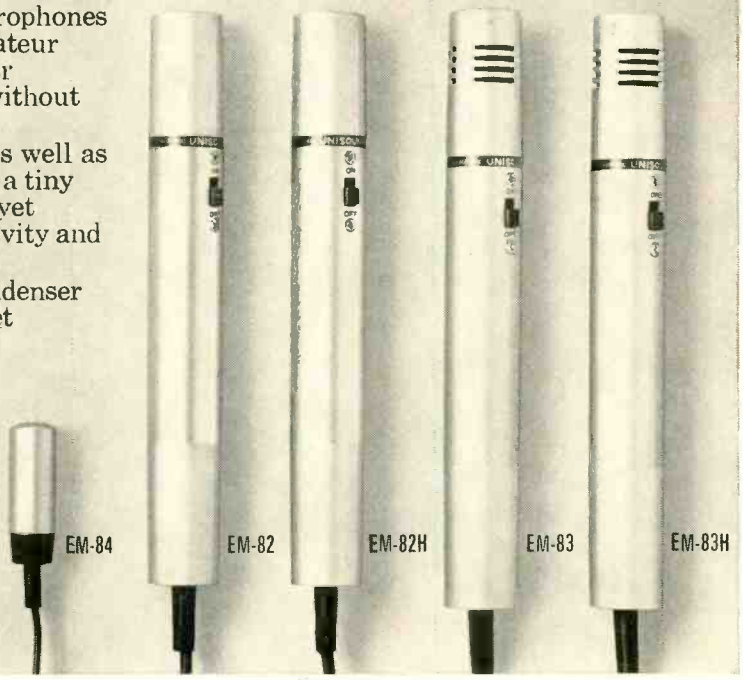

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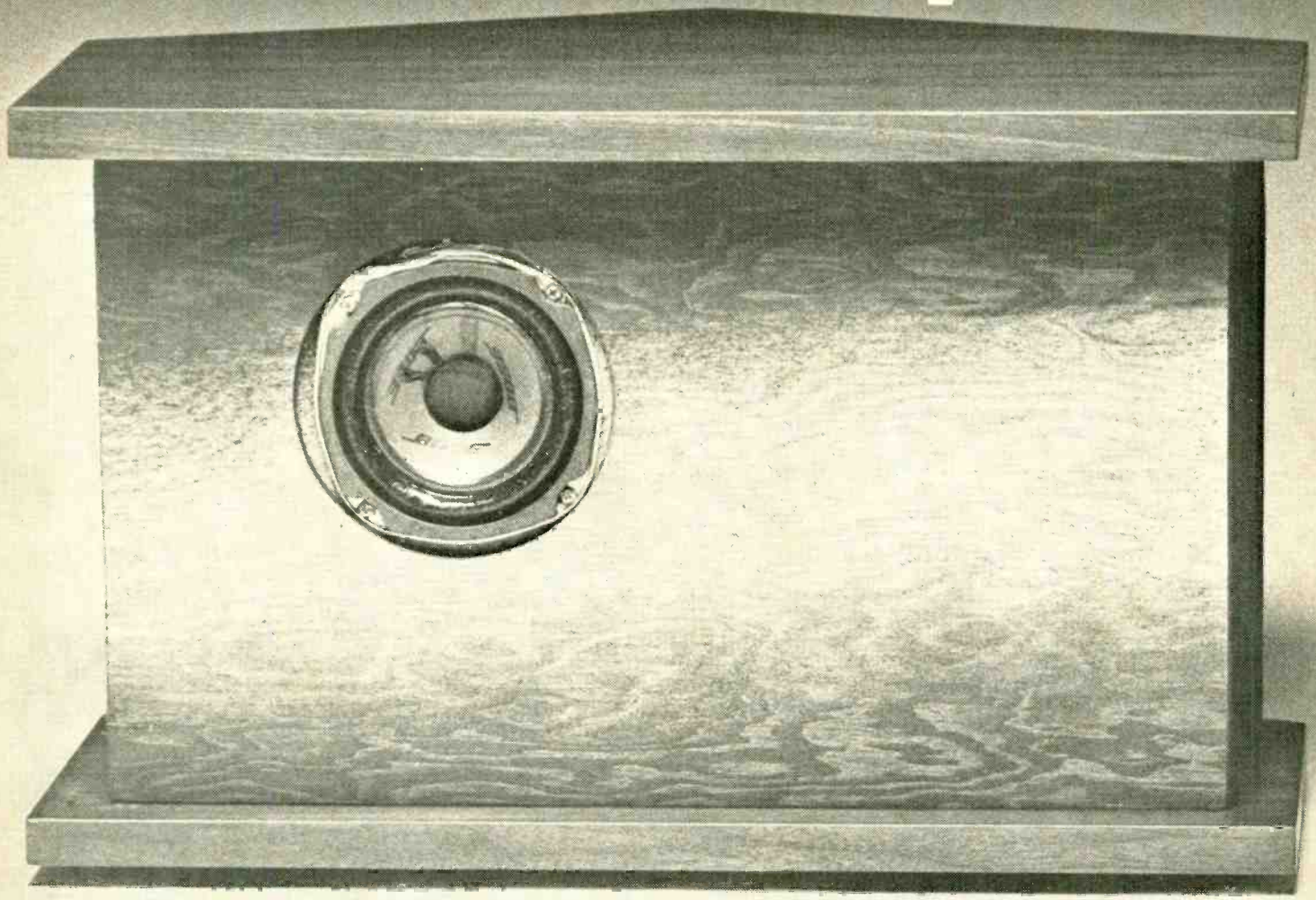

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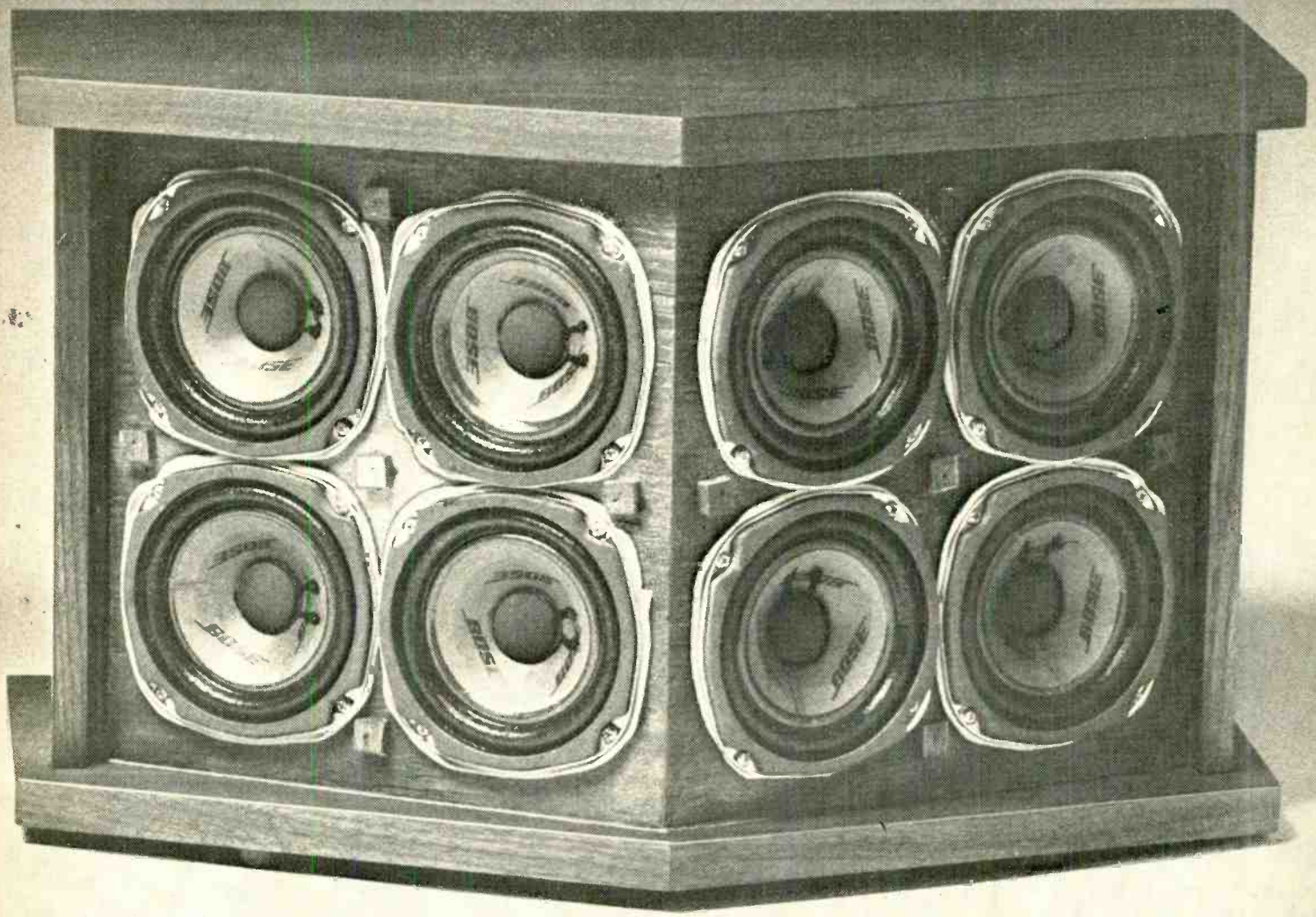

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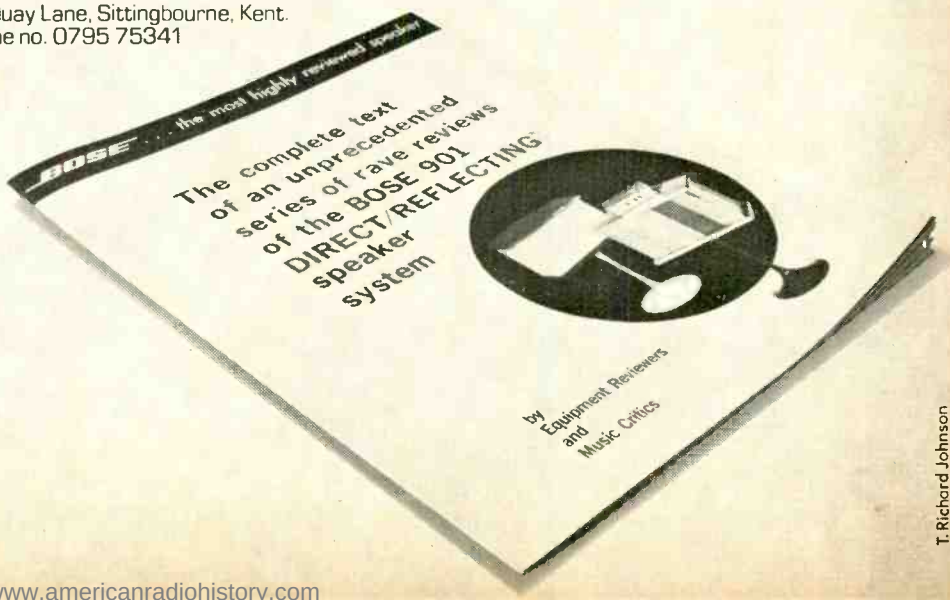

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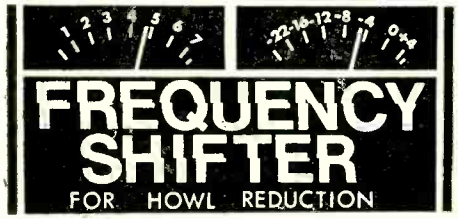

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Frequency response (sync mode)	± 2dB 50Hz to 15KHz.
Crosstalk	35dB
Inputs	100 millivolts up to 20 volts. 20K ohm impedance.
Outputs	1. Headphones 600 ohms. 2. Line 600 ohms OdB.
Distortion	Less than 1% at Ampex and Dolby level.
Oscillator frequency	100 KHz.
Complement each channel	11 transistors, 3 IC.

Options:
Variable speed, remote control

Price:

£1,790.00 + VAT

U.K. Agent: Industrial Tape Applications,
5 Pratt Street, London, NW1 0AE.
Tel.: 01-485 6162/7833
Telex: 21879

How to keep the musical excellence you've already paid for:

Your tape system

The tape equipment of your system is your musical memory bank. It is the **one** area where only the best makes sense. Choose carefully, select a recording instrument that neither adds nor detracts from the sound you put into it. Few machines really meet this requirement. The Revox A77 does – and by a safe margin.

Your tape recorder and your money

A **truly** professional quality tape unit is your wisest audio investment. It will last for years and years.

Witness the number of Revox machines built more than 20 years ago that are still in service! It's hardly surprising then, that Revox recorders command very high prices second or third hand – if you can find them available!

Revox owners seldom change – other than to a later model Revox.

It's also interesting to note that our warranty records show that on average our users have bought 2 or 3 other makes before choosing Revox. Then we read the lament "I only wish I'd bought a Revox sooner."

When you play it later, will it still sound the same?

At first sight this could seem an unnecessary question. It's not though. In the course of time a high fidelity enthusiast upgrades one or more units in his system.

With time, rising affluence plus advancing technical innovation in all aspects of audio, will bring better reproduction within the scope of all.

The recordings that you make now could, therefore, sound even better in the future – when, as finances permit, you add a better amplifier or loudspeaker to your equipment.

Conversely, a poor recording made now will sound **really** inferior when exposed to more exacting playback.

With the Revox A77 you will **retain the excellence** of every recording to enjoy now – and perhaps appreciate **even more** in the future.

So visit your nearest Revox Dealer for full information and a demonstration.

Record it on a Revox A77

REVOX

The illustration contains optional extras.

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Revox International: Regensdorf 8105 ZH, Althardstrasse 146 Switzerland.

BHE