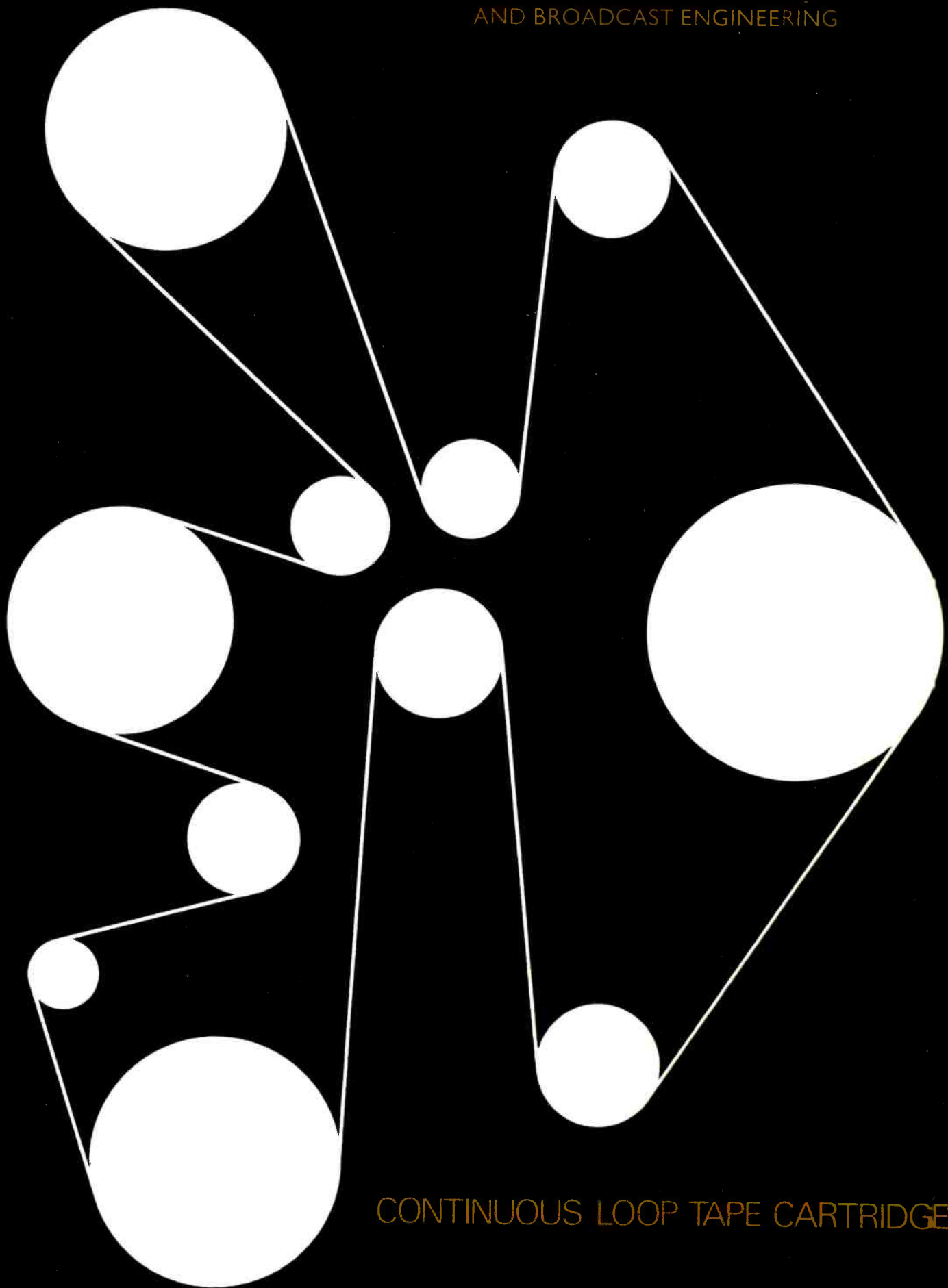
studio sound

May 1976 35p

AND BROADCAST ENGINEERING



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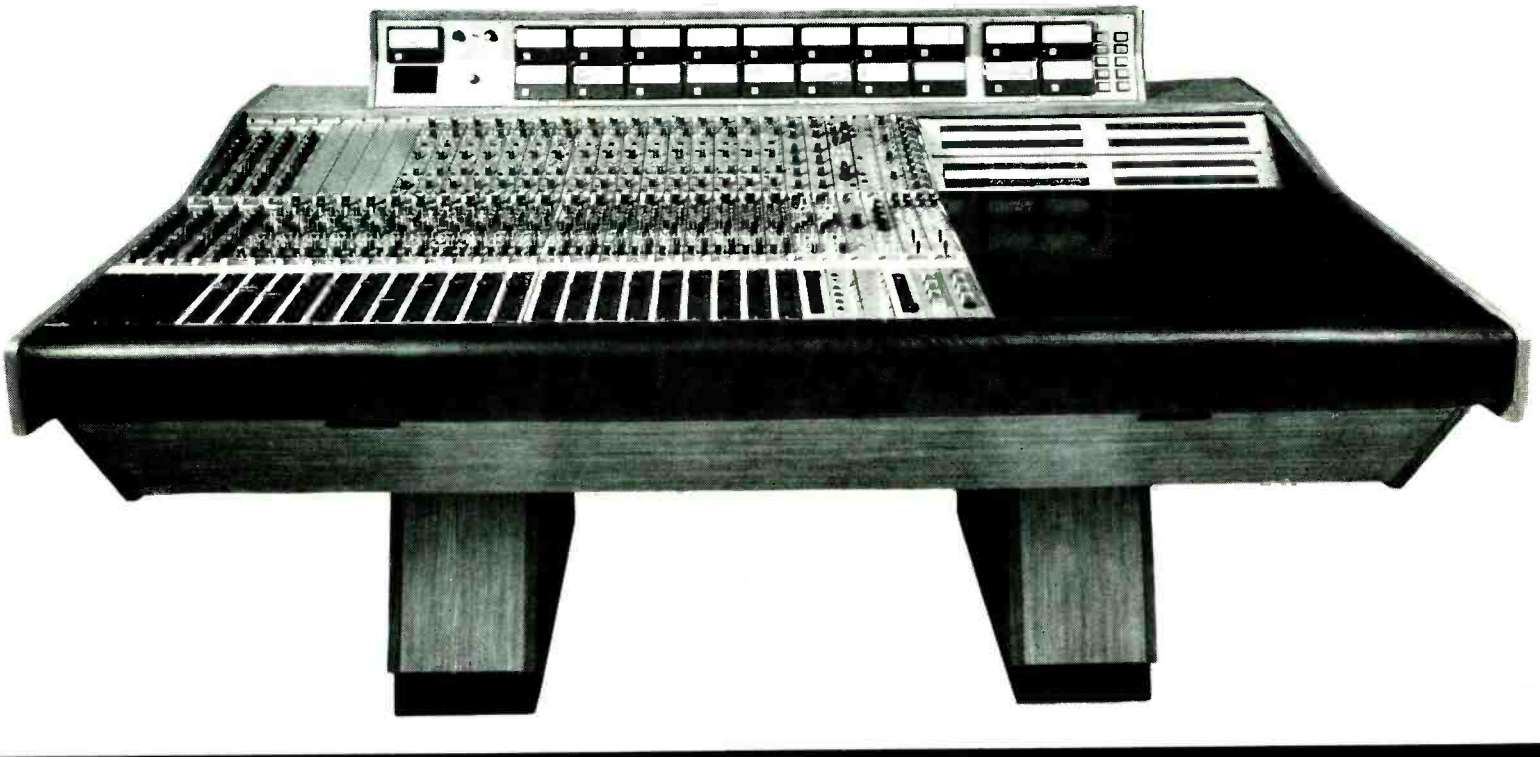

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studio sound

AND BROADCAST ENGINEERING

Playback studio equipment is not the most glamorous of hardware, and disc jockeying is not the groovy pinnacle of the studio business. Largely this is a hangover of the early amateur days of ten years ago when the most noticeable shared characteristic among playback people was something going wrong. Now, the demands for slickness and creative presentation are rather more consistently realised, and a particular delivery skill has developed owing rather more than to just a wing, a prayer, and a calm sea and prosperous voyage.

The feedback of demands from djs and radio stations has resulted in cue linkage systems permitting sequential control of operations; this can be extended in principle as far as necessary, and logic systems can enable an operator to tighten up program aspects beyond that which a two-handed dj could reasonably cope with in real time. This directly parallels the use of automation in music remixing.

The main thing which has been lacking for too long is the technical quality of replay machines available. This can be particularly offensive in the US when tunes are transferred to cartridge for repeated broadcast and then further abused with rather more compression than coverage really dictates. Hopefully, with the arrival of azimuth-adjustable cartridge systems and the second generation Unisette player we have the chance to improve on the situation which has probably festered unduly because of the absence of viable competition in the quick-access tape area. Such developments are long overdue.

If these improvements are forthcoming, then such convenience could easily find its way into the ideally uncompromising sonic areas of the music recording studio, particularly if control could be integrated with the rest of the remix paraphernalia. Such control is child's play compared with the automation systems available, and could be easily developed and marketed. Cued systems would relieve the frequent pressure on space that an effects-oriented multitrack master has to bear, and would make setup of those effects much simpler than present rather tedious transfer jobs.

contents

MAY 1976 VOLUME 18 NUMBER 5

Congratulations

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on new arrivals

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RELEASE: sets attenuation time of filter or gate

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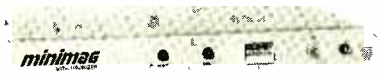

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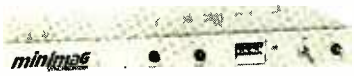

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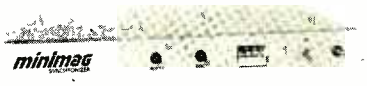

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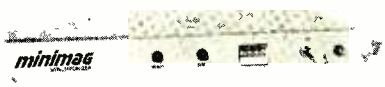

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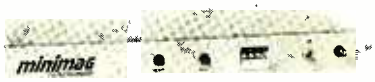

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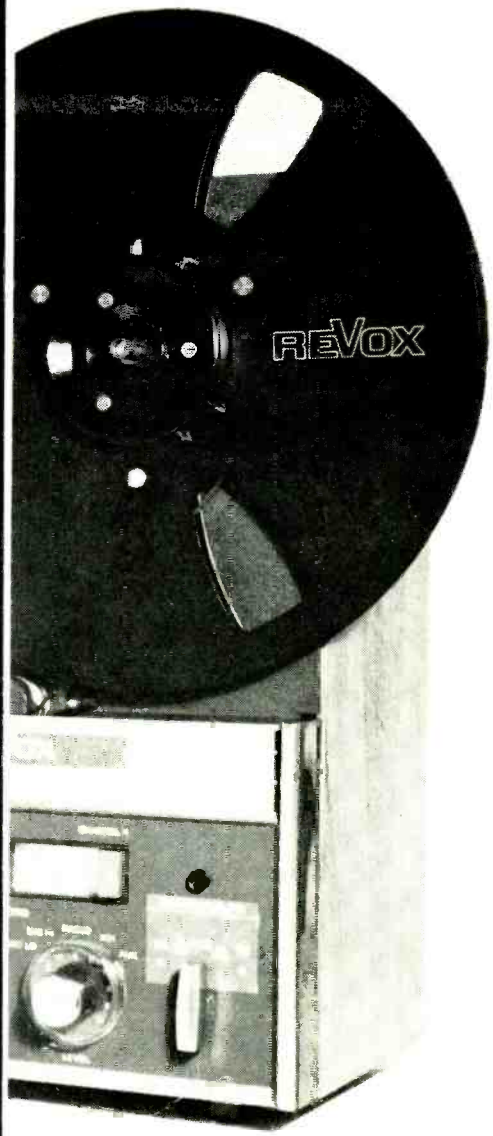

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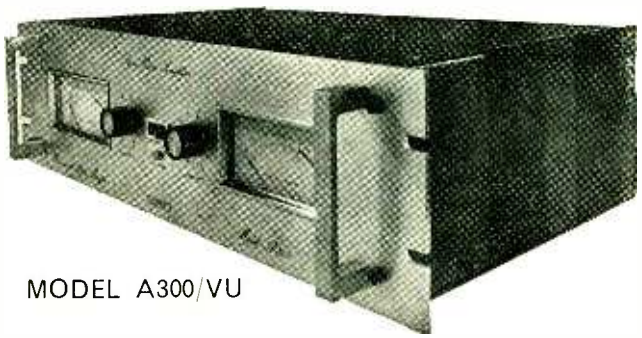

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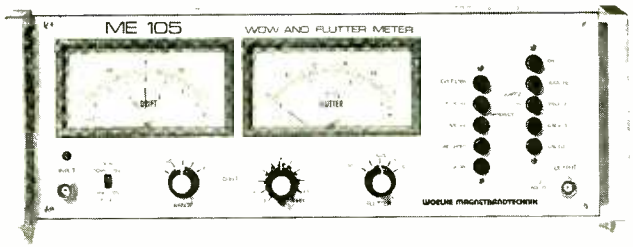

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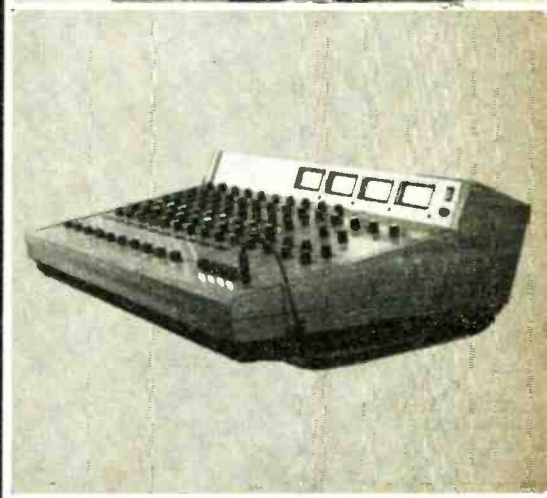

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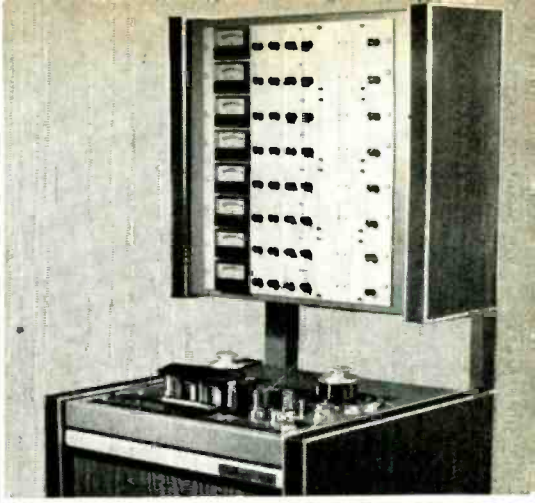

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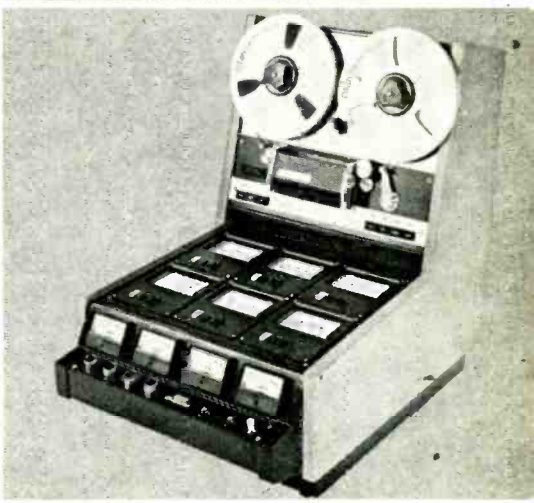

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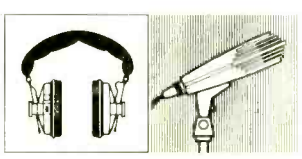

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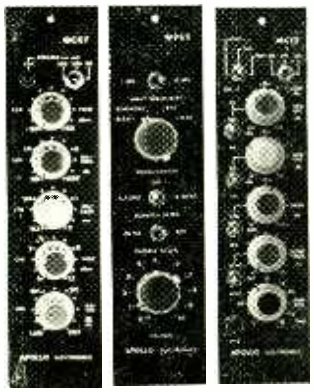

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Necam

The Neve computer-assisted mixdown system has been a long time coming. Long enough for its basic features to be common knowledge when it arrived, and long enough for the advantages and disadvantages of a mechanical as opposed to the now conventional vca systems to be superficially debated. Much of the philosophy behind what is paradoxically seen as a radical departure from techniques which were initially in themselves a break with tradition has been presented in various papers in the US by Geoffrey Watts, and in Derek Tilsley's article in STUDIO SOUND of October last year (along with Paul Buff's contrasting Allison Research vca discussion).

For a broad appraisal of the ideas behind both techniques, and their differences, it's useful to refer to these past articles. While the new Neve system, introduced publicly in March, offers wider scope than can be covered here, it's worth summarising the departures. The basic system configuration is shown alongside, and represents a development on current procedure in several respects.

For the first time the link between multitrack tape machine and mixer becomes more than a human connection. Commands affecting both are entered on a small, simple keyboard. The processor which controls the channel levels is also co-ordinating them with the tape transport via a simple interface governing normal transport functions and tape/head lift. The code on tape is simply basic SMPTE time code, with the 25 frame/second resolution, and this links via the processor with the control signals appropriate to that time segment. Data storage is on a conventional floppy magnetic disc whose capacity is claimed to be more than sufficient for typical usage. If necessary, data can quickly be deleted (selectively), relocated, or even transferred to another disc.

The dynamic tape control is not conventional in that continuous contact between head and tape is not necessary, with obvious advantages in lack of wear. The processor assimilates the characteristics of the transport and dictates transport conditions according to the journey specified, be this of rewind through 2½ minutes or complete tape search. Faced with an unfamiliar tape machine, the logic still performs a certain amount of hunting before coming to rest on a particular frame, but this inaccuracy lessens with repetition. In the first London demonstration, several of the rewinds were carried out with a single tape movement only, the tape coming smoothly to rest in the appropriate place. Tape contact with heads occurs sometimes briefly during the rewind, as a check, and during the final location only. Overall, contact is less than might be expected during a manual search not depending on tape counter, and the contribution to head wear is slight.

The idea of servo driven faders is not new, but this is the first practical system to incorporate it. The basic channel facilities offered will include the particular fader, which is controlled by the processor and follows level commands in a mechanical and therefore readily identifiable manner. To update a channel setting, it is only necessary to grab the fader and move it as required: the computer then records the movement. Should the fader be left in a position not corresponding to the previous level setting at that point in the program, movement back to a previous reading will not take place until a channel level command is encountered.

Each channel fader has associated three way switching. *Manual* disconnects the computer commands, although the movements are still recorded and may be replayed in the usual manner. *Normal* mode is that detailed above. *Relative* mode gives proportional adjustment; in other words a shift at one time of some level will affect the whole mix segment, so that individual tracks may be raised relatively throughout without need for overall gain riding.

While the response time of the fader can be fast, and in practice as fast as can be achieved manually given the frictional drag felt (which is a marked contrast in 'feel' with conventional systems) it is not sufficient for quasi-edit situations where instruments are brought in fast from nothing. A processor-controlled in/out channel switch facilitates this operation. Thus, levels may be set and channels dropped in and out at a very specific point. For example, a drum entry may be located manually, as if preparing to edit. This position can be labelled, and the channel then brought up at this point as fast as any splice and without the danger of irreversible razor blade action. Thus, complex changes can be wrought within one mix provided it is continuous on the multitrack tape. Since further tape machines could be linked it's obvious that crossfades and any other peripheral control required are also facilitated.

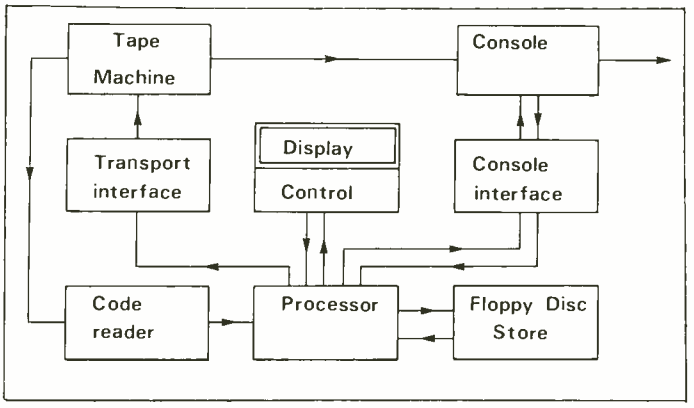
As a mixdown session proceeds, different takes are carried out, and different options established. These are recorded as separately numbered takes, and can be recalled independently and irrespective of the number of updates carried out subsequently, providing of course that the data storage limit has not been exceeded. Thus, it's possible to return to a particular stage in a mix and restart, as it were, rather than returning right back to the beginning.

Due to the synchronisation between the processor and the tape time code, further refinements become feasible. 'Time' is defined by the code, not by the speed of the tape passing the heads. Thus, it is possible to do a number of things by relating to this code which are not easy with conventional systems. The most immediate is the merging of different mix segments. By labelling different areas of the music, different sequences can be established. These may be mixed entirely separately and independently. The data may then be sorted, and the information for the two sections laid out sequentially in the disc store, so that the mixer can 'edit' two sections together which he has worked on separately (provided, of course, that they are sequential musically).

There are things to be anticipated at the changeover between sections, but these are directly parallel with normal editing continuity thoughts anyway, and are no different from those already observed. The changeover point may be located as for an edit, by hand, and then registered with the computer memory. Again, this gives the option for mistakes to be corrected, not always so easy with a razor blade and slivers of tape a few millimetres short. By use of the channel in/out facility, faders may be preset and brought in instantaneously at any point; such an operation does not rely on a previous signal to in/out the channel, for such information is stored as a state function, which the computer recognises immediately it appears and adjusts accordingly.

The merge facility may also be split further. Separate groups of tracks may be mixed within a take such that one section from one is desired whereas one from another take might be considered more appropriate for another section. Selected tracks may be merged between separate mix takes, as required. This is where possibilities far beyond conventional techniques begin to open up.

Sub-grouping feeding the main groups is simple and convenient. A short command operation establishes one fader controlling any number of others directly, all servo driven, with all the relative functions already detailed immediately accessible. For external output group switching other than



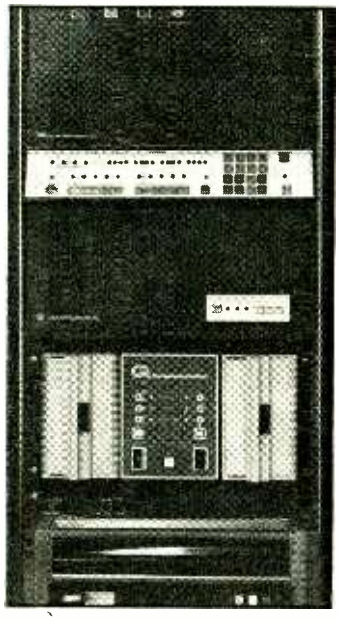
Previous page: *display control unit of the Necam system.*

This page below: *view of the mini-computer.*

Left: *the console with automatic fader control.*

Mic survey boob

We quoted the address for Hampstead High Fidelity, agents for the CE range of microphones, as 91 Heath Street, Hampstead, London. It's not. The survey entry (April 76, p38) should have read: Hampstead High Fidelity, 63 Hampstead High Street, London NW3 6SS. Phone: 01-435 0999/6377.



the main mix groups, control is available which extends also to in/out switching as usual. This is available through the more familiar led null indicator level matching rather than the servo faders, although these are available if necessary. Pan is dealt with in the same way.

Equalisation has not been computer-assisted in this NECAM system, the reasoning being that level control is the bulk of the problem, and in any case if particular equalisation treatments were required, they could be hand operated far more conveniently than in a conventional mix situation. However, it's obvious that use of subgroups feeding outboard eq can be controlled, so that some degree of such control is possible with a bit of inspired routing. With the channel facilities available, it would be possible to control every band of a graphic equaliser in this way; perhaps that's a bit extreme, but it's there. Similarly, other peripheral equipment feeds, and returns, can be set up under computer control, although actual equalisation and external functions which need changing during the course of a mix are generally small. For console setup, additional storage is available to recall a position of the console; this simple facility has been supplied on Neve broadcast consoles already over the past year.

It's too early yet to even speculate about the possibilities of such a board, but it begins to be clear that there could be far reaching consequences for the normal procedures in mixing and general album session routines. At present, the technique is to take one track of an album at a time and mix it to finished state. This becomes defined as a data track on the multitrack or, in non-automated studios, a master tape. The increased tape control and flexibility of NECAM means that an album could start as a series of rough mixes which could then be worked on gradually when and where inclined until the whole set of 24 track masters was felt worthy of the name 'master'. Then the transfer to the master tape as such takes place.

Thus, the old problem of remixed tracks sounding fine in themselves but not so good when in context is avoided. While this is possible with vca systems, the increased flexibility seems more encouraging for such approaches here. An additional encouragement is that it is impossible to erase information on a master during computer assisted mixdown, since there is no recording action taking place, unlike present systems which rely on data track jumping. Slave tape machine systems coming from other manufacturers resolve this problem at the expense of a separate additional tape transport.

The recording process may more conveniently be controlled. As a track is built up, the monitor group feed to the control room may be treated as it might be in the mix with no extra bother. Thus, as the overdubs went on they would sound more in context, in contrast with the present normal operating situation where a straight monitor mix comes back with no variations and the musician has to use correspondingly more imagination. Musically, that overdub is close to the original meaning. Similarly, the foldback sends are controlled. Once set up, any changes and relative levels would be repeated automatically at a point in the music until an alternative command was given. By giving a clearer idea of the eventual product, much repetitive trial and error could be eliminated.

The system is not cheap, starting at around £25 000, with correspondingly augmented US prices for a 16 channel system of faders, processor, store and tape machine interface. Production time quoted is about nine months, and interface is with recent Neve boards. Tape machine may in principle be any available make, with successful trials carried out with Studer *A80* and 3M *M79*; the Studer needs some additional modification to the tape/head lift mechanism, but once converted is capable of normal connection and operation without readjustment.

It's up to you to do the sums and discover whether it's worth it in customer appeal. Certainly the impressionable producer may enjoy the faders doing their own weird thing untouched by human hand, and the visual display unit, which informs you as to the state of play and if you have done anything out of turn (in a very polite, English manner) may be available reading anything you like, or even linked to the clock and making a conversion to pounds, dollars or the time in Tokyo. And it's up to your friendly neighbourhood A&R department to decide whether the extra hourly cost delivers better product in less overall time. Whatever, orders are confirmed for Air Studios, and the Music Centre, London.

Michael Thorne

Robinson mixer

Since February, David Robinson, designer of the 'Studio Quality Mixer' (series of constructional articles appearing in STUDIO SOUND throughout 1970) has moved to the States to take up an appointment with Dolby Inc. He says that, although he no longer supplies circuit boards for the project, he has arranged for continued production with Mike Crowther-Watson of Euro Circuits Ltd, Highfield House, West Kingsdown, Sevenoaks, Kent.

Naturally, this company can't answer questions of a technical nature although they hold a series of reprints of the article. However, if people are totally at a loss for assistance, David Robinson can be contacted at Dolby Laboratories Inc, 731 Sansome Street, San Francisco, Ca 94111, USA. He further states that letters arriving without an international reply coupon 'will be thankfully ignored'.

Cuba

Neve has completed a series of contracts in Havana, Cuba, including the installation of a 20/4 pa desk at a 5000 seat concert hall. The company has also installed a

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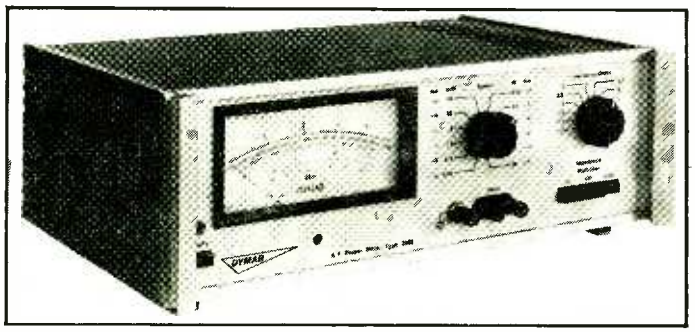
couple of 12/2 desks at an open air theatre and amusement centre predictably named 'Parque Lenin' of the outskirts of das kapital. They further report there were no problems arising from the location of the stage, a floating podium in the middle of an ornamental lake 'which moves during performances.'

Rupert Neve & Co Ltd, Cambridge House, Melbourn, Royston, Herts SG8 6AU. Phone: 0763-60776.
USA: Rupert Neve Inc, Berkshire Industrial Park, Bethel, Conn 06801. Phone: (213) 469 4822.



Dymar 2085 audio power meter

Audio power meter

Although rather better known for communications equipment, The Dymar company manufactures some very useful audio test gear—a spinoff from the communications side of the business. The latest product to be announced is an audio power meter type *2085*. Reading out on an 11 cm moving coil meter, the instrument provides full scale deflection in 12 ranges between 150 μW and 50W. Input impedance is switchable in 39 steps between 1.2 and 1000 ohms; each value is capable of dissipating up to 50W continuously.

The instrument uses a temperature compensated square law detector giving true power readings on a reasonably linear scale. Frequency range is quoted as 30 to 30k Hz for fsd accuracy within ±2%. The sensitivity of the meter allows direct readouts for signal-to-noise ratio calculations. An additional calibration of the meter scale from -18 to +47 dBm is provided. Dymar Electronics Ltd, Colonial Way, Radlett Road, Watford, Herts WD2 4LA. Phone: Watford 37321.

dbx for Nagra IVS

The *192* two channel switchable noise reduction unit has been specifically designed for use with the *IVS* recorder. It measures approx 22.9 x 17.8 x 3.2 cm. Mounting brackets supplied allow easy attachment to the base of the machine. Connection of both signal and power lines from the recorder is made by a single seven pin DIN connector/cable assembly.

The *192* incorporates no internal power supply; this makes for a compact unit. Current drain from the recorder's internal batteries is about 33 mA resulting in a reduction of operating time per charge of around 20%. Using the standard dbx comparision principle of 2:1 decilinear, the manufacturers claim an effective noise reduction of around 30 dB unweighted system performance. Other bonuses include a quoted 10 dB increase of headroom and an unspecified improvement of print-through.

The unit costs £368 dbx Inc, 296 Walton Street, Waltham, Mass 02154, USA. Phone: (617) 899 8090.
UK: Scenic Sounds Equipment, 27/31 Bryanston Street, London W1H 7AB. Phone: 01-935 0141.

Quadraphony in USSR and Poland

According to a recent announcement by Moscow radio, which has come as something of a surprise, the USSR has begun experimental quadraphonic broadcasting. The experiments, carried out on the basis of work done by the Popov Institute in Leningrad, used four discrete channels in the vhf band and were broadcast by the Leningrad radio. Apart from being an interesting development in its own right, at a time when there is some flagging of interest in quadraphony in the West, it is an interesting reflection of the growing consumer orientation of this communist society. The only other East European country known to be experimenting actively with quadraphony is Poland, which is already producing quadraphonic audio equipment for the consumer market. It seems more likely that Poland will use a subcarrier or 4-2-4 matrix system for its broadcasts, though few details of plans have been released as yet. Meanwhile the Polish equipment manufacturer Unitra, which itself produces equipment under French licence, has designed and produced a tape recorder which is to be sold in France in stereo and quadraphonic versions under a French manufacturer's label.

John Fisher

Columbia

Traditionally, people of sound mind steer clear of patent and trademark disputes. No one has yet summed up the situation better than the high court judge, in 1892: 'A man had better... have anything happen to him in this world, short of losing all his family by influenza, than have a dispute about a patent'. There have for years been the makings of numerous, meaty trademark disputes in the recording and broadcast world. For instance, in the USA the trademark 'Decca' is owned by MCA, but by Decca in the UK. Thus USA Decca releases are handled by MCA in the UK. RCA in the USA hold rights on the 'His Master's Voice' doggie logo and in Spain, Columbia are the agents for Decca. Most widely known however, is the fact that the mark 'Columbia' belongs to CBS in the USA but EMI in the UK. This is widely known because the companies involved spent their life savings arguing the

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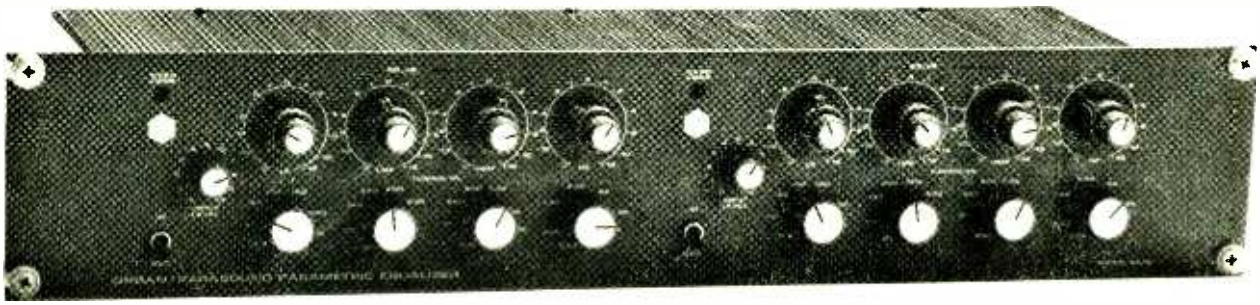

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For full information or a demonstration of the 516 EC dynamic sibilance controller, the 621B Parametric Equaliser or any other Orban product contact:

Scenic Sounds Equipment, 27-31 Bryanston Street, London W1H 7AB. Phone No. 01-935 0141.

Orban/Parasound San Francisco, California 94109

point in court last year. A transcript of those proceedings has just become available and it makes both entertaining and informative reading.

Originally, all CBS SQ discs were imported from the USA, but legal trouble arose because the imported discs were inevitably emblazoned with the trade mark 'Columbia'. At first, relations between EMI and CBS were friendly, and an attempt was made to paste stickers over all visible references to the word 'Columbia' on CBS records reaching these shores. But before long relations soured, with CBS reckoning that there was no need to put stickers on the disc labels as well as the sleeve. EMI reckoned otherwise and applied for an injunction to prevent further CBS 'Columbia' sales.

Evoking memories of the Monty Python 'Dead Parrot' sketch learned counsel argued in Court that 'CBS are using a trademark without any lawful right . . . they are impostors; their goods, so far as they bear that trademark, are spurious; they must be stopped . . . CBS lack any legal title to them. There was even talk of embezzlement'.

But, mellowing a little, Counsel then re-assured the court, 'we are not in any way seeking to deprive the European public of the opportunity of hearing Mr Dylan singing *On The Tracks* (sic). The learned judge subsequently proved himself (understandably) thoroughly confused about quadraphonics, but let slip the interesting piece of information that over the three preceding years only 60 000 quadraphonic records in all had been sold in the UK.

Although the British judge finally decided to grant the injunction blocking the sale of further CBS 'Columbia' discs in the UK, he did so only as a temporary measure, and referred the whole question to the EEC court in Luxembourg for a final ruling. CBS UK had, of course, no option but to abide by the injunction in the meantime. They were, however, free either to press SQ records in the UK or resort to complete stickering of both the disc label and sleeve. According to the court record this is said to cost only 3.4p per individual record. But as previously reported (*UK*-4, STUDIO SOUND, March 1976), there was no sign of either course of action being adopted.

The European court in Luxembourg has just now finished hearing the case, and both EMI and CBS are doubtless biting their nails, waiting for the final, and potentially far-reaching decision that is due any day now. The largely unnoticed irony of the situation is that if EMI wins in Luxembourg the main effect will be nails into the coffin of SQ in the UK—even though EMI is currently issuing records only in SQ format.

Adrian Hope

Noise

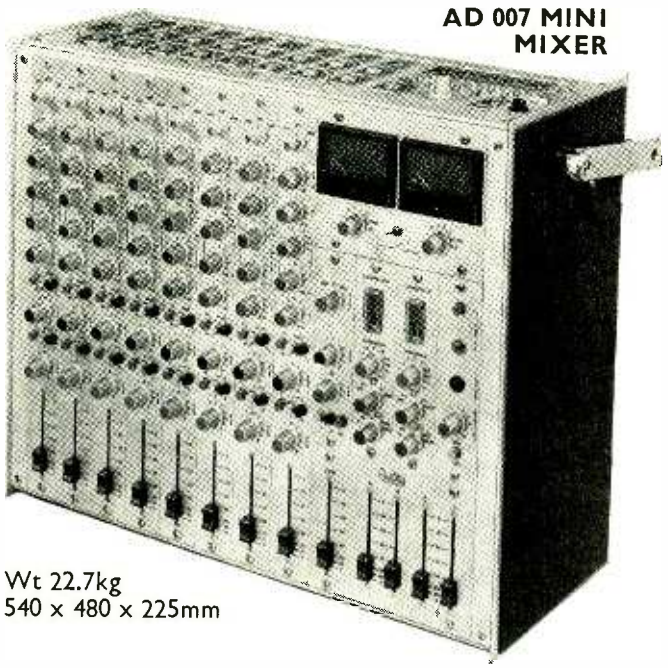
Although the code of practice finally adopted by the GLC is more liberal than the draft code almost universally criticised it could still put a stop to some of the longer, louder events if enforced. By a happy coincidence a move is afoot among manufacturers of high power audio equipment to protect their interests against what is seen as potentially dangerous moves by the GLC, to curb sound levels too drastically. Dave Martin, of Martin Audio, and Dave Cottam, active in marketing high power audio equipment and himself a musician, are currently inviting anyone else in the industry concerned at the sound level limits proposed by the GLC (and previously dissected in these pages) to contact them, c/o Martin Audio, 54/56 Stanhope Street, London NW1. Phone: 388 7162.

While welcoming any moves to control cowboy lunatics in the pa business, Martin and Cottam are anxious to nip in the bud any further hardening of the GLC line. Says Martin: 'Whereas you can drive a car at exactly one mile per hour under the legal speed limit, the dynamic nature of music makes it quite impossible for a band to play at 1 dB under the proposed GLC peak limit of 102 dBA. So groups will have to average around 10 dBA under the legal maximum to cope safely with drum breaks—which means the decidedly low average level of 92 dBA for a live concert'.

Anyone interested in obtaining a copy of the GLC code in its final form, should approach County Hall with £1.50. In return they will receive not only the code but a reprint of many of the comments made of the original draft. Pride of place among these must go to that made by the BBC who, it now emerges, 'fully support the basic premise of an equivalent continuous sound level of 90 dBA'. Thus if the BBC could have their way there would be no pop music in London.

Adrian Hope

AD 007 MINI MIXER



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Cartridges: technology and practice

THOMAS A. LEE *

There are in common use at present three types of pre-loaded tape packages supplied loaded with a length of tape and used for pre-recorded speech or music: the Philips compact cassette, the Learjet 8 track cartridge and the 'NAB' cartridge. Whereas the former two are in common domestic use the latter is used by broadcasters. The following article refers to this, and explains some of their facilities and the reasons why they are becoming increasingly popular in the studio environment.

*Lee Engineering Ltd, Walton-on-Thames, UK.

History and Evolution

Cartridge recording for audio originated in the United States in the mid 1950s when the original patents were issued to Eisch of Conley Electronics. Around the same time Cousnio also developed an endless loop design. These two parties were in dispute for some years, each claiming to be the originator of the tape cartridge. It looks in retrospect as if, in spite of the patent issuance, the original cartridge idea was an outgrowth of the 16 mm film cartridge which had been in use for educational and industrial applications for years, prior to borrowing the idea for 6.25 mm magnetic tape.

So far as is known, the first applications for cartridge recording in radio broadcasting were accomplished by the radio station engineers using a proprietary cartridge deck and building their own electronics. These first machines used foil sensing to locate the beginning of the message on each cartridge. In 1958 the founders of Automatic Tape Control in Bloomington, Illinois, developed the idea of using cue tones on a separate track for automatic cueing and obtained the patent on the cue tone principle for cartridge recording.

In 1963 the National Association of Broadcasters recording and reproducing Standards Committee organised an industry and broadcasting group to develop standards for cartridge tape recording which resulted in the document issued in October 1964. This was a rare and excellent example of industry and broadcasters working together towards the common good, and the cue tones finally adopted are very similar to the tones originally devised by ATC.

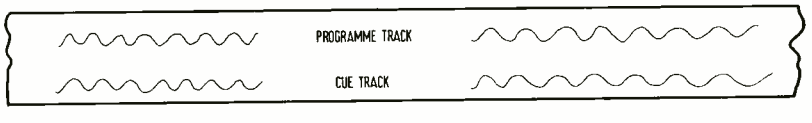
These NAB standards are in common use with broadcasters in the UK, except that the BBC uses NAB and the IBA/AIRC use the CCIR audio response characteristics; more on this later. The first 'professional' cartridge machines were introduced on the market in 1958-1959 to broadcasters, and in the next few years cartridge units were being offered by almost every broadcasting equipment manufacturer in the US. In their area of application, cartridge recorders have made a profound impact on the manner in which commercial traffic, spot announcements and jingles are handled by broadcast stations around the world, the evolved format being a single length of lubricated 6.25 mm tape fitted to a single spool inside the cartridge. The length of tape in standard NAB format varies from 20 seconds to 31 minutes and there are three cartridge sizes designated A, B and C. A bulk erased tape is used as there is no erase facility on any NAB cartridge machine, this being considered undesirable in the studio operating environment for obvious reasons.

There are three standard cue tones, 1 kHz primary, 150 Hz secondary, 8 kHz tertiary. Equipment in basic form is supplied with the 1 kHz primary cue tone with the secondary and tertiary optional extras. In practice, the action of pressing the 'record' button introduces a short burst of 1000 cycles on the cue track which is used to locate the beginning of each message or recorded portion of a cartridge. The two other cue tones are available for arbitrary assignment. The 150 Hz cue is normally used as an 'end of message' tone and in the field of programme automation is used to start the subsequent event in the programme. The 8 kHz is used, for example, in television to trigger automatically slide changes during a cartridge 'commercial' or in programme automation as a logging tone to identify the commercial being broadcast at that time.

Since in cartridges the endless tape loop is constantly rubbing other layers of tape, the quality of the audio programme can be affected by the cartridge itself. This is particularly true if the cartridge player does not provide sufficient torque to overcome the binding which can occur as the tape pack varies. In the best professional equipment, a massive direct drive capstan motor is used with a large diameter slow speed capstan to provide a reserve of pulling force to minimise such problems in the cartridge. Also, in practical use broadcasters require a virtually instantaneous start, rather like the slip-cueing technique used with discs/records, to enable them to

Capital loading the cartridges

FIG. 1 DIAGRAMMATIC REPRESENTATION OF RECORDING OF PROGRAMME AND CUE(S) DURING RUNNING TIME OF CARTRIDGE



sustain an up-tempo delivery. One of the measures of a good quality broadcast machine is its ability to get started with an aurally undetectable start-up, without any consequent wow or flutter and to be able to do this all day and every day for several years. Smaller units have marginal size drive systems and can have poor wow and flutter characteristics.

Another potential problem in tape cartridges is tape-skew as the tape passes the corner post just before passing across the record and play-back heads in the machine. Early cartridge equipment relied on the moulded plastic guide within the cartridge itself for tape guidance. This was not satisfactory and could cause loss of high frequencies in some cases, and extreme phase problems in stereo recordings.

The latter two to three years have found cartridge equipment users creating their own requirements. In television, for example, the convenience factor of having a number of cartridge machines with a library of pre-recorded sounds enables the television programme companies to do their own sound or film dubbing within moments. In this context, had the equipment been difficult to handle or been unreliable the studio operators would have found reasons for not using it. In the event the converse has applied. Also, latterly, the successful disc jockeys have had their own dj facility built in their homes and are now able to produce their own programmes. The functional convenience of use and reliability of modern cartridge machines continues to expand their popularity. In the US the top 20 or 40 contemporary hits are recorded on to cartridges and automatically played; in fact in some stations discs are hardly used.

One of the questions to which we should draw attention is that until recently the industry was working on a cartridge standard produced by the NAB and last revised in 1964 as stated previously. These standards were very loose, not so much in the electrical characteristics but in physical dimensions. Now, over the last several years, the BBC have been using cartridge techniques, with NAB frequency response characteristic; and more recently in the UK the IBA controlled commercial radio station have specified the CCIR recording characteristic. Thus, standards begin to be a problem.

The IEC committee decided some while ago to improve the various characteristics of the NAB cartridge format. One of the problems is the various sizes of cartridge being made, of different thicknesses; another is the height of the tape passing across the heads. At the 1974 NAB Convention in Dallas, contact between the NAB and the IEC committee was made to ensure that the revision of the latter's standards would be compatible with the NAB standard. The NAB committee was quickly reconvened at that time.

But there is more to standardisation than that. During the last week of that convention I spoke to every cartridge machine manufacturer at NAB, and most other cartridge manufacturers. Naturally, the cartridge makers took the view that they were in business and therefore supplied cartridges that fitted the cartridge machines that were being used. As an example, two results are differing head heights and different head penetration into the cartridge from different manufacturers. This gives some idea of the general looseness of the NAB specification as it stood. Over the last year or so, a committee headed by Jack Jenkins, of International Tapetronics, Gates and others, has been active. BBC interests were represented by Cecil Henocq, of their Designs Department.

Presently, continental Europeans do not generally use cartridge techniques, as much as the UK. One of the reasons for the BBC and the IBA being interested in a tighter specification for cartridge machines is because the worst shortcomings of cartridge machines manifest themselves when operating in the stereo format, particularly if a stereo source is used and then merged together to give a mono signal.

Application and uses

The reason for the increasing success and acceptability of the cartridge technique, in spite of its shortcomings, is because of its instantaneous ability to let the operator have a unique or discrete message, that is to say one cartridge has one message. And that cartridge can be pulled in or out of the machine in an instant so that a machine or machines can be set up to switch quickly, one to the other. You can have several programme sources which you can change very rapidly. While you can of course have these sounds on a reel to reel machine, you have also to find them. Also you cannot separate those messages in that format, if you want to take one message to one studio and another message to another studio, or even a different site. Now, typically, cartridges have recorded on them station identifications, commercials, programme previews or sound effects.

We take, say, a typical circumstance at the BBC or one of the commercial stations. A disc jockey who has got quite a spell to do will go into his studio not only with his pile of records but his bagful of cartridges. Each cartridge is labelled as such. Therefore he can pick up a cartridge which has a label on the front telling him that is the *Cadbury advertisement* or that is *Next week's preview for Take it From Here* or *Take Your Pick* or whatever. The whole acceptability of the dj operation is linked to a high pace of delivery; we must not have a moment's silence. So the cartridge machine or machines allow the disc jockey to operate himself and with the instant start of the machine, he can control from the moment when the sound is going to come in. Remember, it is only the disc jockey who knows exactly when he is going to stop talking. You could of course have an external operator in the studio. But if you're just doing one or two of those you still have to remember there are several programme sources and the whole thing must have a sustained pace, to give the right sort of delivery. It's difficult to coordinate.

It is also a fact that, increasingly, cartridge machines are being used by disc jockeys on road shows. Again, they need the fast delivery and they like to bring in the numerous different gimmick effects, lighting or whatever, to get the whole thing going and to give a professional, polished sound. They cannot bring in all those sources of music so quickly, and from so many sources as conveniently as they can from cartridge machines.

The major shortcomings of a cartridge machine, compared with a reel-to-reel machine, is that the tape guide path for a cartridge is about 50 mm, which is from the corner post within the cartridge to the pinch roller capstan of the deck. This compares with about 250 mm for a reel-to-reel machine. The result is that you do not get

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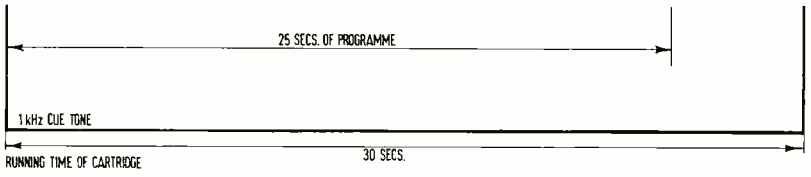
Capital broadcast studio

FIG. 2 USE OF ONE (PRIMARY) CUE TONE ONLY



such even reproduction. In practice, though, it is really fairly marginal, and if you consider some of the peculiar gimmicks and odd sounds which are put out on cartridge or radio perhaps we shouldn't worry so much anyway.

Despite this, cartridge machines have a very substantial motor built into them, far bigger than necessary just to turn a short length of tape at 19 cm/s, for it must have sufficient torque to give instant start. The rest of the machines are similarly built with extreme ruggedness, particularly the solenoid, which pulls the pinch roller and tape cartridge on to the massive capstan. One cartridge manufacturer uses a special 15 years aged machine-quality aluminium, 12 mm thick, to ensure that in long and extended hard use the machine and chassis will not warp from heat or mechanical shock. The path to various broadcasting stations and studios is littered with equipment manufacturers who have decided that they could make a cartridge machine a great deal lighter than necessary. Disc jockeys don't press switches, they *hit* switches. They don't gently ease a cartridge into a machine, they *slap* it into a machine.

A standard cartridge machine, as we said, has cueing facilities. These cueing facilities allow the operation of other equipment at a chosen moment; for example, a cartridge is recorded with automatic primary cue tone, the start point of the tape. If the equipment only has one (primary) cue tone, you may for example have a 40s cartridge, on which you record a 30s message; after 30s you stop recording, the machine carrying on for the remaining ten seconds and will then stop at the start, or primary, cue tone. Thus, the cartridge is 'cued' once more at the start of the message.

Very often, particularly in the automation application used, an additional two cue tones are employed. We speak of the first primary cue tone. Next we have secondary or what we call the stop, or end of message tone. Imagine again our 40s cartridge. We record a 30s message; at the end of that message we put on to the cue track our stop tone. Now that stop tone can, when the cartridge is being played, switch something else, another cartridge machine, so that there is an immediate carry-on of a programme; meanwhile that cartridge will carry on the additional 10s till the beginning of its own message. Again it has cued itself in the 'ready' position. So the second cue tone is operating as a control function for other equipment. The tertiary cue tone is put on anywhere at will, as a disc jockey may want to switch in some extra or extraordinary sound effect, or maybe even lighting. By means of these controlled signals this can be done with a minimum of operators and with maximum tightness. These control signals, apart from the primary tone, can be put on to the track at any time, any number of times. Another possibility is that you may have several messages on one cartridge tape. So we have a start signal, followed by a message, with a stop signal. We have another recorded message, complete with its start signal, and another stop signal. At any point along there the tertiary or first cue tone signal can be placed any number of times. And there is nothing to stop us putting the stop signal there, any number of times too. So the machines also allow the interlock by the sequential follow-on control, of many units and thus whole programme units may be compiled.

Another interesting application is the production of soundtrack for film and soundtrack for commercial jingles. At Yorkshire Television, they have a very effective operation whereby they take their location shots and build the whole sound track in the dubbing theatre. After the film is shot, they take it back to the studio and the sounds are dubbed on. A shot in a film which lasted about 30s could be conveniently handled by cueing these machines, attempting much the same end as in conventional film-sound studio techniques. And it would not take long to prepare.

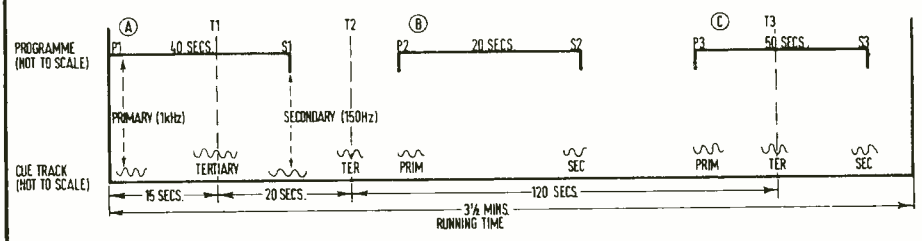
In the USA, something over 600 of the broadcasting stations have some form of programme automation. This depends almost entirely on cartridge techniques, whereby music and sound, commercials and effects, are accessible via automatically controlled cartridge machine players. It is possible to use a reel-to-reel machine but again a reel-to-reel machine does not give such quick or random access. In the USA there are several Top 20, Top 40 or Top 100 stations which just retransmit over and over, all day, every day. These records are interspersed perhaps by local news, station identification, commercial and network programmes. By means of a programme, which really is a preset switching, you can switch from any number to any number of programme sources to bring in these facilities. All of your top 20 and 40 are going to be on cartridge, all of your commercials on cartridge, even your station identification is going to be on cartridge.

The only thing that can't be quite so convenient on cartridge is the local news, although this is probably on cartridge anyway and slotted, with perhaps updates two or three times a day. Then there is the network programme, which is switched in automatically by means of the switching circuits available. At this level of required convenience, programme stations exist on programme material coming from cartridges. A local station may be quite a small facility, outside the town; typically the station manager may go in in the morning and set up the rest of the programme for the day, bearing in mind his station has been automatically switched on at 05.00 if it went on the air during the night. The station manager sets up his automated programme for the rest of the day. He then, say at 10.00, goes on to the town to sell commercials, find or interview people or news items, leaving the station in the hands of his secretary, who types out the invoices for the commercials and reports for the FCC. He may come back in the evening and replay his interviews or maybe even a live interview. Now he may have an engineer who works from 09.00 to 17.00 or someting, who is not involved in controlling or operating on air, or with the transmission equipment, all of which works quite satisfactorily and very reliably on its own when set up to an automatic system.

A lot of people think that automation may sound automated but you can really be sure that it doesn't have to, given thoughtful operation. There are various devices and techniques for making it sound more live than live. You can pack a programme more tightly than any disc jockey could sustain. You are even able to get, in the mornings when people want to know these things, the time announcements from cartridge. The whole thing can be very, very polished.

BBC Radio One studio

FIG. 3 THREE MESSAGES/JINGLES A, B & C:-A IS STARTED BY P1 AND STOPPED BY S1, B IS STARTED BY P2 AND STOPPED BY S2, C IS STARTED BY P3 AND STOPPED BY S3 AT ANY ARBITRARY TIME. WE HAVE CHOSEN TO PUT OUR THIRD CONTROLLING SWITCH FUNCTION, IE. TERTIARY CUE, AND HAVE SHOWN IT AT T1, T2 AND T3



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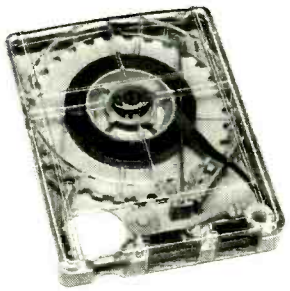

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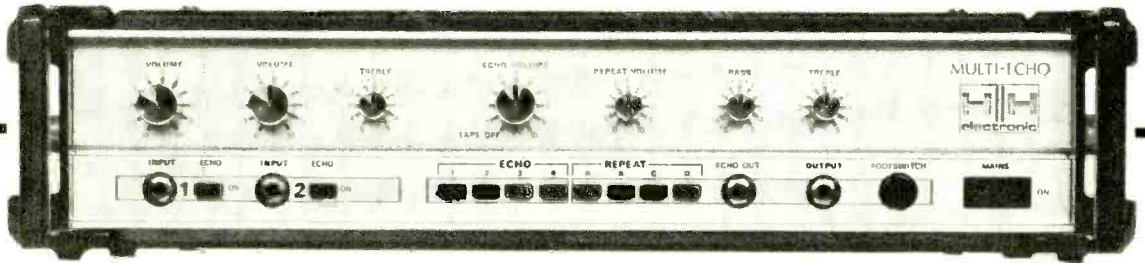

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Survey: tape cartridges

Forthcoming surveys
We would be grateful for copy on the following by the given dates:
July: Film sound equipment (April 30)
August: Studio consultants (May 31)
September: Noise reduction and control (June 30).

AIRCHECK

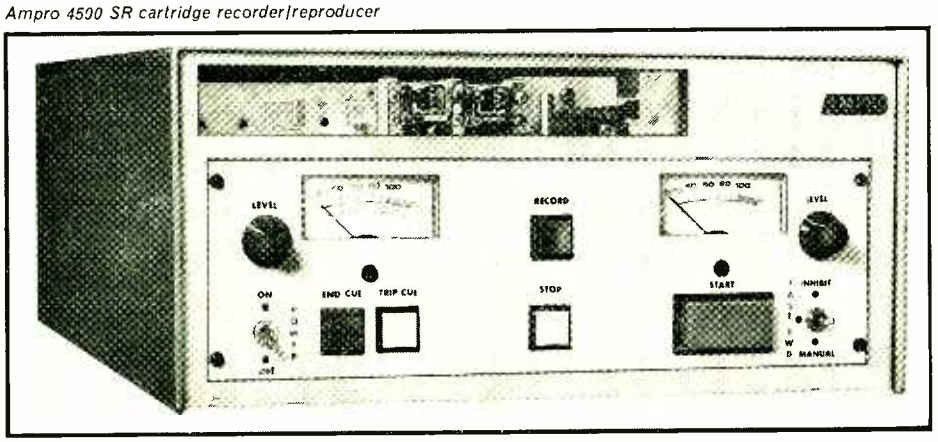
Sound Audio, Electronic and Video Techniques, 1 Oldershaw Mews, Maidenhead, Berks.
Phone: 0528-33011.

Format: mono playback, mono record/playback. Stereo record/playback.
Tape speed: 38, 19, 9.5 cm/s.
Cartridge size: NAB A.
Cue tones: 1 kHz stop, 8 kHz aux, 150 Hz aux.
Equalisation: CCIR, NAB, IEC or optional.
Frequency response: 45 Hz to 14 kHz ± 2 dB at 19 cm/s.
Crosstalk: —54 dB.
Signal to noise: 57 dB stereo.
Wow and flutter: 0.2"„ at 19 cm/s.
Start time: 60 ms.
Stop time: 60 ms.
Weight: 16.4 Kg.

AMPRO

Ampro Corporation, 850 Pennsylvania Blvd, Feasterville, Pennsylvania 19047, USA.
Phone: 215-322 5100.

Ampro 4500 SR cartridge recorder/reproducer



UK: Leevers-Rich Equipment Ltd incorporating Bias Electronics Ltd, 319 Trinity Road, London SW18 3SL.
Phone: 01-874 9054.

Basic technical specification
Tape speed: 19 cm/s.
Cue speed: 57 cm/s.
Cartridge size: NAB A, B, C.
Cue tones: 1 kHz stop, 8 kHz aux, 150 Hz aux.
Equalisation: NAB.
Frequency response: 50 Hz to 15 kHz ± 2 dB.
Crosstalk: 50 dB.
Signal to noise: 58 dB with 3% THD.
Wow and flutter: 0.2%.
Start time: 100 ms.
Stop time: 150 ms.
2500 Series
Format: mono or stereo playback, A carts.
Prices: $855 to $1140.
3500 Series
Format: mono or stereo playback, A and B carts.
Prices: $855 to $1140.
3500 Series
Format: mono or stereo playback/record, A and B carts.
Prices: $1540 to $2045.
4500 Series
Format: mono or stereo playback, A, B, C carts.
Prices: $855 to $1140.
4500 Series
Format: mono or stereo playback/record, A, B, C carts.
Prices: $1540 to $2045.

AMITY

Amity Schroeder Ltd, 3/4 New Compton Street, London WC2.
Phone: 01-836 7811.
Telex: 23197.

Cartmaster
Format: Stereo, mono playback or record/playback.
Tape speed: 19 cm/s.
Cue speed: 38 cm/s.
Cartridge size: NAB A.
Cue tones: 1 kHz stop, 150 Hz aux.
Equalisation: NAB.
Frequency response: 40 Hz to 15 kHz +3 -2 dB.
Crosstalk: -50 dB.
Signal to noise: 50 dB relative to NAB level.
Wow and flutter: 0.2"„.
Start time: 100 ms.
Stop time: 100 ms.
Price: £485 to £785.

CONSOLIDATED ELECTRONIC

Consolidated Electronic Group, PO Box 21, 15A Anderson Road, Thornbury, Victoria 3071, Australia.
Phone: 44 0791.
Telex: AA 32463.
UK Agents: Mellotronics Ltd, 35 Portland Place, London W1N 3AG.
Phone: 01-637 0692.

900 Series
Format: mono or stereo playback or record/playback.
Tape speed: 19 cm/s.
Cue speed: 57 cm/s.
Cartridge size: NAB A.
Cue tones: 1 kHz stop, 8 kHz aux, 150 Hz aux.
Equalisation: CCIR, NAB, IEC.
Frequency response: 40 Hz to 15 kHz ± 2 dB.
Crosstalk: 55 dB.
Signal to noise: 54 dB mono, 52 dB stereo with 3% THD.
Wow and flutter: 0.2"„.
Start time: 100 ms.
Stop time: 100 ms.
Dimensions: (w h d): 14.6 x 13.3 x 33 cm.
Weight: 11.5 Kg.
Price: on application.

EMT

Elektromesstechnik Wilhelm Franz KG, D-7630 Lahr, Schwatzwald, Postfach 1520, West Germany.
Phone: 07821 2053.
Telex: 754934.
UK Agent: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Hertfordshire WD6 4RZ.
Phone: 01-953 0091.
Telex: 27502 BAUCH BORWOOD.

Loopmatic
Format: *LU004* mono playback, *LU005* stereo playback, *LU014* mono record.
Tape speed: 19 cm/s.
Cartridge size: loopmatic 15 min max.
Equalisation: CCIR.
Frequency response: 40 Hz to 15 kHz ± 2 dB.
Signal to noise: 54 dB.
Wow and flutter: 0.15"„.
Start time: 500 ms.
Stop time: 200 ms.
Other: Tape may be recorded on either a full or half track studio recorder and loaded into Loopmatic cartridge.
Price: On application.

HARRIS/GATES

Harris Corporation, Broadcast Products Division, 123 Hampshire Street, Quincy, Illinois 62301, USA.
Phone: 217-222 8200.

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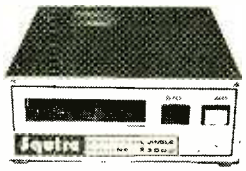

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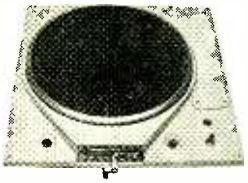

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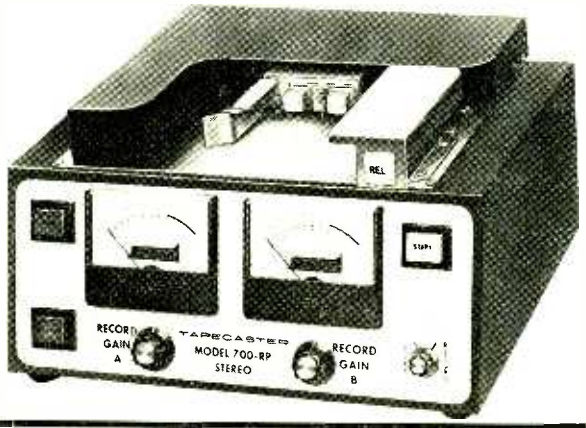

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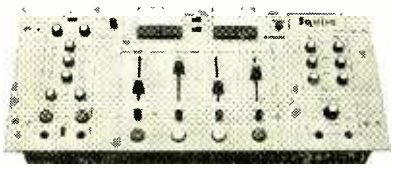

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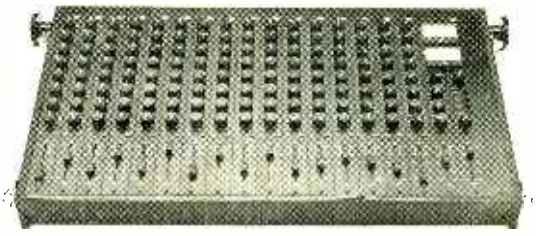

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Telex: 910-246 3212 HARISGATES QUI.
UK agents: Lee Engineering Ltd, Napier House, Bridge Street,Walton on Thames, Surrey KT12 1AP.
Phone: 09322 43124.
Telex: 928475 LEETECH WALTON.

CC-I
Format: Mono or stereo playback.
Tape speed: 19 cm/s
Cartridge size: NAB A and B.
Cue tones: 1 kHz stop; 8 kHz aux, 150 Hz aux optional.
Equalisation: CCIR NAB.
Frequency response: 50 Hz to 15 kHz ±2 dB.
Crosstalk: -50 dB approx.
Signal to noise: 45 dB mono, 43 dB stereo. NAB ref level.
Wow and flutter: 0.2%.
Start time: 125-500 ms, adjustable.
Stop time: 125-500 ms, adjustable.
Dimensions (w h d): 4.2 x 22 x 32 cm.
Weight: 9 Kg.
Other: Two units mounted in a 48 cm wide rack are also available.
Price: From £535.

CC-II
Format: Mono or stereo, playback or record/playback.
Technical specification as for CC-I but with optional record.
Price: On application.

CC-III triple deck
Format: Mono or stereo playback.
Technical specification as for CC-I but uses common capstan for three separately controlled decks.
Dimensions: 28.5 x 22.5 x 48.5 cm.
Weight: 17 Kg.
Price: From £1117.

ITC
International Tapetronics Corporation, 2425 South Main Street, Bloomington, Illinois 61701, USA.
Phone: 309-828 1381.
UK Agent: Lee Engineering Ltd, Napier House, Bridge Street, Walton on Thames, Surrey KT12 1AP.
Phone: 09322 43124.
Telex: 928475 LEETECH WALTON.

NP Series
Format: Mono or stereo record/playback.
Tape speed: 19 cm/s.
Cue speed: Available.
Cartridge size: NAB A, B, C.
Cue tones: 1 kHz stop, 8 kHz aux, 150 Hz aux optional.
Equalisation: CCIR or NAB.
Frequency response: 50 Hz to 15 kHz ±2 dB.
Crosstalk: -50 dB.
Signal to noise: 58 dB mono, 52 dB stereo.
Wow and flutter: 0.2%.
Start time: 100 ms.
Stop time: 100 ms.
Dimensions (w h d): 44.5 x 28 x 13.6 cm.
Price: From £998.

SP/WP Series
Format: Mono or stereo playback.
Tape speed: 19 cm/s.
Cartridge size: NAB A, B.
Cue tones: 1 kHz stop, 8 kHz aux, 150Hz aux options.
Equalisation: CCIR or NAB.
Frequency response: 50 Hz to 15 kHz ±2 dB.
Crosstalk: -50 dB.
Signal to noise: 58 dB mono, 52 dB stereo.
Wow and flutter: 0.2%.
Start time: 100 ms.
Stop time: 100 ms.
Dimensions (w h d): *SP* 21.5 x 25 x 13.5 cm, *WP* 44.5 x 28 x 13.5 cm.
Weight: *SP* 10.5 Kg, *WP* 12.7 Kg.
Price: From £604.

3D series triple deck
Format: Mono or stereo playback.
Technical specification as for *SP/WP* series but with three separate decks using common capstan.
Dimensions: 21.5 x 32.5 x 27 cm.
Weight: 18.6 Kg.
Price: £1268.

RAPID-Q
Garron Electronics Inc, 1216 Kifer Road, Sunnydale, California 94086, USA.
Phone: 408-736 8737.

Technical specification
Tape speed: 19 cm/s.
Cue speed: 2 to 3½ times play.
Cue tones: 1 kHz stop; 8 kHz aux, 150 Hz aux options.
Equalisation: CCIR, NAB, IEC.
Frequency response: 50 Hz to 15 kHz ±2 dB.
Crosstalk: 55 dB.
Signal to noise: 57 dB below tape saturation.
Wow and flutter: 0.2%.
Start time: 50 ms.
Stop time: 50 ms.
RQ-71RP
Format: Mono record/playback, A, B, C carts.
RQ-71SRP
Format: Stereo record/playback, A, B, C carts.
RQ-71P2
Format: Dual mono playback, A, B, C carts.
RQ-71SP2
Format: Dual stereo playback, A, B, C carts.

RQ-71P1C
Format: Mono playback, A, B, or C carts.
RQ-3122
Format: Mono record and two playback modules, A carts.
RQ-3122S
Format: Stereo record and two playback modules, A carts.
RQ-3222
Format: Triple playback, A carts.
RQ-3222S
Format: Stereo triple playback, A carts.
RQ-3232
Format: Dual record/playback, A carts.
RQ-212
Format: Record/playback, A carts.
RQ-222
Format: Mono dual playback, A carts.
RQ-222S
Format: Stereo dual playback, A carts.
RQ-12
Format: Single mono/playback, compact, A cart.
RQ-12S
Format: Single stereo playback, A cart.

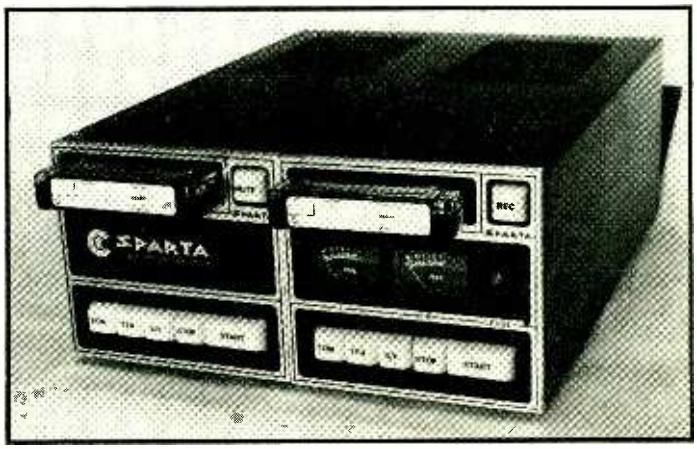
SIS
SIS Ltd, 57 St Andrews Road, Northampton NN1 2PB.
Phone: 0604 32905/30559.

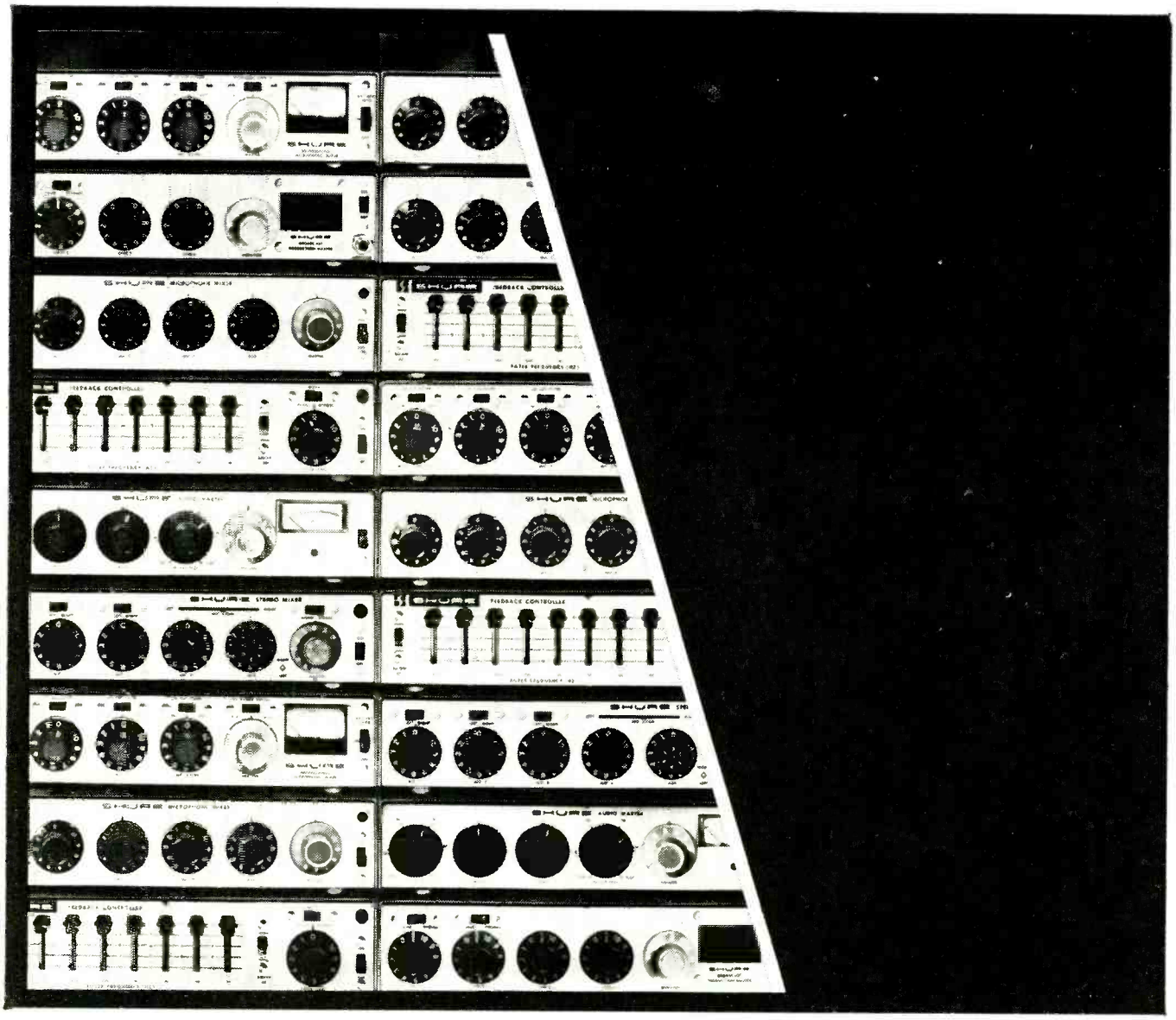
S125
Format: Mono playback.
Tape speed: 19 cm/s.
Cartridge size: NAB A.
Cue tone: 1 kHz stop.
Equalisation: NAB or IEC.
Frequency response: 60 Hz to 10 kHz ±3 dB.
Signal to noise: 45 dB.
Wow and flutter: 0.3%.
Start time: 40 ms.
Stop time: 40 ms.
Dimensions (w h d): 30 x 10 x 26.8 cm.
Weight: 5 Kg.
Price: £145.

S150 series
Format: Mono or stereo, playback or record/playback.
Tape speed: 19 cm/s.
Cartridge size: NAB A.
Cue tones: 1 kHz stop, 150 Hz aux option.
Equalisation: CCIR, NAB or IEC.
Frequency response: 50 Hz to 12 kHz ±2 dB.
Crosstalk: 48 dB.
Signal to noise: 50 dB mono, 52 dB stereo. 28 ▶

SIS S150 and R151

Sparta record/replay machine





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Shure Electronics Limited
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SONIFLEX

Soniflex, 15 College Street, Irthlingborough, Northants NN9 5TU.
Phone: 0933 650700.

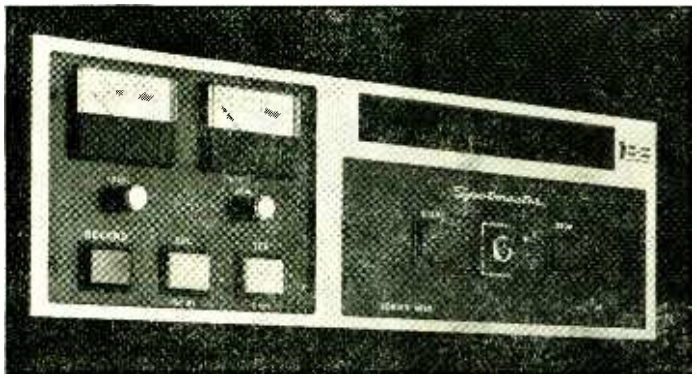
SR3000
Format: Mono playback/record or playback.
Tape speed: 19 cm/s.
Cartridge size: NAB A.
Cue tones: 1 kHz stop.
Equalisation: NAB.
Frequency response: 40 Hz to 14 kHz ± 2 dB.
Signal to noise: 56 dB re.
Wow and flutter: 0.04 "„.
Start time: 40 ms.
Stop time: 40 ms.
Dimensions (w h d): 26 x 8.2 x 25.4 cm.
Weight: 4.3 Kg.
Other: Stereo being released shortly.
Price: £135 to £285.

SPARTA

Cetec Corporation, Sparta Division, 5851 Florin Perkins Road, Sacramento, California 95828, USA.
Phone: 916-383 5353.
Telex: 377488 SPARTA SAC.
UK Agent: Cetec Systems Ltd, Cetec House, Lincoln Road, High Wycombe, Buckinghamshire.
Phone: 0494 446311.
Telex: 837329 CEC HWYC.

Century Series
Format: mono, stereo, record/playback.
Tape speed: 19 cm/s.
Cartridge size: NAB A.
Cue tones: 1 kHz stop; 150 Hz aux optional.
Equalisation: NAB.
Frequency response: 50 Hz to 15 kHz ± 2 dB.
Signal to noise: 55 dB mono, 52 dB stereo.
Wow and flutter: 0.2%.
Dimensions (w h d): 30 x 38 x 15.2 cm.
Price: $525 to $1220.

Century II
Format: Stereo, mono, playback/record.
Tape speed: 19 cm/s.
Cue speed: available.
Cartridge size: NAB A, B, C options.
Cue tones: 1 kHz stop; 8 kHz aux, 150 Hz aux.
Units will be available in single, dual and triple versions.
No further details at present.



Spotmaster 4000 record replay unit

SPOTMASTER

Broadcast Electronics Inc, 8810 Brookville Road, Silver Spring, Maryland 20910, USA.
Phone: 301-588 4983.
Telex: 710-825 0432.
UK Agents: Broadcast Audio Equipment Ltd, PO Box 31, Douglas, Isle of Man.
Phone: 0624 4701.
Telex: 627900 SPOTMASTER IOM.

Basic Spotmaster technical specification
Tape speed: 19 cm/s.
Cartridge size: NAB A, B, C.
Cue tones: 1 kHz stop; 8 kHz aux, 150 Hz aux options.
Equalisation: CCIR or NAB.
Frequency response: 50 Hz to 15 kHz ± 2 dB.
Crosstalk: —50 dB.
Signal to noise: 62 dB mono, 60 dB stereo with 3% THD.
Wow and flutter: 0.15 "„.
Start time: 100 ms.
Stop time: 100 ms.
5301 three deck
Format: Stereo or mono playback, A or B carts.
Dimensions: 21.9 x 26.9 x 33.9 cm.
Weight: 16 Kg.
Price: $1670 to $1985.
4300P
Format: Stereo or mono playback/record, A, B, or C carts.
Dimensions: 43.1 x 13.3 x 30.7 cm.
Price: $1315 to $1540.
4200P
Format: Stereo or mono playback, A or B carts.
Dimensions: 21.5 x 13.3 x 30.7 cm.
Price: $750 to $835.
3300P
Format: Stereo or mono playback/record, A, B, C carts.
Dimensions: 29.8 x 13.3 x 39.3 cm.
Price: $795 to $855.
3200P
Format: Stereo or mono playback/record, A or B carts. Optional 57 cm/s fast forward.
Dimensions: 22.2 x 13.3 x 39.3 cm.
Price: $750 to $835.
3100P
Format: Mono or stereo playback for A carts.
Dimensions: 14.9 x 13.3 x 39.3 cm.
Price: $730 to $840.
2000 Series
Format: Mono or stereo record/playback, A or B carts.
Dimensions: 21.5 x 14.2 x 30.4 cm.
Price: $498 to $965.
1000 Series
Format: Mono record/playback, A or B carts.
Dimensions: 21.5 x 14.2 x 30.4 cm.
Price: $475 to $690.

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AES 54th Convention, a preview

The 54th Audio Engineering Society Convention is to be held from May 4 to 7, at the Los Angeles Hilton, Los Angeles, California. The Awards Banquet will be held on May 6 and reservations can be made through AES Inc, Room 449, Lincoln Building, 60 East 42nd Street, New York, NY 10017. Phone: (212) 661-2355. Telex: 620298. Although details of the exhibitors are not finalised, it is expected that there will be an increase over last year's event, possibly to around 110.

TECHNICAL SESSIONS — SEMINARS
GOLDEN STATE ROOM
Tuesday, May 4
9.30 am

Session A
DISC RECORDING AND REPRODUCTION
Chairman: John Eargle, JME Associates, Hollywood, California.

A-1 The Electro-Forming of Phonograph Record Stampers: A Need For Reappraisal and Redirection — Stephen F. Temmer, Gotham Audio Corporation, New York, New York.
A-2 Nonlinear Distortion in Phonograph Reproduction—James V. White and Arthur Gust, CBS Technology Center, Stamford, Connecticut.
A-3 Flux-Loop Calibration of Phonograph Reproducing Systems—Lyman G. Miller, Jr, Hewlett-Packard Laboratories, Palo Alto, California.
A-4 Low Mass Discrete Four-Channel Playback Styli with Shibata, Paroc, or Pramanik Contours—Dr Ernst Fr. Weinz, Industrie-Edelstein-Fabrik, Postfach, Germany.
A-5 Experimental Evaluation of Band Pass Filter Design for CD-4 Quadraphonic Disc Demodulation—Nobuaki Takahashi, Fujio Suzuki, and Katsuya Goh, Victor Company of Japan, Kanagawa-ken, Japan.
A-6 Wide Band Tracing Correction in Carrier Quadraphonic Discs—Teruo Muraoka, Victor Company of Japan, Kanagawa-ken, Japan; and John Eargle, JME Associates, Hollywood, California.
A-7 The RCA Quadulator — Gregory Bogantz and Joseph Wells, RCA Records, Indianapolis, Indiana.

LOS ANGELES ROOM
Tuesday, May 4
2.00 pm

Session B

AUDIO IN BROADCASTING (AM/FM/TV)

Chairman: Andrew K. Laird, KDAY Radio, Los Angeles, California.

B-1 Considerations on Providing Audio Coverage in Television Production Studios — Bruce Lowell, NBC-TV, Burbank, California.
B-2 Square Wave Response of Broadcast Equipment—State of the Field —Jim Noble, KGBS, Hollywood, California; and Dick Rudman, KFWB, Hollywood, California.
B-3 A Proposed AM Stereo Broadcasting System—Hirotaka Kurata, Shozo Koshigoe and Susumu Takahashi, Sansui Electric Company Ltd, Tokyo, Japan.

GOLDEN STATE ROOM
Tuesday, May 4
2.00 pm

Session C

ELECTRONIC MUSIC I

Chairman: Stuart Dudley Dimond III, The University of Utah, and Wasatch Music Systems, Salt Lake City, Utah.

C-1 An Almost Locked Oscillator for Electronic Music Synthesis—James G. Simes, California State University at Sacramento, Sacramento, California.
C-2 A 'Hybrid-Synthesiser'—Bob Moore, The Evergreen State College, Olympia, Washington.
C-3 A Patchable Electronic Percussion Synthesiser—Brent Gabrielsen, Gabriel Engineering, Mesa, Arizona.
C-4 A Microprocessor Controlled Digital Waveform Generator—Stephen M. Christiansen, ISMUS Project, Iowa State University, Ames, Iowa.
C-5 Use of Tape Recorders in Real Time Electronic Music — Philip West, Department of Music, California State College San Bernardino, San Bernardino, California.
C-6 Modular Addressing of a Computer-Controlled Music Synthesiser — James Beauchamp, Ken Pohlmann and Lee Chapman, School of Music, University of Illinois at Urbana-Champaign, Urbana, Illinois.
C-7 Indicators of Auditory Signal Processing Modalities of the Brain and Their Use as Controls in Electronic Music—David Rosenboom, Aesthetic Research Centre of Canada, and York University, Downsview, Ontario, Canada.

GOLDEN STATE ROOM
Tuesday, May 4
7.00 pm

Session D

ELECTRONIC MUSIC II

Chairman: Stuart Dudley Dimond III, The University of Utah, and Wasatch Music Systems, Salt Lake City, Utah.

D-1 A High Speed Digital to Analog Conversion System for Digital Music Synthesis—Thomas Wood, School of Music, Indiana University, Bloomington, Indiana.
D-2 An Electronic Valve Instrument (trumpet) for Controlling an Electronic Music Synthesiser—Nyle A. Steiner, Steiner-Parker, Salt Lake City, Utah.
D-3 Analysis-Synthesis As a Tool for Creating New Families of Sound—Tracy Lind Petersen, University of Utah, Salt Lake City, Utah.
D-4 Microprocessor Based Control and Generation Techniques for Electronic Music—Stuart Dudley Dimond III, University of Utah, and Wasatch Music Systems, Salt Lake City, Utah.
D-5 Things Any Boy Can Do With a 16-track, a DBX and an Eu Polyphonic Synthesiser—Dr Patrick Gleeson, Different Fur Music, San Francisco, California.
D-6 A Polyphonic Music Synthesiser Utilizing Master Programmed Electronic Synthesis Modules for Each Key—Lee F. Ferguson, UNIDINE Electronics Inc, New York.

GOLDEN STATE ROOM
Wednesday, May 5
9.00 am

Session E

MAGNETIC RECORDING AND OTHER INFORMATION, STORAGE TECHNIQUES

Chairman: Dale Manquen, Altair Electronics, Glendale, California.

E-1 The Print-Through Phenomenon and its Practical Consequences—Neal Bertram, Michael Stafford and David Mills, Ampex Corporation, Redwood City, California.
E-2 Holomorph Recording—Richard C. Heyser, California Institute of Technology Jet Propulsion Laboratory, Pasadena, California.
E-3 A Tape Time (Position) Locator Using Microprocessor Technology —John A. McCracken, Mincom Division —3M Company, St Paul, Minnesota.

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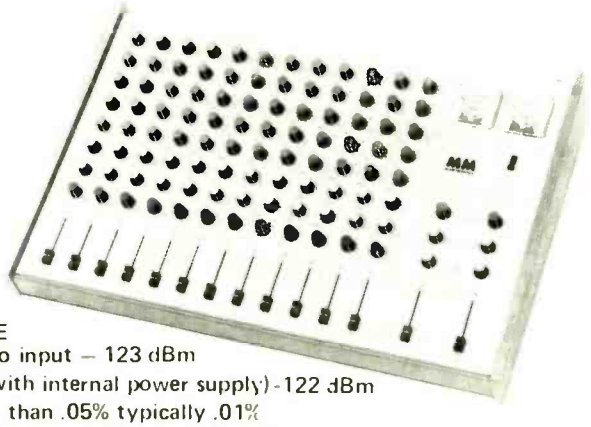
12 CHANNEL STEREO MIXING CONSOLE



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Tel. Wilmslow 29599 (speakers), 26213 (Hi-fi, PA etc.)

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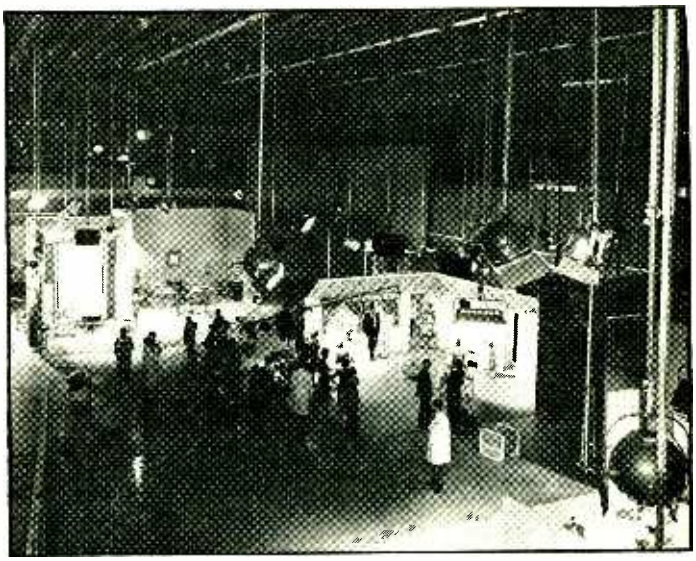
The great sound of American television

GORDON SKENE

American television sound is largely limited by antiquated technology and outmoded transmission procedures. There is plenty of scope for immediate improvement, if it is wanted.



AMERICA can pat itself on the back for spawning a generation known as television babies, of which I am one. We are the privileged lot of society which has had the unexplained pleasure of seeing technology grow and give birth to itself before our very eyes. From the days when entire neighborhoods would cram into our house to see a monstrous box with a microscopic screen belching moans, groans and the occasional picture, to the sophistication of the nine inch portable color Trinitron, one thing has remained pretty much the same: sound.

For one thing, America (as well as the rest of the world I am told) has been increasingly concerned with the quality of the image, the transmission of the picture, be it from down the street, or live via the Moon. But one thing has remained constant, with very few exceptions, and that is the generally poor quality of the transmitted sound. The word is *transmitted* sound, not the sound that is cut in the studio or the sound that emanates from the origination point; the problem begins to occur right after the origination point and continues on from there.

In finding out more about the problems incurred by our networks, I recently spoke with Ken Fause, himself a freelance television audio engineer and video consultant. He sees the situation as a four-fold problem: 1. The original source material. 2. Transmission. 3. Video tape. 4. The home TV set. Much of this problem comes from the lack of concern on the part of the networks. The situation with television audio is much the same with motion pictures; more time is spent on the visual and the last detail looked at is invariably the audio.

The first problem, original source material, is mostly apparent in the musical show. The typical talk show or news program is not a serious area of concern as it is only voice and quality is really not that critical there. Basically the overall frequency response from its origination point is from 50 to 15 kHz with 65 dB signal-to-noise ratio from microphone input to transmitter output and a pre-emphasis curve that gives a lot of high-end boost, and to keep it from over-modulating there is high-end limiting which has to be taken into consideration and often isn't when mixing the original track. The other problem is that this track has to come out of the tv transmitter with an audio section whose response parameters are 20 years old, much the same problem as is shared with fm broadcasting which also has a pre-emphasis curve of 25 microseconds (which is not now needed because at 15 kHz you get a 17 dB boost anyway). Along comes a cymbal crash and the subsequent hf limiting puts its foot on everything. So the sound has to be mixed with this pre-emphasis characteristic in mind.

Moving on in the area of original source material and *its* problems, we come to the second, the 50 mm quad transverse scan tape. The fact that the grain orientation on the tape itself is different, to compensate for the transverse recording, is one thing, but the audio band on the tape is recorded longitudinally. Quite simply, the grain is then backwards or 90° out. What happens is, in effect, a saturation of high frequencies because of the grain orientation of the tape; therefore, you have a working signal-to-noise ratio of 46 dB at 38 cm/s. And this is on the basis that someone has taken the time out to bias the audio track to the tape stock. A lot of time is spent adjusting the video heads, but it is very seldom that an engineer will actually go in and adjust the audio head bias.

This lack of concern creates a side-band problem, especially in multiple tape copies where the problem becomes progressively worse, and as the standard operating procedure now is to shoot in segments and assemble to a master you are now down to a third-generation master and, in many cases, a five-generation master. When the taping started out, it had a 46-50 dB signal-to-noise ratio with a marked tendency towards third harmonic products that increase because of the grain orientation.

So what happens is that the third harmonic tape distortion sound, which increases as the frequency increases, and this problem increases drastically with generations. For this reason, if you want quality, you have to mix with the tape stock in mind, and it is not uncommon to use a limiting device, as would be used at the transmitter, as a frequency-dependent limiter ahead of the tape because the tape stock behaves very similarly as a result of its saturation. In one case, we have a rising pre-emphasis curve that requires frequency dependent limiting to prevent over-modulation and in the other we have a medium that saturates with a similar curve that could be construed as pre-emphasis and therefore requires frequency dependent limiting.

One of the ways around this problem, or a satisfactory alternative to it, is to cut the master audio track on eight, 16 or 24 track audio tape. This system is being adopted rapidly and it is not at all an uncommon occurrence today. In essence, we are now talking about longitudinal recording on longitudinal tape and we are not fighting the 46 dB signal-to-noise on a vtr or the 960-980 Hz modulation of the lateral tape movement due to the impact

drag of the tape across the heads, which in film terms can be construed as flutter. All of this can be avoided, so the technique is being used primarily with music; this happens particularly when an artist, who is aware of the problem, is able to demand that the technique be used in order to get the same sound that would ordinarily come from a recording studio.

Now that the inadequacies of the original source and the problems inherent with the video tape machine have been covered, the transmission of the signal itself over the network becomes of concern. With much the same system as is used throughout the rest of the world, the audio relies heavily on telephone company cabling. The lines used are at least 20 years old and, to say the least, antiquated, but we've managed to move along with standard results. The difference with American television is that network feeds rely on a hub system of transmission. For example, the show that is beamed out of Los Angeles live or taped will be sent to New York, at a distance of approximately 5600 Km. The startling part is that instead of Los Angeles seeing its own show from its origination, Los Angeles is actually seeing the show routed back from New York at another distance of 5600 Km. In essence, approximately 11 000 Km of telephone company cable are used; and no matter how much quality is intended to be kept, it is lost. With current technology there is no particular excuse for having transmission lines with two per cent distortion; the lines very simply do not meet with FCC specifications, and frequency sweeps through them will not even meet frequency specifications to say nothing of noise and distortion. The justification is to say 'well, that's an awfully long line,' but that's merely a poor excuse. You can send video 11 000 Km with reasonable quality, so why can't you push audio that far? However, noise is a different problem: what's visible and what's heard. But given what is routinely done in other countries, processing equipment that is available for long-lines telephone applications, noise and distortion performance should be improved. The South African system uses Dolby for long-line programming, apparently not at all an uncommon technique; they en-code and de-code.

Another promising system can be used: the dbx noise reduction system or any other successful such technique. The situation is that the telephone company has in the middle a lot of horribly outdated equipment that is quietly running along from one end to the other; and heaven help you if you get a microwave link that has a snowstorm going through it. The diversity routing equipment is switching in and out, creating a white-noise effect while the switching gear hunts between which antenna it is going to work on. That type of transmission equipment is a problem, and perhaps a representation should be made to the telephone company to transfer its program circuits to a more stable transmission. A suggestion to go with satellite links might take care of the problem, and is now being very carefully investigated. In fact, ABC-Radio in New York has been using the system for a few months now with very good results.

When asked as to how this system worked and who, if anyone was experimenting with it, Fause said: 'This area is being very heavily investigated both for economics and the viability of it . . . it is done in Europe; I believe the BBC did a lot of pioneering work by running the audio digitally encoded in the vertical interval and by being able to take the audio along with the same video base-band or microwave link, so that the routing on the audio and the video is identical. So you don't have the problem that does crop up of dual-ordering everything, such as video and audio links for the particular carrier requirements, as well as the routing requirements and the switching locations.

'So this whole process becomes much simpler if the audio rides the video and the audio is buried somewhere in the 6 MHz bandwidth. Since the video is much more carefully taken care of than the audio, it's more than likely that the audio will get from point A to point B an awful lot cleaner. And that is the system that is most heavily under investigation, just because of simplicity and economics. The reasoning is "well, the video got there, the audio did too": you may have an encode and decode problem at both ends, but at least you don't have a mess in the middle'.

That would solve the problem with the telephone company's umpteen million companders on the line, which is really the problem. As these units go on the line from point A to point B and onwards link by link across the country, the information is supergrouped and fed back to base band and patched as audio. In effect, you are setting out on a modulate/de-modulate system throughout the country. Through that many stages and that many companders you get accumulative loss. That audio transmission equipment was designed for another time and another technology. Certainly it's improving, but the improvements are largely being made for data links, which have a different set of requirements from long-line audio links.

Satellites may not solve the problems: they may make inexpensive links, but they will be much more economical in use with the encoding system. The result would be that if you buy a 6 MHz band, you don't have to buy a 6 MHz video link plus enough carrier groups to get a 15 kHz audio link plus whatever order lines you need with that. Of course if you were using satellite you would have to run either video on the satellite, audio on the satellite or video on the satellite and audio on land-line. But this is a 'last resort' way to do it, because the quality derived from the land-line is, as was said before, less than adequate. However, if you *are* running audio over a land-line it is necessary to use digital delay to get everything back into sync. Consider trans-Atlantic hook-ups: you have to hire the audio over the trans-Atlantic cable, and bounce the video signal off the satellite. If you are transmitting a program from London to New York, via satellite, you have up to 5500 Km of cable with a velocity propagation factor of 50-60%. You're talking about a round figure of 11 000 Km of audio cable and 88 000 Km from the satellite. The speed of light becomes a real concern. So you find a situation of perhaps having to get a quarter second of delay to get things back into sync. Again, the encode/decode situation would greatly improve the matter. Still, the problem resolves to what to do with audio now with the satellite system under consideration. Digitally delaying an already bad sounding trans-Atlantic cable feed might only make matters worse with a sound that can be, at best, described as fair, but certainly not a startlingly clean signal.

Unfortunately startlingly clean signals are not in vogue these days, nor will be for quite some time, for the inevitable reason that the average television set has a speaker built into it that is no bigger than 10 cm, so it's no small wonder that the consensus of opinion on the part of engineers and network executives alike in the US is a sort of 'why does it matter, it's only coming out of a little speaker anyway' attitude toward the whole thing. But no one in the audience is complaining about the sound, and if no one complains, nothing gets looked at. But it's an attitude problem that has to be solved. When a show is taped, who is the sound mixer mixing for? The audience? No, unfortunately it happens to be the producer who will give him his next job. This is by no means saying that the television audio mixer in the US is concerned only with the producer giving him his next job, or the producer not caring about what his audience is going to hear. In many cases the producer is *very* conscious of the sound problems and does everything he can to rectify the situation. *Midnight Special*, the rock music weekly show over NBC, is one of the few musical shows where the audio mixer gets the last say if a take goes all right. This situation was almost unheard of as little as five years ago, and *Midnight Special* is a unique venture in televising rock music. Other shows of this nature, such as Don Kirshner's *Rock Concert* and *In Concert* utilize a remote situation at various auditoriums around Southern California. Here the situation is rather different and more complex. As opposed to the in-studio mixing situation which *Midnight Special* has, the show is recorded *at* the NBC facilities in Burbank, and live mixed. The *In Concert* and *Rock Concert* shows are cut on eight, 16 and 24 track machines (depending on the complexity of the band performing), mixed down and equalised in the later post-production phases of the show. It's a toss-up as to which of these two systems works the best, largely depending on how the performer feels about the mix and, once again, how the producer feels the audience will like the show.

Much of this, oddly enough, is a question of importance to the sponsor.

We here in America do not, for the most part, have the luxury of commercial-free entertainment. I know that statement is food for many an argument as to whose system is better; often our

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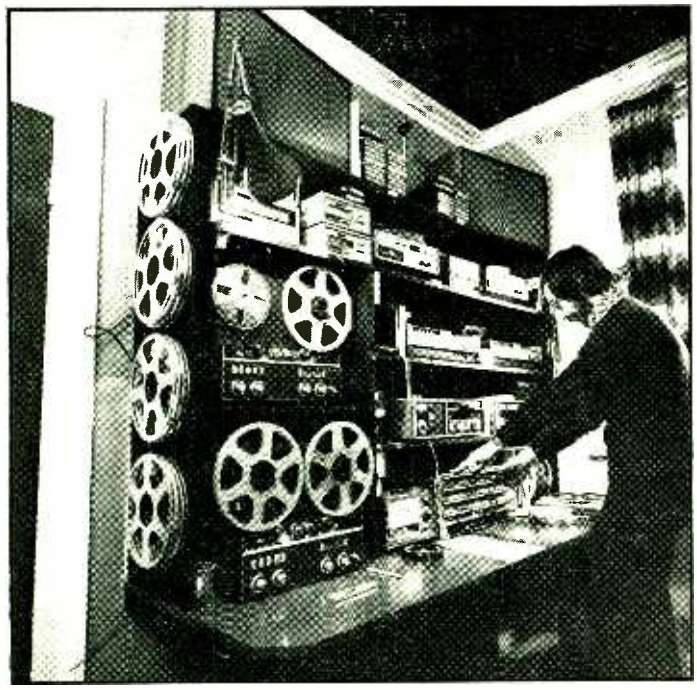
work

Roger Squire

Les McKeown's brother—think he said his name was Robby but it could have been Henry or Angus, but I don't suppose it matters really—bent over the long suffering receptionist to deliver a parting kiss. Gplonk. And would she make sure that she watched tv that evening coz his Ma and Da were on the box, the subject of a far reaching ten minutes into the roots of the Rollers. Such is vicarious charisma. But what is probably more important is that, under his arm could have been glimpsed a reel of tape bearing the Roger Squire label—a radio dj demo tape. Another visa in the passport to success, along with the Corvette parked outside and a strong recommendation from his brother.



Above: *Engineer Chris Davies in the transfer posture*

Below: *Foot-operated faders.*

Squire started his business around the mid sixties by building up a fleet of mobile discos. At one point he had between 15 and 20 of them on the road fulfilling a need created from the lack of competent live acts who could provide good hopping music. That isn't to say that there weren't plenty of bands around. There were, although most followed then current music fashions playing in the heavy acid style. The only way you could take it was generally lying down or at best, seated. Strong rhythm was regarded by many as an anachronism. Tamla Motown rarely provided live acts for weddings, funerals and other private functions, and reggae was a non-starter unless you happened to live in Brixton. . .

There was another factor. Pirate radio introduced a UK mass audience to the fast moving needle programme where silence is deadly. It spawned the classic pop radio presentation of record plays, talk overs, commercials and jingles and accapellas—jingles incorporating the station id theme. Of course, the style originated in the States but has subsequently been demanded of and followed by every British commercial and national pop station ever since. But familiarity demands adherence to a format. Thus when people paid money to hear records in clubs and discos, they demanded their music to be pre-packaged in the same style as their acoustic wallpaper. This could be readily provided with just two record decks, a microphone, a set of records and someone to play them. Also one man and his disco worked out less expensive than four men and their band. But one man and his Dansette worked out cheaper still.

About two years ago, Roger Squire gave up his interests in mobile discos. Cowboys had moved in to the point where music lovers expected to pay no more than £12 to £14 a night for a professional disco. It simply wasn't on to run a professional outfit at these sort of rates. Of course, if you work during the day and bundle your hi-fi into the boot of father's car, you're quids in. Roger realised it was far more profitable to sell jingles, studio time, dj tuition and disco hardware rather than any operational aspect.

Dj tuition takes place at two levels. The first gives prospective clients the theory and practice of disco jockeying from the basics of how to cue a record to an appraisal of their patter and style using tape recorders and an instructor of proven ability. The basic How To Get Slick course costs £30 and culminates in a half hour session in a London club with real live punters. The object is always to develop whatever personality the man might have rather than attempt to stereotype him. Perhaps of greater interest is the course, operated by the Squire organisation, for neophytes in the world of broadcasting.

There is need for it. Terry Way, studio manager etc, explains: 'We've had people come here who've applied to the BBC for an audition . . . they're sat down in the studio and told to get on with it and show what they can do. If they're naive, they might never have seen a bank of faders or an instant start turntable or a cartridge machine before . . . they just seize up. If they come on our course, at least they've seen the equipment before. They know how it works although we don't try and teach them heavy technicalities. The thing is that radio stations can afford to be fussy; there are so many people around these days so naturally they take people in they haven't got to train . . .' Unfortunately, this is not the sum total of the situation.

As with nearly every other branch of the music industry, knowing the right person is at least as important as knowing your job if you wish to gain entry to a particular organisation. Having a really good audition tape isn't an automatic passport, but it helps: 'When producers get an audition tape sent in with a Roger Squire's label on it, they know it's probably going to be worth listening to. Occasionally, we get audition tapes sent in to us backed with a letter that usually goes something like this: "Look we sent in this audition tape to XXX and we got a letter back saying it wasn't really in their style. What would you suggest?" When you listen to it, it is immediately apparent that they're simply disco dj people who've strung together a load of records. We insist that our clients put together an audition tape with commercials, weather

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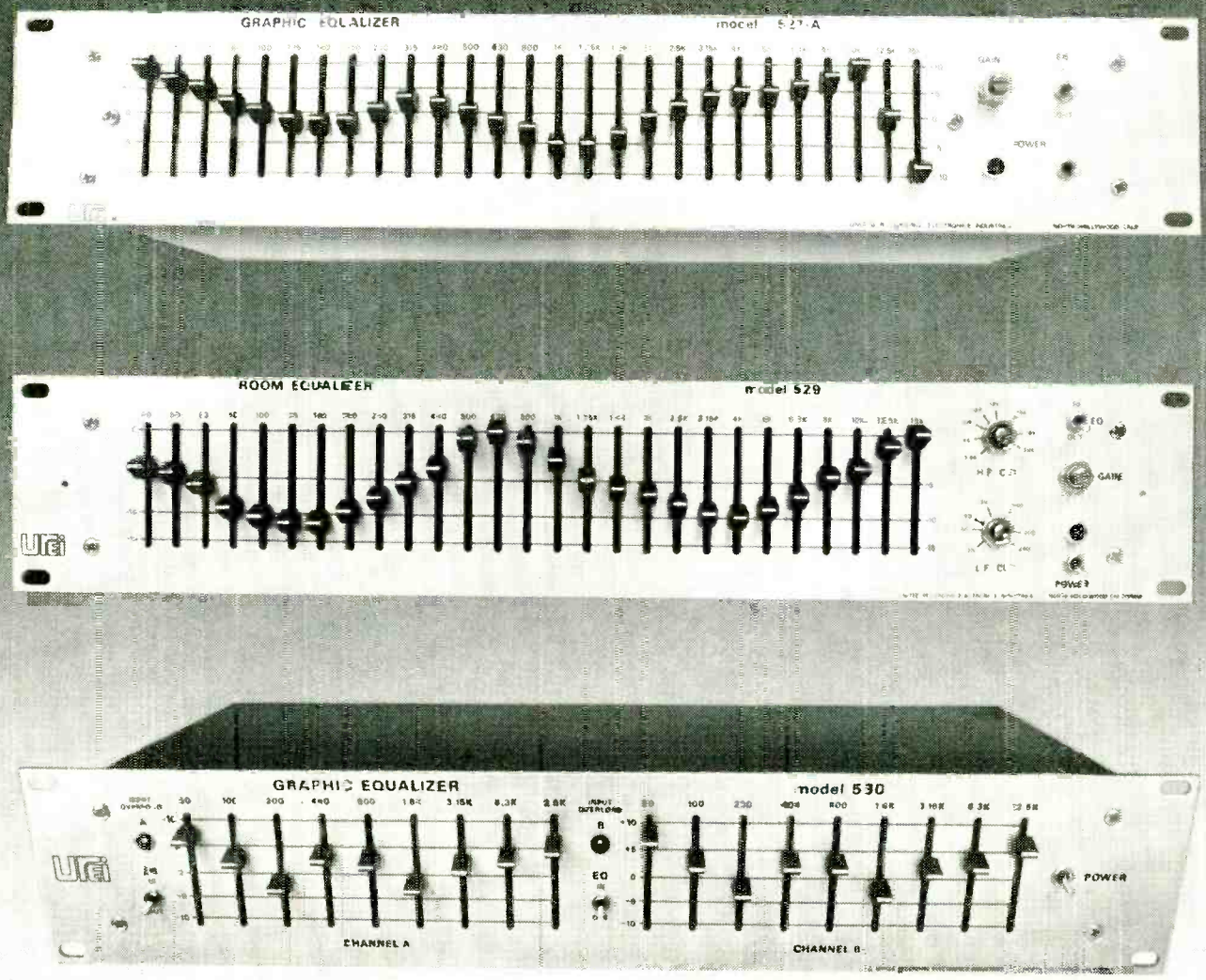
UREI

Graphic in Audio



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forecasts, traffic reports, three or four record links at least, but mainly the dj talking. He must also do at least one voice-over commercial because that's what stations expect nowadays.'

Chris Davies is the resident engineer in the broadcast style studio. He also does much of the tutoring. In his time, he has been backup engineer behind presenters, both at BBC and LBC. He says that operational procedures are changing, particularly in respect of commercial broadcasting in the UK. Stations are turning self-op whereas much of the cueing and balancing was handled by the engineering staff. This meant that the voice on the radio was a presenter who never did any actual jockeying. That ain't good enough now. The Squire's studio possesses the right facilities for clients to practice: three instant start turntables, two ITC cartridge machines, and a couple of AKG mics. In front of the operator there is a bank of faders and a set of remote starts for the cartridge machines. All the final balancing, limiting, echo and anything else like that is done on the engineer's panel to the rear of the main desk, mostly of Alice origin.

They intend to expand upstairs to handle the increasing amount of work for local radio stations, notably advert production. They will build a larger studio with round table type interview facilities and a separate control room; at present, it's two people and somebody's friend and things are getting kinda crowded. But even with existing facilities, the studio has tasted the modern equivalent of Alchemy, the miracle transformation of plastic into gold, the Hit Record. The production, *King of the Cops* by Billy Howard, couldn't have been done without facilities such as those on offer at Roger Squire's. It required the interface of music backing tracks, pre-recorded at a music studio with, punched in from cartridge, sound effects together with accompanying voice-overs from performer. A few strategic splices and the production became very tight. Mastering was carried out using one of the numerous high speed *A77* Revox liberally distributed throughout the studio and the transfer suite next door.

Roger Squire markets a service which is probably unique in the UK. His company handles the production of accapellas through a block booking arrangement with a Stateside studio. While the finished product is not exactly tailor made, clients can choose their style by reference to about 100 samples held at the Roger Squire's studio. Clients state that they would like their theme produced in a similar style. The requested name is then scored, performed and produced by the unnamed American studio along with several others to make the procedure economic. The master tape is then sent back and re-recorded on to cartridge form. Clients generally include discos and campus radio who desire some customisation of their product. The obvious question is 'why can't they be done over in the UK?' Terry Way suggested that there is simply no one over here who can provide a comparable, punchy product; or even an acceptable product at a reasonable price.

Frank Ogden

City Sugar

The critics were generally kind about the play *City Sugar* by Stephen Poliakoff although rather less than convinced by Adam Faith as the central character—Leonard Brazil, a supposedly cynical dj in a Leicester commercial radio station. Being a bit of a philistine myself I could have done with less of its sledgehammer social message and more of its biting and very funny satire. This would have brought the social message over just as well and made the play a whole lot more enjoyable. Local radio badly needs satirising. Capital even ran a competition on the morning after the play's opening in which the prize was a pair of spare tickets to Las Palmas, with an airport check-in time literally a couple of hours away and no hotel accommodation booked for the lucky winners on arrival. The background to how this play was prepared for West End opening confirms once and for all that there's no biz like showbiz. In fact it must have been enough to make most of those involved seriously consider taking a nice nine-to-five job with the Inland Revenue.

The play was first performed last October at the Bush Theatre, in Shepherd's Bush, and when Michael White decided to bring it to the West End with Adam Faith in the starring role he hired Victor Kravchenko and Autograph Sound Recording of Chalk Farm (ex-Covent Garden sound men Philip Clifford. Andrew Bruce and Philip Edward) to handle the electronics. As the script and production call for Adam Faith to spend much of the play operating a dj broadcast console on stage, with additional action live on mike in an on-stage control room, tape cueing from an

Above: *Who can scream loudest? Final question in the on-air finals of the 'Competition of the century' organised by dj Leonard Brazil.*

off-stage console and 'live' broadcast phone calls from out of sight in the wings, there was a lot to handle in the short time available. It was acknowledged right from the start that discs could not safely be used on stage (the turntables that Faith 'operates' are dummies) so all the musical material had to be prerecorded on tape.

Philip Clifford gained considerable experience with prerecorded theatre sound at Covent Garden and was subsequently involved in the production of five West End plays which relied on prerecorded sound from NAB cartridges. This followed the experimental use by Jim Douglas (now with the National) of cartridges for a few days towards the end of the run of *Habeas Corpus*, the open reel material for that production being transferred to carts (and incidentally back to open reel again soon after). Clifford worked with cartridges first with the *Doctor Who* stage production, which involved nearly 200 separate tape start cues. After that came *Murderer* and *Otherwise Engaged*. Although the Faith play requires only 60 cues, there was a substantial added complication—it was planned to leave some of them to Faith live on stage and others to the sound engineers off-stage.

For on-stage use a standard Chilton 10/2 mixer was built into a dj console, along with the dummy turntables and an ITC single stack cartridge machine. Four mikes on the console and one in the on-stage studio control booth were rigged live through the on-stage mixer, with the main stereo gain control in series with a similar mixer front-of-house in a box. Also rigged in the off-stage box was a three-stack ITC cartridge machine for the additional tape cues. The series connection of the two main gain controls, feeding Amcron and HH power amps, was intended to give Faith up-and-down fade control from the stage but with the main level set off-stage. The danger with such a system, of course, is that the off-stage engineer is powerless to correct an on-stage main fader mis-setting.

The ITC cartridge machines belong and are normally in daily use at Autograph's Chalk Farm premises, and it was never Clifford's intention to have them tied up in a London theatre. But his efforts to find a reliable alternative in the short pre-production time available failed. The most hopeful-looking machine was physically far too large (although for playback only) and Clifford found nine faults on the playback heads alone (leads too short, faulty connections and connectors, etc); so it was the ITC machines that went into the theatre. Around this time, however, what is always delicately known by the press as a 'conflict of personalities' arose, between Kravchenko and Adam Faith. Lack of communication during the pre-theatre rehearsal stages seems to have been the bone of contention, and the outcome was an 'either he goes or I go' ultimatum by Faith. Not surprisingly, it was Kravchenko who went; and inevitably a puzzled Autograph went too.

That was 12 days before the opening date, and with the electronic rig only just beginning to take shape. Faith knew and felt confidence in Marshall Equipment Hire, so MEH was brought in to finish the job. Six days later MEH went out again, and, with less than a week left, Autograph was brought in again to finish the job. Although most of the comings and goings were amicable they lost the production a week of theatre rehearsal. In the meantime Emison had been asked to handle the tape-to-cartridge transfers. In view of the panic over dates, Emison advised

that everything be handled in stereo, to avoid the now perennial problems of cartridges—poor mono compatibility due to phasing discrepancies on playback.

When I visited the theatre, on a Saturday morning with the first scheduled preview that night, Clifford had worked three days and two nights without stopping. By that stage everything worked, in that if you put the right cartridges into the right slots and pressed the right buttons and moved the right faders the right sound was produced. Unfortunately, because of the six days' technical rehearsal time lost, Adam Faith was having his work cut out knowing which cartridge and which button to choose. Not surprisingly, the first preview, scheduled for that night, was cancelled. There was inevitably still no policy over sound level, with no one sure what settings for the various sources would provide a steady acceptable overall level for the audience. The massive pair of Altecs dominating boxes left and right of the stage were, in fact, disconnected. If you looked closely, you could just see a pair of Bose *901*s (incidentally, deliberately facing the wrong way round) doing their work.

Not surprisingly, everyone was by this time so tired that what the production needed most of all was a day off and a night's sleep. Instead, a full weekend of rehearsal was scheduled, with the possibility of a policy decision to scrap the whole idea of having Adam Faith self-op on-stage.

The Saturday afternoon rehearsal brought just such a decision. It proved all too easy for Faith to leave a mike live when it should have been dead or dead when it should have been live. So all too often words spoken 'on air' and intended to come loud through the front of house speakers would fall on a dead mike and come through only acoustically, while casual off air remarks were sometimes bellowed out through the pa.

To shift all control facilities from the on stage console to the off stage box took the rest of the weekend and at one time it seemed likely that the Monday preview also would be cancelled. But the electronics were re-arranged in time and the cueing was re-scheduled.

Faith was left only with a 'panic button' on stage to drop the pa level by 15 dB if a missed off stage cue threatened his lines.

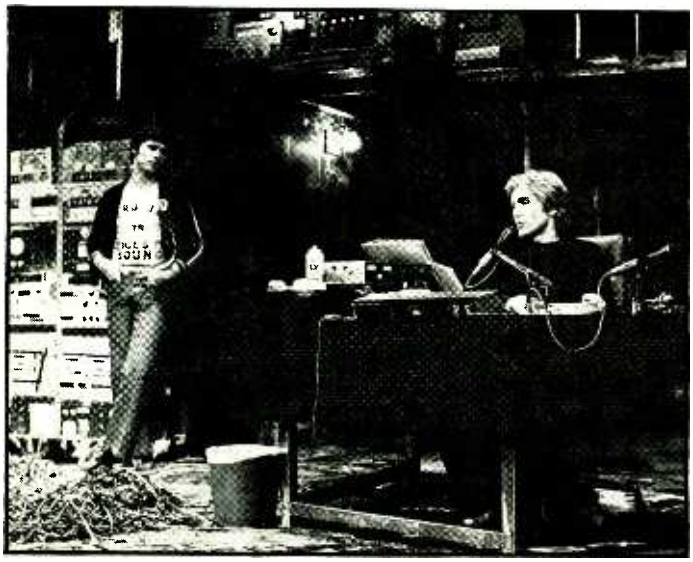
In the event, at the Monday preview I couldn't be sure from the Stalls whether he was self-opping or not.

Although it was 'alright on the night' there is no doubt that it very well could not have been. In many respects it was the sheer professionalism of Adam Faith as an actor and the skill and willingness of the engineers to go a week without sleep that saved the day. Next time things could be different.

There is a valuable lesson to be learnt from the production problems of *City Sugar*. In a heavily technology-dependent production any kind of confrontation between an irreplaceable member of the cast and indispensable technicians must be prevented rather than cured. Pick a team you can trust in the first place and stick with them.

Adrian Hope

Below: *The tape on the floor contains unedited phone calls from listeners. 'Why do they phone me, why not each other?' asks Brazil.*



Fun of the fair

Ramport, the Who's studio in Battersea, London, now boasts a rather out-of-the-ordinary clock in its reception area. It was built by the studio engineers and, apart from reading out the time of day on digital display tubes to one-tenth of a second, incorporates fascinatingly useless reaction-testing circuitry. One spot of light runs continually around a circle of leds, and another spot cycles vertically down a straight row. But the vertical spot can be extinguished by a re-set button and will then reappear, to start a rapid downward run, after a random delay of a few seconds. It can then be stopped en-route by pressing another button. The number of led steps it passes before stopping is a measure of reaction time and thus, in clever scientific words, is directly proportional to the falling-about state of the subject. The leds are labelled accordingly: 'good', 'normal', 'sub-normal', 'pissed', 'moronic', 'dead?' and 'negative iq'. But for reasons which are still baffling clever scientists, the machine always seems to register 'pissed'.

Adrian Hope

Dunno mate, I only work here

Inscrutable Studios was launched in Silesia several years ago by three session musicians, Arthur Nomen, Morris Gadworthy and Sheila Nunquam. It soon earned the reputation of a busy, successful outfit with plenty of big names in the pop world either working in the studios or 'relaxing' in the bar, or both. We were prompted to write a belated report, partly because of Inscrutable Inc, the Grimshaw studio opened in 1974 in which Inscrutable Studios owns a 70 per cent stake, partly because of the recently commissioned additional studio in Silesia, and partly because of the Rock n Roll Revival activities of guitar - singer and Inscrutable managing director Arthur Nomen. With a re-created band (labelled, with no marks for modesty, 'The Greatest Rock n Roll Band in the World'), Nomen recently recorded an album for Gramophone Records at Inscrutable and toured coast-to-coast with a series of one-night stands.

We wrote to Nomen seeking an interview; but had to wait two months for a reply, during which we made a pilgrimage to witness TGRRBITW in action. (Frankly, it wasn't too hot—but that is another story, and we hear the album is tighter.) When we finally heard from Nomen, he suggested that we phone the studio to arrange an appointment. This we did but the secretary making the appointment neither knew, nor was prepared to find out, whether the studio had any publicity material already available. When we arrived, duly, and fully equipped with camera and flash, Nomen was nowhere to be found. There was no offer of assistance, or a guided tour, or anything from anyone. After an hour we grew tired of buying our own in the bar, and went home. Naively expecting at least an apologetic phone call, we waited a week before writing again to Nomen. Three weeks later we had still heard nothing, so we tried phoning the studio with some genuinely innocent questions—like 'How are things in Grimshaw?'. But no one seemed to know anything about what was going on. Or was it perhaps, we started wondering, that no one was going to let on what they knew?

Without doubt Inscrutable Studios has been highly successful workwise, establishing an enviable reputation internationally, catering not only for the big names but also for a continuous stream of session musicians and producers. They have made a lot of hits there too. But most of the work has been, and still is, booked by outside customers rather than coming from Inscrutable's own internal production activities. There are two record labels associated with Inscrutable through Arthur Nomen, but these two labels are not yet capable of generating enough work to fill the 60 per cent studio time essential to maintain a steady cash flow. In the 'happy' amateur days of a few years ago, it was enough for a studio to wait for the phone to ring; but now a studio should be able to rely on its integrated production activities accounting for 60 per cent of its time booked. That's what the experts say and it makes sense, particularly for big outfits with a large capital investment, like Inscrutable. The crippling rates of British Income Tax has been driving more and more major recording artists abroad, and this is reducing to nil the number of studio customers who can afford to block book for a month or two, even if they do only use a couple of nights now and again. This evaporation of easy money has hit all studios, Inscrutable no doubt included.

The main intention behind the establishment of Inscrutable Inc was to provide Silesia-style facilities in Grimshaw; a good move, in an international business. Everything in Grimshaw is compatible with the gear at Silesia, just as Record Plant in New York City is compati-

38 ▶

WORK

ble with its sister studio in California. So how has it all worked out?

Like most studios Inscrutable has its share of bad debts, of which one, at least, is into five figures. And the expensive quad-capable extra studio in recently-acquired premises was opened just as the market was falling. This was doubtless bad luck rather than bad judgement: a lot of others got caught the same way. But one or two informed observers saw this extra studio floor as an investment of doubtful merit anyway, and felt priority might have been better given to a disc-cutting installation and a modest cassette duplicating machine to provide a fuller customer service. After all, it's service the customer comes to buy, and the more comprehensive the service the better the customer likes it and the more often he comes back for more of the same.

And, talking of service, one session musician spoke recently of an hour-plus delay 'caused by technical problems on the session that could and should have been sorted out in advance'. He went on to say that it took the session into overtime, which could kill a tight budget. To be fair, though, the technical breakdown is every engineer's secret nightmare and they happen everywhere, however hard you try to prevent them. (Incidentally, why is it that there is always some helpful chappie on hand who once built a d-i-y amplifier kit and who knows exactly what's wrong?)

About a year ago the three Inscrutable directors retained their newly-retired bank manager, Mr Charles Crispworthy, as financial adviser. His job has been to tighten control over the budgets which, in the present recession, is a vital function. In this area he is clearly achieving success. But, as equally clearly emerged when Crispworthy appeared to offer a decidedly half-hearted apology for Nomen's absence, he (like all but a very few money men connected with the studio business) knows little or nothing about studios and recording. The names *Work* and STUDIO SOUND, for instance, were obviously new to him. Does that matter? Well, think about it. If you are in a business offering a customer service, it may help if you can speak the customer's language.

Currently, Inscrutable, like many other of the larger studios, are willing to talk terms with a potential purchaser. Approaches have been made but nothing concrete has yet materialised. Probably negotiations are at the delicate stage of 'examining the books', a stately ritual performed to strict rules and without vulgar haste. A single false move can blow the whole thing, like that certain case a year or two back which ended in liquidation. Perhaps that is why Inscrutable has been reticent to the point of rudeness. But ironically, if only they had said so, or simply practised the noble art of pr, that innocent and somewhat puffy *Work* piece which we had originally intended to write (and which would by now have already appeared in print) might have added a little lustre to their negotiations—and even a few thousand to the fetching price.

Norman F. Bodkin

agony

The presenter on the early morning radio show had obviously had a late night and seemed to be taking it out on his engineer, who was nearing the end of his tiring night shift. Threats didn't appear to calm the presenter down. The station had the usual few seconds programme delay for profanity purposes. A bit of overplugging on the jackfield was all that was necessary to feed delayed programme to the presenter's headphones so at the end of the record, when the presenter put his cans on, he heard himself coming back several seconds later. This had a remarkable effect on speech, which may have interested early morning listeners.

GREAT SOUND OF AMERICAN TV

European counterparts feel American television is the best, and we Americans vote hands down that European television is overall the best. It merely boils down to a question of who's living where and for how long.

What we found particularly ironic was the policy (and this has been curtailed recently though you wouldn't know it) of mixing a commercial between six and eight dB higher than the rest the programming. What is also ironic is that the sound quality on commercials is much higher than the programming itself. The reason, and this is returning to an original point, is one of care on the part of the mixing and production. It is financially more feasible for a mixer to pre-record a track than it would be to mic for a difficult shot. It is easier and less time consuming, and in television time *is* money.

We've allowed ourselves a certain degree of complexity in the front-end of the television industry, but again it's all under such time-rush that a change in any *real* positive direction in a commercial situation cannot easily happen when the emphasis is on strictly visual orientation.

For all intents and purposes, American television is an art form from which the art has been traded in on an expansive bank roll. A careful analysis of early American television concepts and ideas will quickly show you that the then-neophyte form was not intended to be the way it is today. American network Television sound is archaic, and its archaic for a reason; the consumer public is not interested in the sound when they buy a 19 inch Sony Trinitron television, they're interested in the devastating color. And 19 inches worth of color is far away more important than three inches worth of sound. ABC, NBC and CBS are not interested in working on a new system that will eliminate the 'hub' in network transmissions because the audience is not complaining about the sound. The telephone company is not going to make any startling changes in their sound transmission setups because nobody from the networks is complaining about the sound.

No one complains, and the problem goes nowhere.

Note: Special thanks to Ken Fause and Dave Kelsey Sound in Los Angeles for supplying me with facts, figures and many hours of exhaustive conversation on an endless subject. Additional information on this subject can be obtained from the Audio Engineering Society, Society of Motion Picture and Television Engineers and the Federal Communications Commission.

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Format: Mono playback or playback/record
Tape speed: 19 cm/s.
Cartridge size: NAB A.
Cue tones: 1 kHz stop.
Equalisation: NAB.
Frequency response: 50 Hz to 12 kHz ± 3 dB.
Signal to noise: 56 dB with 3% THD.
Wow and flutter: 0.2%.
Start time: 100 ms.
Stop time: 100 ms.
Dimensions (w h d): 20.6 x 8.8 x 25.4 cm.
Weight: 4 Kg.
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Phone: 301-881 8888.
UK Agent: Roger Squire Ltd, 55 Charlbert Street, London NW8 6JN.
Phone: 01-722 8111.

Tapecaster playback
Format: Mono or stereo, playback or record/playback.
Tape speed: 19 cm/s.
Cartridge size: NAB A.
Cue tones: 1 kHz stop; 150 Hz optional.
Equalisation: NAB.
Frequency response: 50 Hz to 12 kHz ±2 dB.
Signal to noise: 55 dB.
Wow and flutter: 0.2%.
Start time: 50 ms.
Stop time: 100 ms.
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Zurich~AES 53rd convention

FRANK OGDEN

The 53rd Convention of the Audio Engineering Society was held between March 2 and March 5 1976 in Zurich, Switzerland.

The hills are alive with the sound of music—mostly 24 track in origin, automated reduction and going virtually all the way up the 32 floors of the Hotel International am Marktplatz. People were keen, busy and happy. Zurich is a very cheap place to be, providing you stand on the spotlessly clean pavements taking in the bracing air. Take or do anything else and you get an ache in the hip pocket which runs all the way up to a burning pain in the exchange rate. However, everybody knew that all along and there was no way that it impeded the undoubted impact and stature of the show.

Right from the moment the show opened, nearly every one of the 56 stands was buzzing with activity of a very cosmopolitan nature. Naturally, the interest centred on those introducing new products and, in some showcases, new technologies. Among the latter were Studer with their potentially computer controlled broadcast Unisette tape cassette transport and EMT with a delay, echo and reverb processor. But more about these later. The opinion from both sides of the selling floor was that something was about to happen in the record industry if not happening already. The barometer of the recording industry must be the machines on which it records. Certainly, just about every known contender for the 24 track market was represented with no apparent lack of studios prepared to put money behind their stated intentions. Virtually the same could be said for the mixer market even though several up-market organisations were not officially in residence anywhere within the two halls or dozen odd demo rooms. They may have missed out.

Apart from the usual preprint problem, the Swiss AES did an impressive job of organisation. Things happened on time and communications were excellent. The paging system was augmented by cctv which offered a continually updated programme of events, together with messages. The convention had the clichéd precision of a Swiss watch, helped by the unobtrusive efficiency of the hotel staff. Works were oiled by a conversant, multi-lingual AES administration section. Everything else got oiled at SFr2.50 on the convention floor during the working day, or at twice the cost on the 31st floor heading towards breakfast . . .

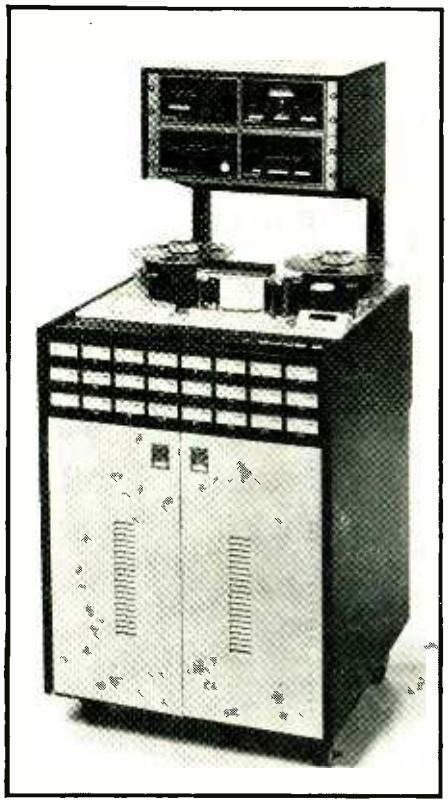
The role of bars in the music industry is legendary. This AES show proved no exception; it served the Monks, Bauch and Felner British Bucolic Corporation/Swiss Poker Face League equally well. There was a difference, however, from former industry shows. Whereas the chat is often divided about 80 per cent rude stories and 20 per cent business, this time it was very much the other way round. The general feeling agreed that much of the market activity was concerned with remix facilities. It was a matter of much speculation whether, when the upturn arrived, current studio capacity would prove adequate for track laying, but by the same token, it might block remix activities. After all, if that is all that you want to do, why tie up money in a recording facility just because the two normally go together?

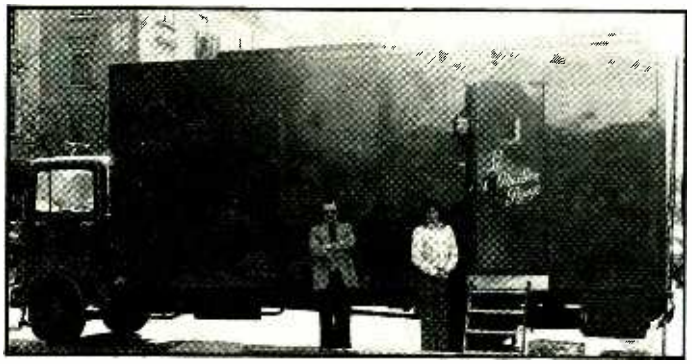
It is certain that the rate of studio building is slowing down except in special areas where there is a tax incentive; it could be either geographical or personal. The former applies strongly to the recent interest in Swiss facilities; the latter area is generally too sensitive for useful comment. One buzz going around was that a recent US tax ruling could provide a boost to foreign time sales to the slight detriment of the US industry. Apparently, superstars rich enough to warrant a Cayman Islands style tax haven are deemed to have earned the sum total of revenue of the resulting record in the States if so much as one note is recorded there. It implies that there is no tax advantage to be gained from a tax haven-based record/publishing/holding company if any of the work originated in an American studio. In any event, the effect will be minimal because Names who play tax games account for far more noise than volume.

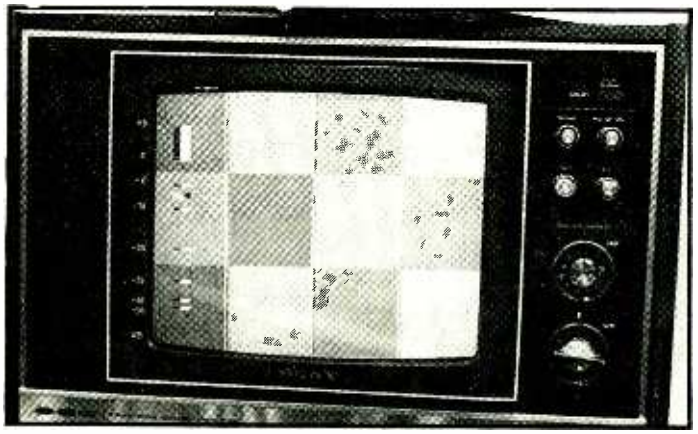
Exhibits

Broadcast mixers are a specialist product. Tonographie Apparatebau specialise within this group. They manufacture a modular desk system based on channel modules with 30 mm fixing centres, a very compact package when used with a moderate number of channels. This offers a useful format for ob vehicles. To save space, a vertical sliding pad is mounted next to the channel fader. The 16/2 format desk on display measured only 80 cm wide by 60 cm deep. Despite the size, it featured four-knob eq, individual channel limiters, four subgroups of four, two sends and mic/line input facilities.

Mixing, no hands, was represented by Automated Processes with their now well known 16/4 demo unit, the subject of at least two previous AES appearances (see STUDIO SOUND Sept 75, p54). Among the merits of the API system must at least be included one of durability in the face of transport round the world trade shows. Either that, or perhaps company President Lou Lindauer, also on stand, doubles as a uniquely gentle roadie. Concurrent with the processor demo, he had organised a convincing demonstration of the Maglink programmable synchroniser utilising a broadcast vtr and







Previous page: *Acoustic Research aren't sure how to market their 16 channel augmented delay system. Stereo image speakers can be seen either side of the electronics table; eight of the delay speakers are elevated to the front. The remaining eight are mounted in the same relative planes behind the listening area. The perceived result is impressive.*
This page far left: *Ampex MM1200*
Top left: *La Maison Rouge provided coffee freebies.*
Bottom left: *The audio ppm indication on the left-hand side of the screen was superimposed by an NTP processor inserted in the video line for simultaneous audio/video monitoring.*

multi-track audio machine.

Language barriers can create problems at foreign trade shows. This is invariably the situation on Telefunken stands. However, this time, Ken Owens of Hayden Labs, UK distributors, was on hand to explain things. The big 24 track has never reached the UK or America. This is not due to deliberate marketing policies but rather more to the (self-confessed) high price tag at over £17 000. Apparently, in spite of this, the machine sells well both in Germany and Italy. They also displayed a range of very useful tape duplicating gear. The eight or 16 times speed system uses converted *M12* or *M15* transports depending on duplication speed. The master with an open reel respools to the start at the appropriate cue tone. The slave(s) produce a pancake for the most interesting exhibit on the stand—a single-button-no-hands cassette loader. It does everything. The operator throws a handful of assembled cassettes fitted with leaders in the chute at one end and that's all there is to it. Servos, motors and air pumps take over, resulting in a steady flow of totally assembled and spliced cassettes plopping out of the other end.

It's little things like those on show on the Sescom stand which make spools go round for the recording engineer. The company is well known for its line transformers and, recently, a neat lavalier mic. The former has found a new package in the shape of a plated tube with an *XLR* mounted at each end. The diameter is the same as a standard connector with a length just about double. The modest dimensions give the impression that the tube is a pencil capacitor mic. There was also a line isolator with a stepped attenuator switch between 0 and -30 dB. Just right for some direct injection applications.

One of the most interesting facts to be learnt at the show concerned NECAM. That stands for Neve Computer Assisted Mixing System. At the time of writing, the appropriate details had not been released officially. Therefore there was no model open for public consumption at the AES. However, Derek Tilsey explained the principles. His main theme was that it was not an 'automated' mixdown system but a fully blown computerised mixdown facility using a full blooded mini-computer as the cpu and a floppy disc (magnetic storage system) for control setting data storage and interface. For fuller details, see the *News* section.

The actual stand exhibit was a superficially 24 in, 16 out, stopping off at Zurich en route for EMI, Mexico. Of course, it does much more. Thoughtful switching arrangements facilitate up to 40 inputs by making use of redundant output channels, although every channel had a line out as well as line in facility. Additionally, it was fitted with the very useful five frequency eq modules and no less than four echo and two cue sends per channel. Although it had no actual panpots, the desk offered quad positioning with a two knob x-y system.

NTP continues to market a range of column ppms, to which two more models have been added. These use widely differing concepts. The first is based on a column of gas discharge elements which light successively with increasing signal level. They give a clear, concise indication with a resolution rather better than column leds. The device indicates overload by brightening up in that sector. The other new model takes the shape of the classic black box. It superimposes a ppm arrowhead and marker scale on the left-hand side of a video picture to enable simultaneous monitoring of sound level and picture quality. The box converts the audio signal level to a control signal in the appropriate format which gates the video; a nice concept.

Schlumberger displayed an 8/2 · two stereo subgroups sound desk destined for installation with Danish tv. Although the facilities were fairly routine for broadcast applications, the construction employed an enormous amount of diecasting resulting in an ergonomic, rugged if not visually exciting desk. But sound desks aren't for looking at and the channel parametric eq would be very useful. They also displayed their *F412* 6 mm tape machine which, once again, used the same style of diecasting, giving the impression of immense mechanical stability. With tip-up transport in the console, the plug in, plug out and return to factory electronics modules may be the operational maintenance engineer's ideal.

There is now an automation facility available with MCI desks, although the company is still undecided as to which processor to recommend. The only evidence of the new facility on the single channel module displayed was three read, write and update buttons with associated leds virtually right on top of the voltage controlled amp fader. The same channel module incorporates four switched bell eq network plus shelves each end. The 32 routing buttons plus individual leds with panning between odd and even numbers looks interesting. There have been small changes to the 50 mm tape machines which now feature 35.5 cm spool capacity, although not much daylight hits the deck. Tension adjustment has been given a third position to suit. On the same subject, spooling motors

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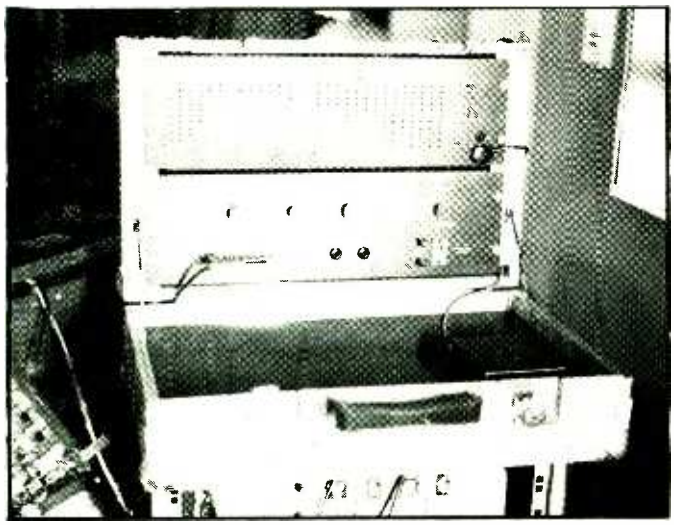
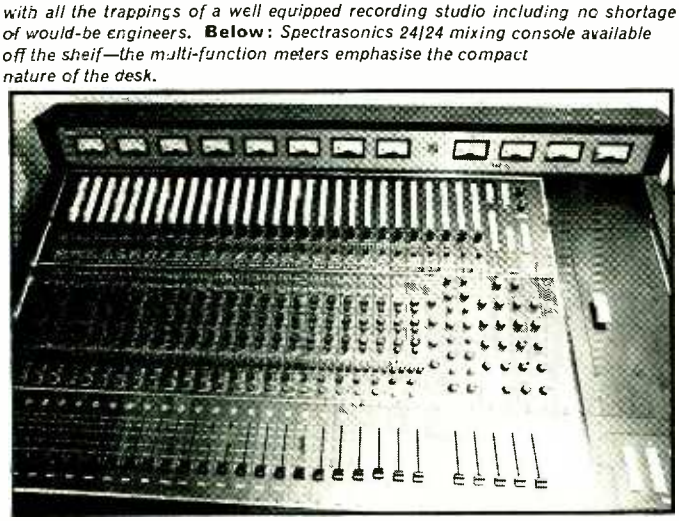
are now dc, brushless. Clever electronics now provide a very steady tape spooling speed. Dag Fellner, the UK agent, claims that even without the capstan, spooling at low speeds with lift-off defeat results in flutter of less than 0.1%. Benefits of the new system are said to arise when two machines are locked up in master/slave on all functions. Faster sync occurs when spooling to a program point.

Ampex introduced a revamped version of the *MM-1100* to be known as the *MM-1200*. Apart from cosmetics, the most important change concerns response to the criticism often levelled at the earlier sel-sync operation. The machine now offers an unrestricted choice of operating modes taking in line, sync and play on an individual channel basis or as a group of channels. These are selected with the standard three toggles plus leds for each mode per channel. Much work has been done to make maintenance easier through rationalisation of internals. Signal electronics remain unchanged. The machine now features as standard the search-to-cue locator plus digital tape timer. It will accept up to 40 cm reels, with the tension now adjustable from the top plate.



Above: *Steve Court of Court Acoustics hawked round a 27 centre real time spectrum analyser accepting line inputs from —85 to +30 dBm. The matrix indicates 11 discrete levels. Manufactured by his own company, it costs £1200 and comes in a James Bond metal flight case. It also keeps cutting engineers' sandwiches fresh . . .*

Above: *Soundcraft demo. The £1760 series 2 16/4 desk was surrounded with all the trappings of a well equipped recording studio including no shortage of would-be engineers.* **Below:** *Spectrasonics 24/24 mixing console available off the shelf—the multi-function meters emphasise the compact nature of the desk.*



It is now common knowledge that ex-Westlake President Tom Hidley has left his company, which commenced life in a garage, to form a European corporation, Eastlake Audio, based in Montreux, Switzerland. The Zurich AES provided the first public venue for his new business venture, which, since it was created three months ago, has accepted 15 design consultancy deposits. By the end of the year, Tom confidently expects to have completed 24 major facilities geographically spread from Athens to Helsinki under the Eastlake banner.

He states that the reason for the change was principally the increasing level of European business coupled with the difficulty of servicing the various contracts from halfway across the world. To pre-empt cynics, he readily admits that there are many tax advantages in terms of corporate taxation in Swiss-based concerns, but his conviction that it will improve service to the European customers seems very sincere. Both Eastlake and Westlake, the latter now run by former partner Paul Ford, enjoy a regular interchange of information by way of transatlantic telephone calls. Equally, both companies find themselves in competition as well as association. The Westlake monitors, well known feature of control rooms of the same name, will be available under the Eastlake label, manufactured in London.

Acoustic Research provided a demonstration equitable with the company name. In effect, it was the simulation of the concert hall environment using two conventionally mounted stereo speakers, and 16 separate delay sound sources placed equidistantly around the sound rectangle. The latter are fed with delayed signals at appropriate amplitudes proportional to those first reflections in the real hall situation with the orchestra considered as a point source.

In practice, the 12 bit digital delay chain is driven from the stereo sum signal. Tappings for the 16 outputs to the surround 10W amp/AR7 speaker combinations are available in 1 ms steps from the delay ladder; each output level can be individually programmed. Maximum ladder delay is 256 ms giving a max simulated echo path length of 76m. System creator Bob Berkovitz produced computer acoustic analyses of various halls with which to programme the delay processor to produce a particular environment although he says that useful results can be obtained with 'simulated halls' of contrived characteristics.

The subjective impression is real; open your eyes and the brain can't cope with the Albert Hall four metres square. Further, moving about in the listening room seems like walking through the hall in ten league boots. The system appeared to work particularly well with the *Sergeant Pepper* intro—you could really be one of the Billy Shears groupies—lending 'real' dimension not present in the original. Church organ music took on an ethereal quality that was, if anything, 'hypernormal'. It sounded very akin to a good matrix quad recording but without the sensitivity to listening area for correct image perception.

So far, Berkovitz isn't too sure exactly what the marketing possibilities of his sound system are, or even what to call it. Unclassified, the system's got class. But some people's wives freak out with two loudspeakers . . .

EMT produced the ideal complement to the *action man* engineer —a Rather Wonderful piece of electronic gizmology incorporating the potential subtleties of a high speed Revox, a delay line and a Cooper Time Cube. The digital reverb, which stands about 1m high and is intended for installation next to the desk, uses four Concorde throttle style multi-way push step switches with associated leds per step to set the delay time and function. A further set of push buttons elect the status of the delay programme: function and time can be set in real time with the bright coloured plastic control levers, or with all four set up in the appropriate positions and then brought in by the punch of a single button from a previous combination. Operationally, no moving parts. By digital recirculation, it provides

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AES 54th CONVENTION, A PREVIEW

E-4 Performance Limitations of Linear Analog Magnetic Recording — Alastair M. Heaslett, Ampex Corporation, Redwood City, California.

E-5 A Review of Factors Affecting the Quality of Duplicate Magnetic Recordings Generated at High Speed—Peter Butt, Consultant, Los Angeles, California.

E-6 Magnetic Head Relapping Techniques—Joseph F. Dundovic, Nortronics Company Inc, Minneapolis, Minnesota.

GOLDEN STATE ROOM
Wednesday, May 5
2.00 pm

Session F
SIGNAL PROCESSING
Chairman: William Windsor, Quad Eight Electronics, North Hollywood, California.

F-1 Digital Computer Assisted Post Production Mix-Down—John C. Kountz, Office of the Chancellor, The California State University and Colleges, Los Angeles, California.

F-2 Programmable Mixdown — Phase Two—Paul C. Buff, Allison Research, Nashville, Tennessee.

F-3 Microcomputer Application to Console Automation—James S. Ketcham, Quad Eight Electronics, North Hollywood, California.

F-4 The Monolithic Compander—A High Performance Gain Control I.C.—Craig C. Todd, Signetics Corp, Sunnyvale, California.

F-5 A Programmable Signal Delay Network—David McIntosh and Robert Berkovitz, Teledyne Acoustic Research, Norwood, Massachusetts.

F-6 A New Digital Time Delay and Reverberation System. Part I: An Economical High Performance Digital Encoder and Decoder—Richard E. DeFreitas, Hybrid Systems Corporation, Bedford, Massachusetts.

F-7 A Low Cost Real-Time Audio Spectrum Analyser—Lyman G. Miller, Jr, Hewlett-Packard Laboratories, Palo Alto, California.

F-8 Vertical Mosfets (VMOS) in High Quality Audio Power Amplifiers—Lee Shaeffer, Siliconix Inc, Santa Clara, California.

SAMUEL GOLDWYN THEATRE
BEVERLY HILLS, CALIFORNIA
(Transportation Provided)
Wednesday, May 5
7.30 pm

Session G
MOTION PICTURE SOUND
Chairman: Richard N. Jamieson, Jamieson & Associates, Minniapolis, Minnesota.

G-1 Film Consoles: The New Technology—Robert L. Bennett and William Windsor, Quad Eight Electronics Corp, North Hollywood, California.

G-2 CP 100 Cinema Processor—A New Audio Control Center for Movie Theatres—David P. Robinson, Dolby Laboratories Inc, San Francisco, California.

G-3 History of Motion Picture Sound Recording—Dr John G. Frayne, retired, Pasadena, California.

G-4 Design and Performance Parameters for a Magnetic Film Re-recording System Incorporating Interlock at High Speed and an Automated Control System — Frank E. Pontius, Westrex, Beverly Hills, California.

G-5 Live Multitrack Dialogue and Live Music Recording on Location for the Movie 'Nashville'—Johnny Rosen, Fanta Professional Services, Nashville, Tennessee.

G-6 A Demonstration of the Sensurround System—Richard J. Stumpf, Universal City Studios, Universal City, California.

Thursday, May 6
9.00 am

Session H
SOUND REINFORCEMENT
Chairman: Robert Trabue Davis, Altec Sound Products Division, Anaheim, California.

H-1 Sound Reinforcement in Large Theatres; Is the Central Cluster Enough? — Charles Boner, Boner Associates, Austin, Texas.

H-2 Audio-Visual/Room Acoustics for the Board Room—Part I: Glen M. Ballou, United Technologies, East Hartford, Connecticut; and Part II: Ralph H. Gibson, Jr, Gibson Associates, New Hartford, Connecticut.

H-3 Background Music and Paging Control — A New Approach — Robert Bushnell, United Sound Systems, Burbank, California; and John Probst, Marriott's Great America, Burbank, California.

H-4 An Interphased Dual Sound System For a Church—Charles J. Catania, Catania Sound Inc, San Rafael, California.

H-5 A Budget Approach to University Union Sound Reinforcement—W. Kay Collins, Brigham Young University, Provo, Utah.

H-6 Board Chambers Speech Reinforcement—Richard D. M. Negus, Purcell + Noppe + Associates Inc, Chatsworth, California.

H-7 The Louisiana Superdome Sound System — J. Jacek Figwer, Bolt, Beranek & Newman, Cambridge, Massachusetts.

H-8 Experience in the Application of Automatic Mixers—Robert C. Coffeen, Coffeen, Anderson & Associates Inc, Mission, Kansas.

GOLDEN STATE ROOM
Thursday, May 6
2.30 pm

Session J
ARCHITECTURAL ACOUSTICS AND ROOM DESIGN
Chairman: Jack B. C. Purcell, Purcell + Noppe + Associates Inc, Chatsworth, California.

J-1 Acoustics in Primary Schools—The Australian Experience—Mark Eisner, Carr & Wilkinson, Canberra City, Australia.

J-2 Instrument Isolation for Multiple Track Music Recording — Michael Rettinger, Consultant on Acoustics, Encino, California.

J-3 Alienating Sound—A Definition for Noise—Alex J. Szecsody, Arizona State University, Tempe, Arizona.

J-4 An Overview of Church Acoustics —David L. Klepper, Klepper Marshall King Associates Ltd, White Plains, New York.

J-5 Commonsense Room Acoustics — Ronald L. McKay, Bolt Beranek and Newman Inc, Canoga Park, California.

J-6 Construction Problems Encountered in the Design of Noise Masking Systems—Bruce E. Walker, Westlake Village, California.

GOLDEN STATE ROOM
Friday, May 7
9.00 am

Session K
AUDIO STANDARDS
Chairman: Warren Rex Isom, Indianapolis, Indiana.

LOS ANGELES ROOM
Friday, May 7
9.00 am

Session L
SPECIAL APPLICATIONS IN AUDIO
Chairman: Robert Rypinski, Playa Del Rey, California.

L-1 A Multiplexed Remote Control System—David M. Jacobson, and Richard N. Crowley, Audiovisual Service, Loma Linda University, Loma Linda, California.

L-2 Preliminary Results of 1975 AES Hearing Survey — Samuel Gilman, UCLA, Los Angeles, California.

L-3 Comparative Performance of Audiometric Earphones in the IEC Artificial Ear and the NBS Acoustic Coupler—John E. Jenkins-Lee, University of California-San Diego, Department of Applied Physics and Information Science Department, La Jolla, California.

L-4 Modular Design Ideas for Portable Sound Systems—Robert G. Heil, Heil Sound Ltd, Marissa, Illinois.

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AES 54th CONVENTION, A PREVIEW

L-5 Design of an Automated Graphic Equaliser—Arthur K. Yeap, Audio Developments—ADI, Palo Alto, California.

L-6 Synthetic Cues in Binaural Localisation—Jeffrey C. Lawton, Technical Service Associates, Van Nuys, California.

L-7 Simplified Measurement of Direct and Reverberant Sound Fields in Enclosed Spaces — Bruce Walker, Consulting & Research in Acoustics, Westlake Village, California.

L-8 Feedback Elimination Simplified—Harro K. Heinz, Rauland-Borg, Chicago, Illinois.

GOLDEN STATE ROOM
Friday, May 7
2.00 pm

Session M
TRANSDUCERS

Chairman: Robert B. Schulein, Shure Brothers Inc, Evanston, Illinois.

M-1 An Efficiency Constant Comparison Between Low-Frequency Horns and Direct-Radiators — D. B. Keele, fir, Electro-voice Inc, Buchanan, Michigan.

M-2 Dissimilar Woofers in a Common Enclosure—G. L. Augsberger, Perception Inc, Los Angeles, California.

M-3 Ultimate Performance of Wide Range High Frequency Compression Drivers—Clifford A. Henricksen, Altec Corporation, Anaheim, California.

M-4 Improved Piezoceramic Noise Cancelling Microphone — Austin J. Brouns, Vought Corporation, Advanced Technology Center, Dallas, Texas.

M-5 Outdoor Speaker Measurements and Some Useful Parameter Tests—W. R. Torn, Dukane Corporation, St Charles, Illinois.

M-6 Establishing a Loudspeaker's Directivity Figure of Merit—Don Davis, Synergetic Audio Concepts, Tustin, California.

M-7 Active Crossover Networks for Non-Coincident Drivers — Siegfried H. Linkwitz, Hewlett-Packard Company, Santa Rosa, California.

M-8 A Time Align Technique for Loudspeaker System Design — Edward Long, E. M. Long Associates, 4107 Oakmore Road, Oakland, California. ■

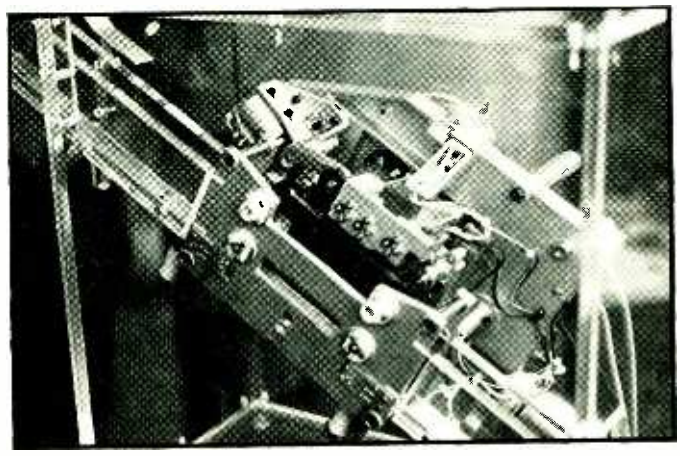
ZURICH-AES 53rd CONVENTION

reverberation, long echo with delay, one shot echo or one shot delay for adt and Haas effect. Judging by the heat given out from an operational unit, the electricity bill would match the price tag of DM.33 000.

An ever so slightly covetous man from another stand said that if his company were to sell 50 consoles to their broadcasting organisation, they wouldn't bother to exhibit at the show at all. However, Kajaani Oy of Finland did and did. Their desks are totally oriented to broadcast use, even down to the modular fitting clock which can provide a switching signal for automatic cue such as time pips etc. Overall modular construction allows system expansion associated with the format. Phone-in programme content is accommodated by suitable stacking facilities provided on the desk.

In the Soundcraft demo room, Phil Dudderidge and Graham Blythe of the same company demonstrated the potential of their 16/4 mixing desk surrounded by all the peripherals that publicity provides. This improbable hotel facility also enabled some interesting demos using the new Audio & Design (Recording) Ltd modular rack sound processing system sourced from a Studer *A80* with a 50 mm master provided by the BBC. They call it SCAMP —that stands for Standardised Compatible Audio Modular Package. It provides a range of functions in standard module format fixing into a rack and mother board assembly. Because they measure only 25 mm wide, 17 can be included in a standard rack including power supply. All use a uniform edge connector regardless of specific module function. Naturally, such a system costs a lot less to implement than either hard-wired or modular construction using flying leads and connectors. Think of virtually any sound processing function apart from copyright noise reduction units and it's probably there, or will soon be, in this format. The main demonstration centred around an *SO6* dynamic lo-pass filter with a roll-off that flattened out with increasing input level. A soloed bass drum with heavy leakage from the cymbals didn't seem to lose very much in the way of subjective attack, or create too much noise pumping when the release time was considerately set. The BBC tape was deliberately chosen for its lack of noise reduction. Judicious juggling produced appreciable hiss reduction without losing too much transient, although this is essentially a characteristic of any expansion system.

With their new mixer, Trident seem to have catered nominally four the sound reinforcement market but from the sample *Fleximix* modular mixer on display they evidently had in mind the possibility of a much wider audience. Specifically for live sound, the unit fits in a very neat flight case; but no such application would need up to ten output groups, the maximum provided by the format of this mixing system. Up to 24 input modules plug into the main frame, which is backed by a mother board with edge connectors. The pins on these correspond to a standard configuration of input and output lines plus effect buses implying that specific modules whether they be input, output or ppm by units can plug anywhere in the mixer without the need for hard wiring. Naturally, one has to give up some advantages of more conventional systems. With this it is the absence of a specific patch panel. However, input and output jacks at the top of each channel module enable direct patching along the length of the mixer from channel to channel.



Studer Unisette automatic transport. The cassette slides down the chute on the left-hand side, goes into play, rewinds and slides out the bottom.

In spite of the large crowds around the Studer stand, further investigation proved it to be a relative disappointment. Although their prototype Unisette transport was operational, it was not interfaced with either record/replay amplifiers or the automated broadcast console with which it is appropriate for interface. The way it works is that tapes are fed in an inclined chute, and from there slide down to a lock. On impulse from the start button the lock opens, allowing the cassette to slide into a bay whereby a series of motors drop and secure it in place and bring up the capstan pinchwheel headblock assembly. The machine then goes into a play mode until the appropriate cue tone has been sensed by the head, whereupon the machine instantly goes into rewind taking the Unisette back to the start. It is then removed from the bay and rejected at the far end of the chute. A Unisette can accommodate up to 20 minutes at 9.5 cm/s and the rewind mode for 20 minutes play takes a mere seven seconds.

The other approach to Unisette reproduction was shown but not demonstrated by EMT in the form of a prototype player. It uses, from an operator point of view, a similar principle to existing NAB cartridge machines. You stick the Unisette in the slot in the front of the instrument, press the start button; jingle comes across, machine stops and that's just about it. The big difference is that when it has finished playing the Unisette is rewound back to the start ready for further use. Obviously, with both Unisette playback systems there has got to be a great deal more complexity of internals than is the case with NAB cartridge machines. For example, the EMT studio playback unit uses no less than five motors to achieve a similar function to the NAB cartridge, albeit with better performance specifications. Both companies expect to be in production within three months.

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reviews

Squire S3000 MkII NAB cartridge reproducer and record module

Hugh Ford

MANUFACTURER'S SPECIFICATION
Cartridge Reproducer
Cartridge format: NAB style A cartridge.
Head format: Monophonic 2 track. Upper track programme, Lower track cue.
Tape speed: 19.05 cm/s (7½ ips) ±0.4%.
Output level: 0 dBm (adjustment ÷ 6 dBm by internal preset control) into 600 ohms.
Maximum output level: +10 dBm into 600 ohms.
Output impedance: 600 ohms unbalanced.
Wow and flutter: Unweighted less than 0.2% rms.
Signal-to-noise ratio: —56 dB below +6 dBm unweighted, reproduce. Cue breakthrough —60 dB below +6 dBm unweighted.
Equalisation: NAB.
Frequency response: ±3 dB; 50 Hz-12 kHz, ref 1 kHz.
Distortion: Total harmonic distortion less than 3% at +6 dBm, 600 ohm load.
Start and stop times: 100 ms.
Controls: Local play and stop with a remote play facility, momentary make-to-engage play mode.
Autocue: Machine will stop on a 500 ms 1 kHz cue burst at a level corresponding to 0 dBm programme level.
Cue burst: 500 ms ÷ 250 ms, 1 kHz ±75 Hz.
Dimensions: 88.9 mm x 206 mm frontal x 254 mm deep.
Weight: Approximately 19.8 Kg.
Power requirements: 240V 50 Hz, 40W.
Connectors: DIN 5 way 180° output and remotes. DIN 7 way interlink to recorder.
Recorder Module
To be used with the *S3000 Mk 2* NAB cartridge reproducer to provide recording and cue facilities.
Input impedance: 10k ohm nominal, unbalanced.
Input sensitivity: 75 mV maximum.
Input level control: Front panel uncalibrated gain control.
Metering: vu style meter indicating 0 vu for 0 dBm recording level.
Controls: 'Record off' and 'record'.
Frequency response: ±3 dB, 50 Hz-12 kHz ref 1 kHz.
Bias frequency: 100 kHz nominal.
Cue frequency: 1 kHz adjustable by internal preset control.
Cue burst: 500 ms actuated by reproducer 'play' switch.
Record-signal-to-noise level: —3 dB above bulk erased tape unweighted.
Dimensions: 88.9 mm x 206 mm frontal x 254 mm deep.
Weight: 8.8 Kg.
Power requirements: 240V, 50 Hz, 10W.
Connectors: DIN 5 way 180° input. DIN 7 way interlink to player.
Interlock: When operated with the *S3000 Mk 2* reproducer the recorder is interlocked so that the recording mode cannot be engaged during play.
Price: Reproducer £155. Record module £135.
Manufacturer: Roger Squire Ltd, 55 Charlbert Street, London NW8, UK.

JUST a look at the price tag on this equipment shows that it is not intended to compete with the highly priced broadcast cartridge equipment. It is, however, bound to be attractive to the cartridge machine users with small budgets, such as small broadcast stations and other radio services.

Both the replay unit and the record module have identical dimensions, and they are similar in construction with the base and ends being formed by a 'U' shaped metal tray. The free corners of this tray are secured to each other by metal rods, and a 'U' shaped cover completes the case, providing a solid mechanical construction.

The replay unit has only two operator controls, which are illuminated 'start' and 'stop' switches, there being a screwdriver-operated replay gain control accessible through a hole in the base of the unit. At the rear of the unit there is a standard metric fuseholder and a fixed mains lead which could well be secured better to the instrument (the same comment applies to the record module). In addition there are two DIN sockets —a seven-pin socket for matching into the record unit, and a five-pin socket which provides the unbalanced audio output and also a remote play facility which is actuated by linking two pins.

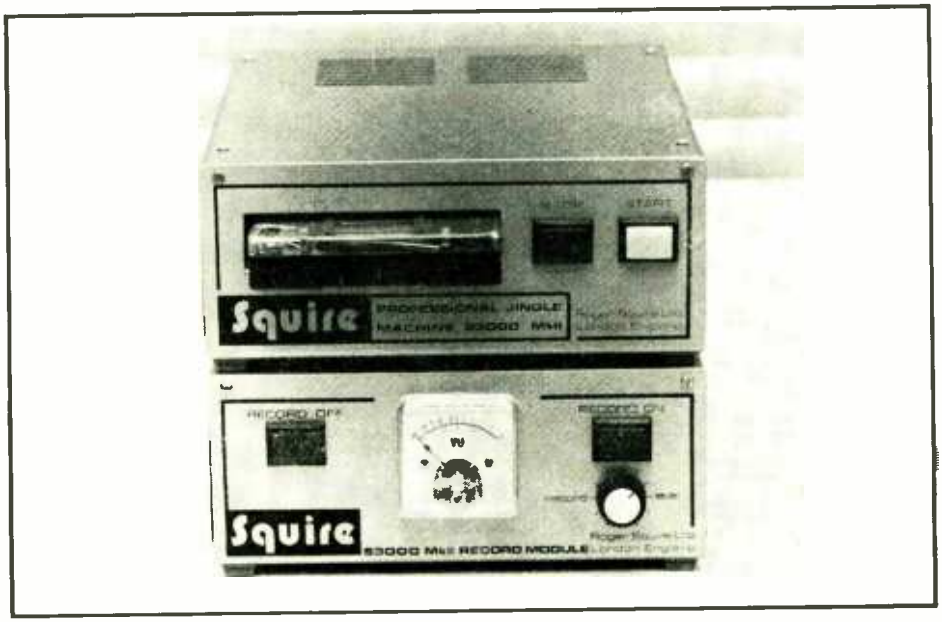
Turning to the tape transport, this accepts the NAB style 'A' standard cartridge and has quite positive cartridge location and solid head mounting with civilised head azimuth adjustment. The track format is to the NAB monophonic standard with the upper track being the programme track and the lower track the cue track, separate record and replay heads being fitted for both program and cue. As is normal, once the machine finds a cue tone the transport is stopped.

The electronics of both the replay and the record units are mounted on good quality printed boards and the overall standard of wiring and layout is to a good commercial quality. While the individual components are not identified on the printed boards, the instruction manual provides layout diagrams for the printed boards in addition to circuits and a full electrical parts listing.

The record unit, like the replay unit, has its separate mains lead and fuse and also two DIN sockets on the rear panel, one of which interfaces with the replay unit. The second DIN socket provides for the signal input in addition to which remote record switching is available by shorting two pins.

A degree of record interlocking is included, in that it is not possible to go into the record mode when the machine is in replay; also, when the machine is manually stopped in the record mode, it reverts to the replay mode. However, if the machine finds the cue tone when in the record mode it does not revert to the replay mode, so that pressing the start button in this condition will lead to over-recording.

Record level is controlled by an uncalibrated rotary potentiometer on the record unit, the level being indicated by a 'vu style meter'. The manufacturer is unusually honest by giving the meter this title, as it is one of those Japanese products which look like a vu meter but among other sins only has a half wave rectifier. The remaining operator controls on the record unit are two illuminated switches which control 'record on' and 'record off' and work in conjunction with the 'play' switch on the replay unit.



A standard primary cue tone comprising a 1 kHz burst is recorded on the cartridge whenever the equipment is set to record by first pressing the 'record on' button and then the 'play' button, and the tape is automatically stopped at a recorded cue tone in either the record or the play modes; thus it is impossible for the tape loop to be over-run in the record mode as the tape will stop at the cue tone at the beginning of the recording. However, as has been mentioned, the record interlock does not give protection if this condition is found by the machine.

Replay Performance

Initial attention was paid to the replay frequency response, which is specified as being to the NAB standard of 50 μs and 3180 μs within ± 3 dB from 50 Hz to 12 kHz. The first results were quite disastrous, with the 10 kHz level being more than 10 dB down. However, realignment of the head azimuths cured this trouble, but even then all was not well.

It does appear that, while the correct high frequency time constant has been used in the replay amplifier, the head resonance has been tuned to too low a frequency with a resulting unwanted high frequency boost around 10 to 12 kHz. The following table shows the replay response from both NAB and CCIR (70 μs) calibration cartridges, the best results being obtained with the incorrect cartridge.

	Replay Output	
	NAB	CCIR
Frequency	Cartridge	Cartridge
15 kHz	−1 dB	0 dB
12 kHz	−4.5 dB	−3 dB
10 kHz	−4 dB	+2.5 dB
8 kHz	−3 dB	−0.5 dB
5 kHz	+1 dB	0 dB
3 kHz	+0.5 dB	0 dB
1 kHz REFERENCE	0 dB	0 dB
600 Hz	−0.5 dB	
400 Hz	−1.0 dB	
200 Hz	−0.5 dB	
100 Hz	−0.5 dB	
80 Hz	−0.5 dB	
60 Hz	+1.0 dB	
50 Hz	0 dB	

Noise was measured with respect to a tape flux of 200 nW/m under a number of different conditions. The following table shows the overall noise for the replay chain alone without tape, for bulk erased tape (Aristocart) and for machine recorded tape which has been recorded without any input signal to the machine. Measurements were made for rms band-limited noise, rms 'A' weighted noise and CCIR weighted noise in both rms and DIN quasi-peak measurements (see below):

It is to be noted from that below that the band-limited results show little difference between the various measurement conditions, and the cause for this was quite clear from subjective results where a considerable amount of motor induced noise was present in the replay output. **Fig. 1**, which is a spectrum analysis of the replay noise, clearly shows that there are a multitude of mains frequency harmonics in the output which are at quite high levels, even at 500 Hz. This appeared to be caused by the stray field from the capstan motor being induced into the replay head.

In other respects there is no complaint about the replay noise which has a good margin on tape noise, but the manufacturer should pay some attention to this problem and that of replay equalisation.

The output impedance was found to be 600 ohms with a maximum drive capability of + 10 dBm when loaded into 600 ohms, or 6 dB higher into an open circuit with the output level control offering a very wide range of levels and thus being rather coarse in operation.

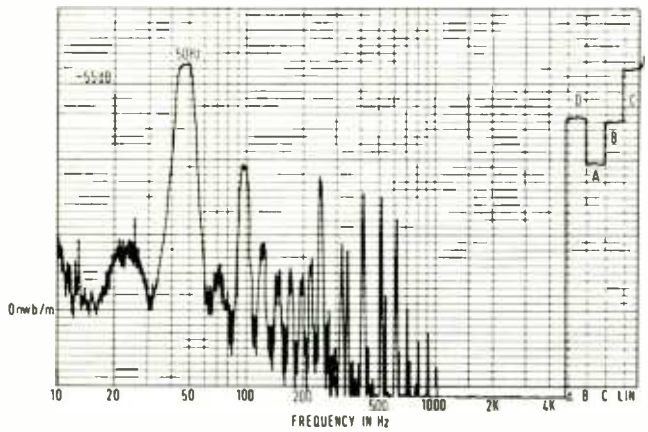
Wow and flutter were found to be surprisingly good when tested with an Aristocart 70 second cartridge, the DIN weighted performance on record followed by replay never being worse than 0.1% quasi-peak weighted, or 0.35% unweighted. Similarly, the start time was found to be to specification, with a more rapid stop than start.

Finally, on the replay end the cue tone breakthrough was found to be at a very low level, and no trouble was experienced with missing cue tones or other cueing faults.

50 ▶

	Reference Level to Noise (200 nW/m)		
Condition	Replay Only	Bulk Erased	Machine Recorded
Band limited 20 Hz-20 kHz	−51.1 dB	−51.1 dB	−50.5 dB
'A' weighted rms	−65.3 dB	−58.7 dB	−55.0 dB
CCIR weighted rms	−64.0 dB	−53.5 dB	−48.5 dB
CCIR weighted quasi-peak	−59.0 dB	−48.5 dB	−44.0 dB

FIG.1
SQUIRE REPLAY NOISE
OF MACHINE ONLY
NARROW BAND ANALYSIS



SQUIRE S3000 MKII NAB CARTRIDGE & MODULE

Record/Replay Performance

Fig. 2 shows the overall record/replay frequency response using an Aristocart without adjusting the bias. Certainly there is no cause for complaint in this department, with the possible exception of the low frequency deviations which would appear to be a head pole piece wavelength effect.

Three per cent third harmonic distortion at 1 kHz was found to occur at +1.5 dB, to the reference level of 200 nW/m, which corresponded to 7 dB above the zero indication on the level meter. If this meter were a genuine vu meter this margin would have been on the small side, but the use of non-standard metering makes it really impossible to give serious comment on level indication; however, the level indicator was found to be before record pre-emphasis, which is generally undesirable.

Third harmonic distortion at zero meter indication at 1 kHz was found to be 0.35% rising to 0.8% at +3 dB meter indication. The setting of the input level control had no effect upon distortion because it is at the input to the record amplifier, thus it was found that the input level could lie anywhere above 125 mV for recording the reference level of 200 nW/m.

Input impedance showed mild variation with the input level control setting, with extreme values of 8000 ohms and 11 600 ohms which give no cause for complaint.

Both the level and the frequency of the cue tone were found to be within NAB specifications, but the duration was on the margin at 700 ms as opposed to the maximum permitted of 750 ms; however, it is not difficult to adjust this parameter.

Fig. 3 shows the uniformity of output at 1 kHz and at 8 kHz, from which it is to be seen that the 1 kHz uniformity is quite acceptable for a cartridge machine. However, at 8 kHz it is felt that better results should be demonstrated. However, such a performance is typical of the shortcomings of the NAB cartridge system.

FIG. 2
SQUIRE RECORD/PLAY
ARISTOCART

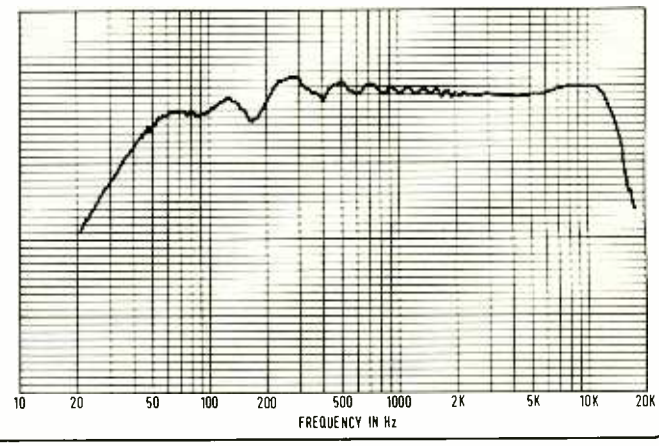
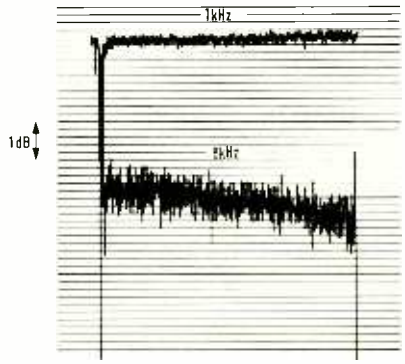


FIG. 3 SQUIRE UNIFORMITY



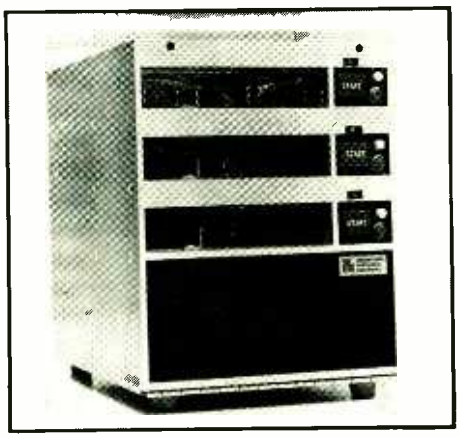
General

The remote record and play functions operated as prescribed in the specification and the overall impression was that the mechanical design was substantial and operation should be generally fault free.

It does seem a great shame that the replay noise induced from the motor was so bad and that the replay response is not a little better, as these two matters spoil the performance of what can easily be an extremely good machine. If the manufacturer corrects these problems there will be no doubt that the machine will offer outstanding value for money, but even as it stands it represents a cheap cartridge system which is quite suitable for the less serious applications. The manufacturer informs me that he is paying attention to these comments, and I hope that a modified machine will be produced. This would be a real winner.

International Tapetronics cartridge recorder/reproducer—Rp

Hugh Ford



MANUFACTURER'S SPECIFICATION

Replay Section

Power: 117V ac, 60 Hz, 70W; other voltage and frequency variations are available on special order.

Tape speed: 19 cm/s; direct drive, hysteresis-synchronous capstan motor with electrolyzed shaft and instrumentation-type, permanently lubricated ball bearings.

Wow and flutter: 0.2% or less NAB unweighted.

Timing accuracy: 0.1% or better.

Audio output: +12 dBm before clipping: normally +4 dBm: 600 ohms balanced. May be strapped for 150 ohms.

Distortion: 2% or less, record to playback at 0 vu record level, 400 Hz.

Noise: 55 dB or better below reference of 400 Hz at 3% thd, monophonic. 50 dB or better below reference of 400 Hz at 3% thd, stereophonic.

Crosstalk between channels: Better than 50 dB at 1 kHz.

Frequency response: ±2 dB from 50 to 15k Hz.

Equalisation: NAB. Adjustable to compensate for head wear.

Cue signals: NAB primary cue, 1 kHz standard. Secondary cue 150 Hz, and tertiary cue 8 kHz optional. External information when tone is sensed furnished as relay contact closure.

Playback time: **SP Series:** 2s to 16 min, NAB size A and B cartridges.
WP Series: 2s to 31 min, NAB size A, B and C cartridges.

Start time: 0.1s at minimum solenoid damping.

Stop time: 0.1s at minimum solenoid damping.

Ambient temperature: 55° C maximum.

Remote control: All controls and indicators.

Mounting: Table top mounting with rack mounting adaptors optional.

Dimensions: SP Series: 216 mm width, 133 mm high (add 9.5 mm for feet), 279 mm deep.
WP Series: 438 mm width otherwise as *SP* Series.
Weight: SP Series: 10.5 Kg.
WP Series: 12.7 Kg.
Head configuration: NAB (provided with reproduce and dummy head only; except *WP* Series supplied with recording head when purchased with *RA* Series recording amplifier).
RA Series Recording Amplifier
Power: From reproducer's regulated power supply (24V dc).
Audio input(s): Line input impedance; 600 ohms balanced (two for stereo), —20 dBm to 0 dBm level; accepts higher input level by changing input pad.
Metering: Taut band movement with 'A' scale. Internal meter switch allows selection for metering the following levels: recording input; playback; bias; cue playback; or peak recording.
Distortion: 2% or less, record and playback at 0 dBm record level, 400 Hz.
Noise: 55 dB or better below reference of 400 Hz at 3% thd, monophonic.
50 dB or better below reference of 400 Hz at 3% thd, stereophonic.
Crosstalk between channels: Better than 50 dB at 1 kHz.
Frequency response: ±2 dB from 50 to 15 kHz.
Equalisation: NAB.
Cue signals: Standard 1 kHz primary cue, automatically recorded at start of recording (may be defeated and applied as required at user's option); 150 Hz and 8 kHz cues, optional (may be recorded during recording process or during playback); individual oscillators for each frequency with adjustable frequency and output level.
Bias oscillator: Push-pull, 82 kHz; individual gates and level controls for program (separate left and right in stereo units) and cue.
Remote control: All indicators and functions except meter switch.
Dimensions: WRA Series: 133 mm high x 222 mm wide x 305 mm deep.
RP Series: 133 mm high x 451 mm wide x 305 mm deep (includes *RA* recorder and *WP* reproducer on single panel). (Add 9.5 mm for feet.)
Weight: WRA Series: 5.9 Kg.
RP Series: 17.3 Kg.
Manufacturer: International Tapetronics Corporation, 2425 South Main Street, Bloomington, Illinois 61701, USA.
UK agent: Lee Engineering Ltd, Napier House, Bridge Street, Walton-on-Thames, Surrey.
Price: £606, $1225.

THE review version of this machine was a stereo record/replay unit equipped with the full complement of cue tones and remote facilities, but without the optional fast cue feature. This optional feature runs the tape at four times normal speed when a 150 Hz cue tone is encountered (end of message), and stops the machine at the next primary (1 kHz) cue tone.

Initial inspection of the machine clearly shows that great lengths have been gone to to design a heavy duty machine which should stand up to continuous use and also be easy to maintain. Furthermore, full remote control facilities are provided so that not only can the normal machine functions be remotely controlled, but also the machine can be interfaced with automatic broadcast equipment and other devices which require logical information from the machine.

The tape transport is of substantial construction, the main component being a flat alloy plate which is about 1 cm thick and on which the tape transport components are mounted. The method of head mounting is of equal proportions and clearly aimed at stable head positioning with ease of adjustment of head height and azimuth. Drive to the tape cartridge, which can be to any of the NAB standard sizes, is from a direct drive synchronous motor with a specially treated capstan shaft; the pinch roller is applied by a massive solenoid which is equipped with variable air damping. The solenoid is to the rear of the heads and is a well screened assembly; the capstan motor is below the mounting plate upon which the heads are mounted and to which the cartridge references. so there is very unlikely to be any interference picked-up by the replay head assembly.

As is to be seen from the manufacturers specification, the record and replay electronics are effectively two separate units. In practice the replay electronics (including cue detection) are mounted on two plug-in printed boards to the rear of the cartridge transport which occupies the right hand end of the review machine and record electronics and metering occupy the right hand side of the assembly. These similarly comprise printed boards which contain the vast majority of the electronic components. The printed boards are keyed so that they can only be inserted in their proper sockets, and the layout and quality of the boards is to the highest standards; they do not have printed component identifications, but layout diagrams and a wealth of servicing data is to be found in the comprehensive instruction manual.

The electronics compartments are fully screened by a metal cover which has holes for screwdriver access to the various pre-set controls, and all the control functions are clearly identified on the covers.

Local operation of the machine is by five illuminated pushbutton switches on the front panel. The tape transport is operated by a start and a stop switch, neither of which is illuminated unless a cartridge is correctly loaded. Then, the stop switch becomes illuminated white. The illumination of the start switch is at two levels; in the normal running mode the illumination is dim green, but the illumination becomes brighter if a secondary cue tone is found on tape. Similarly, the stop switch is not illuminated in the normal run mode, but it becomes illuminated if a tertiary cue tone is located on tape.

Of the remaining switches one is the record (red) switch which is interlocked with the start and stop switches such that it is impossible to go into the record mode when the tape is in motion. The final two switches are for inserting the secondary and tertiary cue tones which may be done in either the record or replay mode, no safety interlock being provided. As is normal with cartridge machines the primary cue tone is automatically inserted when the machine is set into the record mode.

To the rear of the unit there are two Imperial size power fuses, which are 52 ▶

ITC-RP

thoughtlessly identified by the symbols 'F1' and 'F2' instead of their values which have to be sought in the instruction manual should they fail. Also, as readers may realise, fixed power leads seem never to be the right length.

Two six pin (Elcom flat pin type) connectors serve as audio signal inputs and outputs—the provision of standard *XLR* series three pin connectors would suit the audio industry far better. Remote controls are connected by one 15 and one 18 pin version of the same type of connector; these do have the advantage of being easy to wire when compared with many more modern connectors.

Virtually every front panel facility and in addition a large number of other functions are available at the remote connectors, including relay contact closures for secondary and tertiary cue detection and facilities for inhibiting the primary cue tone.

In addition to these facilities no mention has as yet been made of the two front panel vu meters which serve a number of purposes. In normal operation the meters indicate the replay level from tape, but an internal switch is provided so that the metering can be used to indicate a large number of other functions. These include bias for programme or cue, level for replayed programme or cue, and programme record level either after or before pre-emphasis in the record amplifier. Each of these functions is individually adjustable for meter indication by a preset within the electronics, over and above which are a number of other preset controls including the record sensitivity presets which can be operated with a screwdriver through holes in the front panel.

Near the internal meter switch there are two pushbutton switches; one of these is used to inhibit the recording of the primary cue tone (useful for testing) and the other inserts a primary cue tone when depressed—the remaining internal preset controls will be mentioned later.

Replay Performance

The review sample bore a label stating that it was equalised to the CCIR (70 μs), standard, so the initial investigation into the replay frequency response was aimed at checking the replay response against a Magnetic Reference Laboratory calibration tape. Being suspicious of devices which are intended to be loaded into 600 ohms, I checked the replay response into 600 ohms and into an effective open circuit, the result being that a 1 dB difference in replay response at 15 kHz was found; the better performance occurred without a load. However, as a 600 ohm load is specified, here are the excellent results, which are even better into an open circuit:—

Frequency	Left Channel	Right Channel
15 kHz	—0.8 dB	—1.0 dB
12 kHz	—0.6 dB	—0.8 dB
10 kHz	—0.4 dB	—0.4 dB
7.5 kHz	9 dB	—0.2 dB
5 kHz	0 dB	0 dB
2.5 kHz	+0.3 dB	0 dB
1 kHz	0 dB	—0.1 dB
700 Hz	0 dB	0 dB
500 Hz	+0.8 dB	+0.9 dB
250 Hz	—0.7 dB	—0.1 dB
100 Hz	+1.3 dB	+2.0 dB
50 Hz	—0.8 dB	—0.6 dB

It will be noted that while this performance is 'par excellence' at high frequencies, the bass end exhibits relatively wide deviations. The cause of this effect is the pole piece wavelength effects on the replay head, as will be observed from the overall frequency response.

Examination of the replay noise levels also gave very good results, and subjective listening tests showed that hum induction and mains harmonics were virtually non-existent on the right channel but that there was a mildly undesirable breakthrough on the left channel. The following table refers noise levels to a reference level of 200 nW/m in terms of unweighted noise over the band 20 Hz to 20 kHz, 'A' weighted rms noise, CCIR weighted rms noise and DIN quasi-peak noise.

Measurement	Left Channel	Right Channel
Machine only—no tape		
Band limited 20 Hz to 20 kHz	57.7 dB	59.9 dB
'A' weighted rms	64.9 dB	66.6 dB
CCIR weighted rms	62.3 dB	63.9 dB
CCIR weighted quasi-peak	56.5 dB	59.4 dB
Bulk erased Aristocart		
Band limited 20 Hz to 20 kHz	51.3 dB	51.6 dB
'A' weighted rms	54.8 dB	55.0 dB
CCIR weighted rms	49.0 dB	49.4 dB
CCIR weighted quasi-peak	44.3 dB	44.7 dB
Machine erased Aristocart		
Band limited 20 Hz to 20 kHz	47.7 dB	47.4 dB
'A' weighted rms	49.9 dB	49.8 dB
CCIR weighted rms	44.0 dB	43.9 dB
CCIR weighted quasi-peak	39.0 dB	38.9 dB

The output impedance was found to be 600 ohms as specified, and whilst it appears to be American practice to load into 600 ohms from a 600 ohm source, it always seems simpler to use low output impedances and relatively high input impedances—this practice is quite straightforward with solid state circuits where a minimum input impedance of say 10k ohms and a maximum output impedance of say 100 ohms makes life much simpler.

The onset of output clipping was found to be +6.5 dBm on the left channel and +8.5 dBm on the right channel (into 600 ohms), and while a further 6 dB is available into an open circuit these levels are rather low by modern standards.

Measurement of wow and flutter gave a pleasant surprise using a 70 second Aristocart, the DIN weighted wow and flutter on record/replay being only 0.07% with an associated unweighted performance of 0.28%—a creditable performance for a cartridge system.

Cue tone breakthrough was generally satisfactory, the primary 1 kHz tone breakthrough being negligible, but the level of 8 kHz being −52 dB with respect to a flux of 200 nW/m and the worst offender being the 150Hz tone at −38.5 dB below the same reference level.

Record/Replay Performance

Like the replay frequency response, the two channels exhibited virtually identical record/replay performance as is to be seen in **fig. 1.** While this performance is generally to specification, the low frequency boost at just around 100 Hz is perhaps unfortunate as it will boost any recorded second harmonic of the power line. The cause of this boost, and the higher frequency minor boosts is clearly the head profile, and this appears to be a common shortcoming of cartridge machine heads.

Reference to the noise performance shows that the noise introduced by the machine above bulk erase noise is about 5 dB (A) and considerably in excess of this with the CCIR weighting—such a performance is clearly disappointing, and it is felt that perhaps the manufacturer should probably pay more attention to the bias oscillator waveform.

Attempts to measure the point at which 3% third harmonic distortion occured brought to light severe limitations in the signal handling capacity of the replay amplifier. When loaded into 600 ohms the replay amplifiers ran into severe waveform distortion at +2 dBm and +4 dBm for the left and right outputs—this corresponds to only 1.5 dB above reference level of 200 nW/m in the case of the left amplifier

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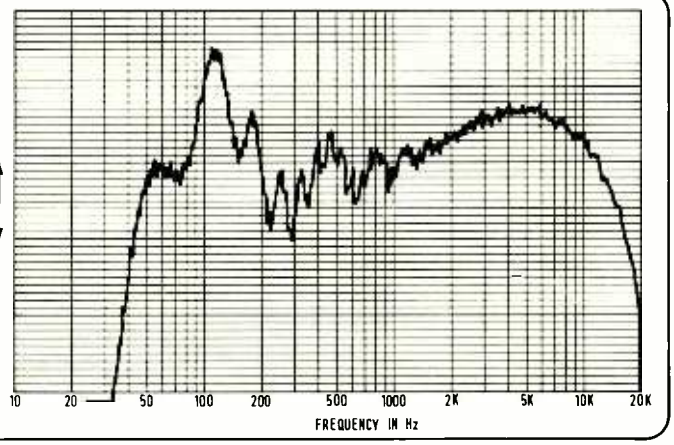
FIG. 1
ITC RP
OVERALL
FREQUENCY RESPONSE



RECTIFIER: RMS
ZERO LEVEL: N/A
LOWER LIM. FREQUENCY 10Hz
POT.: 10dB
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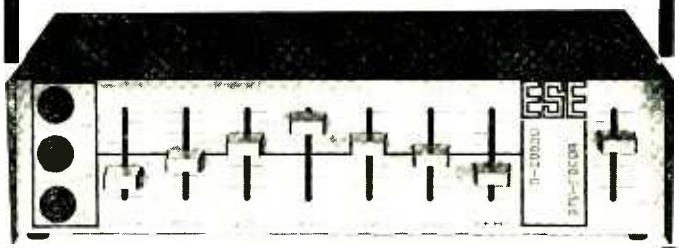

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which was found to be the same as +1.5 dB on the alleged vu meters. These meters, which are clearly labelled 'vu' are furthermore nothing like the standard vu meter; the application of the standard 300 ms tone burst gave severe overswing and the frequency response was out of specification at both 10 kHz and 35 Hz—8 dB in error at the latter frequency.

Reverting to the measurement of distortion, the maximum level was determined by lowering to replay amplifier gain by 6 dB, when 3% third harmonic at 1 kHz was found to be at 6.5 dB above the reference level of 200 nW/m; this is respectable. Furthermore, the distortion at 0 vu under the original conditions was found to be 0.6% at 1 kHz.

The floating transformer inputs had a measured input impedance of 670 ohms, which was sensibly constant with frequency, and the input sensitivity was more than adequate with a maximum of 44 mV. However, 600 ohm terminations are often somewhat inconvenient and personal preference is for an input impedance of at least 10k ohms with a switched option of 600 ohm terminations for those who still work with 600 ohm lines.

The uniformity of reproduction is shown in **fig. 2,** which shows the deviations of a 1 kHz and an 8 kHz tone which has been recorded and then replayed to a high speed pen recorder. It will be noted that there was a certain amount of cyclic non-uniformity at 1 kHz; this defect was noted on several different cartridges, but it is peculiar that it does not appear at 8 kHz in the form of lack of uniformity.

Wow and flutter as measured with a 70s Aristocart was found to be 0.7% as by the weighted quasi-peak method, or 0.28% unweighted, both of which are good figures for a cartridge system. Another, and this time most impressive feature was the phase shift between tracks. Deficiency here is a well known disease of cartridge machines, and reference to **fig. 3** shows that the phase jitter at even 8 kHz was minimal and far less even than many reel-to-reel machines.

The final matter to be investigated under the heading of record/replay performance was the crosstalk performance between tracks. So far as the audio tracks are concerned, the situation is shown in **fig. 4,** which demonstrates that the performance is very good. In the instance of the cue tones, the adjacent track performance was such that cue tone breakthrough was at the following levels with respect to the reference level of 200 nW/m.

Cue Frequency	Breakthrough
150 Hz	—38 dB
1 kHz	—60 dB
8 kHz	—52 dB

At a level of only −38 dB the 150 Hz cue will be clearly audible in the output, but the other cues are at an adequately low level.

Other Matters

The record level and detection level of the cue tones is fully adjustable, but the recording frequency is fixed, as is the duration of the primary cue tone. In fact the tolerance on the cue frequency was well within the NAB standards but the duration of the primary 1 kHz cue was rather near the upper limit at 700 ms. It was further noted that when using the internal cue insertion button it was essential to hold this pressed for the full cue duration if a full length cue tone was to be recorded—the manufacturer should correct this fault. It was further noted that the duration of the secondary and tertiary cue was not internally controlled, and the cue duration depended entirely on how long the cue button was depressed.

The final matter to be checked was the sensitivity to mains voltage variations, and this was found to be negligible over a 15% input range.

Summary

Having regard to the review sample's being a well used demonstration model, the mechanical performance was excellent. It is, however, felt that the performance of the electronics leaves something to be desired. Firstly, the limited available output from the replay amplifier is a distinct limitation—so much so that the conventional setting of 0 dBm as operating level cannot be used if the tape is to be properly driven.

On the record amplifier front it is felt that the noise introduced by the record amplifier could be better. The overall standard of construction is good. Serviceability is first class, as are the overall metering and control facilities. It is therefore a pity that these defects exist in the design.

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FIG. 2
ITC RP
UNIFORMITY

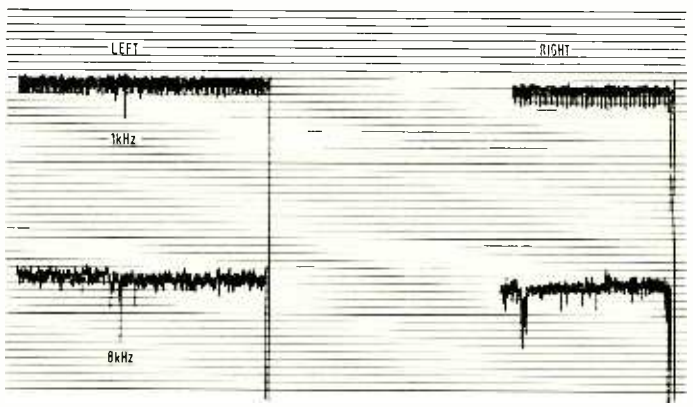


FIG. 3 ITC RP PHASE JITTER PAPER SPEED : 3mm/s

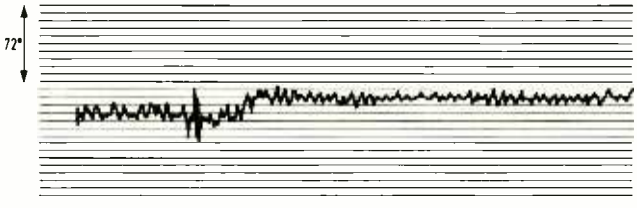
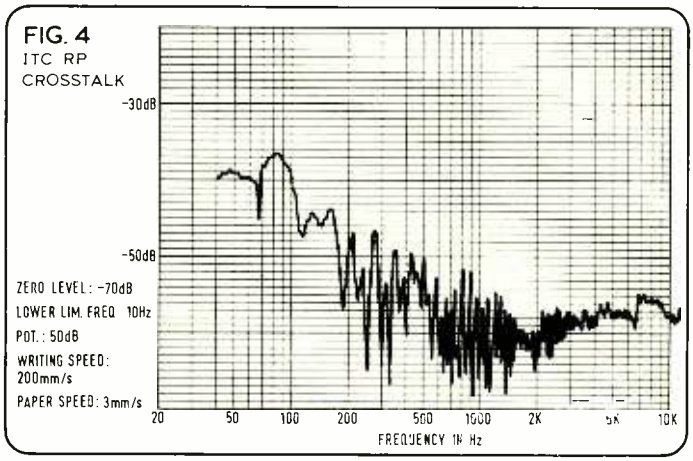
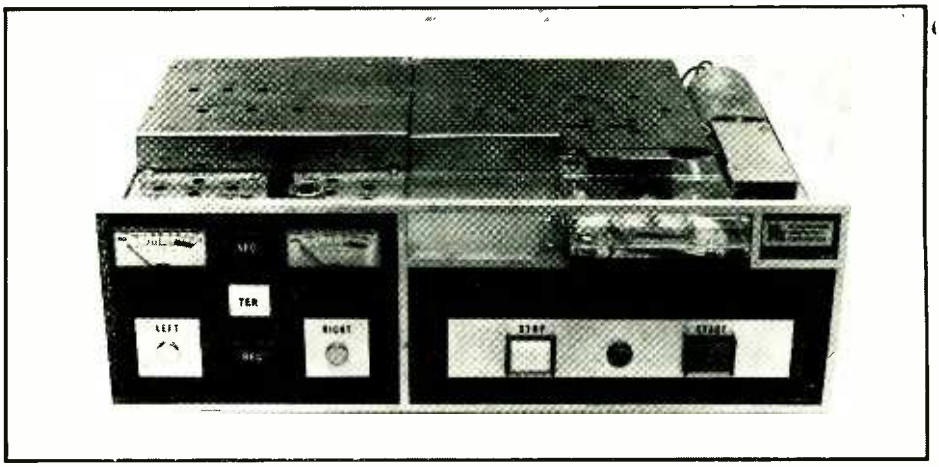


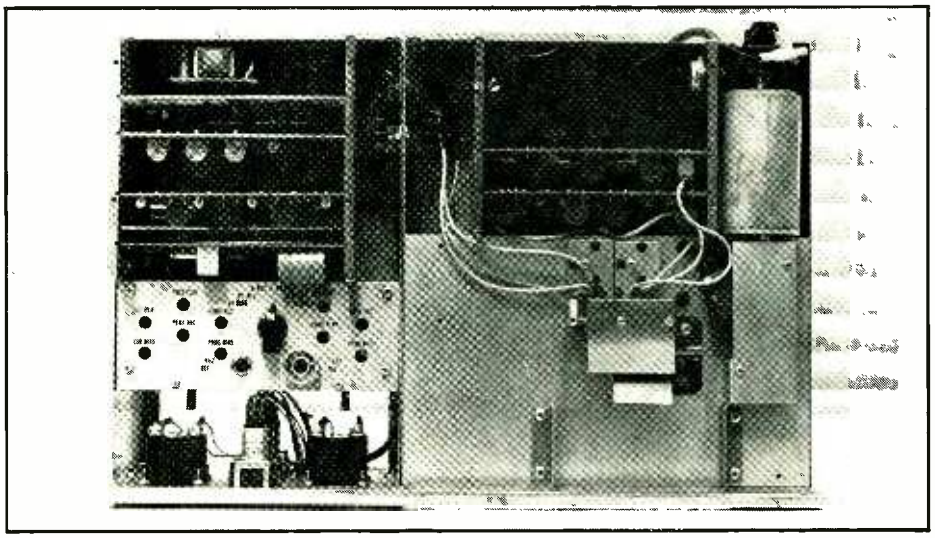
FIG. 4
ITC RP
CROSSTALK



International Tapetronics 3D cartridge reproducer

Hugh Ford





MANUFACTURER'S SPECIFICATION

Power: 117V ac, 60 Hz, 144W. Other voltage and frequency variations available on special order.
Tape speed: 19 cm/s. Other speeds on special order. Direct drive, hysteresis synchronous, common-capstan motor with electrolysed shaft and instrument-type permanently lubricated ball bearings.
Timing accuracy: 0.1% or better.
Wow and flutter: 0.2% rms or less, unweighted.
Audio output: +15 dBm before clipping; normally +5 dBm; 600 ohms balanced. May be strapped for 150 ohms (+18 dBm available on special order). Independent output for each deck.
Distortion: 2% or less, record to playback at 0 vu record level.
Noise: 55 dB or better below reference of 400 Hz at 3% thd, unweighted monophonic. 50 dB or better below reference of 400 Hz at 3% thd, unweighted, stereophonic.
Crosstalk between channels: Better than 50 dB at 1 kHz.
Frequency response: ± 2 dB from 50 to 15k Hz.
Equalisation: NAB. Adjustable to compensate for head wear. CCIR available.
Head configuration: NAB. Two tracks monophonic, three tracks for stereophonic.
Cue signals: NAB. Primary (stop) cue, 1 kHz, standard. Secondary cue 150 Hz, and tertiary cue 8 kHz, optional. Utilises adjustable tuned circuit detector for each tone and furnishes relay contact closure for external control.
Tape capacity: NAB size A and B cartridges. 2s to 16 min with 25 μm lubricated tape at 19 cm/s each deck.
Start time: 0.1s.
Stop time: 0.1s.
Ambient temperature: 55°C maximum.
Remote control: All indicators and controls.
External connectors: Latching type. Mating plugs furnished.
Mounting: Table top mounting. Rack mounting adaptors optional.
Dimensions: 216 mm width x 327 mm depth x 267 mm height (add 16 mm for feet).
Weight: 18.6 Kg.
Price: £785, $1587.
Manufacturer: International Tapetronics Corporation, 2425 South Main Street, Bloomington, Illinois 61701, USA.
UK agent: Lee Engineering Ltd, Napier House, Bridge Street, Walton-on-Thames, Surrey. Phone: 09322-43124.

THE *3D* series of cartridge drives consists of a series of drives all of which are capable of handling three cartridges simultaneously; monophonic and stereophonic replay only versions are available with either single tone (primary) cue facilities or triple tone cue facilities.

A single capstan motor is used to drive the three cartridges by means of a single direct drive shaft penetrating the three cartridge drives which are arranged in vertical array. Each cartridge drive is based on a massive alloy plate onto which the replay head and the pinch roller mechanism are mounted, these features being identical to those used in the type *RP* machine which is also reviewed in this issue.

Unlike the *RP* machine, no record facilities are provided and the record head position is occupied by a dummy head to preserve the tape alignment. Also, cartridge control is by two pushbuttons which are simply stop and start buttons; inserting a cartridge illuminates a yellow 'ready' lamp, and subsequently pressing the start button illuminates a green indicator within the start button. Upon stopping the cartridge manually, or if a primary 1 kHz cue tone is detected, the green illumination is extinguished and the yellow 'ready' lamp again becomes illuminated.

Each cartridge is associated with a 15 pin remote control socket which provides all these functions and also provides normally-open relay contacts for the secondary and tertiary cue detectors when these are a fitted option. In addition to these sockets, the signal output is via a six-pin socket associated with each transport which has a floating and transformer-coupled output. All these sockets are of the old fashioned flat pin (Elcom) type, where at least for the audio outputs an *XLR* type might be preferred. A further socket provides for the lower cartridge transport to be connected to an external recording unit which is an optional extra.

These sockets, and two Imperial size fuseholders, occupy the back panel of the unit. As is all too common, the fuse holders are not identified with their fuse ratings and you have to dig in the parts list to extract this vital information.

Removing the back cover gives access to the signal electronics which appear to be identical with those used in the series *RP* machines; however, unlike the *RP* machine, the controls are not identified which means that you have to refer to the instruction book to align the electronics.

A common power supply in the base of the unit provides the power for the three sets of electronics, Capstan motor and output transformers are also to be found in this department.

The standard of mechanical construction of the entire unit is extremely solid, heavy section alloy sheets and bars forming the main chassis to which the cartridge transports and the electronics card frame are attached. Whilst the entire unit is very compact, the accessibility of most components is relatively easy and all the signal electronics are included on six printed circuit boards which are interchangeable between transports.

Electronics

Inspection of the replay amplifiers and cue tone detectors showed that they appeared to be identical to those used in the type *RP* machine, therefore reference to that review

FIG. 1 ITC 3D SERIES REPLAY RESPONSE

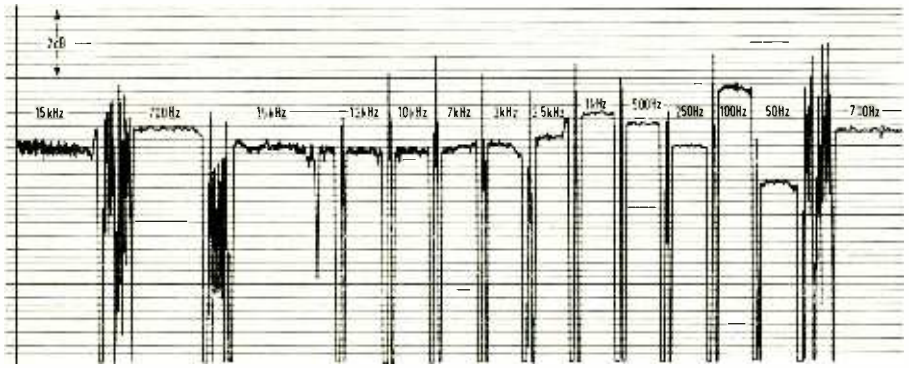
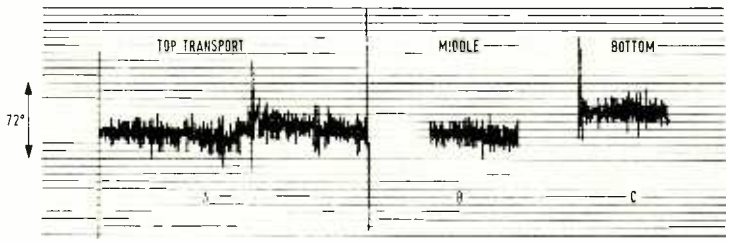


FIG. 2
ITC 3D SERIES
PHASE JITTER
AT 8kHz



provides performance data on the replay machine.

In spite of this situation, certain replay amplifier parameters were checked and some comment is appropriate. The replay frequency response shown in **fig. 1** is again exceptionally flat, but it will be noted that the same characteristic boost at 100 Hz is present, suggesting that the replay heads are the same as the type *RP* unit.

The noise performance was checked with some care, because of the different layout of the tape transports which might lead to hum problems, but it was found that the 'A' weighted noise was if anything slightly better than the *RP* type unit and that there was no problem with hum induction into the replay electronics.

It was again found that the available drive from the replay amplifier was inadequate, but for some reason the replay only units had a margin of 6 dB on the reference level of 200 nW/m when this represented +4 dBm into a 600 ohm load which is better than the type *RP* unit. However, even with this extra margin the available output is very restricted.

Other Matters

The wow and flutter performance was investigated with some care because of the three transports being driven from a single capstan shaft. DIN weighted wow and flutter was found to be 0.1% or less irrespective of the number of tape drives in use with an associated unweighted figure of 0.4%.

As was only to be expected with this drive system there was an increase in wow and flutter for a short time after a second or third drive had been started. This amounted to an increase to a DIN weighted figure of up to 0.3% for a period in the order of three seconds after the start, and it is felt that this this is a potential limitation in the use of the common capstan system.

Unfortunately I did not have a sufficiently accurate reference tape for checking the absolute speed of the transports, but using a tape which had been recorded on the type *RP* record/replay unit it was found that the replay unit ran on an average 0.4% fast with a variation of 0.2% between transports. It is however perhaps not reasonable to criticise the units on this score, as both the record/replay unit and the replay only unit were well used demonstrators.

Checking the phase jitter between tracks showed that not only were the individual transports accurately aligned with each other, but also that the phase jitter was small, as is shown in **fig. 2,** which illustrates the phase jitter of a 8 kHz tone.

The start time was found to be just less than 100 ms for a 70s cartridge and the start was achieved without any electrical interference between transports.

Cue replay being identical to the type *RP* unit with the exception of the indicator lamp functions did not present any problems and no other significant points were noted about this machine.

In summary, the mechanical performance of the replay machine was to a high standard, as was the details of construction. With the exception of the limited available output, the electronic performance left nothing to be desired but it is felt that the machine should have considerably more output level available.

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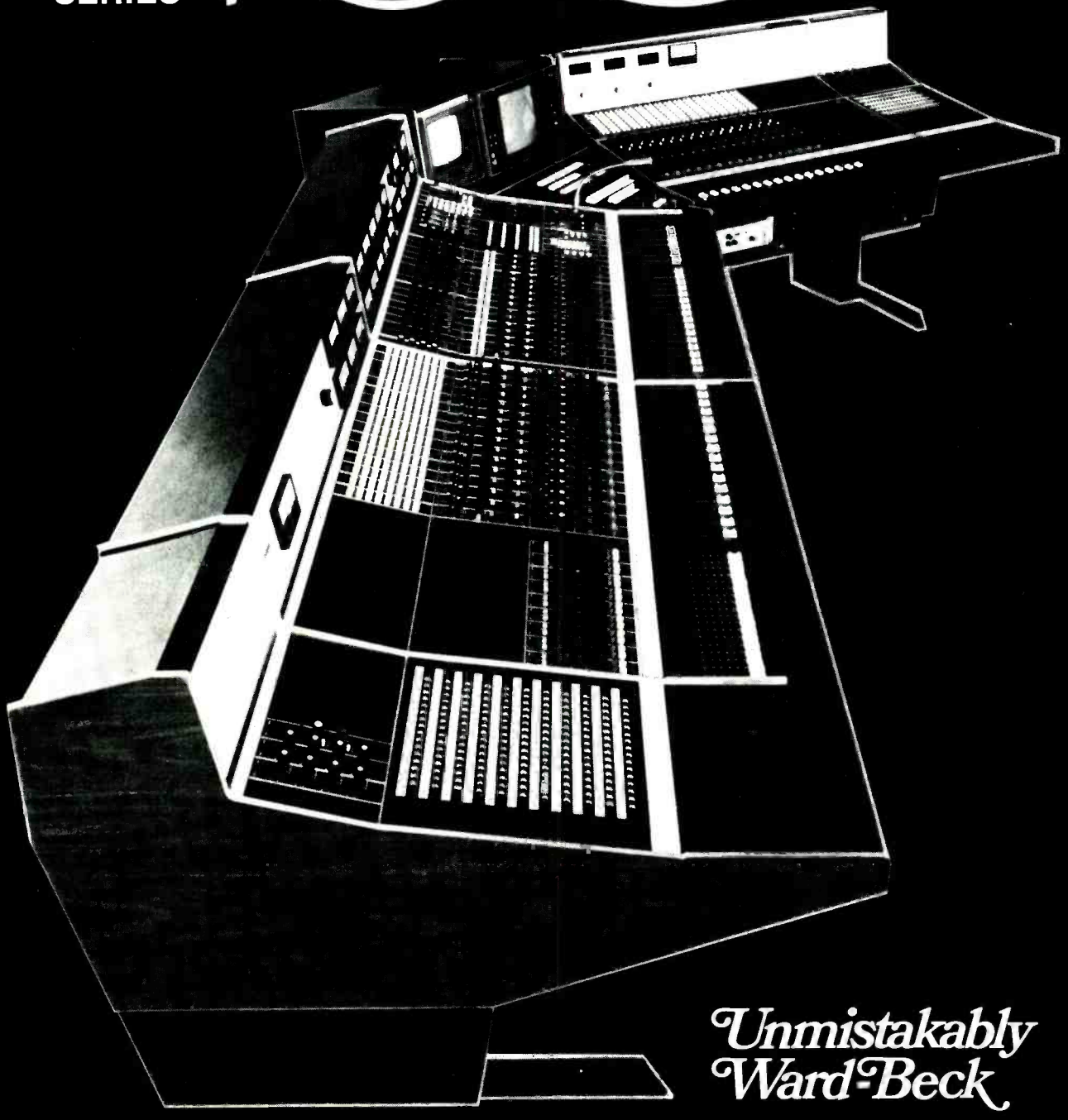
SERIES



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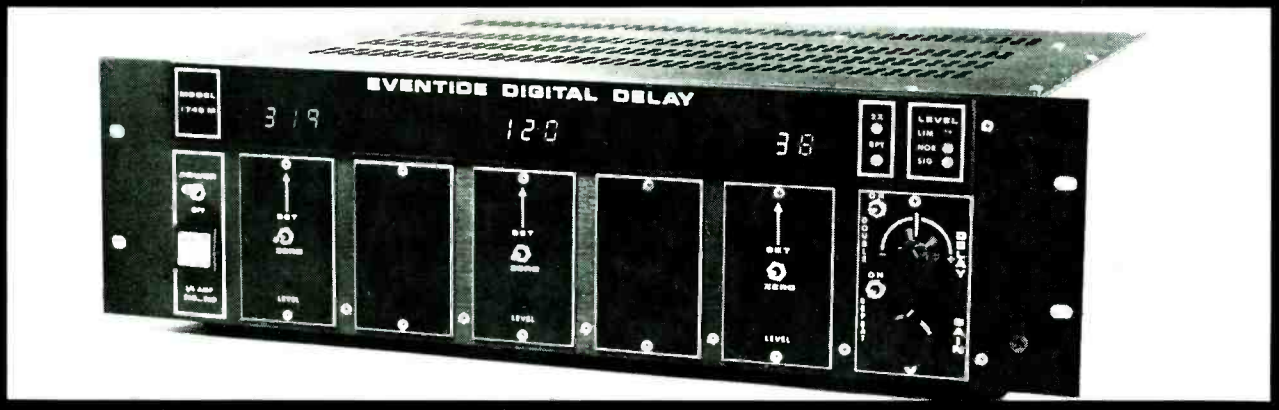

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