studio sound

AND BROADCAST ENGINEERING

May 1982 £1

A LINK HOUSE PUBLICATION

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Pinewood film console
Record reproduction equipment

THE CHALLENGER:

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MCI, the best selling "mid-range" console maker in the United States issued the challenge: "If you can find professional recording equipment that does more for less, buy it." Soundcraft, the best selling midrange console maker in Europe wants you to accept the challenge.

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Soundcraft, Inc.
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Torrance, CA 90501
(213) 328-2595

Soundcraft
THE CHALLENGER

Phil Dudderidge • Graham Blyth

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STUDIO SOUND is published on the second Friday of the preceding month. The magazine is available on a rigidly controlled requested basis only to qualified personnel (see back page for terms) or for an annual cost of **£16.50** UK, **$40** US surface mail, **$75** US airmail, **£17.50** overseas surface mail or **$32.50** overseas airmail to non-qualifying readers or where more than two copies are required in a studio or small organisation. *All* subscription enquiries, including changes of address (which should be *in writing* and preferably including an old address label or at least the 7-digit label code) should be made to the **Subscription Department** at the above address.

Studio Sound and Broadcast Engineering incorporates Sound International and Beat Instrumental.

US mailing agents. Expediters of the Printed Word Ltd, 527 Madison Avenue Suite 1217, New York, NY 10022. Controlled Circulation postage paid at New York, NY.

Total average net circulation of 13,056 per issue during 1980. UK: 5,662. Overseas: 7,394.

Printed in England

studio sound

AND BROADCAST ENGINEERING

MAY 1982
VOLUME 24 NUMBER 5
ISSN 0144-5944

A LINK HOUSE PUBLICATION

ABC MEMBER OF THE AUDIT BUREAU OF CIRCULATIONS

This month's cover of SME pickup arms by Roger Phillips

Never mind the quality . . .

We have been complaining for a long time about the tacky quality of many record pressings, suggesting most unfashionably that *this* was the real reason (along with exorbitant prices) for falling record sales, rather than the more conventional and more expensively-marketed reason we keep 'herring' about.

As Barry Fox has already pointed out, the home video boom is just the audio boom a few years on, and already the infant world of pre-recorded video tapes is exhibiting the same cancerous and self-destructive features as the record business. Half the time it's the same companies. I have yet to come across a video tape with what you might call 'good' audio recorded on it. Common problems include awful wow and flutter, poor HF response, noise, and overload distortion. Much of this is due to the fact that pre-recorded video tapes are recorded on tacky Mk.1A domestic recorders all daisy-chained together—paradoxically, the real-time copying process doesn't produce good results because the machines are worn out! In addition, there is seldom any indication as to whether the audio is Dolby-encoded or not—you have to find out by experiment. No doubt we would find the video signal equally nasty if the eyes weren't so tolerant.

Suffice to say, of course, that if it's a movie you're after, which may cost beyond the £45 mark these days, you will get far better quality if you wait for it to appear on TV. And of course, the home video industry rests largely on the fact that the vast majority of machines are record/replay devices, just like cassette recorders. In the wake of the Universal/Disney/Sony controversy, T-shirts have already appeared in the United States with the legend *"Support the right to tape—It's your business!"* printed on them. If the manufacturers—video or audio—can't be bothered to produce software of 'merchandisable quality', the consumer is bound to look for a different solution. And—with the continuing seeming inability of the BPI to supply me with *any* good reasons why I should even *consider* supporting their view on home taping, despite several requests—I tend to come down on the side of the consumer and on the side of quality. Next time you go out and buy a special 'Limited Edition' of an album, pressed on virgin vinyl in Germany and sold for what we might call an 'enhanced' price, only to discover that this special, 'high quality' pressing was in fact a copy of a dirty, eccentric regular disc pressing and not of a master tape at all, perhaps you, too, will think twice about supporting the excuses of an aspect of the audio industry that thinks too much of profit, and too little of the need to give the end-user good value for money and a reasonable rendition of the painstaking work of artists, engineers and producers.

Richard Elen

Reviews

This issue was scheduled to include a review of audio calibration tapes, however, as Telefunken kindly offered us the opportunity to review its *MX-80* digital tape machine and *DDL-1* digital preview unit at short notice, we have been obliged to hold over our review of calibration tapes to the June issue.

APRS 82

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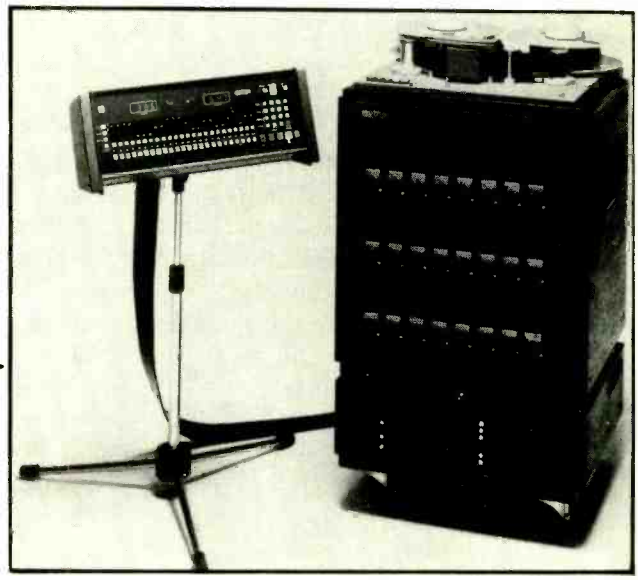
The RAINDIRK CONCORD Mixer Console is a high quality Mixer which is an ideal partner for the SOUNDCRAFT range of professional Multitrack Machines.



Soundcraft 762 - 24X with 9 memory Auto-Locator

The SOUNDCRAFT 762-24, 24-track 2" Machine, ► with standard Remote, locate zero and Auto-Cycle function. This high quality, compact, fully professional 24-track Machine, comes with the well proven SOUNDCRAFT back-up and reliability factor, well known throughout the World, and is a must for the discerning Studio Proprietor, with an eye to current Studio economics.

The CONCORD is housed in an attractive wooden Console, and is supplied with a full patchbay. Being an In-Line Mixer, it has the capability of using the Monitors in Remix, giving 56 inputs during mix-down.
The CONCORD has silent Prom Switching with master Status Control, which can be over-ridden on the Channels. Each input has separate Mic and Line inputs, with a 20dB Pad on the Mic Amp. The EQ section has high and low shelving, with two swept mid sections, plus a low frequency filter.
There are four Auxiliary busses, including a stereo fold-back send. The Monitoring is on the input channels, making the CONCORD a very compact Console, while having the facilities of a much larger Desk.

The SOUNDCRAFT/CONCORD Package is available only from:
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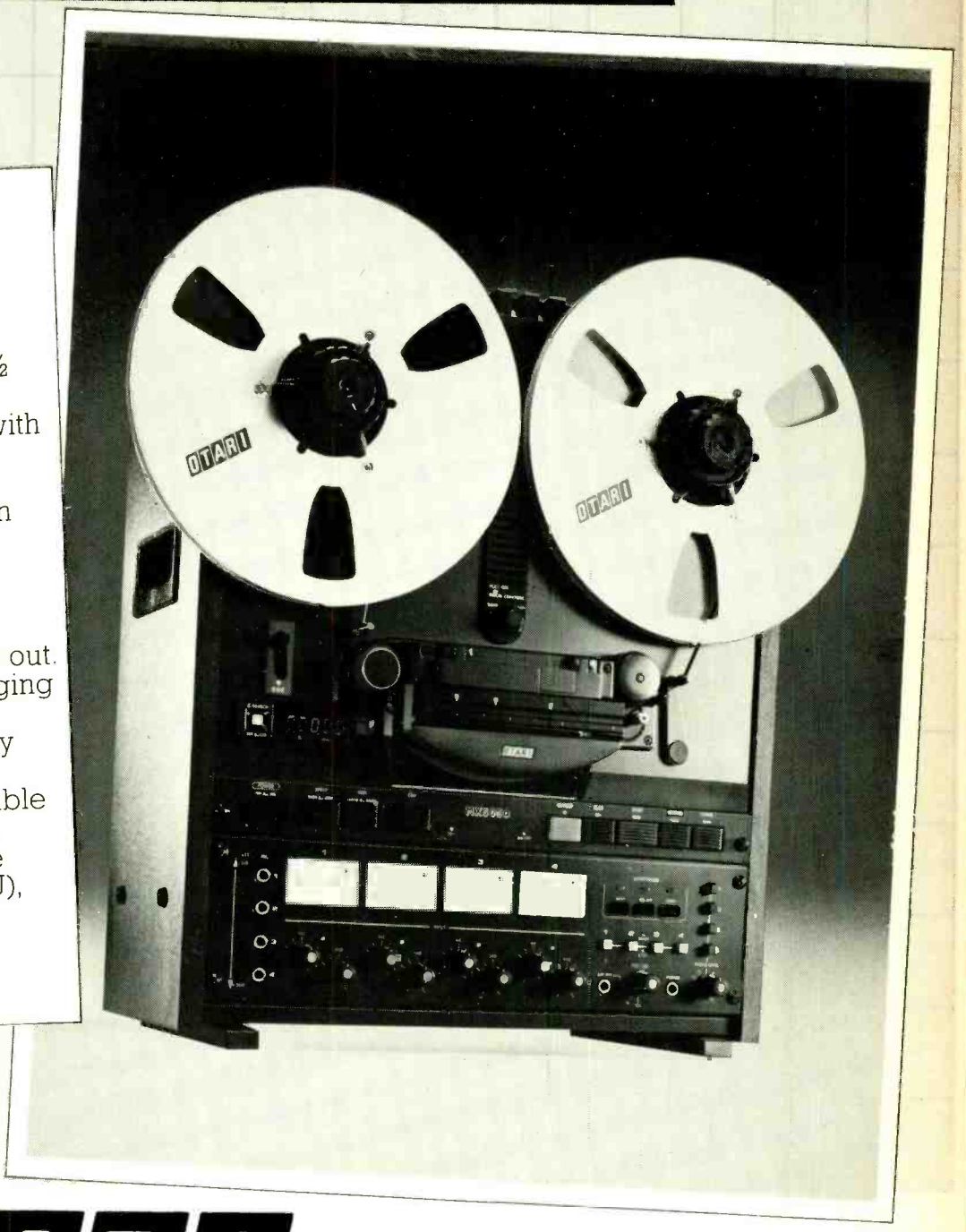

* Completely new microprocessor-based transport logic.
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* DC servo capstan 15/7½ ips direct drive with ±7% varispeed (record/playback).
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* Wide range of bias adjustment, suitable for all tapes.
* Built-in 1kHz/10kHz test oscillator.
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* Single card per channel modules and externally accessible electronics adjustment.
* Audio control section has the same functions as the 2" Otari MTR90 series. All audio functions and transport functions repeated on optional remote control.
* Tacho output and DC servo capstan makes the MKIII-8 most suitable for audio/video locking applications.

OTARI

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The Professional Revox.

The PR99 has been developed from the highly successful B77 in order to meet the stringent demands of the recording and broadcasting industries. The PR99 offers the professional these important features:

1 Raised deck plate for easier editing
2 Improved tape start
3 Tape dump
4 Two way self-sync with automatic sync/input switching
5 Balanced line inputs and outputs
6 Calibrated or uncalibrated level adjustments
7 Manual or remote control operation, with fader start

The Revox PR99 is available in several versions: mono or stereo 3¾/7½ ips NAB or 7½/15 ips NAB or IEC. And being built to Studer precision, the PR99 achieves exceptional performance and reliability but now at an easily affordable price.

For more information on the PR99 phone or write for a catalogue.

STUDER REVOX

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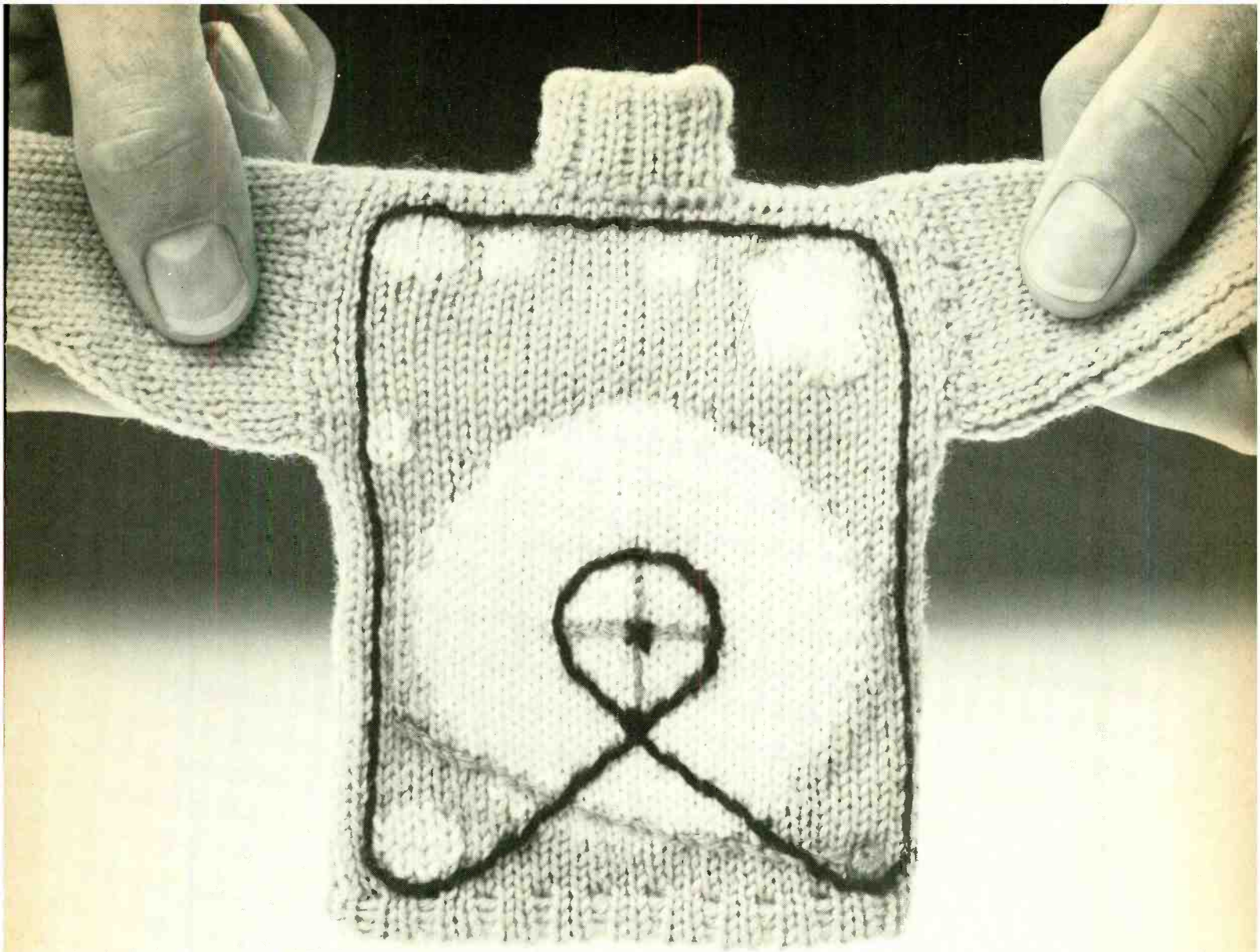


SOME MACHINES MAKE CARTRIDGES A LITTLE WOOLLY!

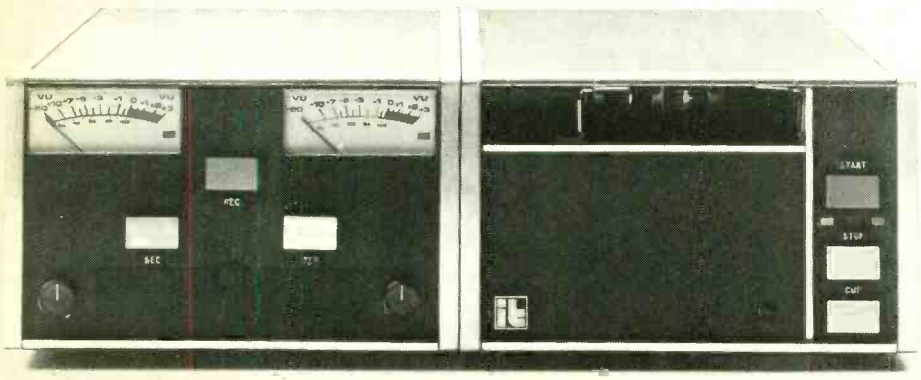
Not the ITC 99. A cleaner, crisper sound. That is what ITC cartridge machine technology is all about. And the ITC 99 delivers precisely that.

Built around a rugged deck that is not cast but milled from half-inch thick, solid aluminium tool plate, the ITC 99 contains such advanced features as a crystal-referenced servo-motor, a positive, mechanical latching solenoid, a micro-adjust head module and a distortion-free cartridge positioning system. To the user, these features mean reduced wow and flutter, improved azimuth (phase) stability and long-term speed accuracy.

In short, reel-to-reel performance from a cartridge machine.

ITC also offers the unique ELSA option. This cartridge preparation system automatically bulk erases the tape, aligns the recording head azimuth to compensate for cartridge variations, erases the cartridge again to remove the alignment tones and locates the splice which is then positioned just beyond the capstan shaft. This results in a clean, splice-positioned tape ready for recording.

The ITC 99 microprocessor-controlled cartridge machine and recording amplifier are truly a sound above the rest. If you want to rid your cartridges of their woolliness, talk to F.W.O. Bauch about the ITC 99.



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TRIMIX

Trident Audio are proud to announce their new range of expandable consoles: Trimix.

Trimix offers all the previous features of the well established Flexímix system, plus more facilities at a similar price

Trimix features

- Compact size: Each mainframe housing up to 24 modules measures only 40'' wide.
- Any module can be placed anywhere in the mainframe allowing 'ergonomic tailoring' to customer's requirements.
- 4 band equalisation on each input plus 60 Hz filter and EQ bypass.
- 4 auxiliary sends, each switchable pre or post fader.
- Separate mic and line gain controls.
- Precision five L.E.D. level indicator on each input module.
- Eight group outputs plus separate stereo master outputs.
- Long throw conductive plastic faders on both inputs and outputs.
- Comprehensive monitoring facilities including monitor pan, monitor level and mute for each group output/machine return.
- Full sub-grouping facilities.
- V.U. metering as standard, L.E.D. column P.P.M.'s available as an option.
- Can be 'Fadex' automated at any time.
- Frames can be joined together both electrically and mechanically to make larger systems.
- Eight way monitor module available to provide sixteen track monitoring.
- Integral patchbay available.

Trident Worldwide Representation:

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Wilson Audio Sales, Nashville. Tel: 615-794-0155
Trident (U.S.A.) Inc., 652 Glenbrook Road, Stamford, Connecticut 06906 U.S.A. Tel: 203-348-4969

Australia John Barry Group, Sydney. Tel: 2-439-6955

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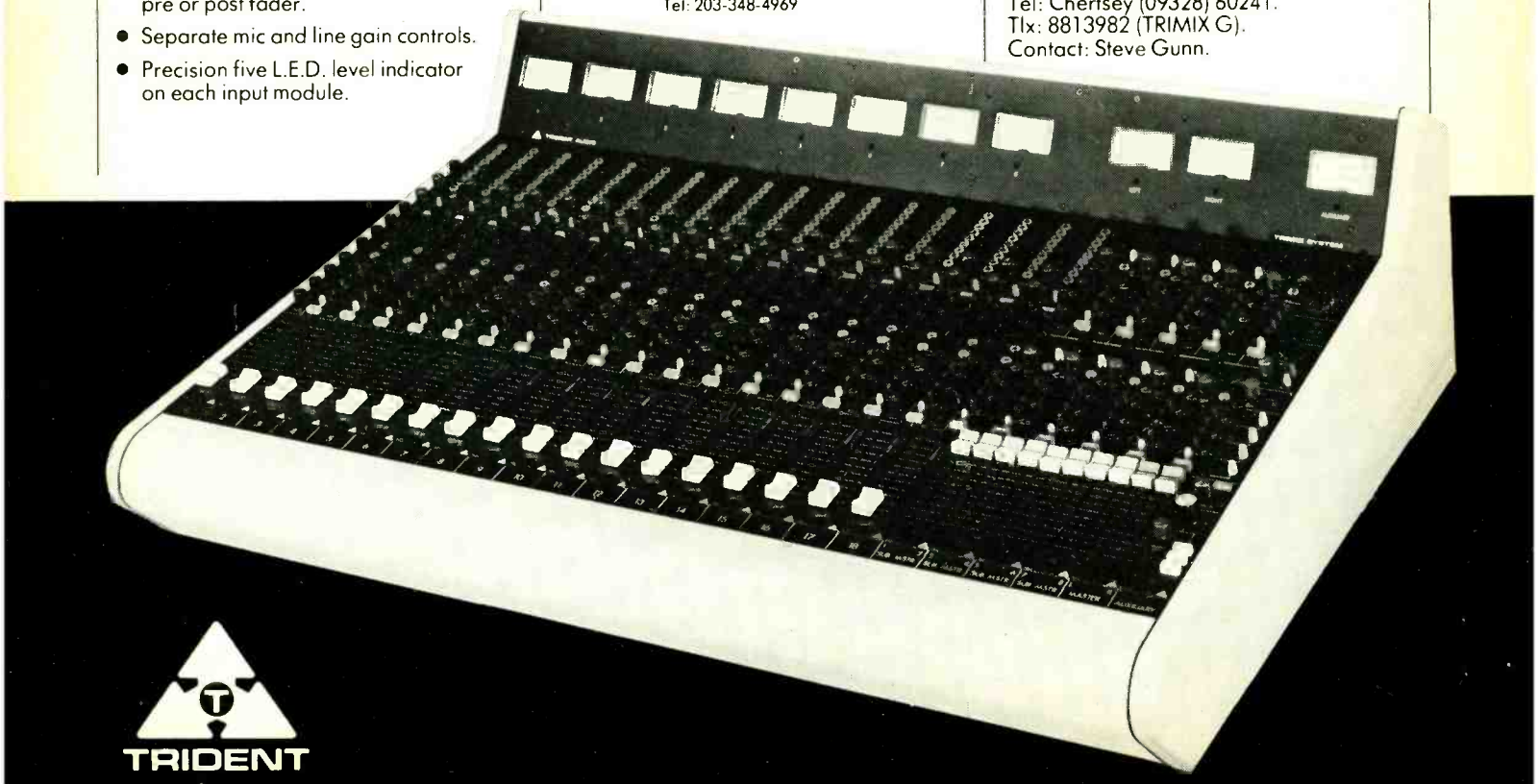
Contact: Steve Gunn.



TRIDENT

The image builders.

PCM41 and Prime Time: Lexicon digital delay systems that enable recording artists and live performers to explore new dimensions in sound.

The Lexicon PCM41, developed from the Prime Time, offers a complete repertoire of effects; such as automatic double tracking, flanging, slap echo, infinite repeat, doppler pitch shift and many others. Its ease of control makes it ideal for on-stage use where dramatic sounds can be created with studio precision.

The Lexicon Prime Time is a real sound builder. It makes studio enhancement 'live' and, offering an integral input and output mixer on two outputs, it is central to the stage performance of many top musicians.

Lexicon digital delay systems are used throughout the world in concert halls, auditoriums and stadiums. Lexicon creates clean musical effects to enhance performance and open up new dimensions in sound.

For the complete story, talk to F W O Bauch about Lexicon digital delay systems.

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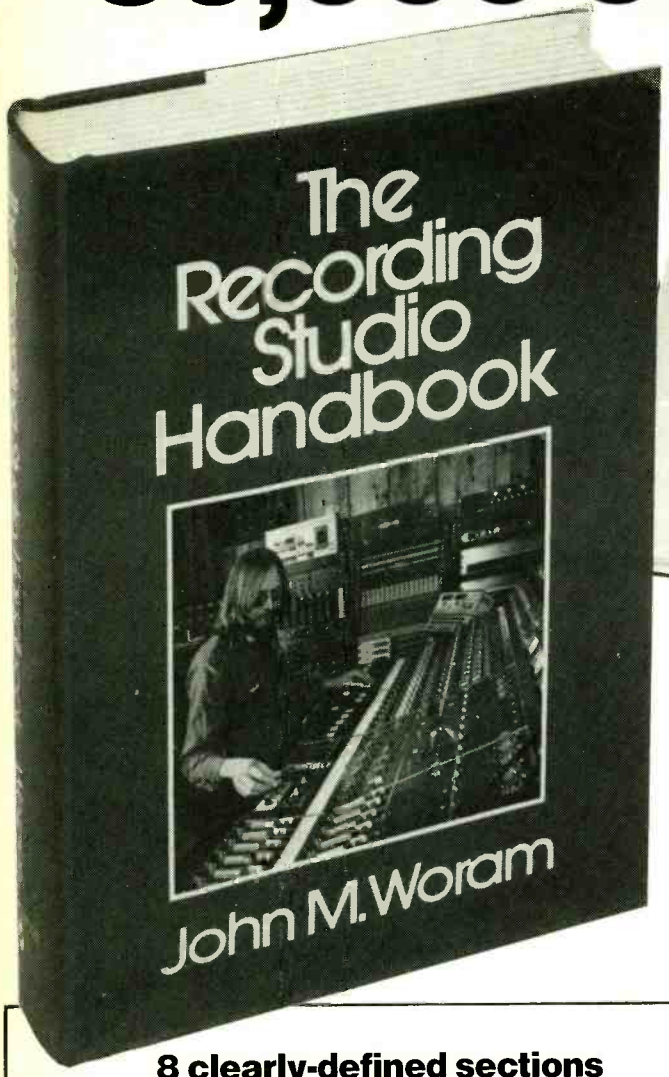

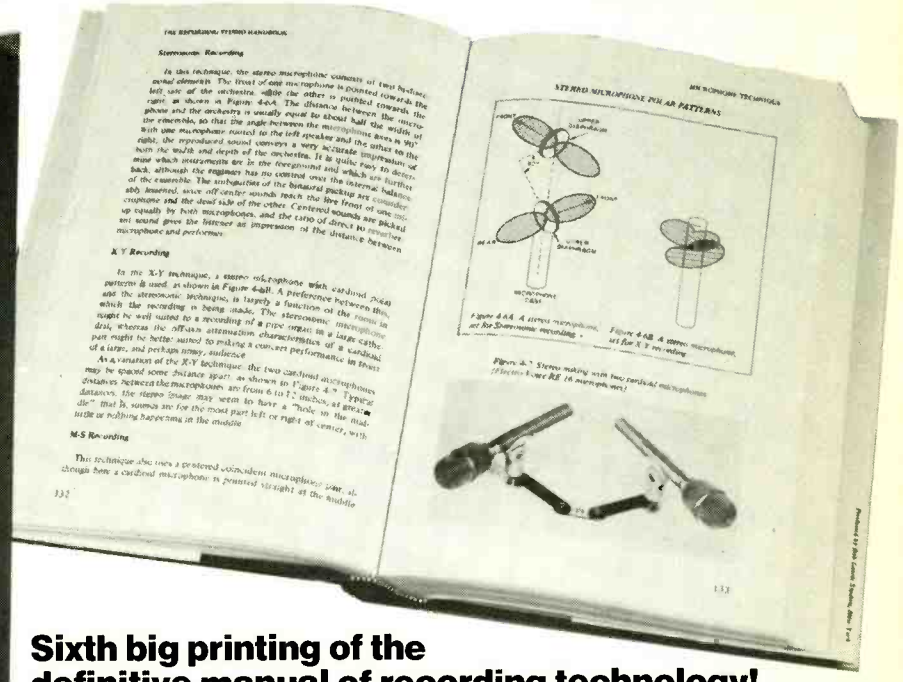

Sixth big printing of the definitive manual of recording technology!

"John Woram has filled a gaping hole in the audio literature. This is a very fine book . . . I recommend it highly." **–High Fidelity.** *And the* ***Journal of the Audio Engineering Society*** *said, "A very useful guide for anyone seriously concerned with the magnetic recording of sound."*

So widely read . . . so much in demand . . . that we've had to go into a sixth printing of this all-encompassing guide to every important aspect of recording technology. An indispensable guide with something in it for everybody to learn, it is the audio industry's first complete handbook on the subject. It is a clear, practical, and often witty approach to understanding what makes a recording studio work. In covering all aspects, Woram, editor of *db* Magazine, has provided an excellent basics section, as well as more in-depth explanations of common situations and problems encountered by the professional engineer.

It's a "must" for every working professional . . . for every student . . . for every audio enthusiast.

8 clearly-defined sections
18 information-packed chapters

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Sound

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The Tape Recorder

V. Noise and Noise Reduction
Noise and Noise Reduction Principles
Studio Noise Reduction Systems

VI. Recording Consoles
The Modern Recording Studio Console

VII. Recording Techniques
The Recording Session
The Mixdown Session

VIII. Appendices
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Conversion Factors
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Judge for yourself. Some swear it's a trick, others swear by it. Aural excitement is a patent psychoacoustic process that corrects for generation loss. If you programme or produce music, you should discover how the EXR improves separation, enhances music and adds loudness.

Auratones

Listen on a legend.
A compact British amplifier is now available to drive Teak and Road versions for personal monitoring.

Goldline Analyser

A price breakthrough in hand held analysers. Built in microphone displays signal on a 10 by 10 LED matrix. Kit includes a white/pink noise for rapid alignment of equipment and sound systems. Now you can trim controls and see the results.

Annis Magnetometer

Play safe. Point the base of this precision instrument at tape path components and any residual magnetism registers on the scale. It's the only way to be sure you are not damaging precious masters.

Wright Microphone

Call us and arrange to compare this radical development against the best in the world. You'll hear a new transparency . . . clarity . . . a big capsule sound in miniature.

Find out more or evaluate these innovations for yourself by calling:

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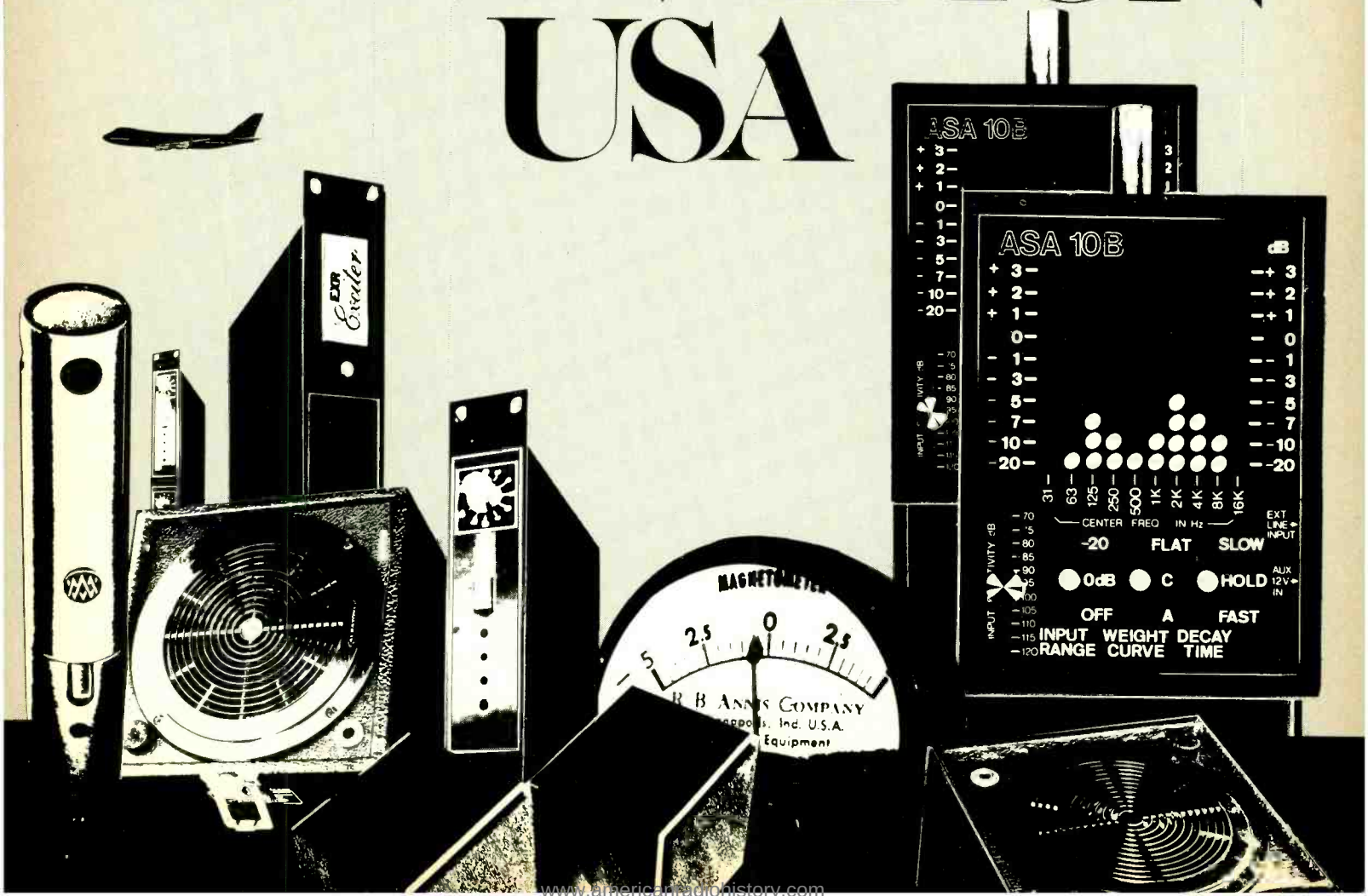

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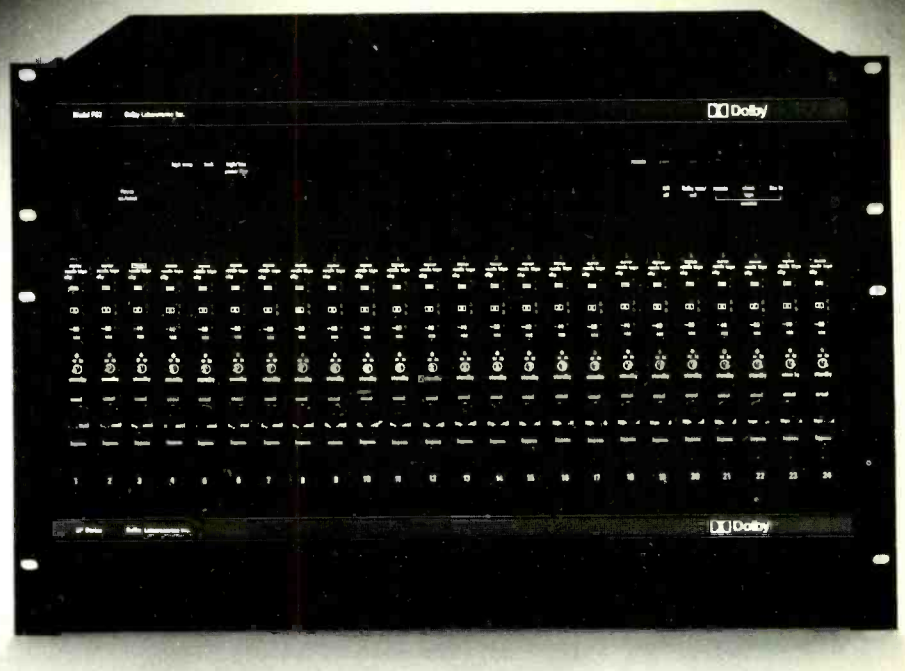

New from Dolby Laboratories:

The Dolby SP Series Multi-track noise reduction unit

Dolby noise reduction is an integral part of professional multi-track recording practice in music, radio and TV broadcasting, and film studios throughout the world. A new noise reduction unit, the Dolby SP Series, has been developed for these and other applications, and provides up to 24 tracks of Dolby A-type noise reduction in only 12¼" of rack space. The SP Series' combination of compact size, ease of operation, and new features makes it ideal for equipping new recording facilities and upgrading existing ones.

For further information on the SP Series and other professional noise reduction equipment, contact Dolby Laboratories.

Highlights of the Dolby SP Series:

- Up to 24 tracks in only 12¼" of rack space, including power supply.
- Dolby A-type noise reduction characteristics utilizing standard Dolby Cat. No. 22 modules.
- Separate regulated power supply unit with electronically-controlled output protection.
- Low-noise fan cooling.
- LED display for each track permits accurate Dolby level calibration (within ±0.1 dB if desired) by matching intensity of LED pairs; further LEDs indicate the presence of signals and clipping, and assist alignment with high-level reference tapes.
- Front-panel "UNCAL" control for each track permits rapid resetting of Dolby level for playback and punch-in on nonstandard-level tapes, then instant restoration of preferred preset studio Dolby level without recalibration.
- User-selectable option of "hard" or electronically-buffered bypass of individual tracks and of all tracks simultaneously.
- Snap-fit connectors on rear panel for rapid disconnection and reconnection.
- Balanced and floating input stages.
- Output stages drive either single-ended or balanced 600-ohm loads at levels up to +28 dB (19.5 V) before clipping.
- Ultra-low-distortion input and output amplifiers.
- Remote ground-sensing output configuration minimizes hum pickup when driving single-ended loads.
- Discrete FET switching for reliable, noise-free routing of audio signals.

Dolby Laboratories, 731 Sansome Street, San Francisco, California 94111, Telephone 415-392-0300, Telex 34409. 346 Clapham Road, London SW9, Telephone 01-720-1111, Telex 919109.

16 plus Fact File

Building 16 and 24 track studios is our business. In castles, cinemas, attics, and basements to name but a few. Some are in our hands from the time the first brick is laid, others we equip and commission.

Based on our involvement with these projects and their problems, we have prepared a unique file of information. It contains vital facts and figures, covering all aspects of establishing a successful studio.

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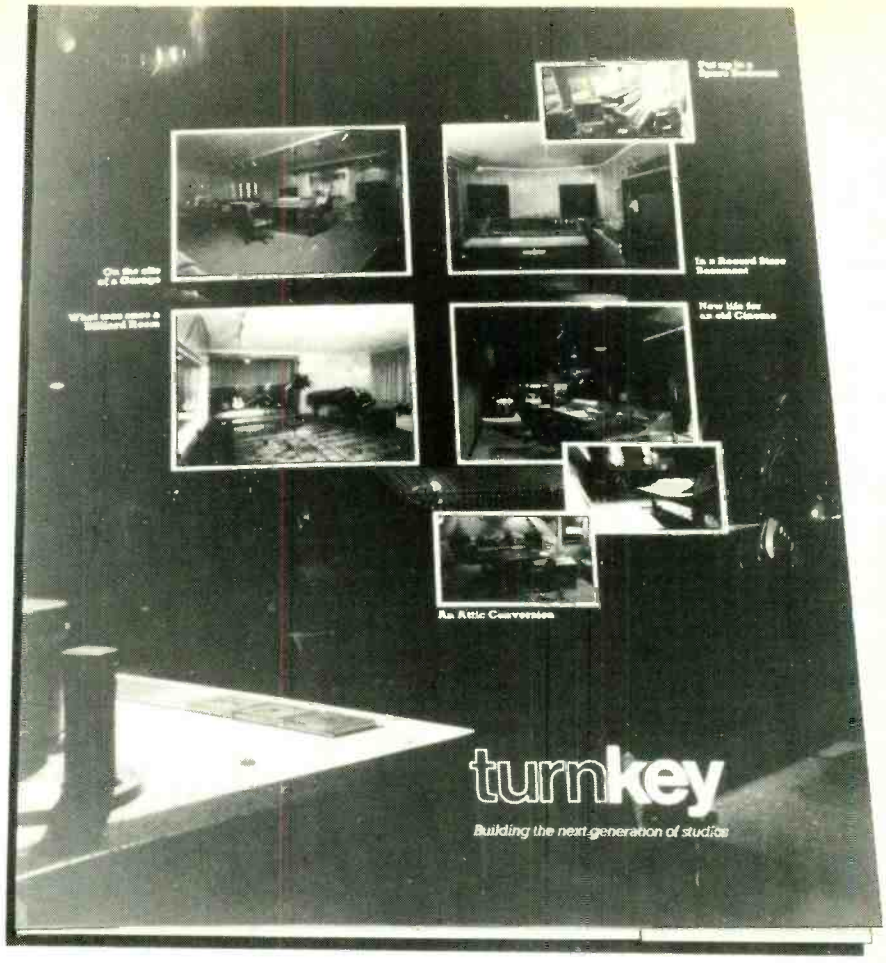

In brief, this 40 page file covers;

What to look for in a building and what to ask the local authorities.

Building from the ground up, what it costs and how long it takes.

Studio Cashflow Planner and completed examples.

Finance and how to get it, what to tell your bank manager.

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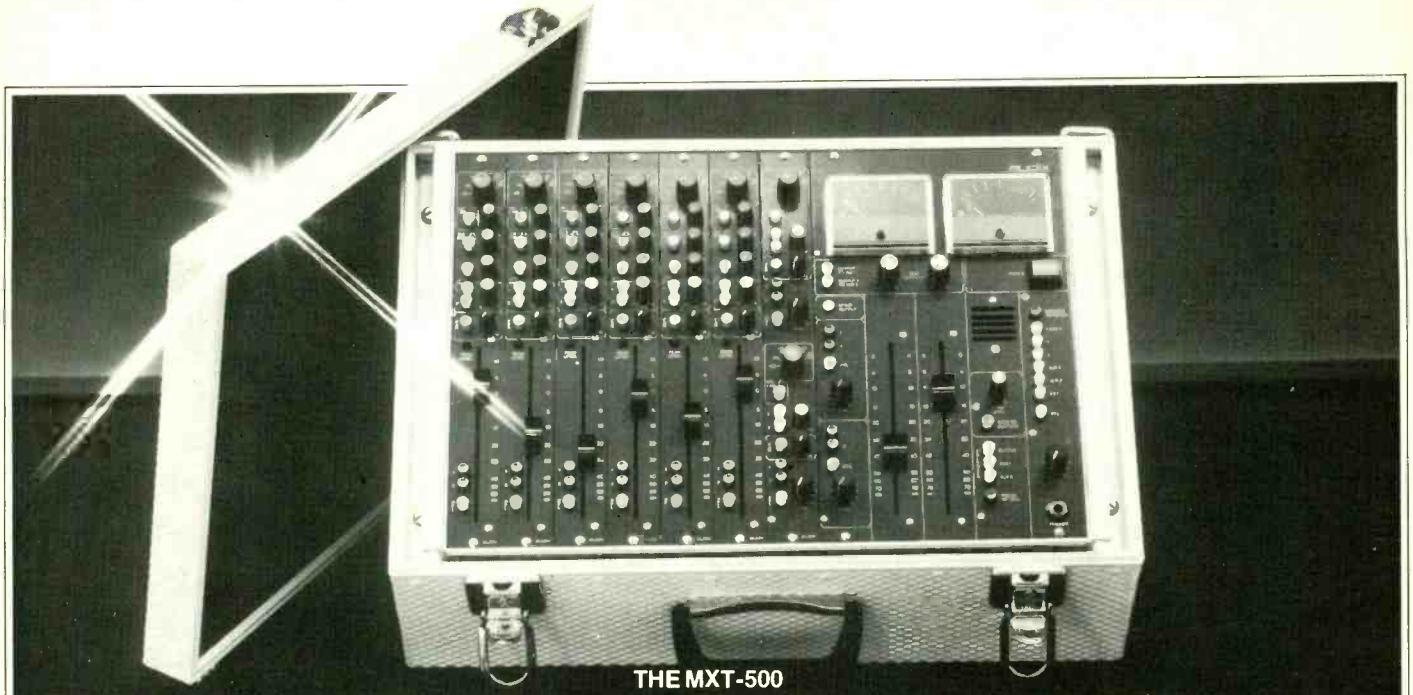

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diary

AlphaSyntauri with Apple computer

NAMM news

The recent Winter NAMM (National Association of Music Merchants) Show, at the Anaheim Convention Centre, Los Angeles was, rather surprisingly, packed with a host of interesting new products this year. Sequential Circuits Inc (the *Prophet* people) introduced their new programmable polyphonic synthesiser, the *Prophet-8*, an eight voice with a six octave touch sensitive (velocity and pressure) keyboard. Programs can be layered, and the memory is capable of storing 128 different sounds. A lot of nice things (and one or two harsh ones) were being said about this machine. SCI also introduced their programmable signal processing system, the *PRO-FX;* this is a single racking system with plug-in effects such as phase shifter, parametric, reverb, distortion/sustainer, etc, all hooked up to a master programmer which can be used to store 64 different effect patchings/settings.

AlphaSyntauri (to be seen on the BBC's "The Computer Programme") is a computer based synthesiser system based on the *Apple II* and Mountain Computer Inc's digital oscillator card. So for under $5,000 you can have a polyphonic digital synthesiser complete with five octave velocity sensitive keyboard. The manufacturers' roots lie in a software house; however, the system has received several recent updates making it much more 'playable'. You may be aware that CBS, and in particular the Rhodes division, have taken over ARP, and at the Anaheim show they were showing the new *Chroma,* a 16 channel programmable polyphonic synth with dynamic keyboard. A nice feature of this machine is that the voices are individually accessible, and that Rhodes have developed an interface card so that the *Chroma* can also be played by an Apple computer.

Con Brio seem content to continue producing the ugliest instruments around; their latest machine, the *ADS 200-R*, is claimed to be a 'complete, self-contained music production facility'; they've incorporated several new features in this polyphonic machine—64 programmable digital oscillators, click-track, various synthesis modes, and a musical score writer, which can put down, in notation, what is being played, the *SCOREWRITER*. This is obviously designed to compete with New England Digital's SCRIPT facility on their *Synclavier II*, though neither seem to compete with the *McLeyvier* system.

At last Moog have got things together with their *MemoryMoog*, and it looks as though it will be with us by the summer. It looks and sounds great, retaining the discrete Moog filters that produce such a fat rich sound. It is a six voice programmable with several unique features, most notably three oscillators per voice. US price is expected to be $4,195!

Digital seems to be the word in terms of new musical instruments, and swords are now drawn between Oberheim Electronics with their new *DMX* drum machine, and the latest unit from Linn, the *LinnDrum*. Both machines offer similar programmable facilities using real drum sounds digitally encoded, and are both around the $2,900 mark. I tried them both, and it's a close thing.

A few other items on show included a pentaphonic (yes) synth from Gleeman at $2,795—a good price; the *Voyetra Eight* from Octave-Plateau Inc, a rack-mounted polyphonic; the *Sound Chaser* digital system, again based on the *Apple II* from Passport Designs and of course the new *Emulator*, from Emu Systems, and *Synergy* from Digital Keyboards were drawing very large crowds. All in all a most impressive show, and especially worth visiting as Disneyland is of course just across the road.

Dave Crombie

AES British Section

The AES British Section has announced details of its forthcoming lecture programme. Lectures include 'Fifty Years of Loudspeaker Measurement' on May 11 presented by Peter Fryer and Gareth Millward of Rank-Wharfedale; a visit to Nimbus Records, the independent classical UK record company with its own pressing plant and studios, on May 14/15; 'Experiences with Digital Audio' on June 8 presented by F A Griffiths of Decca; and 'The BBC Approach to Loudspeaker Design' on July 6 presented by Derek Mathers from the BBC Research Department. Full details of the lectures are available from: The Secretary, Audio Engineering Society (British Section), 8 Granville Road, Sevenoaks, Kent, UK. Phone: 0732 51980.

Racal-Zonal tape

Following the demise earlier this year of the Racal-Zonal tape manufacturing operation, it is heartening to learn that after successful negotiations for the sale of the manufacturing plant at Redhill in Surrey, Stanley Productions has been appointed exclusive UK distributor for Zonal's magnetic sound film and ¼in audio tape. Coincident with this announcement we also learn that John Rooke, formerly Racal-Zonal's general sales manager, has joined Stanley Productions as marketing/sales director, and Sam Hann, formerly Racal-Zonal's UK sales manager, has taken an identical position with Stanley Productions. As a result Stanley Productions are able to offer a total package of magnetic recording products to the UK film industry, broadcasting authorities, and professional recording studios.

The company's latest catalogue of products includes a sizable range of cutting room supplies; audio tape in all the usual tape width formats; magnetic film and spacer; printed academy, SMPTE and DIN leaders; video cassettes and video tape; plus test and alignment tapes. Details of product availability are obtainable from Stanley Productions, 147 Wardour Street, London W1, UK. Phone: 01-439 0311. Telex: 269836.

Tannoy returns to British hands

Norman Crocker, managing director of Tannoy Products Ltd, has announced that as from December 14, 1981, the company has been purchased by the existing Tannoy management from Beatrice Foods, the former owners.

Electrical symbols

The British Standards Institution has just published a new standard, BS 6217, a *Guide to graphical symbols for use on electrical equipment*. This standard, which is identical to IEC 417 and incorporates IEC supplements 417A, B, C, D and E, establishes uniform graphical symbols, their graphical form, dimensions, meaning and application for electronic and telecommunications equipment. The symbols, which are designed to be placed on, or in part of such equipment, are also suitable for pictorial use on plans, drawings and diagrams. Copies of BS 6217 may be obtained from: BSI Sales Department, 101 Pentonville Road, London N1 9ND, UK. Price is £66.00 (BSI subscribing members £33.00).

Cassette label art guide

A layout guide to simplify the preparation of camera-ready artwork for offset printing of 12-up cassette label stock has been developed by Kenneth A Bacon Associates. Designed to aid the production of labels, the guide uses non-reproducing guidelines to centre copy and horizontal lines, thus easing the task of producing identically labelled cassette copies. Full details of the layout guide, which may be used with a variety of cassette label stock colours, are available from Kenneth A Bacon Associates, 216 Montego Key, Bel Marin Keys, Novato, Cal 94947, USA. Phone: (415) 883-5041.

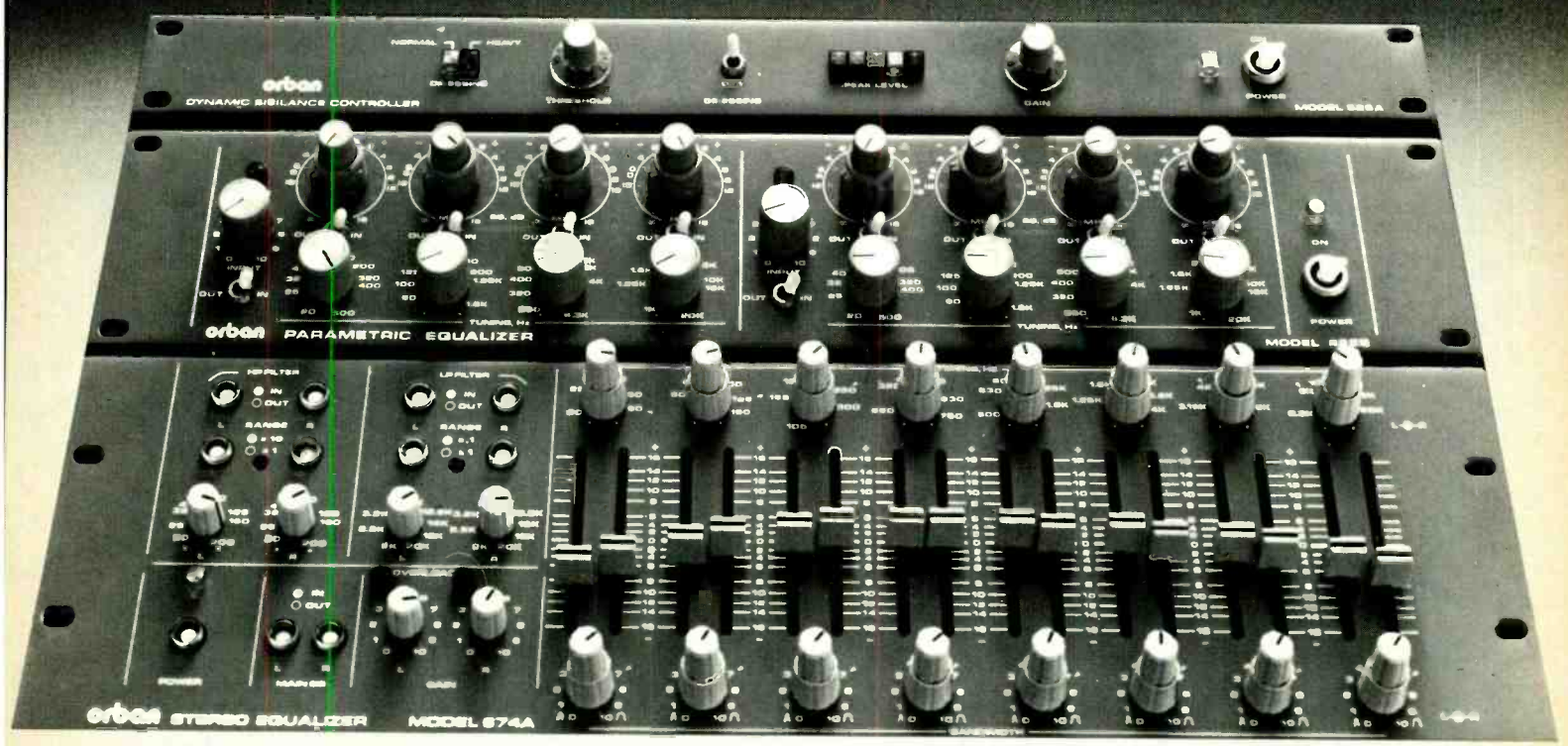
Trebas Institute

The Trebas Institute of Recording Arts, based in Montreal has moved its headquarters to a new location. New address is 1435 Bleury, Suite 301, Montreal, Quebec, Canada H3A 2H7. Phone: (514) 842-3815. The Institute which offers courses on record production, audio engineering, and record industry management, also informs us that although its students to date have been from North America it also accepts overseas students.

David Leonard, founder and executive director of the Trebas Institute has also been elected vice-president of the American based Music Industry Educators Association. This association which was founded in 1978, has the aim of establishing and maintaining music industry education throughout the world and developing education programmes for the recording industry.

Tools of the Trade

Signal Processors by orban



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England Industrial Tape Applications **Belgium** Trans European Music (Bruxelles) **Finland** Studiotec (Espoo)
France 3M France SA, Mincom Div (Paris) **Germany** Estemac (Hamburg) **Greece** Audiolab Hellas (Athens) **Holland** Cadac Holland (Hilversum)
Italy Audio Products International (Milano) **Spain** M. Llewellyn-Jones (Madrid) **Sweden** Tal & Ton (Gothenburg)
Switzerland Audio Bauer AG (Zurich)

diary

Studer tape transports

Studer has asked us to point out in connection with various tape machines detailed in our recent tape machine products guides, that the company has no outstanding agreement with CB Electronics or other manufacturers to supply basic tape transports without Studer's own amplifiers or electronics. In addition the company would like to state that it is not its policy to endorse compilation products utilising Studer tape transports.

People

● Walter Cronkite, CBS News Special Correspondent, has been named as recipient of the National Association of Broadcasters' 1982 Distinguished Service Award.

● Richard Stevens has been appointed south-eastern regional sales representative for Sony's professional digital audio division in the USA.

● Bill Ticen has been appointed international sales manager of broadcast equipment manufacturer Moseley Associates.

● Sony Broadcast Ltd has announced a number of promotions. David Lambert becomes sales director; Tony O'Connell becomes regional sales manager for Western Europe; and Shin Hara becomes senior product manager.

● Harrison Systems has appointed Claude Hill, formerly with Audicon, as vice president of sales and marketing. Further appointments include Eric Johnson and Brad Harrison as sales representatives.

Agencies

● Melkuist Ltd has appointed Trident (USA) Inc as its north-eastern American dealers. Trident (USA) Inc, 652 Glenbrook Road, Stamford, Connecticut 06906, USA. Phone: (203) 357-8337. Telex: 643678.

● Rank Strand Sound has been appointed exclusive UK and Eire distributors of the Altec Lansing range of studio monitors. Rank Strand Sound, PO Box 51, Great West Road, Brentford, Middx TW8 9HR, UK. Phone: 01-568 9222. Telex: 27976.

● STL (Standard Tape Laboratories) has appointed Precision Audio Marketing as UK distributors for the company's range of calibration tapes. Precision Audio Marketing, Bimini House, Christchurch Road, Virginia Water, Surrey. Phone: 09904 4416.

● Orban has appointed Audio Resources, Westmont, Illinois as its Midwest American agents.

Sony/MCI

It's finally happened. After one of the longest on/off takeover negotiations the professional audio industry has known, Sony has announced its acquisition of American console and tape machine manufacturer MCI. The Sony/MCI deal has been an open secret for some time, with the takeover having been apparently near completion on a number of occasions. However, after some two years of negotiations, the takeover has now been finalised.

Although the financial terms of the acquisition have not been disclosed, the Sony Corporation of America has purchased all the assets of MCI Inc including the company's 156,000sq ft manufacturing plant in Fort Lauderdale, Florida. Under the terms of the acquisition, MCI will remain an independent division within the Sony Corporation of America, and it is anticipated that MCI's worldwide network of overseas agents will remain intact. MCI founder/owner "Jeep" Harned will remain as president and chief executive officer of the MCI Division, which will have its own board of directors. Michael Schulhof, a director of the Sony Corporation of America, has been appointed chairman of the division.

The acquisition of MCI is likely to be mutually beneficial to both companies for not only does it give Sony a substantial boost in its marketing plans for professional and consumer digital audio, but it also gives MCI valuable financial and technological support. In addition to its established product ranges it is likely that MCI, under the new arrangement, will become more involved in the newly expanding market of television broadcasting (including stereo transmission) in conjunction with Sony Video.

Red Acoustics USA

Red Acoustics has opened an office in the USA. All American enquiries should henceforward be directed to: Red Acoustics (USA) Ltd, 65 East 55th Street, Suite 902, New York, NY 10022. Phone: (212) 888-0892.

Bach-Simpson catalogue

Bach-Simpson (UK) Ltd has just published its new 1981/1982 illustrated price list. This 16 page list covers standard and customised panel meters, multimeters, frequency counters and a wide range of other test instruments. Copies are obtainable from Bach-Simpson (UK) Ltd, Trenant Estate, Wadebridge, Cornwall PL27 6HD. Phone: 020 881 2031. Telex: 45451.

Ionize your studio

A year after ionizers were installed in the master control room and continuity suite at Westward Television, reports indicate that working conditions are much improved. Ionizers used for this purpose emit a stream of negative ions, usually generated by a diode pump or similar high-voltage generator providing very low (and safe) current, and the theory goes that negative ions counter headaches, dizziness and tension produced by a build-up of positive ions in the atmosphere. Such a buildup is likely to occur, it appears, in closed rooms with no direct air intake, particularly where metal-framed buildings and electronic equipment are involved. Static electricity—often associated with such devices as TV monitors and man-made fibre carpets—is also believed to be a factor in the buildup of positive ions.

The ionizers in use at Westward, whose staff 'would not want to part with them' were supplied by Medion Ltd, 4 Beadles Lane, Oxted, Surrey (phone: 08833 2641) but similar devices are available from many manufacturers in the UK and overseas. BBC Pebble Mill, Birmingham, have used ionizers in their production offices for the past three years, apparently with beneficial results.

Of course, the crowded, smoky atmospheres of recording studios are particularly prone to positive ion buildup, if you go along with the theory, and are ripe for ionizer installation. Limited experiments in a basement studio in Central London a few years ago *[carried out by colleagues and myself—Ed.]* indicated that even a small unit mounted on top of the console and pointing towards the operating position was capable of making dramatic changes to the 'quality of life' in the studio environment. Tension appeared to be reduced and there was a notable 'lightening' of the atmosphere in the rather small, cramped control room. As no electrical discharge occurs, the noise level is unaffected. So if you could describe your basement studio as 'cosy and intimate' and it drives you to distraction, an ionizer is an inexpensive experiment to try. Let us know at *Studio Sound* of the results!

Cassette duplication

We have received details of a new realtime cassette duplication service operated by studio engineers. The new service is offered by Cassette Project Developments, 8 Newport Crescent, Waddington, Lincoln LN5 9LZ, UK. Phone: 0522 722171.

Sony Corp restructure

The Sony Corporation of America has restructured its organisation and announced a series of senior management promotions and appointments. The new structure is divided into the following groups: marketing and sales; manufacturing; service; engineering laboratories; and diversified operations such as Sony Aviation Inc and a liaison office for the Sony Trading Co which exports a variety of American manufactured products to Japan.

The new marketing and sales group includes the Sony Consumer Products Co responsible for sales of consumer audio and video products; the Sony Communications Products Co responsible for industrial video, office products, professional audio and special projects; the Sony Tape Sales Co responsible for audio and video tape products; and a new company Sony Broadcast Products Co responsible for broadcast equipment.

The manufacturing group includes the Sony Manufacturing Co of America which manufactures TVs and the Sony Magnetic Products Inc of America which manufactures magnetic tape.

The service group comprises a new company Sony Consumer Service Co responsible for parts and service back-up.

Finally, the engineering laboratories group comprises the Sony Technology Center Inc and the Sony Consumer Electronics Laboratories.

The new appointments which go hand in hand with the restructuring include the appointment of Kenji Tamiya as president and chief operating officer for the Sony Corporation of America; the appointment of Robert Dillon as executive vice president for the Sony Corporation of America; and the appointment of Neil Vander Dussen as president and chief executive officer of the newly created Sony Broadcast Products Company.

Otari forms new division

The Otari Corp has announced the creation of a new Industrial Products Division to encompass the company's range of high speed tape duplicators and ancillary equipment, plus its new *VL Series* of video cassette loading machines. The new division, which is headquartered at the company's Belmont, California location, is managed by Michael Pappas.

Otari also inform us that it is the latest company to become an Advisory Member of SPARS. ■

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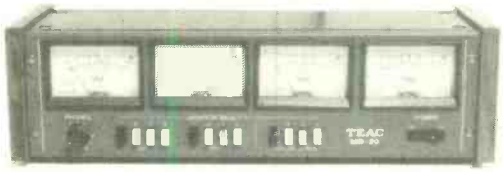

MB20 metre bridge for model 2A mixer.
R.R.P. ~~£429.57~~ + VAT
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RX9 dbx for 3440
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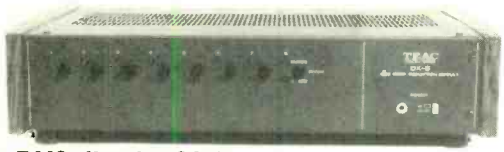

DX8 dbx for 80-8
R.R.P. ~~£867.87~~ + VAT
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EMI 816 10½" Mastering Tape £8.50 a reel

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Revox B77 high speed still available at the old price
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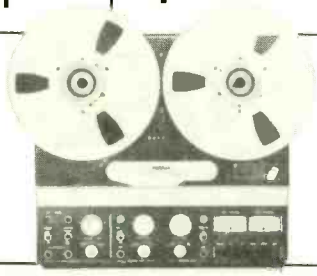

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new products

Fidelipac Master Cart II

Broadcast tape cartridge manufacturer, Fidelipac, has introduced a new NAB type AA audio tape cartridge, the *Master Cart II*. The new cart has an upper and lower tape guide limiting device permitting the cart to be used in older cart machines where lack of precision tape guides prevent successful utilisation of the original *Master Cart*. Other features include wider pressure pads for long wear and better tape-to-head contact, a new bearing supported one-piece reel assembly for longer tape life and lower wow and flutter, thicker cart walls, and a more rigid construction for greater durability.

The precision tape limit system permits properly adjusted cart machines to precisely control the tape path, thus providing repeatable stereo phase and performance. Additionally, when the *Master Cart II* is used in older cart machines or machines lacking critical tape guides, the cartridge 'takes over' and controls the tape path. Factory loaded *Master Cart II* cartridges are supplied with Fidelipac *HOT* tape as standard.

Fidelipac Corp, PO Box 808, Moorestown, New Jersey 08057, USA. Phone: (609) 235-3511. Telex: 710-897 0254.

Scotch 226

3M has introduced a new professional audio mastering tape, *Scotch 226*. The new tape which is available in ¼in, ½in, 1in and 2in widths, and in both standard and long play lengths, is claimed to offer 2 to 3dB less print through than comparable studio mastering tapes with modulation noise similarly reduced across the audio spectrum. 3M stress that the new tape is not a compromise as it is designed to give both optimum S/N ratio and recording headroom—two parameters which usually suffer in the quest for minimising print through.

Technical specifications of the new tape include: maximum output level +13.5dB (+8.5dB at 10kHz); third harmonic distortion –60dB; sensitivity +1.5dB at1kHz, +2.0dB at 10kHz and 14kHz; modulation noise –67dB at 1kHz,–63dB at 100Hz; background noise level –68dB; S/N ratio (dynamic) –79.5dB; print through –52dB; and signal to erase ratio –70dB. 3M claim that output uniformity at 1kHz within a roll is ±0.25dB, while from roll to roll uniformity at 1kHz is claimed to be ±0.5dB.

3M Magnetic Products Division, 3M Centre, St. Paul, Minnesota 55101, USA. Phone: (612) 736-9567. Telex: 297434.

UK: 3M UK Ltd, 3M House, PO Box 1, Bracknell, Herts RG12 1JU. Phone: 0344 26726. Telex: 849371.

Pulsar sound level meter

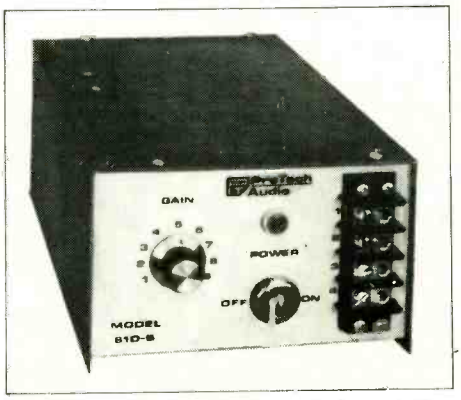
Pulsar Instruments has produced a new battery powered digital integrating sound level meter, the *Model 228*. This meter has a total integrating range of 40 to 140dBA with six 40dB display ranges and 10 preset measuring times. These times range from 2s to 16min allowing the meter to be used for a wide range of applications. Features of the meter include automatic reset and restart at the end of each measuring period; display hold of a previous measuring period; an output capable of driving a paper recorder; an LCD digital display with indicator tags for battery status, overload and insufficient data; and the facility to take direct readings with a 0.1dB resolution.

Pulsar Instruments, 40-42 Westborough, Scarborough, North Yorks YO11 1UN. Phone: 0723 71351. Telex: 527244.

ProTech additions

ProTech Audio has introduced two new power amplifiers, the *610-S* and the *625-S*, these being rated respectively at 10W and 25W. Both models have been designed to fill applications which require a moderately priced professional audio amplifier of limited power. The design features a chassis whose front panel has all controls and terminals accessible, allowing the units to be mounted in out of the way locations while retaining easy access. Features of the units include a power on/off switch which incorporates a built-in circuit breaker; output short-circuit protection; bridging input; <0.4% THD at full output; noise –85dB below rated output; and a frequency response of 20Hz to 20kHz ±1dB.

ProTech has also introduced a new broadcast automation tone sensor card in its *Integra 3* series of plug-in printed circuit cards. The new card, *Model 725ATS*, is a compact modular card which detects the presence of a 25Hz tone and provides relay contact closures to remotely start and stop machines in sequence. An adjustable time delay is provided between the start and stop relay closures. The sensing circuit is calibrated



for 25Hz ±1Hz and features a frequency trim control and LED 'lock-on' indicator allowing users to readjust to variations in 25Hz tone sources. Relay contacts are rated at 4A at 250VAC max. Companion cards to the *725ATS* are the *725FA* 25Hz notch filter card and the *725OSC* 25Hz tone oscillator card.

ProTech Audio Corp, Flowerfield Building, Suite 1, St James, NY 11780, USA. Phone: (516) 584-5855.

New VCA

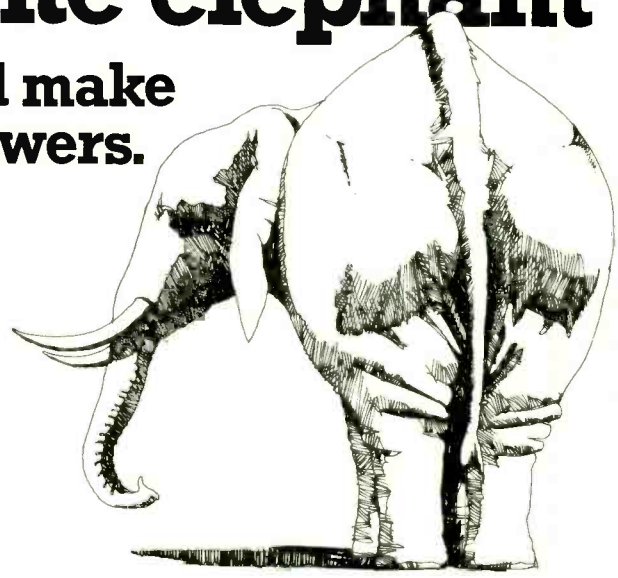
We have received details of a new VCA suitable for professional audio applications from American manufacturer Solid State Micro Technology. The company, which is already involved in the design and manufacture of ICs for audio and electronic music applications, has now introduced the *SSM 2012*, a low cost, high performance linear-antilog VCA with full class A performance. The new VCA has a 100dB S/N ratio (20Hz to 20kHz) at 0.01% THD (0.025% IMD); bandwidth is 100kHz; it has >12dB of headroom at its rated specifications; and it has a gain capability of 40dB. The *SSM 2012* features current inputs and outputs for easy signal summing and minimum external component requirements. In addition, inherently low control feedthrough (–40dB untrimmed) and low second harmonic distortion make trimming unnecessary for most applications.

Solid State Micro Technology for Music Inc, 2076B Walsh Avenue, Santa Clara, Cal 95050, USA. Phone: (408) 727-0917. Telex: 171189.

28 ▶

Before your next monitors turn into a white elephant

...ask some questions, and make sure you get the right answers.



Do they provide wide dispersion at all frequencies?
The unique construction of the Tannoy Dual Concentric places all of the HF horn behind the LF cone, with the flare of the cone continuing the horn flare. Unlike even other co-axial monitors, therefore, the Tannoy Dual Concentric provides smooth transition at crossover, and extremely wide dispersion at all frequencies, enabling you to monitor an accurate stereo image from any point at the desk.

Do they handle high power reliably?
Our massive magnet construction, our lead in hot voice coil technology, together with thermally and mechanically stable crossover components, provide power handling capabilities of up to 1000 watts. Rigorous testing and quality control standards ensure Tannoy Monitors will maintain that capability over long periods of hard use.

Are they phase coherent?
Our Dual Concentric construction places the HF source and the LF source on the same axis, with the result that a Tannoy Dual Concentric has the lowest phase error of any monitor. When used actively, the Tannoy XO5000 electronic crossover with adjustable time delay can reduce that error to zero.

Is the sound quality good enough for your use?
Tannoy has always stood for the best in reproduced sound, and our latest Dual Concentric monitors continue that tradition, with a quality of sound reproduction so good that more and more radio stations are specifying Tannoy to monitor the quality of their output.

Is the Monitor your considering part of a sound co-ordinated range?
All Tannoy Dual Concentric Monitors are designed to provide the same characteristic of sound. You can be sure, therefore, that by using Tannoy for all your applications you will hear the same sound from first track to final cut, or from OB to on-air.

Can you position them almost anywhere?
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Leading recording and broadcast studios worldwide have asked the same questions, and specified Tannoy Dual Concentric Monitors.
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new products

Jensen direct box transformer

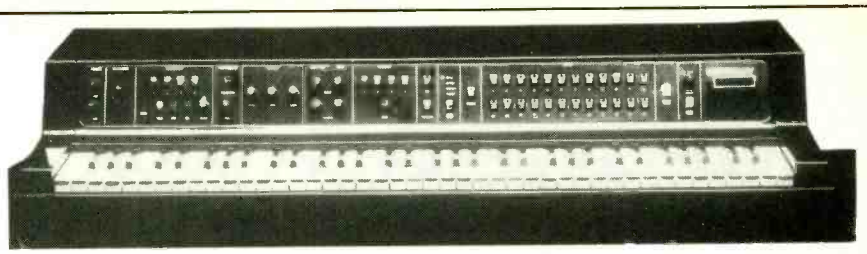
Jensen Transformers has introduced a new direct box transformer, the *JE-DB-E,* which is claimed to have a remarkably transparent sound. The new unit features independent Faraday shields (electrostatic screens) for the primary and secondary windings, permitting complete isolation of guitar or other electronic instruments from an amplifier or mixer. In addition, the transformer has a mumetal case providing an extra 30dB of magnetic shielding.

To sound 'transparent', a direct box transformer must be able to handle the high levels and sharp transients generated by guitars and other live instruments without saturation and distortion, and bass frequencies are the most demanding in these respects. To satisfy these criteria the *JE-DB-E* handles up to +19dBV at 20Hz and +30dBV at 50Hz before saturation. Below saturation level, distortion is <0.1% at 20Hz and decreases by a half for each higher octave, measuring <0.005% at 1kHz. Bandwidth of the transformer is very wide (–3dB at 80kHz) resulting in a very clear top end. In addition, the unit's squarewave response is excellent with less than 1% overshoot, and without a resonant peak.

A complete data sheet for the *JE-DB-E* is available on request, and includes extensive application notes with details for building a direct box.

Jensen Transformers, 10735 Burbank Boulevard, North Hollywood, Cal 91601, USA. Phone: (213) 876-0059.

UK: Scenic Sounds Equipment Ltd, 97-99 Dean Street, London W1V 5RA. Phone: 01-734 2812. Telex: 27939.



Synergy

Digital Keyboards, manufacturers of the *GDS* (General Development System) synthesiser, has now added the *Synergy* to its range. The *Synergy* is a 48-voice totally digital polyphonic synthesiser, at a rather remarkable price—only £2,975. It has a six octave dynamic keyboard which controls 48 voices, 24 of which are preset while a further 24 voices are available on an interchangeable cartridge. Features of the synthesiser include assignable performance characteristics for each voice: key sensitivity with respect to volume, timbre and modulation; vibrato rate, depth and delay; and speed of portamento (three modes—smooth with retrigger, smooth with no retrigger of envelopes, and semitone quantisation). Each voice may be assigned to the keyboard in one of four modes, polyphonic, monophonic, keysplit, or rolling mode, and the keyboard can accommodate up to four sounds simultaneously. Each voice may also be panned to the left or right outputs, both outputs, or to alternating left and right. Further facilities are available via a four-function joystick control offering pitchbend up and down, and leadline or global vibrato. In addition, a 4-channel sequencer is incorporated which may be used polyphonically or monophonically, and recalls all phrasings, pitchbends, nuances and key velocities. This sequencer resynthesises sounds on playback allowing various parameters to be changed dynamically including timbre balance, vibrato, transposition, speed (without altering pitch) and even the substitution of a fixed metronomic rhythm for the original rhythm. Other features include a sustain pedal and a sustenato pedal which functions like the centre pedal on a piano. Normally, eight notes are playable simultaneously, although this varies according to the number of oscillators required for each note of the active timbres (there are 32 digital oscillators, and most timbres require four oscillators).

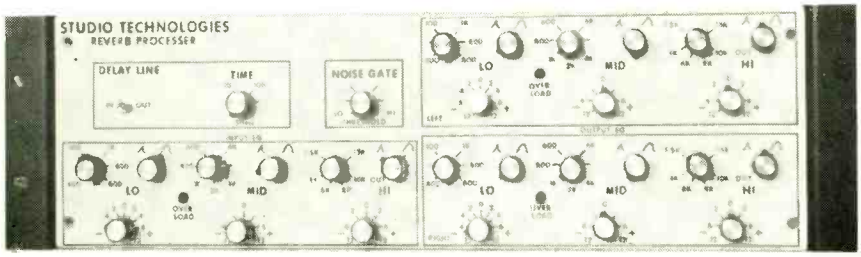
Digital Keyboards Inc, 105 5th Avenue, Garden City Park, NY 11040, USA. Phone: (516) 747-7890.

UK: Syco Systems Ltd, 20 Conduit Place, London W2. Phone: 01-723 3844.

Seltech 6010

UK broadcast equipment manufacturer, Seltech, has introduced a new 19in rack mount, self-contained audio/video routing switcher, *Model 6010.* This new unit is 1U high and is available with up to three level facilities: video only; video plus mono or stereo audio; or mono or stereo audio only. The basic switcher is a 10 × 1 unit although it may be expanded to 20 × 1 or more with additional units and one control interconnection. Facilities include provision for the replacement of one or both audio channels with timecode or control buss, and remote control via a shielded audio pair. In addition, tally is available (one open collector per input), plus parallel BCD control for automation interfacing. Audio input impedance is >20kΩ balanced, while outputs are 600Ω balanced with a maximum output level of +24dBm.

Seltech Equipment Ltd, Rose Industrial Estate, Cores End Road, Bourne End, Bucks SL8 5AT, UK. Phone: 06285 29131. Telex: 848960.



Studio Technologies reverb processor

Studio Technologies, manufacturer of the *Ecoplate* plate reverb unit, has announced the introduction of a new reverb processor. Designed to enhance any reverb system, the new processor contains an analogue delay line, three 3-band parametric equalisers with continuously variable Q, two noise gates, and an exclusive feature termed a stereo stretcher.

The processor is configured such that the variable delay line and one parametric equaliser are in the send circuit to the associated reverb unit. Each of the stereo returns from the associated reverb unit being routed through a parametric equaliser, the stereo stretcher, and finally a special noise gate. This noise gate follows the reverb decay down to a –60dBm level then gently kills to a –90dBm level. The noise gate also has a threshold control allowing the user to shorten the 'tail-out' of the reverb unit—an effect which can be used to 'fatten' certain sounds such as vocals and horns. Many other new effects are possible using this reverb processor, for example, the use of increased HF boost on the reverb returns is permissible as the noise gate will eliminate any noise not masked by the signal.

The exclusive *stereo stretcher* incorporated in the unit, widens the stereo spread of the reverberation creating a wall of sound stretching beyond the loudspeaker boundaries. This effect is additionally made frequency selective by using the two parametric equalisers in each of the stereo returns from the associated reverb unit.

Studio Technologies, 6666 North Lincoln Avenue, Lincolnwood, Illinois 60645, USA. Phone: (312) 676-9400.

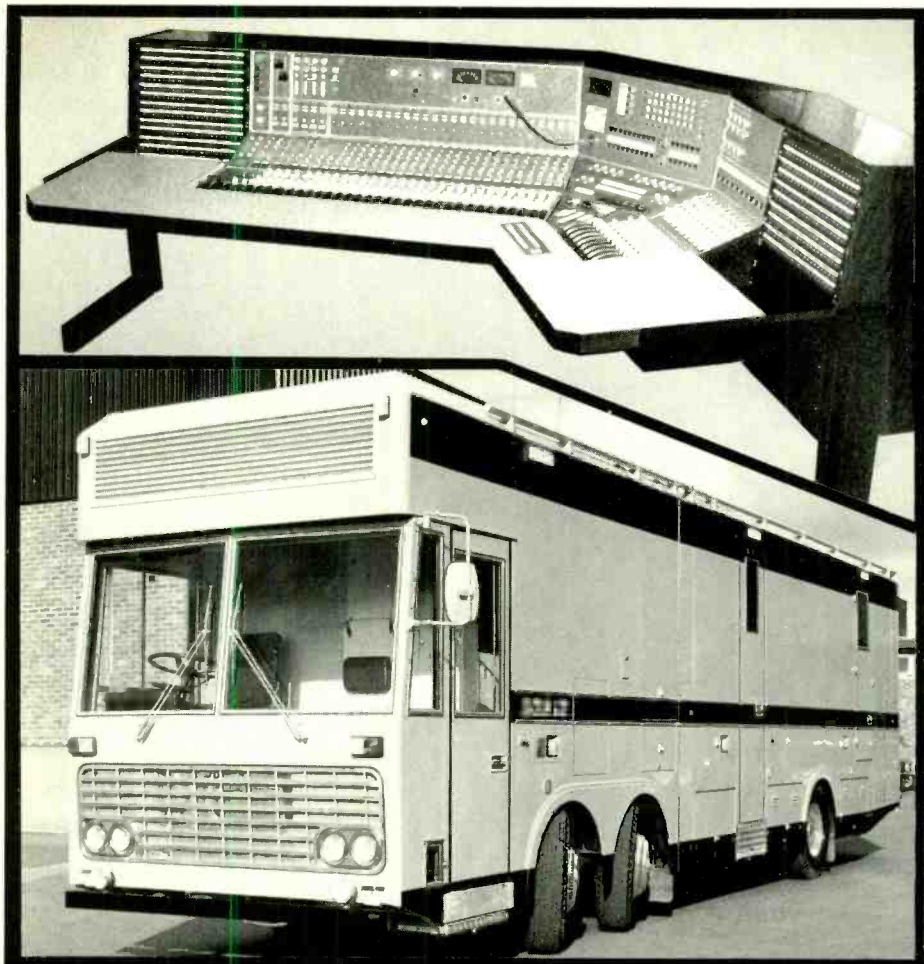
UK: Turnkey, 8 East Barnet Road, New Barnet, Herts EN4 8RW. Phone: 01-440 9221. Telex: 25769.

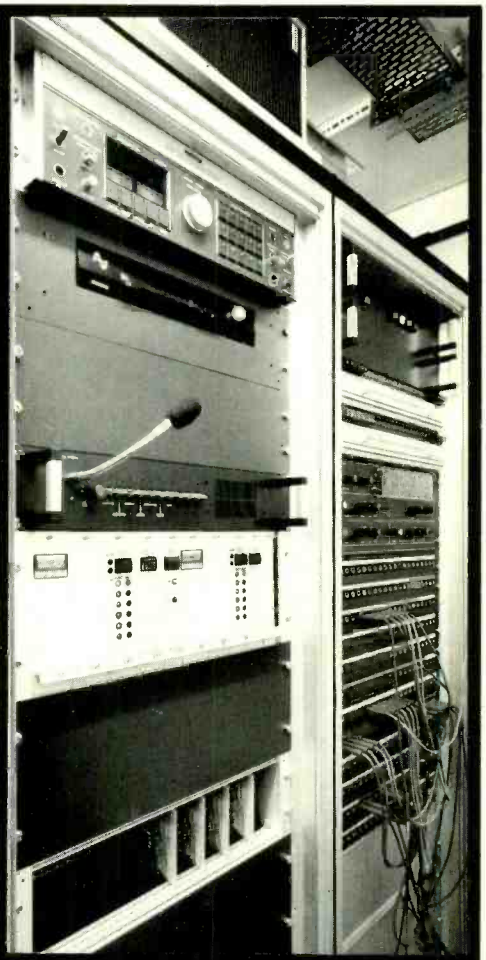
ADR DI box face lift

Audio & Design (Recording) Ltd has given a face lift to its transformerless DI box. Powered by either a *PP3* battery installed within the unit, or by phantom powering, the box is suitable for injecting any instrument with a magnetic pickup system directly into a console. Advantages of the unit's transformerless design include no phase shifts, no loading problems, no transformer distortion, improved transient response, and no loss of signal level. The unit accepts either 10MΩ or 100kΩ inputs and is suitable for driving loads of 1kΩ or greater.

Audio & Design (Recording) Ltd, 16 North Street, Reading RG1 4DA, UK. Phone: 0734 53411. Telex: 848722.

USA: Audio & Design (Recording) Inc, PO Box 786, Bremerton, Washington 98310. Phone: (206) 275-5009. Telex: 152426. ■





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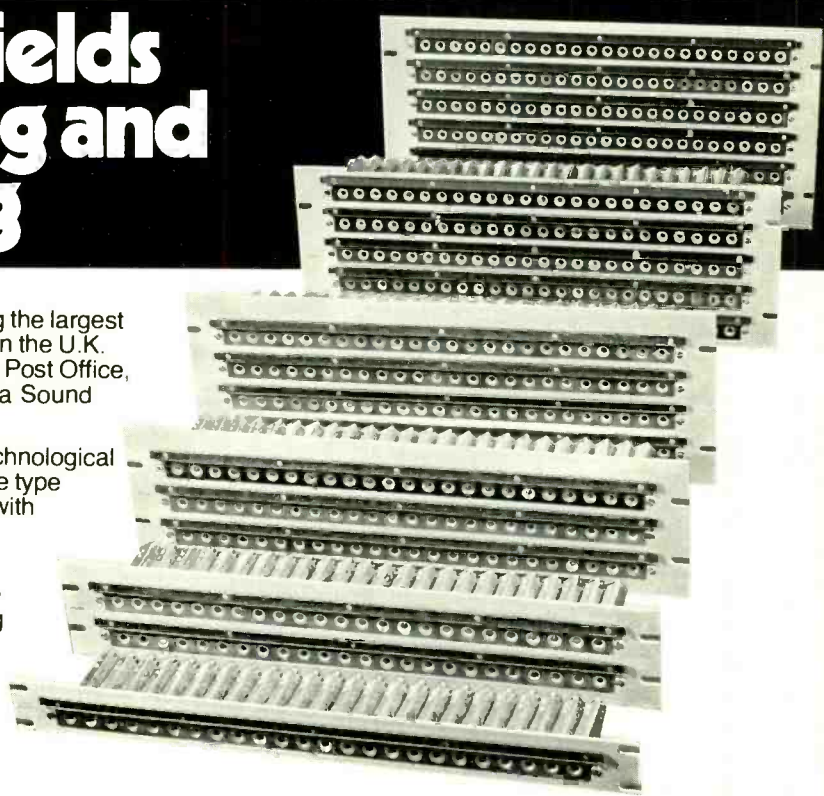

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Studiofile:1

Genetic Sound, nr Reading

Genetic Sound is a studio designed to producers' brief, and since the two producers in question (Martin Rushent and Alan Winstanley) happen to have had an awful lot of hit records over the years, the studio setup provides an interesting insight into their particular formula.

Martin Rushent has been in pro-audio since 1966 when he "wanted to be a star", Alan Winstanley is more recent, he built up a relationship with Martin at the beginning of the Punk era through The Stranglers. Between them they have worked in hundreds of studios all over the world, almost every studio in London and several dozen throughout the States so they've had plenty of ideas (and lack of them in some studios) on which to base their plans.

"To start off with", recalls Martin, "we wanted a good, solid base for the new studio. Prior to deciding on it we had packed all our equipment into an old bungalow that was on the land I bought together with the house."

"Conditions were a little cramped, to say the least, but at least we could start saving towards a custom complex and try out some first-hand experimentation".

A stream of hit records soon emerged from the bungalow and Martin put into execution the second phase of his ideal set-up—the building and control room.

"We couldn't afford to build the thing in one go *(not many can—Ed)* but were itching to get the control room sorted and, admin-wise, out of my house into some decent office facilities". Since Genetic is halfway up Streatley Hill the first thing to do (after removing the sheep, goats and chickens) was to gouge a big chunk out of the hillside. In this operation several hundred tons of earth had to be removed to create a 'shelf' on which to put the new building. The shell was then constructed and the services of Eddie Veale called upon for the internal architecture.

"We feel", said Martin, "that a control room should be reasonably live, to a certain extent emulating the typical listening environment. We also wanted plenty of room to allow control room overdubs and co-op producing where it's called for. Any idiot can design a dead control room with a reasonably flat acoustic, but something a little more lively, in a controlled way, is a whole lot more risky. Alan and I knew what we wanted, but in terms of taking risks we felt it was better to leave that to a practising acoustician who knew what he was doing."

"I've heard people say that Eddie Veale is expensive, that really depends on your point of view. Eastlake, for instance, will charge you a lot of money to build something you could have built yourself—that's expensive. Eddie built what we wanted and couldn't do ourselves and, as a result, the studio, control room or monitoring have not needed any alteration from the original plan, everything went up as planned and there were no 'I wish I'd. . .' after the job was completed. We just went in and started working."

The mixing desk at Genetic Sound

Working from their brief Eddie Veale came up with the goods and the producers proclaim themselves "well pleased" with the results. Possibly the most striking feature of the room is the one you can't see. In order to avoid resonance, provide a dense medium and yet retain some of the HF, the ceiling was cast in a mould using 54 tons of concrete! ! !

In other respects the room features a good ergonomic use of its 30 sq yd area, housing all power supplies, amps and other non-session use items away in elegant teak enclosures and enfolding the MCI desk and auxiliaries (see equipment list) in a custom built horseshoe configuration around the engineer's chair.

No two walls are square, and a large, conventionally arranged double glazed window looks out on to the 25 x 40ft studio. Monitoring is several fold, with both Martin and Alan in agreement on the JBL *4350* 'main' monitoring yet varying considerably with their secondary tastes, which themselves change according to mood. Hence, the room also sports JBL *Century 100s*, Tannoys, Auratones and Wharfedale *XP*s, the latter two items reflecting their eternal search for the 'living room' sound.

Because of the more live acoustic, the monitoring comes across very loud. "And yet", states Martin, "our monitoring is no different from most studios, it's simply that we don't, having spent good money on a monitoring system, then go and spend even more good money on a dead acoustic that absorbs all the energy from the speakers."

Outside the control room is the expected array of loos, kitchen, washroom and general office, off of which is a large fire proof security tape store and exceedingly well equipped maintenance setup manned 24 hrs a day by their technical man Tim Cuthbertson (he of Air, London), who doesn't sleep much.

Both Alan and Martin, as freelancers before Genetic, had collected a considerable amount of auxiliary equipment which was installed in the control room together with Martin's extensive array of electronic goodies, a list appears at the end of this article but the following items were deemed worthy of note.

The desk is an automated MCI *500*, 28/24, eight aux, six sends job with plasma display, modified to mix foldback individually from six separate lines to a stereo mix. Each musician has his own 6-channel stereo mixer, in addition to the normal foldback facility.

The tape machines are all MCI, with remotes/autolocates built in to the desk and the monitoring amplification is bi-amp using Crown and HH. In the aux racks, among the usual array, is an ADR *Transdynamic* 'Rock Box' *Tri-band* compressor/limiter/clipper/you name it. . .!

Instruments abound for free use and, for a small charge (my boy) you can get your hands on the new Fairlight *CMI* (that will put us all out of a job), Roland *System 700* synth (the last of the great analogues) with micro-composer, Linn drum machine and all manner of keyboards.

Genectic are standardised on Ampex *Grand Master*, 320nWb/m at 30ins, without noise reduction. "We use Dolby (*M series* and *361*s) for track bouncing," explains Martin, "since one of my favourite techniques in electronic music is to track bounce on the multitrack building up." "With Human League, for instance, we bounced some of the brass parts at least a dozen times to build up an ensemble, each time varying pitch etc. All added-up I think by conventional multitrack standards we would have needed about 72 tracks to do it. By this method, Dolby is vital in keeping down the tape noise, especially when you consider that 75% of my work is electronic to some extent, but straight stuff (and the final bounces) are all clean, as is mixdown."

Genetic are undoubtedly successful, having five singles in the Top 40 as I write, and the new Madness album straight in at No 9 in the album charts. Bands who have hits out of Genetic read like *Who's Who*, namely Madness, Ten Pole Tudor, Human League, Altered

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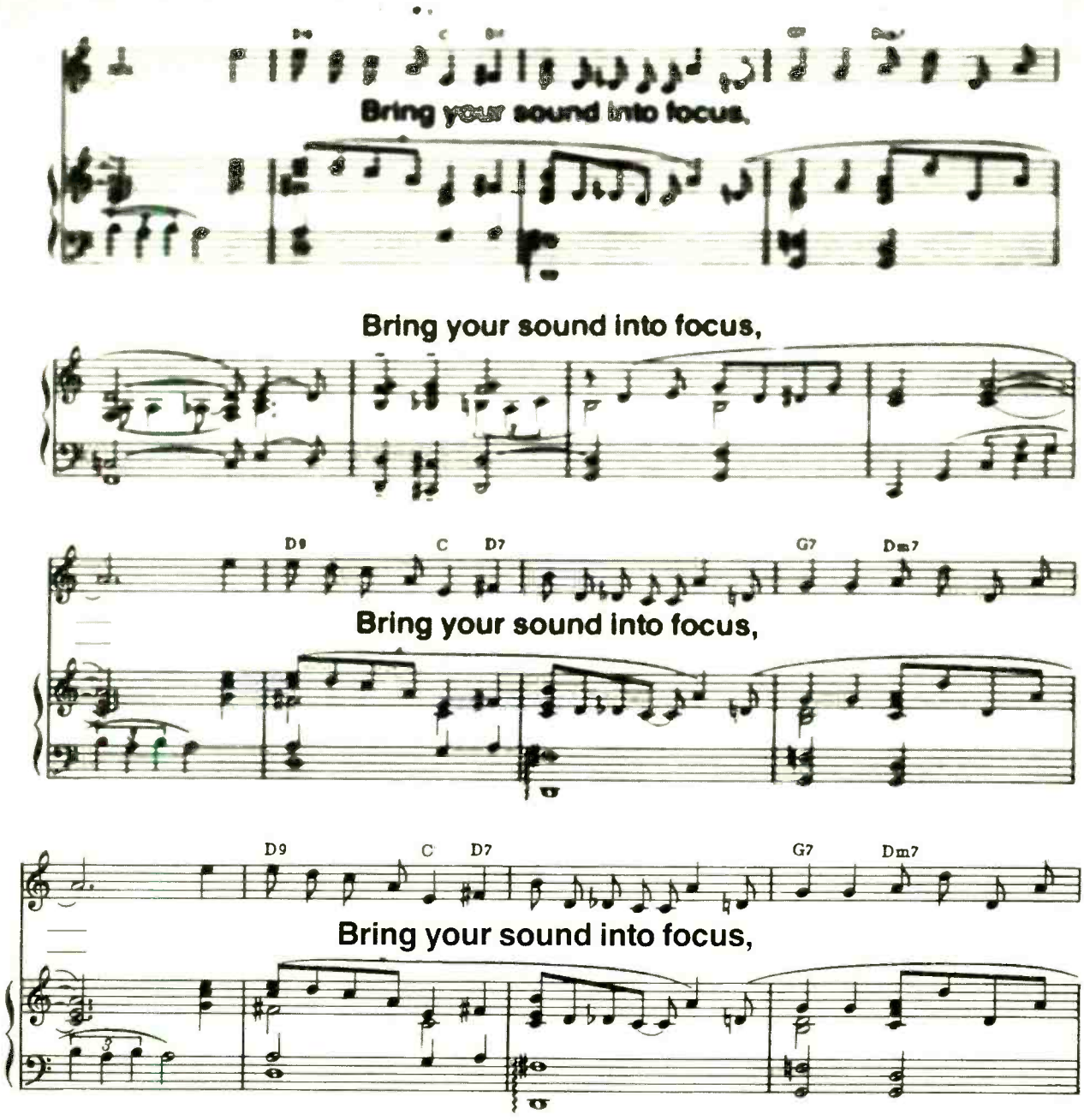
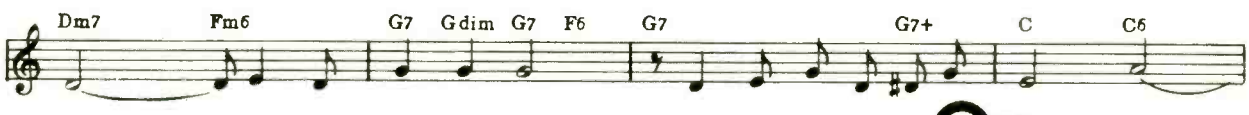


Aphex II



Available in the U.K. through:

AKG Acoustics, Ltd.

Aphex Systems, Ltd.
7801 Melrose
Los Angeles, CA 90046
(213) 655-1411
TWX: 910-321-5762

Studiofile:2

Genetic Sound cont'd

Images, Teardrop Explodes, Telephone, Visage, Peter Shelley, Kirsty McColl, Rachel Sweet and the Ray Beats. All of whom have sampled the Genetic formula.

"If you book into our studio we don't go a bundle on catering for megastar egos," asserts Martin. "If you want something, as often as not you get it yourself. But we do break our necks making sure that everything is to hand and working, technically."

"One way in which we differ from other, purely commercial, studios is the way we view the end product. From the minute a band arrives the whole place is geared to making a hit record, mainly because they're our own productions I suppose, but the aura rubs off on everybody. A commercial studio sees the use of its facility as providing a service to be used and the end product is a bill to the record company for time and materials used, what they achieve is not in the studio's direct 'end product' reckoning (although if they didn't ever produce hits they wouldn't last long, agreed) whereas here we want to make hits, billing comes later in our considerations."

The studio, which is separately air conditioned from the control room is basically oblong in shape and features some neat modular screening facilities (ie build your own booth) with, in addition, a large wooden drum area. The acoustic grades from lively through to dead-ish which gives the added bonus in that for guitar overdubs the guitarist doesn't come in and immediately think his amp's packed up because its output is being soaked up by the room acoustic.

Both Martin and Alan show similar taste in mics. *D12*s are preferred for bass drum/guitar but little else is to a standard pattern. Both producers were honest enough to say that they would frequently try a position with any mic and just listen. Alan even professed to having condenser or dynamic moods depending on the way he felt at the time. Hardware in use on the Ten Pole Tudor (Christmas single/album) session under way was: snare-*U84* and Shure *SM57* (take the better sounding), *451*s overhead (or whatever's left), guitar (bollocky) Electro-Voice *RE20,* (clean and simple) *U87*. Vocals mostly *U87* (or *U67*s if I can get 'em—Alan). Genetic also has the usual array of AKG/Beyer et al.

Genetic sound is located in a very pretty part of the Thames Valley and, considering London is only one hour's drive (Heathrow 35min), quite rural. Views across the Goring Gap are yours for the taking and down in the village of Goring is a weir and lock on the Thames. In the grounds are facilities for tennis and swimming, with a games room for hi-fi/video, pool table, TV, etc and a squash court planned.

Genetic can also accommodate/arrange same for several people and supply snacks and meals as appropriate. For overseas visitors they'll even lay on transport and sort out customs and other formalities.

Genetic Sound, Streatley Hill, Streatley, Berks, UK. Phone: 0491 87 3042. **Harry Mangle**

THE EQUIPMENT AT GENETIC

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MCI 24-track tape machine with autolocate; MCI and Revox 2-tracks
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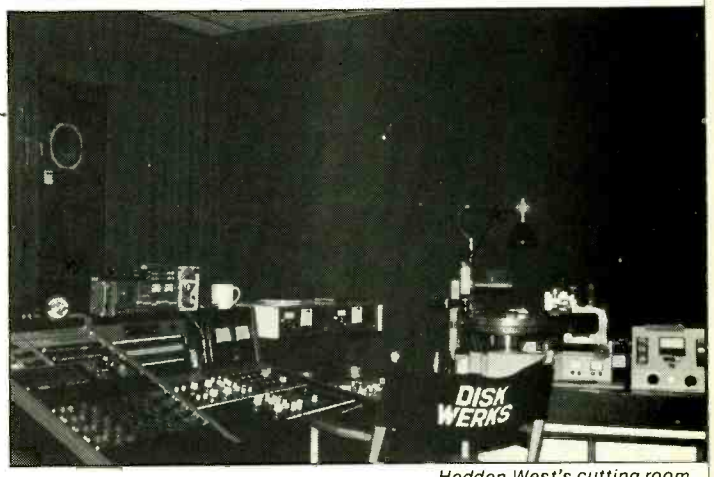
...and the instruments...
Wurlitzer electric and Yamaha *C3* pianos; Fairlight *CMI;* Linn *LM-1* drum computer; Korg; Roland *Series 700,* micro-composer, *MC-8* interface; Casio *VL-Tone;* and Hammond, Clavinet and Fender *Rhodes* Keyboards Ludwig drum kit; Rototoms Marshall, Vox, Ampeg and Fender amps; Gibson, Fender and Ovation guitars

...and mics are AKG; Beyer, Neumann, Shure, Electro-Voice and Crown



Hedden West's cutting room

Hedden West Studios, Illinois

"We can stay in business charging as little as we do because we have very high volume — between our two 24-track rooms we average about 200 hours a week." So says Mike Freeman, vice-president and manager of Hedden West Studios, one of the least expensive fully-equipped facilities one is likely to find anywhere. The company's newer room goes for $45 an hour, while its original, formerly 16-track, studio is available for $35.

"The rate includes an engineer," explains Freeman, "from our pool of freelancers, many of whom used to be on staff here when we kept a staff. Of course, we can provide some really top engineers but they cost more. If a client brings in his own, we'll discount the rate, but otherwise our card stays pretty firm."

Freeman came to the States from his native London in 1973 as a tour manager for various English bands. "I was publishing a free consumer music paper in Chicago," he recalls, "when I met Gavin McCammon and Gary Hedden, who were planning to build a studio. Gary, who did all the designs and specifications, had worked as chief engineer at Motion Picture Sound in Cleveland as well as other places all over the country. He picked up a Clio award along the way and also served as an officer with the Audio Engineering Society. He still travels a lot, and has his own designing and consulting company. McCammon, a graduate of the Harvard Business School, was responsible for laying the business foundations, and is now president of the company.

"They wanted their own facility in a major city, but not in a downtown area. The idea was to have a spacious environment which wouldn't have bodies falling all over each other."

Success story

Hedden and company opened their first room in 1975 in an industrial park in the suburban town of Schaumburg, a high-growth area about 45 minutes from Chicago's Loop, 20 minutes past O'Hara International airport. Originally a 16-track room with Ampex tape machines and Altec monitors, what is now Studio B went 24-track six months later, with an MCI *JH-114* multitrack machine and Electro-Voice *Sentry III* monitors.

The studio now has time-aligned UREI *813* speakers, and the ¼in machines have been replaced with Studer *B67*s and Revox *B77*s. Outboard gear includes dbx *160* comp/limiters, Eventide flanger and *Harmonizer*, Lexicon digital delay, and an EMT *140* reverb plate. A concrete hall behind the studio can be used as a live chamber. The original console, a prototype Sphere that Hedden helped design, is still in place. There is dbx noise reduction for mixdown, but Freeman says it is rarely used. "If we have a delicate acoustic guitar in a soft passage, for instance, or if a producer requests it, we'll switch it on, but otherwise we prefer to run at 30in/s without it. We can also rent Dolby if a client wants it." House tape is Scotch *250*, and the transition to *226* is in progress.

Studio A, which opened in 1979, shares space in a separate nearby building with the company's disc mastering facility. The studio is quite a bit larger than the first room, measuring 1200 sq ft, while the control room measures 500 sq ft. Equipment includes a production-line Sphere desk, 24 channels of dbx noise reduction, more UREI *813*s, and much of the same outboard complement as Studio B. There are also UREI *1176* limiters and Omnicraft gates, as well as an 'Audio Clarifier', a custom-built unit designed to achieve the same effect as an Aphex. Reverb is handled by a Gold Foil EMT *240*. "We already had the plate in the other studio," explains Freeman, "and we really didn't want to move it." Both control rooms sport *Auratones*, and both studios use JBL *4311*s for musician's playback, which can be brought into the control rooms for mixing. The two rooms are designed to be compatible, and many clients switch buildings in mid-project. A rack of extra outboard gear floats between the rooms.

The large mic collection is also shared by the two studios, but each room has its own complement of Neumanns, including *U87*s, *U47* tubes, *KM84*s, *KM86*s, and *KM88*s. There are also four Crown *PZMs*.

The main tape deck in Studio A is an MCI *JH-24* with *Autolocator III*.

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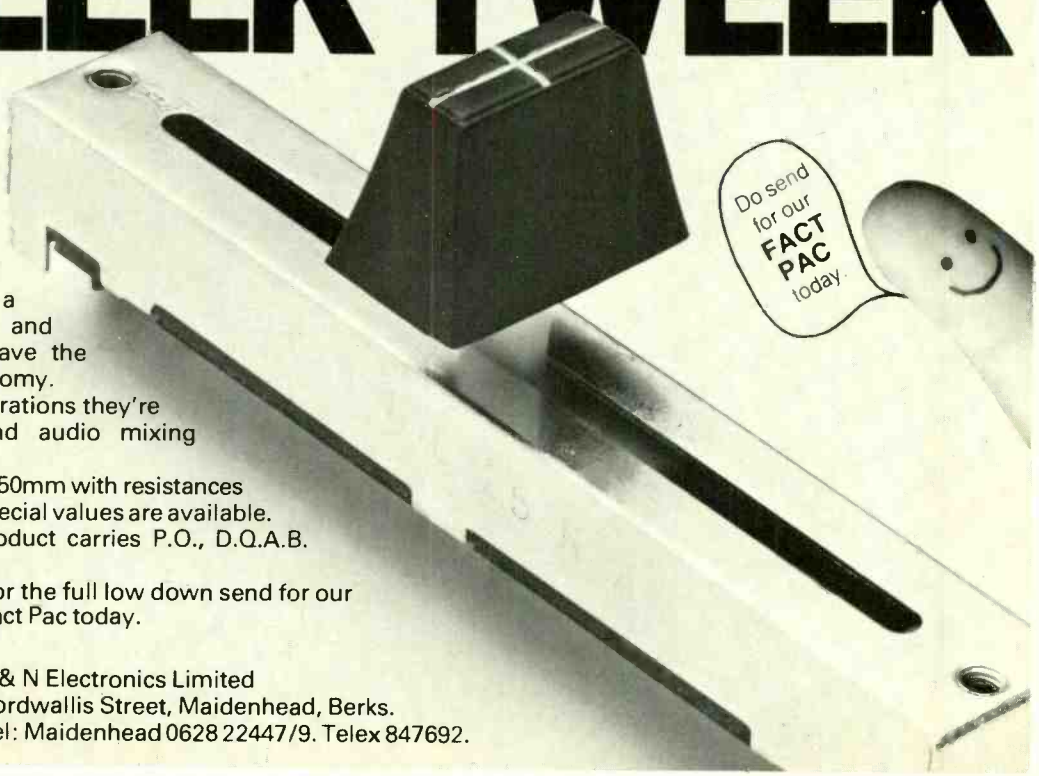

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Studiofile:3

Hedden West cont'd

The 2-tracks are, again, Revoxes and Studers. The console is mounted sideways with respect to the glass, in the "old European" style, and a producer's desk sits directly in front of the glass, giving that gentleman full access to the musicians while keeping him out of the engineer's way whilst tracks are going down. The surfaces in the control room are more or less designed to simulate a living room, with a variety of textures, including wood, glass, carpet, and acoustic tiles. The front end of the studio room is very live, and it gets deader away from the control room. "We do a wide spectrum of music here," notes Freeman, "like rock, R&B, jazz, and even gospel. Many engineers like to take advantage of the room sound, but for some types of recording a more controlled sound is necessary, and we can give them that, too."

Cutting room

The third, and, at $50 an hour plus parts, the most expensive room at Hedden West is the cutting room. This part of the business, which operates under the name 'The Discwerks,' has been presided over since its 1977 opening by Kevin Vogts and Ron Lewter, who is now with JVC in California. Vogts originally became involved with the studio as a student in one of the studio's engineering classes, which are still given to aspiring engineers and musicians who want to know more about the field.

The transfer console is a Neumann *SP77*, of which only three were ever made, the other two according to Vogts, still being in Neumann's hands. A Studer *A80* preview deck, which uses the same heavy-duty transport motors as the company's 2in decks, handles the master tape, and a second, much older Studer is used to make reference tapes of the console-modified signal. The console features completely redundant electronics for the preview and the programme heads, including Trident 3-band equalisers and NTP compressors. There are also two stereo sets of Neumann level and EQ controls, and provision for automatic switching between them when the tape deck senses leader, which allows for adjustments for different tracks to be preset.

The Neumann *VMS-70* lathe is completely remote-controlled to prevent mechanical vibrations from reaching the *SX-74* cutting head. The *SAL-74* drive amps are equipped with HF acceleration limiters for catching sibilant bursts, a tracing simulator which can compensate for tracking error in tangential-arm turntables, and an adjustable 'echo' function which spreads the grooves in the spaces between selections.

A Dolby mainframe is permanently installed, with dbx cards close at hand.

"We're the only quality cutting room in town," says Freeman. "Our nearest competitors are in Minneapolis and Nashville. Besides doing releases for local groups, we also find that the room is used by a lot of touring bands who come in with a tape they've been working on, so they can find out immediately what it's going to sound like on vinyl." Some of the acts who have taken advantage of The Discwerks' availability have been Cheap Trick, the Impressions, the Dells, and Tom Paxton.

The studios, too have had their share of big names, including Styx, Bill Quateman, and Mickey Gilley. Almost all of Hedden West's bookings are music sessions, with only about two per cent of the time spent on commercials or audio/video projects. According to Mike Freeman, the rooms are booked at least two months in advance. He attributes much of the success to the studio's consistency of quality. "We don't like surprises, and neither do the clients." The only surprise, one would assume, would be the nice small numbers on the final bill.

Hedden West Studios, 1200 Remington Road, Schaumburg, Illinois 60195, USA. Phone: (312) 885-1330. **Paul D Lehrman**

Eel Pie, Twickenham

It is not uncommon nowadays, with the increased availability of less expensive second hand equipment, for successful artists and producers to invest in their own private multitrack studio. Pete Townshend on the other hand has had such a place for about six years situated by the river, in a boathouse at Twickenham. During those six years the physical structure, and equipment therein, have gone through many changes as Pete has tried out different ideas and formats.

Sometime around the spring of '81 he finally decided, for various reasons, to go commercial, and with the able assistance of studio designer Keith Slaughter and technical engineer Roger Knapp, went about setting down on paper the definitive design. November saw the completion of all the major work and the studio is now in operation.

The control room is where most of the work has been done. The floor and certain areas of the walls have been covered in a warm coloured red carpet, which nicely complements the mahogany monitor housing, doors and general trim. The same black cloth is used for the monitor covers and the ceiling located bass trap covers, with the remainder of the wall area being covered in a light brown hessian. A small window in the rear wall looks out over the river and across the park on the far bank, and although the room is only 25 x 18ft, the overall effect is airy, warm and relaxing.

It is a room within a room construction, the inner skin being made from a double layer of ½in plasterboard stud work, mechanically isolated from the outer shell by *Neoprene* rubber pads.

The front half of the ceiling is reflective, close boarded in ash, the area behind it being an open boarded, wide band absorptive area, with membrane type bass traps forming a sort of squared off horseshoe shape around the periphery of the side and rear walls. Roger informed me that the sound field is remarkably even and controlled and that although they have a pair of Court Acoustic 31-band graphic equalisers in the monitor circuit, they are usually left in bypass.

UREI *815*s are installed as standard although Tannoy *Reds* or *Lockwoods* with *HPD* drivers can be easily substituted on request. JBL *4311*s and *Auratone* cubes are also available for alternative monitoring. BGW power amps are used throughout.

The desk is an SSL 40/32 with *Total Recall* and the other normal SSL computerised facilities.

There are two Studer *A800*s, two Ampex *ATR* stereo machines and a good complement of other ¼in machines, record and cassette decks. A ½in stereo headblock is available for one of the mastering machines, both of which are fitted with what Ampex term a '4-speed padnet' which allows each machine to be preset in terms of bias and EQ settings for any four combinations of tape, speed and head format. In this case it is set for 15in/s or 30in/s on either ¼in or ½in tape.

In front of the console is a double, sliding patio door which leads into the overdub room. Above the door are two large colour TV monitors. Either side of the door, beneath the monitor housing are two 12in monochrome TV monitors, making four in all. The main reason for such a large complement is that there is no direct visual contact with the main studio area from the control room. To compensate for this there are six cameras located in various positions around the studio: two in the main studio area, one of which is remotely movable from the control room; one in the piano booth which is adjacent to the control room; one in the corridor outside the control room, which is also used as an extra isolation booth, one in the small stage area at one end of the main studio and one in reception for security. The four 12in monitors are dedicated to the first four cameras which, together with the last two, are fed into a small vision mixer, the output of which is fed in turn to the right hand of the two larger TVs above the door, while the left hand one deals with the *Total Recall* functions and other computerised session information.

The main studio floor area has been left pretty well unchanged. All the walls are simply bare plaster, the complete acoustic treatment consisting of a curtain track and associated curtain which runs round three of the walls, and a suspended ceiling of acoustic tiles. There's not a bass trap or pad of Rockwool in sight. It is left that way because that's the way Pete likes it and he is joined in his appreciation by various other artists and producers who have used the studio over the years.

At one end of the room is a large sliding glass door which leads into a 22 x 15ft piano booth, while at the opposite end is a small stage area measuring approximately 27 x 12ft plus a 12ft square extension rostrum which slides back under the main stage when not in use. This area can of course be used for video productions and rehearsals. A series of bars over the stage and a simple square grid over the studio area provides the flying facilities for the stage lighting. The control gear consists of a 12-way, 2kW thyristor dimmer pack, and a 6-channel, single preset board with individual flash facility on each channel. The power for the lighting is on a separate phase to the sound and all cables are run in separate trunking, thus precluding interference.

Roger Knapp, Eel Pie's technical engineer, has included several nice touches in the studio including a small, inconspicuous electret talkback microphone in each main area, and a lead tester mounted in the trunking of the main studio. All the talkback mics are fed into a little mixer in the amp room from whence the composite signal is sent to the *Auratones* in the control room.

Next door to the control room is a large (about 400sq ft) hexagonal conservatory with a pinball machine, cooking facilities and an excellent view out over the river. There is also a large roof top patio which shares the same view and on which, during the warmer months, barbeques and the like are held.

Depending on the traffic, it's between 30 and 50min out of town, or substantially less if you happen to own a power boat.

Eel Pie Studio, The Boat House, Ranelagh Drive, Twickenham, Middlesex. UK. Phone: 01-892 3642.
James Betteridge

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Alan Blumlein

Early

WOE betide the inventor who gets his timing wrong. Antony Askew has meticulously catalogued the efforts of Clément Ader to interest the world in a stereo telephone system, a hundred years ago (*Studio Sound*, September, October, November 1981 issues). Although visitors to the 1881 Paris Exhibition of Electricity were queueing to hear the world's first stereo transmission of sound, from the stage of the Opera across the city, and although Ader patented his system, it was commercially ahead of time. The public was only just coming to terms with the idea of a mono telephone, let alone a stereo version.

Ader's ideas were many times rediscovered and re-patented, for instance by Harry Wier of Western Electric in 1921 and by Chicago inventor W Bartlett Jones in 1927. Harry Wier (in US patent 1 508 432) and Bartlett Jones (in US patents 1 855 149 and 1 855 151) took Ader's ideas a step farther. They both proposed ways of *recording* two channels of sound, whereas Ader was concerned only with transmission. Wier patented a double groove cylinder and Bartlett Jones a double-grooved disc. Bartlett Jones even suggested recording two channels of sound in a single groove, one channel recorded by vertical modulation and the other by horizontal modulation. Bell Labs ran a permanent demonstration of binaural sound at a Chicago museum in the '30s and '40s. The idea was forgotten but came to the surface again, mainly in Germany, in the '70s. Binaural stereo recording and radio transmission was then seen as a commercially viable alternative to the primitive systems of 4-channel quadraphony being foisted on an unsuspecting public. The time was then 'right' for binaural. But it still failed to achieve real commercial success because all the 'inventors' of binaural stereo have been up against a problem which is much more significant than that of nice timing. It still remains, and will remain, a curiosity for the simple reason that headphone listening is not only uncomfortable, and fatiguing, it is also downright anti-social. There is no more infuriating sight in this world than a companion revelling in invisible pleasures derived from a pair of headphones.

The need for a loudspeaker system to reproduce stereo, or 'auditory perspective' as it was originally known, was soon recognised. By the late '20s and early '30s research teams in both the UK and USA were working independently, but virtually in parallel, on an answer to the problem. By coincidence the success of those research teams in recording and reproducing loudspeaker stereo makes these winter months not only the centenary anniversary of anti-social stereo listening, but the 50th anniversary of stereo sound recording and reproduction as we know it today.

The British work, by Alan Dower Blumlein of EMI (now Thorn-EMI), has already been reasonably well documented. This followed an upsurge of interest in Blumlein's work during 1977, when the Greater London Council erected a commemorative plaque on Blumlein's last London home, in Ealing. This commendable gesture by the GLC was itself timed to coincide with the 35th anniversary of Blumlein's tragic death. He was killed in 1942 when a Halifax bomber, in which he was testing a radar prototype, crashed in the Wye Valley.

A biography on Blumlein has long been promised but nothing has ever appeared. For those whose memory needs jogging, Blumlein arguably contributed more to audio and video technology than any other Briton. In his short life he was responsible for no less than 128 patents, an average of one every six weeks of the time he spent on research at EMI's central labs in Hayes. Of these patents BP 394 325 was by far the most significant. It describes Blumlein's proposals for stereo recording on disc and film. It describes the techniques (which we today take for granted) which are needed to convert phase differences at a coincident pair of microphones into amplitude differences at a spaced pair of loudspeakers so that they create a stereo image spread. In searching for an alternative to headphone listening, Blumlein gave up trying to solve the problems of acoustic crosstalk and turned them to his advantage.

When a binaural stereo recording is reproduced through loudspeakers, the binaural effect is degraded. This is because of acoustic crosstalk. The sound from the left loudspeaker reaches both the left and right ears, instead of just the left ear as would be the intended case for headphone listening. Blumlein forgot about trying to re-create an accurate replica of the original sound field at the listener's ear. Instead he concentrated on fooling the listener's ear and brain into hearing an illusion of the original sound field. By converting phase differences at the microphones into amplitude differences at the loudspeakers, and relying on the fact that the sound from each loudspeaker would reach the ears of a listener at slightly different times, Blumlein recreated phase differences across the listener's head. This gives the listener reasonable freedom of movement between a pair of loudspeakers without loss of stereo image. It's the psychoacoustic principle on which all modern recording relies for its stereo effect.

Blumlein also developed, and patented in BP 394 325, a system of capturing the two channels of sound information necessary to achieve the effect. He did this using only a single soundtrack or single record groove. For film stereo he split a conventional 35mm optical soundtrack into two halves, one for the left sound channel and the other for the right channel. For disc stereo he recorded two channels of sound in a single groove by driving the cutting stylus in two planes at the same time. The two planes were vertical and lateral or, as is the established stereo standard today, each at 45° to the disc surface.

There is an interesting story behind the adoption of this standard for stereo recordings. The decision on 45/45 cutting was taken by the Record Industry Association of America (RIAA) on March 25, 1958.

Stereo Recording

Barry Fox

But the standard wasn't referred to as a Blumlein standard, instead it was credited to Westrex. This prompted an editorial outburst from the normally staid British magazine *The Gramophone*. In the April 1958 issue Percy Wilson, the technical editor, reminded the world that the 45/45 system was called the Westrex system only because Westrex "happened to give a demonstration of it at Los Angeles last September". Wilson also detailed the work of Decca in producing equipment that coped with both vertical/lateral and 45/45 stereo cut all based on the original work of Alan Blumlein. Decca had in fact also developed equipment for a third stereo system. This adopted the 'multiplex' approach proposed by Bill Livy of EMI in which the two channels were separated in frequency, in a manner similar to that later used by JVC for the *CD4* quadraphonic system.

"In 1498, we are told, Columbus discovered the Continent of America; and since that date the inhabitants of that wonderful land have from time to time discovered Europe. But only occasionally, it seems, do they discover what the Europeans have been doing—or at any rate given credit for it" *wrote Percy Wilson.*

Ironically, as we shall see later, the Americans had not even discovered what their own fellow countrymen had been doing! The Westrex system was not only anticipated by Blumlein's work, but also by the closely similar work of a team of engineers at Bell Labs. The Bell engineers had been working on the same problems as EMI at the same time, and had come up with some closely similar answers. The supreme irony here is that Westrex was once a division of Western Electric, which was the sister company of Bell Labs. Both Bell Labs and Western Electric are of course part of the giant American Telephone and Telegraph Company (AT and T) which controls the American telephone network, called the Bell system. We shall also see how Bell Labs came to develop, and patent, a stereo sound recording and reproduction system, with the enthusiastic help of Leopold Stokowski and the Philadelphia Orchestra.

Recently Bell Labs have issued (on limited edition and available only for libraries and archives) two LP discs of high quality recordings made in the winter orchestral season of 1931/32. As part of that coincidence mentioned above, which ties the centenary of binaural stereo to the 50th anniversary of high fidelity recording and loudspeaker stereo, the Bell releases contain what is arguably the world's first high fidelity disc recording. This was cut on December 1, 1931. Stokowski was rehearsing Berlioz' *Roman Carnival* and the Bell Labs engineers captured some excerpts on a high quality disc system. They also made what must surely be the first high fidelity stereo recording. This was made during a concert of Russian music given by Stokowski on March 12, 1832. The Bell Lab engineers were present and recorded two short extracts from Scriabin's *Poem of Fire*. This is also on the Bell disc reissues.

To complete the anniversary picture of coincidences the first documents that went to make up Blumlein's famous patent BP 394 325, were filed at the British Patent Office on December 14, 1931.

It would be nice to be able to say that EMI (now Thorn-EMI) has produced a tribute to Blumlein which is comparable to the Bell Labs tribute to the pioneering work with Stokowski in the winter season of 1931/32. Unfortunately it is impossible to bestow any such compliment on EMI.

Blumlein completed a stereo sound film, using the techniques described in his patent. These techniques are so closely similar to those used today by Dolby Labs for optical sound film stereo reproduction, that Dolby engineers have confirmed that the Blumlein film would be playable on modern Dolby stereo film equipment. But since the mid '30s, when Blumlein completed the production of his test films, what remains of them rests apparently uncared-for in the EMI Labs at Hayes. These early films are on nitrate stock, which is inherently unstable. Nitrate film burns explosively if ignited, but turns to goo and then dust if not carefully stored, ideally at low temperature. There is no evidence that EMI is storing the Blumlein film carefully. A few years ago it was simply sitting in a cupboard. Also, despite repeated promises, there is still no firm news of a transfer to modern safety stock. If the Blumlein film turns to dust in the uncaring hands of EMI; it will be to the company's everlasting shame.

Blumlein also made some stereo test disc recordings 50 years ago, using the double modulation tech-

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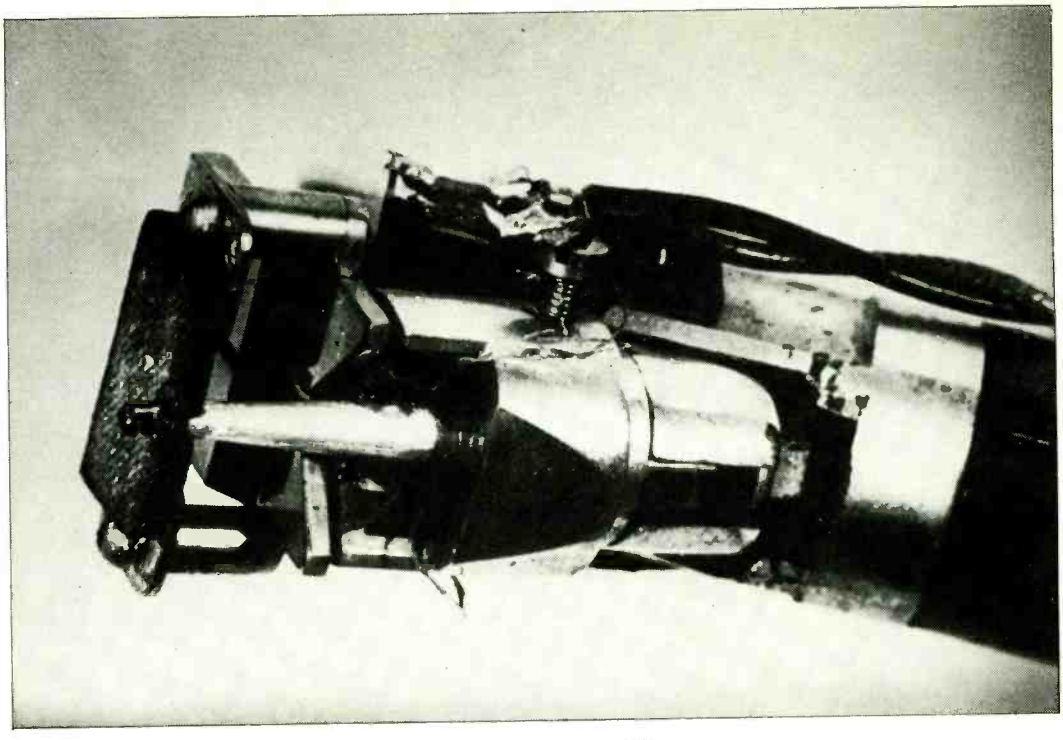
Early Stereo Recording



Blumlein's original stereo pickup

niques described in patent BP 394 325. Although these discs appear to be in safer keeping, EMI has done little to exploit their historical potential. Indeed getting hard fact information on what archive software exists in the EMI vaults, and its condition, is like squeezing blood from a stone. It all makes a sad and marked contrast with the attitude of Bell Labs who have been at pains to publicise their archival tributes.

The first stereo tests were made by Blumlein at Hayes. His assistants walked round a room and talked at the microphones as Blumlein altered the circuit configuration. These 'walking and talking' recordings have been occasionally played at lectures and demonstrations, but they have never been made widely available, even for historical interest. If you have heard a 'walking and talking' Blumlein recording, it was probably one that was cut on December 19, 1933.

Exactly one month later, on January 19, 1934, Blumlein took his stereo recording equipment to EMI's Abbey Road Studio One where Sir Thomas Beecham was making a commercial recording (in conventional mono) of Mozart's *Jupiter Symphony*. Sir Thomas Beecham, like Stokowski, was always interested in new audio techniques. It was Beecham for instance who, in 1936, made the first orchestral recording on magnetic tape, at the BASF concert hall in Ludwigshafen, Germany. During the Abbey Road *Jupiter* recording, Blumlein made several tests in stereo. Again it is hard to extract useful information from EMI, but it seems that these were cut in vertical/lateral form rather than 45/45. Before the recent Bell Labs re-issues and their 1932 stereo cuts these Blumlein-Beecham tests of 1934 had always been cited as the world's first orchestral stereo recordings. The main difference is that the Bell cuts were made using a double groove technique.

The Blumlein single groove cuts remained for nearly half a century closeted in the EMI vaults, along with the walking and talking tests and the decaying optical stereo film. But finally, amidst virtually no publicity, a snatch of a stereo test appeared on the one side of one disc in an 8-disc boxed set issued by EMI-World Records to commemorate the centenary of Sir Thomas Beecham. "At last," thought those of the audio world who cared, "a chance to hear original Blumlein stereo." But enthusiasm was short lived. The brief segments turned out to be a terrible disappointment. The Blumlein stereo sounds more like mono! The faint illusion of stereo that persists probably stems only from the fact that there is tonal imbalance between the left and right channels. Blumlein must be turning in his grave at the sound of his work as released to the public by his old employer nearly 50 years after the tests were recorded. Those who know what crossed pair stereo can sound like are sure there must be a far superior stereo image locked on the original discs held by EMI. The company promised to check the originals and comment on the issue, but despite reminders it never happened.

The Blumlein-Beecham issue sounds especially poor in comparison with the superb Bell Labs transfer. This is doubtless due to the fact that Bell Labs employed Arthur Keller, one of the engineers responsible for the original recordings, to supervise classification of the Bell archives and transfer of the 1931/32 winter season recordings on to modern LP disc format. EMI can of course not call on Blumlein for similar help. But is it really so difficult to transfer V/L recordings on to tape and from there on to modern 45/45 stereo LP format? Surely not.

All is not lost. Perhaps the publicity for the archival issues by Bell Labs will stir someone, somewhere inside Thorn-EMI to more positive action. Blumlein's work made EMI's involvement in the record business possible. At the last count, Sir Richard Cave, the boss of Thorn-EMI earned £96,961 a year. The least Thorn-EMI can now do is produce an archival disc record of Blumlein's pioneering work, shown to the best possible advantage. In this respect time is on Thorn-EMI's side. January 1984 marks the 50th anniversary of Blumlein's original tests with Sir Thomas Beecham.

In the early '30s when Blumlein in Britain and Bell Labs in America were working separately, and in ignorance of each other, on the same problem of reproducing stereo with loudspeakers rather than headphones, the time was most certainly *not* ripe for the introduction of any such system on a commercial scale. Both Britain and America were in the grips of a deep recession. Unemployment in the UK was around three million and in the USA around twelve million. Radio had taken over from the gramophone as the most popular medium. As Arthur Keller, who engineered the original '30s recordings of Stokowski and was recently re-employed for two years by Bell Labs to work on the re-issue of selected excerpts, recalls: "People had difficulty in raising the money for one loudspeaker, let alone two." Why then was Bell Labs, a research laboratory for a national telephone company, able and willing to devote so much time, attention and money to the development of such a commercially irrelevant system as high fidelity stereo recording? The simple short answer is that Bell Laboratories has a very wide research brief. Anything connected with sound communication, and now vision communication, is fair game for Bell's research interest. And there were good reasons for Bell to improve the quality of disc reproduction even in those bitterly depressed days. Curiously it all began with the cinema . . .

In the '20s the disc was still an imperfect medium. Records were pressed from shellac which was noisy and the modulation was horizontal, rather than vertical as had been proposed by Edison. Horizontal modulation is more difficult to track. Also groove spacing and playing time per side, becomes a direct function of modulation levels. But it's easier to generate high levels of sound if the groove is modulated 'laterally' because the stylus excursion can be made very large.

There were no magnetic tape recorders, and although the idea of recording sound optically on film had been proposed, it had not been developed into a workable system. So to provide a soundtrack for a film it was necessary to use discs, and these offered poor quality. In any case, Hollywood wasn't too interested in providing soundtracks for films, because most of the studio executives firmly believed in the long term future of silent pictures. But Bell Labs needed a sound film system for a special reason. The company used to recruit graduate engineers from universities and for this purpose made its own publicity films. These were screened with an accompanying talk by a Bell Labs employee.

In 1922 the Bell engineers tried synchronising their films with a talk pre-recorded on disc. In fact the synchronisation was very loose and there was no direct speech into the camera, simply a commentary. But two years later they achieved lip sync with a mechanical gear system linking a gramophone and film projector. The quality of reproduction was still poor because the disc was lateral

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Early Stereo Recording

cut and pressed from shellac. Quality also suffered because even 16in discs had to run at 33⅓ rev/min to give a reasonable playing time. But Bell saw the commercial potential of their sync system and demonstrated it to the movie industry. Only the Warner brothers were interested and the rest is more or less history. The system, called *Vitaphone*, was first used by Warner's to produce *Don Juan*, a musical sound film with an introduction spoken in lip sync from the screen. Then, the next year came *The Jazz Singer*. The discs used for *Don Juan* and *The Jazz Singer* were played by steel needles tracking at around 11b and each needle lasted only one side. Dynamic range was around 30dB and bandwidth 4.5kHz.

That was 1927 and over the next three years the Bell engineers beavered away at improving the sound quality of disc recording. By the time they had succeeded, a practical optical sound film system had been developed. Essentially it's still in use today. But Bell's work on sound-film-discs laid the groundwork for improved gramophone sound. It also laid the groundwork for stereo reproduction or 'auditory perspective' as it was then called. Bell's work on recording led to research into the live transmission of high quality sound, in 3-channel stereo, across the country in subterranean telephone lines. In turn this generated more research into recording. In all this work the Bell engineers had a valuable ally in Leopold Stokowski who, like Sir Thomas Beecham in Britain, had a very open mind and keen interest in new sound technology.

In 1933 Stokowski's orchestra played at the Academy of Music in Philadelphia, while, over a hundred miles away, in Washington's Constitution Hall, Stokowski himself sat at the controls of a 'discrete' 3-channel sound reproduction system. Four meticulously equalised telephone lines connected the two locations. Three lines were used for the audio link, the fourth was kept as a spare. By using a suppressed high frequency carrier technique the Bell engineers were able to carry signals 150miles, with a frequency characteristic which was flat to within ±1dB from 40Hz to 15kHz, and a dynamic range of 80dB. The amplification system could in fact add an extra 10dB to the reproduced signal, so that an orchestra of 100 musicians in Philadelphia was made to sound like 1,000 in Washington. Incidentally no compander system was used at this time, even though companders were well known and available to Bell engineers. Three moving coil microphones picked up the sound of the orchestra and fed three loudspeaker banks through three separate phone channel links and amplifiers. In practice three microphones were spaced out between the conductor and orchestra with a fourth for solo voice pickup. When this spot mic was switched in, only the two side channels were used to pick up the orchestra. The spotted voice was transmitted and reproduced over the centre channel.

It's important here to remember that although Blumlein in Britain was working on a 2-loudspeaker system, with phase differences in the sound field converted into amplitude differences for the loudspeakers to re-create phase differences at the ears and so produce the illusion of a stereo spread, Bell engineers were committed to the 'wave front reconstruction' philosophy. If an infinite number of microphones were placed in front of a sound source, and connected to an infinite number of loudspeakers by an infinite number of cables, then the original wavefront could be reconstructed and full auditory perspective or true stereo reproduced. But this is obviously an impractical solution, and while Blumlein looked for a way of making two speakers spread a mix of sound, Bell's experiments were aimed at finding the minimum number of discrete reproduction channels which could provide a spread of sound without a hole in the middle. They found that three channels was the minimum. Hence the 3-channel link between Philadelphia and Washington.

Arthur Keller with the special gramophone recently built to replay the original masters for dubbing on to modern format

Over the next decade Bell continually improved the system, and used it for live sound reinforcement, for instance at the Hollywood Bowl in California for orchestral concerts. There was an obvious incentive to try to record this 3-channel sound, but it was clearly impractical to achieve this with a disc record. So Bell developed a film recording system, with three channels of sound recorded optically down the centre of a length of 35mm film, and a fourth track recorded to control a compander operating on the three audio tracks. This was used, again with Stokowski's co-operation, for a concert of recorded sound staged at Carnegie Hall in 1940. Soon afterwards a modified system, developed by Disney Studios in co-operation with RCA, was used for *Fantasia*. This system has already been described in *Studio Sound* (August 1979), because the final 3-channel soundtrack, with single-channel compander control track, was derived from a 9-track optical master. It was thus arguably the first multitracked recording.

Two early pick-ups—slightly heavier than their more recent companions

But long before Bell recorded multitrack sound optically on film, and even before the public demonstration of high quality live line transmission, Bell engineers had both improved the quality of disc recording and developed a 2-channel binaural stereo recording technique. Although this work was originally stimulated by the need to improve the quality of sound film disc recording, momentum carried the research and development on long after the cinema had lost interest in sound-on-disc recording. In all, Bell engineers made 6,000 test records during the period of three years from 1931 to 1934. Only around 700 of these originals now remain, because many have been discarded as valueless, lost, stolen or deliberately destroyed. And for the same reasons none of the original sound films or optical sound recordings remain since they were on nitrate stock like the EMI Blumlein material. Of the original master discs, still in the Bell archives, 128 were recorded with Stokowski during the 1931/32 season. It was from these recordings

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Spain	**Mike Llewelyn-Jones** Francisco de Rojas 9, 2 DER, 9 Madrid 10 Tel: Madrid 445 1301
Germany	**Audio Vertrieb Peter Strüven GmbH** Hamburg Tel: Hamburg 5245151
Switzerland	**Audio Bauer AG** Bernerstrasse Nord 182 Zurich CH 8064 Tel: Zurich 016 43230

Early Stereo Recording

An exhibition stand shows an example of the double groove technique used in early stereo recordings

that the two recent Bell Labs re-issues were produced.

In 1931 Bell rejected lateral cut modulation in favour of vertical cut, because they found it easier to track a hill-and-dale groove accurately. Shellac was discarded as a disc material and pressings made from a then-new material, vynilite. This had been produced by Union Carbide for moulding telephones. Traditionally wax disc masters had been rubbed with graphite, prior to electroplating, to make them conductive. But Arthur Keller found that this roughened the surface and increased noise. So he and his colleague engineers built a high-vacuum, high-voltage, gold-sputtering machine which deposited a thin layer of pure gold on the wax disc surface. Because the discs were used only for tests, not commercial releases, the metal layer was simply stripped off and used as a stamper. To produce commercial quantities of disc record it is of course necessary to go through a 3-stage electroplating process, and produce master, mother and then stampers. But Bell didn't need commercial quantities and could use the metal master as a stamper.

Keller and his team used mainly 12in masters running at 33⅓ rev/min (16in discs had been necessary only for film use, where the playing time of a disc had to match that of a reel of film). All the discs were recorded with centre start, the stylus tracking out towards the outside. Because the modulation was vertical, rather than lateral, groove pitch could be kept fine.

By the winter season of 1931/32 the adoption of vertical cut modulation and the use of vinyl material for the pressings had brought about a marked improvement in audio quality. Dynamic range had been extended to 60dB and bandwidth to 10kHz. It's a revelation to compare the very boxy (30dB; 4.5kHz) sound of *Don Juan* or *The Jazz Singer* with the very respectable sound of the Stokowski recordings now re-issued, especially those made towards the end of the winter season. By this time the Bell engineers had cured some early problems, for instance of over-modulation, which marred the first cuts made in December 1931.

The recordings Stokowski made with Bell 50 years ago were kept a secret from the performing musicians. Only recently, when Arthur Keller lectured in Philadelphia and played some of the original recordings, did some old musicians in the audience learn that they had been recorded!

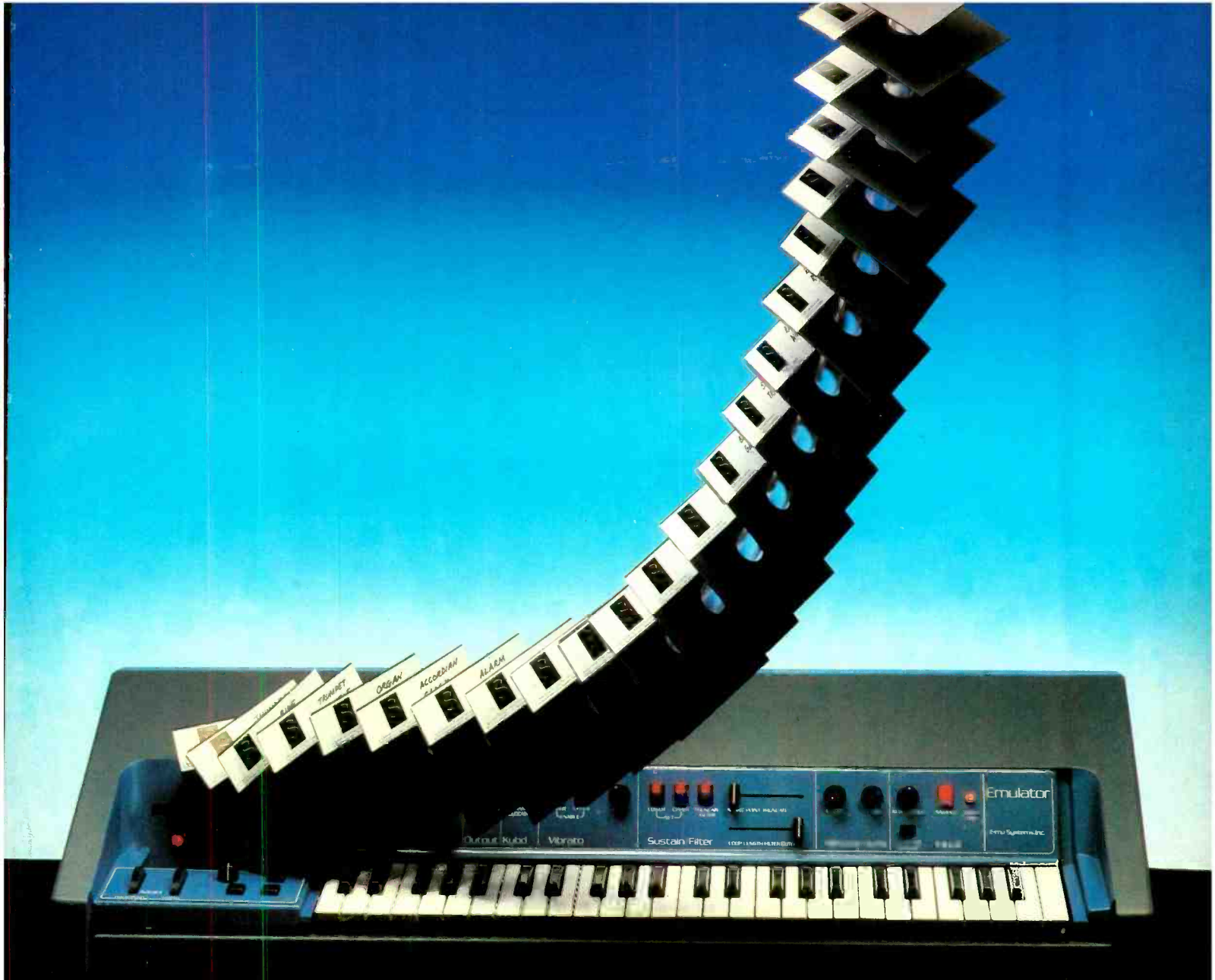
When Arthur Keller was re-employed by Bell Labs to sort through the old masters and arrange re-issues, recording engineer Ward Marston IV was also employed to help piece together the original material and dub from the original discs on to tape and then on to modern LP format. This proved to be a mammoth task. For one thing, because the tests had never been intended for commercial release, many of the recordings were incomplete. Also the early recordings, made in December 1931, were of far inferior quality to those made in the Spring of 1932. It proved impossible to get clean pressings from the gold sputtered masters so Keller and Marston had to devise a system of playing the masters themselves. These are negatives, so the turntable has to run backwards and the stylus track a ridge rather than a groove. They used Stanton forked styli, but needed a range of different shapes to cope with different cutting levels. This was the only way to cut down on pre- and post-echo where the originals had been recorded at high level. There was also a problem of keeping the stylus firmly on the master ridge, because the gold masters are less than perfectly flat. And some of them showed signs of flaking through age, mis-handling or bad storage.

All in all it's remarkable that the Bell re-issues sound as good as they do. The Weber *Invitation to the Dance* track is for instance a mix of incomplete takes from two quite different concerts recorded with different microphone placements. One piece of Wagner contains 20 splices. Different sections of material had to be tracked with four different-sized styli and then cut into a remarkable cohesive whole.

The 1932 stereo recordings were made by a double groove technique; one channel was recorded with one cutter head, starting from the centre of the disc, and the other channel was recorded with another cutter head, starting halfway out from the centre. According to Arthur Keller the 2-channel recording was intended to be replayed through headphones. Bell was aiming at wavefront reconstruction for speaker stereo using at least three channels. But it sounds remarkably good today, even when replayed through a conventional stereo pair of loudspeakers. Transferring the 2-track stereo on to tape, and then on to modern 45/45 stereo disc format, was a terrible headache. Ward Marston had hoped to lay his hands on one of the old double-groove players made by Emory Cook, but had to settle for two modern pickups lined up on a turntable plinth by trial and error. He attempted to synchronise them with an oscilloscope, but finally ended up dubbing the two separate channels on to two tapes and then syncing them by ear.

Release of the Bell Labs stereo recording made in March 1932, has inevitably stirred up controversy over who should be credited as the true and first inventor of stereo recording. At first sight Bell Labs were clearly first to record an orchestra in stereo, and they did this even before Blumlein had made his 'walking and talking' stereo tests at the EMI Laboratories in Hayes. To recapitulate on the bald facts: the first Bell-Stokowski stereo recording was made on March 12, 1932, the Blumlein 'walking and talking' tests were recorded at the EMI Laboratory in Hayes on December 19, 1933, and the first Blumlein-Beecham orchestral stereo recording was made at Abbey Road on January 19, 1934. But the Blumlein-Beecham recording was made with a *single groove cut* of two channels, whereas the Bell-Stokowski recordings of 1932 were made with *two quite separate grooves* cut on the same disc. To confuse the issue further, and add fuel to the fire of controversy, Arthur Keller and his colleague at Bell Labs, Irad Rafuse, developed and patented a *single groove* stereo recording system, virtually identical to the Blumlein system. So both Blumlein and Bell Labs proposed what is now standard practice, namely that two channels of sound should be cut in a single groove, at right angles to each other and at 45° to the disc surface. But whereas Blumlein lodged his British patent (BP 394 325) for a 45/45 cut on December 14, 1931, Keller and Rafuse didn't lodge their US patent (USP 2 114 471) until June 20, 1936. This delay was partly a result of a peculiarity in the US legal system and partly due to the low priority given to the idea by the Bell Labs legal department in those depressed times. In America a signed notebook can help date an invention, whereas in Britain an early filing at the Patent Office is more important. Arthur Keller has himself recently confirmed that because of the depression, the Bell Labs lawyers didn't get round to filing a patent application on the idea until long after he and his colleagues had built a system. Thanks to the American legal system, there was less incentive to hurry than there would have been in other countries.

It is now impossible to say with certainty who did what, first, and when. It's also singularly pointless. Clearly neither Bell Labs nor EMI knew much—if anything—of each other's work, and there was certainly no commercial incentive to be first with a workable stereo disc system. The British Beecham recordings, and the Stokowski recordings in America, were made only for experimental purposes. We should simply be glad that Bell Labs has invested money in the production of two re-issue albums, and be sorry there are unlikely to be any more. The Bell Labs management seems to think that enough's enough. But we should be even more sorry that there is as yet nothing of comparable significance from Thorn-EMI to honour the work of Alan Blumlein. Perhaps with the 50th anniversary of those historic Blumlein-Beecham recordings due in January 1984, Thorn-EMI can now be enthused or embarrassed into remedial action. ■



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product Record reproduction equipment guide

AKG (Austria)

AKG GmBH, Brunhildengasse 1, A-1150 Wien. Phone: (0222) 92.16.47. Telex: 11839.
UK: AKG Acoustics Ltd, 191 The Vale, London W3 7QS. Phone: 01-749 2042. Telex: 28939.
USA: AKG Acoustics Inc, 77 Selleck Street, Stamford, Connecticut 06902. Phone: (203) 348-2121.

P8ES: cartridge for use with arm featuring less than 15mg friction in any direction.
PE8: cartridge for manual or semiautomatic turntables.
P6R: robust cartridge designed to withstand backcueing.
P10ED: robust cartridge designed to withstand backcueing.
P15MD: cartridge for manual or semiautomatic turntables.
P25MD: cartridge for use with high quality arms, stylus has special *Analog 6* configuration.

AKG P15MD

ALICE (UK)

Alice (Stancoil Ltd), 38 Alexandra Road, Windsor, Berks. Phone: 07535 51056. Telex: 849323.

Alice GU 200: self-contained gram unit for broadcast use; based on Technics *SP10 MkII* turntable with choice of tone arms and cartridges.

AUDIO-TECHNICA (Japan)

Audio Technica Corp, 2206 Naruse, Machida, Tokyo 194. Phone: 0427-22-7641. Telex: 2872-357.
UK: Audio Technica Ltd, Hunslet Trading Estate, Low Road, Leeds LS10 1BL. Phone: 0532 771441.
USA: Audio Technica US Inc, 33 Shiawassee Avenue, Fairlawn, Ohio 44313. Phone: (216) 836-0246. Telex: 986411.

APT-12T: tone arm for 12in turntables adjustable for a range of heights and base thickness.
APT-16T: similar to *APT-12T*, but for 16in turntables.
APT-1: robust cartridge for backcueing with rugged hum resistant construction.
APT-2: robust cartridge for fixed installations; backcueing.
APT-3: robust cartridge for fixed installations; backcueing.

CETEC (USA)

Cetec Broadcast Group, 110 Mark Avenue, Carpinteria, Cal 93013. Phone: (805) 684-7686. Telex: 658461.
UK: Acoustics International Ltd, 42-50 Steele Road, Park Royal, London NW10 7BP. Phone: 01-961 4397.

Model GT12: broadcast turntable designed for one hand cueing and start; 33⅓ and 45RPM speeds.
Model AT1005: tone arm with pivot bearings behind smoked plastic cover for inspection ease, anti-skating device, and precision adjustment of tracking force.
Model ST220: less complex version of *AT1005*, rotation on small precision ball bearing with adjustment for arm height, lateral balance and tracking force.

CLYDE ELECTRONICS (UK)

Clyde Electronics Ltd, Ranken House, Blythswood Court, Anderston Cross Centre, Glasgow G2 7LB. Phone: 041-221 5906.

Harris CB1201

BTU1: self-contained broadcast unit with Technics *SP10* turntable and choice of tone arm, complete with equalising amplifiers and optional monitoring facilities.

DOMINUS (UK)

Dominus, PO Box 1, Cranleigh, Surrey GU6 7JF. Phone: 04866 6477.

Stereo disc amplifier 3: stereo phono preamp producing line level RIAA equalised outputs from moving magnet cartridge inputs; adjustable input loading.
Moving coil preamplifier: stereo preamp suitable for use with all low impedance moving coil cartridges; adjustable.

DSD (USA)

Dynamic Sound Devices, PO Box 369, Commack, NY11725.
UK: Wilmex Ltd, Compton House 35 High Street, New Maiden, Surrey KT3 4DE. Phone: 01-949 2545. Telex: 8814591.

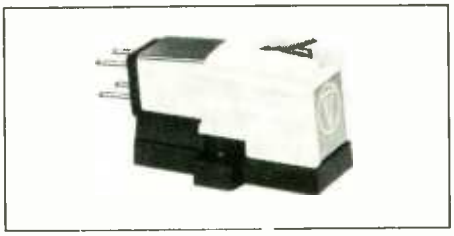
DSD Optimizer: phono pick-up cartridge load optimiser which allows the addition of extra capacitance to meet the correct loading required by many preamps, and also resistive loading.

EMT (West Germany)

EMT-Franz GmbH, Postfach 1520, D-7630 Lahr. Phone: 07825 212. Telex: 754319.
UK: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ. Phone: 01-953 0091. Telex: 27502.
USA: Gotham Audio Group, 741 Washington Street, New York, NY10014. Phone: (212) 741-7411. Telex: 129269.

EMT 928 series: turntable system with built-in preamplifiers with aux platter for fast start under electromagnetic control; 33⅓, 45 and 78RPM.
EMT 930: turntable system with choice of separate preamps, quick start; 33⅓, 45 and 78RPM.
EMT 948: turntable system with direct drive and fast start, stop, backcue and remote control; motor driven tonearm lift; built in amps with line outputs and cue monitor; 33⅓, 45 and 78 RPM.
EMT 950: turntable system with direct drive, console or chassis mounting, preamps, monitor loudspeaker and fast start; 33⅓, 45 and 78RPM.
EMT 929: statically and dynamically balanced tone arm with extremely low frictional losses, typically 0.5Nm or 50mg at stylus tip, stylus force adjustable from 0 to 5g.
OFS15/OFD15/OFS25/OFD25/OFS65/OFD65: mono cartridges for use with EMT *155* preamp.
TSD15/TMD25/TMD65: stereo *T series* cartridges with magnifying lens for use with EMT *155* or *153* preamps.

Audio Technica ATP Series



ENERTEC (France)

Enertec, 296 Avenue Napoleon Bonaparte, F-92505 Rueil-Malmaison. Phone: (1) 977.92.23. Telex: 203404.
UK: Clive Green & Co Ltd, Britannia House, Leagrave Road, Luton LU3 1RJ. Phone: 0582 411513. Telex: 826138.

TD212/2, TD222/2: turntable system with built-in preamplifiers and monitoring system; available freestanding, or chassis console; 33⅓, 45 and 78RPM.

FM ACOUSTICS (Switzerland)

FM Acoustics Ltd, Tiefenhofstrasse 17, CH-8820 Wädenswil. Phone: (01) 780.64.44. Telex: 56058.
UK: FM Acoustics (UK) Ltd, 2 Kempston Road, Weymouth, Dorset DT4 8XT. Phone: 0305 784049.

FM 212A: stereo moving coil cartridge preamp with two sets of inputs; front panel switchable input impedance; power supply available for 100 to 120V or 200 to 240V.
FM 240: reference preamp with comprehensive cartridge input facilities.

HARRIS (USA)

Harris Corp, Broadcast Products Division, PO Box 4290, Quincy, Illinois 62301. Phone: (217) 222-8200.
UK: Dynamic Technology Ltd, Zonal House, Alliance Road, London W3 0BA. Phone: 01-993 2401. Telex: 935650.

CB1201: turntable with synchronous motor and idler-wheel drive; 33⅓, 45 and 78RPM.

KEITH MONKS (UK)

Keith Monks (Audio) Ltd, 26-28 Reading Road South, Fleet, Hants GU13 9QL. Phone: 02514 20568. Telex: 858606.
USA: Keith Monks (USA) Inc 652 Glenbrook Road, Stamford, Connecticut 06906. Phone: (203) 348-4969.

POL: producers turntable unit with Technics *SL82* turntable, stereo preamp and 10W output amps.
M9BA Mk3 Improved: laboratory tone arm, low mass, damped, unipivot, with contact system using mercury wells, magnetic bias (skating) compensation, accurate balance.

MCI (USA)

MCI Inc, 1400W Commercial Blvd, Fort Lauderdale, Florida 33309. Phone: (305) 491-0825. Telex: 514362.
UK: MCI (Professional Studio Equipment) Ltd, 54-56 Stanhope Street, London NW1 3EX. Phone: 01-388 7867. Telex 261116.

Broadcast turntable system comprising Technics *SP10 MkII* turntable platter, Ortofon arm and RIAA preamp built specially by Audio & Design. Available in horizontal 19in rack-mounting format, or built into a standard MCI console.

McCURDY (Canada)

McCurdy Radio Industries Ltd, 108 Carnforth Road, Toronto, Ontario M4A 2L4. Phone: (416) 751-6262. Telex: 963533.
UK: Seltech Equipment Ltd, Rose Ind Estate, Cores End Road, Bourne End, Bucks SL8 5AT. Phone: 06285 29131.
USA: McCurdy Radio Industries Inc, 1051 Clinton Street, Buffalo, NY 14206. Phone: (716) 854-6700. Telex: 4923219.

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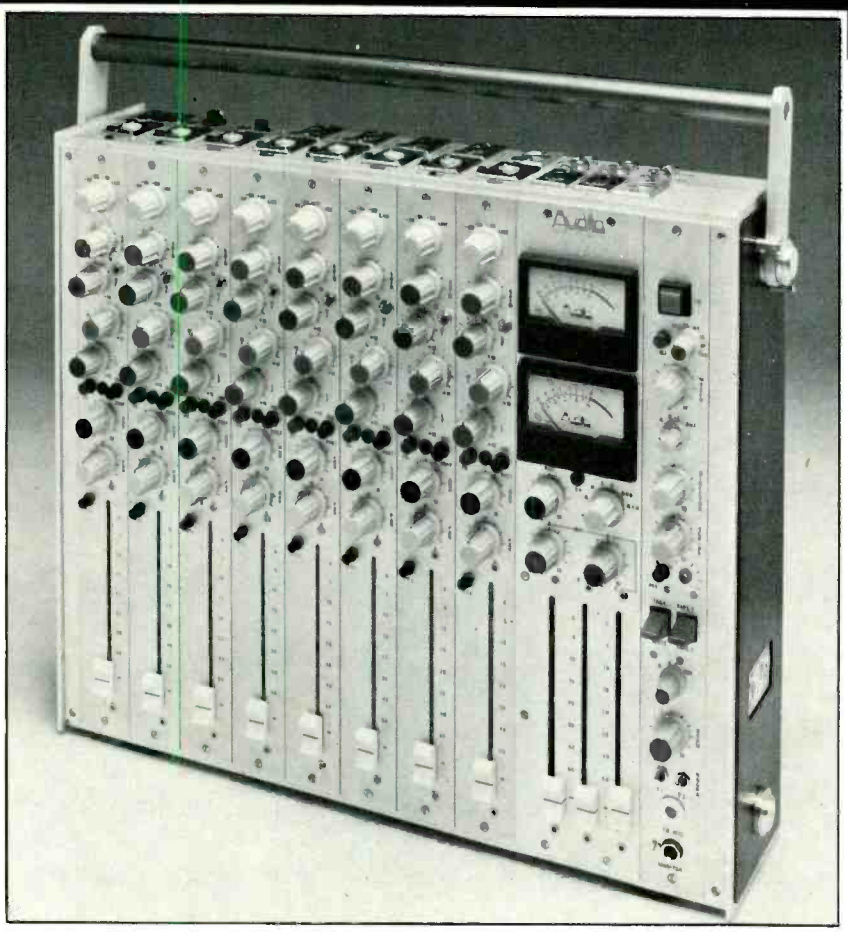

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product Record reproduction equipment guide

SS3159: console mounted unit comprising a Technics *SP10D* direct-drive turntable platter Micro-Trak *303* tone arm Stanton *500L* or Shure *M44C* cartridge; local or remote operation and optional cue amplifier.
AT235: magnetic cartridge phono preamp for broadcast applications; matched to all popular magnetic cartridges; gain adjustable by varying feedback resistor on edge connector.
SA236: phono preamp package in mono or stereo using *AT235.*

MECHANIKAI LABORATORIUM (Hungary)

Export: Elektroimpex, 1392 Budapst, PO Box 296.

SL-101: turntable system with preamps, direct drive, monitoring, console or chassis mounting; 33⅓, 45 and 78RPM.

MICRO ACOUSTICS (USA)

Micro Acoustics Corp, 8 Westchester Plaza, Elmsford, NY 10523, USA. Phone: (914) 592-7627.
UK: Webland International Ltd, 129 Walham Green Court, Moore Park Road, London SW6 2DG. Phone: 01-385 9478. Telex: 25570.

2002e: professional cartridge.
530MP: professional cartridge.

MICRO-TRAK (USA)

Micro-Trak Corporation, 620 Race Street, Holyoke, Massachusetts 01040. Phone: (413) 536-3551. Telex: 955497.
UK: Lee Engineering Ltd, Napier House, Bridge Street, Walton-on-Thames, Surrey KT12 1AP. Phone: 09322 43124. Telex: 929475.

Model 720: turntable; 33⅓, 45 and 78RPM.
Model 740: turntable as *720* but heavier platter; 33⅓ and 45RPM.
Gray Micro-Trak 303/306: professional tone arms which feature horizontal viscous damping providing a retardant force to fast motion whilst allowing slow motion such as tracking without any hindrance.
Model 206: viscous damped transcription arm similar to the *303* but with greater mass.
Model 6405: stereo preamp which can be mounted inside turntable cabinet or on front panel.
6400 series: self powered, RIAA/NAB equalised disc preamps.

ORTOFON (Denmark)

Ortofon Manufacturing A/S, 11B Mosedalvej, DK-2500 Copenhagen-Valby. Phone: 01-46.24.22. Telex: 27587.
UK: Harman (Audio) UK Ltd, Mill Street, Slough, Berks SL2 5DD. Phone: 0753 76911.

M20FL Super/M20E Super: cartridges using variable magnetic shunt principle.
F15E MkII/FF15E MkII/VMS20E MkII: cartridges using variable magnetic shunt principle.
MC20/MC30: moving coil cartridge, stylus must be returned to factory for exchange.
CAP 210: cartridge capacitor which fits over the terminal pins of the cartridge and adds 210pF to the load capacity.
FF15X MkII/FF15XE MkII: cartridges using variable magnetic shunt principle.
Ortofon/SME 30H: integrated arm and cartridge (see also SME).

PICKERING (USA)

Pickering & Co Inc, Sunnyside Blvd, Plainview NY 11803. Phone: (516) 681-0200.
UK: Sound Source, Station Approach, Rickmansworth, Herts. Phone: 09237 75242.

XSV/3000: high quality cartridge with stereohedron stylus, and cleaning brush attached.
XV-15 series: range of cartridges with cleaning brush attached.
XUV/4500-Q: wide bandwidth cartridge for stereo and discrete quad discs such as *CD4*, with brush.

QRK (USA)

QRK Electronic Products Inc, 1568 North Vista, Fresno, Cal 93703. Phone: (209) 251-4213.
UK: Lee Engineering Ltd, Napier House, Bridge Street, Walton-on-Thames, Surrey KT12 1AP. Phone: 09322 43124. Telex: 928475.

Galaxy: professional turntable with DC servo controlled motor; ±10% speed control provision for cue slipping without loss of speed, plus backcueing with no motor drag; remote switching; 33⅓ and 45RPM.
12C: rugged turntable with tone arm; 33⅓, 45 and 78 RPM.
Custom 2: similar to *12C* but only 33⅓ and 45RPM.
S-260/S-320 Tone Arm: professional tone arm, gimbal assembly incorporating individual double sets of 5 ball, 1mm bearings, silicon damped, spring tension dialable balance control.

REVOX (Switzerland)

Willi Studer GmbH, CH-8105 Regensdorf, Althardstrasse 150. Phone: (01) 840 2960. Telex: 58489.
UK: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ. Phone: 01-953 0091. Telex: 27502.
USA: Studer Revox America Inc, 1819 Broadway, Nashville, Tennessee 37203. Phone: (615) 329-9576. Telex: 554453.

B790: direct drive electronic turntable with ultra short tangential tone arm with servo electronic tone arm follow-up; supplied with Ortofon *VMS20E MkII* or *M20E Super;* 33⅓ and 45 RPM.
B795: direct drive electronic turntable with ultra short tangential tone arm with servo electronic tone arm follow-up; supplied with Revox *P20MDR* cartridge; 33⅓ and 45RPM.

SHURE (USA)

Shure Brothers Inc, 222 Hartrey Avenue, Evanston Illinois 60204. Phone: (312) 866-2200. Telex: 724381.
UK: Shure Electronics Ltd, Eccleston Road, Maidstone, Kent ME15 6AU. Phone: 0622 59881. Telex: 96121.

Shure SC39ED

M232/236: professional tone arms, simple and rugged with full range of adjustments. *M232* is for 12in turntables, *M236* for 16in.
SC35C: rugged cartridge for broadcast and disco, withstands repeated backcueing.
SC39: series of cartridges suitable for broadcast use.
V15 Type IV: high performance cartridge with damper with carbon fibre brush.
M64 series: self powered stereo disc preamps with RIAA/NAB EQ.

SME (UK)

SME Ltd, Steyning, Sussex BN4 3GY. Phone: 0903 814321.
USA: Shure Brothers Inc, 222 Hartrey Avenue, Evanston, Illinois 60204. Phone: (312) 866-2200. Telex: 724381.

Series II Improved: precision tone arm with low friction pivots, low inertia, lever operated hydraulically, damped lifting control
Series III: precision tone arm which uses high precision moulded components with added metal inserts where weight is required, nitrogen hardened titanium tube, carrying arm removable for multi-cartridge use.
Series IIIS: simplified version of the *Series III.*
ORTOFON/SME 30H: low mass integrated cartridge and carrying arm. The cartridge is manufactured by Ortofon and the arm is designed to operate with *Series III* and *IIIS* units.

SONETEC (France)

Sonetec, 21 Avenue du Fort, F-92120 Moutrouge. Phone: 654.07.07. Telex: 203347.

DR1000: turntable system usng Technics *SP10 MkII* with *EPA-100* tone arm, Shure *M75* cartridge and RIAA preamp.

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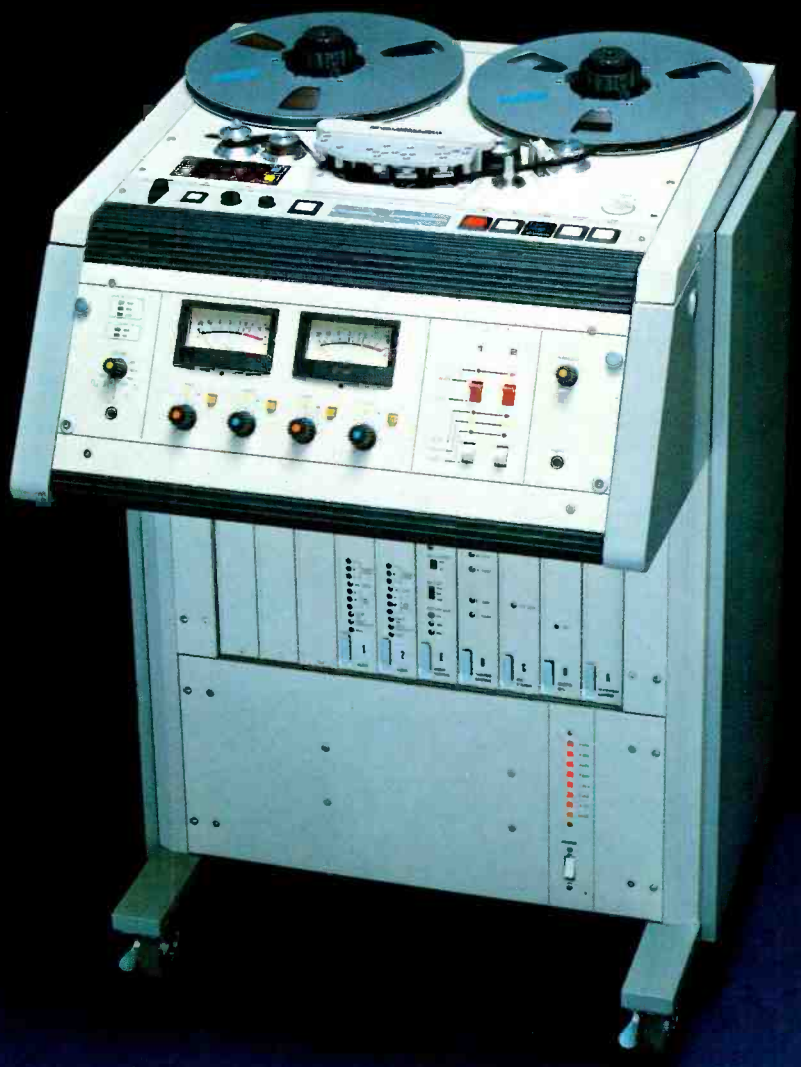


OTARI MTR-10

Bridging the gap between the new technology and old reliability, it's the logical extension of the innovative technology built into our multichannel MTR-90. The new MTR-10 gives the professional unprecedented control:

- Measurable and audibly discernible performance improvements. More than chips and buzz words, a balanced engineering approach: adjustable phase compensation with internal square/sine wave generator; electronically balanced I/O with direct coupled outputs.
- Full servo, D.C.PLL transport governed by an on-board microprocessor — an industry first.
- Unmatched production features — exclusive multiple edit modes, reverse play, standard alignment level presets, and dual-mode varispeed. Other features include controlled wind, preset master bias switching, three speeds and IEC, AES and NAB selectable. Also it includes return-to-zero and offers an optional tape locator with ten position memory and tape shuttle.
- Comprehensive servicing and support. Fully modular power supply, audio and transport electronics card frame. A highly dedicated distributor service network with factory trained and supported technicians.
- Available in full-track 1/4", 2-track 1/4" and 4-track 1/2". Comes with optional DIN-head and overbridge versions.

OTARI

Otari Electric Co., Ltd.
4-29-18 Minami-Ogikubo, Suginami-ku Tokyo 167
Phone: (03) 333-9631. Telex: J26604

product Record reproduction equipment guide

SONUS (USA)
Sonic Research Inc, 27 Sugar Hollow Road, Danbury, Connecticut 06810. Phone: (203) 792-8822.
UK: Mossrail Ltd, 27 Fleet Street, Holbeach, Lincs PE12 7AD.

Dimension 5: cartridge for use with high precision tone arms.
Gold series II: cartridge for use with high precision tone arms.
Silver series II: cartridge for use with medium or low mass tone arms.
Bronze series II: cartridge for use with medium or low mass tone arms.
Black series II: cartridge for manual or semi-automatic turntables.

SPOTMASTER (USA)
Broadcast Electronics Inc, 4100 North 24th Street, Quincy, Illinois 62301. Phone: (217) 224-9600. Telex: 250142.
UK: Lee Engineering Ltd, Napier House, Bridge Street, Walton-on-Thames, Surrey KT12 1AP. Phone: 09322 43124. Telex: 928475.

Cue-master: turntable accepting 10in tone arms; 33⅓, 45 and 78RPM.
Studio pro: turntable accepting 10in tone arms; 33⅓ and 45RPM.

STANTON (USA)
Stanton Magnetics Inc, Terminal Drive, Plainview, NY 11803. Phone: (516) 681-0415. Telex: 510-221 1845.
UK: Wilmex Ltd, Compton House, 35 High Street, New Malden, Surrey KT3 4DE. Phone: 01-949 2545. Telex: 8814591.

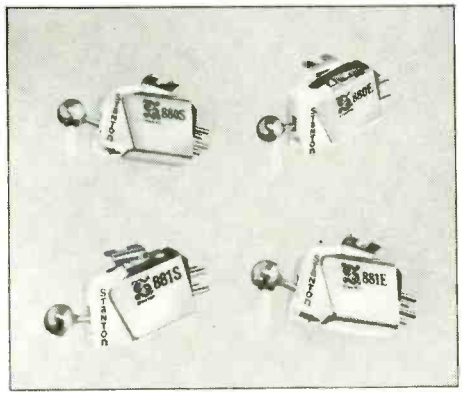
500 Broadcast Series: cartridges for broadcast use.
680 series: budget reference cartridges for broadcast use.
681 series: calibration cartridge series.
881S: high quality calibration cartridge series.
Model 310: self powered stereo preamp with selectable flat or NAB postemphasis curves, switchable rumble filter, individual adjustment of gain, and cartridge capacitance loading trimming.

SURREY (UK)
Surrey Electronics Ltd, The Forge, Lucks Green, Cranleigh, Surrey GU6 7BG. Phone: 04866 5997.

Stereo disc amplifier 2/3: suitable for broadcast and disc monitoring and transfer usage: features include a switchable 18dB/octave scratch filter, *2* balanced outputs. *3* unbalanced.

TECHNICS (Japan)
Matsushista Electric Trading Co Ltd, PO Box 51, Osaka Central 530-91, 1006 Oaza Kadoma, Osaka 571. Phone: 06 908-1121. Telex: 63426.
UK: Technics, National Panasonic (UK) Ltd, 300-318 Bath Road, Slough, Berks SL1 6JB. Phone: 0753 34522. Telex: 847652.
USA: Technics by Panasonic, One Panasonic Way, Secaucus, New Jersey 07094. Phone: (201) 348-7000.

Stanton 880 and 881 Series



SP-10 MkII: direct drive turntable; 33⅓, 45 and 78RPM.
EPA-100: variable dynamic damping universal tone arm, titanium nitride arm pipe on gimbal suspension.
SP-1000 MkIII: unit comprising *SP-10 MkII*, and *EPA-100* arm mounted in *SH-10B3* obsidian turntable base weighing 26.4lb to prevent acoustic feedback.
SP-15: direct drive turntable; 33⅓, 45 and 78RPM.
EPA-500: tone arm system with interchangeable arms for perfect matching with different cartridges.

THORENS (Switzerland)
Thorens Franz AG, Hardstrasse 41, CH-5430 Wettingen. Phone: 056 262861. Telex: 53681.
UK: Cambrasound Ltd, Freedex House, 4-10 North Road, Islington, London N7 9HN. Phone: 01-607 8141.

TD126 MkIII: semi-professional transcription turntable; 33⅓, 45 and 78RPM.
TD 160: belt driven turntable driven by a 16-pole 2-phase synchronous motor with slip clutch for rapid start; 33⅓ and 45RPM.
TP16 MkIII: isotrack tone arm.
TMC 63: moving coil cartridge.

TRIO/KENWOOD (Japan)
Trio Electronics Inc, 6-5, 1-Chome, Shibuya, Shibuya-Ku, Tokyo.
UK: Harman (Audio) UK Ltd, Mill Street, Slough Berks SL2 5DD. Phone: 0753 76911.
USA: Kenwood Electronics Inc 11315 E Watsoncenter Road, Carson, Cal 90745. Phone: (213) 518-1700.

L-07D: direct drive turntable with integral tone arm; 33⅓ and 45RPM. ■

product Audio tapes guide

This product guide only contains audio tapes suitable for professional analogue or digital mastering purposes. Audio tapes for cassette duplication, audio cartridges, and hi-fi applications are excluded.

AGFA-GEVAERT (West Germany)
Agfa-Gevaert AG, D-509 Leverkusen.
UK: Agfa-Gevaert Ltd, 27 Great West Road, Brentford, Middx TW8 9AX. Phone: 01-560 2131. Telex: 28154.
USA: Agfa-Gevaert Inc, 275 North Street, Teterboro, New Jersey 07608. Phone: (201) 288-4100. Telex: 0134410.

Range of professional mastering tapes: *PEM 468* available in ¼in, ½in, 1in and 2in widths; new *PEM428* extended play version of *PEM 468* available in ¼in, 1in and 2in widths; and *PEM 369* extended play tape only available in a ¼in width.

AMPEX (USA)
Ampex Corp, 401 Broadway, Redwood City, Cal 94063. Phone: (415) 367-2011. Telex: 348464.
UK: Ampex Great Britain Ltd, Acre Road, Reading RG2 0QR. Phone: 0734 85200. Telex: 848346.

Range of professional mastering tapes: *406* available in ¼in, ½in, 1in and 2in widths; *407* long play available in same widths; *456* also available in ¼in, ½in, 1in and 2in widths, plus 2in available on 14in NAB spool. New *466* tape for digital tape machines available in ¼in, ½in and 1in widths.

BASF (West Germany)
BASF AG, Carl Bosch Strasse 38, D-6700 Ludwigshafen/Rhein. Phone: 0621 601. Telex: 464811.
UK: BASF UK Ltd, Haddon House, 2-4 Fitzroy Street, London W1P 5AD. Phone: 01-388 4200. Telex: 28649.
USA: BASF Systems Inc, Crosby Drive, Bedford, Mass 01730. Phone: (617) 271-4000.

SPR 50LH: available in ¼in, ½in, 1in and 2in widths, plus 2in available on 14in NAB spool.

3M (USA)
3M Magnetic Products Division, 3M Centre, St. Paul, Minnesota 55101. Phone: (612) 736-9567. Telex: 297434.
UK: 3M UK Ltd, PO Box 1, Bracknell, Berks RG12 1JU. Phone: 0344 26726. Telex: 849371.

Scotch: range of professional mastering tapes. *206* standard play tape available in ¼in, ½in, 1in and 2in widths; *207* long play version of the *206* available in the same widths; *250* offers improved dynamic range (4dB) and is available in the same widths as above; *256* similar to *250* but offering improved print through performance, also available in ¼in, ½in, 1in and 2in widths. *Scotch 262* is a ¼in mastering tape. 3M also produce *Scotch 265* digital tape for digital mastering available in ½in and 1in widths on 12½in reels. *Scotch 226: see New Products.*

Agfa-Gevaert PEM range

MAXELL (Japan)
UK: Maxell UK Ltd, 1 Tyburn Lane, Harrow, Middx HA1 3AS. Phone: 01-243 0688.
USA: Maxell Corp of America, 60 Oxford Drive, Moonachie, New Jersey 07074. Phone: (201) 440-8020.

UD35, UDXL35: professional mastering tapes available in ¼in widths.

PYRAL (France)
Pyral SA, 47 rue de L'Echat, F-94001 Creteil. Phone: (1) 207.48.90. Telex: 23742.
UK: Pyral Magnetics Ltd, Courtlands Road, Eastbourne, Sussex. Phone: 0323 638965.

CJ 90: professional mastering tape available in ¼in, 1in and 2in widths.

RACAL-ZONAL (UK)
UK: Stanley Productions, 147 Wardour Street, London W1. Phone: 01-439 0311. Telex: 269836.

675: high output, low noise, low print through ¼in tape to BBC specifications.

SONY (Japan)
UK: Sony UK Ltd, Pyrene House, Sunbury-on-Thames, Middx TW16 7AT. Phone: 09327 89591/ 876441. Telex: 266371.
USA: Sony Corporation of America, 9 W 57th Street, New York, NY 10019. Phone: (212) 371-5800. Telex: 424595.

Sony produce two ¼in tape types suitable for mastering purposes—a ferrichrome type designated *FeCr*, and a low noise tape *ULH*.

TDK (Japan)
UK: TDK Tape Distributors (UK) Ltd, Pembroke House, Wellesley Road, Croydon CR0 9XW. Phone: 01-688 7372. Telex: 946727.
USA: TDK Electronics, 755 Eastgate Boulevard, Garden City, NY 11576. Phone: (516) 627-0238.

LX35B and *GX35B* long play ¼in tapes. TDK also produce standard play versions of the above designated *LX50B* and *GX50B*. ■

Nothing reproduces better than a Sony microphone.

If the microphone you're using gives anything less than completely faithful reproduction from studio to control room it certainly isn't a Sony. The C48 simply can't be bettered in that respect. Its performance is so outstanding, it won't leave so much as a whisper behind in the studio.

And the same level of sound quality applies throughout Sony's range of professional microphones.

The C35P and C36P uni-directional condenser types perform beautifully on stage and are particularly suitable for multiple-microphone recording.

In theatre and outside broadcast situations Sony C74 and C76 shot gun type microphones will accurately pick up frontal sound, with excellent indirect and ambient noise rejection.

Newer additions to the Sony microphone range include the ECM 969 and 989 single point stereo mikes with the option of remote control of directional axes, and the F560 and 660 uni-directional dynamic types, particularly suited to vocal performances.

In fact from the tiny ECM 50 PS tieclip mike to the F115 omni-directional dynamic microphone which will stand up to the harshest climatic conditions without any loss of sound quality, there's a Sony Microphone to suit just about any professional requirement.

Because after 30 years in the business there aren't many situations Sony haven't been called on to cope with.

If you'd like to hear more, contact Keith Smith at Sony (UK) Ltd, Pyrene House, Sunbury Cross, Sunbury on Thames, Middlesex or telephone Sunbury 81211. **SONY**

PROFESSIONAL AUDIO

The Speed-King Model 790 cassette loader, designed so one attendant operating three machines can produce up to 9000 high-quality, C-60 cassettes in seven hours...

That's fast!

(and that's standard)

The Speed-King Model 790 is the most accurate, reliable cassette loader in the world today. It is easy to operate, with all operating controls being located in a single front panel. It is easy to keep in service, because the 790 has a computerized quality control system with a digital panel that identifies problems if they occur . . . And usually the operator can solve the problem.

Even the stacker/stamper is unique: it offers you two choices for labeling and packaging. You can have the loaded cassettes stacked one side up, or alternately.

Other King innovations range from the automatic self cleaning vacuum system — to a DC Servo motor braking system that requires no adjusting — plus the most reliable cue detection system for maximum yield of prerecorded cassettes — and a vacuum counter wheel that counts each second allowing accuracy on blank lengths to ± two seconds (4 inches).

But what's really innovative about the new Speed-King 790 is its price when measured in low cost per cassette, and savings in labor and floor space.

For further information on the Speed-King 790 cassette loader call or write:

King Instrument Corporation
80 Turnpike Road • Westboro, MA 01581 • USA
Phone: (617) 366-9141
Cable: KINGINST/Telex 94-8485

KING

World Leader in Tape Tailoring Systems®

product Test tapes & discs guide

AGFA (West Germany)
Agfa-Gevaert AG, D-509 Leverkusen.
UK: Agfa-Gevaert Ltd, 27 Great West Road, Brentford, Middx TW8 9AX. Phone: 01-560 2131. Telex: 28154.
USA: Agfa-Gevaert Inc, 275 North Street, Teterboro, New Jersey 07608. Phone: (201) 288-4100. Telex: 0134410.

Range of recording test tapes in a variety of widths and speeds to the DIN/IEC format only.

AMPEX (USA)
Ampex Corp, 401 Broadway, Redwood City, Cal 94063. Phone: (415) 367-2011. Telex: 348464.
UK: Ampex Great Britain Ltd, Acre Road, Reading RG2 0QR. Phone: 0734 85200. Telex: 848346.

Test tapes in all size formats between ¼ and 2in in full and separate tracking; 30, 15, 7½ and 3¾in/s; EQ to DIN or IEC (30in/s uses AES); reproduce alignment, flutter test and level set tapes available.

AMPRO/SCULLY (USA)
Ampro/Scully, Newton Yardley Road, Newton, Pennsylvania 18940. Phone: (215) 968-9000.
UK: Lee Engineering Ltd, Napier House, Bridge Street, Walton-on-Thames, Surrey KT12 1AP. Phone: 09322 43124. Telex: 928475.

Test Cartridges: NAB cartridge test tapes, *9243-1* speed, *9242* torque, *9240* azimuth and response; also head cleaner cartridge.

BASF (West Germany)
BASF AG, Carl Bosch Strasse 38, D-6700 Ludwigshafen/Rhein. Phone: 0621 601. Telex: 464811.
UK: BASF UK Ltd, Haddon House, 2-4 Fitzroy Street, London W1P 5AD. Phone: 01-388 4200. Telex: 28649.
USA: BASF Systems Inc, Crosly Drive, Bedford, Mass 01730. Phone: (617) 271-4000.

Test tapes in all size formats to IEC/DIN specification only.

B & K (Denmark)
Bruel & Kjaer, DK-2850 Naerum. Phone: 02 80.05.00. Telex: 37316.
UK: Bruel & Kjaer (UK) Ltd, Cross Lances Road, Hounslow, Middx TW3 2AE. Phone: 01-570 7774. Telex: 934150.
USA: Bruel & Kjaer Instruments Inc, 185 Forest Street, Marlborough, Mass 01752. Phone: (617) 481-7000.

QR2009: stereophonic gliding frequency records, 12in 45RPM; frequency sweeps from 20Hz to 20kHz, with 16 bands divided into groups of four.
QR2010: stereo test records, 12in 33⅓RPM; 15 different bands with signals for measurement of frequency response, tracking, wow and flutter, polarity, crosstalk, rumble and arm resonances.
QR2011: pink noise test record, 12in 33⅓RPM, for listening room investigations; programme consists of ⅓-octave filtered pink noise.

CAMFORD (UK)
Camford Productions, 4 Cambridge Drive, Eastcote, Ruislip, Middx HA4 9JS. Phone: 01-866 3790.

IEC format ¼in test tapes; full track 7½ or 15in/s. Tests include wow and flutter; speed; reference level; azimuth alignment; and frequency response.

CBS (USA)
CBS Technology Center, 227 High Ridge Road, Stamford, Conn 06905. Phone: (203) 327-2000.
UK: Feldon Audio Ltd, 126 Great Portland Street, London W1N 5PH. Phone: 01-580 4314. Telex: 28668.

STR 151: broadcast test record to RIAA standard.
STR 100: stereo frequency test record.
STR 101: lining up record for domestic equipment.
STR 112: squarewave, tracking and intermodulation test record.
STR 120: extended frequency test record; 10 to 500Hz, 500Hz to 50kHz glide tones.
STR 130: RIAA frequency response test record for calibration of professional replay equipment.
STR 140: pink noise tests for acoustical testing of systems and loudspeakers and for psychoacoustic tests of reproduction equipment.
STR 170: record employing 3180μs EQ characteristic with constant amplitude recording below 500Hz and constant velocity above this point.
SQT 1100: quadraphonic test record for calibration, verification and adjustment of SQ replay systems.

DGG (West Germany)
Beuth-Vertrieb GmbH, Burgenstrasse 7, D-1000 Berlin 30.
UK: Lennard Developments Ltd, 206 Chase Side, Enfield, Middx EN2 0QX. Phone: 01-363 8238.

Family of test discs to calibrate replay equipment to the following DIN standards: *45541* frequency response; *45542* distortion; *45543* crosstalk; *45544* rumble; *45545* wow and flutter.

EMI (UK)
EMI Records Ltd, Manchester Square, London W1. Phone: 01-486 4488.

TCS 101: stereo frequency response disc with recorded characteristic to BS 1928/1960, but with level of frequency bands above 10kHz dropped by 6dB; spot frequencies and reference tones.
TCS 102: series of glide tones for detecting resonances.
TCS 104: as *TCS 101* but mono only (lateral modulation).
TCS 105: as *TCS 104* but with vertical modulation.

FERROGRAPH (UK)
UK: Audio Video Marketing, Unit 21, Royal Industrial Estate, Jarrow, Tyne & Wear NE32 9XX. Phone: 0632 893092. Telex: 537227.
USA: Neal-Ferrograph (USA) Inc, 652 Glenbrook Road, Stamford, Conn 06906. Phone: (203) 348-1045. Telex: 643678.

Series of ¼in test tapes including 0VU DIN + 70μs, ¼-track alignment; NAB, DIN, IEC and CCIR EQ.

FIDELIPAC (USA)
Fidelipac Corp, 109 Gaither Drive, Mt Laurel, New Jersey 08057. Phone: (609) 235-3511. Telex: 710-897 0245.
UK: Mr H. E. Lovell, 127 Pullman Court, London SW2 4SU. Phone: 01-671 8391.

NAB Test Cartridges: mono alignment spot frequency calibration tape levels 0 and −10dB, frequencies 50Hz to 16kHz; wow and flutter tape 3.15kHz, fast sweep frequency mono calibration tape frequency range 500Hz to 16kHz with 100ms sweep, also similar but stereo; cue/logging calibration tape with threshold, logging tone, standard level and duration and bandwidth selectivity tests; guide height gauge and right angle zenith gauge; head insertion gauge.

JVC (USA)
JVC Cutting Center Inc, RCA Building, Suite 500, 6363 Sunset Blvd, Hollywood, Cal 90028. Phone: (213) 467-1166.
UK: JVC UK Ltd, Eldonwall Trading Estate, Staples Corner, 6-8 Priestley Way, London NW2 7AF. Phone: 01-450 2621. Telex: 023320.

TRS 1001: mono disc for checking frequency response, mechanical resonances, etc.
TRS 1002: stereo disc for checking frequency response, wow and flutter, etc.
TRS 1003: stereo frequency response record for testing response of *CD-4* pickup cartridges.
TRS 1004: record for quick checks of HF response, crosstalk, and phase of *CD-4* cartridges; primarily intended for checks during production.
TRS 1005: record for HF response and crosstalk checks on *CD-4* cartridges using level recorders.
TRS 1007 MkII: stereo disc for checking frequency response, separation and crosstalk; EQ to IEC A-weighted and RIAA curves.

LENNARD (UK)
Lennard Developments Ltd, 205 Chase Side, Enfield, Middx EN2 0QX. Phone: 01-363 8238.

Manufacture and distribution of test tapes and discs.

MRL (USA)
Magnetic Reference Library Inc, 229 Polaris Avenue, Suite 4, Mountain View, Cal 94043. Phone: (415) 985-8187.
UK: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ. Phone: 01-953 0091. Telex: 27502.

Wide range of test tapes, each with calibration graph; most available in ¼in, ½in, 1in and 2in and at 7½, 15 and 30in/s speeds (with three tapes at 3¾in/s); NAB, IEC and AES EQ. Range of rapid sweep tapes which sweep from 500Hz to 20kHz for display on an oscilloscope using a special graticle. ¼in only azimuth adjustment tape using the difference method—multispeed use.

SHURE (USA)
Shure Brothers Inc, 222 Hartrey Avenue, Evanston, Illinois 60204. Phone: (312) 866-2200. Telex: 724381.
UK: Shure Electronics Ltd, Eccleston Road, Maidstone ME15 6AU. Phone: 0622 59881. Telex: 961?1

TTR103: cartridge trackability test record requiring lab instrumentation.
TTR109: cartridge level, channel balance and separation test record requiring lab instrumentation
TTR110: audio obstacle course similarly formatted to the *TTR115*.
TTR15: audio obstacle course; tests cartridge and arm trackability, plus resonances, phasing, etc needs no instrumentation.

STL (USA)
Standard Tape Lab Inc, 26120 Eden Landing Road, No 5, Hayward, Cal 94545. Phone: (415) 786-3546.
UK: Precision Audio Marketing, Bimini House, Christchurch Road, Virginia Water, Surrey. Phone: 09904 4416.

Range of test tapes and cartridges, reproduce alignment contains azimuth tone, voice frequency run and level set tone, ¼in, 3¾, 7½ and 15in/s NAB or IEC, also 30in/s AES; mono or 2-track. NAB cartridges in compatible mono or stereo. Full track Compact cassette. Flutter and speed tapes, all full track in above formats.

WEBBER (UK)
Webber Tapes Ltd, Coburg House, Western Road, Wood Green, London N22. Phone: 01-889 9347.
UK: Scenic Sounds Equipment Ltd, 97-99 Dean Street, London S1V 5RA. Phone: 01-734 2812. Telex: 27939.

Range of tapes with format and tone durations NAB or IEC EQ available in ¼, ½, 1 and 2in widths, variously at 7½, 15 and 30in/s. ■

business

BARRY FOX

Sony PCM adaptor

News from the Consumer Electronics Show in Las Vegas. Sony was showing the new *PCM-F1* digital audio adaptor for video cassette recorders at the winter Show. This unit, which is intended for use with a Sony *Beta* recorder should by now be on sale in the US at around $1,900. As previously reported *(Studio Sound,* January 1982) the original Sony plan was to market the *PCM-F1* in 14-bit format, even though it contains 16-bit chips. But buried in the technical specification for the *PCM-F1* shown in Las Vegas is the welcome news that the unit will be switchable between 14-bit and 16-bit operation. So it is only a question of time now before recording studios can buy a 16-bit digital stereo recording system (the PCM unit and a matching video cassette recorder) for around £2,000. This is a portable system which will run off batteries or mains and is smaller and weighs less than most open-reel analogue stereo decks. And it offers video recording capability as a bonus. That's the good news. The bad news is that there isn't a single native UK manufacturer with a claim staked in the digital gold rush.

Bugging before Nixon

Recently I chanced on the story of an American history professor who has discovered that President Roosevelt bugged the White House 30 years before Nixon. Professor Robert Butow teaches history at the University of Washington in Seattle. In 1978 he was researching in the Franklin D. Roosevelt library in Hyde Park, New York State. This library holds a collection of documents relating to the President and his wife Eleanor. One night, after reading all day, Butow joked to the librarian that he was tired of reading and would like to hear the Roosevelt tapes. Since Watergate and the film, *The President's Analyst,* it's been a standing joke in America that everyone is permanently bugged. But the librarian took him seriously. "OK," he said. "I'll bring you a list of what's available."

It turns out that Roosevelt lost patience with his military aides in the summer of 1940. They kept leaking information to the press, who then quizzed and mis-quoted Roosevelt. Or so he thought. So the President asked his White House staff to try and rig a hidden recorder to provide positive proof of future mis-quotes.

What he wanted was something that would make long, uninterrupted recordings. This ruled out discs. Magnetic wire was still in its infancy and the only working tape recorders were in Nazi Germany. So the White House talked to RCA about the possibility of making a modified optical sound recorder. RCA Photophone engineers in Camden, New Jersey, built Roosevelt a one-off film recorder which could be loaded with half a dozen reels at the same time and go on recording for hours on end. This was hidden in the basement of the White House and connected to a microphone hidden in a lamp on the President's desk. He also had an on/off switch inside his desk drawer. For 11 weeks, between August and October 1940, Roosevelt switched on the recorder whenever the press or his military aides were coming in for a briefing. Sometimes he forgot to switch it off again after they'd left. In any event he couldn't switch off too early because it would have given away his secret. So hours of recordings piled up in the White House basement, on film.

When Roosevelt died in 1945 his successor, Harry S. Truman, was told about the secret recording system. He said he didn't want it and called in the RCA engineers to dismantle the system. But fortunately they used it to transfer at least some of the film recordings onto discs before scrapping the recorder. These discs were shipped to the FDR library and forgotten until the early 70's. The FDR library staff then transferred their Roosevelt disc recordings on to tape for safe keeping. But, even after Nixon had been caught bugging the White House with 8-track Scully's, Dolby noise reduction and studio mixing desks, the FDR library academics never thought to tell anyone about the Roosevelt tapes! It wasn't until Professor Butow stumbled on them by that chance remark in 1978 that anyone outside the library staff knew about them.

Butow kept his secret for three years because he wanted to break the story, fully researched, for the centenary of Roosevelt's birth, earlier this year. It took him three years to put the jigsaw together and work through the tapes. Because the original film recordings were of low fidelity, and their transfer through several generations of disc and tape had made them even worse, the voices on tape are almost unintelligible. But now that the story has broken, the tapes are being computer-enhanced, using correlation techniques, to reduce background noise.

Speaker phase-checker

Rank Wharfedale of Bradford has come up with an interesting idea. It's a hand-held phase-checker for loudspeakers. Who needs an electronic gadget to help them get their loudspeakers in phase, I can already hear someone say? All you need is a pair of ears and a mono signal. Yes, fair enough, *if* you have an ideal stereo pair situation. But what about public address loudspeaker stacks, four channel monitoring, or show demonstrations where a range of loudspeaker pairs have to be set up round a room? Anyone who has tried to wire up a domestic surround sound system will know the very real problems involved in getting the phase correct, not only at the front and rear, but at the sides as well, between the front and rear. It's also no fun at all trying to phase the speakers of a multi-way in-car stereo system.

It isn't safe to rely on colour coded leads because there's always the risk that someone has got the colour coding crossed at the other end, or even inside an amplifier or switching box. A year or so ago, at a London audio show, Harman UK were proudly demonstrating a pair of JBL monitors which produced a curious diffuse image. Are you sure they are in phase? I asked. Check the wires for yourself, I was told. The loudspeaker cable colour coding was correct but swopping positive and negative on one lead brought the image into focus, as if by magic.

The Wharfedale phaser is a hand-held meter which you point at the loudspeaker being checked while playing a pre-recorded test disc or tape of unipolar pulses. A microphone in the phase checker picks up the sound from the speaker bass unit and op amps separate the positive-going and negative-going pulses. The order in which these pulses are produced is detected by a pair of monostables and depending on which monostable is triggered first the other is inhibited. The monostables feed red and green indicator lamps, so the red lamp signals one phase state for the loudspeaker and the green lamp signals the opposite phase state. All you do, of course, is to connect every loudspeaker so that they all light the same colour lamp.

Rank have a patent application on the idea but haven't yet decided whether to market the phase checker. I've used the prototype and it seems to work well. I know of nothing else similar on the market, which is probably why so many domestic audio systems are wired with speakers out of phase and their owners none the wiser.

Up or down?

True story. Well known and seen-it-all-before balance engineer is working with well known classical producer who favours multitrack and just loves to hear those solo instruments leaping out of the orchestra like a jack-in-the-box. "Did you bring up the flutes at bar 89 like I asked?" he asks during the mix-down session. "I certainly did," assures the balance engineer. "Well I think I was wrong," admits the producer. "We should leave them where they are. Let's do it again." "No need," says the balance engineer. "I didn't bring them up anyway!"

Flying follies

More and more airlines are now putting stereo jack sockets in the arm rests. The cabin staff provide first class passengers with a pair of stereo headphones as an alternative to the usual and awful acoustic stethoscope headsets that produce the minimum quality with the maximum of discomfort. But it isn't always only the first class seats that have stereo jacks; on a recent Cathay Pacific flight to the Far East, I found them on seats throughout the plane. So if you travel a lot it's worth taking a pair of headphones. But headphones are awkward things to put in a pocket or briefcase. Koss have one answer with the *Sound partner,* a pair of collapsible headphones that fold small enough to fit in a pocket. They come complete with plug adaptors so that you can use them with a *Walkman,* which uses a mini stereo jack, or a domestic or aircraft system which uses a standard stereo jack. Cost is under £20 and they sound pretty good. Incidentally KLM uses Sony headphones; Cathay Pacific and Lufthansa have opted for Sennheiser.

While airline sounds get better, airline food gets worse. We used to get real milk with our coffee or tea. Then they started giving away packets of 'powder milk'. The airlines then got more honest and started labelling the same packets as 'creamer'. Now, presumably working on the principle that total honesty is the best policy, Lufthansa is supplying packets of 'coffee whitener'. This is described as being "predominantly of vegetable origin" which presumably means it's never seen the inside of a cow. If you are travelling by Lufthansa, pack a bottle of milk as well as your headphones. ■

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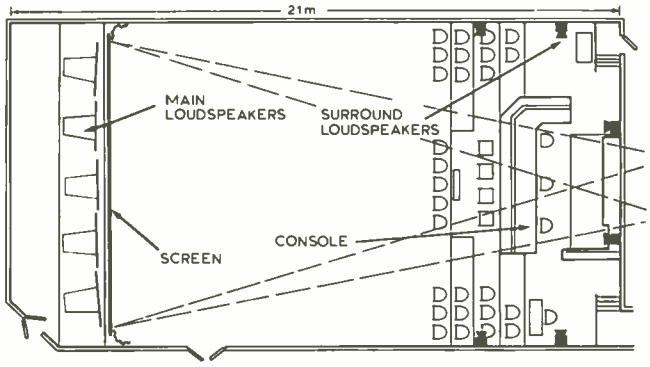

Fig 1: Theatre Two layout

Film post production console design - a case study

Sam Wise
Theatre Projects

The Theatre Projects film post-production project for Pinewood Studios began with a telephone call from Geoff Labram – head of technical services. He had been impressed by one of their console designs and wondered whether they were interested in a custom design project.

PINEWOOD is often looked upon as Britain's premier feature-film studio. Certainly it is the largest, with 12 sound stages and four silent stages (including the legendary *007* stage, nearly 400ft long). The buildings cover nearly half of the 90 acre site, and include workshops for every film making skill, especially for building, decorating and storing the amazing sets designed by art directors – from accurate, painstaking recreations of real places to exciting flights of sheer imagination. Almost every department is represented on the studio's payroll, and the crews who work there have earned high praise from international film producers.

In particular, the sound department, the biggest of its kind in the country, has many famous soundtracks to its credit, including *Fiddler on the Roof* (which brought an Academy Award), all the James Bond movies, *Superman I, Clash of the Titans* – and even an IMAX production for the giant 100ft screen. A staff of about 35 mixers, engineers and projectionists are continuing a tradition which extends back to 1936, when the studio opened, and have embraced every new technique as it appeared. Indeed the department has been responsible for much innovation over the years, and has also been in much demand for its experienced expertise in the field of multitrack stereophony. At the time of the *fateful* phone call, the principal soundtrack mixing theatre was in urgent need of a replacement for its famous-make console, whose impressive capabilities were being overwhelmed by the increasing complexity of modern high-fidelity stereo. The work was slowing down, and a larger, more flexible desk was becoming essential.

The Pinewood project

Theatre Projects have been designing and manufacturing audio control equipment for seven years. Over that period the company has produced consoles for every sort of sound reinforcement application, for theatre sound effects, radio broadcasting, and its own recording studio. In addition it has designed many other specialist items of electronic equipment, including all of the sound and communications equipment for the Barbican Theatre in London. Aside from being manufacturers it has also done contract design work for outside manufacturers. It was one of these designs which led Geoff Labram in their direction.

It became apparent that Pinewood felt the need for a custom console designed specifically for their film post-production requirements. They had approached several console manufacturers and had turned them down for all sorts of reasons. Some could supply consoles based on music recording requirements but were not willing to do major design work. One supplier had been found that would consider custom design, but its prices were astronomical. Post-production designs from some United States suppliers had been examined and rejected, largely on the grounds of cramped controls or excessive reach, although some of Pinewood's requirements differed from their norms. Theatre Projects were accustomed to meeting individual requirements in its designs however, so it accepted the challenge of producing a quotation.

Starting from basics

An initial look at the specification produced by Pinewood led to the conclusion that this would be the largest and most expensive single piece of equipment Theatre Projects had built to date. Although there were requirements in the specification which it had not encountered before, much of the work could be built on preceding experience. In earlier contracts solutions had been derived to the inherent problems of large console design, so there was really no reason why an even bigger one shouldn't be built for Pinewood.

As a part of the initial costing process, it was necessary not only to understand the letter of Pinewood's specifications, but also the purposes behind it. It was also important to the client's confidence that Theatre Projects as the manufacturer really understood the application and could give the right advice as the final design specs were hammered out.

Planning the console's electronic architecture was important to understanding the complexity of wiring required and other aspects which would affect the costs of both design and manufacture. This required a thorough understanding of the application in order to produce the correct design decisions.

A rough estimate of the cost involved was arrived at, based on previous experience and once it was clear that the budget price was within bounds for both parties and that Pinewood were really serious, work began to produce a firm quotation.

At this point the staff at Theatre Projects had no experience of the feature film dubbing environment, although they did have some film experience on a much smaller scale in their own studios. They have always taken pride in their ability to listen carefully, understand and question until they have a 'gut feel' for the application. So the next task was a visit to the studios to interview the dubbing mixers and ask apparently stupid questions about aspects of the specification. They also made a trip to Los Angeles for the AES show, cornered several US film sound people there, visited the Academy of Motion Picture Arts and Sciences, and attended every possible lecture on the subject. To them, custom design means customer-oriented design.

A feature film mix takes place in a projection theatre which is designed to resemble the best of public cinemas. Thus the dubbing mixers (as the mixing engineers are called), are able to listen to their material in the same sort of acoustic environment as the ticket buying customer. Standard cinema loudspeakers are used and the final signal chain duplicates that in a good quality cinema. **Fig 1** shows the layout of Pinewood's Theatre Two where the console has been installed.

The work of the feature film dubbing theatre is to sift and combine many parallel recordings which include wild tracks, post-sync dialogue, music tracks and extremely complex effects. All of these tracks must run together in perfect synchro-

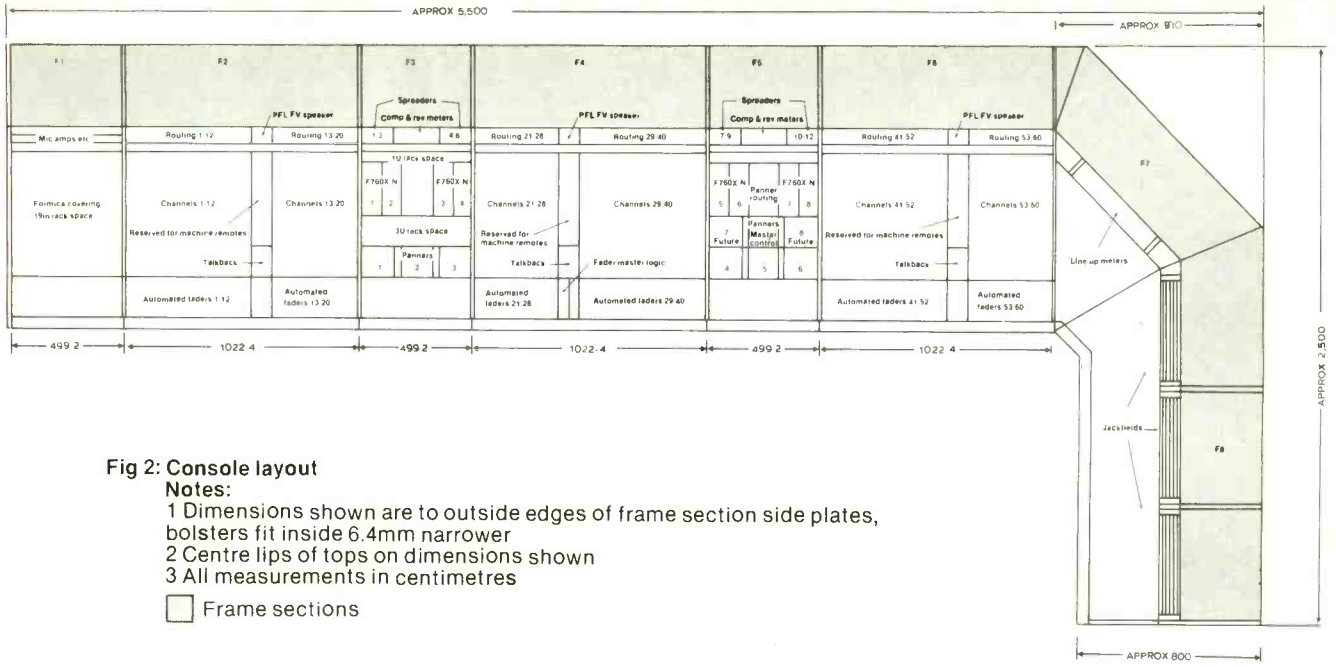

Fig 2: Console layout

Notes:

1 Dimensions shown are to outside edges of frame section side plates, bolsters fit inside 6.4mm narrower

2 Centre lips of tops on dimensions shown

3 All measurements in centimetres

☐ Frame sections

nism with each other and with the picture. Separate magnetic film recorders are often used in preference to multitracks. This allows the source recordings to be easily shifted in their time relationships with each other and with the picture in order to alter the impact of the mix. A master mix is made from these many sources which makes it relatively easy to derive the final soundtracks (release prints) in their various forms. It is usual for this master to contain three components – dialogue, effects and music – which are retained as separate tracks, giving greater flexibility at the mixdown stage. At the final mixdown stage the component mixes are put together into a final form appropriate to the chosen loudspeaker format.

The sheer volume of material to be handled makes a mixing crew of up to four people necessary. Each man has responsibility for a selection of the incoming source recordings, with one of them having the role of chief dubbing mixer. The chief is responsible for the artistic control of the overall balance. In American dubbing rooms, each person in the mixing crew normally concentrates on one component of the mix and the consoles are often set out with only one set of component busses accessible from each section. In the UK, however, things are operated on a more flexible basis and the work will be delegated around the console to suit the needs of the moment. This leads to the requirement for a free routing console where any operator's section can be routed to any of the three sets of component busses.

The creation of effects takes up a large proportion of the dubbing effort. This can consist of the piecing together of hundreds of small individual bits of sound to create a continuous auditory illusion which complements the picture. Often the sound effects will not sound like a recording of the real thing but will be more like what we expect to hear, or they are used to emphasise something in the action. They can be exaggerated sounds, or something which is not at all related to the visual image but which causes the desired emotional effect. This is also very true of the music tracks. Next time you watch a dramatic production at the cinema or on television, try to imagine it with a dialogue, but without the sound effects or music – this is how the film sounds when it arrives in the dubbing theatre.

You will notice that *sets* of component busses are mentioned above. The film dubbing environment is unique in that the final mix formats are not just mono, 2-channel stereo and quad as in the music recording industry. In the cinema there are formats which include mono; 2-, 3-, and 5-channel behind-the-screen stereo; and up to seven channels are used with surround speakers in the auditorium. There are formats which are virtually standard, but a major dubbing theatre like Pinewood is required to provide whatever the customer may want. Additionally, the formats are not as easily compatible in the cinema as on a recording, because the visual image provides the cinema listener with more clues about where things are than his hi-fi counterpart. Thus a change in the sound quality or location of an image caused by using different source and replay formats is far more obvious in the cinema.

Another aspect of the cinema dubbing environment which provides its own problems is the size of the visual image. Because the screen is large, a 2-speaker stereo source is not generally adequate, suffering from the well known 'hole in the middle' effect. Therefore it has been standard in the cinema industry to use three or even five loudspeakers behind the screen, each having its own audio source. You will notice this in **Fig 1.** This means that a 2-channel panpot as would normally be supplied in a music recording console is not adequate, so film dubbing consoles have 3-channel panpots giving left, centre, and right outputs from each input module.

A further aspect of panning in the cinema concerns the width of the image as heard by the audience. A little thought reveals that the visual image can be anything from a single cowboy far off in the distance, to an army which occupies the whole screen. Each of these visual images requires a different width of sound image in order to produce a realistic effect. Theatre Projects were required to provide not only a 3-channel panpot, but one with fully variable width as well. This provides a narrow spot sound image for a scene like the lone cowboy, or the sound can be adjusted to occupy the whole screen. The control as supplied to Pinewood also builds the overall sound power in the theatre as the width is increased providing the right effect for such things as a herd of elephants entering from the left and building up in vision at the screen centre. The width control can be supplied with a constant sound power characteristic if that is preferred. Perhaps we should call this a 'synergistic parametric panpot'! Panning happened to provide the most interesting aspect of the design exercise for Theatre Projects, but more about that later.

Since the dubbing mixer has to create his mix in harmony with the visual image, his focus of attention must be the cinema screen, not the console surface. Ideally he should be able to work without ever looking down. This is one of the areas where the application is very different from music recording, which led Pinewood to seek out a custom design. Instead of requiring every possible facility on a channel, they required a carefully selected set of functions and equally careful planning of the module layout.

Implementation

The console layout as originally sketched by Pinewood's engineers had a similarity in profile to that of a well known modern design. This console, however, differed in layout from standard music recording types in that its 48 channels were split among three operators. Also there were spaces provided between the three sections to house special panners, compressors and other ancillary equipment within easy reach. During the design phase but fortunately before manufacture was fully under way, the requirement was expanded from 48 channels, 20 groups, and 3 × 4-track working to 60 channels, 32 groups, and 3 × 6-track working! The design was made as flexible as possible in order to provide a basis for future sales which meant that the expansion of size and format was relatively simple.

Fig 2 shows the console layout as supplied. All Theatre Projects' previous designs had the aim of placing a relatively large number of channels within the easy reach of one man. In this case we were aiming to make three men comfortable with a much smaller number of channels each. The overall length of the console came to 5.5 metres, but each operator's section is just under 1 metre wide. As it turned out, one of the major design problems was building a console which Pinewood's chief dubbing mixer Gordon McCallum could handle physically (he is a small man). McCallum won an Oscar for his work on *Fiddler on the Roof*. It was part of Theatre Projects' job to provide him with a tool to help him earn his next one. The arm reach, knee room, and sight

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Post production console

lines of the console were all seriously constrained by the mix of personnel who would be using the console. This then defined the maximum sizes of the frames which in turn ultimately dictated the sizes and shapes of the modules.

The result was a square section, tubular steel, welded sub-frame with legs which extend toward the front to prevent any tendency of the console to tip if anyone should ever happen to sit on the arm rest. The console was built in sections for ease of transport – and to prevent the need to knock a wall down at Pinewood. There were three sections of 20 channels, each of which were referred to as 'operator's sections'; three sections with a 19in standard ancillary mounting area which were called 'intermediate sections'; and a wing at the right end of the console which would house the jackfields and final output group modules.

In the operator's sections, the sub-frame was extended upward at the rear to allow an internal swing-down section to be fitted. A card frame was installed in this swing-down section which housed mix cards for a set of 20 channels and a row of multipin sockets to allow interconnection of the console sections with the jackfield. This swing-frame made it easy to build and install the wiring looms, easy to debug during test and easy to service but its main purpose was to make it possible to incorporate modifications and additions easily throughout the life of the console.

Not many manufacturers like to admit it, but there are few consoles which have survived their first six months, let alone their 10-year working life, without all of the blank spaces being filled up with various contraptions. Theatre Projects have merely designed-in the facility to make a first class job of these additions. Ease of service and modification was also considered in the design of the underpart of the console which has plenty of headroom beneath the channel modules and no obstructions, thus providing easy access to the channel module wiring.

On to the sub-frames were hung the traditional aluminium plates carrying extrusions to support the modules and connectors. Since the company had no standard frame type of this scale, they decided to base their sizes on the international Eurocard standard. This meant that a large portion of the pieces necessary for fabricating module cassettes were readily available. It also had the benefit that the frame design could be easily adapted to future custom requirements and that all frame spaces were multiples of standard rack mount heights.

Two-part connectors to the DIN 41612 standard were used throughout for all module-to-frame interconnections. The frame wiring used foil screened cable crimped to removable contacts for all of the line level audio signals and insulation displacement ribbon cables for all busses. The crimp version of the connectors would give improved support to the wire over that of a soldered connection and the contacts could easily be removed to allow wiring changes or replacement. Wire support becomes important once anyone starts to mess around with the cable structure for either maintenance or modification purposes. Many of you have probably experienced the frustration of knocking off more wires than you attach while standing on your head under a console with only 1mm of clearance around the side of your hot soldering iron. As you see the wire adjacent to the one you have been working on fall off, you curse and inadvertently burn a hole in the insulation of another wire. Theatre Projects' design team have a strong bias toward serviceability and reliability derived from their personal experiences in electronic maintenance in early years. It is their opinion that no-one should be permitted near the drawing board without at least a year of maintenance experience.

All of the wiring between frame sections or to the jackfield was connected via Varelco 120-way connectors. Generous wire ducts were built into the lower rear section of the frames and when the console sections were taken to site, levelled and bolted together, the covers of the ducts were removed leaving a clear route for the 21 or more multicores. Each in turn was just lifted into place and plugged into its appropriate socket. The covers were then replaced, totally covering the wiring. Once again any additions would become a very simple process.

While the frame design was in progress, Dave Higton the circuits boffin was busy prototyping circuits to meet the performance requirements which the customer had established. These included a 3-band parametric equaliser with ±15dB boost/cut, fully variable swept frequency adjustment, widely adjustable swept Q control, and bell/shelf switching on the top and bottom bands; swept highpass and lowpass filters; and the 2/3-channel panpot with variable width. The equaliser design was particularly satisfying since a high standard of noise and distortion performance was obtained with a wide variation in frequency and Q. When satisfaction with the performance of each of the circuits was reached, a prototype was built into a box and sent to Pinewood for evaluation. Any necessary changes were carried out and approved by Pinewood's staff before the design was fixed.

Following a decision on the frame size and shape, trial module designs were put on paper and sent or taken to Pinewood for discussion. Once the layout seemed likely to be acceptable, a mock-up was made so that it could be evaluated by the mixing crew. This process was very time consuming due to the interactive nature of the mechanical design process, and the difficulty of getting opinions from the dubbing crew who hit a very busy period at the time. Priorities were set on the position of the various channel controls according to their frequency of use, trial layouts were made and then things were shifted until they came right. There was a manufacturing constraint imposed on the position of controls as well, that being to mount as many of them as possible on the PCBs to reduce manufacturing cost and improve the consistency of performance.

In order to make the replacement of mechanical parts as easy as possible two techniques were adopted. First, all of the PCB mounted pots were set back from the front panel by about 35mm. Long shafts were fitted which extended through the front panel and mounting brackets were designed to provide functional support for the pots and prevent any damage to printed circuit board tracks over the long term. Thus to replace a faulty pot, its knob would be removed, the pot nut loosened slightly with a small spanner, and its terminals desoldered from the PCB. The pot would then be removed from the rear of the module without disturbing any of the other components.

One of the other techniques adopted to make service easy concerned the pushbutton switches used for various functions, especially routing. Rather than fitting a block of 16 switches in one bank as on the routing module, they were fitted in pairs. Pairs of switches were mechanically stable for ease of fitting on assembly and easy to align. If one of a bank of 16 should fail (and it is usually the middle one) only a pair of switches would need to be removed to effect a repair. These could also be replaced without disturbing other components.

In addition to making repair easy, Theatre Projects also chose the components carefully for reliability and consistency of performance. As Steve Dove recently pointed out in his series *Designing a professional mixing console*, pots were a particularly difficult problem. Pots from many manufacturers were evaluated and many hours spent on the telephone embarrassing technical sales staff before they found what they were looking for, a pot with consistent law performance, the right 'feel', acceptable size, affordable price and a design which would result in a long trouble-free life. Even then they almost came unstuck when, due to a change in process, the production pots were shipped with a different law than the prototypes. These pots were consistent, all right: consistently wrong. Discussions led to a happy compromise with the manufacturer and replacements being sent in time to meet the delivery schedule. It was a Japanese company, and a common language would probably have prevented the problem to begin with.

(l to r) Nic Le Messurier, Gordon McCallum and Graham Hartstone at work

Input modules

Enough technicalities of design for the moment; let's go on to other features of the console and their purpose for the customer. 58 ▶

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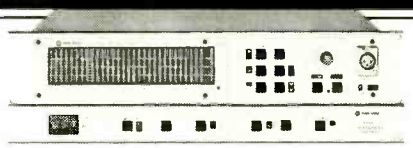

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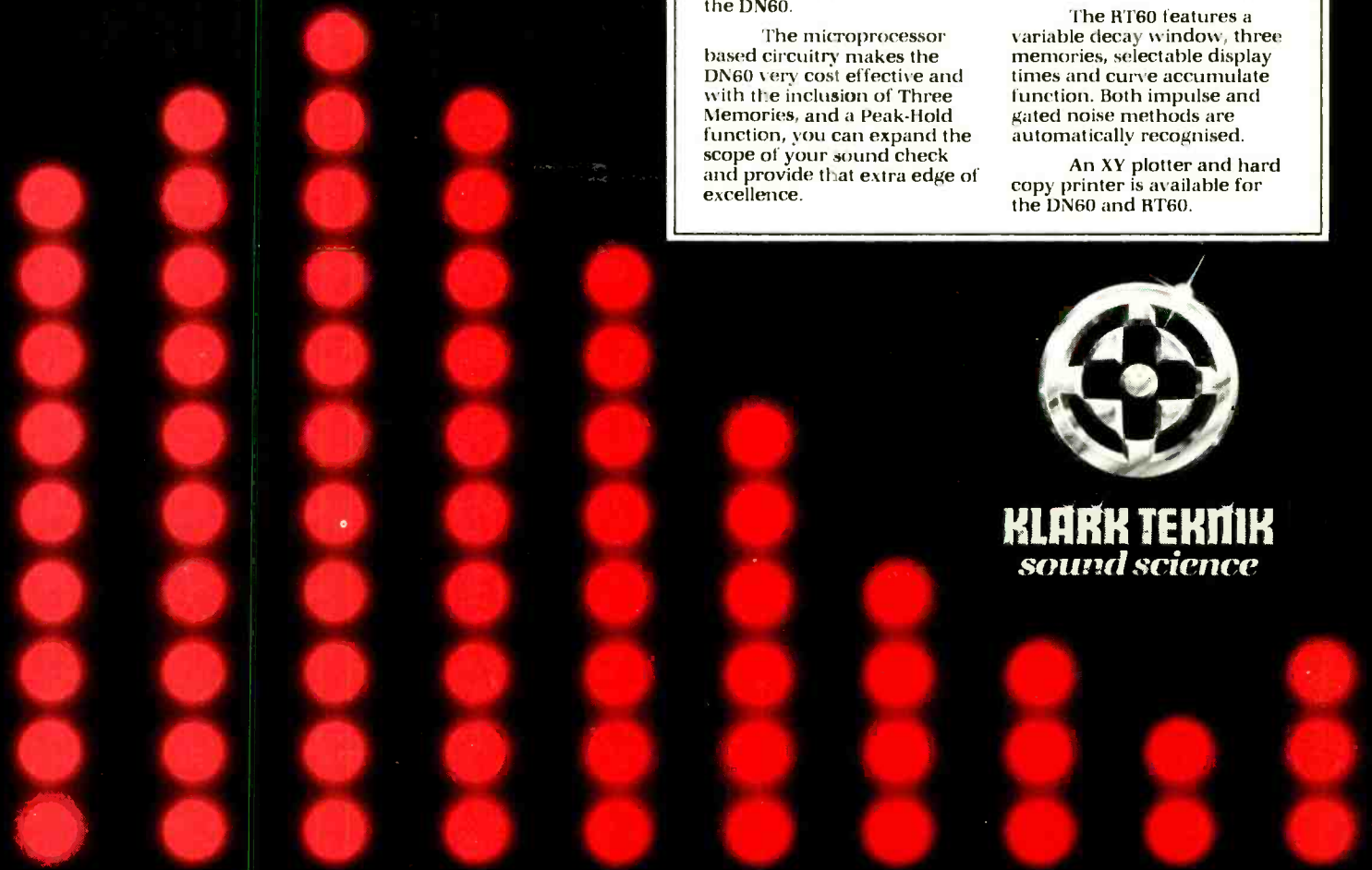

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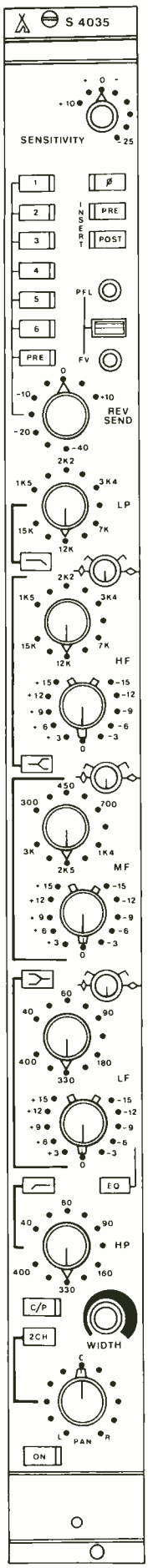


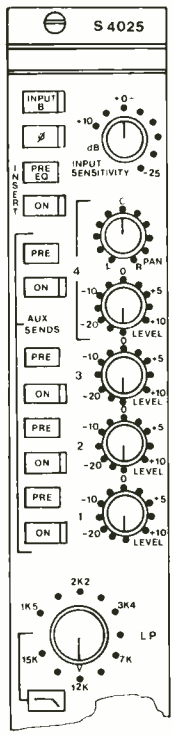


Fig 3a: (left) Channel module line drawing

Fig 3b: (above) Alternative top section with variable sends

Post production console

Looking at the input module (**Fig 3a**) from the top, we first have the input sensitivity control. This was switched for accurate repeatability. You will notice the absence of a mic/line switch. On post-production consoles microphones are only rarely used as inputs, so to save money six separate microphone inputs were fitted, accessible via the jackfield. All console inputs and outputs were isolated by high-performance transformers in order to provide maximum safety from funny voltages on the incoming lines.

Next, on the right side there was placed a phase reverse switch followed by pre and post equaliser insertion point selectors and below this a dual function lever switch to provide pre-fade listen (PFL) and foreign version (FV) selection. Pre-fade listen would select a signal from before the input fader and route it to the local monitor loudspeaker in that operator's section. Foreign version would do the same job, except that the signal wouldn't appear on the local monitor except when the input fader was shut, or mute activated. This function would aid the process of creating foreign language versions of a film. The original dialogue component of a master mix often contains some dialogue-related effects. This is run through the console and the fader is shut or muted whenever actual dialogue occurs. With FV selection the dialogue would appear at the local monitor instead of on the main speaker system providing a reference for subsequent work. The foreign language version could then be dubbed on via another input, with the new dialogue and any original effects information appearing on the main loudspeakers and the new recorded tracks.

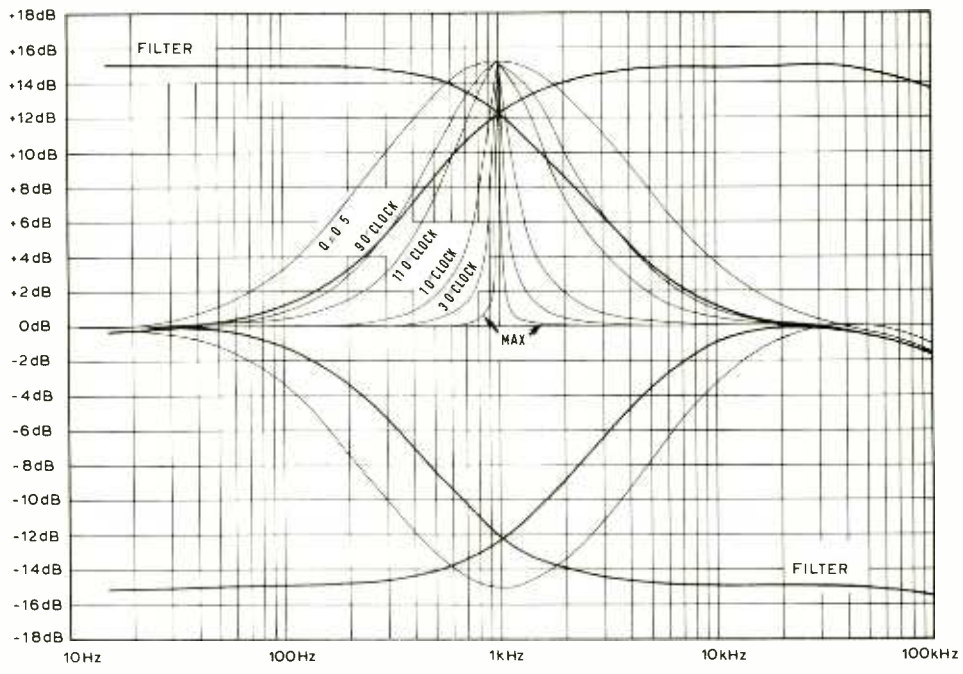
Adjacent to these controls were six routing switches to select the required reverb plate, a pre/post fader reverb selector and the reverb send level control. Since very little material is actually recorded live in a dubbing theatre, there is no requirement for foldback or monitor sends, so none were provided. During planning however, provision was made for implementing more variable sends should they be required by future customers of this design. This option is shown in **Fig 3b.**

Continuing down the module we come to the high cut filter with its separate in/out switch. You will notice that this control was effectively labelled by two methods, the designation 'LP' for lowpass and the symbol on the associated selector switch. At the bottom of the equaliser section, there was a similar low cut filter. The separate switches provided to switch these in/out would allow the filters to be used for 'clean-up' purposes, leaving the parametric section for use separately for other purposes such as effects.

The main body of the equaliser was made up of three parametric sections with the upper and lower sections switchable between a bell and shelf characteristic. The limits of the controls are evident from **Fig 3a** except for the 'Q' control. The width (or Q) of the bell filter was highly variable as is shown in **Fig 4.** Thus any band of the equaliser could provide for either

60 ▶

Fig 4: Equaliser performance curves



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subtle effects or highly tuned 'whine' rejection. The equaliser was a 'constant percentage bandwidth' design, which meant in musical terms that it sounded the same in width no matter where the frequency was set. In addition great care was taken to prevent any interaction between the level, frequency or width controls to prevent any confusion of the user. Getting the performance required, along with accurate resettability and consistency between modules presented one of the larger challenges on the contract. The results were worth the effort.

An important feature of the equaliser section, not obvious from the figure, was the layout and choice of knob used. As was mentioned earlier, one facet of the design of a film dubbing console is the need to operate the controls easily without looking at them. Also much of the pre-recorded material which is provided can originate from recordings which were made under poor conditions. Therefore the equaliser is also often used to remove spots of audible rubbish from tracks while having the minimum effect on the wanted sound. This fact resulted in the need to activate and de-activate an equaliser section rapidly, and to accurately return to the centre position. One solution to this kind of problem is to provide in/out switches on every equaliser section, and possibly to automate this function. This option was offered to Pinewood but they felt that the extra cost involved and the extra controls on the panel were disadvantages which outweighed the benefits. Therefore another solution was adopted.

The highest priority of use in any equaliser section was determined to be the boost/cut control. Therefore this control had space allocated to it which was ample for fat fingers, in addition, a taller knob was selected than is used for the other controls. A Sifam wing knob was chosen and oriented so that an index finger placed between the wings would give an accurate indication of the position of the control. This pot also has a mechanical indent at a very accurate centre position. **Fig 5** shows a typical equaliser in use. You will notice that there is little chance of accidental operation of adjacent controls. Next most important was the frequency selector. This used a standard height knob, with ample space to allow two hands to be used on one equaliser section for fast setting. The least important, and therefore smallest, control was filter width. All equaliser sections were similarly grouped for ease of location and all three controls in a section have identically-coloured caps fitted. The layout was so successful that after very little experience any equaliser control could be located blindfolded. At the bottom of the equaliser section a single in/out switch operates for all three sections.

Fig 5: Adequate operating space reduces the likelihood of inadvertently moving other control knobs

Below the bass-cut filter control the switch for the channel direct output was placed. It was called 'O/P' in this design since 'direct' has a different meaning in the film world. The direct output was a balanced, post fader, mono output from the input module.

Next – the controls for the module pan facility. The '2CH' switch would change the panpot to 2-channel mode for domestic type stereo from 3-channel mode for film-type stereo. In addition a width control active in the 3-channel mode was provided. This would control the amount of 'bleed' between adjacent loudspeakers giving the effect of variable image width or 'fatness' behind the screen. The pan control also had a highly accurate centre detent.

The last control on the input module was an on/off switch which had the effect of killing all channel outputs. Most of the switches had rectangular LEDs mounted alongside, but all switches were mounted near the panel so that their position was clearly visible.

The fader module was built around a slightly modified *Fadex* unit, and this also provided the console automation interface. More mention will be made of the automation system later.

Routing

Pinewood wished to record the separate component mixes on separate recorders with up to six tracks in each component, and they wished to allow routing to any of the components from any channel on the console. In addition they required extra groups for other purposes. For these reasons, the console which Theatre Projects manufactured for them had 32 groups with special routing facilities to provide for their requirements.

During preliminary discussions, the customer was offered the option of keypad-activated routing control using analogue switches. Theatre Projects had already designed a similar system for the Barbican Theatre console. This would have resulted in reduced panel space requirements at a modest additional cost. Another approach was however finally adopted, partly because of the distributed nature of responsibility in a multi-operator environment.

The routing module had essentially two sections of routing switches. At the top were fitted routing selectors 1 to 32 in a format which was familiar from music consoles. In the Pinewood console these were all fed mono information from the associated input module, although provision was made to allow stereo feeds to be fitted in the odd/even pattern. Below these were placed four mechanically interlocked switches labelled ↑, D, E, and M. The first 18 mix busses would be assigned in groups of six to dialogue (D), effects (E), and music (M) respectively, while the console was being used to produce the 3-component master mix in formats up to 6-track. Depressing ↑ would activate the routing switches 1 to 32 to allow them to be used for mixed subgroups or other purposes. D would route the three outputs from channel panpot to busses 1 to 3 as follows: 1 = left, 2 = centre, 3 = right, leaving busses 4, 5, and 6 for surround or 'boom' information depending on the application. Likewise E would route to busses 7 to 9, and M to 13 to 15. More than one of the bottom switches could be depressed together if required, but normal applications would be quick to set up, requiring only one button to be used. Film formats vary in their normal numbering of functions and track assignments, but to save confusion the pan output to track assignments were fixed.

Other modules

The remaining modules in each operator's section were a local monitor/PFL loudspeaker, provision for machine remotes, a talkback module and, at the chief dubbing mixer's position, the master automation controls. All 20 channels in each section would be mixed locally and sent at line level to the main group amplifiers housed under the jackfields at the extreme right of the console.

In the intermediate sections – those between operators as shown on **Fig 2**, some additional facilities were fitted. At the top of each section there were six modules known as spreaders which would accept one audio input and have six pots to allow that input to be 'spread' across the six busses of a component mix as required. The module was also fitted with OFF, D, E, and M selection buttons to route to the required component mix. These modules were fitted three each side of a panel which contained meters for three of the reverb groups and compression indicators for the compressors fitted below. Each intermediate section also contained four Audio and Design *F760* compressor/expander/gates, and operating controls for the Theatre Projects *Multipan* system.

Multipan

Multipan was the most original creation in the project for Pinewood. They had several operating requirements which they wished to fulfil for which no device was known to exist. In addition to the 3-channel panners which were available on the input modules, six special panners were required which would pan throughout the entire cinema space. The requirements were as follows: first, the panning device must be capable of providing up to seven outputs; secondly, the joystick position should make sense in relation to the location of the sound image in order to make panning logical; thirdly,

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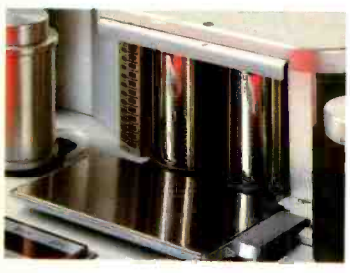
SPOILT FOR CHOICE.



When you come to choose your new multitrack, deciding on a Studer will probably be easy. What will be a little more difficult will be *which* Studer to take - the new A80/VU Mk III or the new A800.

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Post production console

varied image widths were required; and, lastly, Pinewood pan their effects prior to balancing and equalising the mix and so wished to automate the panning process.

Some of these problems were solvable by designing a special purpose panner which would work for one or two of the possible formats, but varied width or accommodation of a whole variety of formats would need several non-compatible panners. This is how the problem had been solved in the past when automation was not possible.

Theatre Projects' *Multipan* system provided a solution to the whole problem, and a few others as well. The system consisted of two types of modules, the joystick unit, and the control unit. The joystick unit **Fig 6a** accomplished the panning function and the control unit **Fig 6b** allowed selecton of the required formats and electronic linking of the panning action of separate audio sources.

Pinewood were provided with six joystick units which were fitted into the intermediate console sections. The stick itself had the obvious function of moving the sound around. This actually controlled up to eight VCAs which were located remotely in a card frame. The relationship between the position of the joystick and the control of the voltages to the VCAs and hence the sound output, was provided by the selected format or 'law'. The chosen law would be displayed in the local status display on the module. In addition, the display would tell whether the joystick was active (a master joystick) or whether its audio input was under the control of another joystick (it is then a slave). So, in addition to being able to select the effect of stick movement in relation to varied loudspeaker layouts, several independent audio sources could be moved in synchronism. This meant that effects, dialogue, and music could be kept in their separate recorded components, but be moved with one 'master' joystick.

Additionally, the X and Y positions of the joysticks could be recorded as the equivalent of two console faders in the automation system. Read/write controls were provided, it having been decided that update makes little sense in 2-dimensional spatial movement.

In order to provide for varying image widths, several versions of each law format were installed with differing bleed between adjacent outputs. The law of the panner was also modified to compensate for the 'image-pulling' effects sometimes evident when using cinema matrixing equipment. Theatre Projects will also provide a version of the panner with a 360° rotating pot for panning, and a separate pot for width. This will allow 360° panning with continuously adjustable image width in any required format.

The control unit would provide the facilities for assigning laws (loading a joystick) and assigning master/slave relationships (linking joysticks). It was designed for ease of use, leading the operator through the possible choices at any stage by illumination of LEDs in suitable switches at every stage. A provision was made for the future addition of a customer operated programming capability should this ever be necessary. Currently laws are supplied in PROMs and are generated in Theatre Projects workshops according to customer requirements.

Automation

The last important area of discussion concerns the choice of automation system. During the design stages many options were evaluated, largely based on selecting from systems available on an OEM or licensing basis – the required delivery date would not allow a 'from scratch' design when added to all of the other design work required. One factor in the equation was the possibility of a second console order even larger than the first. In fact Theatre Projects ended up supplying the second and larger console first. There are few automation systems which will handle more than 64 sources; this one was required to take 60 input sources, and 16 from the panners. Extra capacity was also considered necessary to allow for future developments.

Another choice concerned the type of data storage. Should it be a floppy disk based system using SMPTE code as a synchronising reference, or a tape based system in mechanical lock? Pinewood were not using a multitrack recorder for reasons given earlier, but had a large number of mechanically synchronised film transports. For them it was easy to allocate a separate machine for data of up to 6-track recording capability, whereas generating SMPTE code to synchronise a floppy disk would be more difficult and would still require the data machine. Cost investigations were also made which indicated that the cost of a floppy disk type system (which could not provide the required 76 data channels) was roughly double the cost of a tape based system. The final choice turned out to be to use two Allison *65K* programmers with the data machine to provide six tracks, or three sets of data. Two programmers were supplied in order to minimise the likelihood of data delays becoming apparent with the three operators all simultaneously busy, as well as providing an inbuilt backup and troubleshooting system. If a very large number of update passes caused an audible delay to occur, the magnetic film could easily be shifted a sprocket hole or two to compensate.

Summary

There are other areas of interest in the console, such as the metering system which was specially developed to meet Pinewood's needs. It provides VU and PPM characteristics and three selectable gain states, all of which can be remotely controlled. Additionally, the zero references for the two meter modes are independently adjustable. The meters are hung in mid air about 15ft in front of the console in order to be in the sight-line of all three of the mixing crew. Thus they are larger than most, incorporating 24 level steps in a height of 220mm.

There is much more to be said, but I hope that I have conveyed a little of the excitement of working on a project of this nature. Those of us at Theatre Projects who worked on this contract have enjoyed our first and assuredly not last exploit into the large-scale film industry. Due to the co-operation of the Pinewood staff, it has been a stimulating experience for all involved. Theatre Projects wish Pinewood and their customers the most mutually profitable use of the equipment which we have provided. ■

MULTIPAN PANEL LINE DRAWINGS

Fig 6a: Joystick unit

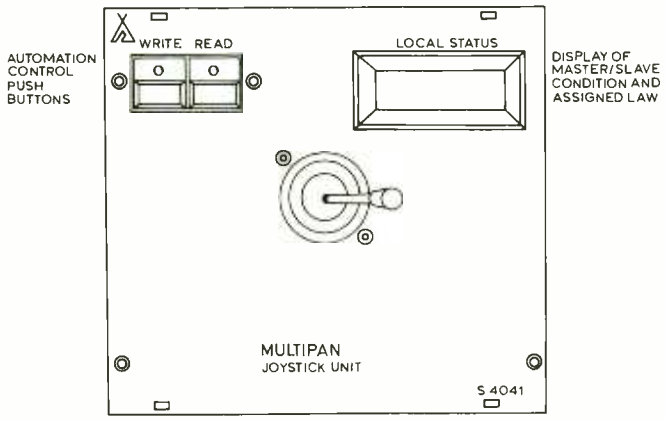
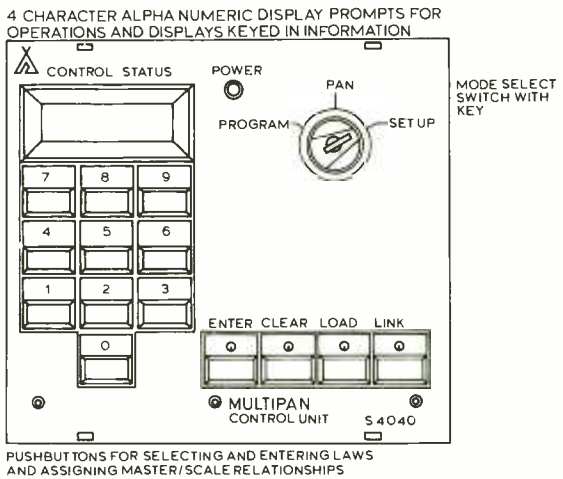


Fig 6b: Control unit



letters

Leave it to the experts

Dear Sir, Forgive me for stating the obvious, but it is becoming increasingly clear that this industry of ours requires a well aimed kick in the pants. Studio Sound, *October, indicates clearly the manner by which and to whom this long overdue favour should be meted out.*

Richard Elen discusses in his editorial, for instance, the layman's view of a modern recording studio, and asks 'is the whole thing really too complex to be useful?'. He rightly points out that it is perfectly feasible, for example, to assign EQ controls, thereby reducing the size and complexity of the desk. But, such a desk would be doomed to failure. Whoever heard of a simple, uncomplicated recording studio? The punters would immediately pass judgement, telling you categorically, that the desk was inferior because it did not have as many knobs as the one down the road.

Manufacturers are as much to blame as anyone else. Doug Pomeroy's letter, in the same issue, spells it out quite simply. Whilst the theory of additional control facilities is fine, in practice it ends up as a commercial product aimed at impressing studio owners and their prospective clients. Its real use becomes somewhat coloured.

The recording industry has, sadly, become bogged down by its preoccupation with status symbol technology, generally at the expense of the sound. Operational technique, and the sort of hands off experience learnt by doing without, cannot be bought by, or traded in for, knobs and buttons.

But it is amazing how quickly a misguided concept can spread. You will continually hear stories of producers and others, so befuddled by the importance of technological progression, that they spend vast amounts of time and money in search of the automated ultimate, missing the true expertise and thereby the point. And what comes out (although our producer friend would never admit it) sounds just like what it is—automated.

But, at last there is a glimmer of hope on the horizon, especially when you realize that, sooner or later, the cost of this 'technology' will not balance with its financial return, leaving the rest of us free to get on with the job of processing the sound with equipment designed by engineers for engineers, rather than for a bunch of misinformed individuals, playing with their train sets.

Yours faithfully, Stephen Tebbitt, Steve Gordon Recording Studio Ltd, Stephen's Place, Rear 10 Upper Mount Street, Dublin 2, Eire.

A question of depth

Dear Sir, In response to the letter sent to you by Denis Comper in the October issue, there is a way to preserve depth even though close miking is necessary. The problem seems to occur most often when recording in a poor acoustical environment at a live performance. Remembering that sound travels at 1.13ft/ms, you can delay the close-placed accent mics to coincide with the arrival of sound at the overall coincident pair thus preserving the depth of the orchestra.

I look forward to receiving your magazine every month; you are a credit to the audio industry, keep up the good work.

Yours faithfully, Alan P Kefauver, Peabody Conservatory of Music, The Johns Hopkins University, Baltimore, Maryland 21202, USA.

Balancing act

Dear Sir, In Balanced or Balanced? *(December 81) Mr Fletcher and friends have come up with some interesting solutions to a non-existent problem. True, if you analyse the input impedance of an R1 = R2 = R3 = R4 diff amp one port at a time you will realise a 2:1 impedance mismatch, however common mode signals by definition are induced into both inputs. The negative feedback that forces the op-amp's minus input to follow the plus effectively bootstraps the minus input resistor for equal common mode input impedance.*

The primary benefit of instrumentation topologies (Fig 3a) is in their ability to provide high input impedance, high CMRR, and low noise at the same time. To realise high input impedance in a simple diff amp would require routing the signal through large (noisy) input resistors. For line level signals the noise performance of a diff amp with 10K to 20K resistors is satisfactory.

Yours faithfully, John H Roberts, Phoenix Audio Laboratory Inc, 91 Elm Street, Manchester, Connecticut 06040 USA. ■

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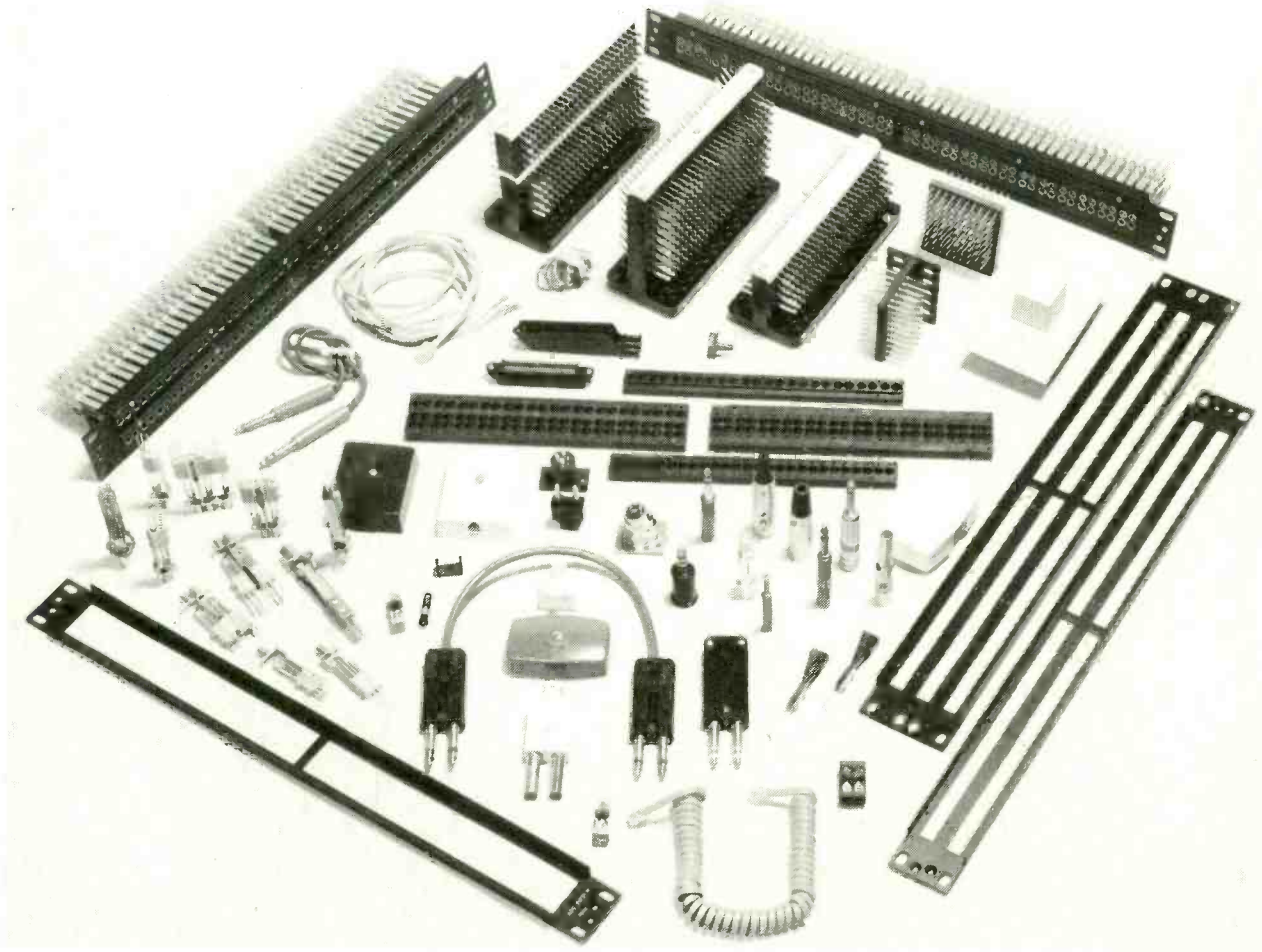

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EMT 948

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Turntable diameter: 330mm.
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Speed accuracy: maximum ±0.1% (quartz controlled).
Run-up time: instantaneous start maximum 0·5s at ambient temperature of 20°C.
Wow and flutter: at 33⅓RPM measured with *EMT 424*, weighted in accordance with DIN 45 507/IEC (ANSI S 4.3—1971), maximum ±0.075%.
Rumble: referred to a peak velocity of 10cm/s at 1kHz. Unweighted 50dB, weighted in accordance with DIN 45 539, 70dB.
Equalisation: DIN, NAB, IEC 75/318/3180μs. Flat 0/318/3180μs changeable by internal plug.
Frequency response: 40Hz to 15kHz ±0.5dB, 30Hz approx −3dB, below 30Hz approx 20dB/octave roll-off, above 25kHz approx 12dB/octave roll-off.
Input voltage: for dynamic cartridges (transformer coupling 1:7) 0.3mV to 1.4mV; for magnetic hi-fi systems (version with input resistance = 47kΩ) 2mV to 10mV.
Input overload margin: 20dB above nominal level.
Output voltage: adjustable between 700mV and 10V (0 to +22dB) into 200Ω.
Harmonic distortion: 30Hz to 12kHz <0.1% at +15dB (4.4V) into 200Ω.
Crosstalk suppression: >55dB, 30Hz to 15kHz.
Mono switching: remote controllable.
Headphone output (mono): unbalanced, adjustable approx 200mV to 600mV.
Headphone output (stereo): unbalanced, adjustable. At a load of 200Ω approx 200mV to 600mV, at a load of 2kΩ approx 500mV to 1500mV.
Mains voltages: 50 or 60Hz, 100 to 120V, 200 to 240V.
Power consumption: maximum approx 85VA, normal approx 40VA.
Dimensions: 18.3 × 9.4 × 18.9in/460 × 235 × 475mm (whd). Depth below panel 6.2 in (157mm).
Weight: 58lb, 26kg.
Manufacturer: EMT-FRANZ GmbH, Postfach 1520, D-7630 Lahr, West Germany.
UK: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ.
USA: Gotham Audio Corp, 741 Washington Street, New York NY 10014.

THE *EMT Model 948* is the company's latest professional broadcast turntable which is normally supplied complete with the EMT pickup arm and sophisticated electronics including line amplifiers.

By broadcast standards the complete unit is very light in weight, the basis being an open steel chassis which houses the electronics underneath and the turntable which is mounted on top of the chassis by four flexible mounts. Based on a flanged casting which forms part of the top surface of the turntable the unit is of extremely solid construction. A separate top section of the turntable is used for mounting the pickup arm and its lifting mechanism, this section being secured to the main casting by four recessed machine screws.

Direct drive is used from a crystal locked servo motor on to the shaft on which the lightweight (850g) metal platter is secured. It follows that there are a minimum of moving parts with a solenoid operated brake pad being pushed on to the motor to rapidly stop the turntable.

At the centre of the platter a large centre for 45RPM records is provided, this latching into a recessed position when it is not required. A heavy rubber turntable mat is provided which rather cunningly has an arm and cartridge alignment grid imprinted on its reverse side. In addition, a stroboscope disc is provided for checking turntable speed using either 50Hz or 60Hz illumination. However, the turntable speed in practice is likely to be far more accurate than the local power supply frequency!

The pickup arm is also of robust design to take the punishment of a broadcast environment with the cartridge being in a plug-in headshell. Tracking force is very simply adjusted as is the bias compensation. A motor driven arm lifter can lift the arm at any position on the record, a locking position being provided. However, this is not strong enough to secure the arm when the unit is in transit.

Four operational controls are located on the main frame to the front of the turntable unit. A 3-position rotary switch selects the speed from 33⅓, 45 or 78RPM, a momentary pushbutton lowers or raises the arm, the button being illuminated in the down position, whilst a further button starts and stops the turntable, this being illuminated in the run condition. Finally a third button runs the turntable at 33⅓RPM in reverse for cueing.

Behind the turntable a fluorescent lamp is provided for record illumination, but I don't consider this nearly as good as the arrangement on earlier EMT turntables. Whilst it is good for showing up dirt on the disc, it gives poor illumination at the stylus position. The headshell is also provided with a magnifier as with earlier models. Protection to the arm and turntable is provided by two features, lifting handles at the sides of the unit and a hinged plexiglass lid. Cleverly this gives access to the handles when open or closed, and in addition gives access to the operational controls when closed.

All connections are recessed at the rear of the unit with the exception of a separate grounding terminal and a link which enables the signal ground to be isolated from the safety ground—a simple and sensible arrangement. The left and right audio outputs terminate at balanced *XLR-3* male connectors with a 6-pin female *XLR* connector providing left and right monitoring outputs, plus a mono monitoring output. Mains power is applied via an IEC connector with European and American type power leads being provided in addition to a set of *XLR* connectors, a remote connector and various other parts.

A 36-way 'D' connector provides three functions, remote control, test signals and feeds for a cue amplifier. The latter is intended to feed an optional external mono 10W cue amplifier whilst the test signal outputs are associated with checking the motor servo performance. Of more interest are the comprehensive remote facilities which include

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remote/local control switching which inhibits the local controls, remote start and stop, duplication of the lift and run lamps, mono/stereo switching, plus a mono feed for headphones. In addition variable speed is available by means of an external 10kΩ pot with direct fixed/variable speed switching.

Turning to the electronics, the power supplies are located at the rear in a completely screened box with the mains voltage selector being accessible at the rear of the unit. The power supplies and all other assemblies are interconnected by plugged ribbon cables to ease servicing. With the exception of the monitor amplifiers which are located on the mother board into which other PCBs plug, all electronic components are contained on plug-in assemblies. Readily accessible at the front of the unit, seven good quality plug-in printed circuits support almost all the components which are clearly identified. The boards have liberal test points and in addition almost all the integrated circuits are socketed to ease servicing.

Of the seven boards three are associated with the servo system, three with the audio section and one with interfacing. Whilst there are few adjustments that cannot be got at from the front, very sensibly an extender board equipped with test points is provided as standard in the card frame.

Dealing first with the servo boards, the oscillator board contains the reference oscillator and the external speed control functions, plus the brake solenoid drive. The only user features on this board are a red LED indicator which becomes illuminated when the servo system phase locks, and a pot associated with the external speed control. The second board is the speed control board which has front pot controls for tachometer and phase lock symmetry plus one other on board symmetry control and a test link. The final board is the servo amplifier which has four front adjustment pots for the amplifiers and a lift speed control for the pickup lift time which can be altered between 1 and 2s.

Turning to the three audio boards, the cartridge output is fed to the equaliser board which has provision for input transformers. Pluggable links on this board allow the removal of the 75μs HF time constant for equalising the amplifiers using Bruel and Kjaer or similar test discs which do not have treble preemphasis. Following this, on board pots are available to adjust the LF roll-off with the time constant alterable between 2200μs and 3200μs. Two further pluggable links allow muting of the mono monitoring output in the remote mode. Finally there are two front pots, one for setting the mono monitoring output level and the other for trimming the gain of the right input equaliser to balance the outputs. From the equaliser board the audio passes to the line amplifier board as well as the right and left headphone monitor amplifiers on the mother board—each of these has a gain control. The only facilities on the line amplifier board are two rather coarse gain controls and pluggable links to provide muting when the turntable is stopped. The third board is purely a power supply stabiliser for the audio section.

We eventually come to the interface board which provides a logic interface between the local and remote controls and the servo logic etc. The only user functions on this board are two pluggable links which give options on the remote start/stop functions allowing fader start with normally open or closed contacts.

Although at the time of writing only a preliminary instruction manual was available, EMT can be relied upon to produce a good manual.

As is expected of EMT equipment the whole unit is made to a high standard of mechanical and electronic engineering with an attractive presentation and finish.

Mechanical considerations

Considering first the EMT pickup arm, this has only three user adjustments. Balancing is achieved by placing a calibrated lever to the zero tracking force position and then balancing the arm/cartridge assembly by rotating a balance weight at the rear of the arm. Once this is done the calibrated lever may be used to set tracking forces between 0 and 5g covering the requirements for most modern pickup cartridges. With careful balancing the accuracy of the calibration was within 0.5g.

The third adjustment, that for bias compensation is achieved by a small weight with a nylon thread which is fed through a wire loop on to a lever attached to the arm assembly. The lever has three notches for compensating tracking forces of 2, 2.5 and 3g and providing measured side thrusts of 200, 250 and 300mg.

As the review unit was not supplied with an EMT cartridge, but a Shure *SC35C*, I have not reviewed the cartridge performance. However, it was noted that with the Shure cartridge the arm resonance was around 12Hz and fairly severe.

The range of balance for the cartridge and headshell could be adjusted from 12g to 30g, the EMT headshell weighing 10g. Thus cartridges weighing up to 20g may be used.

Measurement of the turntable spindle diameter showed this to be 7.136mm (0.281in) which when compared with the NAB standard tolerances (0.286, +0.001, −0.002in) is a loose fit giving 0.003in clearance against the NAB standard or 0.004in against IEC Publication 98 minimum hole diameters. However, for broadcast use where records must be sometimes changed rapidly a large clearance is preferred.

Checking the runout of the spindle showed this to be excellent at less than 0.0001in (2.5μm) with the vertical runout at the periphery of the platter being 0.006in (152μm) TIR—total indicator reading—which is to a good standard.

Speed, rumble, wow and flutter

With the specified speed accuracy being ±0.1% normal test discs or stroboscopic methods could not be used to check the speed accuracy. Therefore a new approach was required and an extremely simple method arrived at. A small magnet was attached to the periphery of the platter with a miniature reed relay placed on a stand such that the magnet passed close to the relay once per turntable

70 ▶

1710A

1700B

1701A

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revolution. By passing a current through the relay, pulses once per revolution were produced and passed to an accurate timer/counter which then indicated the time per revolution. The resulting revolutional speeds were found to be stable at 33.333, 45.000 and 78.26RPM with no turntable loading. Heavy loading of the turntable far in excess of that possible by a pickup arm resulted in less than 0.01% variation in turntable speed—an excellent performance.

Rumble was measured RMS to the standard A and B weighting curves, also known as weighted and unweighted, referred to a peak velocity of 10cm/s at 1kHz. Stereo rumble was the same for the left and right channels at −51dB to the A curve or −69dB to the weighted B curve using the DIN 45 544 and other test discs. It should, however, be remembered that the cartridge/arm combination affects rumble and the test report supplied with the unit showed rumble measurements of −55dB to the B curve or −70dB to the A curve with a Stanton *500* cartridge.

As with rumble measurement the measurement of wow and flutter is limited by the availability of good test discs. For measurements on turntables of this calibre vinyl pressings are of little use and a special original acetate was used. At 33⅓RPM the IEC quasi-peak weighted wow and flutter was excellent at a consistent 0.04% with the unweighted figures also being first class at 0.08%.

Outputs and inputs

The main audio outputs at the *XLR* connectors are in fact transformer coupled floating outputs with a low impedance of about 28Ω. The output voltage using the Shure *SC35C* cartridge could be adjusted over the range −11.5dBm to +27.5dBm for 10cm/s by the controls on the line amplifier board which are normal pots as opposed to multiturn types, with the result that the adjustment is excessively critical.

At the mono and the stereo monitoring outputs the unbalanced outputs were of very low impedance with the level adjustment range being from −15dBm to +0.5dBm for the stereo outputs or −5dBm to −15dBm for the mono output.

At the equaliser inputs the impedance was found to be 46.5kΩ in parallel with 200pF irrespective of the amplifier gain. Sensitivity for 0dBm at the main outputs could be varied from 150μV to 15mV with a maximum input level of 150mV at 1kHz at the onset of serious distortion.

Checking the range of the gain trim pot in the right channel showed this to have a range of 5.5dB which should be quite sufficient to correct the imbalance in the worst pickup cartridges.

Frequency response and noise

For the measurement of the overall frequency response an inverse RIAA network was used, this being within ±0.2dB from 30Hz to 20kHz. The resulting frequency response from the cartridge leads to the main outputs is indicated in **Fig 1** which shows that in the 'flat' fully equalised condition the amplifiers are within ±0.5dB from 35Hz to 18.5kHz with a sensible 20dB/octave roll off below the −3dB point at 30Hz and a 12dB/octave roll off above the −3dB point at 25kHz. The effect of moving the link which inserts the high frequency 75μs time constant is also shown in **Fig 1** with the 3dB point being correct at just over 2kHz.

Noise was measured at the main outputs with the motor running and referred to a velocity of 3.16cm/s lateral or vertical (2.24cm/s RMS at 45°) using the Shure *SC35C* cartridge with a specified sensitivity of 5mV.

TABLE 1

Measurement method	Noise
22Hz to 22kHz RMS band limited	−71.5dB
A-weighted RMS	−75.0dBA
CCIR weighted quasi peak ref 1kHz	−62.5dB
CCIR weighted RMS ref 1kHz	−67.0dB
CCIR/ARM weighted ref 2kHz	−73.0dB

The consistently good results shown in **Table 1** were virtually identical for the two channels with no significant hum present irrespective of the position of the pickup arm. With the outputs muted noise fell to −86dB unweighted or −89.5dBA weighted to the A curve.

Distortion

Amplifier distortion was evaluated by applying the input signal to equalisation amplifiers via an inverse RIAA network with the overall gain such that the Shure *SC35C* cartridge gave an output level of 0dBm for a recorded velocity of 3.16cm/s RMS lateral or vertical.

Second and third harmonic distortion was consistently below 0.01% at mid band at any level up to +20dBm output, at which level the harmonic distortion products are as shown in **Fig 2**. The situation was similar at +10dBm output but with the harmonics at high frequencies dropping at lower levels.

Intermodulation distortion was also measured to the CCIF twin tone method using two tones separated by 70Hz. With this test the intermodulation products remained below 0.05% at frequencies up to 20kHz with output levels up to +10dBm—a very good performance.

Other matters

Crosstalk between the two channels remained below −90dB up to 5kHz rising to −75dB at 20kHz—certainly no cause for complaint here.

The start time was always fast, being only 350ms to 33⅓RPM, 400ms to 45RPM or 700ms to 78RPM. Using the cueing marks around the turntable showed that full speed had been achieved in about 1/6th of a revolution for the lower speeds with the outputs being de-muted at precisely the correct time.

Extremely wide variation in the power supply voltage had no effect upon either the turntable or the electronics and no switch-on transient appeared in the outputs. Upon switch-on the pickup arm automatically raised if it had been left in the down position, but it was rather irritating that the motor always started upon switch-on.

The turntable suspension gave very good isolation from knocks and bangs and in addition the acoustic isolation was unusually good such that discs could be replayed at quite high levels with the turntable in front of a loudspeaker without any oscillation occurring.

Summary

The *EMT 948* is an excellent turntable system which is in general a delight to use, my only reservation being the poor stylus illumination.

Both mechanically and electronically the performance was excellent with comprehensive monitoring facilities and a very good standard of construction.

Hugh Ford

FIG.1 EMT 948
FREQUENCY RESPONSE

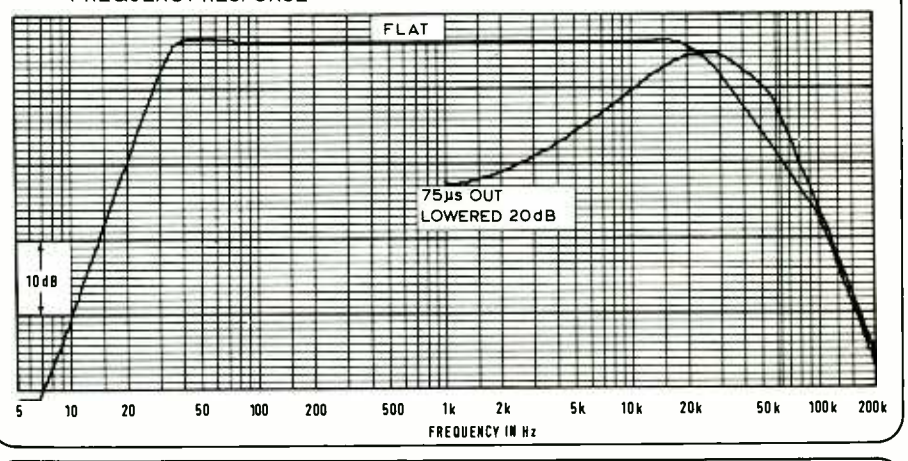
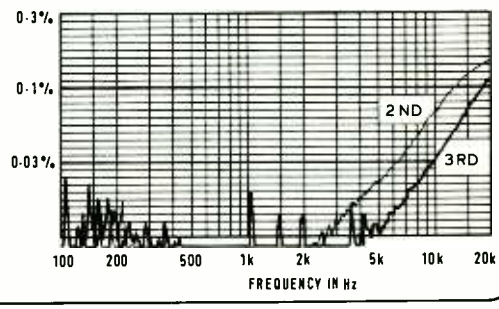


FIG.2
EMT 948
HARMONIC DISTORTION



Telefunken MX80 digital audio recorder

The Telefunken units reviewed in this issue are currently manufactured by Mitsubishi in Japan, although it is intended that Telefunken will produce these digital units in Europe at some stage in the future.

MANUFACTURER'S SPECIFICATION
PCM: 2 channels.
Analogue (cue): 1 channel.
Address code: 1 channel.
Tape speed: 15in/s (38cm/s).
Tape width: ¼in (6.3mm).
Recording time: 1hr with 10in reel.
Power: 117/240VA ±10%, 50/60Hz; consumption 350VA.
Ambient temperature: 5°C to 35°C.
Tape counter: digital (counter roller).
Line input level: +6dBm.
Line input impedance: 10kΩ (balanced).
Line input connectors: *XLR-3-13* terminals.
Line output level: +6dBm.
Line output impedance: for 200Ω load (balanced).
Line output connectors: *XLR-3-14* terminals.
Frequency response: 20Hz to 20kHz +0.5dB/ −1.0dB.
Dynamic range: >90dB.
Distortion: <0.05% (ref. input level).
Crosstalk rejection: 80dB (1kHz).
Wow and flutter: limited only by quartz-crystal oscillator accuracy.
Sampling frequency: 50.4kHz.
Coding: 16-bit linear.
Weight: *Model MX80* 165lb; *Model MX80A* 244lb.
Dimensions: *MX80A* (whd) 650 × 1070 × 750mm.
Manufacturer: Mitsubishi Electric Corp, Mitsubishi Denki Building, Marunouchi, Tokyo 100, Japan.
Europe: AEG-Telefunken, Studio-Magnetbandgerate, Bucklestrasse 1-5, D-7750 Konstanz, West Germany.
UK: Hayden Laboratories Limited, Chiltern Hill, Chalfont St. Peter, Gerrards Cross, Bucks.
USA: Mitsubishi Electric Inc, 7045 N Ridgeway Avenue, Lincolnwood, Illinois 60645.

THE TELEFUNKEN type *MX-80* and *MX-80A* are portable and studio console versions of the Mitsubishi *X-80* and *X-80A* digital audio recorders. From the point of view of performance the models are identical but the portable version is transported in two parts and lacks some of the facilities of the console version.

The review sample was the bulky console version which is housed in a massive wooden cabinet with fixed wheels to the rear and hinged wheels at the front. The wooden cabinet alone adds 50mm to the width of the machine which is 650mm and which is said to weigh 100kg. Let into the top surface of the cabinet is the tape transport which handles con-

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ventional NAB reels of special digital ¼in tape. Above the tape transport a penthouse contains the metering and two small monitoring loudspeakers plus the audio controls.

The electronics of the recorder are in four separate sections. Within the penthouse are the loudspeaker drive amplifiers, the transport control electronics are suspended under the tape transport and the audio electronics including the digital signal electronics together with the power supplies are located in a card frame in the base of the console.

Turning to the tape transport, this is based on a substantial flanged alloy casting, the top face of which is machined to form a reference face for mounting the tape guides, headblock, etc. The tape spools are driven directly by servo reel motors, the spools being secured by NAB adaptors which collet fix on to the motor shafts. Solenoid operated band brakes operate upon brake drums attached to the motor shafts.

From both spools the tape passes to a fixed guide post and thence to a fixed guide on a spring loaded tension sensing arm, the position of which is optically sensed. On the pay-off side the tape is then fed to a large diameter rubber covered roller, the shaft of which is coupled to a tachometer disc which is used to drive the tape timer from where the tape arrives at the plug-in headblock. The latter is based on a steel plate which secures to the reference face of the main casting by three screws.

At the entry to the headblock the tape is subjected to a spring loaded guide which loads the tape against the top of the guide. There is then the ferrite full-track erase head followed by a tape lifter pin. After this the oxide surface of the tape rubs on a perforated plate which presumably helps clean the tape and also reduce curl. There is then a fixed guide post followed by the write head and the read head in between which there is a second tape lifter pin.

Each head accommodates eight digital data tracks plus an analogue audio track and an address track for SMPTE timecode. Both heads are mounted on small castings which themselves secure on to the headblock plate by means of three Allen screws and spring washers which provide a secure azimuth and zenith adjustment.

At the exit from the headblock there is a second spring loaded guide from whence the tape is fed to a large diameter (12.083mm) capstan which is directly driven by a DC servo motor. A solenoid operated pinchroller of conventional design applies the tape to the capstan.

The complete top surface of the transport is covered by a decorative trim which hides the hours running timer which is let into the top surface of the transport casting.

To the front of the transport there is a row of illuminated pushbutton switches which include the conventional start, stop, fast forward and reverse and record buttons. Except when in record it is possible to jump directly between modes, but the only way out of the record mode is via stop, the entry into record requiring the play and record buttons to be pressed simultaneously.

To the left of the transport is the power on/off switch followed by three white illuminated push-buttons. One of these controls the fast winding speed between normal and slow, the latter being at about 60in/s as opposed to the fast mode at about 300in/s. The next button initiates timecode recording which is exited by the stop function. Thirdly there is the edit button which releases the reel brakes and permits rock and roll location of an edit point using the analogue audio track for edit point location.

The final transport control is the cue button which just removes the tape lifter pins in the fast wind modes. Centrally located is the tape timer indicating hours, minutes, second and tenths of seconds on seven segment displays.

Beneath the tape transport a small card frame contains six plug-in PCBs which house the majority of the tape transport electronics. This includes the usual servo board for the DC capstan motor, capstan drive, tension control, an oscillator board and a sequence control board. In all these have 16 potentiometer adjustments, but no service information was available about these.

Audio signal control is located in the penthouse which includes two VU meters and two peak level indicators in the form of vertical fluorescent displays with 6dB increments. The three upper displays are red covering signals above 12dB below clipping with the remainder being green. Four interlocked pushbutton switches control monitoring at the meters and at the audio outputs. Monitoring includes the input signal, the digital replay, the cue track and electronics to electronics monitoring which puts the A/D and D/A conversion in circuit but excludes tape. The monitoring level via the internal loudspeakers is controlled by two pots with the headphone jack having a separate pot. The final controls on the penthouse are stereo input and output level step attenuators. These are identical with 2dB steps down to −32dB followed by four steps to −50dB and an infinity position.

In the base of the console there is a further electronics section. This contains the DC power supply unit and ten large plug-in PCBs each 205mm high and 305mm long with a most exceptionally clean layout and clear component identifications.

The A/D and D/A converter boards do the obvious conversion operations for the left and right channels, the digital signals from the A/D converter being fed to the coder clock board. This section of the recorder may be switched to receive digital data from another recorder for digital dubbing, but normally generates a cyclic redundancy check, generates synchronisation information and interleaves the digital left and right information channels. From here the coded signals are fed to a modified frequency modulation modulator and thence to the digital write amplifiers.

The cue signal used for editing is recorded at the same time as the digital signals, but is subjected to a delay of 10.8ms to compensate for the time required to process the digitised signal before it is recorded.

In the replay mode the read heads feed a head amplifier on the tape transport from where they are fed to the read amplifier board in the electronics frame. From here they go to the modified

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frequency modulation demodulator board and then to a timebase correction board. This board corrects jitter caused by wow and flutter in the tape transport and forms part of the capstan servo mechanism in the replay mode.

The recovered digital signal is fed to the decoder board where there is a cyclic redundancy check which enables error correction followed by de-interleaving of the left and right channels and decoding. The recovered digitised signals for the left and right channels then are fed to D/A converters and thence to the analogue outputs.

Other than two toggle switches on the PCBs there are no user controls as opposed to preset pots. One switch is used to enable the connections used for a digital disc cutting preview unit with the other switch enabling cross-fade in the editing board.

The remaining features in the electronics section are five red LED indicators on the edit board. The main function of these is to provide warnings about the recorder's functional state. One LED is illuminated when the capstan servo locks in the replay mode, the second flashing when read errors are detected. It is perhaps unfortunate that this indicator is buried in the machine and not on the top panel, as this indicator provides a useful judgement for tape condition or head cleanliness.

Further LEDs are illuminated when edit splices are detected and when uncorrectable errors are detected. The latter mutes the recorder's output and illuminates the mute LED which also functions when unrecorded tape is replayed or when the replay servo lock is lost. The remaining LED's indicate the selection of the digital dubbing function and indicate dubbing on or off.

To the rear of the electronics card frame are the audio input and output connectors in the form of *XLR* connections in addition to which two phono sockets provide unbalanced monitor outputs. SMPTE code track input and output connections are also unbalanced but via BNC sockets with the mains power input being a modified IEC connector not compatible with normal IEC mains leads.

Two multi-way D-type connectors feed the digital disc cutting preview unit when in use, with a further D-connector allowing remote control. Interconnection between various sections of the recorder is by plug-in leads with locking connectors, three of these feeding between the electronics unit and the tape transport and a fourth feeding the penthouse.

The standard of mechanical construction of the tape transport was excellent as was the standard of all the PCBs and the components used. However, the wiring on the tape transport was rather untidy and the interconnecting cable between sections of the recorder at the rear made rather a birdsnest.

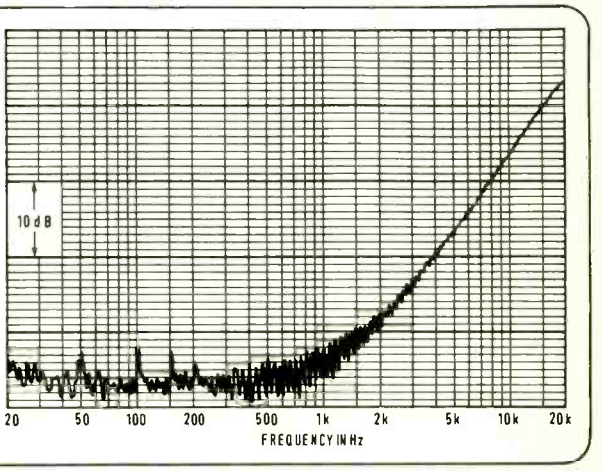
Overall the functional parts of the machine seemed very small compared with the enormous box within which they are contained which had much empty space.

Mechanical considerations

Whilst lacing the recorder is simple it can be incorrectly done and a lacing diagram on the tape transport would not come amiss. Once laced, access to the tape for placing edit marks upon the replay head is reasonable as is the facility for rock and roll edit point location.

All transport controls were clearly identified and functioned in a controlled and predictable manner with the tape tension always remaining close to 80g irrespective of the transport mode. In the event of mains power failure the transport was slightly prone to slinging tape loops, but this only became dangerous in the fast wind mode, but even then serious tape damage would be unlikely.

FIG. 1
TELEFUNKEN MX80 CMR



Using the Ampex *466* 'high energy digital' tape supplied, the tape winding in the slow wind mode and the record/replay modes was good, but the slow wind is at only 60in/s and the tape is matte backed double play working at the rather high tension of 80g for this tape thickness. In the fast wind modes at 300in/s tape winding was poor with severe leafing which makes the tape very prone to accidental edge damage. Certainly a lower winding speed is highly desirable for this tape type.

Checking the accuracy of the tape timer showed that it gained 3s in 25 minutes playing time (0.2%) but the return to zero accuracy was far better at 0.05% using the slow wind mode, an accuracy which was repeated in the fast wind mode.

Overall, access to the tape transport components was quite good as was access to the electronics section which was equipped with many test points. Provided with proper circuit information servicing should not present a serious problem.

Inputs and outputs

The main audio inputs at the *XLR* connectors are floating inputs with an input impedance of 11.2kΩ which remained constant with the input gain setting. The maximum sensitivity for peak recording level was +9.4dBm with the input attenuator offering 2dB gain reduction steps within 0.1dB overall accuracy. Input levels in excess of +34dBm could be handled without introduction of distortion. As shown in **Fig 1** the common mode rejection ratio was excellent.

At the main audio outputs the circuits were also floating with a low output impedance of 10Ω. With the input and output attenuators at the same setting the overall gain was unity with the maximum output level at the onset of output stage clipping being +27.5dBm loaded into 600Ω or +27.8dB Ref 0.7V unloaded.

It is perhaps unfortunate that in the digital replay mode it is possible to clip the output amplifiers at maximum output gain, but at least the clipping is well behaved as shown in **Fig 2**.

The unbalanced monitor outputs were found to

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FIG. 2

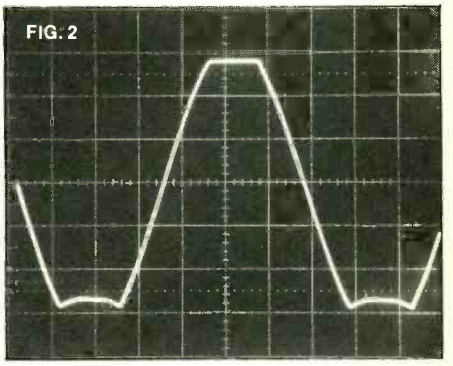
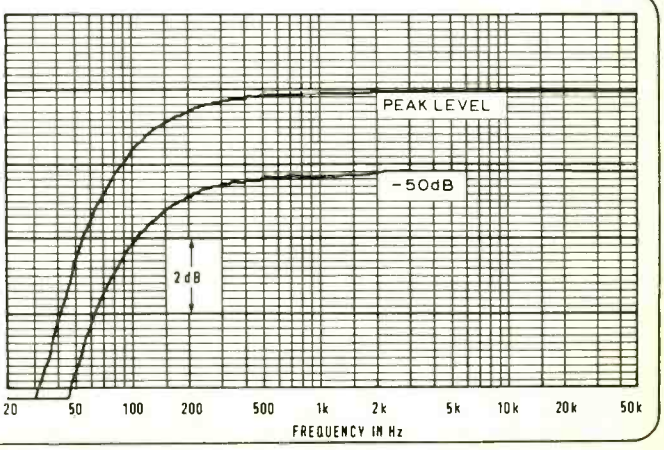


FIG. 3
TELEFUNKEN MX80
FREQUENCY RESPONSE



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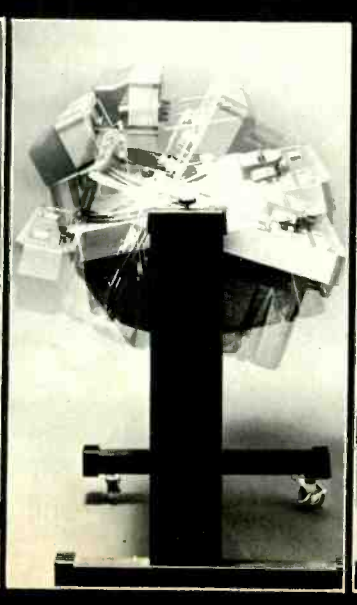

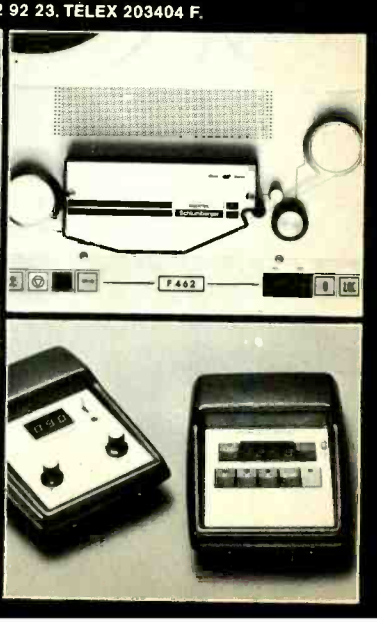

give 1.5dB less output than the main outputs from a source impedance of 1.8kΩ. Loading these outputs affected the monitor loudspeaker levels.

At the stereo headphone jack the maximum output level was identical to that at the main outputs with the source impedance varying with the headphone gain setting, being a maximum of 96Ω at maximum output gain. The headphone outputs appeared not to be buffered from the main outputs with the result that headphone loading can affect the main output levels.

SMPTE timecode connections comprised an opto isolated input with the diode rated at +1.6V at 5mA being compatible with 680Ω in series with a TTL input. The SMPTE output is derived from a *7407* TTL buffer with a 470Ω pull-up resistor to +5V.

Frequency response

The frequency response of the digital record/replay process was found to remain constant irrespective of the recording level up to the peak level, the response from 20Hz to 20kHz being within +0.1dB, −0.6dB as shown in **Fig 3**.

At high frequencies the −3dB point occurred at 21.985kHz for the left channel and 21.940kHz for the right channel with the attenuation becoming −50dB at 22.8kHz and −60dB at 62kHz. This overall characteristic is shown in **Fig 4**, there being a complete lack of aliasing.

In the input monitoring mode the frequency response is effectively unrestricted and flat from 12Hz to 20kHz with the −3dB points at 7Hz and 82kHz.

TABLE 1

Measurement method	Direct	Tape
2Hz to 200kHz unweighted RMS		−87.5dB
22Hz to 22kHz RMS band limited	−99.0dB	−92.5dB
A-weighted RMS	−100.0dB	−96.0dB
CCIR weighted RMS ref 1kHz	−93.0dB	−87.0dB
CCIR weighted quasi-peak ref 1kHz	−89.0dB	−83.5dB
CCIR/ARM ref 2kHz	−100.0dB	−94.5dB

Noise

Noise measured at the main outputs was referred to the peak recording level in both the direct to input and the digital replay modes with the impressive results shown in **Table 1**.

Both channels had a closely matched noise performance irrespective of replay gain. However, in the direct mode the noise varied mildly with the record gain setting, the quoted figures being the worst case which occurred in the −10dB gain area.

Whilst the outputs were completely free from power line hum significant amounts of the sampling frequency (50.400kHz) and its harmonics could be present in the line outputs. Peculiarly the levels were highest in the direct to input mode and depended upon the input and output gain settings, reaching almost 1mV in the worst case.

Distortion

As is inevitable with digital systems the minimum distortion occurs at the maximum recording levels until clipping occurs at the maximum level, the nature of the clipping at 1kHz being shown in **Fig 5**.

Measurement of the total harmonic distortion just below clipping gave 0.008% at 1kHz, 0.018% at 10kHz or 0.02% at 100Hz. At lower levels it is not possible to measure the total harmonic content due to noise and **Fig 6** shows the second and third

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FIG. 4 TELEFUNKEN MX80 HF RESPONSE

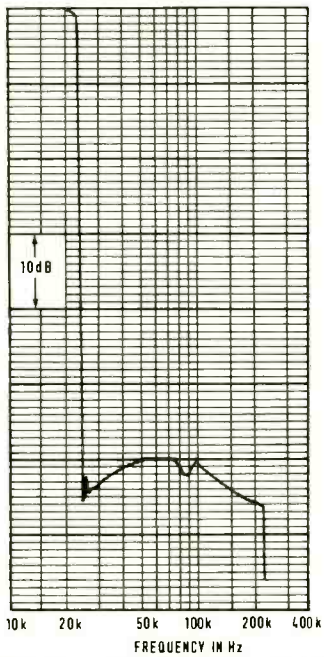


FIG. 5

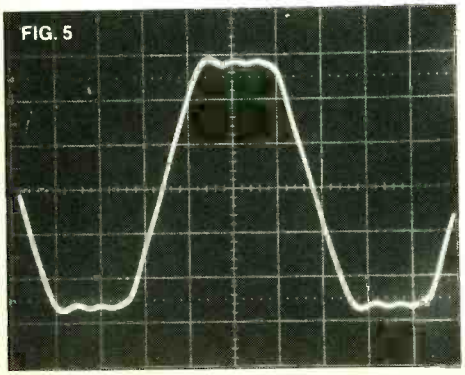


FIG. 6 TELEFUNKEN MX80 HARMONIC DISTORTION AT -50dB

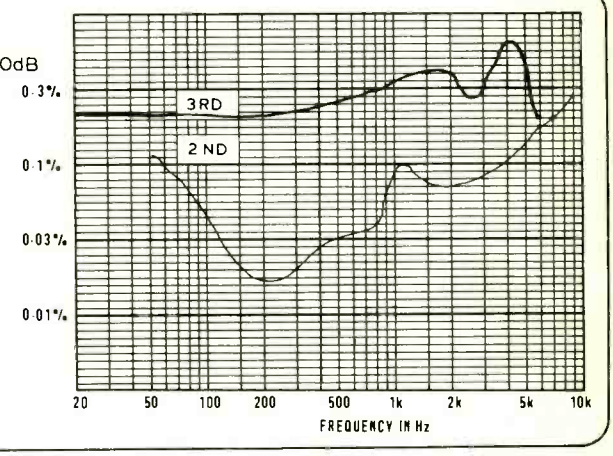
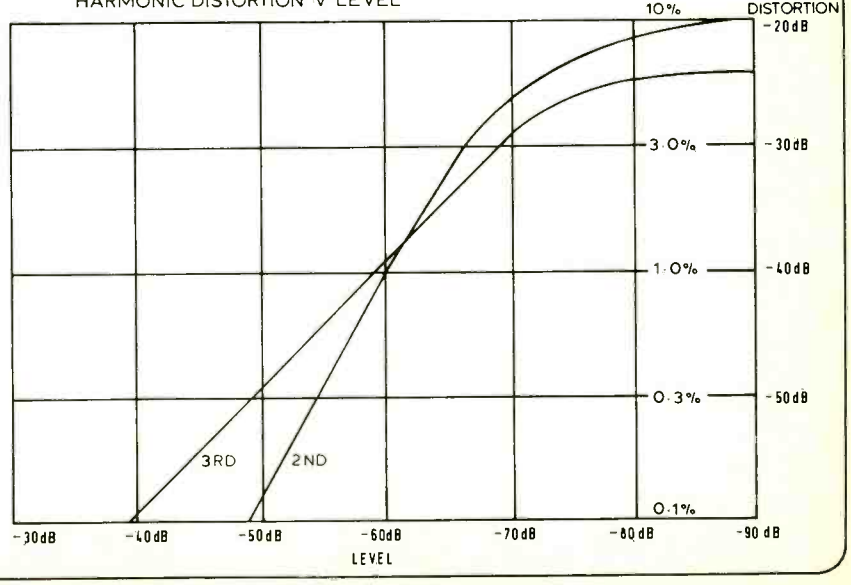


FIG. 7 TELEFUNKEN MX80 HARMONIC DISTORTION v LEVEL



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harmonics related to frequency at 50dB below the maximum level. As the level is progressively reduced the harmonic contents inevitably increase, the pattern being shown in **Fig 7** which clearly shows that analogue recorders are far superior to digital recorders at low levels so far as distortion is concerned.

CCIF difference tone type intermodulation distortion was measured near the peak level and at 50dB lower. Near peak level the distortion remained below 0.03% at frequencies up to 5kHz and then rising to 0.3% at 20kHz. At the lower level the distortion remained between 0.1% and 0.3% up to 20kHz.

Whilst tone bursts were passed sensibly through the recorder, the recording and replay of a 1.5kHz squarewave at any level produced the alarming ringing shown in **Fig 8**. This ringing did not occur in the input monitoring condition, but only when the signal had been recorded.

Level meters

Checking the rise and fall times and also the rectifier characteristics of the two VU meters showed that they were genuine VU meters meeting the requirements of American Standard C16.5. Furthermore the 0VU indication corresponded to a sinewave level 14dB below recorder clipping which is a sensible level for VU meters.

As with the VU meters the frequency response of the bar type peak indications was absolutely flat from 20Hz to 20kHz, the bar meters having a peak rectifier characteristic. The rise time of the peak meters was very fast at less than 100μs with the fall time being well arranged at 150ms giving good readability. The accuracy of the peak level indication was found to be good, it being particularly useful that the indications extended down to −54dB below clipping.

Other considerations

Wow and flutter in the digital mode was below measurable limits with no evidence of the interleaving/de-interleaving producing flutter. In fact the actual wow and flutter of the transport was measured as 0.05% IEC peak weighted on the analogue track. Similarly any phase jitter between the two outputs was very small at about 1μs.

Crosstalk between the left and right channels was found to be −83dB up to 2kHz, rising to −70dB at 20kHz—hardly any problem here.

Cue track

The sole purpose of the cue track is intended to be edit point location, so as such the cue track only requires a mediocre performance.

The 3% third harmonic distortion point of the cue track at 1kHz occurred at an input level indication of −3VU corresponding to +6dBm output when monitoring the cue output—this is 20dB below the digital peak recording level and perhaps reasonable. At this recording level the frequency response of the cue track is shown in **Fig 9** which demonstrates a more than adequate performance for the intended purpose.

Noise performance of the cue track was decidedly poor and a source of irritation, but here again, the performance is likely to be quite adequate for the intended purpose.

Table 2 shows the 3% MOL of the cue track referred to the noise.

TABLE 2

Measurement method	3% MOL to noise
22Hz to 22kHz RMS	−34.0dB
A weighted RMS	−37.0dB
CCIR weighted RMS ref 1kHz	−31.0dB
CCIR weighted quasi-peak ref 1kHz	−27.0dB
CCIR/ARM ref 2kHz	−37.5dB

Timecode track

The recording and reproduction of a 2.4kHz squarewave was accomplished with no sign of dropout either at the normal 15in/s tape speed or even in the fast wind condition with the cue button depressed. Rise time of the reproduced signal was 400ns with a clean wavefront, however the fall time was as shown in **Fig 10** with a severe overshoot extending to about −4V over a period of just under 100ns. Whilst this will not necessarily cause problems, the overshoot is clearly undesirable.

Editing

Unlike other digital machines the Telefunken machine allows cut and splice editing provided that certain precautions are taken. Firstly, edits must be at right angles to the tape edge, the machine automatically inserting a crossfade when it detects an edit.

Whilst the manufacturer recommends the use of 16μm thick splicing tape none of this was available at the time of the review, so I used normal 50μm tape. The use of gloves is also recommended when editing to avoid contamination of the tape but the machine had a remarkable tolerance to finger marks on the tape. Only severe damage or a too

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FIG. 8

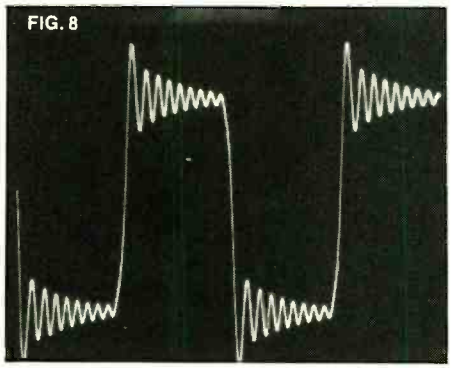


FIG. 10

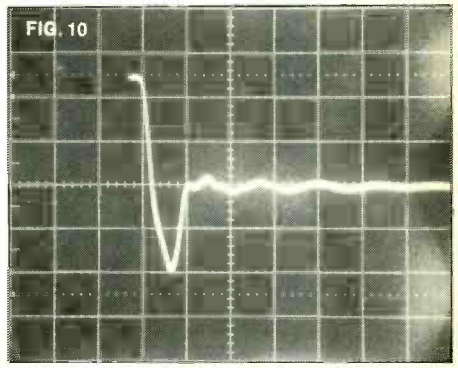
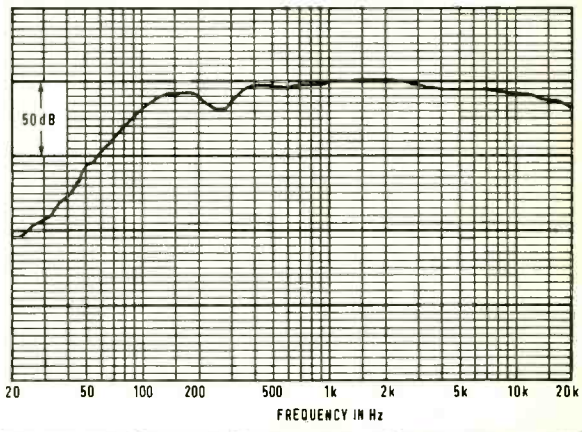


FIG. 9
TELEFUNKEN MX80
RESPONSE OF CUE TRACK



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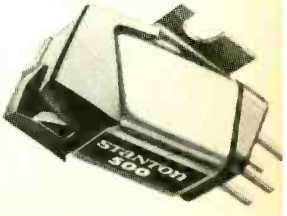

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wide a gap in the splice produced the type of dropout shown in **Fig 11** for a 1kHz tone.

In order to avoid tape damage edit points must be marked with a video type editing pen as opposed to a wax pen. When the splice is made a gap of 0.5mm between the edited tapes is recommended so that the machine can detect the edit and do a crossfade. As very thin tape is used extra patience is needed when editing and the dimensions of the gap are fairly critical. It is not however difficult to judge the acceptable gap and provided that it is not too large (say in excess of 0.7mm) the edit is properly detected without a dropout.

The capabilities of the crossfade mechanism are illustrated in **Fig 12** which in the top trace shows the effect of an edit in a 100Hz tone on the analogue cue track, the bottom trace shows the same edit as replayed in the digital mode.

Clearly a sinewave poses problems worse than live material when crossfading edits and a worst case edit in a 100Hz sinewave is shown in **Fig 13** —certainly a conventional analogue edit would not be better.

A final point on editing, dropping in is not possible as any attempt to drop in leaves a 1·3s erased gap.

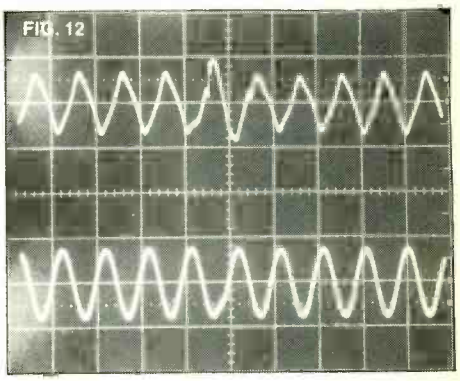
Summary
The ability to cut and splice edit digital recordings enables traditional editing techniques to be used and also eliminates the expense of an electronic editor. It is, however, understood that there will be an electronic editor for this machine.

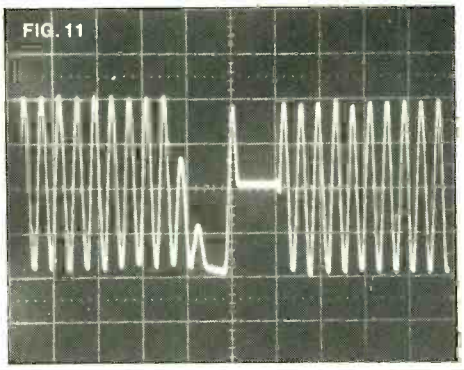
Overall the performance of the machine was excellent and it it a very well made unit which should be simple to service. The standard of mechanical construction of the tape transport is outstanding for a machine not of European origin.

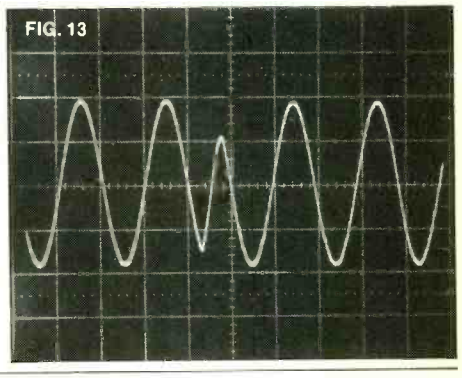
Clearly extra precautions are needed when using tape at such a high packing density, but the electronics seemed to be remarkably tolerant of tape errors.

The one severe criticism I have of this machine is the poor tape winding performance at high speeds which was such that tapes should not be removed from the machine until they have been rewound using the slow wind feature.

Hugh Ford







Telefunken DDL-1

MANUFACTURER'S SPECIFICATION
Inputs: two PCM channels.
Coding: 16-bit linear.
Sampling frequency: 50.4kHz.
Outputs: two delayed PCM channels; analogue preview signal.
Delay time: 0·01 to 1·95s (in 0·01s steps). Optionally extendable to 3·25s.
Preview output level: +4dBm.
Output impedance: suitable for 600Ω load (balanced).
Output connectors: *XLR-3-14* terminals.
Ambient temperature: 40°F to 90°F.
Power: 220VAC ±10%, 50Hz, power consumption 200VA.
Weight: 33lb (15kg).
Dimensions: (whd) 17⅜ × 7⅜ × 15in/440 × 187 × 380mm.
Manufacturer: Mitsubishi Electric Corp, Mitsubishi Denki Building, Marunouchi, Tokyo 100, Japan.
Europe: AEG-Telefunken Kommunikationstechnik AG, Bucklestrasse 1-5, D-7750 Konstanz, West Germany.
UK: Hayden Laboratories Limited, Chiltern Hill, Chalfont St. Peter, Gerrards Cross, Bucks.
USA: Mitsubishi Electric Inc, 7045 N Ridgeway Avenue, Lincolnwood, Illinois 60645.

THE TELEFUNKEN type *DDL-1* preview unit is specifically designed as an accessory for the *MX-80 Series* digital tape recorders to act as a preview and delay unit for disc cutting.

At the left of the front panel are the two operational controls, the illuminated power on/off switch and a second switch which selects delays for 33⅓RPM or 45RPM cutting. These separate delays are set by controls underneath a removable front panel the removal of which also reveals the plug-in printed circuit boards.

Two separate sets of three thumbwheel switches set the delays for the two speeds in 10ms increments. Above the switches a red LED is illuminated if the set delay time exceeds the available digital storage in the unit.

Normally the unit is supplied with six storage boards, three for each channel, giving a maximum 1,950ms delay. However, there is space for two sets of two further boards which then provide a maximum delay of 3,250ms.

The delay elements themselves consist of 32 *Type 4116* integrated circuits on each delay board, each integrated circuit storing 16,384 bits. The remaining boards consist of two register boards, a control board, an analogue board for digital to analogue conversion and a parity board. The latter adds a parity bit to the input data from the digital recorder and checks parity after the delay elements. Should a parity error be detected the sample is replaced with the last sample without a parity error.

The unit functions by taking the digital input data from the recorder and splitting it into two paths. In the preview path the data is D/A converted taking only the 12 most significant bits of the 16 available, and then passed to a lowpass filter and the analogue output amplifiers. This provides the preview output with a lower S/N ratio than the main signal, but there is no need to retain a large dynamic range in the preview signal.

From the input data the delayed signal is obtained by adding parity and then passing the data to a memory, the effective size of which is switched to provide the desired delay. The data read from the memory is parity checked and then passed back to the digital recorder where the internal 16 bit D/A converters are used to provide the best quality signal.

Interconnection with the recorder is by means of two 25-way *D* connectors at the rear of the unit. It is surprising that these were used, as only nine pins on each are used. Neither ends of the leads had locking devices and it was all too easy to accidentally disconnect them.

The remaining rear panel features include two *XLR-type* preview audio outputs and a modified IEC type power socket with its nearby fuse.

Within the unit the power is fed to a 240/110V transformer and thence to +5V and +12V switching type power supplies for the digital logic. A separate ±15V supply feeds the audio output section.

A card frame with wire wrap sockets houses the

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PCBs, with the exception of the analogue output board which is at the rear of the unit. Construction of the PCBs was to a high standard with clear component identifications, and the hand wiring that did exist was quite tidy.

Mechanically this is a free standing unit and whilst the width is suitable for rack mounting there is no provision for rack mounting ears and I do not feel that the mechanical construction is solid enough to tolerate safe rack mounting.

Outputs

The audio outputs which are floating and transformer coupled offered a maximum output level of +19.4dB Ref 0.7V or +18.1dBm loaded into 600Ω. The output impedance was measured as 94Ω.

As with the *MX-80* recorder's output, severe ringing occurred with 1kHz squarewaves irrespective of the output loading.

TABLE 1

Peak signal level to noise ratio

	No signal		With signal	
Measurement method	left	right	left	right
Unweighted 2Hz to 200kHz RMS	71.4dB	70.4dB	70.0dB	68.7dB
Unweighted 22Hz to 22kHz RMS	101.4dB	93.4dB	71.8dB	70.4dB
A-weighted RMS	99.4dB	95.9dB	73.9dB	71.9dB
CCIR-weighted RMS ref 1kHz	92.9dB	87.9dB	65.4dB	63.4dB
CCIR-weighted quasi-peak ref 1kHz	89.4dB	84.4dB	59.4dB	58.9dB
CCIR/ARM ref 2kHz	99.4dB	94.4dB	72.4dB	69.9dB

TABLE 2

Level	Second harmonic			Third harmonic		
	100Hz	1kHz	10kHz	100Hz	1kHz	10kHz
Peak	0.06%	0.06%	0.06%	<0.02%	<0.02%	0.03%
−10dB	0.06%	0.03%	0.08%	0.03%	0.04%	<0.01%
−20dB	<0.02%	<0.02%	0.30%	0.10%	0.03%	<0.01%
−30dB	<0.02%	<0.02%	1.00%	0.30%	0.40%	<0.01%
−40dB	<0.10%	0.40%	3.00%	1.60%	1.00%	<0.10%

Frequency response

Whilst the delay unit has no effect upon the recorder's frequency response, the response at the preview output is another matter.

Fig 1 shows the performance of the preview output at 10dB intervals below overload, it being seen that the high frequency rolloff remains constant with level. The −1dB point occurred at 10.6kHz, −2dB at 16kHz and −3dB at 19.2kHz. At low frequencies trouble was experienced with instability which depended upon the level and also the output loading. Below the minimum frequencies show in **Fig 1** the output distorted seriously and the gain locked up. This potentially serious complaint is thought to be associated with the 3.5dB boost at 5.4Hz shown at −30dB in **Fig 1**. At lower levels this boost became a very serious matter to the extent of a 10dB error at 6.9Hz as shown in **Fig 2.**

Noise

In the absence of an audio signal the output had very low noise, but the application of a low level signal opened up the output as with a noise gate. Indeed, when listening to low level recordings at the preview output the audio cut in and out, just as with a noise gate. This occurred at 70dB below peak recording level, with severe quantising noise occurring at higher levels.

The noise performance was measured without an input signal and also using a 1kHz probe tone which was removed by a notch filter at the output at which noise was measured. In practice this noise was effectively constant with signal level but there was some significant noise difference between the two channels as shown in **Table 1**.

I have doubts if these matters are significant when using the preview signal for disc cutting, but there is certainly no pleasure in listening to the preview signal. However, the delay unit had no effect upon the delayed output from the recorder.

FIG.1 TELEFUNKEN DDL-1 OUTPUT

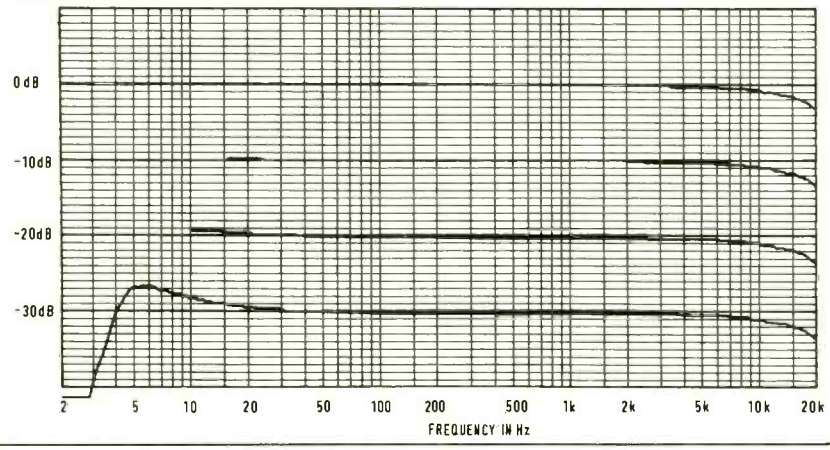
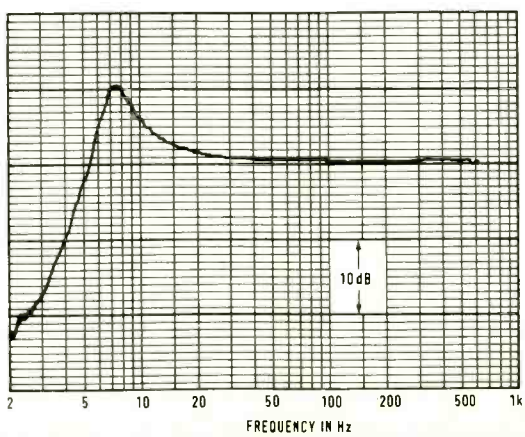


FIG.2
TELEFUNKEN DDL-1
LF ERRORS AT LOW LEVEL



Distortion

Harmonic distortion was measured at 10kHz, 1kHz and 100Hz at recording levels in 10dB steps below peak level (**Table 2**). Clearly the above performance is more than adequate for normal preview use.

Time delay

The actual delay time between the preview output and the main recorder outputs was measured at various delay time settings and found to be consistently 0.188% short which is of little consequence, the delay being controlled by a 2MHz crystal oscillator.

Summary

The *DDL-1* delay unit had no effect whatsoever on the recorder's output signal, other than providing the desired delay. The available delay time as standard extending to 1,920ms nominal is just in excess of one disc revolution at 33⅓RPM, this occupying 1,800ms.

Whilst the delay can be extended to 3·25s by adding more memory, this delay is not sufficient for half speed cutting if a full revolution of delay is desired.

So far as the preview output is concerned, as this uses 12 bits the distortion performance is degraded as is the noise in comparison with the recorder's output. However, for disc cutting preview use this is not significant.

The one matter of concern in this unit was the instability at very low frequencies which should not be too difficult to rectify. **Hugh Ford**

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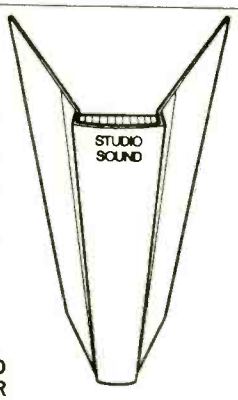

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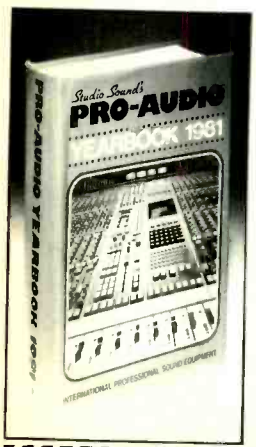

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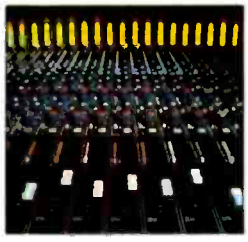

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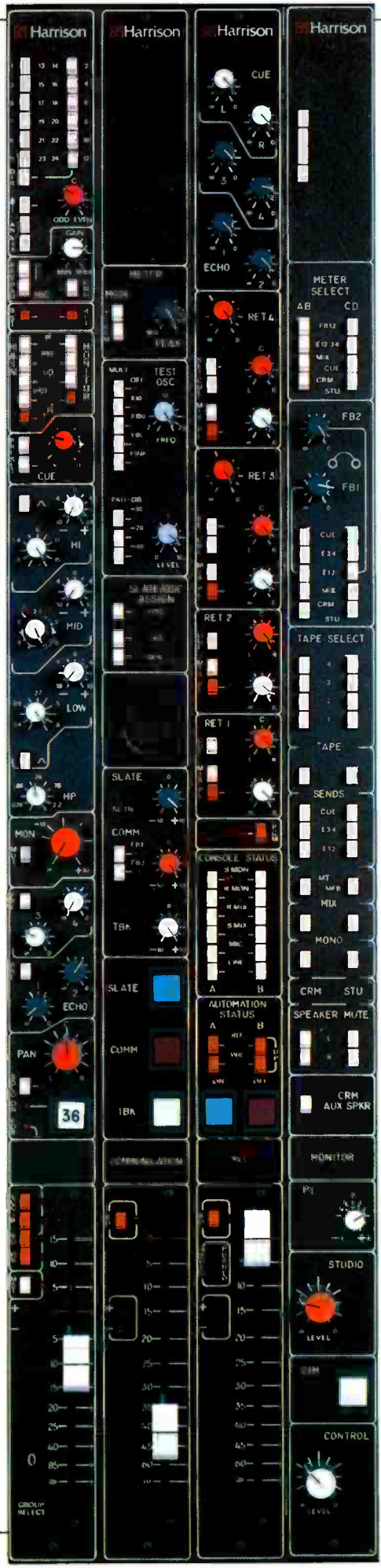

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