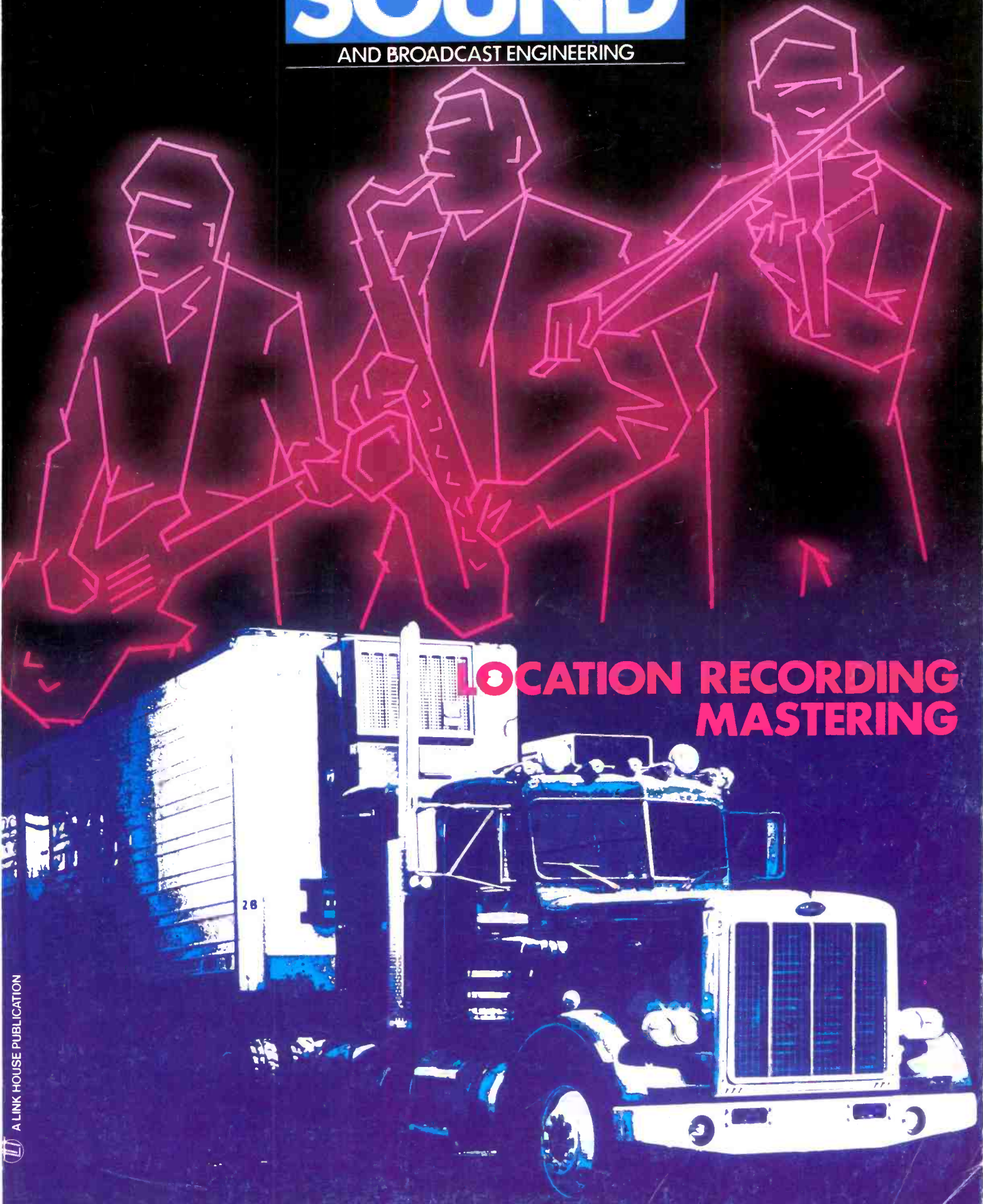


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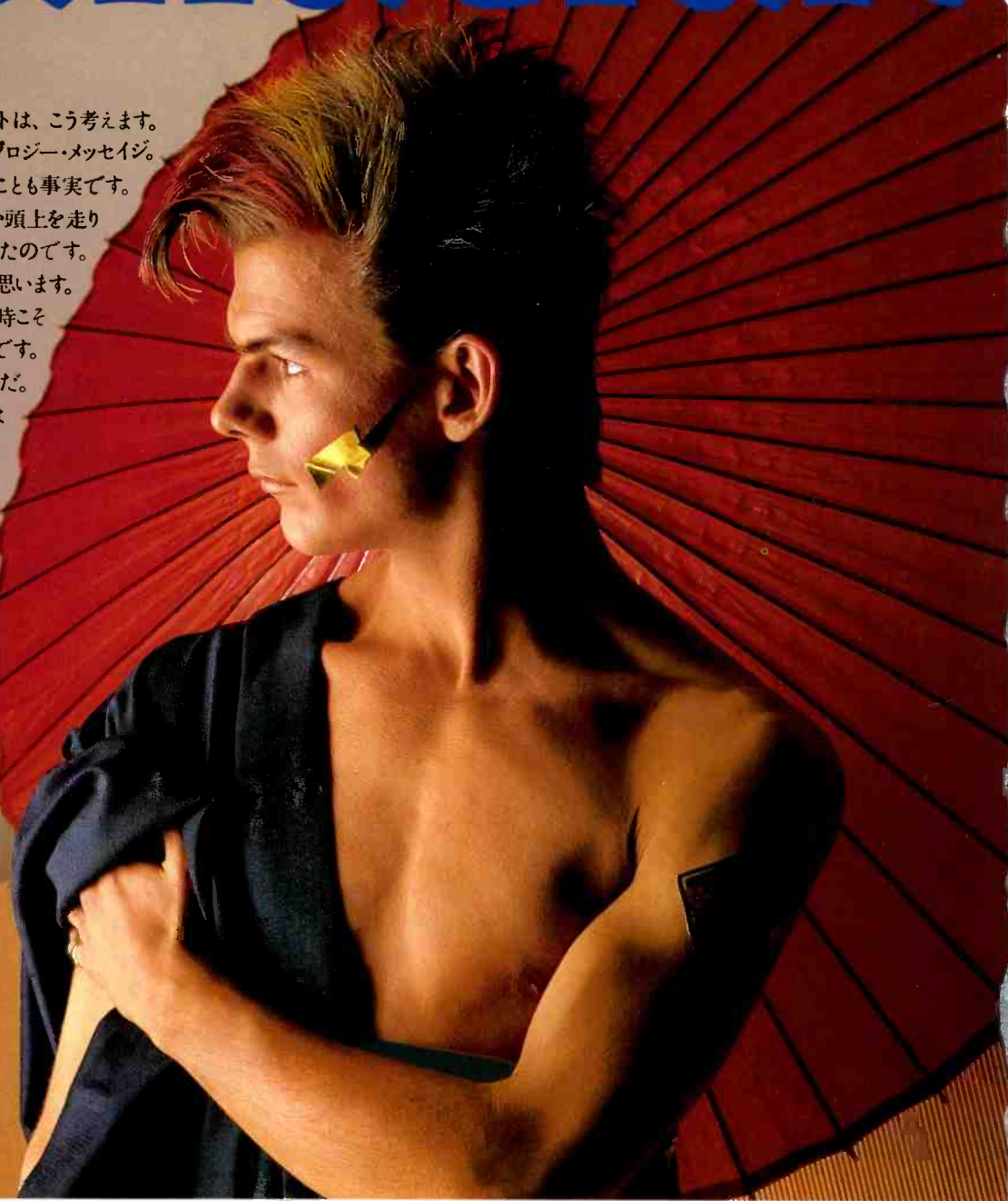
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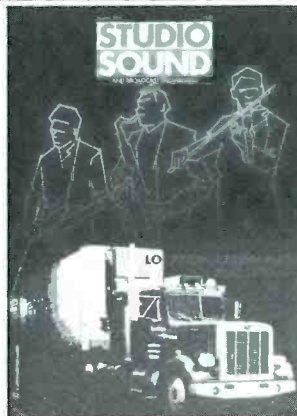
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IMPORTANT ANNOUNCEMENT

Sony PCMF1/SLF1



Sony PCM701ES/SLC9



To clear any confusion or misunderstanding about the above Sony Digital recording products, please be advised:

1 The Sony PCMF1 is still in production in Japan, and is available from HHB. The Sony SLF1 video recorder has indeed ceased production, but HHB has managed to secure limited numbers of these desirable machines.

2 It should also be borne in mind that an alternative system exists for applications where portability is not essential. This system comprises the Sony PCM701ES processor – identical in function and compatibility to the PCMF1 and SLC9 video recorder.

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EDITORIAL

EDITORIAL

Good guys and bad guys

In recent months the recording industry has, through SPARS, APRS and a number of professional publications including *Studio Sound*, brought a degree of honesty to the record companies over the issue of 'digital' labelling of CD releases. Although they probably will not admit the fact, they grudgingly accepted the recommendations at levels ranging from full embracement to quietly stopping previous dubious practices—and only just in time. If the issue had not become so widely publicised when it was, the consumer press would have had all the ammunition it needed to wrap up their confused feelings over CD and this cuckoo in their nest would have been influentially dumped. The record companies don't know how lucky they were.

From where I stand, and I imagine most of the industry, this issue was basic. We, the recording industry were the Good Guys and they, the record companies were the Bad Guys, although I might allow them to plead blissful ignorance. There are, however, questions that we as a professional industry ought perhaps to ask ourselves where the issues are not so clear and in many ways *we* might be seen as Bad Guys.

Before this CD labelling question, there was another long term bubbler—how live is a live recording? Or perhaps more practically—how live ought a live recording to be? It was never answered. Tales were rife of albums that were completely re-recorded keeping only the audience and bass drum from the original live location recording. There are even stories of overdubbing different audiences when the response of the original was not as enthused as the artist might have hoped. A recent straw poll of a number of mobiles and studios who mix a lot of live albums showed that 50% said it doesn't happen as much as it used to, and the other 50% said that it happened more now although they didn't do much of it themselves. Make your own mind up or perhaps you know better.

There are of course many reasons for such repair jobs. There can really be little to fault the actual process of improving live recordings as such and I have actually done it myself. The question must be, however, how much can you alter, replace, repair, etc, and still describe the recording as live on the finished product? This is perhaps the opposite of the CD issue in that here we are trying to pass a technically superior product off as what is sometimes recognised as not usually to such a level, rather than pretend that an 'inferior' product is really something better. However, surely the question must be put—we may be tacitly approving of a misleading statement that is in fact giving a better product but is not what it claims to be. The ethics are far from clear and it surely must be a matter of

degree. Completely wrong, I feel though, is the addition of stacked harmonies and instruments, etc, that were not present on stage at the original recording. If we consider the live album as an advert for an artist, then presenting as a live performance something that is far from a real live performance is wrong.

This occurrence is not restricted to disc by any means. There was recently a promo video from a well known Irish band where they were very clearly miming to a backing track with vocals for half of the clip and this was shot from the front of the stage. There were then shots of the backs of the band taken from the rear of the stage looking out into the audience which were undoubtedly from a live show. By intercutting these shots it produced a clip that looked like a live recording but due to the limited camera angles, lack of continuity of stage lighting and positioning of the singer were patently not. No claims were made that it was live but the attempt was obviously to make this band appear to be far superior on stage than they really are.

While on the subject of live recording—if the audience are going to be the only live part of a 'live' recording perhaps more attention could be paid to the art of recording them. Straight clapping simply sounds like rain on a tin roof and is almost impossible to record in a way that sounds right. However the positioning of audience mics is critical—too high above the audience and the response sounds single level; and too close a pair of mics gives a stereo image of two separate audiences or at worst, you have spot miked the one idiot in the audience. Some of the best audience recordings that I have heard were with multi-mic techniques to try to capture the full variety of audience sounds. Very good examples of this technique were to be found on the TV special recordings made by Ruggles-Reeber & Associates who have had to apply themselves to this area so that they can obtain a proper audience sound for Tate surround sound.

A further thought—with the increased use of electronic instruments on stage and the studio, there are some bands that are recorded completely DI'd excepting the vocal mic. The output of the instruments will sound the same on stage as in the studio. In cases where this is taken even further and the instruments are under sequencer/memory control simply replaying their memories used for the recording—the concept of the live performance as being an interaction between audience and artist is subtly destroyed.

How long will it be before the audience, as the only truly live part of such a 'live' recording, decide that it is time to collect their royalties.

Keith Spencer-Allen

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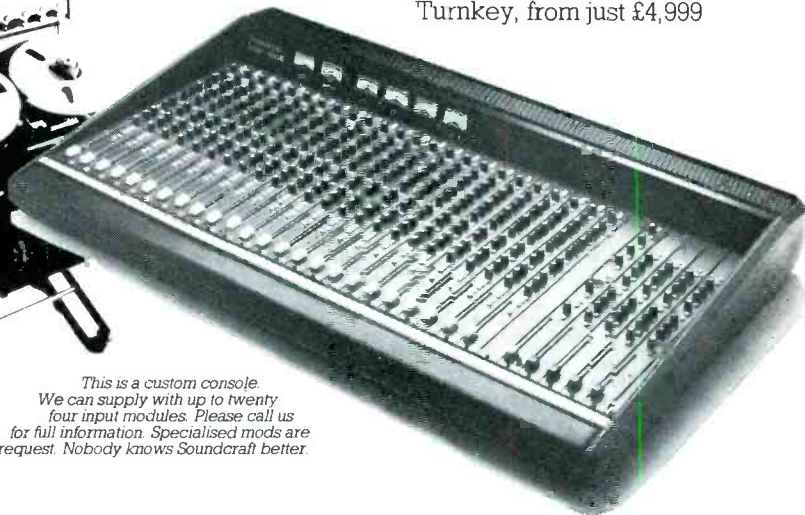
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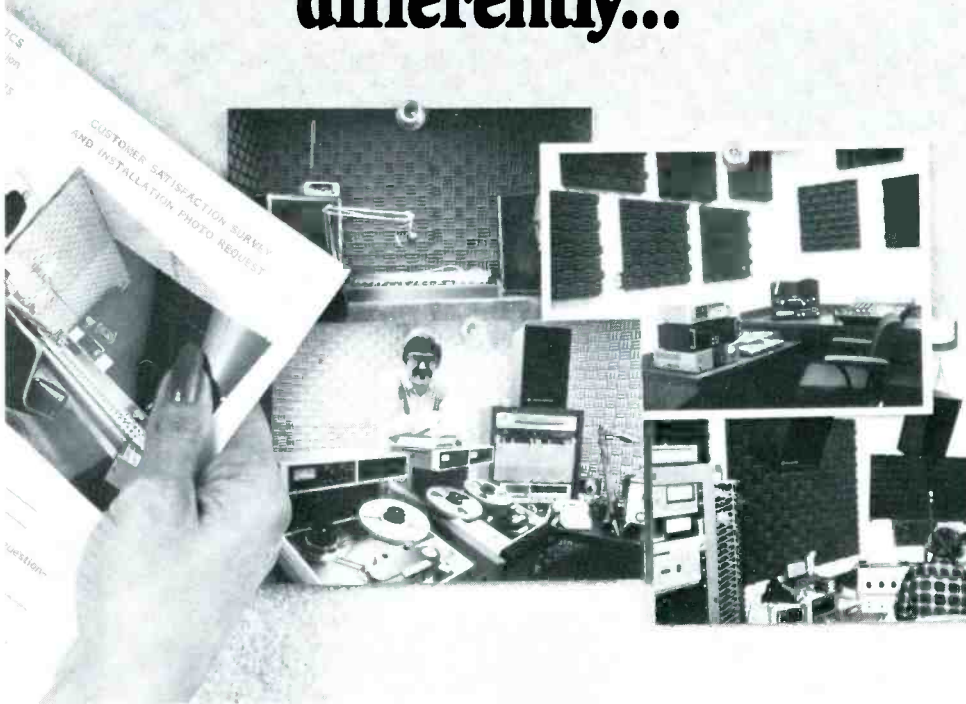


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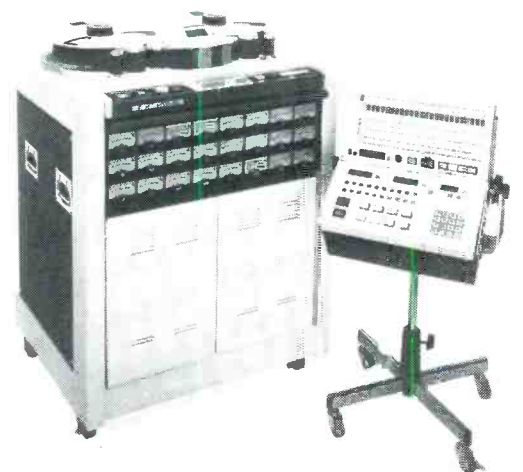
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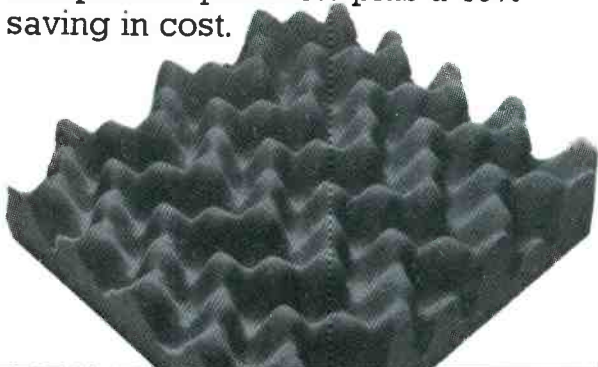
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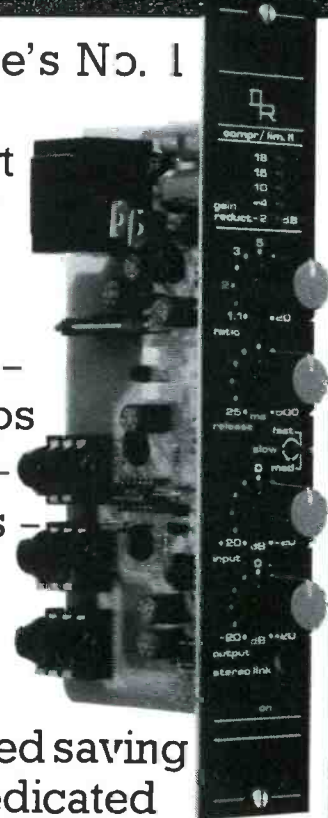
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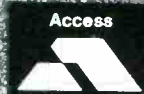
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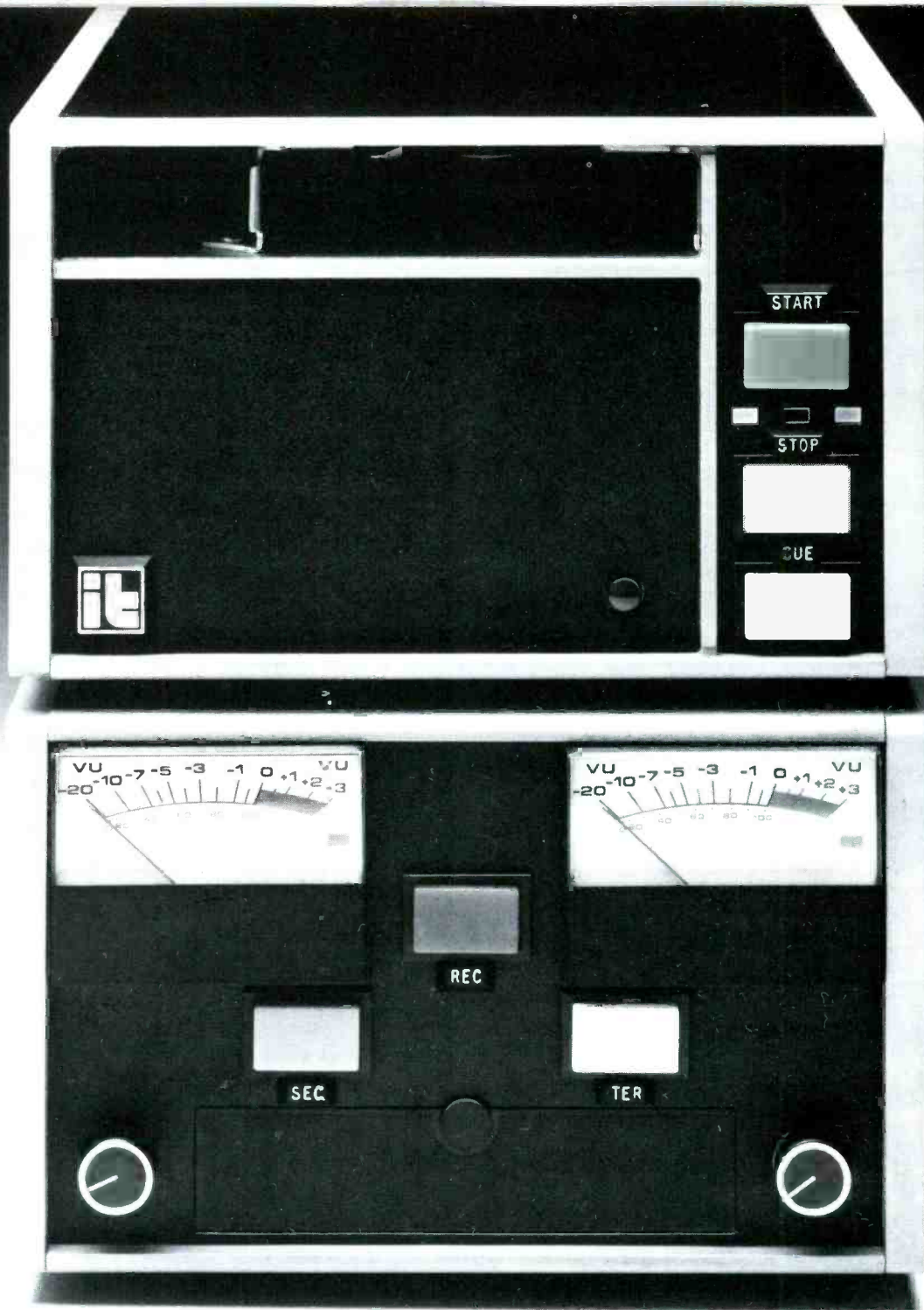
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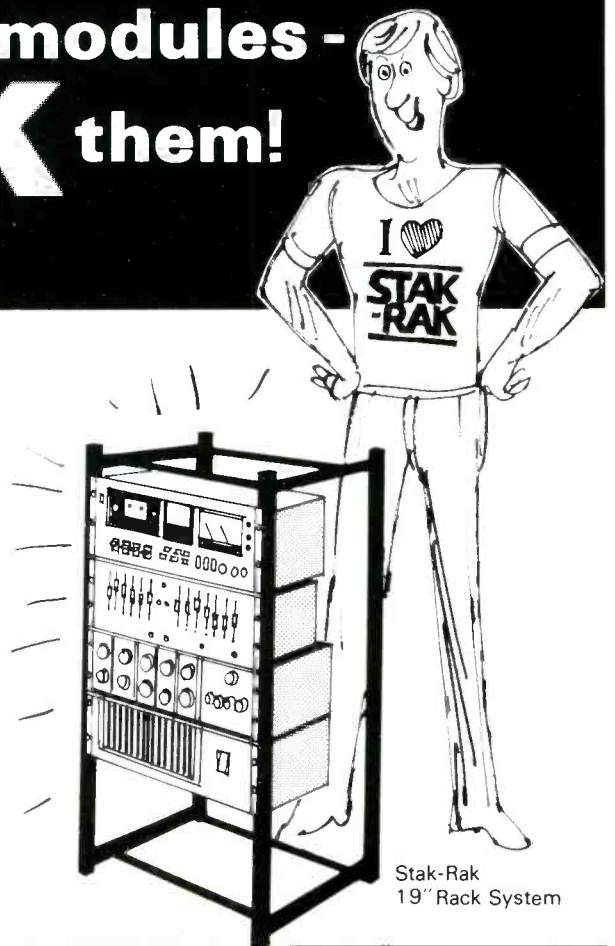
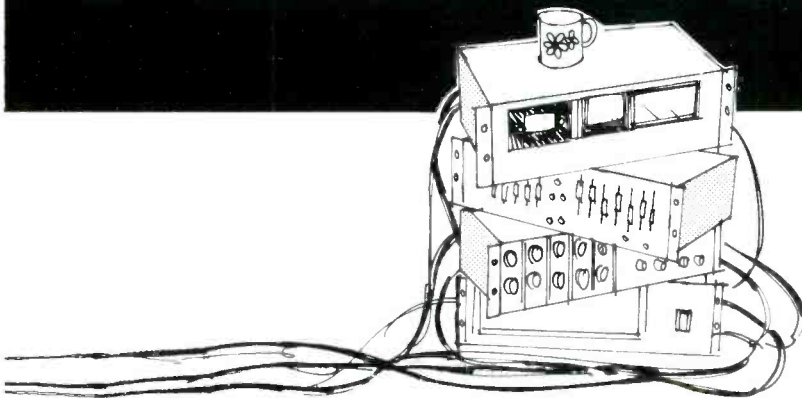
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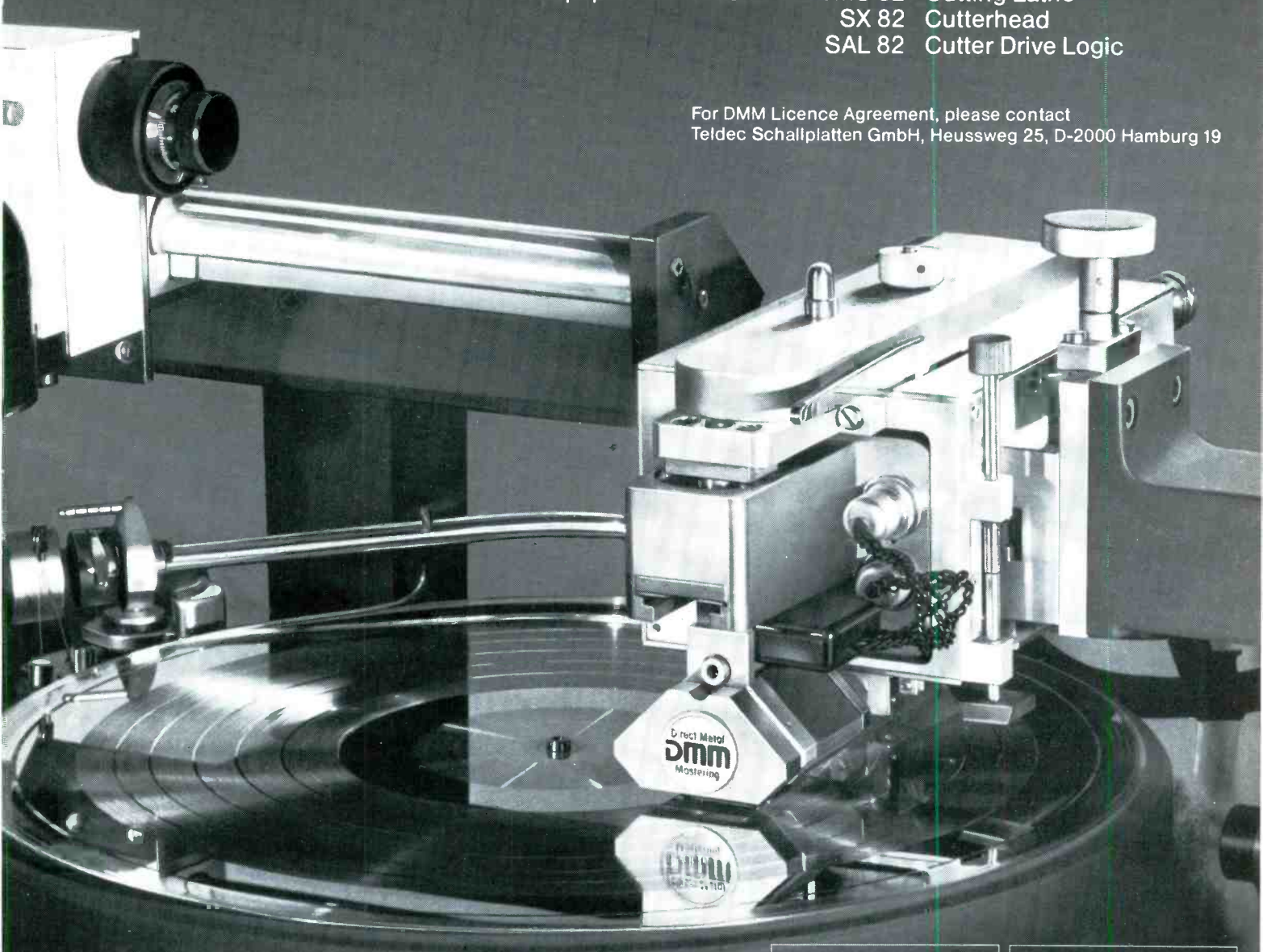
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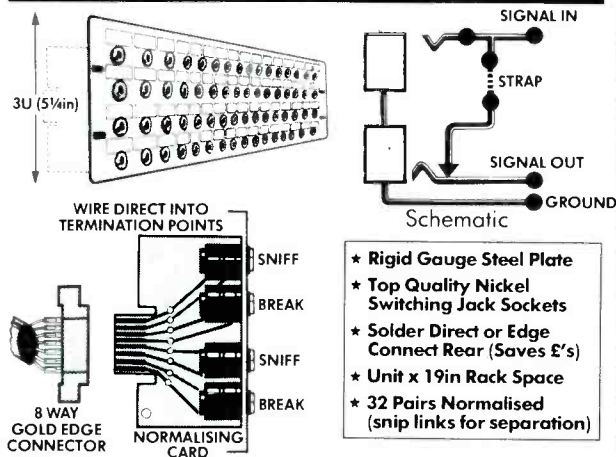
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Gain Brain II

Widely adjustable limiter/compressor and ducker, specially designed for production work. Major advantages include 'natural' quality of sound, flatness of VU and improved low frequency performance.

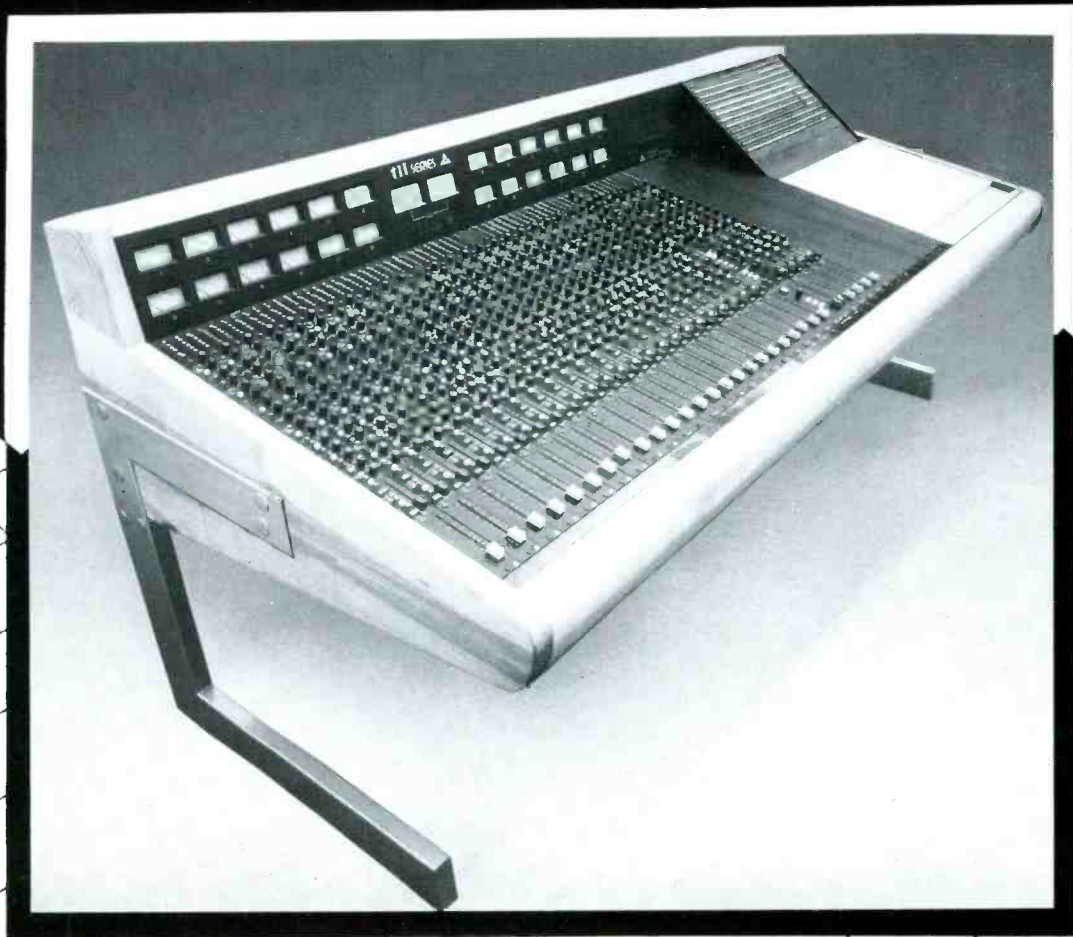
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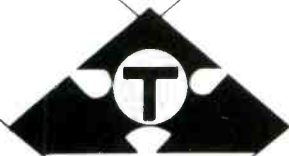
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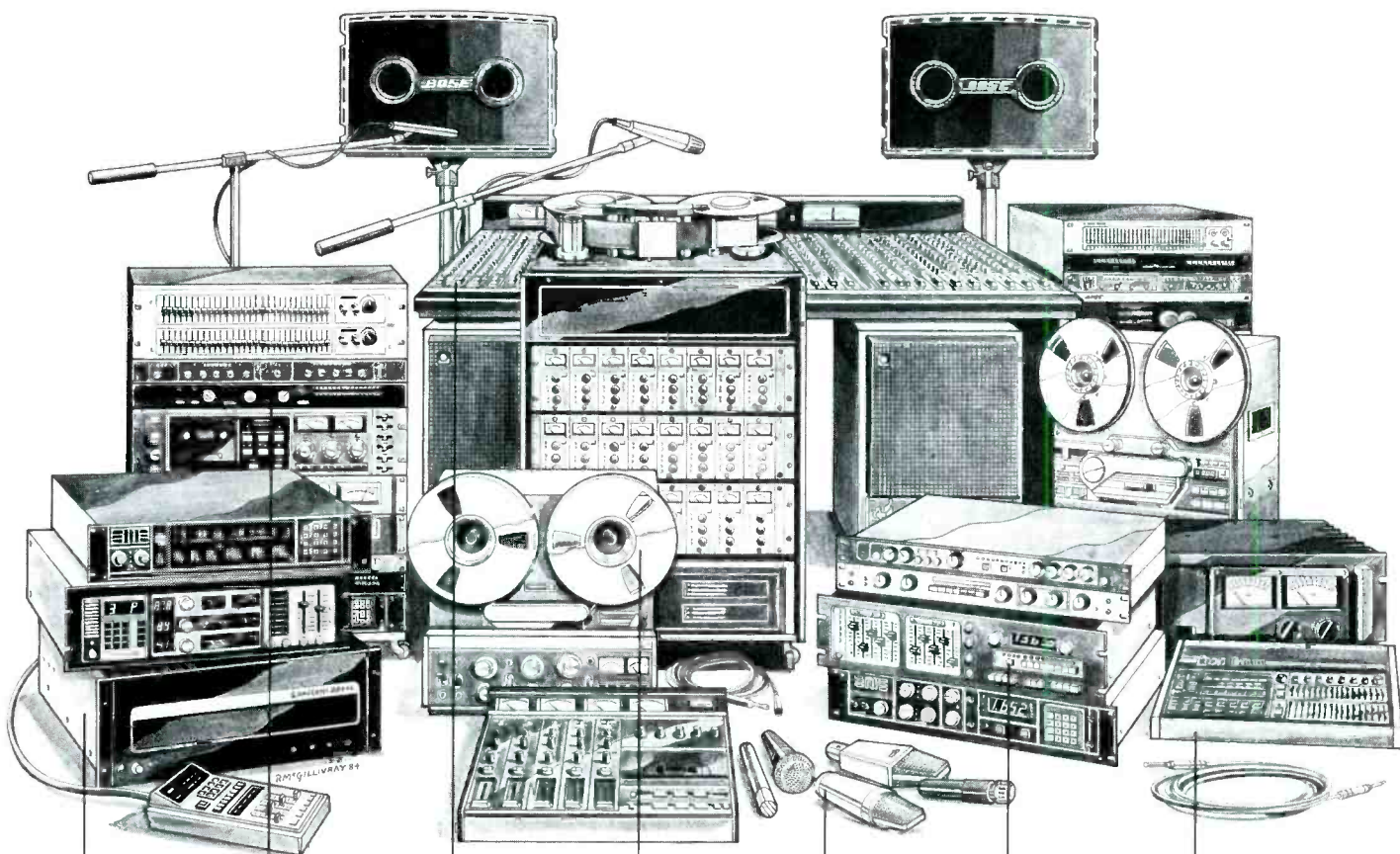
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When we set out to develop the industry's most advanced line of stage microphones, we insisted that every mic be able to stand up to brutal spl's without distorting or changing tonal characteristics. We demanded the same ruggedness and reliability that have made Fender famous. And we wanted every microphone to sound better than the popular competitors in its class — plus deliver unbeatable value to boot.

After thousands of hours of critical testing and refinement, we're satisfied that we've achieved our goals.

D-Series Dynamics

Designed with singers in mind, the D-Series mics feature the special warmth and presence of a fine dynamic, with carefully controlled directionality that minimizes leakage and feedback. Smooth off-axis response and effective shock mounting and blast filtering make them shine in hand-held applications.

P-Series Condensers

A microphone breakthrough that combines the ruggedness and high spl tolerance of a well-designed dynamic mic with the precise, wide-range response and open, uncolored sound of a condenser. Among the select few studio-quality mics that can stand up to the rigors of the road.

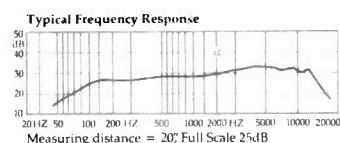
M-1 Miniature System

A whole new approach to microphony. The fingertip-sized condenser element combines ruler-flat response with ultra-high spl capability to handle the most difficult tasks. A wide range of optional accessories extend the M-1's versatility.



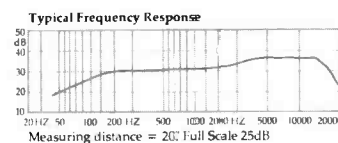
D-1 Dynamic Microphone

The exciting new D-1 directly challenges the most popular vocal mics on the road today—and emerges the clear winner in price/performance comparisons. Features a well-behaved cardioid pickup pattern, smooth off-axis response, and superior shock mounting—plus the presence lift and bass proximity effect that enhance vocal reproduction. \$70 (suggested retail).



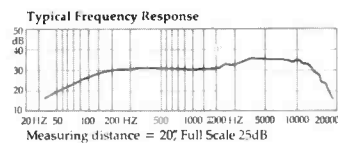
D-2 Dynamic Microphone

The satisfying heft of the D-2's satin gunmetal case and the smooth, seductive sound it lends to vocals place it a step above other dynamic mics. Its low harmonic distortion and high spl capability tell part of the story—but specs alone can't convey the D-2's natural, well-balanced, exceptionally musical sound quality. \$137 (suggested retail).



D-3 Slim-Line Dynamic

Finally, a great performance mic designed specifically for the smaller hand—with an elegant, slimmed-down case and a response curve that's carefully shaped for warmth and smoothness. And the thin profile doesn't sacrifice directional characteristics or ruggedness. A stunning new combination of great looks, sound, and value. \$149 (suggested retail).



The Truth Comes Out.



P-1 Condenser Microphone

This superbly accurate, multi-purpose mic uses Fender's breakthrough technology in permanently charged condensers. It can reproduce blistering sound levels of over 150 dB without overload. Four switch-selectable response options allow tailoring of frequency response for virtually any application. External phantom or battery powered. \$220 (suggested retail).

P-2 Condenser Microphone

With the same advanced element technology as the P-1, this economical mic offers much of the same great performance. Consistent on- and off-axis sound and amazing ruggedness make it an unbeatable all-around stage mic with studio-quality sound. Like the P-2, the P-1 is covered by Fender's 1-year Road Hazard™ warranty. \$99 (suggested retail).

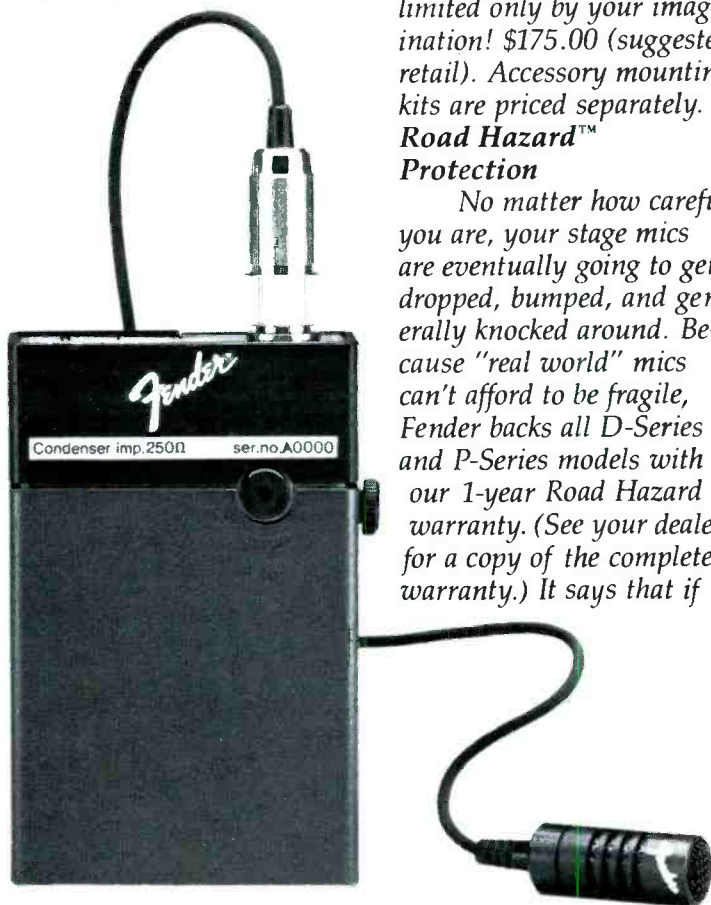
M-1 Miniature Condenser Microphone System

A brilliant bit of Fender applications engineering that opens the door to a whole range of innovative microphone techniques. The high-performance cardioid

you the freedom to get as close as you like to any sound source. Special, optional application kits let you mount the M-1 to a drum stand, an acoustic guitar, a headset or eyeglass frame. The possibilities are limited only by your imagination! \$175.00 (suggested retail). Accessory mounting kits are priced separately.

Road Hazard™ Protection

No matter how careful you are, your stage mics are eventually going to get dropped, bumped, and generally knocked around. Because "real world" mics can't afford to be fragile, Fender backs all D-Series and P-Series models with our 1-year Road Hazard warranty. (See your dealer for a copy of the complete warranty.) It says that if

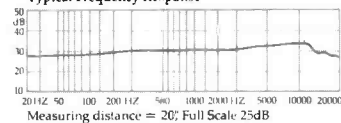


condenser pickup fits virtually anywhere. The M-1 features a pocket-sized pre-amp box that's packed full of features. Its notch filter (tunable from 50 to 320 Hz) increases gain before feedback at least 6dB in acoustic guitar applications. There's also a music/voice switch for reducing breath blast and excessive proximity effect. The M-1 is able to withstand an incredible 150+ dB spl. This gives

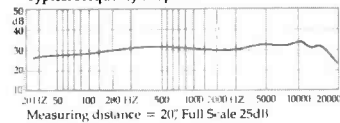
the microphone fails to operate for any reason, Fender will repair or replace it at no charge.

You can see and hear our exciting new line of stage mics now at your Fender Pro Sound dealer.

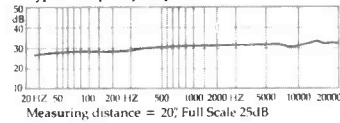
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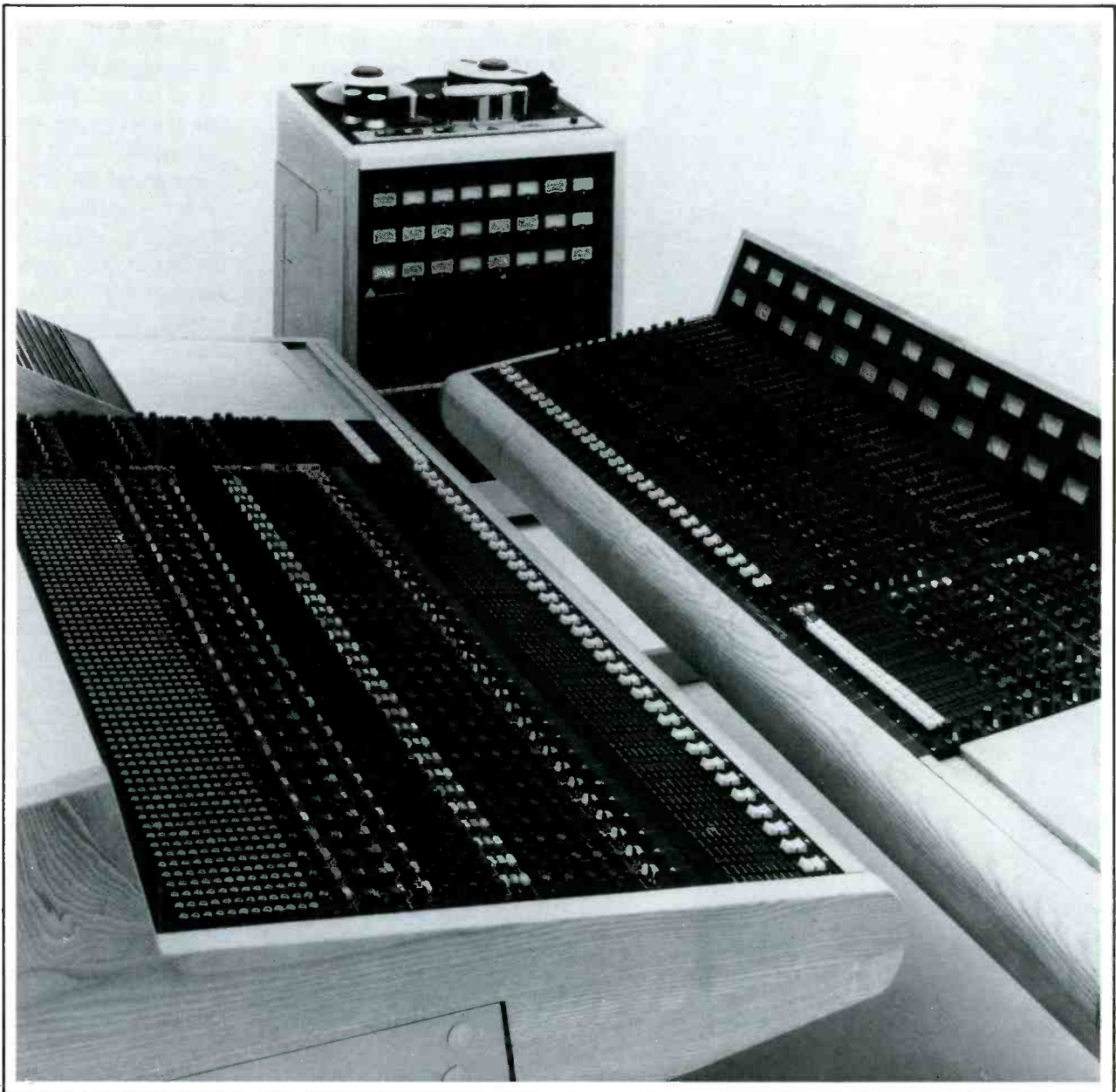
Typical Frequency Response



Typical Frequency Response



In a word, Trident



For the committed professional there is one word that represents the highest standards in studio hardware – Trident.

The Series 70/Series 80B consoles and TSR machine are production engineered to the quality you associate with Trident. Off the shelf or customized you've never been able to buy a Trident for less.

Using the TSR multitrack machine as the foundation of the system, Trident packages cover advanced recording for the producer's studio up to full industry standard.

The range consists of TSR 16 and 24 track machines, supplied with remote controls

and full auto locator at a price that foreign imports can't match.

The Series 80B is a 32 input, 24 group/monitor console, and the Series 70 is a 28 input, 16 group 24 monitor console. Both desks are fitted with a fully professional patchbay, 4 echo returns with EQ, and have the facility to use the monitor section as further inputs on remix.

Your limit isn't 32 inputs, Trident's engineers will design you an individual 56 input console at a price which will impress your bank manager.

So don't mince words – say Trident.

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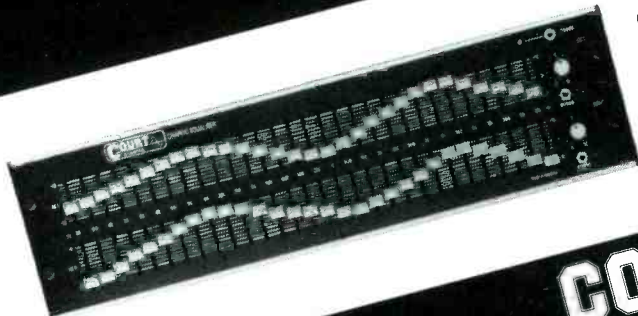
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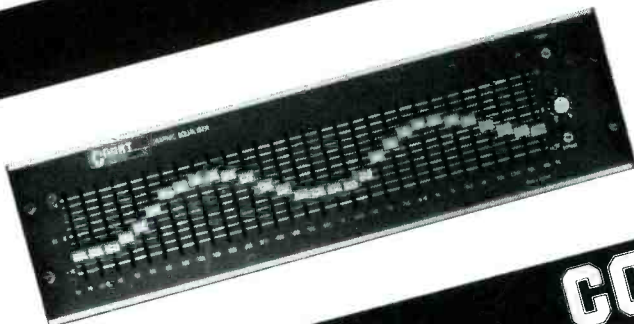
COURT ACOUSTICS

GE 60 — recognised as the most comprehensive Graphic Equaliser on the market, uses large coils as part of a multiple LC network. The GE 60 is not only suitable for equalising sound systems, but, as an indication of its "music" quality, is used by leading recording studios for musical instrument equalisation — the ultimate quality requirement.



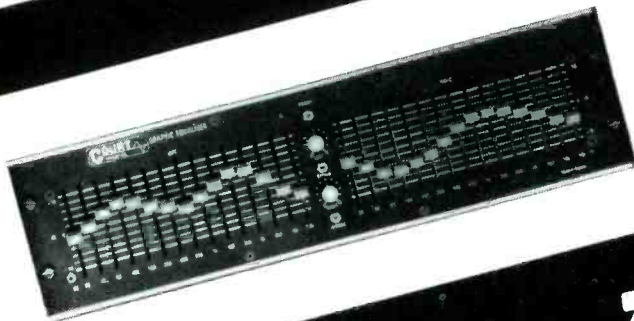
COURT ACOUSTICS

GE 30 — a single channel unit, identical in performance and construction to the GE 60, but with the large 60mm travel faders for more accurate control of the audio spectrum.



COURT ACOUSTICS

GE 1515 — for applications where equalisation is required, but with 15 wide band filters rather than 30 narrow band, making it ideal for clubs, PA, discotheques and studios.
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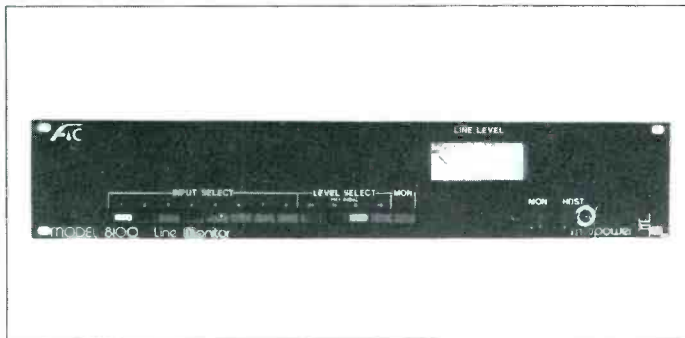
Advancing line monitor

Model 8100 is a new line monitor from the Advancing Technology Company. Signal levels are displayed on a backlit VU meter whose sensitivity is selectable for -20, -10, 0 and +8 dBm ref the VUs zero level. Front panel switching permits the monitoring of eight line sources, the input itself being 600 Ω balanced.

An internal MOSFET

amplifier can drive an external 8 Ω speaker, and there is also provision for headphone use via a panel-mounted jack. The 8100 comes in a 19 in rack-mountable cabinet.

Advancing Technology Company, 27106 46th Avenue South, Kent, WA 98032, USA. Tel: (206) 854-1044.



RTW studio processor set

The RTW *PCM-Set 2* is a 2-unit digital processor and interface set designed for professional applications. The pair comprises a modified Sony *PCM 701* and RTW's Interface *AD2*. The latter enables the *701*'s performance as a 16-bit digital processor to be exploited in studio and broadcast applications. The combination offers: balanced line level matching with *XLR* signal socketry; a digital interface for direct bit-to-bit copying on Sony's *1610* professional system; error correction displays; a headroom control (to allow the optimisation of record level versus dynamic range of programme); status displays

and switches for audio mute, mute hold, copy prohibit, pre-emphasis, video copy, NTSC/PAL and external meter; and RTW's (optional) peak-reading meter.

RTW see the combination as ideal for use as a digital master recorder in studios, as a PCM playback unit for conversion from EIA-J 16-bit to PCM *1610* code, or for digital live recording.

Radio-Technische Werkstätten GmbH, Elbeallee 19, Postfach 710654, D-5000, Köln 71, West Germany. Tel: (0221) 701055.

UK: Feldon Audio, 126 Great Portland Street, London W1N 5PH. Tel: 01-580 4314.

ADA multi-effects

ADA Signal Processors' *2FX* digital multi-effects box is claimed to be the only professional digital delay processor to be able to produce two effects at once. The *2FX* has separate controls for each of its Flanger, Chorus and Delay facilities. Flanger or Chorus can be used simultaneously with the Delay or Repeat Hold functions, and there is a patch switching system to allow the positioning of effects within the signal

processing chain. An optional foot switch unit provides control of Bypass/Effect selection and has a memory function which can hold a variety of preset effects, these being accessed 'at a tap'. A delay of over 1 s for 17 kHz bandwidth and a 10:1 flanger sweep range are features.

Analog Digital Associates, 2316 Fourth Street, Berkeley, CA 94710, USA. Tel: (415) 548-1311/(800) 241-8888. Telex: 470880.



Electro-Harmonix 64-Second looper

Big brother to their well-known 16 s unit, Electro-Harmonix' new 64 s *Digital Looping Recorder* has all the functions of the smaller unit (built-in click track, sound-on-sound with infinite hold, reverse playback, double or half speed, digital chorus and flanging) plus a host of new features.

Maximum delay now is 64 s, ie 15 Hz to 12 kHz bandwidth is available out to 8 s; the minimum delay approaches zero so that short, slap-back echoes are feasible; there is a 4-digit readout of total loop length; an Echo Tap Control provides for accurate sync with the beats of a rhythm machine; a 10-LED display which shows the echo tap setting and progress through

the loop; a Fast Erase which silences the entire memory in just 4 s; an inter-clock facility to allow one recorder to control the rates of several other units; a Low Frequency Sync Input for external control of the clock (for rhythm units, etc); an extra input for mixing in the output of a rhythm unit without recording it.

19 in rack mounting in two standard spaces, professional *XLR* socketry and standard studio signal levels are additional features. Provision is also made for using Electro-Harmonix' 6-function remote foot controller.

Electro-Harmonix, 27 West 23rd Street, New York, NY10010, USA. Tel: (212) 741-1770.

Advantage noise and level meter

Advantage *Model 310* audio noise and level meter has been designed to provide professional studio and broadcast facilities with a low cost measurement device which is nevertheless capable of very high resolution. The unit offers: isolated, balanced, 'Trans-Amptm' differential inputs to eliminate noise, RF and hum pickup; a 10 Hz to 100 kHz wideband filter; 20 Hz to 20 kHz and 400 Hz to 20 kHz multiple-pole

(18 dB/octave) filters; A- and CCIR-weighting filters; average, RMS and peak detector responses; dual-scale analogue meter; full-scale range selection; detector output; preamp output/return. **Valley People Inc, PO Box 40306, 2820 Erica Place, Nashville, TN 37204, USA. Tel: (615) 383-4737.**

UK: Scenic Sounds Equipment Ltd, Unit 2 Comtech, William Road, London NW1. Tel: 01-387 1262.



Graham Gouldman has recorded in the world's best studios.

(That's why he recorded his latest album at home)

Graham Gouldman, as a leading member of 10cc, has recorded in many world-famous studios, and certainly knows what makes a good recording, and also when he's achieved one. "But," he says, "I've always felt that the most creative recording environment is at home, in one's own space and in one's own time."

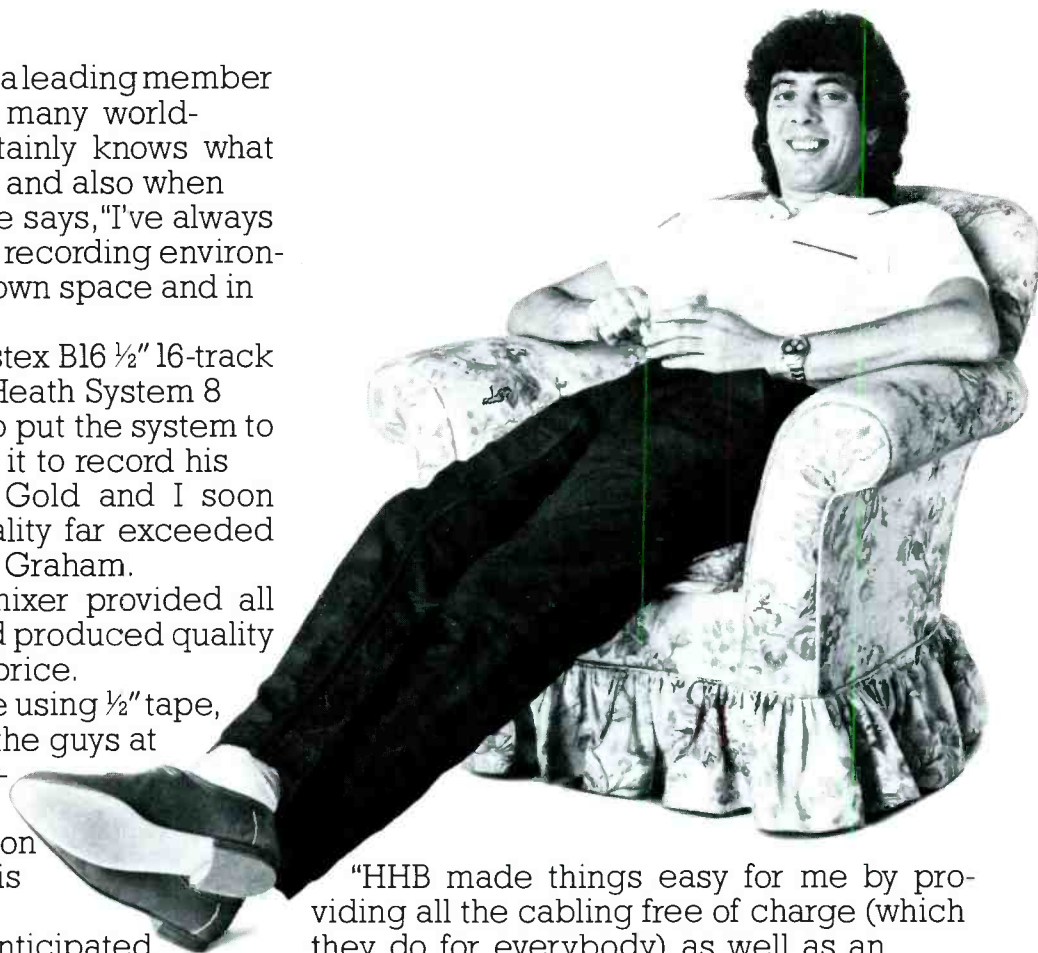
When he bought a Fostex B16 ½" 16-track recorder and an Allen & Heath System 8 16/16 mixer, he decided to put the system to the ultimate test and use it to record his current album. "Andrew Gold and I soon found that the sound quality far exceeded our wildest dreams," says Graham.

"The Allen & Heath mixer provided all the facilities I needed and produced quality to a standard beyond its price.

The Fostex B16, despite using ½" tape, was silent and accurate; the guys at Fostex really have mastered head technology, and the Dolby 'C' noise reduction really works a treat. All this for around £5000?!"

"For mixdown, we had anticipated having to transfer to 24-track – but when the time came, both Andrew and I agreed that the B16 sounded better.

You can hear the results for yourself on the new 'Common Knowledge' single 'Don't Break My Heart', on Phonogram Records"



"HHB made things easy for me by providing all the cabling free of charge (which they do for everybody), as well as an informative demonstration, sound advice and a reliable back-up service to complete the package."

"I can thoroughly recommend this low-cost, high-performance multitrack system."

For further details about Fostex and Allen & Heath, and all other recording products, contact Martin Westwood by phoning 01-961 3295.



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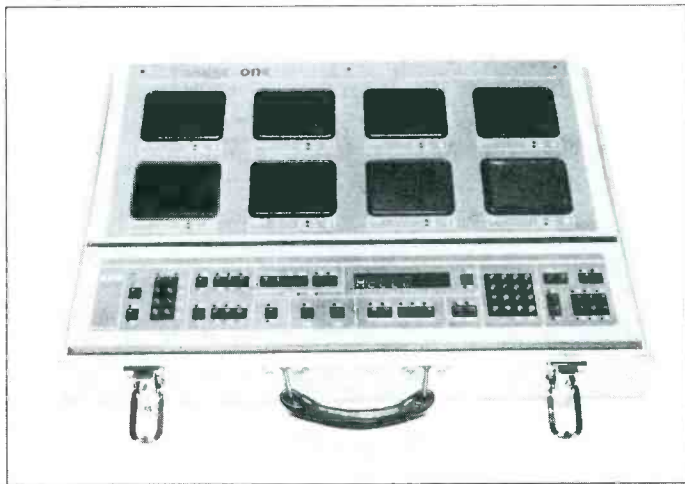
New from Allen and Heath Brenell is the *Inpulse One* drum computer, which is claimed to be the first state-of-the-art digital drum machine to allow a wide range of dynamics to be programmed while the user is playing on the eight touch-sensitive pads. Pitch and decay are individually adjustable, there are separate outputs and trigger inputs for each pad, and the stereo mix is programmable. Sixteen basic sounds are provided as standard, eight in ROM and eight on the supplied cassette. The unit has an internal capability to handle 15 songs of up to 999 bars duration, derived from 99 patterns. At present storage is on cassette but there is an expansion port for future interface with computers, etc. A clock output is provided to interface with synthesisers, etc, and the unit incorporates SMPTE timecode,

which removes the need to juggle with rewinds. All inputs and outputs are ¼ in jacks, with a 40-way connector for future expansion.

Also new from AHB are two mixers, the *SRM18-6*, which is a flight-cased model designed to provide all the features required of an on-stage mixer, and the *MBI Series 12* broadcasting mixer. The latter is intended for use in OB and news situations where a flexible yet easy-to-operate unit is needed. *Series 12* can operate with or without a Penny & Giles fader pack, providing AGC and optional output limiting.

Allen and Heath Brenell Ltd, 69 Ship Street, Brighton BN1 1AE, UK. Tel: (0273) 24928. Telex: 87825.

Allen & Heath Brenell (USA) Ltd, 5 Connair Road, Orange, CT06477, USA. Tel: (203) 795-3594. Telex: 643307.



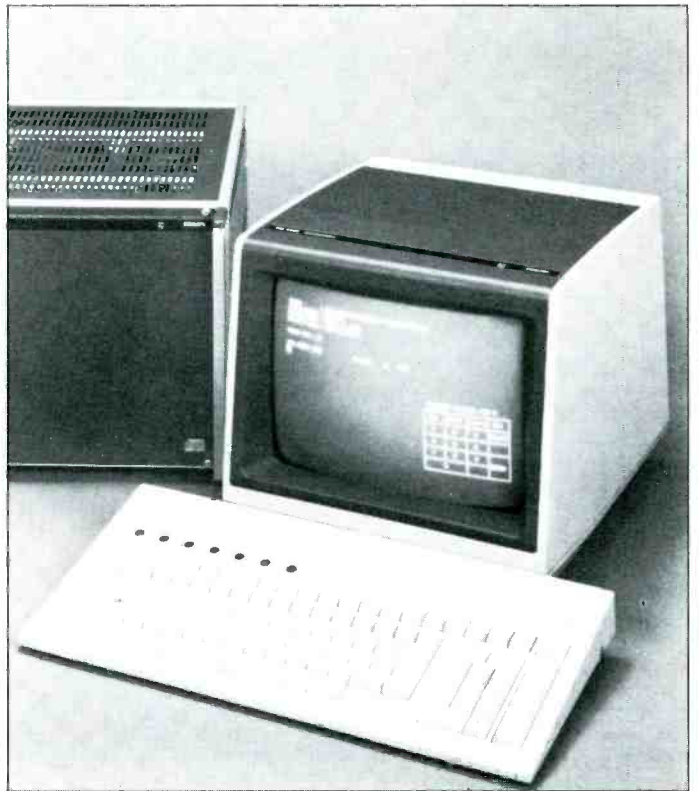
Stand-Off mounts

Connectronics' shock-isolated microphone mounts come in a variety of different configurations for vocalist and instrumental use, providing 'a flexible and cost-effective answer to the problem of transmitted microphone noise'. The mounts attach to the instruments or their stands, eliminating the need for vast arrays of mic stands. Neoprene-foam inserts in the mounts minimise the transmission of vibration.

Back-line amplification can be simply miked using the 'Reflector', an aluminium box

unit which is suspended in front of the speaker in question. This maximises the local soundfield while minimising unwanted pick-up from nearby gear. The 'Silencer' is a shock-mount for mic stand use, again useful for coping with obtrusive stage-transmitted vibration.

Connectronics Corp, 652 Glenbrook road, Stamford, CT 06906, USA. Tel: (203) 324 2889. Telex: 643678.
UK: Connectronics Ltd, 20 Victoria Road, New Barnet, Herts EN4 9PF. Tel: 01-449 3663. Telex: 8955127.



Philips CD-Subcode processor/editor

Philips have released details of a new Compact Disc subcode processor/editor, the *LHH 0425*, which will offer extensive operational facilities for CD production factories as well as significant reductions in the requisite paperwork. The *LHH 0425* facilitates generating and editing of CD-PQ cue code data and in its editing mode enables the incorporation of programme and mastering related text information to the tape master itself. When the cue codes are printed out, visual indication of subcode and text

information is provided. The unit can also generate CD-PQ code data for recording on to the standardised CD-master tape; automatic production of this information is possible. Operation of the unit is straightforward, all commands being entered from a conventional alpha-numeric keyboard. The functions selected are displayed on a clearly formatted VDU. **Philips Export BV, Electro-Acoustics Division, PO Box 218, 5600MD, Eindhoven, The Netherlands. Tel: 040 (7) 23715/24. Telex: 59533.**

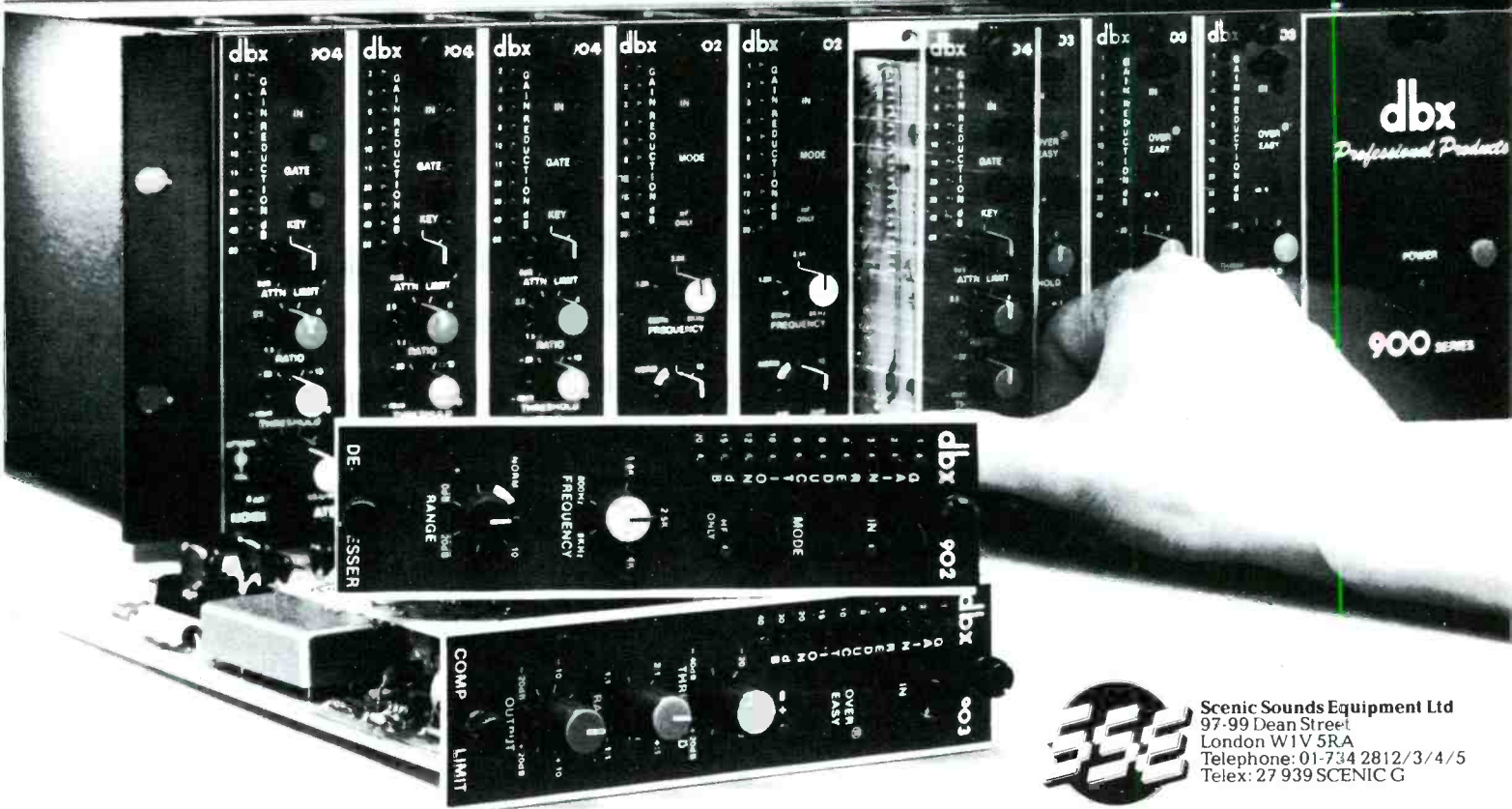
BBC-B MIDI package

Electromusic Research has produced an interface unit and supporting software package (disc or cassette based) to allow full control of any MIDI compatible instrument from the computer. EMR are developing a range of software applications programs for popular small computers, but their first is for the BBC Model B. 'Miditrack' is a manual (step) input program which enables composition on

up to six tracks with full 'memory assignment' of 7,500 notes. Parameters stored include pitch, dynamics, style and voice. Full on-screen editing is possible and any combination of track and channel material can be set up, with up to six MIDI instruments controlled. **Electromusic Research, 14 Mount Close, Wickford, Essex SS11 8HG, UK. Tel: (03744) 67221.**

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NEW PRODUCTS

NEW PRODUCTS

Equipment, modifications, options, software

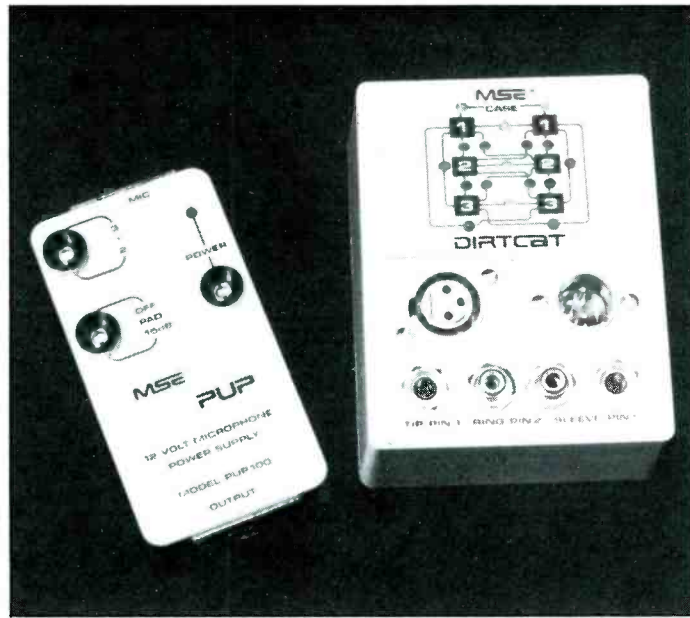
MSE microphone power

PUP100 is a new 12 V supply unit designed specifically to power Sennheiser 405, 415, 435, 805 and 815 microphones. The *PUP* can accommodate either US or European standards as regards polarity types (pin 2 or pin 3 positive), and a switchable 15 dB pad is provided. Two 9 V batteries will work for up to 60 hours, battery condition being monitored via the 'On' LED.

MSE's *DIRTCAT DCT100* has been around for a couple of years now, but a reminder

may be timely. This is a digital real-time cable analyser which can monitor 2- and 3-cable status, indicating all active signal paths. In addition, a 100 Hz squarewave signal is available for checking headphones and speakers. Lamps and fuses can also be checked with the unit. *XLR*, *RCA* and *TRS* are provided, but there is room to fit *BNC*, *TT*, etc, if required.

MSE, PO Box 185, Laguna Beach, CA 92652-0185, USA. Tel: (714) 497-5118.



Electrospace Time Matrix

Since the introduction of their multi-tap digital delay system *Time Matrix*, Electrospace have incorporated a number of changes to its specification. The unit now provides a maximum delay of 1600 ms but its memory bank facility has been reduced to 80 options: 20 re-programmable and 60 user-definable presets.

Time Matrix has three modes: delay, reverb and echo. In the delay mode eight taps are available, each with a readout showing the delay time. Each also has level and left/right routing controls. One of the effects this allows is 'increase' of the stereo spread by introduction of a delay between channels. Each tap can be programmed individually, all 80 memories being accessed via thumbwheel

switches.

Eight further taps are used for the reverb mode, again with various memory presets for reverb and decay time, with high and low filtering available for 'progressive' effects. Reverb itself can be delayed and one of its taps is used in the echo mode.

General features are: an on-board level meter, an input level control, a 'silent' bypass switch, and balanced in/outputs via *XLR*s. Digital conversion is 12-bit giving a 17 kHz bandwidth.

Electrospace Developments Ltd, Suite 3, 39/41 Newnham Street, Ely, Cambs CB7 4PQ, UK. Tel: (0353) 61251.

Export: Musimex, 33 Church Crescent, London, N20 0JR. Tel: 01-368 2716.



JBL mini and subwoofer speakers

Two new speakers from JBL are the *SLT-1* miniature and the *4645* subwoofer. The *SLT-1* is a compact, rugged design intended for mobile or reference monitor use. A 2-unit model, it uses a 5/4 in LF driver with a flat wound, ribbon-wire coil, with a 1 in ferro-fluid damped, hard dome tweeter. The cabinet is diecast and the frame of the LF driver is integral with the baffle. It has 8 Ω nominal impedance, sensitivity 87 dB SPL for 1 W at 1 m.

The *4645* has been developed to augment LF reproduction in a variety of professional

applications. Driver is an 18 in unit utilising a 4 in voice-coil housed in a direct-radiator, braced, reflex enclosure. System response is flat down to 35 Hz and usable at 25 Hz. Use of JBL's *5234A* frequency dividing network and *51-5138* crossover cards is recommended.

JBL Inc, 8500 Balboa Boulevard, Northridge, CA 91329, USA. Tel: (213) 893-8411. Telex: 674993.

UK: Harman (Audio) UK Ltd, Mill Street, Slough SL2 5DD. Tel: 0753 76911. Telex: 849069.

Otari prototypes at AES

Otari had two new tape machines being shown at the recent Paris AES in preproduction form. The *MX-70* is a multitrack tape machine based on a new 1 in tape transport and will be available as an 8-track, 8 wired for 16, or a 16-track. They will be available in floor or console versions. Interfacing with external controllers is simple and each machine will come with its own dedicated remote unit.

The other Otari machine is the *BTR-5* which is a broadcast orientated machine to be made in four types—compact, portable, floor console or desk-top and as mono or 2-track 1/4 in. It has a 12-in

reel capacity and there will be a host of options. One very useful feature is the take up of slack tape—when editing and the tape is laying loose, pressing any of the control buttons will cause the tape to slowly be taken up by the reels.

Otari Electric Co, Otari Building, 4-29-18 Minami, Ogikubo, Suginamiku, Tokyo, Japan. Tel: 03 333-9631. Telex: 26604.

UK: Otari Electric (UK) Ltd, Herschel Industrial Centre, 22 Church Street, Slough SL1 1TP. Tel: 0753 38261.

USA: Otari Corp, 2 Davis Drive, Belmont, CA 94002. Tel: (415) 592-8311. Telex: 910-376 4890. □

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There is something romantic about the idea of mobile recording. Roaming the highways and byways with a couple of multitrack recorders and several tons of ancillary equipment. King of the road.

Free to go to interesting places, meet interesting people and record them. Trucks with two multitrack machines for continuous coverage of a live performance evolved in the last 10 to 15 years but the Gramophone Company (HMV) had mobile recording units with two disc cutting lathes almost 60 years ago. One of them recorded Ernest Lough singing *O For the Wings of a Dove* at the Temple Church, London, in 1927 and the record was so popular that a copy of it can be found in any pile of 78s more than 12 in high. A modern descendant of that unit went to Scotland in 1977 and recorded the first single to sell over 2 million in the UK—*Mull of Kintyre* by Wings.

With the increasing number of outlets for high quality stereo sound, mobile recording units continue to be in demand. Doug Hopkins has been involved with mobile recording trucks for over 10 years. In that time he has been responsible for running TEAM, RAK, Island and, currently, the Pumacrest mobile; although these four names actually refer to two vehicles.

Some 25 years ago Doug Hopkins was a junior vision maintenance engineer with BBC Television and he worked on the first programme to be transmitted from the newly-opened Television Centre in 1960. He then joined the ATV London OB department at Elstree as a junior sound engineer.

“ATV were certainly king of the outside broadcasts at that time and they were doing all the massive pioneering shows. The Palladium show was a nightmare and I think that anybody who was ‘fortunate’ enough to be involved with it learned something—if they survived. *Sunday Night at the London Palladium* was a true variety show with acrobats, comedians, conjurors, dancers, jugglers, singers and a really big act to end the show. In 1961 it was attracting audiences of 20 million. The discipline in a place like the Palladium at that time was absolutely phenomenal, everybody used to jump and stand to attention when the stage manager shouted. It was run like a sort of military operation and we were part of it I suppose. I spent three years doing Sunday Palladium shows virtually every Sunday which was a very, very good training. You had the basics of mobile type location recording from a television point of view sort of drummed into you because there was no time, things happened fairly rapidly, and for those days they were pretty complex. It was nothing unusual to have 70 or 80 microphones even in those days. It was incredible.

“We used to get in there at something like 7.30 or 8 o’clock in the morning and be ready for a band call at 9.30 sometimes. The show was actually live. It used to go on from 8 until 9 in the evening. Then, because they had to set up for the next day in the theatre, we had to strip out every single thing that

MOBILE RECORDING

Doug Hopkins has been connected with location recording of all types for many years. In this article he roams the vernacular with Tim Leigh Smith.



we'd put in there, the mics, cables and everything else. The great thing was to de-rig the whole thing and be in the pub before 10 o'clock."

After three years of ATV and three years at Westward TV, Doug joined TVR which merged to form TVI where he became head of sound.

Hit the road, Jack

"In about 1969 I had actually drawn up plans to build a mobile recording truck with, as it was then, 16-track facilities because there was nothing like it. This was before the Rolling Stones truck was built. I tried to convince TVI of the commercial needs for it even though I didn't really know too much

about it at that time, I just had a sort of gut feeling that the facility was required. Of course, sound being the poor relation then, they couldn't see the need but somebody else got to hear of it outside TVI. These people were connected with a merchant bank at that time and they were building a big headquarters in Victoria. The idea was to include some sort of studio, a video or recording studio, in this building and they asked me to organise this for them.

"Because this headquarters building was not going to be ready for a year to 18 months I said that I felt we ought to be getting our name into the business so how about building the mobile recording unit I'd been talking about for so long. Out of that evolved the TEAM mobile which we built, virtually from start to

finish, in about 3½ months and that was the start of my getting into the music business as distinct from the video side of things."

The Trans European Audio Mobile (TEAM) was equipped with an Automated Processes 2488 desk which was adapted to provide 54 inputs/outputs and 24-track monitoring. Two 16-track 3M M79 recorders could be linked by a Maglink synchroniser using the special Maglink timecode. Other equipment included Dolby M16 noise reduction, Aengus graphic EQs, EMT echo plate and Shibaden closed circuit TV. In photographs the TEAM truck looks like a huge pantechnicon but this is an illusion caused by the skirt coming down very close to the road. The van is actually only 7 m long.

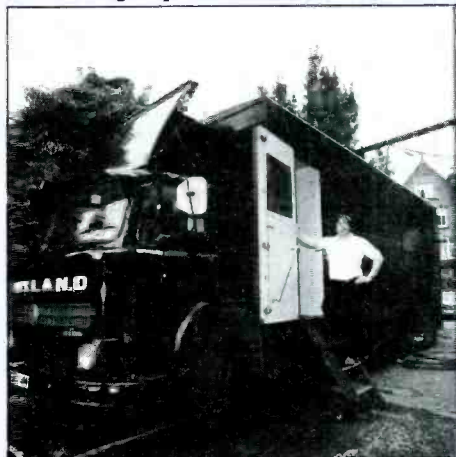
"One of the lessons that I thought I'd learnt from location recording for television was that there are a number of places where it's very difficult to get large vehicles in. The TEAM mobile was designed around what was really the smallest comfortable size that we could actually get all the equipment and two or three people working within it. That has paid off now because it is actually below the limit for a special Heavy Goods Vehicle licence so an engineer can just pick the thing up and drive off. It is actually very compact. Because it was almost the norm at the time it had a basic 24 input console but with 30 other channels with no EQ making a full 54 microphone inputs. They were fairly limited in the way they could be arranged but it catered for a number of fairly large recordings, with certain shortcomings.

"We'd arranged to get all the money through the merchant bank on a leasing deal. We'd actually got all the money available to us and the truck just about to launch when the bank crashed. We were left with all the equipment but absolutely no capital to run it so we had to make it work from day one in terms of paying off the leasing deal at whatever it was per month plus the salaries and the office and all the rest of it. In fact we did that, virtually, and it ticked along fairly well for about nine months. Then the inevitable sort of quiet patch of three or four weeks happened and things didn't actually get sticky but they got wobbly.

"After about a year of the TEAM mobile, quite out of the blue, Mickie Most (RAK Records) rang up and he had this idea of going off to record in France for a variety of reasons. I jokingly said, 'Well don't hire it—buy it.' I didn't hear any more but about a week later this figure turned up in motor bike gear with a crash helmet and it turned out to be Mickie. He walked into the office and said, 'Are you serious?' So we looked at figures and things. Mickie wasn't involved in any studios at that time and it obviously suited him, being very, very successful, to actually get involved in hardware effectively to produce his own material. Within a week or two the whole thing had changed hands and we'd re-named it the RAK mobile. Fortunately all the clients that I'd built up came along and kept on using us, plus, of course, we then started getting direct input from the record industry.



Above Doug Hopkins and below outside and inside the Pumacrest mobile



mobile you're available seven days a week on a daily basis. It's virtually impossible to work out an hourly rate for a mobile and it would be horrendous. If somebody wants to do an hour's recording and you say it's £500 they'd probably faint but if you say they've got the mobile for 24 hours for £500 it's a different story.

"The majority of costs have gone up by 300%. People's salaries have gone up and insurance costs have gone up phenomenally—we have a fairly high liability content of insurance and that's one reason why we like to keep the companies separate because Pumacrest is likely to come in for far, far greater contingent liabilities on a mobile basis. We have a carnet which is continually in force and that is expensive but they reckon that they need 48 hours notice to get a carnet and I could get a call tonight to be on the continent tomorrow. Invariably if one goes abroad these days the expense costs far outweigh the actual hiring cost of the mobile which always seems a bit of a joke. Tape has gone up from about £25 a reel 10 years ago and it's now £75 a reel so we do show where the tape cost is double the actual hire cost. It seems a nonsensical arrangement because in the long run it does actually stop progress as far as the mobile industry is concerned and there's no doubt that there is a call for the next generation."

High costs and low returns have actually reduced the number of mammoth mobiles. For a while The Manor were operating two units installed in 6 m containers but are now back to one. The Maison Rouge mobile was sold about five years ago and faded away into obscurity until last year when it was stolen and vanished without trace. The 'big five' survivors—Manor, Mobile One, Pumacrest, RAK and Rolling Stones Mobile—still seem to be in good shape.

Getting it taped

The major British multitrack mobile recording vans come in a variety of sizes from the articulated Mobile One which is 14 m long to the compact RAK Records truck which is 7 m long. The interior dimensions cover a much smaller range; from 5 m in the RAK truck to 6½ m in the Rolling Stones Mobile. The massive Mobile One uses 5½ m for the 'control room' and has an overdub booth of almost 5 m² which tends to get used more as a store room than a studio. The interior width of all the vehicles is 2¼ m because the exterior width is limited by the EEC Regulations. The limited space restricts the amount of sound treatment which is possible and, as Doug Hopkins points out, it also affects the layout of the equipment.

"Unless you can use the latest BBC technique of actually having a vehicle which grows when you arrive on site—they can pull the walls out on either side and end up with a reasonable sized control room, but obviously at vast expense—you're basically stuck within the legal EEC requirement. Now there are vehicles which carry the desk longitudinally which gives you a very, very short back to front and you can only get about 1½ m away from the speakers.

MOBILE RECORDING



Equipment racks rear truck

"I think the logical thing is to work lengthwise down the truck which means that you've got to have a console which will actually fit across it but still have a reasonable range of controls available to the engineer. There are a lot of new ideas—which I don't altogether agree with—such as assignable mixing consoles. From my experience, when you want to change something while you're actually recording, if you have to recall an assigned module you might just as well forget it because the moment has passed really. If one is recording a live concert, which is obviously what we're set up to do, then from my point of view I would like to have the majority of the controls available to me all the time.

"Mobile consoles can be simpler in terms of certain EQs and outboard equipment—one can leave a certain amount of that to the post-production—but more complex facilities are required because we tend to be linking up more and more with video trucks and one is required to send snippets of sound information, whether it be total mixes or bits of mixes, and communications to various parts of the operation. I can remember doing a *Come Dancing* with the BBC a few months ago where, quite apart from the multitrack we were laying down and the mono instantaneous mix that we were doing, we were sending something like another six or seven different feeds from the console to various parts of the show."

The Island Mobile originally came with a 12 kVA generator towed behind but Doug Hopkins has never found this necessary, not even in those parts of Europe where the mains can be anywhere from 190 V to 240 V depending on what day of the week it is.

"One talks about using a generator and having it available but the only problem that we've had really is getting hold of an electrician to actually connect us up from time to time. Sometimes you go to odd places in France where they've got 3-phase 110 V so you have to start strapping things together to work it out but I don't think there's a single place in Europe where it has posed a problem. We have a voltage regulator which can cope with anything and I assume other

people have as well. The great thing is not to leap up and down as soon as you get the slightest problem when you arrive on site because that can only generate further problems."

Having found a suitable power source there is the question of grounding (earthing) everything for safety without causing hum loops.

"The most important thing from my point of view, where we have a live stage performance and ourselves, is that we have to make sure that our power is provided from the same phase and that the earths are all tied together at a common point. By doing that you usually overcome most of the problems—certainly as far as the danger factor is concerned. You can get problems with lights being spread across two or three phases. If they get things unbalanced on phases you can run into thyristor buzz and what have you—one has to try to talk to the lighting guys. There are various places that have been notorious for thyristor buzz, purely and simply because it was inherent in the systems. London's Hammersmith Odeon used to be one of them but I think it's a bit better now. If you've actually got your cables sitting with a whole bunch of lighting cables with thyristors floating around you're asking for trouble. Very often one can get over these things simply by rerouting cables—it's really a matter of care."

With power and programme cables all over the place another major consideration is public safety.

"London has got to be the hottest place in Europe as far as the GLC regulations are concerned. You mustn't have cables going across public accesses and you mustn't block public accesses with a vehicle and so on. Invariably you end up parked on the wrong side of the street and you spend hours just flying cables over routes that the public are likely to walk along. I suppose it's right and one has to do that whereas you can go to places in Europe where they don't give a damn."

Whose gig is it anyway?

With all the mic cables in the correct place there still remains the question of what is going on the end of the cable: your choice of mic or someone else's.

If you go and record a one-off concert of a show that may have been on the road for 20 weeks and they may have done 30 or 40 different shows, and you come along all big time to record the last one, you have to recognise the fact that the PA guys are professional engineers in their own right. The complexity of stage shows has grown enormously over the last few years and the sort of equipment that they're using now, outboard equipment and so on, is as complex as anything we have to accept that they can provide their job with that particular band a damn sight longer than we have and they have got the cable routing and everything sorted out.

"The only thing that we would possibly do is to add a mic on the bass amp as more often than not the PA people just take a DI. Sometimes it's nice to get the actual sound of the amp as well and decide what you're going to do with it when you've heard it. Also, occasionally they don't use overhead mics on drums



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but for a recording it produces a better overall sound. The reason they (the PA) don't do it is because it's very difficult to get a good sound on stage without getting too much colouration, which can be a big problem depending on how loud the foldbacks and things like that are. There might be problems where they use different microphones from us, possibly more robust microphones which are better suited to the everyday live gig but for a one-off recording we might persuade them to change and substitute one of ours. We would just change the heads on the cables that are already there because everything is pretty well the same standard as far as cables, etc, are concerned.

"I think that if you actually go looking for problems and think you're going to change everything in sight, there is a chance that you won't come up with anything better than the set up which has already been proven by the band on the road and you'll probably run out of time trying to make things work the way you want them. There has to be a lot of give and take on both sides. One has heard the comment, 'This is a live show with a fee-paying public—Hell with anything else,' and I can understand that but I've got the record company saying, 'Go along and record it,' and the record companies by and large keep these bands on the road. There can be a little bit of conflict but nowadays, the amount of equipment that these guys are carting around with them, they've usually got it all worked out and they've already got a row of *XL*Rs which come out and all the split feeds are there. The major PA companies know the requirements because there is so much involvement with film and television shows now.

"One thing does annoy me, though. I was talking to somebody who was doing the out-front sound with one of the groups we were recording. He came out to the truck and said, 'How's the sound?' and added, 'But, of course, you are only laying tracks aren't you.' I'm afraid that gets my goat because, more often than not, laying tracks in a mobile you've only got a one shot pass. If you get something over the top or if you happen to miss a switch on microphones it can cause problems. Unfortunately one does get problems because of the interlinking between us and the stage PA and because they're a world unto themselves once the show starts, and quite rightly, it's very, very difficult to sort things out once the show's actually under way. You can only sit there when they're plugging up PA feeds and try out the lines between you but if nothing is being sent down a particular line then there is very little that you can do once the concert's under way without stopping the whole thing and saying, 'I've lost one of the synths.' If you go on stage and start plugging things around you're likely to get shot by the nearest roadie—understandably.

"Having said that, it may well be that, for a live album, you actually book up to do half-a-dozen concerts of the same show and after the first night you can say, 'That number was a load of ****—let's go for that one the next night.' You can actually build up the album type of

MOBILE RECORDING



Pumacrest mixing facilities

recording in that sort of way or you may just get a magical night where there's a good rapport going between the audience and the band and everything works. That does happen but I would say that the live album that comes out of one concert without overdubs is very rare. I have actually known live albums where I have done all the mixing afterwards and we've ended up by keeping the bass drum throughout the concert and re-recording everything else." It depends on the musicians, even though they're enormously well rehearsed, when they're on stage playing off the audience a lot of it is *ad lib* and it's not the same as having a session musician sitting down and reading from a sheet.

Mic in shot

Even when the recording truck is solely responsible for the sound there can be negotiations over the choice of mics and their placing if the show is being recorded on film or video.

"There has to be a compromise where you get somebody who's interested in his pictures where we're interested in the sound but there are microphones nowadays which will almost give them what they want and give us what we want as well. One producer I've worked with a number of times—who shall remain nameless—sometimes refuses to use what I want to use and then we have one of these diplomatic stand-up fights but we're all in the business to produce the best produce for everybody concerned. In this case, he and I have worked together so often that he knows how much he can get away with by shouting and I know how much of his shouting I can ignore.

"The majority of our work is involved in the promotion of the artist so in the long run one has to do what turns out to be best for that situation and every now and then you swallow a bit of personal professional pride. I think that happens all the way round. The whole thing really is about communication between people and sorting out problems before they become 'Problems'."

Further excitement is provided when

working with television, video or film because of the need to synchronise pictures and sound after the event.

"There's an awful lot of mystique both written and spoken about synchronisers. I think a lot of very good, very competent engineers treat it as a 'black box' syndrome. That's fine as long as things work. When they don't work then chaos reigns where perhaps chaos wouldn't reign if they knew just a bit more about what they were doing. That is one of the sadnesses of the business, there is no doubt that television engineers in general have a higher technical awareness of the equipment they're using simply because the TV companies look for people with that type of background.

"It's basically very simple as long as you obey the rules and one basic rule is that if you have timecode you look after it. You've got to record it correctly. I always insist that we have a timecode reader on the output of our machines so we can check that we have actually got valid timecode being recorded all the time. If you have a piece of video and you want to lock up a piece of audio with it, in the simplest case they should have the same timecode on them. What one shouldn't try to do is record a piece of music and then do another take of the same piece and try to use the pictures from one take with the music from the other. That has been done in the past and caused trouble. Musicians just do not play identically every single time.

"With the tendency to use digital equipment which runs at a very much more stable speed than the majority of video recording equipment—our Sony *PCM-1610* or the 24-track *PCM-3324* will always be more stable than an unlocked C-format machine—we've done experiments such as putting timecode on digital equipment after the event, purely as a trial thing, and actually found that we've been able to retrieve the lock so long as the video recorder was locked to a station sync of some sort. But if one is just talking about getting pictures and audio to run together there's still not a lot wrong with the old-fashioned 50 Hz pulse. It makes things run at the same speed which is really what one is talking about in recording timecode and there aren't too many people that can see a half-frame sync error.

"Having said that, of course, we do need to lock up two 24-track machines because, particularly on live shows, you're bound to get spill which can cause phasing between the two but the standard of accuracy that we can lock up machinery with modern synchronisers is pretty good so you can overcome that."

In recent weeks the Pumacrest mobile has been pursuing flamenco guitarist Paco de Lucia and his sextet around Europe; preserving James Galway and Henry Mancini at the Barbican; location recording for Paul McCartney's feature film *Give My Regards To Broad Street*; and capturing the sound of Echo & The Bunnymen in Liverpool for Tyne Tees Television's *The Tube*.

Doug Hopkins' basic advice to those doing mobile recordings is simple: "Be polite to everybody; assume you'll want to go back there again." □

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RECORDING GENESIS

LIVE

Genesis were completing their latest and most successful tour to date with five performances at Birmingham's National Exhibition Centre in the UK. All five nights were sold out making a total audience of 50,000 people. Two of those 50,000 were to be Their Royal Highnesses, The Prince and Princess of Wales for the charity performance on the last night in aid of The Prince's Trust charity.

The longer a band is successful, the bigger their stage performance seems to become, as each time a tour is produced it has to offer something more than the last one. With Genesis, their stage performance has developed to the extent where it's hard to imagine how it could ever expand any more. The PA system was enormous, with speakers stacked and flown at the stage and a secondary rig flown half way down the hall. The bass frequencies, especially from the electric instruments were something that was felt as much as heard. The lighting rig was centred around 120 Varilites, computer controlled and mounted on independently movable trusses. Additional lights and smoke machines were placed at the sides and back and inside of the stage.

Just as the technical side of the tour was large, so was the personnel. The programme credited 32 people as full time travelling members of the tour. This did not include the local promoter, the catering ladies (I'll never know how she did get into those jeans), the UK tour manager, or the venue staff. This army of people and mountain of equipment was to increase for the NEC dates, because in addition to the usual touring establishment Picture Music had been contracted to record the concerts for release on

Recording a live performance for video release is not just a matter of tailoring the stage feeds as Steve Turner explains



video cassette. Add to the above list an extra 40 people, two large *Portacabins*, a second catering unit, six cameras, a film sound unit, The Rolling Stones mobile and me—I had been asked to engineer the recordings.

I found this quite an exciting project, and was looking forward to the five days in Birmingham, but when I arrived at the NEC complex I was stopped at the security gate on my way to the back-stage area (almost as big as some venues in itself). I said, "I'm with the recording mobile. It should be here already."

"What's the name of the unit?" asked the guard.

With some reticence to mention famous names, for I am not one to name drop and after all the security guard must hear them all the time, I simply said, "The Mobile Studio."

There are times, however when it is expedient to drop a name or two, and this is obviously what Arnold and Charlie, who had brought the mobile up ahead of me, had done at this same gate, because the guard said, "What's the particular name you might mention with this mobile?"

"The Rolling Stones," I said, and the barrier in front of me magically raised itself at the mention of this propitious name. It was obviously going to be a rock and roll gig.

The mobile was already in position, *inside* the building, between the back-stage crew area and the table tennis table—another vital piece of equipment that was completing the tour. Recording an average five piece band would normally be fairly straightforward, but Genesis is no average group and their stage rig is far from straightforward. My main contact with the 'team' was Geoff Callingham who, as the band's technician, had been

involved in all the recordings made by them collectively and individually since he started working with them, and was very active when the band was touring. His room back stage was a very well equipped workshop built into flight cases so that it could quickly be stored away ready for travelling. On this tour it had travelled thousands of miles, and carried spare components for all the electric instruments that the band used, as well as the necessary equipment to service the electronic tour toys, such as *Walkmen*, *Portastudios* and keyboards, and drum machines for hotel room use. (Chester Thompson likes to write sometimes when on tour, so he sits in the hotel room during the day with his instruments.) Geoff knew the stage line-up and the cues for each song, which instruments were used in specific numbers, and which ones it was necessary to keep separate on the multitrack assignment. He also knew who to speak to when we needed any information or changes to the rig, which was a great help.

Stage set-up

The stage layout was roughly divided into six areas corresponding to the six triangular lighting trusses suspended over the stage that formed the main part of the spectacular light show for the performance. These six areas, shown in Fig 1, gave one area for each of the musicians except Phil Collins, who used both the centre stage area for singing and the upstage left segment when playing his drum kits. I was relieved to learn early on that Phil did not play drums and sing at the same time, because of the spill of the drums on to the vocal mic. One can often be faced with impracticalities such as this when trying to reproduce on stage what is simply a matter of overdubbing when in a studio.

Phil is quite busy when on the kit as Fig 2 will show. In addition to having a complete acoustic kit, there is a full Simmons drum kit with hi-hat and an additional acoustic hi-hat. At the beginning of the tour only the acoustic hi-hat accompanied the Simmons kit, but when the Simmons hi-hat arrived Phil wanted to keep the acoustic as well.

The acoustic kit was miked up using *SM81s*, *SM57s* and a *421* on the kick drum. For the toms one mic was used to pick up each pair and placed equidistant from each drum, which actually meant that it

was looking at the small gap between the pair. The snare was miked with a *57* looking over the rim from the audience side of the drum. The hi-hat had a *57* clamped to the stand and looking up to the lower cymbal, and the seven top kit cymbals were miked with two *SM81s*, looking up at the cymbals from the left and the right of the kit. The resulting cymbal pickup was more selective and contained less drum sound than if they had been miked from overhead. It also gave rise to the description 'underhead' mic as opposed to 'overhead' (a description that I had not met before, and needed clarifying). The kit also looked neater from not having two over high stands dominating it. All the signals from the Simmons kit were received as direct inject signals.

Opposite Phil on the stage was Chester Thompson with his double drum kit (see Fig 3), eight rack toms, one floor tom, one snare, two bass drums, six cymbals and a hi-hat. He was quite busy too! As with Phil's kit, the toms on Chester's kit were paired up for miking purposes, with one *57* on each pair of drums. There was a *421* on each of the two kick drums, a *57* on the snare and hat, and two *81s* as left and right 'underhead mics'. It was quite fortuitous for a band that has

two drummers that one is left handed and the other is right handed. Phil and Chester are not only on opposite sides of the stage, but make a symmetrical pattern with left-handed Phil having his snare to his right, and right-handed Chester having his snare to his left. It will make great pictures on the video as well with split screen images from over the shoulder of each of the drummers, especially in the drum duet they play towards the end of the concert.

In addition to these three kits, the percussion section of the band included timbales

and tympani played by Chester, a Simmons drum triggered by Chester using a mic on the rim of his snare drum, and a *LinnDrum* that was placed with Mike Rutherford's guitar equipment and was triggered on a foot-switch by Phil. It fired the *Quadra* in Tony Banks' keyboards. These were picked up with two *57s* on the timbales combined on stage to one signal, a passive DI on each of the Simmons's and *LinnDrum*.

Fig 4 shows the complete keyboard set up used by Tony.

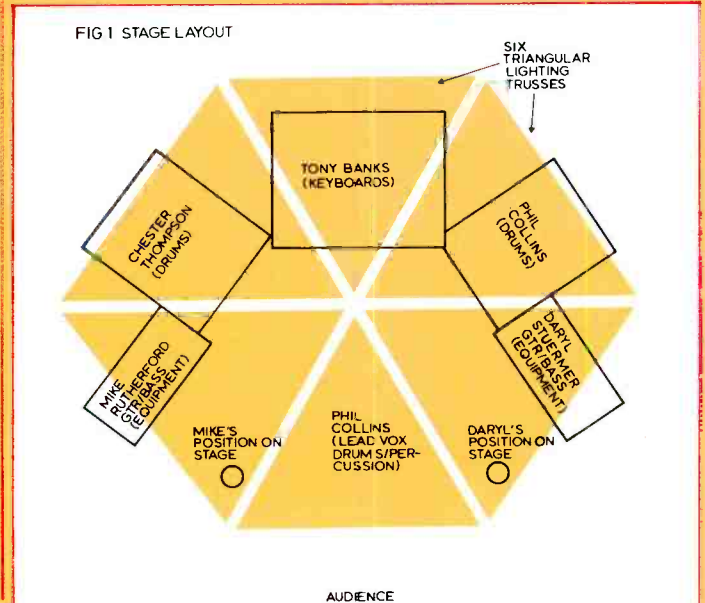
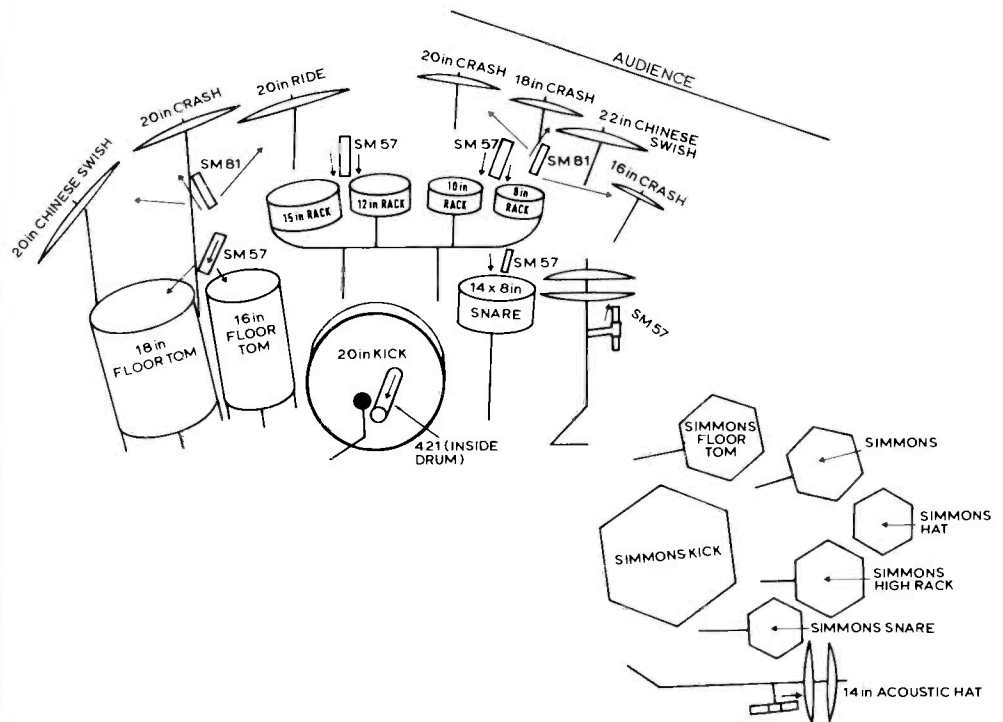


FIG 2 PHIL COLLINS DRUM KITS
Arrows show direction of pick-up of each mic



real echo return was fed into the monitoring only via an external input that is independently controlled on the main desk monitoring panel, and is in stereo (the reverb system used was the Lexicon 224—again a permanent piece of equipment with this mobile).

The patching up of the signals was very complicated, because their position on each desk, and the grouping that would then follow depended on the final track layout. This in turn altered for almost every song that the band played. In some songs, for example, track one was used for tymps, in others for the *LinnDrum*, or Simmons snare or Chester's Simmons, and in one number for the crew's vocal mic. In other songs these same signals were routed to other tracks.

There was a selection, of certain signals that had to be switchable from track to track without interrupting any intermediate tracks by switching through them. For example one of the changes from track to track was very quick, and I selected it so it switched between adjacent, even-numbered tracks. In spite of careful mapping out of these changes there were inevitably some changes made after the initial plugging up, and it was very useful to have the stage boxes not on stage at all but just outside the mobile. **Table 1** gives a list of the different signals that were coming down the multiways, showing how each signal was derived.

The path that these signals then followed was very complicated, for example Chester's kit mics came in on lines 16 to 22. They plugged into the sub-mixer on channels three to nine. These channels were routed to outputs one and two of the sub-mixer, which then went to the echo returns on the main mixer, and were routed to tracks 10 and 11 on the multitrack. Similarly, the crew vocal mic came in on line 51 and was plugged into channel 20 on the sub-mixer. This was routed to output five, which was plugged into channel 20 on the main mixer (but only at the appropriate time as channel 20 was also used for Phil's radio mic). This channel was then routed to group one (or 17 when looking at the other input). Where there was more than one input to each desk channel the inputs were switched at the appropriate time. Where on the sub-mixer several channels were routed to the same output, they were either mixed together, as in the case of the example above,

GENESIS

or were switched so that only one channel was being fed at a time. Where there was more than one type of signal on each track, these were switched at appropriate times so that only one signal was recorded at any time. **Table 2** gives the track layout.

During the recording there was a lot of routing and switching to do as well as normal level control and monitoring. Fortunately the

first performance at the venue was a rehearsal as far as we were concerned, as this was not to be recorded. Had this not been the case we would have needed a complete performance during the afternoon in order to get a balance between the sub-mixed signals, and in order to get a level on the other signals. When the performance began on the Saturday night we had just about finished plugging

and routing. When the performance finished we realised that we had to make some changes in the light of the night's experience. However, because of the complexity of the system one change could not be made without affecting other items in the recording. So we agreed to meet after lunch the following day to adjust the recording arrangements: we would then be ready for the afternoon's sound check.

We made the changes to the previous night's rig, used the sound check as another rehearsal, and then had to rig a third machine, because although the mobile is equipped with two 24-track tape machines, this recording was to be done simultaneously in digital format. Sony had provided a PCM 3324 digital multitrack recorder, and this was rigged inside the mobile, but we had to run from an independent mains supply from the breaker that was feeding the mobile, as the 3324 took too much current to run on an auxiliary supply inside the mobile. (It also made the mobile very hot.)

We then fed the machine with group output signals from the main desk jackfield. The PCM 3324 has 24 digital recording tracks, one timecode track and two analogue tracks, so had we been recording only on digital we could have had more spread on the track layout. As it was we had to record on the digital machines the track layout that had been worked out for the analogue machines, so we used the analogue tracks on the digital machine to record the monitor mix, in stereo. This is something I would have found quite useful in the past on other recordings if there had been the track space.

The digital machine had just been rigged and tested when the Sunday night's performance began, this time for real as far as we were concerned. The monitor mix that was being fed to the digital machine was also being fed to the film unit who used it as a guide for cutting and for playback when some shots were re-done without an audience later in the week.

We also made two cassette recordings of the monitor mix each night so that there was instant reference for the band to listen to after each show. This was an important part in the initial stages of selecting which song would be used in the final programme, as well as being informative for the band who could judge how the recording was going. The

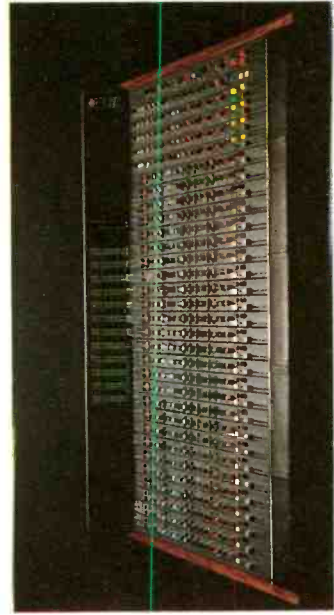
TABLE 1
INCOMING SIGNALS DIRECT FROM THE STAGE

1	Low tom (DI)	}	Phil's Simmons kit
2	Mid tom (DI)		
3	Hi tom (DI)		
4	Kick (DI)		
5	Snare (DI)		
6	Hat (DI)		
7	Acoustic hat (SM57)		
8	Prophet (DI)	}	Chester's
9	Yamaha pno (DI)		
10	Emulator (DI)		
11	Timbales (2 SM57)		
12	Tympani (passive DI)	}	Chester
13	No signal (are they getting superstitious, I wonder?)		
14	LinnDrum (DI)	}	Chester
15	Simmons (DI)		
16	Floor (SM57)		
17	Rack (SM57)	}	Chester
18	Rack (SM57)		
19	Rack (SM57)		
20	Rack (SM57)		
21	Left underhead (SM81)	}	Phil acoustic
22	Right underhead (SM81)		
23	Floor (SM57)		
24	Rack (SM57)		
25	Rack (SM57)		
26	Left underhead (SM81)	}	Phil acoustic
27	Right underhead (SM81)		
28	Open		
29	Open	}	Chester
30	Open		
31	Kick (421)		
32	Snare (SM57)		
33	Hat (SM57)	}	Phil acoustic
34	Kick (421)		
35	Kick (421)		
36	Snare (SM57)	}	Chester
37	Hat (SM57)		
38	Daryl bass gtr (DI from amp)	}	Reference only
39	Daryl peds (active countryman DI)		
40	Mike bass (passive DI)		
41	Mike peds (passive DI)		
42	Daryl gtr (2x421s)		
43	Mike Roland gtr (SM57)		
44	Mike gtr (SM57)		
45	Keys mix left (DI)		
46	Keys mix right (DI)		
47	Open		
48	Open		
49	Phil front vox (M88)		
50	Phil radio vox (Nady 600)		
51	Crew vox (Nady 600)		
52	Mike vox (M88)		
53	Tony vox (M88)		
54	Daryl vox (M88)		
55	Spare vox (M88)		
56	Synclav (DI)		
57	Quadra (DI)		
58	Open		
59	AMS rev 1 (DI)		
60	Open		
61	AMS rev 2 left (DI)		
62	AMS rev 2 right (DI)		

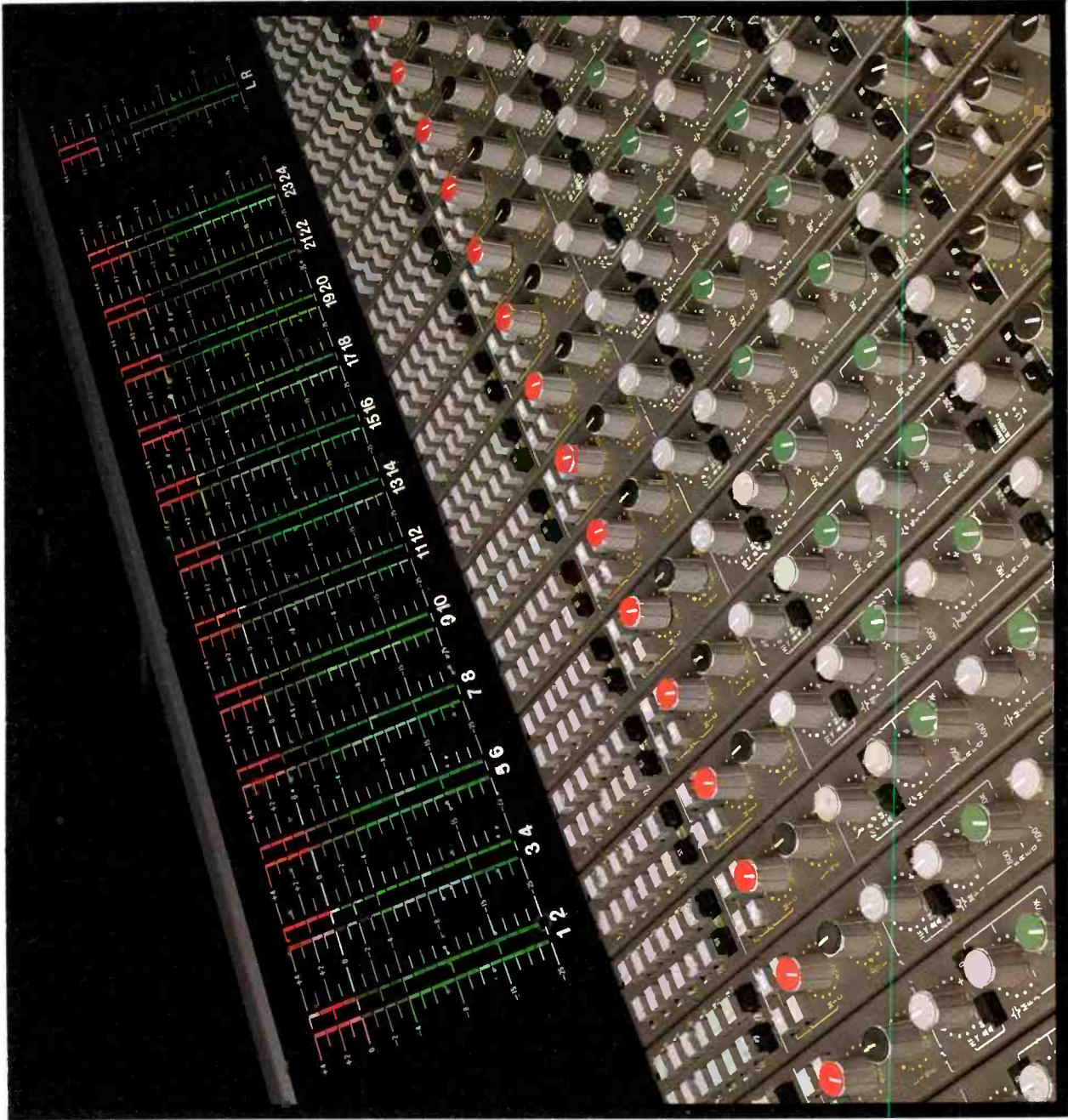
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Our definitive statement...

visual equivalent of this was a nightly despatch of the films to a London processing laboratory who then had rushed copies back up to us in Birmingham by the following morning.

During the actual recording Arnold and Charlie were very busy looking after the analogue tape machines, because we were recording at 30 in/s on 10½ in reels. This gave each reel a running time of 15 mins, but with overlaps and trying to get each song complete on one reel, I think the average time between reel changes was about 8 min. Each reel then had to be clearly labelled and marked up, and the next reel loaded on the machine in readiness for the next change. In the meantime Geoff and I were working squeezed between the sub-mixer and the 60-odd extra leads, checking cue sheets and running orders for the next routing and input changes.

Final mix

The essence of the recording was to get the information down on tape as accurately as possible, without any equalisation or other changes. This was something I was not too happy about at first as I wanted to equalise some of the signals when I first listened to them individually. However, when the band was playing together any alterations that I would have made earlier seemed to be compensated for by other instruments. For example, the sound of the two bass guitars was definitely a bit light when listened to in isolation, but in performance the bass pedals were always being played which added so much low frequency that any fattening of the bass guitars would have made the guitar disappear behind the pedals. Similarly with the guitars, Mike and Daryl had a choice of instrument when playing each number, and the instruments chosen were quite correct in tone and smoothness of frequency for the particular arrangement of that song.

On keyboards Tony had more than enough control to produce the sound that he wanted so that the information he required for the mixing process was on tape. He didn't need an engineer to impose their idea of what might be nice, when Tony had made very deliberate choices in the type of instrument, the quality, and the programming of the sound in the first place.

On the drums the DI signals were from instruments that had been carefully 'tuned'

GENESIS

before performance so that the sound they gave was that which was required. Also the tuning and miking of the acoustic drums gave the sound that was good live and would mix well. In short, Genesis knew what they were doing. It was up to me to give them back on tape what they had given me in performance.

What I did do in the mobile was a slight equalisation of Phil's voice, which needed brightening a little—that was one of the few 'instruments' that could not be adjusted electronically at source! In addition to this I added echo to several signals using the 224 to give variable decay times according to the frequency being treated, so that the vocal, for example had a shorter decay than the *LinnDrum*. The kick drums were miked very close to the skin inside the drum, which

gave a very hard dry sound which needed quite a lot of extra reverb to make them sound as full as they should.

In the house the kick drum sound in the PA was quite full as the sound reverberated round the hall giving it a 'local' fullness. Other instruments were given a slight amount of reverb, but generally the sound did not need changing much. The keyboards and guitars had the right amount of echo and reverb added at source by the players, and the overall internal balance of the band was very good.

At the end of each recording we made slight changes before the next performance, but each night was successfully recorded with the selection of final songs being made on artistic grounds only, and not because of any technical problems, which was quite

satisfying for us. For identification purposes I started the timecode generator at different times each night, so that on the first night the timecode began reading at 10 hours, and on the next night 13 hours, etc.

On the Tuesday afternoon we rigged the mobile for playback of the digital recordings and analogue and were able to switch from one to the other, while running the same part of the same performance on each machine. I did not know how much difference there would be between the two systems, but when it came to the comparison, the digital recording sounded as if a barrier had been removed, the reproduction was so good compared to the analogue recording. I don't think there will be any doubt about which recording to use in the final mixdown of the soundtrack.

After three nights recording and checking of soundtrack monitor mixes and film rushes it was decided that we did not need to record the last night's performance. It is always surprising when a rig that has taken perhaps two or three days to evolve can be stripped out in a matter of hours. That was the case there, and by the time of the final performance one would not know there had been a film crew there at all. I used the opportunity to sit out in the auditorium and see the performance for the first time since we had arrived: although I had had a camera on stage feeding the video monitor in the mobile this was only useful for information and did not give any idea of the spectacular visual effects during the show. It was also interesting to hear the full sound of the PA that until then I had only felt through the floor of the mobile. Obviously there were differences in this sound compared to the monitor mix in the truck, because we were not using any equalisation or hardly any effects in the recording, but basically I think that we captured a good atmosphere and accurate reproduction of the concerts.

It was an experience that I enjoyed immensely. It was challenging for me, personally, and in the way I was able to use the mobile. I don't think there was one facility on the mobile that was not in use and it all worked very well. (Many thanks to the holidaying Mick McKenna, whose absence required my involvement in the recording.)□

TABLE 2
TRACK LAYOUT

1	Crew vox Tympani Timbali LinnDrum Chester Simmons Phil Simmons snare
2	Phil Simmons acoustic hat Phil Simmons hat
3	Synclavier Phil Simmons kick Phil acoustic kick
4	Phil acoustic snare Mike vox
5	Phil acoustic kit left Tony vox
6	Phil acoustic kit right Daryl vox Phil Simmons toms
7	Chester kicks (2)
8	Chester acoustic snare
9&10	Chester acoustic kit (incl hat)
11	Keys left
12	Keys right
13	Bass peds (×2)
14	Bass gtrs (×2)
15	Daryl gtr Mike Roland gtr
16	Mike gtr
17	Phil vox
18	Quadra Synclavier
19	Yamaha piano Emulator
20	Prophet
21	AR left
22	AR right
23	Pulse
24	SMPTE timecode

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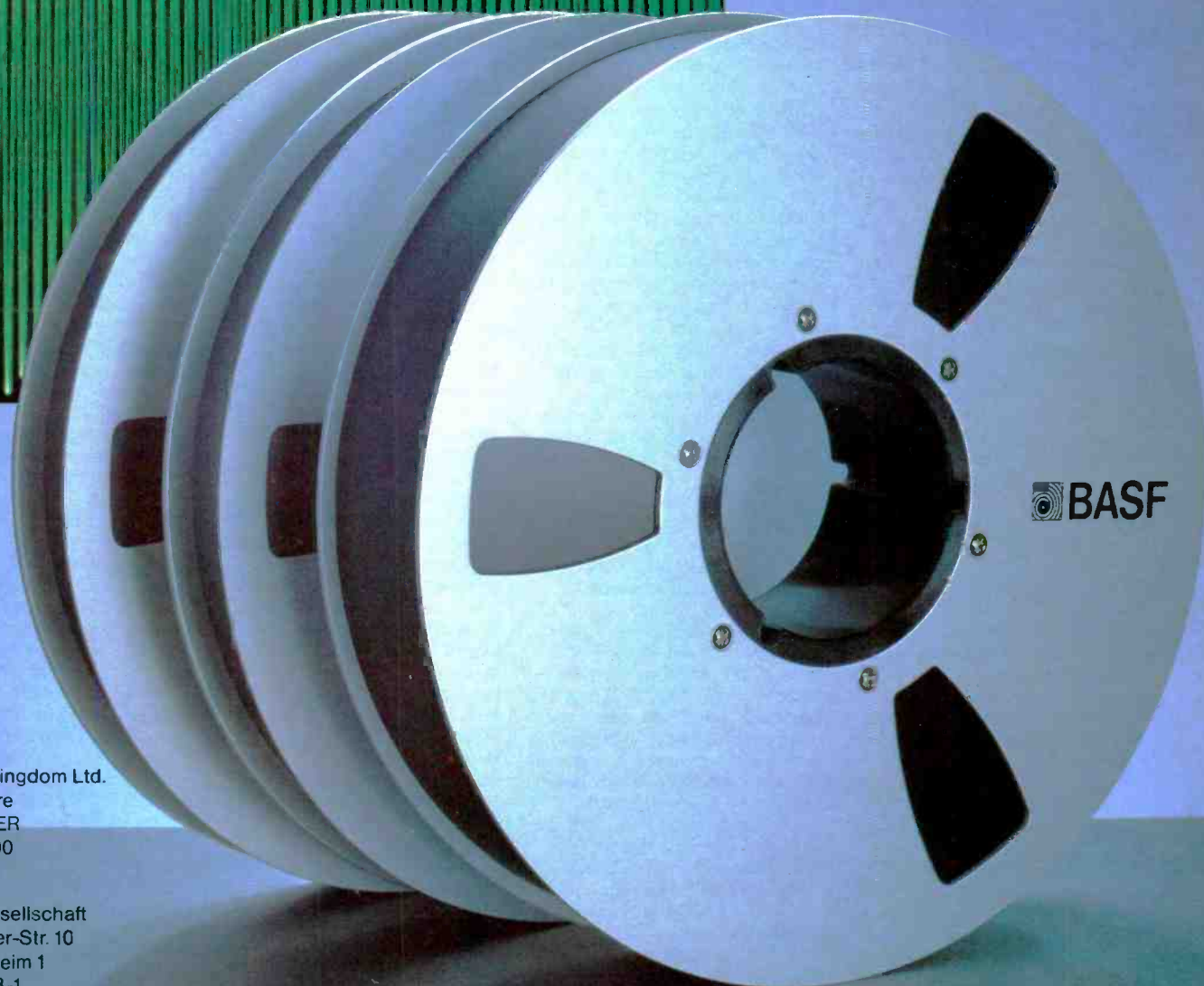
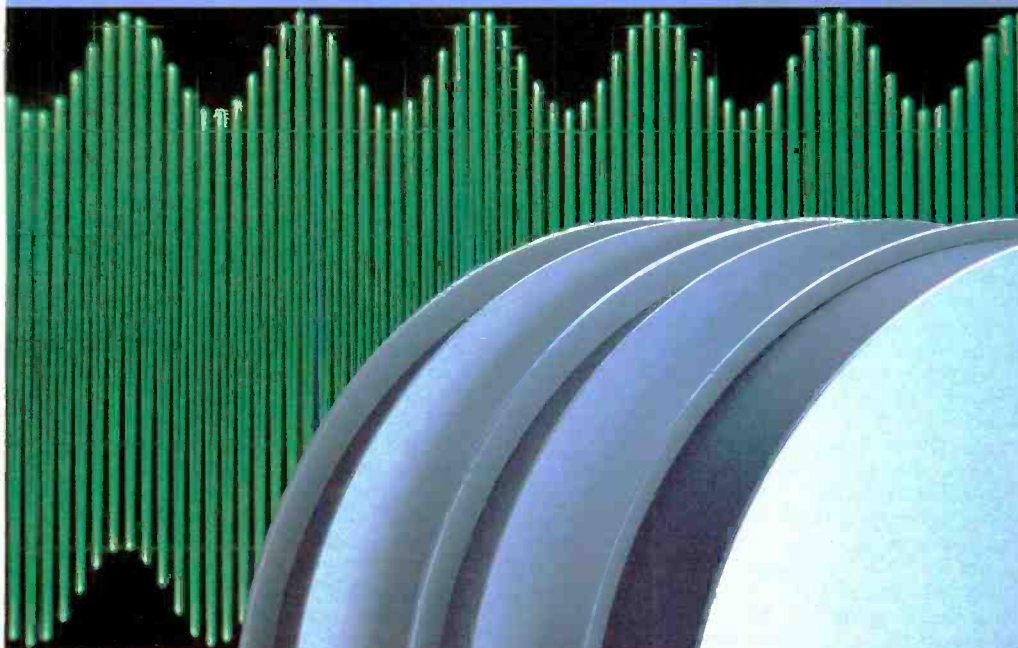
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IN PERSPECTIVE

IN PERSPECTIVE

Comment from Martin Polon, Studio Sound US columnist

The 1980s have been an improving time for many of those in the business of professional audio. But, in this year of 1984, supposedly a year of earth-shaking technical and geopolitical changes (and this must be the 9,000th article this year to touch on it) the only constant for the business of audio with 1948 (the year Orwell wrote and numbered his prophetic classic) is that some audio people are out of work.

In 1948, the rapid rise of the infant 'television' began to affect the production-heavy style of radio broadcasting, that has since been jokingly referred to on both sides of the Atlantic as the 'audio engineers' full employment act'. Equally, the movie devouring public of the English-speaking world started to shift from their weekly diet of films that totalled 500 pictures per year (and thousands of audio jobs) to the audio ascetic style of 'the TV box'.

In 1984, the electronic entertainment industry of the western world has been emerging from a painful economic slump that had its roots at the end of the 1970s. The traditional chain of consumer demand producing economic activity at the professional level was proven. As the industry has recovered in the 1980s, many of the companies and individuals formerly employed in audio and the record industry have had to shift over to the world of computers and electronic gaming. Currently, unemployment/under-utilisation/under-compensation is estimated to affect at least 25% of those qualified to work as audio professionals.

1948 also marked the beginning of the Audio Engineering Society as an international organisation devoted to the propagation of technical information within the ranks of those interested in audio engineering. Cooperation and fellowship also seemed to be functional, if unstated goals of the society. It would be difficult to state that the society found jobs for those unemployed and/or under-equipped technically; and yet, the careers of thousands of audio

The AES—who shall it serve?

professionals have moved forward with access to the changes in technique and theory involving such myriad technologies as the transistor and magnetic recording to today's noise reduction and digital audio.

Where the AES used to be a group united by the excitement of unveiling new technology, today's excitement often involves 'them' versus 'us'. Some equipment manufacturers have come to think of the AES meetings not as a vehicle for advancing technical thought, but as a tool to be used or not used in the enhancement of sales and marketing. Other groups want to restrict meetings to their 'turf' despite the charter of the AES to be truly universal. Still others, concerned because the AES does not serve the recording industry 'properly', want the direction of the society changed. Others want to restrict membership to those who are actually doing audio 'engineering' despite the fact that many successful audio engineers do not have a degree and the term engineer has a different meaning on both sides of the Atlantic.

All these things are clearly within the established rights of each member, but when any vocal minority forms and begins to assume that they can control the direction for an organisation because 'they' pay the bills in one way or another, there breeds the atmosphere for disfranchisement.

A professional audio manufacturer of worldwide impact put it thus: "When the business was flush, the luxury of supporting the AES shows was within everybody's reach, whether we believed in it or not. Since the slump, the AES has become a luxury for many, and an arena for manufacturers' politics for others. The shows seem somehow less important from all of this bickering. All of which is too bad really, because the confusion about when and where, hurts the rank and file membership. What many forget is that most of the potential audio buyers

learn their craft via the AES."

The question of who really is the AES has become pertinent, as pressure groups try to influence the location and timing of the AES technical meetings. In the United States, the well-established (20-plus years) second yearly meeting has been cast aside, to be replaced by a single major technical meeting and convention and the loosely gathered notion of a conference, largely at the behest of some exhibitors. In Europe, the concept of the so-called European show moving to any other world venue including England is met with stiff, almost hysterical resistance, even though the meeting is by definition an 'international gathering'. To some, the pressure by the exhibitors is the tail wagging the dog since the AES consists of nearly 10,000 members who have been seemingly disenfranchised of convention activities formerly scheduled functions of the Society.

A West Coast US member put it in context, "I earn about \$24,000 per year and my job is important to my employers, but there is no way that they or I am going to be able to afford the \$1,000 it costs for plane, hotel and meals if I tried to go East for a convention. Since the demise of the regular meeting schedule, I cannot even plan and save for a future convention since I don't know when or where it will be." Interestingly enough, the Board of Governors has attempted to correct some of the anarchy resulting from the last several years' changes by establishing a five-year schedule of sorts, but that doesn't help the average member whose finances are still limited.

Not that any of these negative effects seem to have been desired by those involved actively in pushing for changes in the Society; rather, it is a case of not really looking at who the 'us' is when playing the 'them' versus 'us' game. That the recent changes strike at the efforts of those who are trying

to keep the Society on course, is another problem. It all seems rather a style of adhering to a strict accounting by those in the business of selling audio equipment. One vendor, questioned at a previous NAB show about the future of the AES without one of its American meetings responded, "I don't care if the Society disappears. Something else will fill its place."

Another example of this attitude gap is the feeling one manufacturer's representative had about students. This good gentleman, when questioned about what was right or wrong with AES meetings, strongly suggested that the "...damned students took too much time away from sales by asking too many questions". It did not occur to the salesman that today's students are tomorrow's audio engineers; making purchases influenced by their student experiences.

All of these attitudes are perhaps inevitable as the audio profession matures and the sense of closeness and camaraderie that seemed to characterise the pioneering of audio technology changes to just another big business. The attitudes of today seem almost to be the classic short-term gains versus long-term goals. The AES should be a long-term goal for the audio industry; a kind of knowledge R & D for its members. AES should not supplant APRS or NAB; but, co-exist with these and other exhibitions without being gerrymandered into a bastard state from which it cannot function effectively.

This author, never before accused of maintaining silence on any issue he has had a correct or incorrect opinion on, and active within the AES for some time, has until now refrained from airing these views under some sense of doing the right thing.

Historically, and currently, talking openly about what's wrong with the AES has been viewed in the same vein as a detailed description of one's haemorrhoids. But, like haemorrhoids, the current problems are really minor in contrast to the good that a healthy AES can do for the audio industry. A lot stands to be gained by a dialogue on what's right with the AES!

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CASE HISTORY

BACKGROUND: Bob Heatlie is a successful songwriter with several recent major hits to his credit. All his writing and arranging is done in his own home studio in Edinburgh.

PROBLEM: Wanting to produce master-quality material, he had reached the limits of what could be done with his semi-professional 16-track set-up, but was rather limited for space.

SOLUTION: The Amek/Otari combination. ITA supplied and fully installed an Amek Angela 28/24 console and Otari MTR90-II 24-track recorder.

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The Otari MTR90-II is being recognised by more and more studio owners, engineers and producers as THE multitrack.

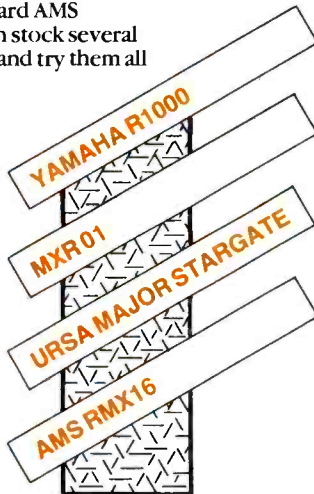
ITA have been associated with Otari for nearly 12 years and with the MTR90 since its inception. Our knowledge of these superb machines is second-to-none.

All the machines in the MTR range are available to serious users for evaluation in their own studios. If you haven't had hands-on experience of them yet, call Mick Boggis now and arrange a demonstration.

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Digital reverberation units are proliferating. At the moment, it would seem that you get very much what you pay for—but even the cheapest unit has several distinct advantages over traditional mechanical systems, not the least of which is its ability to treat percussive sounds without producing extraneous noises.

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OTARI DEVELOPMENTS

Otari MTR12 recorders are now available with a range of headblocks (which can also be retrofitted to existing machines) enabling the MTR12 to play and/or record either or both mono biphase or FM pilot control tracks.

When used with the EC-402 plug-in resolver module, this means that the MTR12 becomes a self-resolving machine with tapes of these formats.

All the circuitry of the EC-402 is also available in the EC-401 Universal Resolver, which additionally provides the facilities of SMPTE/EBU timecode reader/display and universal capstan control of ANY machine. Thus the EC-401 enables virtually any type of machine to be phase-locked to any type of reference signal.

Also available shortly will be another headblock/module set for the MTR12, which will allow the record and replay of centre-track SMPTE/EBU timecode on 1/4" tape, compatible with Studer machines.

More details from Mick Boggis.

Mono Pilot and FM Pilot are compatible with NeoPilot and NagraSync respectively. NeoPilot and NagraSync are trademarks of Nagra-Kudelski Ltd.



CASSETTE DUPLICATION

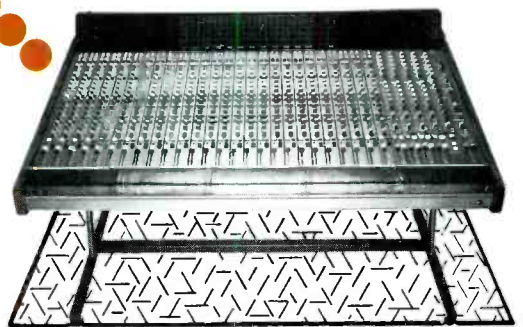
This new modular system from Otari gives a significant improvement in the quality that can be achieved with in-cassette duplication.

The new DP4050-OM reel-to-reel master is a separate unit which can accept 3 3/4" or 7 1/2" ips masters, and you can add to it up to 28 cassette slaves. A DP4050-C1 cassette master unit can easily be interfaced into the system.

As it's Otari, the same consistent quality will be maintained long after other copiers have packed up, and serving requirements are minimal.

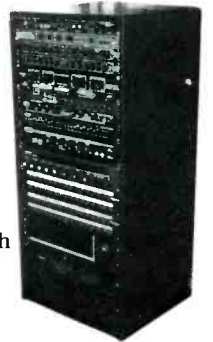
T.A.C. MATCHLESS

This remarkable new console from T.A.C./Amek represents quite a breakthrough in terms of value-for-money. Equally suitable for both multitrack recording or high-quality PA work, the Matchless is a completely modular 26/24/8/2 in-line console with bargraphs, jackfield (not illustrated), 4-band semi-parametric eq., 8 aux. sends, long-throw faders, 2 d.c. mute groups, 8 subgroups, 8 aux. returns, 48V phantom power and much else besides, for under £10,000. The sonic performance is excellent, ultra-high slew-rate devices are used throughout, and active balancing is employed. The low cost does not imply a cut-price standard of construction either; the Matchless is of an exceptionally strong all-steel construction, and will easily stand up to life on the road.



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INSIGHTS INSIGHTS

Richard Elen reflects

Surround soundings

One of the things that took me to sunny Anaheim, California, this May for the AES 'When is a Convention not a Convention? When we can't make up our minds' Conference was the fact that the British Technology Group had organised, with the kind assistance of the AES (and John Eargle in particular) a series of seminars on Ambisonic surround-sound techniques for the studio (see *Studio Sound*, September 1983). BTG, you will remember, are the people who have supposedly been sitting on the excellent Ambisonic system for the last ten or so years without doing anything about it.

Whatever they may (or may not) have done with Ambisonics in the past, they are certainly doing it now, and so are the companies involved at the moment. Virtually everyone who was anyone in Ambisonics was at the Conference, and we had a lot of fun demonstrating the mixing system to nearly-full houses throughout the afternoon.

Notably absent were the odd gripers who, once allegedly part of the Ambisonic team, now spend their time slugging off BTG to the Press (including to *Studio Sound's* own Barry Fox). Being non-present, said persons were of course not up until 2am that morning preparing for the demo after AES had mysteriously mangled the dates without telling anyone. Time has passed by these parts of Olde Balham, and so shall we.

Having established my bias in this direction once again, I cannot resist mentioning a presentation on the Sunday, organised by Martin Willcocks (Willcocks Research) and Greg Badger (Soundfield Systems). Titled 'Recent Techniques for Surround Sound', the event consisted of a totally disastrous attempt to subject a microscopic and dwindling audience to a 'comparative' selection of music and music videos with allegedly surround-sound audio, the intention being to make a blind test of the audience's preferences in surround-sound systems.

The replay decoders were switched between systems during the course of each track, and we, the audience (in my case, we was Roy Easson of BTG and myself by the end, the other two members of the audience having left during the course of the presentation) were asked to fill in questionnaires with the title of the track and the letter representing our favourite surround experience (Willcocks held a card with a letter up from time to time as the systems were switched). For each track, the letters were changed, to make the same system represented by a different letter for each item.

The combination of totally-misaligned (and, in at least one case, completely incorrectly set-up) replay systems, varying amounts of distortion, significant level changes between systems, replay of material recorded with one system through a decoder for another, and above all the fact that the switching was so rapid (every few seconds) that you couldn't *attempt* to get used to one before it changed, and couldn't look down at your questionnaire to write a letter without missing the next changeover, made it impossible for me, at least, to tell anything very much. They all sounded pretty awful.

Willcocks' and Badger's claimed intention was to collate the results and tell (presumably) the world what surround-sound system people liked. Apart from the fact that 20 people or so is hardly a good statistical sample, so on that alone the results will be

Fleetwood Mac will be going into the studio shortly to produce a Holophonic album

meaningless, they will also be meaningless because of the sheer bad management of the test.

And I really can't imagine whether playing back a recording made on system A through a system C decoder actually means anything or not. It sounds a bit like making a stereo recording and playing it back in colour, or vice-versa, or none of the above.

Whatever the results, I suggest that they go straight in File 13 when you see them, as they will be meaningless. Honest. This is a pity, because surround-sound needs support: it's a good idea, and the Tate system, on which Willcocks and Co have done a huge amount of valuable work, is the most impressive of the 'quad' systems (Ambisonics isn't a 'quad' system, of course). Add to that the fact that Willcocks and Co are eminently respectable and respected in the industry as individuals, and there is cause for sadness as well as other emotions (such as anger, annoyance, etc). These fallacious tests (you thought A/B tests were bad? Well, try A/B/C/D at two seconds per selection), and the inevitable publication of their meaningless results, not only harms their own system and their reputations, but does immeasurable

damage to surround-sound as a whole. The two systems, Tate and Ambisonics, can co-exist, but with this kind of embarrassing spectacle there will be those who would prefer us to be left with pan-potted mono and that tedious binaural stuff.

And while we are on the subject of binaural, I hear that Fleetwood Mac's co-producer Ken Caillet, has done some deal with Hugo Zuccarelli on the rights to Mr Z's contentious 'Holophonic' system. Fleetwood Mac will be going into the studio shortly (a studio with a large, airy soundstage available for dummy-head recording) to produce a Holophonic album.

One obviously wishes them the best of luck. Mr Caillet is not stupid by any means—nor are his colleagues and collaborators—and he obviously feels that the system offers him the things that he needs creatively. He appears to be happy with the way the system sounds on speakers at 60° (which is how people will hear it) as well as on headphones and on speakers at 180° to each other.

This is fine. Despite the fact that Zuccarelli seems to think the magazine has said otherwise, *Studio Sound* has never doubted for a moment that the system works, and very well it does too. We have heard the tapes and marvelled, just like the rest of you who can't remember good binaural. Quite simply, it is the best commercially-available dummy-head system we ever heard (and we said *that* last time). The magazine never suggested otherwise, in print or elsewhere.

What we have wondered about, to no satisfactory answers from Zuccarelli, is his bizarre and by now heavily questioned 'theory', there still being no sign whatsoever of the alleged patents (no, he hasn't sent them to US either). Finally, we doubt the usefulness of a system which needs an anechoic chamber and many speakers to do a mixdown, where both Messrs Tate and Ambisonics can do it with none of said paraphernalia. Plus, Ambisonics can be 'decoded' binaurally, and no doubt Tate can too.

These factors should be considered when choosing a new surround sound system, if you want to do more than record classical concerts and sound effects records.

So before Mr Zuccarelli goes round interrupting people at exhibitions and telling them how *Studio Sound* doesn't know what it's talking about, he might read what we said first, understand it second (this is easier than believing his 'theory' as published in *New Scientist*), and then prove us wrong. We can be wrong sometimes, and we will be pleased to change our opinions in the light of the (currently non-apparent) facts.

The patents? That will do nicely sir. □

LETTERS LETTERS

Letters should be marked 'For Publication' and sent to the Editor at the Croydon address on page 3

APRS standards

Dear Sir, We read with interest the letter (May) from T Frost, Harman (Audio) UK Ltd. Of course, the heading to the letter and the March Editorial made it slightly misleading but we were not privy to writing the article which led to Mr Frost's comments. It does seem to us that the Association's objectives may not be fully understood in all quarters. We, therefore, give a resumé of what we are trying to do in respect of the relationship between studios and the clients.

First and foremost, every transaction should be profitable to both sides. We think the client is entitled to expect:

the equipment to be in good order, which implies adequate maintenance;
that the staff be experienced;
that the studio environment is acceptable in respect of heating, ventilation, décor and acoustical insulation;
that the recorded material shall be protected against loss through any cause and of a format acceptable throughout the industry—particularly for interchange of tapes between studios;

adequate facilities for refreshments, relaxation and an absence of restriction as to recording hours.

The studio is entitled to expect:

that the client is willing and has the capacity to pay having regard to the capital required to provide a modern studio;

will be ready to enter into a formal agreement as to date, time, session duration and terms of payment;
will observe reasonable house rules and will recognise each studio as unique with its own characteristics.

Bearing in mind these major reciprocal and sometimes conflicting needs, and the law as regard contracts and the present position of a studio in respect of damages to or loss of tapes, the APRS have endeavoured to ensure that the clients will be satisfied and that the studio will be adequately recompensed and protected by the creation of recommended terms of business to which the Office of Fair Trading have found no objection and by visits to studios by representatives of the APRS to ensure that the standards are maintained.

We disagree with the statement 'Quality limitations are not in the format but rather in the level of care'. We suggest the quality limitations are very much affected by the format assuming correct maintenance. Consequently, we are not clear in our mind how our objectives can be stated on the lines of the IBA Engineering Code.

We suggest that none of this displays elitism but rather solid commercial sense.
Yours faithfully, Robin Jones,
chairman, APRS Membership Committee, 23 Chestnut Avenue, Chorleywood, Herts WD3 4HA, UK.

Better listening

Dear Sir, Hitherto I have refrained from entering the lists in the discussion about how to use the Soundfield microphone, because I do not think that anyone who has taken part in the development of an audio technology should try to dictate to others how they should use it.

However, I cannot resist expressing my pleasure in John Whiting's letter from October Sound (June) particularly the acknowledgement that the fundamental agreement between himself and Gerald

Reynolds exceeds any area of difference.

I particularly appreciated the paragraph in which he placed mono, stereo, ambisonic horizontal and periphonic surround, and live concert, in a list each member of which becomes relatively unacceptable when one has just heard the next one up. Would that this attitude were more widespread in the audio industry.

Yours faithfully, Prof P Fellgett,
Dept of Cybernetics, University of Reading, 3 Earley Gate, Whiteknights, Reading RG6 2AL, UK. □

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DIARY DIARY

More DSP from Neve

Neve have announced the confirmation of a fourth *DSP* order. They will be supplying the National Sound Archive with a 2-channel digital processing unit based on the *DSP* but especially tailored for restoration of archive sound material which at present is stored on wax cylinder, disc or magnetic tape. The desk will allow field recordings made on the Sony *F1* to be directly interfaced to digital signal processors and then re-recorded via the *F1* for archiving without multiple A/D D/A conversions.

In brief

Jay Siegel has announced he has acquired **Mayfair Studios**, New York. Major capital improvements have started with the installation of an automated MCI 636 in Studio A, the addition of video synchronisation and full-coat transfer facilities. . . **The Music Works**, North London, will soon be opening a second 24-track studio on the same premises together with disc cutting and tape copying facilities. . . **Soundcraft Electronics** announced record sales in 1983, their 10th year of operation. Output was about 90% up on 1982 and sales of subsidiary **Soundcraft Magnetics** was up 40%. . . A new catalogue is available from **Optronics Ltd**, the UK fibre-optic components distributor; UK and US specifications are included. Tel: (0223) 64364. . . **Sigma Sound** of New York are now operating their audio for video post production facility offering 24-track recording and mixing to picture and dubbing or layback to video or mag film. Tel: (215) 561-3660.

PPG in UK

The German based company PPG has established a sole UK retail outlet in London for their range of synthesisers and computer controlled music systems. There will be provision for demonstration, a full after sales service and a workshop facility for repairs and modifications.

The PPG range has recently been expanded to include the 2.3 as well as the 2.2, a new *Waveterm* and the *Processor* keyboard. Prices on PPG equipment have also recently been reduced. PPG UK, 505-507 Liverpool Road, London N7, UK. Tel: 01-609 8501.

Goodmans Loudspeakers sale

Thorn-EMI has announced the sale of its 79% interest in Goodmans Loudspeakers Ltd, to Actclose Ltd which is a new company incorporated by the directors of Goodmans Loudspeakers. The Plessey Company plc, who owned the remaining 21% in Goodmans has agreed to sell to Actclose at the same time.

UK Lexicon distribution

Scenic Sounds and FWO Bauch have announced that they have concluded a product line rationalisation agreement whereby from June 1st, 1984 Scenic Sounds Equipment became the sole UK distributor for the entire product line of Lexicon. This means that rather than as at present, SSE will stock the effects and broadcast products in addition to the reverb devices.

SSE and FWO Bauch feel that this new arrangement will remove the confusion that has sometimes surrounded the distribution of Lexicon in the UK.

Forthcoming events

- September 21 to 25
International Broadcasting Convention, Brighton, UK
- September 25 to 27
AES Convention, Melbourne, Australia
- October 8 to 11
AES 77th Convention, New York, USA
- November 29
Sound Broadcast Equipment Show, Birmingham, UK
- March 1985
AES Convention, Hamburg, West Germany

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THE CUT AND AFTER

For many years now the vinyl or black disc has been the most popular method of reproducing recorded music. Throughout its long and distinguished career it has evolved from producing the scratchy sound that is typical of recordings made on old 78s to the superb fidelity that is possible from the modern stereophonic long playing record. In addition the playing time has increased to over 30 min per side.

One might be forgiven for thinking that a product which has been around for over 70 years could not be improved but nothing would be further from the truth: over the last few years there have been some dramatic developments which have improved the quality of the disc even further. The odd thing is, that some of the improvements have been gained by going backwards, as many of the companies who produce specialist direct-cut discs will confirm. They believe that the key to high quality recordings is to reduce the number of components in the recording chain to a minimum.

Not that recording this way is new, because for many years it was the only way available to the recording engineer until the advent of the tape recorder with AC bias. What is new is the

Even after 70 years of development there are still many variables to take into account when mastering for that perfectly cut lacquer. Mike Jones suggests a few points for consideration in the first of a two-part series

combination of high quality electronics and the latest generation of cutting lathes.

Linn Products of Glasgow are one of the few companies actively involved in both sides of the industry. Having produced one of the best turntables available to the consumer, the *LP12*, and not being satisfied with the quality of many mass-produced records they decided to investigate the recording and cutting process. In doing this they have gone right back to the basic principles of reproducing sound from black vinyl records, having developed their own unique adaptation of the Scully lathe in the process. The resultant records are some of the best samples I have ever heard.

The lacquer companies, from whose products the majority of records are still mastered, have improved the quality and consistency of the acetate—two of them have even invested in brand new plants in recent

years. Despite this the majority of cutting engineers would probably like to see acetates improved beyond the current stage.

One possible answer to the cutting engineers' problems in terms of quality and economy could lie in the 'Direct Metal Mastering' (DMM) process which has been developed by Teldec in West Germany. In addition to this, Teldec have introduced a new standard in recording quality by only allowing the 'DMM' label to be applied to recordings of exceptional quality and those that have been cut and pressed to the highest standards. Providing it is correctly controlled the 'DMM' label on the front of the sleeve will mean a quality product to the consumer and this could extend the commercial life of the black disc.

The vinyl LP or Black Disc, as it has often been referred to since the introduction of the silver coloured Compact Disc,

is faced with an ever increasing amount of competition from both CD and pre-recorded cassettes—both of these offer advantages of convenience over the black disc. In addition, sound reproduction quality on the digital CD has the ability to be superior. Due to the introduction of chrome tape and personal hi-fi sales of music cassettes now represent nearly 50% of all LP sales.

In view of these trends not only has the popularity of the black disc waned but many people inside and outside the industry believe it will no longer be with us at the turn of the century. This bears out on technical evidence alone but it will be the major record companies who finally decide.

This eventual decision will be affected by two other important factors (a) the acceptance by the consumer of the alternative systems; and (b) the quality of the black disc itself.

The record industry has already proved that it is capable of producing superb quality records on a selected basis and by improving the quality of mass produced discs the industry could add several years to the life of the black disc. As Joe Kempler of Capitol said, "We can't stop the LP from disappearing, but by improving the quality we can delay its departure."

Fig 1

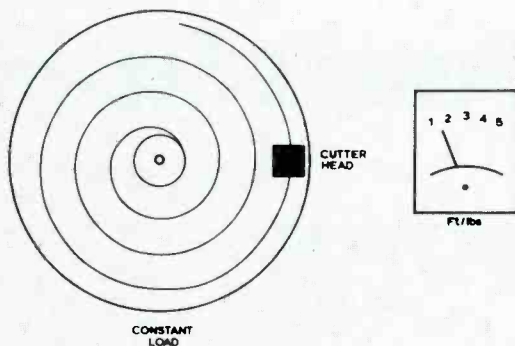
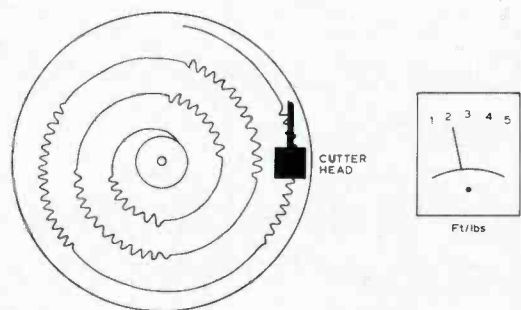


Fig 2



So with this in mind we look at some of the latest technology and thinking that lies behind some of the latest developments.

Reducing the process of record reproduction down to its very basics it could be described as a mechanical waveform of the music or sound that is cut in a spiral track on to the surface of the record by a cutting stylus which is vibrating in sympathy with the music. On playback the process is merely reversed. For the pitch to remain constant it is essential for the platter on the cutting lathe and the platter of the turntable to spin at identical and constant speeds.

Let's look at some of these points in more detail starting with the spinning of the platter and how its speed is easily affected by the modulation level of the music (see Fig 1). If we cut a silent groove or a constant tone at a fixed level then the load on the torque of the platter will remain constant. As the modulation level increases (Fig 2), for whatever reason then the loading on the platter drive will increase and so will the torque which will have a slowing down effect on the platter in a similar way as the brakes slow your car down when they are applied. With

servo controlled motors this slowing down effect is countered by increasing the power to the motor and in doing so keeping the speed of the platter constant, or so we are led to believe. For if the increase in level occurs in a very short space of time as it can with a transient then, depending on the amount of torque which was available, at that moment in time, the platter could slow down while the servo reacts.

The alternative is to use a heavier platter which gives it plenty of momentum enabling it to cope with transients and to drive it with a small synchronous motor which could be controlled by a crystal oscillator to ensure speed stability.

Whatever the drive system used the platter has to be supported by a bearing of some kind or the other. Many of the older lathes used ball races which would soon wear in use and become extremely noisy and even when changed on a regular basis it is doubtful if they could ever achieve the low rumble figures of the single point or hydraulic bearing used on the lathes and turntables of today.

When they obtained their Scully lathe Linn, quite naturally, fitted it with a larger version of the same bearing that they used so successfully in their LP12

turntable (see Fig 3). This is of a single point oil bath design where the spindle is housed in an oil-filled case. The sides of the spindle are supported by low friction plastic and when the housing is filled with oil it forms a thin film between the spindle and the plastic. Thus the only contact between the spindle and the bearing is where the former makes contact with the thrust plate. As this occurs at the centre of rotation the velocity is very low, thus reducing rumble and wear. The tip of the spindle which has to be precisely centred sits on the thrust plate which is made from high speed tool steel and has been ground and lapped to a mirror finish.

In designing the LP12 turntable Linn found that the slightest vibration or rumble transmitted to the platter from either the bearing, drive motor or any external source may have an adverse effect on the quality of the sound, masking a great deal of the subtle detail that is so essential to enjoyable music.

They argue, that if vibration and noise can affect the playback turntable, then it can also have a detrimental effect on the cutting lathe. So they set about isolating the platter and cutter head from all sources of noise and vibration, be it from the lathe itself or the outside world. The results they have achieved with the modified Scully lathe would tend to support this view.

To reduce vibration from the motor they have isolated it completely from the platter by mounting it directly to the floor on a substantial frame and the motor itself is connected to the platter by a ground rubber belt. Likewise the motor which drives the traverse screw of the cutter head is mounted on the wall of the cutting room and is connected in a similar way.

The improvements made by the modifications to the lathe can be seen in a detailed analysis of the rumble shown in Fig 4.

Another area where

improvements were made were to the Ortofon cutter head and suspension system. In specific terms Linn have increased the rigidity of the head mounting method by using two high tensile screws connected directly to the magnet assembly in place of the single screw which is normally fixed into a plastic insulator.

Removing the flexible insulator meant modifications to the electronics, in addition to which Linn replaced the existing head driver amplifiers with a pair of bridged Naim 250s each one capable of delivering in excess of 400 W and with extremely fast slew rate. The overall result was yet further improvements to the transient and musical performance of the lathe.

Not that the engineers at Linn stopped there for having fixed many of the problems on the lathe itself, they then investigated various methods of cutting and processing the resultant master.

For example they looked into the problems that arise due to the relaxation that takes place in the surface of the acetate after it has been cut. If the original quality of the recording is to be retained, especially at high frequencies the acetate should be processed immediately after it has been cut. Linn found that even the small amount of relaxation that would take place over a couple of hours at normal temperature would spoil the fidelity of the recording and that this could be reduced by cooling the lacquer after cutting and transporting it to the plating plant inside a small portable refrigerator.

As Martin Dalgleish, who is in charge of R&D at Linn, said, "By looking after the finer points and by taking more care we can improve the quality of the final record. Making it quieter and far more enjoyable to listen to." A similar point of view has been expressed by Professor Fouque and Mr Redlich of Teldec in Berlin. DMM has many commercial advantages when compared to masters and clearly Teldec are totally committed to quality.

The copper mastering process originated from the development of the video disc process by collaboration between Decca and Telefunken in 1971 and while the system was technically successful, it was not commercially viable because of the high software costs: a 10 min disc cost

Fig 3

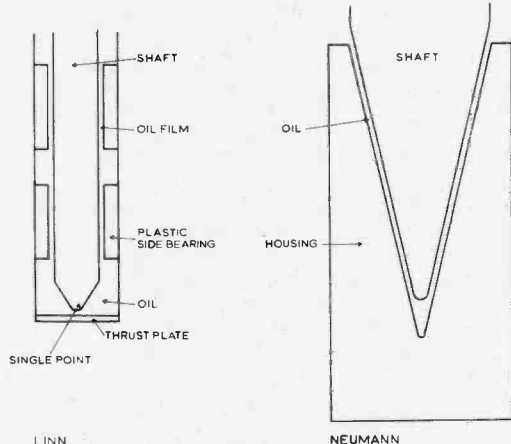
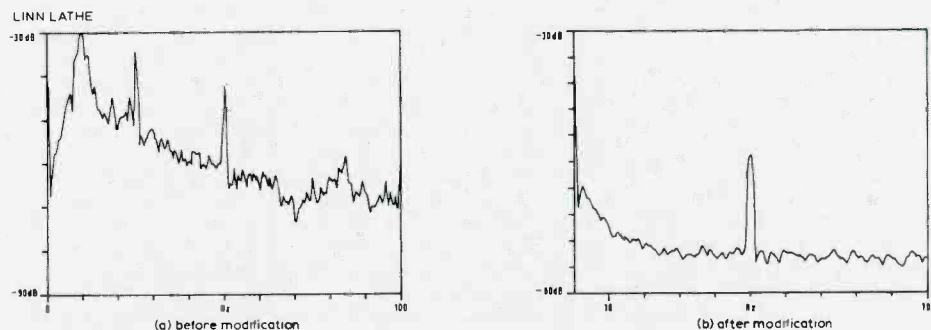


Fig 4



THE CUT AND AFTER

around £8.00 (\$11.50 approx) or so.

Initially all the masters for the Teldec video disc (in the early '70s) were cut from acetate lacquers but these proved to be very unreliable in processing because of the very small groove. The situation was so bad that only one in five masters cut proved to be satisfactory after plating. When copper was introduced the reject rate was dramatically reduced from 500% to 10%. An added bonus was the improvement in luminance noise by 15 dB. So not only had the production costs been reduced but the quality had been improved as well.

These results led to a series of tests which were carried out at Teldec's laboratories in Berlin to see if copper masters could be used for audio. But because of the different physical requirements, the use of copper masters for audio presented quite a few problems. A look at **Table 1** will demonstrate.

Apart from the differences in the groove dimensions Teldec also found that the mechanical cutting force required to cut the deeper groove is 10 times higher than that required for a conventional lacquer which meant that a normal lathe could not be used. In brief the lathe required several major modifications to enable it to cut DMM masters effectively. First, a larger drive motor is required to cope with the higher cutting force. Then the vacuum system that removed the chip had to be modified and lastly the suspension of the head was improved, again to cope with the higher forces required. Lastly special electronics were designed to artificially maintain the cutting angle at 20° while the physical cut was carried out at about 0° and the stylus is modulated at 70 kHz to reduce the cutting forces on the diamond stylus.

In the end, after a great deal of development, a special lathe, the *VMS 82*, was designed by Neumann for Teldec and as the system has become more popular they have produced a kit to upgrade existing *VMS 80* lathes to the new technology. The two companies are closely linked anyway as Teldec own 25% of Neumann.

Teldec found that they had to develop a unique copper alloy containing special brighteners and lubricants.

TABLE 1

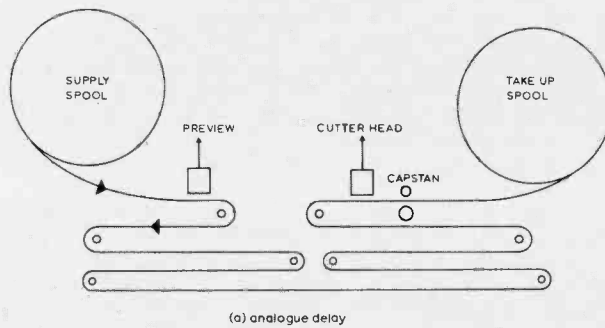
Parameter	Video	Audio
Groove width	2 micron	150 micron
Groove depth	$\frac{1}{5}$ micron	27 micron

TABLE 2

Width of land (Microns)	Echo in dB	
	Acetate	Copper
10	-55.0	-69.5
30	-56.5	-70.0
60	-60.0	-72.0
100	-65.0	-74.5

Average results for both channels.
Source: Teldec.

Fig 6



The copper surface of the blank is plated on to a stainless steel substrate which after polishing to a mirror finish has 2 microns of nickel plated on to it to provide a good key for the special copper alloy which is plated on to the nickel up to a thickness of 120 microns.

Currently the copper master has to be cut within two weeks of it being plated but once cut it can be left indefinitely without deterioration. Teldec are developing a new type of copper where the pre-cut life is extended to last several months. However due to very short delivery times plus the fact that many licensees manufacture their own discs, the short pre-cut life of current discs is not a problem in practice.

When one considers the problems that have arisen in the past with supplies of lacquers, the ability to manufacture one's own discs and the security that this gives must be one of the largest incentives a record manufacturer can have to use the DMM process. Another is the lower cost of the copper blanks when compared with acetate and the ability to produce stampers directly from the copper master in a fraction

of the time it takes with conventional masters. Indeed with this process the only time a manufacturer needs to make a father and mother is when very high volumes are involved for it is possible to make at least 20 stampers from each copper master.

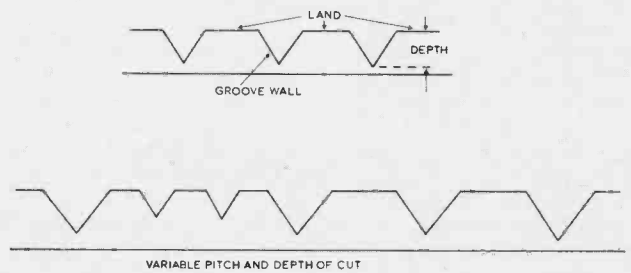
Record producers are always trying to extend the playing time of records without degrading the audio quality. The pressure to do this, especially with classical recordings has increased lately due to CD which can offer in excess of 1 hr unbroken music. To achieve longer playing times the cutting engineer has to make maximum use of the space he has available to him on one side of the record which he does by varying the pitch and depth of cut. As the level of music increases the vari-pitch system built into the lathe will reduce the number of grooves per radial inch which in turn increases the amount of land between the grooves to avoid echo and mistracking. As the modulation level reduces the pitch is increased and the number of grooves per inch increases (see **Fig 5**).

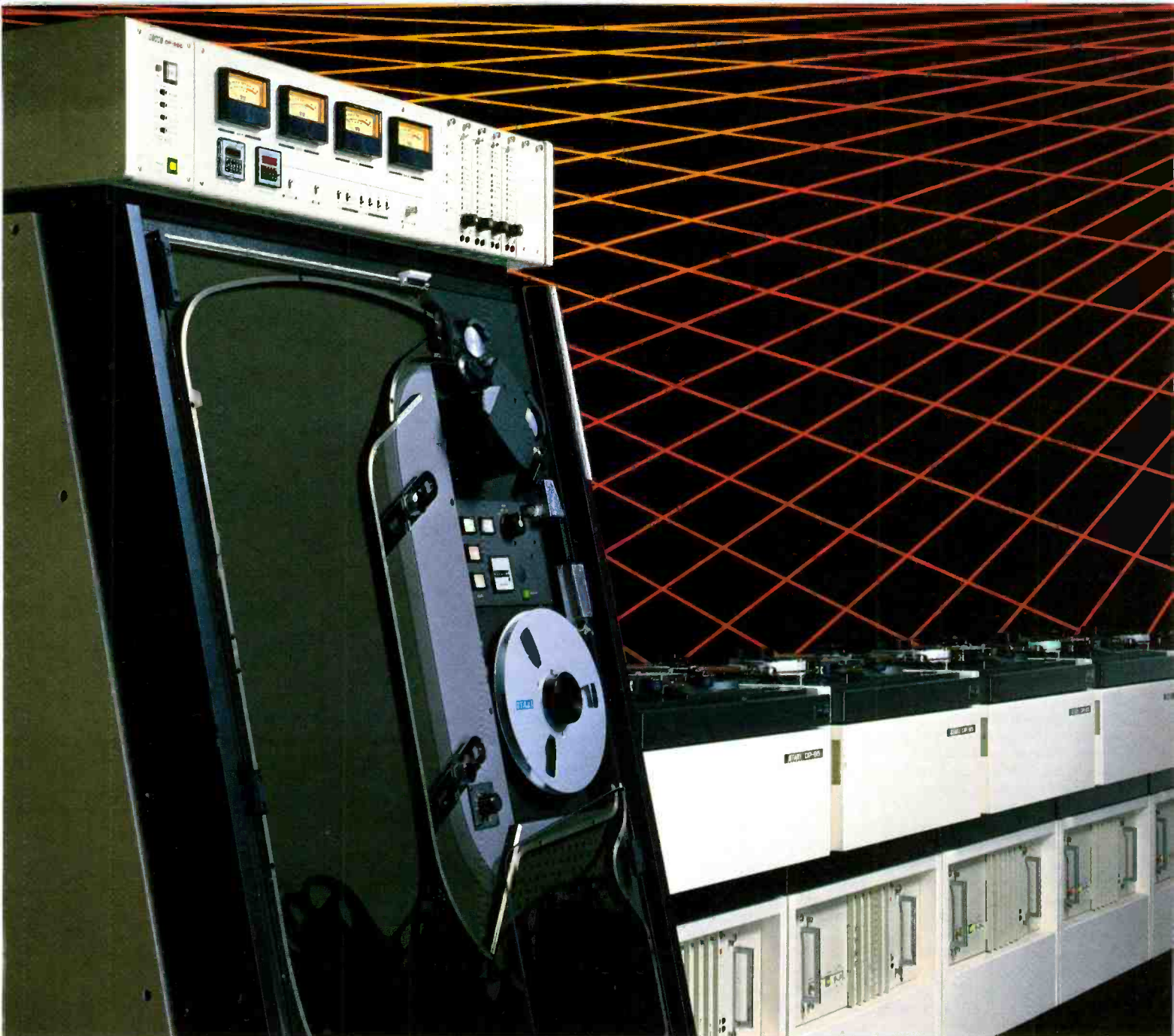
To control vari-pitch systems a preview head used on an analogue tape deck or a digital delay is used for digital recordings. Both systems are adjusted to measure the level of the system $\frac{1}{2}$ a revolution before the same signal reaches the cutter head. Thus giving the vari-pitch system time to react to the varying modulation levels.

On analogue recordings Teldec always use the tape delay path on a Studer *A80* playback machine while on digital, where they use several systems including one built by Mitsubishi they use digital delay. Block diagrams for both systems are shown in **Fig 6**.

In addition to vari-pitch the majority of modern lathes can also vary the depth at which records are cut. In particular high level low frequencies require the groove to be cut more deeply to avoid mistracking and because the top of the groove is wider the pitch has to be adjusted accordingly. One could leave the groove at the same depth of course but this would reduce playing time. Now with acetates the response time to vary the depth of the groove is about 900 ms because of the ploughing effect that would take place if the depth of cut were increased too rapidly and

Fig 5





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the acetate is pushed out of the way as opposed to being cut cleanly. But on copper the time is reduced to 100 ms because of the harder material being used and for these reasons it is possible to record up to 40 min of programme material per side without any degradation in quality.

The hardness of copper offers other advantages such as the ability to improve crosstalk and echo by as much as 15 dB as shown in Table 2.

The copper master also offers improved transient response because, unlike the acetate, it does not relax after it has been cut.

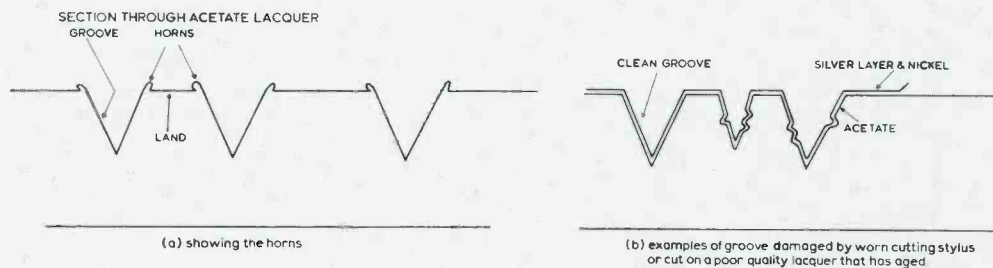
Apart from the initial silvering stage, which is omitted, the plating process for copper masters is identical to that used for acetates as the same processing equipment can be used. However, unlike acetate, the record manufacturer can either obtain his stampers directly from the copper master or for longer runs of over 30,000 pressings, a father and mother can be produced in the conventional way.

A great deal of care and attention is required during the various plating and cleansing processes where either the silvered acetate or the copper master is plated with nickel. Being an electrochemical process the record manufacturer has to be very careful to avoid contamination which can cause all sorts of problems.

The silver is applied to the acetate lacquer chemically by means of a reduction process. This is done to provide a key for the nickel which is plated on to the silver layer in two stages. The first, or pre-nickel stage, which is only 10 microns thick, is carried out slowly to obtain the highest quality and this is followed by the main nickel layer which is plated at a faster rate, using 25 A of current per square decimetre in place of 1 A and by increasing the temperature of the electrolytic.

When silvering acetates, problems can arise, especially if the groove walls have not been cut cleanly because either the lacquer was not cut at the correct time or the cutting stylus is worn (Fig 7b). If the score marks are too severe then the father will not pull away cleanly which will lead to a very noisy, if not ruined record. So it is very important that lacquers are cut at the right time, for like

Fig 7



the copper blank their physical characteristics alter with age, and the cutting stylus is checked for wear and replaced when worn.

Another process which is carried out on acetates and not copper masters is polishing which is normally carried out on the mother, to remove the horns that form at the edges of the groove wall as shown in Fig 7a. Unless carried out extremely carefully it would be very easy to damage the information contained within the groove and the quality of the resultant sound.

The chemistry also needs to be carefully controlled. For example, at Teldec, in addition to monitoring its strength, the electrolytic solution, which is used in the electroplating baths, is continuously pumped through very fine filters which can remove any particles from the solution which are larger than 1 micron.

In between each plating stage the disc goes through a complex cleaning, neutralisation and preparation process to prepare it for the next stage. In between the various stages the nickel discs are stored in water which contains a buffer solution until they are ready for the next part of the process. This is done to ensure that no dust or dirt can get on to the surface of the disc. In separating the discs from each other a magnetic knife is used to collect the swarf that falls off the edge of the nickel when the two discs are separated.

Before the stamper can be used on the presses it has to have the centre hole punched and be formed into the correct shape so it will fit the tool on the press.

The first stage is to locate

the precise centre of the record and to punch a hole in it. This is done by mounting the stamper on a machine, which centres the stamper, using the final run out groove as a guide and then punches the location hole in the centre of the stamper to an accuracy of 20 microns.

This is followed by the forming process which is carried out in two stages. The first locates the centre hole and forms the outer ridge of the stamper, removing the excess nickel at the same time and the second stage shapes the centre.

A great deal of the rumble heard on records comes from the plating process and not the lathe, as one might expect. To reduce this the back of the stamper is ground to smooth away the rough surface left by the plating process using three grades of abrasive paper, each one getting progressively finer.

Once formed and smoothed the stamper is then plated with a thin layer of chrome to improve handling in the plating room. For example finger prints are easier to remove from chrome than nickel and after pressing the stamper can be returned to stock without re-polishing.

Care during the pressing stage is also important especially with the choice of raw materials and the way in which they are blended. Use an inferior plastic and the record will sound noisy. Press it too quickly or handle it carelessly and it will become warped.

In particular the plastic, or compound as it is normally referred to, is crucial for high quality pressings and like the majority of other manufacturers Teldec blend their own compound, which they also supply to other pressing plants, buying the raw PVC from a supplier in southern Germany and mixing

it dry with colour and stabilisers. After which it is plasticised and cut into small pellets by a machine similar to a giant food mincer.

To obtain precise control over the melting point of the compound they vary the quantities of two types of PVC and this is done to maintain consistency and low noise figures.

Over the years the amount of plastic used to make a record has gone down and while Teldec believe that the optimum weight for their compound is 125 grams there are many companies who use less than this. In many ways it depends on the way the record is handled once it comes off the press. But from the consumer's point of view the thicker the better because of the added physical strength that the extra thickness offers and its ability to withstand high temperatures for a longer period.

The presses used at Teldec are fully automatic and are supplied by Toolex Alpha of Sweden; while the machines are identical to many others in the industry Teldec believe a great deal of their consistency comes from the quality of their tooling and the 'energy house', as they fondly call the large plant room which supplies all the factory's compressed air and steam, etc.

To produce a good record from any press, be it automatic or manual it is essential that the shape of the tool and stampers are precisely matched otherwise distortion and stresses will be set up in the pressed disc. It is just as important that the plant room can cope with the highest demand made on it by the pressing room and have sufficient capacity to allow for maintenance and breakdowns. Otherwise if your plant uses 200 ft³ of air per minute and you can obtain this from two

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THE CUT AND AFTER

compressors, install a third as a reserve unit.

Cycle time and temperature are two other important factors which will affect the quality of the record. If, for example, the temperature is not correct then the plastic will not flow correctly and if the cycle time is too short the disc will warp because it did not have sufficient time to harden before it was ejected from the press. The problem with long cycle time of course is the high cost, but what price do we put on quality?

Even moving the disc after it has been pressed is important, for when it comes off the machine the plastic is still soft and is easily damaged. At Teldec the records are placed on a spindle by a robot in stacks of 50 with a steel plate inserted into the stack at the midway point. Then they are transferred to a hold area awaiting audio assessment.

This is carried out by a unique machine developed by Teldec being based on a Revox parallel tracking turntable which is designed to detect any impulses pops or clicks in the record. The traverse slider of the arm is split into 100 segments each one covering 1 mm, from which the operator knows the precise position of any problems (see Fig 8).

After this process the records are moved into the main quality control, storage and finishing area where the top record of each stack, which was the last record off the press, is examined for defects. If a fault is detected then the entire 50 is examined to determine the extent of the problem and the faulty discs rejected. If they pass then they are stored in a computer controlled magazine for a minimum of 4 hours before packing (see Fig 9).

Even the packing machinery, which is automated, is designed to handle the records gently to avoid warping. The record is supported and kept flat during its journey through the plant and before it leaves it is securely packed into stout cartons to protect it in transit.

The DMM process is available to any record manufacturer or cutting house under licence from Teldec or their agents. But for them to be able to use the DMM sticker then certain quality standards have to be met as follows.

Fig 8

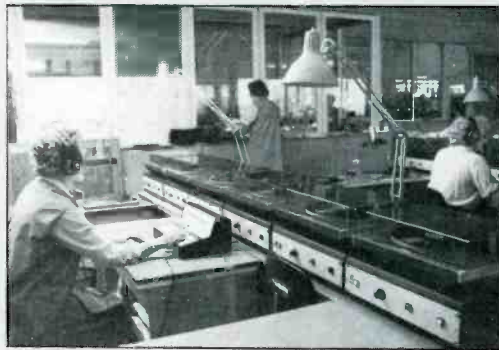


Fig 10

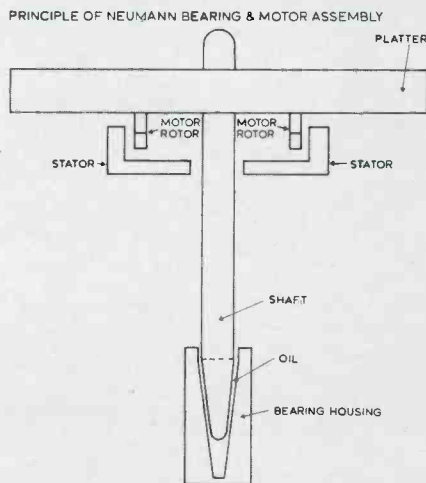


Fig 9

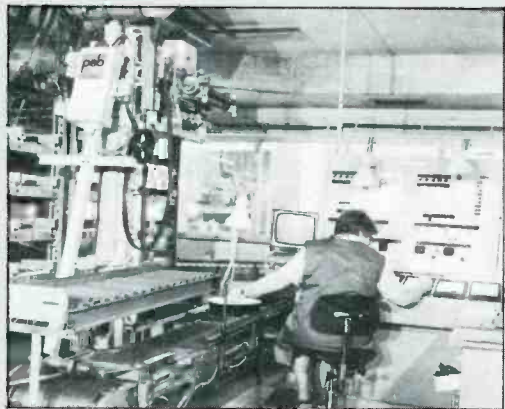
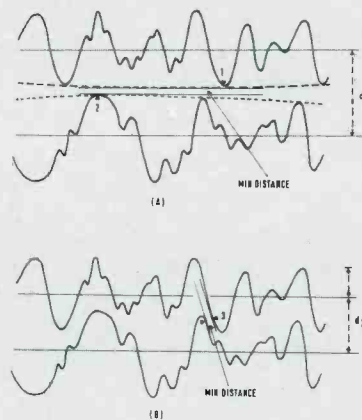


Fig 11



- The master tapes designed for DMM transfer to disc should satisfy high audio quality standards. No audible detrimental effects like non linear distortion, print-through, wow and flutter tape noise or hum should occur.

Teldec feel that these requirements are generally fulfilled by either a digital recording or a first or second generation copy of a tape master using Dolby A or Telecom noise reduction.

They also require the correct alignment tones to be recorded on to the master tape to ensure optimum playback conditions. These should include Dolby level and a band for azimuth adjustment.

Under the terms of the licence it is left to the cutting engineer to decide if a master is worthy of the DMM label. Teldec also reserve the right to check on the quality of any record carrying the DMM label to ensure it complies with the conditions of the licence.

- The centre hole of the record must be within 0.1 mm of the centre in addition to which the record must comply with the IEC specification number 98.

Precise rumble and noise requirement are laid down

with a figure of 64 dB being quoted as a minimum when measured according to IEC 98 or DIN 45 539. This should not represent a major problem as the VMS 82 has a rumble of -77 dB.

There are other criteria, but the extracts above serve to demonstrate that Teldec are serious about setting a new standard.

As you can see from the above information in addition to the licence fees it is essential for a cutting house to either purchase a new VMS 82 cutting lathe from Neumann or to modify an existing VMS 80 to cut DMM. The problem is that you cannot use the same lathe for both types of work. This is because of the differences in the cutter head, vacuum system and other parts of the lathe which have been altered to handle the copper medium.

Having said that it is well worthwhile ending this by looking at the two lathes and the company that produced them.

The basic design of the two lathes is identical but there

are some essential differences. Common to both models is the unique hydraulic bearing which is based on a conical shaft which sits in a conical bearing filled with oil. As soon as the shaft turns it is supported entirely by oil which is forced up the sides of the bearing by the rotating action of the shaft, as shown in Fig 10. The direct drive motor is split into two parts with the stator fixed to the lathe chassis and the rotor to the platter which has been dynamically balanced. By using this method of drive there is no mechanical link, not even a belt to introduce any form of vibration or noise to the platter. This type of construction is unique to Neumann and is virtually rumble free.

The method of pitch and depth control which was described in detail in the *AES Journal* Jan/Feb 1979 is designed to improve the packing density of the grooves while maintaining the correct amount of land between them as shown in Fig 11 where we can see that in Fig 11a the traditional pitch control uses the peak envelope of the signal curve where Fig 11b uses the maximum values and

Working Musician's Choice

News Flash: Musician
lands recording contract



Peter Banks (formerly of After the Fire) has just landed a new recording contract! How? By preparing his demonstration tapes at home using Yamaha* and Roland* synthesizers, the Fostex* B16 and naturally the Soundtracs 16-8-16.

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Unlike the 'famous names' who can choose any mixer irrespective of price, Peter had to decide on facilities and quality at a realistic cost. The mixer had to accept multiple inputs from the keyboard and drum units: the

Soundtracs 16-8-16 which allows 34 inputs (24 with full equalisation and 100 mm fader control!) on re-mix was the obvious choice. Comprehensive output facilities which provide simultaneous monitoring of the tape returns normalised to the line inputs so re-patching is not necessary! Dual standard outputs available at either +4dB or -10dB on a 0.25" (6mm) jack socket allow Peter to expand his system to accommodate any tape machine. 16 direct outputs, low noise NE5534 IC's and transparent equalisation complete the specification.

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THE CUT AND AFTER

their phase relationship to each other to determine the correct spacing. The efficiency of the system is such that it can add 15% to the playing time.

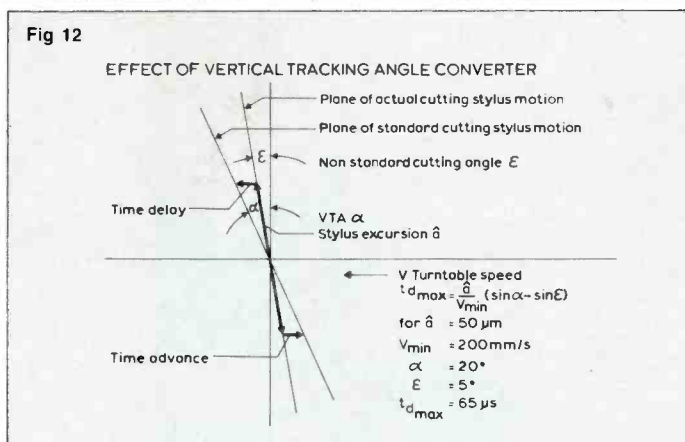
Thanks to the digital control system the VMS cutting lathe is far simpler to use than its predecessors and the operator no longer has to ride the controls to obtain the long playing times which are so often demanded by classical music.

The direct drive motor is servo controlled with several hundred sensors around the circumference of the platter to ensure rapid response to increases in load as the modulation level rises. But while the dynamic torque can be varied the speed is locked by a crystal controlled oscillator to ensure high stability. On the VMS 82 a larger version of the same motor is fitted to provide the increase in torque required to cut DMM.

The cutter head assembly is mounted on a substantial support which traverses up and down the lathe bed on self cleaning Teflon slides. Neumann have found that these prove to be very reliable in service over a long period of time. The bed of the lathe is securely mounted on rubber mountings to isolate it from any floor born vibration with both the drive and traverse motors being attached to the floating bed. Recently Werner Whal of FWO Bauch (Neumann's UK agents) carried out some rumble tests on various lacquers at Utopia cutting studio in Chalk Farm, London with an average result of -77 dB being obtained when measured to the DIN method.

The higher cutting resistance in copper and the reduced damping properties of metal when compared with lacquer, required a new construction of the cutter head suspension on the DMM machine.

The introduction of undesirable oscillations and resonances within the audible frequency range must be eliminated and this has been done by increasing the stability of the suspension and by using a larger damping bath which ensured that the depth of cut could be maintained. 550 W/channel is available to drive the cutter head and sophisticated monitoring circuits are used to ensure that the temperature of



the head never exceeds 200°C which is the maximum operating temperature.

The frequency response of the cutter head is corrected with feedback coils and correction amplifiers to neutralise the effect of the heads natural resonance which occurs around 1 kHz.

By incorporating a feedback coil in the cutter head a precise feedback voltage can be fed to the electronics which inverts the signal then uses it to control the gain of the driver system and the frequency response of the cutter head is linearised.

The 0.1 mm wire used for the construction of the drive coils is pressed into a 0.07x0.14 mm format so the windings are packed more tightly together which increases the efficiency of the coils.

Also because of the high cutting resistance a diamond cutting stylus has to be used which can be readily changed so it can be returned to Teldec for polishing. Another feature of the process is that the physical cutting angle is different from the normal vertical tracking angle used to cut conventional lacquers. This apparent difference is corrected by the Vertical Tracking Angle Converter. This device is an amplitude dependent time modulator which is controlled additionally as a function of the groove diameter.

The unit is able to produce time delays of 0 to 200 μs and permits the cutting angle of 5° to 7° produced by the SX 82 cutter head to be set to the standardised tracking angle of 20 degrees as shown in Fig 12.

The unit is set up as follows. Assuming that the SME arm has been correctly adjusted a cut is made on the outside of the blank with the vertical tracking unit providing a two-tone oscillator fed to both

channels at the same time and connected out of phase with each other so the resultant cut is in the vertical plane. The vertical tracking unit is then adjusted for minimum distortion which is shown on a meter mounted on to the VTU panel having obtained its signals from the Shure cartridge via the playback amplifiers and it is quite critical.

The chip removal for the copper cutting had to be modified from that used for removing the lacquer chip. The vacuum power needed to be increased and the amount of vacuum is controlled as the depth of cut is varied to ensure that the radius of the chip is maintained at optimum.

Finally the vacuum on the turntable has been increased and is fitted with rubber sealing rings to ensure that the copper blank remains securely fixed to the platter. This means of course that only 14 in blanks can be used on the lathe.

Operationally the lathe is used in a similar way to the lacquer version except that a series of tests are recommended before the start of each and every cut. These are designed to optimise the vertical tracking angle, to measure the noise at two depths and to check on the frequency response.

This is carried out by using the SME, which is fitted with a Shure V15 cartridge as the playback device while the cutter head is cutting the test track. These tests which only take a few minutes check the quality of the blank, cutting stylus and tracking angle. If a quiet track is also cut the amount of rumble can also be quickly measured. These tests, apart from the vertical tracking angle are equally applicable to acetate as they are to copper masters.

By explaining the different approaches used by Linn on the one hand and Neumann and Teldec on the other I hope I have demonstrated at least two options that are open to those companies and cutters who wish to improve the quality of their discs. By improving the mechanics of a basic lathe Linn have produced a solution which should prove attractive to the smaller cutting house who could learn quite a lot by visiting the Linn facility in Glasgow and speaking to their engineers.

For the larger record companies and cutting houses who can afford the investment the DMM system has tremendous advantages. The system is already very popular in Germany and is gaining a foothold in the UK. EMI have one lathe at Abbey Road studios and a second on order. Ken Townsend who runs the studio, and the cutting engineers are very happy with the system. They are producing their own copper blanks at Hayes and while they have experienced a few teething problems with the quality of the stainless steel substrate they find they can obtain the same quality and performance figures as Teldec.

Without a doubt the system has great potential but Teldec need to be more flexible in their approach to licensing and should realise that on top of whatever licensing fees they agree the record company still has to purchase a new lathe which costs over £100,000 or get a VMS 80 converted at a cost of £30,000.

So far we have concentrated on the technology of disc production having omitted any detailed comment on methods and the many subjective issues. For example where does the creative part of the recording process end, is it in the studio or the cutting room. In Germany, cutting is not normally regarded as creative whereas in the UK it is. Or, will a disc sound better if the cutting parameters are left static? How should the lathe be set up and what effect does the playback system, built into the lathe, or the monitoring system, or the acoustics of the disc cutting room itself affect the quality of the pressed disc?

A future article will present some of the facts and discuss some of the important issues involved. □

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STUDIO FILE

STUDIO FILE

Situated away from the 24 hour hustle and bustle of Hollywood Boulevard are the Warner Hollywood Studios. The audio department, which is known as the Goldwyn Sound Facility gives an idea of how places can change hands around here. Although there used to be a scoring stage in the complex this has now disappeared, much to the regret of everyone as the sound of the room was apparently quite exceptional.

The audio facility at Warner's now consists of four dubbing rooms and two studios, E and F, with Studio E being for ADR and Studio F for Foley.

Presiding over the operations of the sound facility is Don Rogers, who, in the midst of a hectic schedule still managed to find time for a most friendly welcome and chat. A man of great experience in the film industry, Don retains a very forward-looking attitude to film sound in general and feels that there is still a lot of unexplored potential in the medium. The office walls abound with numerous trophies and awards that underline his experience, one of the more recent ones being for the sound on *Raiders of the Lost Ark*.

The start of the tour of Warner's was the machine room situated behind Studio A. Looking for all the world like a computer room, one is greeted by three rows of Magnatech 35 mm machines, most of them spinning away impressively. The actual machine complement is 24 playback dubbars with one 4-track recorder and one 6-track recorder. There is full Dolby A/CP200 processing and an extra facility is the ability to be able to change from stereo to mono at the flick of a switch. The machine room also houses the crown power amplifiers for the biamplified Studio A monitors, the crossovers being the TH-X model as designed by Tomlinson Holman of Lucasfilm. The room is also pre-wired for the patching in of two 16-track recorders—or a 24-track—as chief engineer John Bonner feels that using 16-track will be an ideal way to record separate 4-track mixes for dialogue, music and sound effects. This will add flexibility in preparing foreign language, mono and stereo releases as well as offering more possibilities in the initial master mix.

Those who regard studio multitrack recorders as opposed to 35 mm recorders with suspicion may be interested to know that in a series of tests carried out by Mr Bonner, the

Warner, Hollywood



Studio A



Charleen Richards in Studio E where the ADR is done

6-track 35 mm came out better compared to a 24-track recorder but the 3-track 35mm came in on a tie with a 16-track machine.

Coming out of the machine room, it is only a step away to the double doors of Studio A. The first point that is very apparent is the excellent isolation of the studio from the outside world. I really had the impression that, once inside, even the Doomsday trumpets would not be heard!

The studio is the size of a small cinema with seating at the rear on a wide raised platform, the console itself being placed down on the main floor away from distractions. This also makes it reasonably near to the screen and gives a better impression of what the cinema audience would hear.

Studio A represents the latest update in the audio facility at Warner and is one of the few film studios that have been re-equipped with the Harrison PP-1 post-production console. The desk for Studio A is a three-man design with the operating sections, from left to right, being 18/8, 12/8, 27/8. Each section has three AutoGraph automation ready 7-band graphic equalisers for additional sound shaping. Other facilities include VCA grouping, joystick panners on the main outputs and comprehensive re-routing.

Special effects units are built into the desk for quick and easy operation and these include UREI *Little Dipper* filter sets (useful for contouring or getting any nasties out without affecting the overall sound), dbx rack with de-esser, compressor, noise gate and parametric equaliser modules, Eventide DDL, UREI 1176 and 1178 compressor/limiters and Ursa Major *Space Station*. Also built into the consoles are the remote controls for two Lexicon 224 digital reverberation units and a Dolby DS-4 monitoring unit.

Apart from the surround speakers, or sixth channel system, the main 5-channel monitoring system consists of five JBL 4675 bi-amplified monitors. Each speaker consists of a twin 15 in bass-reflex cabinet tuned to 35 Hz (model 4508) with an externally mounted 2360 bi-radial constant coverage horn with 2445J driver. A direct radiator bass system was chosen in preference to the more usual horn/reflex cabinets such as the Altec A4 or JBL 4676 because of its smoother response throughout the entire usable frequency range. In order to fully utilise the wide range used in *Dolby Stereo* (flat up to 2 kHz and then rolling off at 3 dB/octave) it was necessary to have precise monitoring where lack of distortion and high definition were the prime

requisites. From this point of view, the Warner engineers were very pleased with the JBLs and have confidence that they can hear everything that is going down. In order to achieve uniform bass response throughout the system, the five speakers are mounted in a plywood baffle that extends across the width of the screen.

From a visual point of view, the most striking aspect apart from the 38 ft screen is the four very large VU meters underneath it! Maybe music recording studios should install these between the monitors to impress their clients.

As well as being re-equipped with hardware, the studio has been renovated acoustically. Apart from the excellent separation from the exterior, the internal acoustics are a tribute to good design. The console area—console to large rear patchbay—has a parquet floor with the rest of the floor area having thick carpet. The raised seating is plush with soft furnishings and is thus absorbent. The side walls are irregular and form floor to ceiling slat absorbers, thus presenting a hard dispersive surface with good low and mid frequency attenuation. The ceiling is non-reflective and consists of staggered sections for varying degrees of absorption versus frequency. The sound itself is rather 'larger than life', the room giving the impression of being bigger than it really is, which is an advantage considering that many cinemas (theatres) are larger than Studio A. Imaging is very stable and the overall frequency response very smooth and un-muddled.

The acoustic design was done by Jeff Cooper after John Bonner and Don Rogers had laid down what their aims were. The large sound was no accident either. The reverberant response was calculated to give a smooth curve between 250 Hz to 4000 Hz with a gentle rise below 250 Hz to add depth. The critical balance was in getting the curve to simulate an average theatre with a reverberation time that was short enough to allow high articulation for speech and accurate imaging of sound sources within the stereo and surround-sound sound field.

The other large dubbing room is Studio D. This is roughly the same size as A but with an older acoustic and a one level floor—and older seating! The type you tend to sprawl over rather than sit in.

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STUDIO FILE

STUDIO FILE

Warner cont'd...

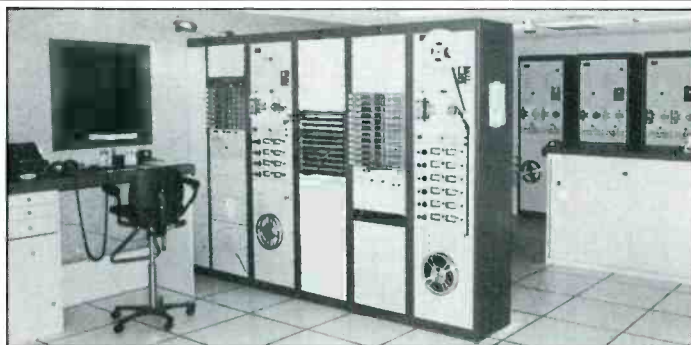
Harrison *PP-1* that was delivered to Warner and is the same configuration as the console in Studio A. The effects equipment is more or less identical as well, meaning that working conditions in either studio are virtually the same. Acoustically Studio D is not as advanced as A but it still gives quite a good account of itself. Monitoring at present is Altec A-4 speakers. However, renovations of the studio is in the pipeline for the near future and it is more a question of finding the time.

At the time of my visit there were some slight panics as a music mix that had been sent in was not satisfactory and a rented Otari *MTR-90* was in the process of being patched-in so that the original 24-track master could be remixed. I was surprised to find at this point that the facility did not have its own machine but the engineers explained that for 95% of the time the music tracks are received already mixed (the facility doing no music recording itself) and that it was more economical to rent when required. However, with the new consoles and acoustics, more-in-house music mixing may well take place and multitracks have been placed on the shopping list.

Even though I got the impression that the remix had come at the worst possible time everybody was taking it in their stride and the overall atmosphere was one of good humour with a dash of panic stations!

The audio facility at Warner's also boasts one of the only, if not the only, woman mixer in Hollywood, Charleen Richards. In the same way that children who have musical parents become musicians, Charleen came into the audio industry through her grandparents who had a studio doing filmwork. This led to contacts with Warner and when her grandparents' studio closed, Charleen joined permanently in 1977. The area she specialises in is ADR (automated dialogue replacement) and this takes place in Studio E.

The control room houses a large console with three channels! Well, script space is at a premium here as well so it is a desk in more ways than one. In terms of hardware the console houses three API mic channels, each with its own direct output and VU meter plus 3-band sweep equalisation, an API compressor/limiter/de-esser



Machine room—recorders

module and a Quad/Eight 2-channel compressor/limiter. In addition, there are remote controls for the projectors and audio machines, the latter being housed in an adjoining room in the form of a 3-track Magnatech 35 mm machine and ¼ in recorder backup.

Monitoring and cueing is tailored to meet all possible variations, depending on how the actor(s) or actress(es) wish to work. For instance, whether they want to hear previous dialogue or not, fading in and out of old and new, etc. In a working situation, there are three cue conditions to be met, the artist, the scriptgirl (who may be in the studio) and the producer in the control room. All three may have different requirements and the monitoring is arranged so that all three can be accommodated according to their wishes.

The remote controls in the console enable start and stop times to be programmed for dropping in and out of record so that it is exact each time. The frame count is simply dialled up, say 311 to 597, and the machines run up. When the projector reaches 311 the Magnatec goes into record mode and out at 597. Simple as that.

The studio itself is quite large, about the size of a decent living room, meaning that it is not claustrophobic. This is important when one realises that dialogue sessions can go on for 10 hours at a stretch! The acoustics are very dead without being anechoic (otherwise it would get oppressive) and consist mainly of V-shaped vertical glass fibre cavities with fabric covered chickenwire facing them. Curtains are used to fine-tune the response as required. The lighting is also very flexible and can be adjusted to provide the mood required! Also noticeable was the quietness of the air-conditioning. The room is very quiet and you really have to put your ear right up to the vents

and then you can only hear anything with great difficulty.

Studio E is very popular amongst the acting profession, including the likes of Richard Burton, due to the feel of the room. The combination of atmosphere and sound just seems to click together with the fact that long sessions are possible without being tiring from an environmental point of view.

Most of the time Charleen uses *U67* microphones and always puts up two, whatever the type. The reasons for this are flexibility and creativity. It is often very easy to change moods by just altering the mix of the two microphones or by going from one to the other. She has also experimented a lot with placement and the mixing of different polar patterns in order to create varied effects, one example being omni with figure-of-eight.

Next to Studio E is Studio F, or the Foley room. For those not too familiar with film jargon, this is the sound effects studio where people can be recorded walking on all kinds of surfaces from plank floor to cobblestones, swishing in the bath or rowing a boat, etc. I asked why the Foley room and it transpires that Foley was the name of the gentleman who thought this type of studio up. The acoustics are fairly dead, the construction being very similar to Studio E, giving leeway for effects processing during dubbing. A variety of microphones are available depending on the sound required.

Time was getting on but I was able to have a little talk with Don Rogers before leaving. The film industry often has a reputation for being a bit stick-in-the-mud and resistant to change, especially in sound, but Don is certainly not amongst that company. It is clear when he talks that film sound is a real passion with him and that he is dedicated to improving it and

getting it right. An anomaly is that whereas the technology and the public demand for film sound to be more exciting has grown enormously, sound production techniques are evolving much more slowly. There is a dearth of music mixers, for example, yet very few engineers come in to the film industry from recording studios partly through lack of interest and partly because of the union problems. (A mixer is a mixer, even if he has no real experience of music recording and union rules stipulate that a union man must be used in preference to an outsider.) This does mean, of course, that the few music recording and mixing engineers in this side of the business are very much in demand and that holidays are a pipe-dream for the future!

Coming back to technical points, Don stressed the importance of proper, quality monitoring systems and included the audio and room in the same package, which, after all, is as it should be. Each room is checked out and measured each day before sessions start to ensure optimum response.

That Don is interested in new technology is exemplified by the purchase of the Harrison consoles which are a radical departure from the traditional market, plus the new listening environment of Studio A. He feels that quality is now what it is about and intends to be at the forefront. Though in film sound for a long time, his actual beginnings were in film where he became a fully qualified cameraman! This was because when starting out there was no real vacancy in the sound department but there was one on the camera side. In this way, Don became a cameraman on the understanding that the moment a vacancy opened up in sound he could switch! However, he doesn't regret the experience and on the contrary, has found it very useful in getting an all-round view of things.

Recent studio credits as well as *Raiders of the Lost Ark* include *Star Wars*, *The Empire Strikes Back*, *The Black Stallion*, *The Last Waltz* and many others.

Warner Hollywood are also among the select few in the world of film sound who produce 70 mm magnetic prints and optical stereo negatives. With the shackles of the 'Academy curve' starting to be cast aside, film sound is advancing apace and you can be sure that Warner Hollywood will be there with the front runners. □

Terry Nelson

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THE MODERN LACQUER DISC

To find out the problems connected with producing lacquers, Hugh Ford visited Capitol's manufacturing plant in Virginia, USA

All modern gramophone records originate by cutting grooves into a lacquer disc which since 1938 has taken the form of a cellulose nitrate coating on both sides of an aluminium core. For some obscure reason these discs are also known as 'acetates'—possibly highly inflammable cellulose acetate may have been used in the coating at one time.

At first sight the production process would appear to be a simple coating problem, but this is very far from the case and is probably the reason why one can count the number of manufacturers on one hand. In practice there are only three significant manufacturers—Pyrall in Europe plus Capitol and Transco in the United States.

For the purposes of this article, I was invited to visit the Capitol Magnetic Products lacquer disc manufacturing plant at Winchester. That's Winchester 'home of the world famous apple blossom festival' in Virginia, USA. Whilst Capitol have a large record pressing and tape duplication plant in Winchester, the lacquer disc plant is a completely separate operation, in its own purpose made building—all for very good reason.

The key to successful production of discs is incredible cleanliness, consistency of materials in the production process and most important, a very flat core before coating.

Production process

Before detailing Capitol's process for the *Apollo Master Audiodisc*, an outline of the manufacture of lacquers is appropriate.

Until recently there was one worldwide source of suitable aluminium blanks for the cores. This was the giant alloy manufacturing company ALCOA who deal in thousands of tons of alloy rather than supplying the relatively small number of special blanks for cores. Consequently this special product became very expensive and disc manufacturers looked for alternative sources of cores, including the use of glass by Pyral. Capitol use aluminium in conjunction with a special production process.

The coating is based on cellulose nitrate with certain additives to control stability, plasticisers, adhesion controllers, brittleness controllers and proprietary additives which manufacturers will not discuss. These ingredients are mixed together with careful control of the viscosity then very exacting filtering is carried out before

the lacquer is fed to the coating machine.

Whilst various techniques are used for coating magnetic discs, so far as I am aware all lacquer disc manufacturers use a curtain coating technique. In this process the cores are fed on a moving belt under the coating head which is in the form of a long slit through which the lacquer is pumped at a constant rate.

From here, the discs with one side coated pass to a drying tunnel. Once one side is dry the second side is coated by the same coating process, the second side being dried before visual inspection for defects. Following inspection the centre hole is punched and a date code stamped on the worst side of the disc—we now have the final product.

This is the method in general use. Let's now look at the process used at Capitol for their *Apollo Master Audiodisc*.

Metal cores

It is a requirement of the end product that the disc should be as flat as possible and completely free from any voids or pimples. Furthermore as the coating is fairly transparent the core must be free from any marks which would make the disc look faulty. Such defects, unacceptable on these grounds, are the result of stretch marks in the blank.

In the past the flatness and general surface quality has relied on ALCOA to produce an acceptable core which was no

mean task—an 80% rejection of cores has been reported. Thus the core was inevitably an expensive product.

At Capitol, techniques are different as the surface of the blanks is subjected to a polishing process. The quality of the original alloy sheet is, however, still important to avoid the inclusion of debris. This means that before the sheet is rolled the aluminium ingots have to be 'scalped'—that is the outside of the ingots have to be cleaned off. After this the sheet is made by a standard rolling process as used for pots and pans before the sheet is punched into 10, 12 and 14 in circles. The circles are then thermo flattened.

The punched blanks, which may not be particularly smooth, are then put through a polishing process where in 3 minutes 0.001 in is removed from each side of the blanks. This process which is used for computer discs also removes any burrs from the edge of the disc producing a core of 0.036 (± 0.002) in thickness.

The next process in producing a good core is ultrasonic cleaning to remove any debris from the polishing process and traces of oils. From here the cores pass to the coating area.

Lacquer coating

As the consistency of the product is very important Capitol has a chemical laboratory which not only controls the lacquer quality but also inspects all incoming materials. This inspection goes far further than most coating plants as not only does the laboratory do routine measurements but is equipped with an infra-red spectrometer and a gas chromatograph to control the purity of all incoming chemicals.

The formulation of the coating unfortunately cannot be discussed as it is a proprietary matter. However the cellulose nitrate is in turn mixed with other constituents in a high shear disperser in a temperature controlled environment. The mixed lacquer is then let down to the correct viscosity and passed to one of two 1,000 gallon storage tanks, one for the *Apollo* product and the other for the standard disc. These

The chemistry laboratory where incoming materials are checked



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storage tanks are continuously topped-up such that there are no discrete batches of coating.

As well as adding new coating, the storage tanks are fed with coating which runs off the machines and also with recycled material from rejected discs. The coating is peeled off these and recycled.

From storage the coating is not clean, thus in the process of transferring from the storage tanks to 300 gallon coating tanks and then to the coating machines the mixture is thoroughly filtered.

Coating and drying

Clean cores and clean coating lacquer are passed to the coating area which is kept dust free to the same extremely high standard as that found in computer disc manufacture. Entry to this area is through an air lock with anyone in the area wearing class 100% cleanroom garments from head to foot. In addition the temperature and humidity are accurately controlled.

In the coating process the lacquer is continuously pumped at constant pressure through a slot in the coating head to produce a continuous curtain of lacquer which provides a 0.02 in coating which dries to 0.007 (± 0.0005) in. Beneath this curtain is a moving belt on to which operators place the uncoated core on a pedestal. The lacquer is thus poured on to the core with the belt being subsequently scraped clean and the unused lacquer returned to the storage tanks.

Once one side is coated the disc is automatically transferred to the drying process which is completely enclosed in a temperature and humidity controlled tunnel which runs not far from room temperature.

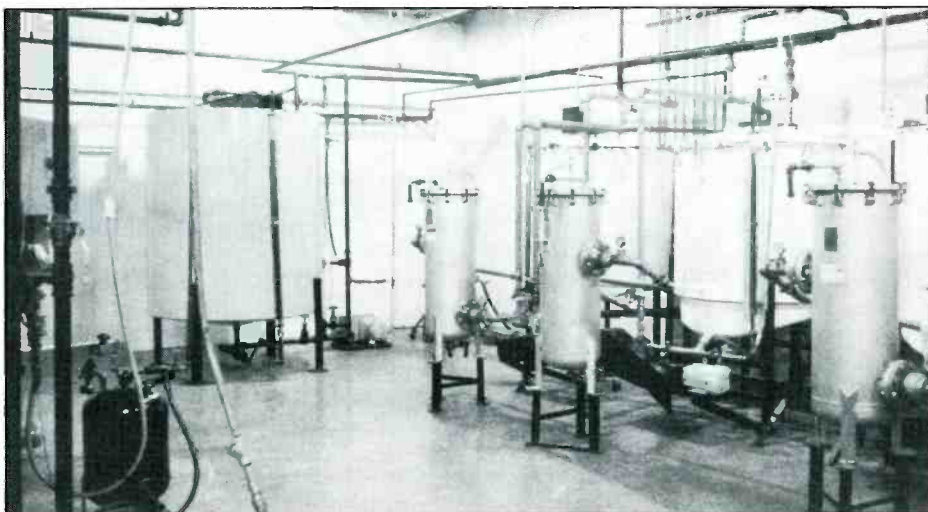
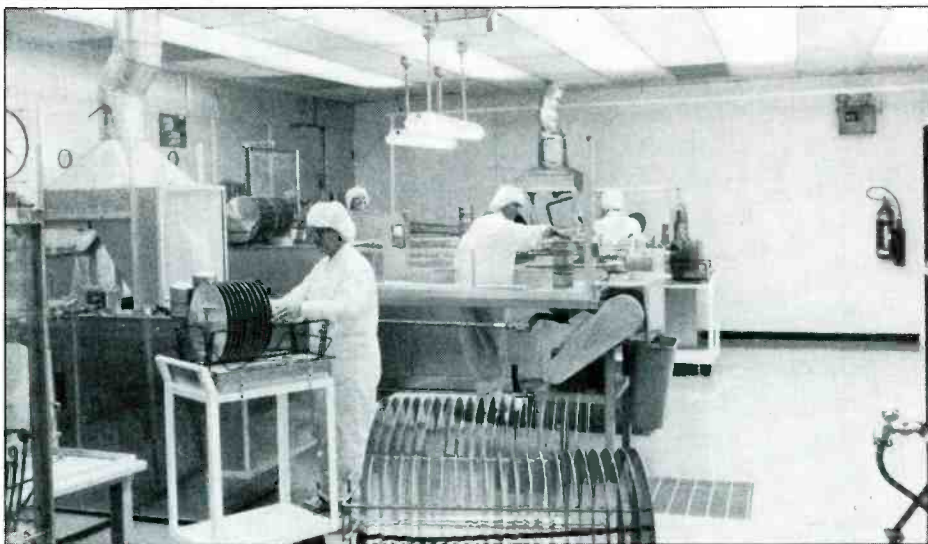
Drying is a long process involving belts running in tunnels which must be at least 100 ft long. After drying initially for 35 min the individual discs are transferred to racks which pass through larger tunnels for 6 hr further drying by which time the coating is 99.5% solids.

The coating and drying process is then repeated for the second side of the discs after which they are automatically transferred through a clean tunnel into large cabinets in the inspection room.

Inspection, punching and packing

The Capitol inspection room is not only a further cleanroom requiring special clothing but is also a specially treated room to aid visual inspection. To this end there are continuous fluorescent strip lights mounted clear of a matt black ceiling with white walls. Inspectors remove the new discs in trays from the cabinets connected to the drying process and inspect both sides of every single disc for defects.

This process cannot be automated and, in spite of the considerable efforts to keep the whole process clean, about 40% of production is rejected due to defects on both sides of the discs. Surprisingly most



Top: loading discs for coating the second side; and (below) a 1000 gallon storage tank and 300 gallon coater feeds tanks in the lacquer area

of the defects are due to dirt but others are caused by such things as air bubbles in the coating and imperfect cores. At this stage the rejected discs are passed out of the clean area to have their coatings stripped. These are then dissolved and passed back to the lacquer department with the cores being ultrasonically cleaned and re-used if still good.

Within the inspection area the discs with one good side have their centre holes punched at the same time as having a date code stamped on to the rejected side.

Before being packed into boxes of 25, a protective 'tyre' is applied to the edges with spacers at the centres to stop the packed discs, in their heavy duty cardboard boxes, touching. They then pass out of the clean area to the final packing area where they are placed in cartons of 50s and 100s for despatch to warehousing where several months' supply of discs is held.

More quality control

Throughout the manufacturing process Capitol take both regular and random product samples for mechanical and chemical checks of such matters as solvent retention, coating adhesion and thickness.

In addition there is a cutting room equipped with Scully and Neumann lathes, tape and disc replay systems plus

suitable measuring equipment. The latter includes not only frequency response and noise measurement but also a spectrum analyser for more detailed analysis of noise.

Capitol's output of lacquers is now about 20% the original *Audiocdisc* and 80% the premium *Apollo* disc with the quality being backed not only by the comprehensive in-house quality control but also by the facilities of other Capitol Records plants.

What about the *Apollo* disc?

Resulting from the factory quality control the *Apollo* disc is claimed to be almost free from ticks and pops and similar types of defect. In addition the new *Apollo* formulation is claimed to give the lacquer a wider tolerance to heater current whilst cutting with cleaner grooves and a consequential cleaner cutting stylus. Further claimed advantages are up to 6 dB less noise together with easier uniformity of silvering and smoother stampers leading to longer stamper life.

Whilst Capitol accept direct to metal mastering to offer significant advantages they feel that it is an expensive process that perhaps cannot always be warranted in comparison with results obtainable from new generation lacquers such as the *Apollo*. □

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BUSINESS BUSINESS

Barry Fox on DBS

Satellite systems

The BBC has now futzed around so long, wondering whether or not to try to broadcast TV and radio direct into British homes by satellite, that the rules of the game have completely changed. The BBC delays have given researchers time to come up with working prototypes of new transmission systems that were only paper proposals when the British Government and BBC first espoused the idea of DBS back in March 1982.

In November 1982, when a Government committee under Sir Antony Part, considered different transmission systems, Plymouth Polytechnic suggested a clever new approach. Part rejected the Plymouth idea because it was only a theory but said he was "... particularly attracted by its elegance and ingenuity". Part also said that he regretted that the time available before the BBC's scheduled start in 1986 was "... much too short to make it a practical proposition".

The committee threw out the BBC's Extended PAL picture coding system and backed the IBA's MAC picture coding system instead. For the sound signal, Part threw out the idea of packet-switched digital code. This decision pleased both the BBC and IBA. In a packet system the data bits are gathered together into small packets, each separately addressed. At the receiving end the packets are sorted out again. The system is very flexible because it lets the bit stream be used to carry virtually any combination of sound, picture and computer data signals. But it's rather wasteful on bandwidth, because extra bits are needed for the addressing. That's why Part agreed with the BBC and IBA that a continuous multiplex system should be used instead. This offers less flexibility but is much more efficient. Without the wasteful address bits in a packet system, the 2.048 Mbit/s data stream available for digital sound can take six separate 0.336 Mbit/s channels. When there is no picture, the full vision channel can be made over to a 20.25 Mbit/s data channel. This can give dozens of sound (or computer data) channels.

The French then said they wanted to use a packet system for the sound. To keep the French happy, and encourage them to join in on MAC DBS, the European Broadcasting Union (EBU) recommended packet switching. In January this year the Home Office in Britain agreed on packet switching. So now the IBA and the BBC are committed to a system that neither they nor Part wanted. No-one has yet demonstrated the system and the IBA and BBC engineers are currently trying to build working prototypes. The number of audio channels available will go down, and the cost of the receiver will go up. In fact it's easy to overlook the fact that the digital

sound circuits of a DBS receiver will in any case be much more expensive than the picture circuits.

Normally one picture signal takes up the whole of the DBS 10 MHz vision channel. The Plymouth Polytechnic technology squeezes two vision channels into one channel. Although no-one talks about it, it's widely believed that the Plymouth work was originally done for the military, as a way of doubling the amount of digital data sent by radio. Plymouth have now built a working prototype with money from an anonymous US company in the satellite business. Crux of the idea is to use phase modulation (PM) instead of frequency modulation. PM is more efficient on power and bandwidth for digital signals but has not been thought satisfactory for analogue. Plymouth converts analogue signals to PCM code. Normally that would soak up far too much bandwidth, but instead of using the usual 8 bit words, Plymouth uses much coarser coding, right down to 2 bit words. The clever part of the trick is to transmit the quantising error as analogue information. Apparently it works: you get two TV channels for the price of one. Could a similar approach be used for digital audio encoding?

Everyone else seems to be going for Delta modulation. Dolby Labs has just released details of its DM system for satellite audio. Whereas for PCM the digital bits are grouped in words, each describing an audio sample, for DM the bits are in a continuous stream, and merely describe signal step changes up or down. In adaptive DM, the step size can be changed. If the control stream is hit by errors, the system goes haywire because the step size goes wild. Dolby samples at around 350 kHz but sends a much slower data stream to control the step size. This slow stream is not so prone to errors. But how, you may well ask, can a slow step control signal cope with rapid audio signal changes, like rim shot transients? Good question. Dolby has the answer. The rapid audio data signal is delayed at the transmitter, in a solid state memory. This gives the slow moving control signal time to cope with rapid transients. Although the memory chip technology is expensive, all the extra cost is in the transmitter. Incidentally there is a third data stream which controls variable pre-emphasis.

dbx is also into delta modulation. Sampling rate is higher at 640 kHz but the step size is fixed. The signal is also compressed. This tackles the problems encountered by Decca engineers when they played around with delta mod, and decided that it needed a gigahertz bandwidth to match PCM quality.

However good the dbx system may be, I pity any studio engineer who tries to learn how it works from the very confusing instruction manual which comes with the model 700 processor. □

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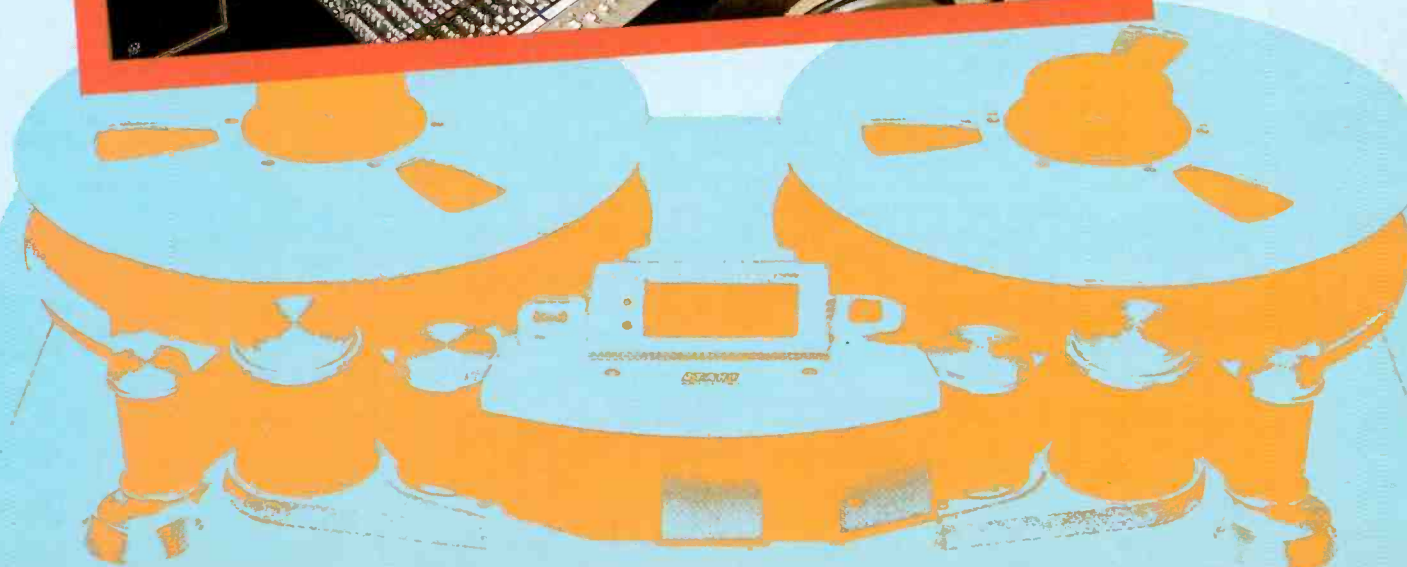
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STUDIO FILE

STUDIO FILE

Scarf, London

Bow, E3. Hm... Talk about venturing into the unknown. Well, anyway, I'm a brave sort of chap and, pointing the car at the Rotherhithe Tunnel I drove into the East End.

It's not as bad as all that really. In fact, Furze Street is full of interesting things like printers printing up video magazines and cranes smashing up wrecked cars...

Scarf Studios started out in life as rehearsal rooms for a songwriting partnership. It was eventually taken over by Alan Alderson who, along with various other partners along the way has seen it grow from rehearsal rooms, through the 'Portastudio' and '8-track' ages to reach its 16-track status of today.

The building was originally a billiard ball factory, so it wasn't exactly purpose built! When enquiring about the design I was met with cries of: "Oh, I wouldn't say it's actually been *designed*." *Designed*—no. Well Nigel's ears are sort of designed around the rooms."

February 2nd, 1981 was the day Le Portastudio est arriv . July 1982 brought the 8-track and October of last year they took the plunge and became fully fledged 16-track with a Soundtracs 16/8/16 mixer and a Teac 32-track 2B and Tannoy *Little Red* monitors as the main equipment.

"As you can see we're not exactly spoilt for effects. In fact quite a lot of what you see here isn't even ours. We are buying some of it in. But we can't afford to have too many. It doesn't matter to us; I'd rather try to do things acoustically or with mic technique or by manipulating the tape. It's much better than using lots of effects and you can do unusual things."

The effects they have got include a Roland *RE201 Space Echo*, Rebis compressor, Rebis ADT unit, a *Great British Spring* (suspended from the ceiling), Ashly *SC33* gates, MXR 1 s delay line and Drawmer stereo compressors. "We're thinking of replacing the GBS with one of those NSF kits. I know someone who's got one and they seem to be quite good." quoth Nigel.

To continue the design

theme, Nigel and Alan aren't that worried about the sound, in spite of the fact that the control room is very small and the window is very large and there is potential for all sorts of problems. "In a proper monitoring position it really sounds OK." Nigel, again.

Alan: "Dolby gave us the seal of approval when they tested some of our tapes. We were really amazed but it must be OK if they say so."

Nigel: "We do all our cutting at Trident, mainly because Ray Staff is so nice! He's got so much time for you and will sit down and give us a progress report whenever we have something cut. The main comment at the moment seems to be that we're getting too bright a sound. So it's good to be told. There are a surprising number of people in this industry who are willing to give us their time and advice. It has been a very pleasant surprise."

Nigel was very happy with the new Soundtracs desk: "It is very good quality and has a lot of features that are normally associated with much bigger desks. Yes, we've been very pleased with it."

Bearing in mind the shortage of effects, the choice of microphone is that much more critical. We spent some time peering at mics held together with gaffer tape trying to work out what they were and this is what we came up with (no, of course they weren't *all* held together with tape!): Shure *SM57s* and *58s*, AKG *D12s*, *D202* and *D224E*, and a Sennheiser *MKH416P48* (vocals). The latter really comes into its own in the corridor. "If you stick this mic behind a screen in the corridor and have the amp out there as well then, by reflecting the sound off the screen back down the corridor and picking it up on the mic you can get this great corridor sound."

The corridor is, indeed, quite large and a great deal of the work goes on in it. The studio area is approximately 21x19 ft, with quite a large 'lump of wood' at one end for a liver sound. The walls are 2½ ft thick, consisting of builder's board, Rockwool and a covering of hessian. Above the false ceiling there are skylights, and behind the

walls there are boarded up windows.

When I asked about the noise from the trains which I kept hearing with frightening regularity they said "What trains?" in chorus. Ah, was I going mad? Did it have something to do with vast quantities of alcohol consumed the previous night? No—all was to be revealed. "That's no train, that's a printing press. It's OK, it's because the doors are all open at the moment. It very seldom bothers us, and they're very nice people. If we ask them to switch off they will."

Nigel learnt all he knows at Scarf although he now freelances elsewhere on suitable occasions. "I learnt all the rules here and then I learnt how to judiciously bend them. I use the room as much as possible to create the sound. The studio itself is semi-live. I can't stand dead rooms—it's not good for communication from the musician's point of view. I discourage people from using headphones when they are doing the rhythm track. I will use room mics wherever possible placed in judicious parts of the studio. Sometimes I will use an ordinary stereo pair in the middle of the room and record a whole band with just a few room mics.

"I'm very anti-separation. You can't get a good drum sound if everything is separated off. Let the bastards spill! I like things to sound like they are played by human beings. If you can keep your drummer happy then you're away.

"I do try not to do anything to the drums—just make them sound live. I may sometimes have to tune them if the band is young and inexperienced in getting studio sounds—but apart from that I try to leave them alone.

"I've got a religious rule never to mic hi-hats. As far as gates go—well, as you can see we haven't exactly been spoilt for gates! So I only use gates when something is seriously wrong, or if I'm trying for a specific sound.

"Putting the guitars and bass down the corridor helps them to sit in the track I've found. Wherever possible I will get the guitarist to play in the control room. I also try to mic

up the bass as well as DI it, and I do like some spill from the drums.

"The work here consists mostly of demos, although we have done about a dozen masters now. Business tends to come word of mouth and our advertising is minimal. It has to be really."

Alan is also involved in the company's own record label and publishing business and he more or less leaves Nigel to get on with it: "He's the perfect engineer for the studio."

Because of the other aspects of the business they are in a good position to advise young bands as to what to do once they have made that all important demo, and they pride themselves in their after-sales service. Nigel, a one-time musician has been through the mill himself, and Alan starting out as a roadie before diversifying, combine to be able to offer help in most areas.

Nigel tends to try to do 2-day jobs which consist of rhythm tracks one day, effects and vocals on the second day, and wherever possible avoids mixing the same day. It helps everyone if a band can go away with the tapes for a few days and work out exactly what they want.

There are a few instruments knocking about the studio but not too many—mainly amps, an upright piano and a drum kit (The Bismark). "We would like to have keyboards and we will get some," says Nigel.

The studio in its present state will be coming to an end in the near future since there are plans afoot to run a road straight through the middle of the building: "...so we'll have to move" says Alan. It certainly looks that way.

They have absolutely no desire to move out of the area. Alan sees it as up-and-coming with the docklands developments and everything else, Bow might soon be the trendiest place to be. Quite apart from anything else, there really isn't a very liberal sprinkling of studios on this side of town. Who knows, they may well be right. Scarf Studios, Unit E1, 24 Furze Street, Bow, London E3, UK. Tel: 01-987 1681. Janet Angus

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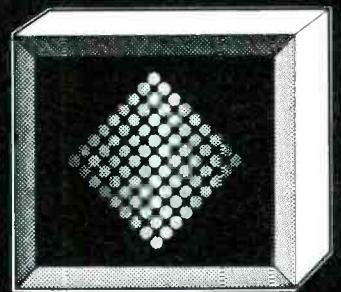
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REVIEW REVIEW

A power amplifier reviewed by Hugh Ford



TANNOY SR 840

The Tannoy/Tresham *SR 840* is a stereo amplifier primarily intended for driving studio monitor loudspeakers, this clearly being an adjunct to marketing Tannoy loudspeakers. At 250 W into 8 Ω or 450 W into 4 Ω this is the ideal power for most studio monitoring applications. The amplifier is also specified at 550 W into 2 Ω so it should be insensitive to 'awkward' loudspeakers.

The rack mounted unit is 3 U high and the nicely finished alloy front panel is fitted with suitable mounting slots for a standard 19 in rack. Each side there are very substantial handles giving protection to the already well protected front panel features.

To the right of the panel a large locking pushbutton switches the mains power—an unusual feature being that a beeper sounds between switch-on and the engagement of the internal protection relays. Near the on/off switch are two red LEDs, one to indicate power on and the other to illuminate in the event of thermal shutdown.

To the left of the panel are two vertical rows of six LEDs forming the **MANUFACTURER'S PROVISIONAL SPECIFICATION**

Input for rated output: 1.1 V (+3 dB) into 33 k Ω unbalanced.

Power output: minimum RMS output power at clipping (+0, -0.5 dB). Both channels driven into 8 Ω —250 W; both channels driven into 4 Ω —450 W; both channels driven into 2 Ω —550 W*; bridged mono into 8 Ω —875 W; bridged mono into 4 Ω —1220 W*.

Harmonic distortion: total harmonic distortion and noise 10 Hz to 20 kHz any power up to rated maximum; 0.05% worst condition, typically 0.01% 200 W/8 Ω .

Intermodulation distortion: 4:1, 50 Hz and 7 kHz—0.03%.

Noise: unweighted ref 250 W/8 Ω -105 dB; A-weighted ref 250 W/8 Ω -116 dB.

Power response: full power bandwidth +0, -0.5 dB 15 Hz to 40 kHz.

Crosstalk: ref rated output 1 kHz >-75 dB; worst case 20 Hz to 20 kHz >-60 dB.

Damping factor: ref 20 Hz to 1 kHz >200.

Rise time: 1.5 μ s.

Slew rate: 100 V/ μ s.

DC offset: <5 mV quiescent.

Output power meters: rise time approximately 10 ms; fall time approximately 1 s; accuracy 2%

*Absolute minimum load impedance. Not for continuous full power operation.

Manufacturer: Tannoy Tresham Ltd, Beadman Street, West Norwood, London SE27 0PW, UK.
North America: Tannoy North America Inc, 97 Victoria Street North, Kitchener, Ontario N2H 5C1, Canada.

level indicators for the two channels, these offering 3 dB increments below full power which is represented by red LEDs. The -3 dB and -6 dB points have yellow LEDs with the remainder at lower levels being green.

Removal of a secondary panel at the centre of the front gives access to the two level setting potentiometers which could more conveniently have knobs rather than being screwdriver operated. Also it is rather annoying that the panel is secured by non-captive Allen screws—they get lost so easily!

So much for the front panel: at the rear power is fed to the amplifier via an IEC socket with a properly identified power fuse and line voltage selector covering all the usually encountered voltages. A useful feature is the inclusion of a line voltage output at an IEC socket which is a switched output rated at 5 A.

The audio inputs are at unbalanced XLR sockets in parallel with ¼ in jack sockets with a slide switch being provided for isolating the power line ground. Like the auxiliary ground

REVIEW REVIEW

terminal the audio outputs are at large diameter terminals. Whilst these may look impressive at first sight their only advantage over smaller terminals is the large diameter knob making tightening easier. In fact the centre spigot of the terminals has only a small hole for inserting wires or terminal pins with no facility for banana plugs. Furthermore the terminal heads are not captive and can be easily lost.

The remaining rear panel feature is the slide switch for selecting either stereophonic or the bridged monophonic mode.

The mechanical basis of the amplifier is a fabricated steel frame to which are attached the front and rear panels by means of cinch nuts. Similarly the alloy plate base of the amplifier which supports the single large toroidal transformer, the rectifier and the smoothing components is secured to the steel frame. Sensibly these components are interconnected with slide connectors for ease of servicing, however, the base includes four $1\frac{1}{4}$ fuses of unidentified value in the low power secondaries of the power transformer.

The external rear sides of the amplifier have large finned heatsinks attached to the steel frame at either side. Within the amplifier a 'U' section for each channel supports the eight output devices, this 'U' section being bolted to the external heatsinks and also supporting the individual channel amplifier printed circuit boards. Each of the boards has two potentiometer adjustments and a 20 mm fuse and is connected by pin connectors to the external world.

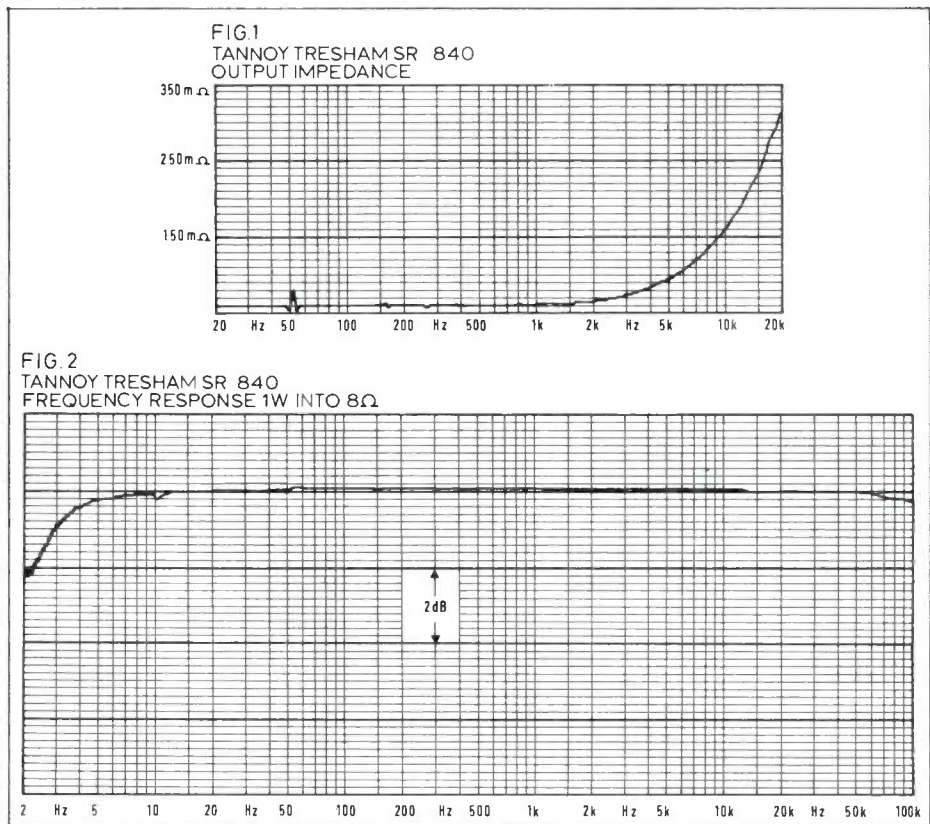
Almost all the area behind the front panel is covered by a further printed circuit board which has the components necessary for the level indicators with the potentiometers for their sensitivity adjustment plus further components.

Whilst in the review unit the general standard of construction was tidy, the printed circuit boards were not the final product and had modifications with not all connections being socketed.

Both mechanically and electrically the construction of the amplifier appeared to be sound, but, if mobile use is contemplated some mechanical protection to the rear panel terminals would be desirable.

Inputs and outputs

The impedance of the unbalanced inputs depended to a certain extent upon the setting of the gain



potentiometer, being approximately $35\text{ k}\Omega$ in parallel with $195/265\text{ pF}$ for the two channels at maximum gain and increasing to about $54\text{ k}\Omega$ at minimum gain—no trouble here for sensible source impedances.

For the rated power output of 250 W into $8\ \Omega$ the input sensitivity was 1.06 V with the two channels being balanced within a creditable 0.04 dB at maximum gain.

At the outputs the maximum DC offset was measured as less than 4.4 mV with the modulus of the output impedance of the left channels being shown in Fig 1 giving a damping factor of 130 reference $8\ \Omega$ below 1 kHz. The same measurements on the

right channel proved to be intermittent and it is suspected that the protection relay in the outputs was the cause.

Frequency response and noise

The overall frequency response working at 1 W into $8\ \Omega$ is shown in Fig 2 to be very flat up to 100 kHz with the low frequency roll-off only being -2 dB at 2 Hz. It follows that some form of highpass filter is desirable in any preamplifier used with this power amplifier if loudspeaker damage is to be avoided.

Noise was a most variable feast with

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REVIEW REVIEW

TABLE 1

Measurement method	Noise referred to 250 W into 8 Ω			
	Minimum gain		Maximum gain	
	Left	Right	Left	Right
22 Hz to 22 kHz RMS	107 dB	95.5 dB	98.5 dB	100.5 dB
A-weighted RMS	112.5 dB	97.5 dB	101.5 dB	104 dB
CCIR-weighted RMS	106.5 dB	96.5 dB	102.5 dB	96.5 dB
CCIR-weighted quasi-peak	94 dB	81 dB	86 dB	82.5 dB
CCIR-weighted ARM	117 dB	110 dB	112 dB	113.5 dB

TABLE 2

Measurement method	Noise referred to 250 W into 8 Ω	
	Mid-point gain	Best obtainable
22 Hz to 22 kHz RMS	65 dB	110 dB
A-weighted RMS	85 dB	118 dB
CCIR weighted RMS	78 dB	110 dB
CCIR weighted quasi-peak	63 dB	103 dB
CCIR weighted ARM ref 2 kHz	93 dB	119 dB

TABLE 3

Load conditions	Power output at clipping		TABLE 4	Burst power output
	Left	Right		
Both channels into 8Ω	305 W	275 W	8 Ω loads 4 Ω loads 2 Ω loads	334/282 W 580/522 W 840/820 W
Single channels into 8Ω	305 W	277 W		
Both channels into 4Ω	448 W	462 W		
Single channels into 4Ω	486 W	486 W		

TABLE 5

		Total harmonic distortion and noise			
		100 Hz	1 kHz	10 kHz	20 kHz
250 W into 8 Ω	left	<0.040%	0.012%	0.048%	0.075%
	right	<0.040%	0.015%	0.037%	0.080%
25 W into 8 Ω	left	<0.056%	0.010%	0.037%	0.055%
	right	<0.056%	0.009%	0.022%	0.038%
450 W into 4 Ω	left	<0.040%	0.018%	0.085%	0.011%
	right	<0.040%	0.013%	0.080%	0.840%
45 W into 4 Ω	left	<0.075%	0.017%	0.063%	0.095%
	right	<0.075%	0.014%	0.033%	0.056%

the two channels giving very different results under some conditions. This trouble appears to be largely due to hum components introduced into the channel modules from the power transformer. These components mainly took the form of mains harmonics in the form of 'spikes' as seen on an oscilloscope. **Table 1** shows noise related to an output of 250 W into 8 Ω for the inputs shorted at maximum and minimum gain settings. These figures were not the worst conditions by any means. The situation deteriorated significantly at mid point gain settings where the source impedance to the amplifier modules is at its maximum.

These results together with the best results that could be obtained by manipulating a screen of 'Telshield' between the transformer and the modules were as shown in **Table 2**—the two channels giving similar results in these cases. This makes it abundantly clear that noise is being induced into the amplifier modules to a very severe extent and amongst other things it is thought that the top cover is partially responsible.

Power output and distortion

Using a stabilised 240 V input in conjunction with precision load

resistors the available power output was determined into various loads at the onset of clipping of a 1 kHz sine wave.

When working with continuous sinewaves into low impedances the output is normally limited by a 6.3 A slow blow fuse in the outputs, but this may be increased to a maximum of an 8 A fuse for 2 Ω stereo or 4 Ω bridging applications.

Table 3 indicates good matching between channels with the single power transformer only slightly degrading the results with both channels operational into 4 Ω. Using tone bursts of 1 kHz and 10 ms duration every 100 ms, the single channel power outputs were significantly in excess of this (see **Table 4**).

Total harmonic distortion was measured at the rated output into 8 Ω and 4 Ω and also at 10 dB lower level all figures being above noise except the 100 Hz performance which suffered from the hum pickup already mentioned. **Table 5** shows a degree of variation between the two channels, however, the distortion products measured were mainly harmonic and these are less disturbing than crossover products which were minimal.

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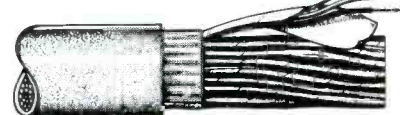
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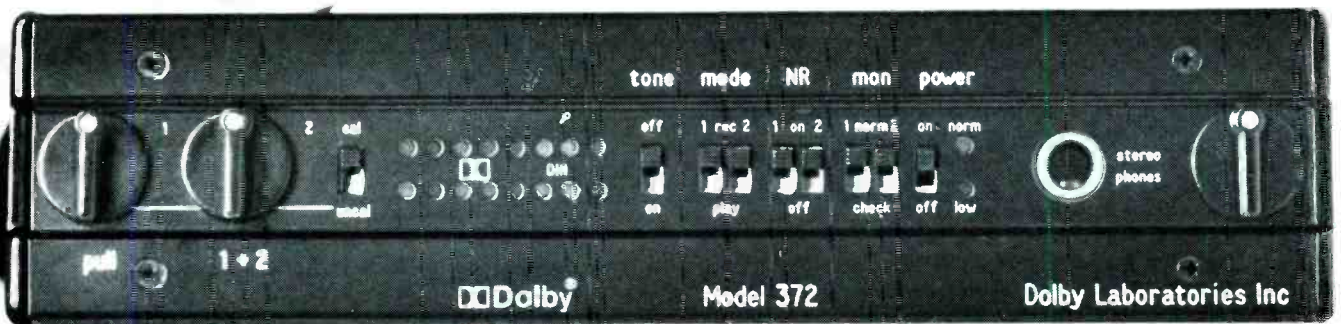
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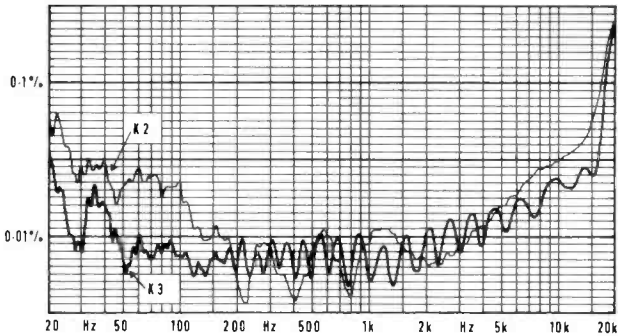
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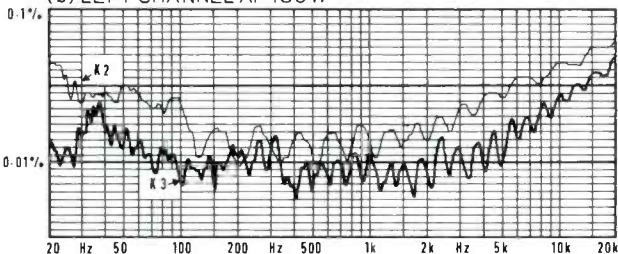
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REVIEW REVIEW

FIG.3
TANNOY TRESHAM SR 840
HARMONIC DISTORTION INTO 4Ω
(a) RIGHT CHANNEL AT 450W



(b) LEFT CHANNEL AT 450W



(c) RIGHT CHANNEL AT 1W

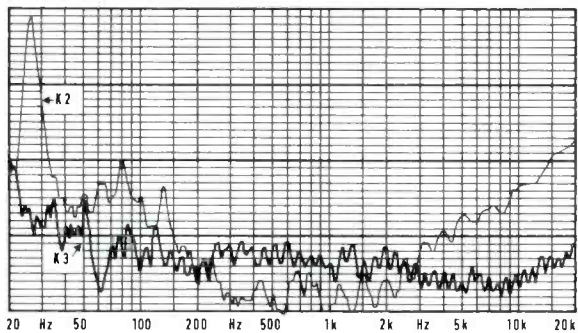


FIG.4
TANNOY TRESHAM SR 840
IM DISTORTION 1W INTO 8Ω

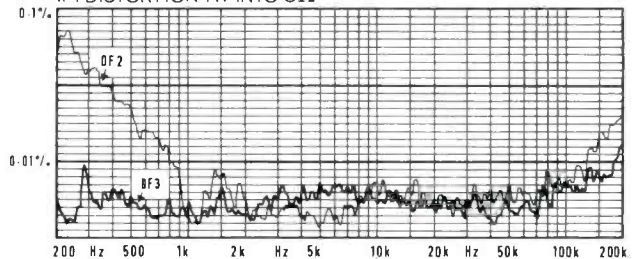
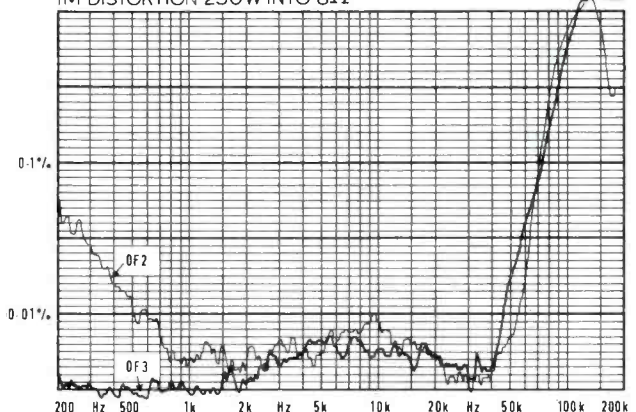


FIG.5
TANNOY TRESHAM SR 840
IM DISTORTION 250W INTO 8Ω



working into 4 Ω at the rated power of 450 W and at 1 W, and found to differ for the two channels, particularly at 450 W. These results are shown in Figs 3a and 3b. Smaller differences occurred at 1 W with Fig 3c being typical.

Intermodulation distortion to the CCIF twin tone method, shown in Fig 4, was very good at 1 W peak equivalent into 8 Ω, however, this increased at very high frequencies as shown in Fig 5 for 250 W peak equivalent into 8 Ω with both channels being fairly similar.

Squarewaves operating into 8 Ω in parallel with 2 μF shows significant overshoot but no ringing as shown in Fig 6 with the rise and fall times being symmetrical at 1.5 μs and the maximum slew rate being fast at 50 V/μs.

Other matters

Driving the amplifier into

asymmetrical overload with clipped tonebursts or by applying a DC offset to the inputs gave a clean recovery with LF offset protection disconnecting the load by means of the protection relays if the DC offset at the output exceeded 4 V. In such a case the 'beeper' alarm sounded with the amplifier recovering rapidly once the

offending input was removed.

Unlike some amplifiers the unit did not go into oscillation upon low frequency overload but waited in the tripped condition until the offending input had been removed. During this time the 'beeper' sounded a warning without any activity at the outputs.

Checking the level indicators showed

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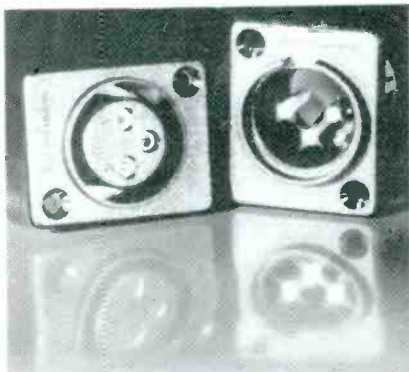
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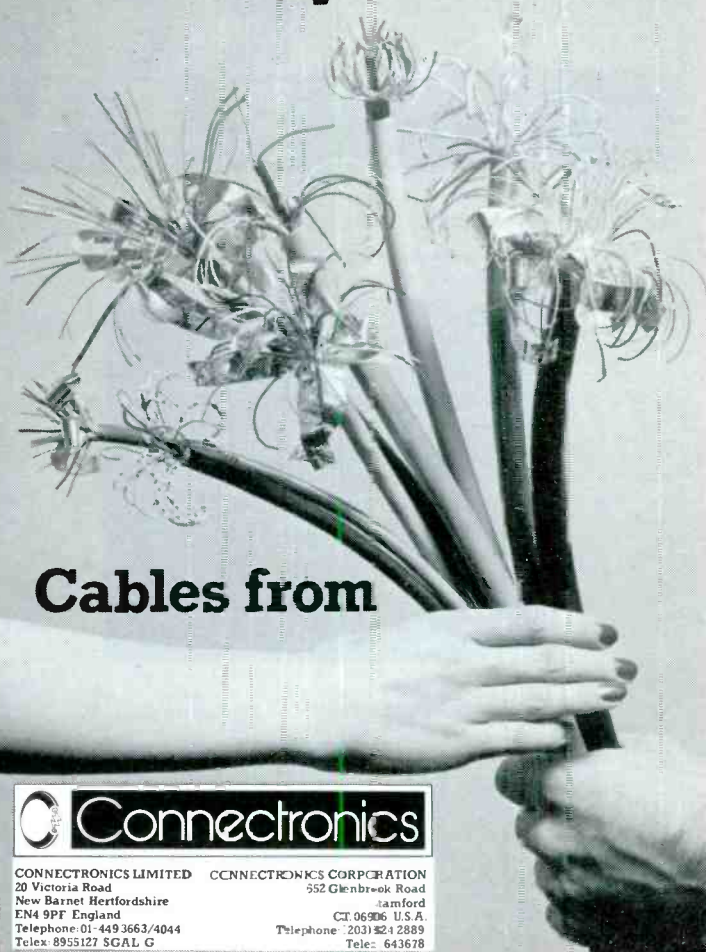
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REVIEW REVIEW

FIG 6
TANNOY TRESHAM SR 840
SQUAREWAVE PERFORMANCE

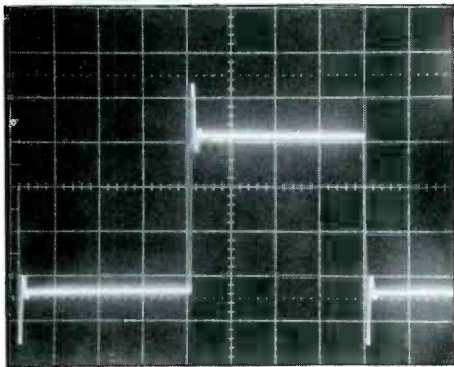


FIG 7
TANNOY TRESHAM SR 840
CROSSTALK

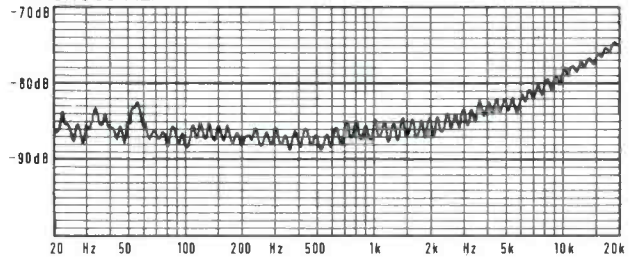
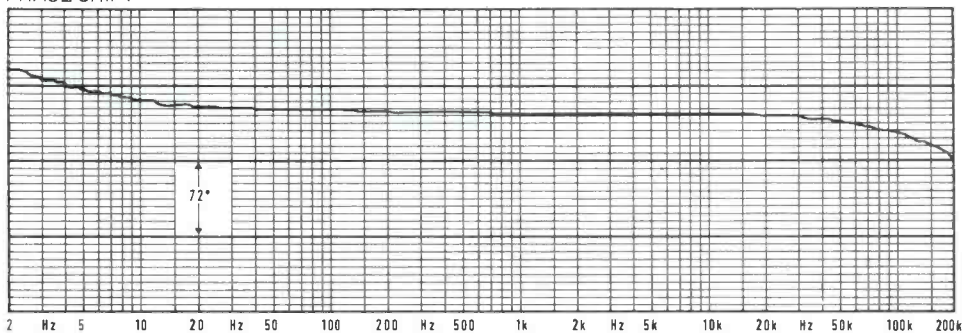


FIG 8
TANNOY TRESHAM SR 840
PHASE SHIFT



the two channels to be identical with the maximum (red) LED corresponding to 265 W into 8 Ω —a reasonable margin below clipping. Below this level the increments of -3 dB were very accurate down to -12 dB nominal which measured -13.2 dB with the lowest indication of -15 dB being -16.1 dB.

The rise time of the indicators was reasonably fast at 15 ms for a clear indication with the overall display fall time being satisfactory at 1.2 s.

Crosstalk between the two channels was minimal as shown in Fig 7 with the phase shift of a channel also being small as shown in Fig 8.

Whilst at times the heatsinks ran too hot to touch, at no time during the review did the thermal overload operate with the current taken from the input line remaining sensible even when the amplifier was driven at very high levels and at high frequencies.

Summary

Whilst many aspects of this amplifier are good or very good, the unit is severely let down by a variable and sometimes poor noise performance. Whilst the noise performance of the modules is good, it appears that insufficient attention has been given to the performance as confectioned for the

final product.

As the amplifier does not have forced air cooling, which appears to be unnecessary, it is acoustically quiet with the exception of a slight hum from the top cover.

Overall this is a well-made unit which has distinct promise as a studio monitor amplifier once the manufacturer has attended to minor problems found in this pre-production unit.

Hugh Ford comments

Following this review I approached the manufacturers regarding the noise/hum performance which they stated was not typical of production.

Subsequent examination of a second sample of the amplifier showed a distinct improvement (See Table 6).

The worst obtainable noise depended a slight amount upon the gain control setting with the results shown in Table 7.

As with the first sample of the amplifier the noise components were entirely harmonics of the power line frequency picked up by the amplifier modules from the mains transformer.

This is a problem known to the manufacturer who rotates the toroid for minimum hum induction. This is a well-known problem with toroidal transformers with many amplifier manufacturers having considerable difficulties in obtaining good quality transformers.

TABLE 6

Measurement method	Noise referred to 250 W into 8 Ω			
	Minimum gain		Maximum gain	
	Left	Right	Left	Right
22 Hz to 22 kHz RMS	110.2 dB	109.8 dB	104.4 dB	112.2 dB
A-weighted RMS	102.0 dB	111.4 dB	106.2 dB	117.5 dB
CCIR-weighted RMS	98.7 dB	113.7 dB	100.0 dB	107.4 dB
CCIR-weighted quasi-peak	84.8 dB	93.4 dB	86.8 dB	98.5 dB
CCIR-weighted ARM (2 kHz)	123.2 dB	117.2 dB	115.2 dB	117.2 dB

TABLE 7

22 Hz to 22kHz RMS	Left	Gain	Right	Gain
A-weighted RMS	100.2 dB	mid	106.2 dB	min
CCIR-weighted RMS	102.0 dB	min	111.4 dB	min
CCIR-weighted RMS	98.7 dB	min	104.2 dB	mid
CCIR-weighted quasi-peak	84.8 dB	min	93.4 dB	min
CCIR ARM ref 2 kHz	110.2 dB	mid	112.2 dB	mid

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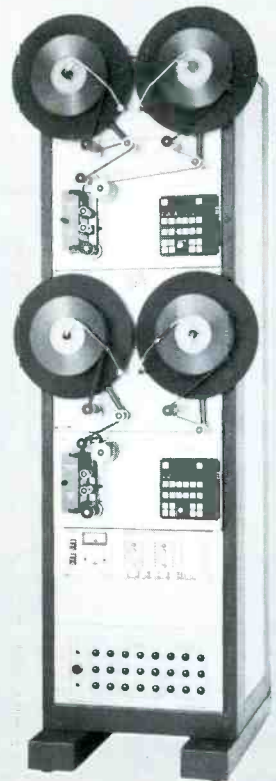


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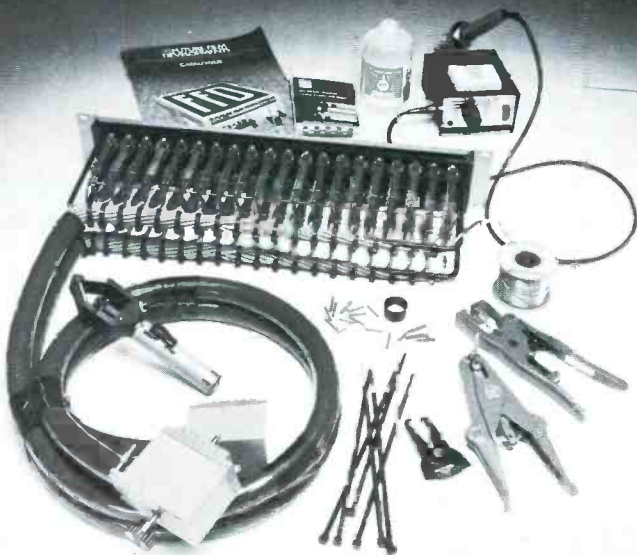
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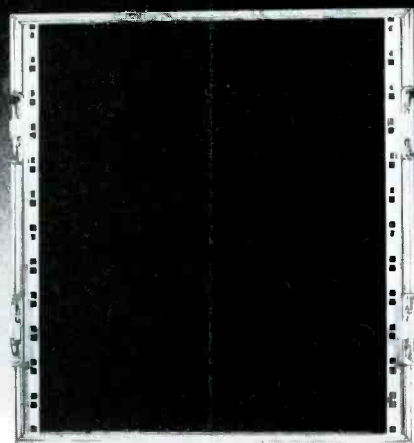


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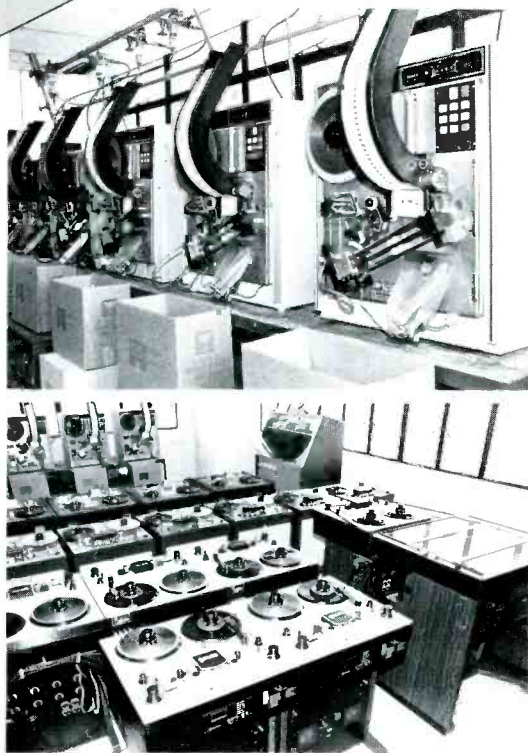
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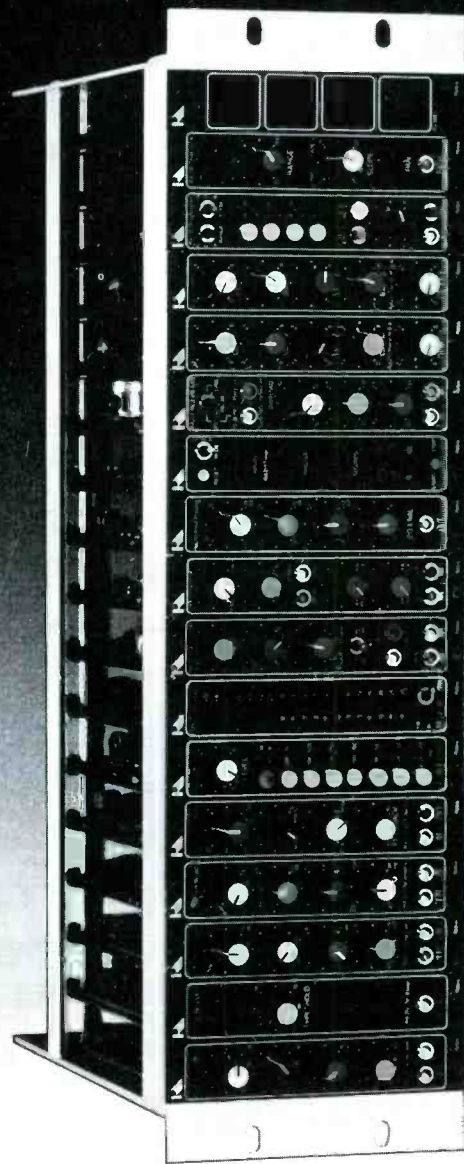
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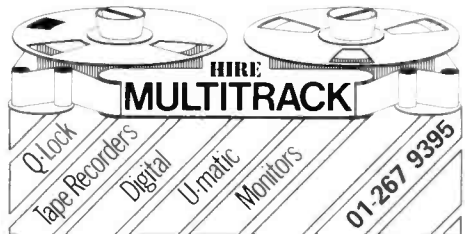
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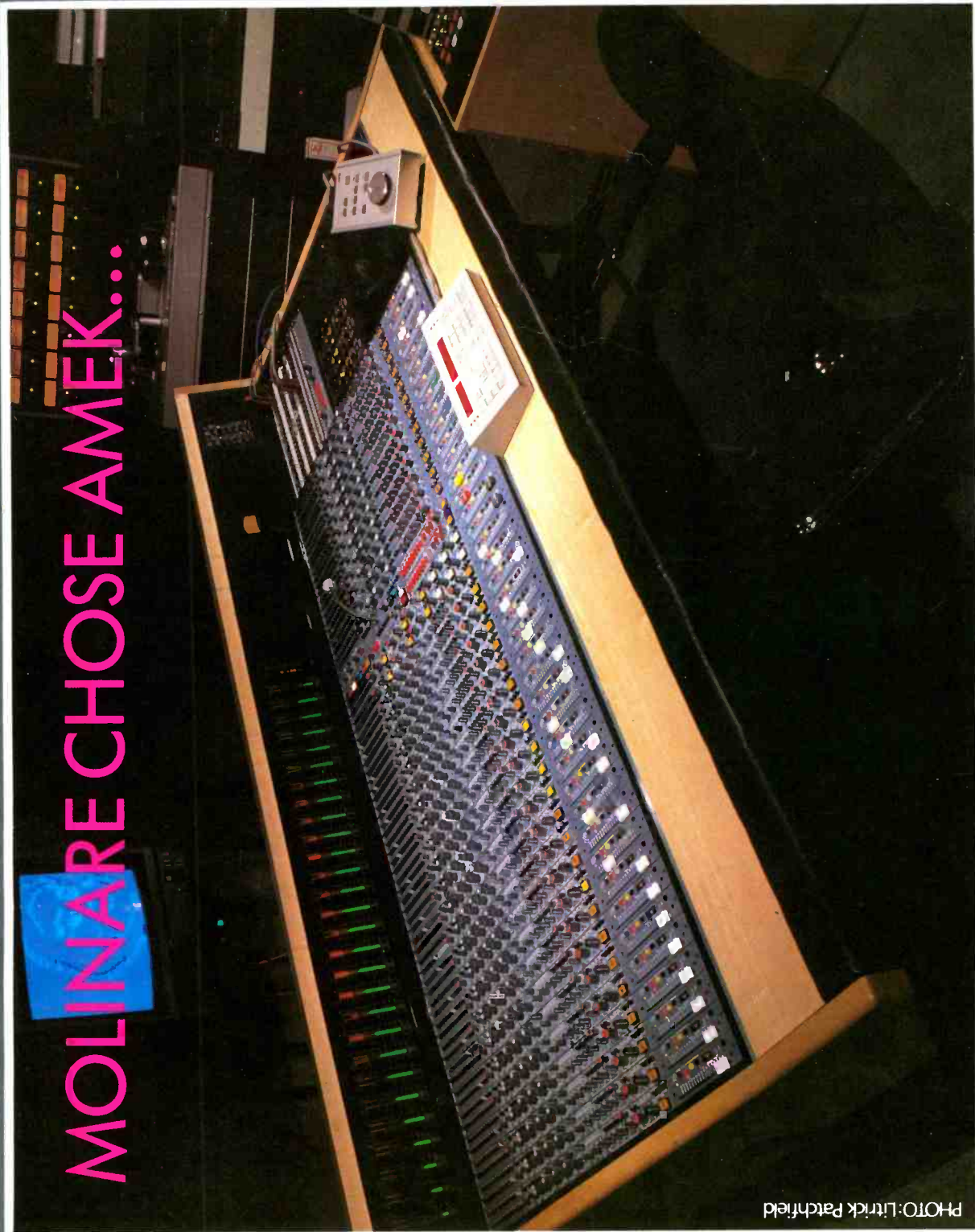


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