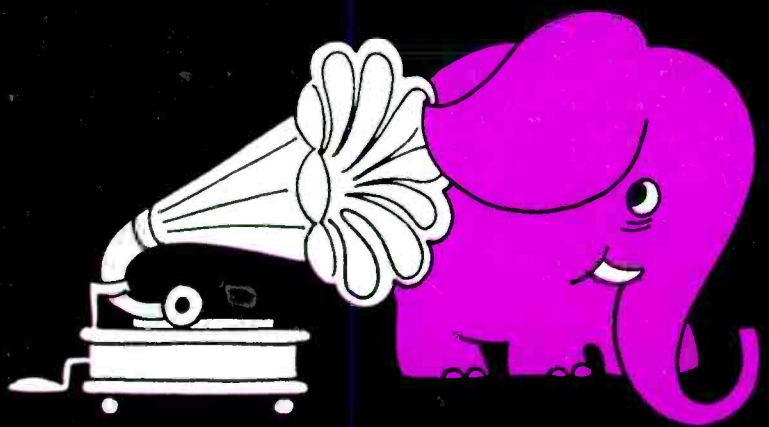
September 1978 60p

studio sound

AND BROADCAST ENGINEERING



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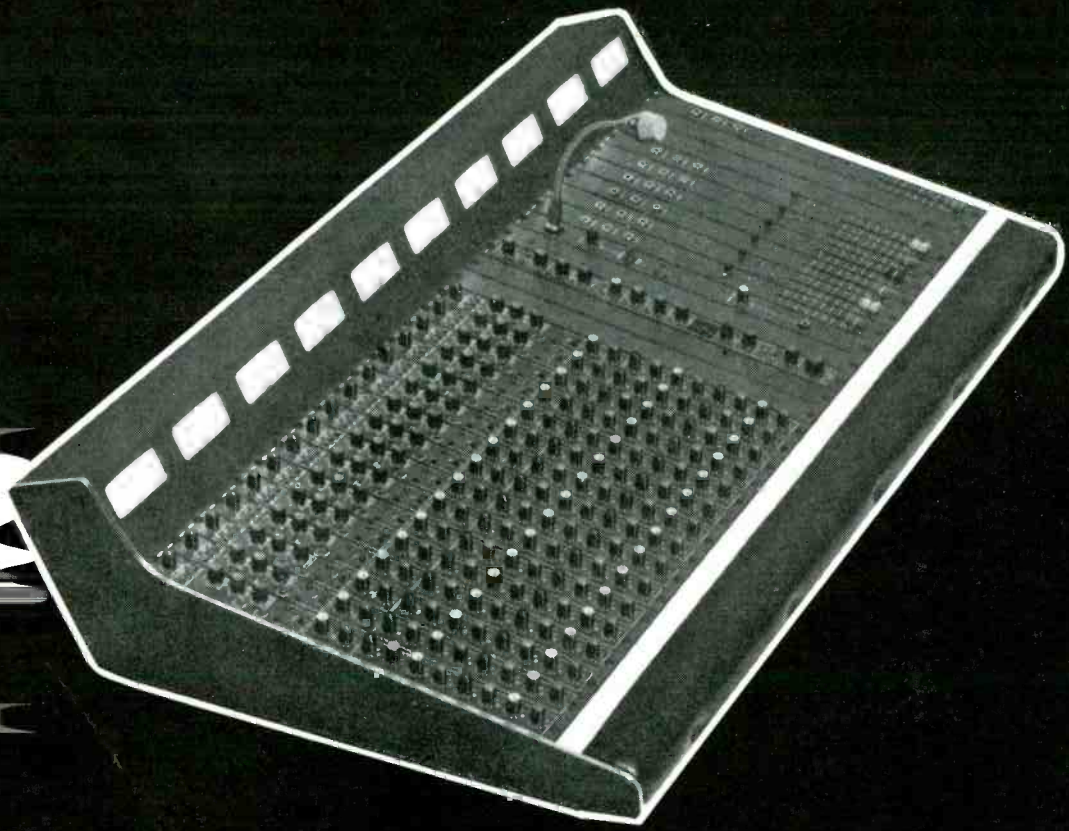

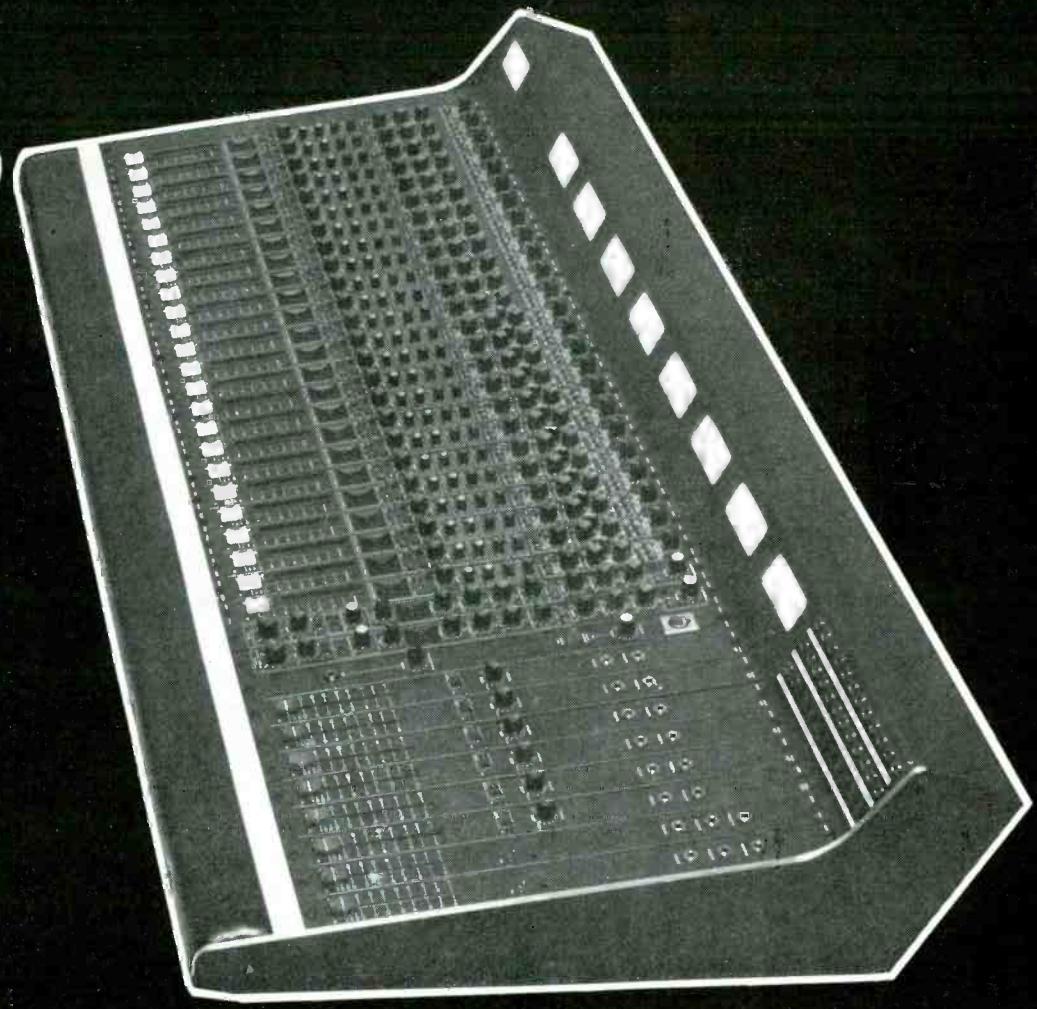

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CHRISTINE BROWN

PUBLISHER
DOUGLAS G. SHUARD

Editorial and Advertising Offices:
LINK HOUSE, DINGWALL AVENUE, CROYDON CR9 2TA, ENGLAND
Telephone: 01-686 2599
Telex: 947709
Telegrams: Aviculture Croydon

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studio sound

AND BROADCAST ENGINEERING

If one looks at an exhibition planner such as published monthly by *Exhibition Bulletin*, it is plainly apparent that the two annual exhibition seasons are May/June and September/October with a much smaller number hanging on either side. Each year, we have a multitude of professional audio exhibitions—*March* European AES, *April* NAB, *May* West Coast AES, *June* Montreux (biennial), *June* APRS, *September* IBC (biennial), *November* East Coast AES. And that doesn't include the SMPTE conventions or related hifi shows. Not content with three European exhibitions a year, the French are now reported to be holding a show in Paris from October 3 to 4. Although in many cases, only local exhibitors attend the various shows, invariably all principal brand names are represented in one booth or another. Exhibitions are enormously expensive to attend and participate in, both for exhibitors and delegates alike. Broadcasting exhibitions such as NAB, IBC and Montreux restrict themselves to one show per continent each year simply on economic grounds since video and transmitting equipment requires large exhibition stands to mount proper demonstrations, and the square metres, plus the large stand staffs required mean budgets of £25,000 to £100,000 per show. Of course audio gear is less complex and only requires a pair of headphones to give a demonstration (of a sort), so stands are smaller and thus less costly. How much longer can small companies afford to partake all these exhibitions, or rather what consequences ensue if they don't? As usual, *Studio Sound* will continue to be represented at all these exhibitions . . .

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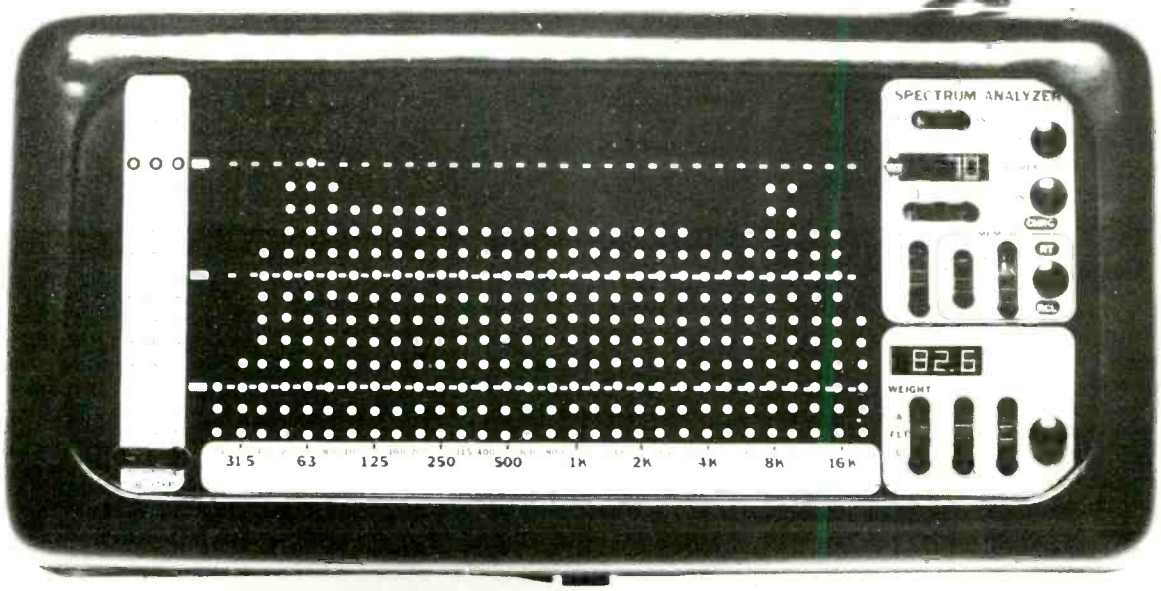

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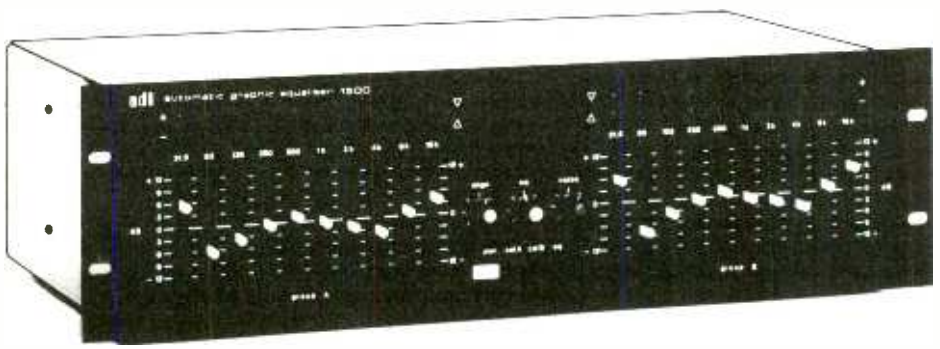

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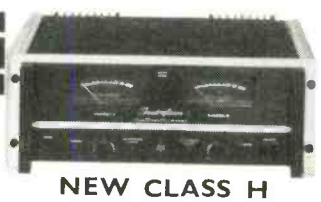

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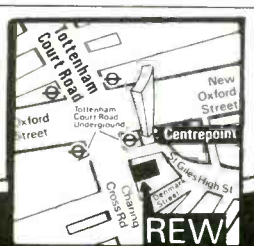

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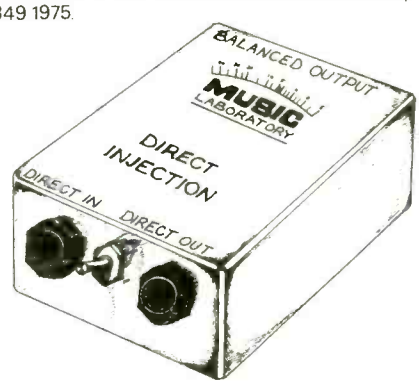

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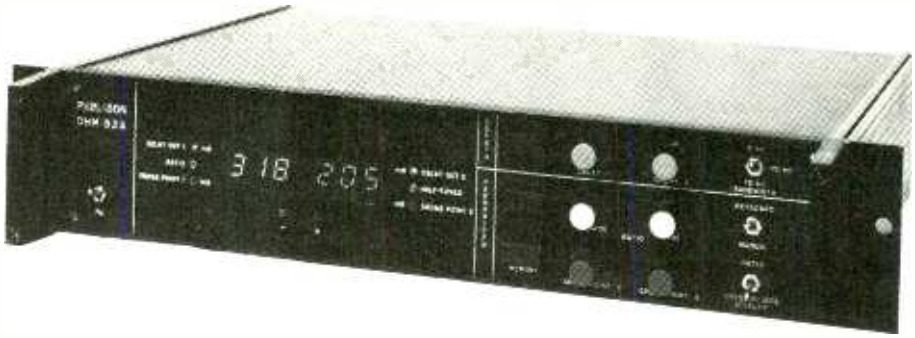

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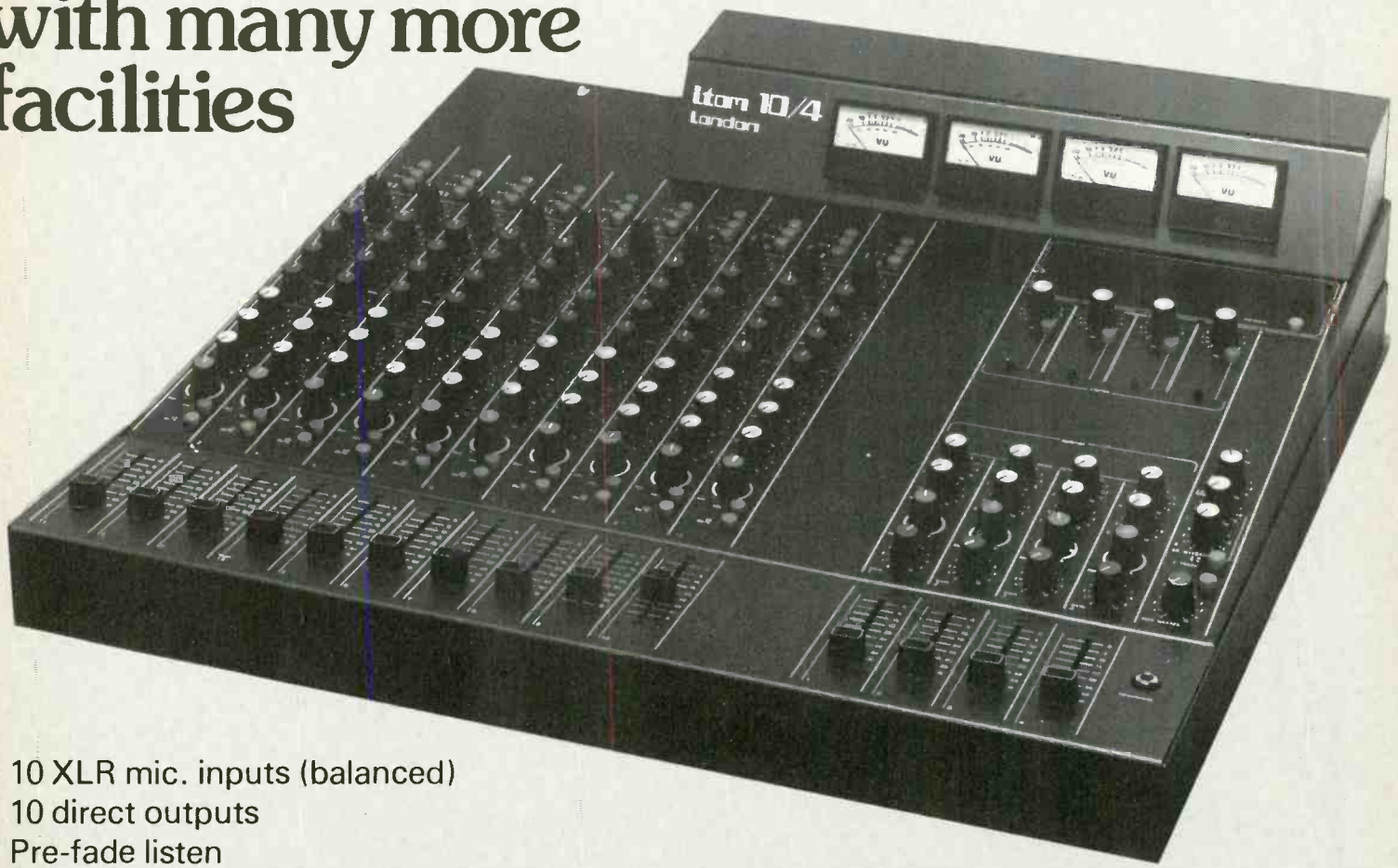

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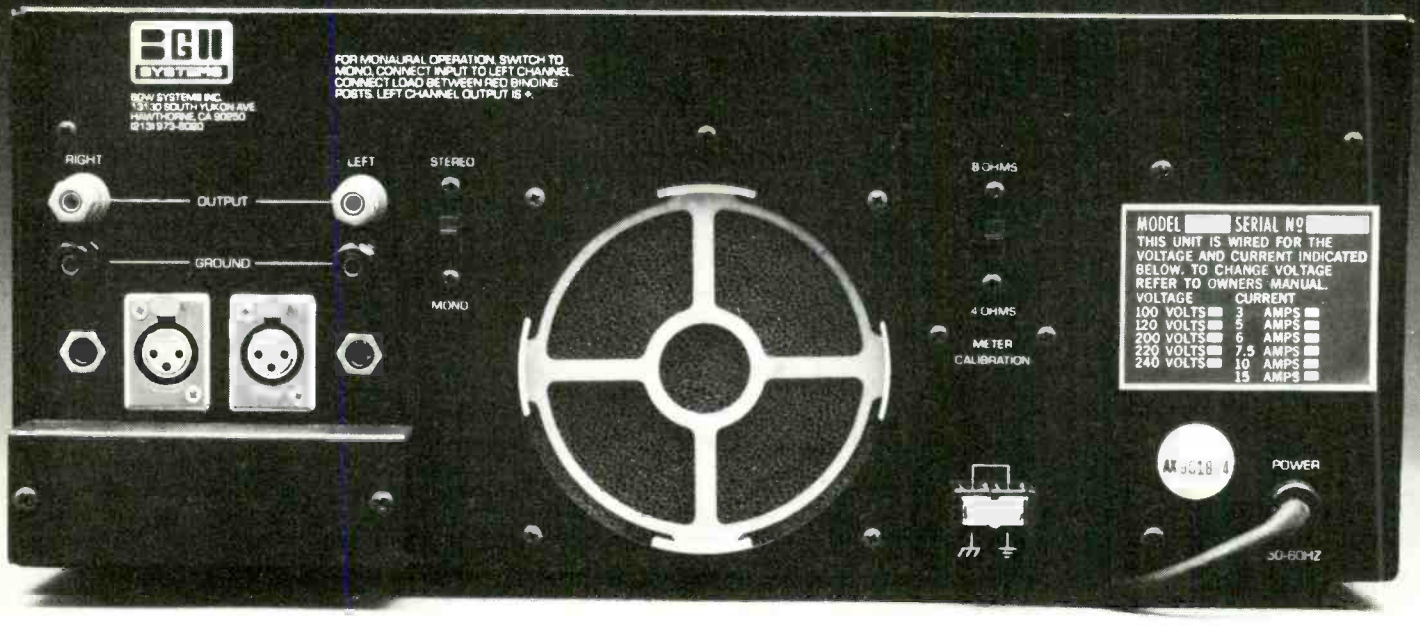

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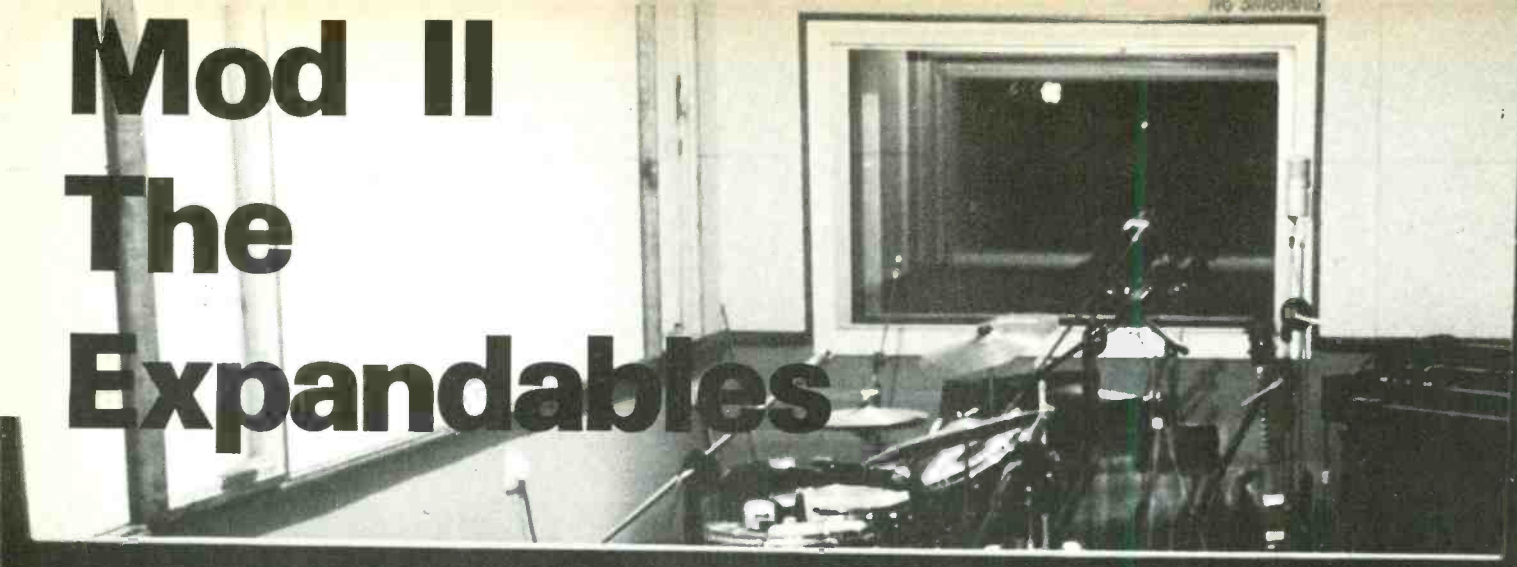

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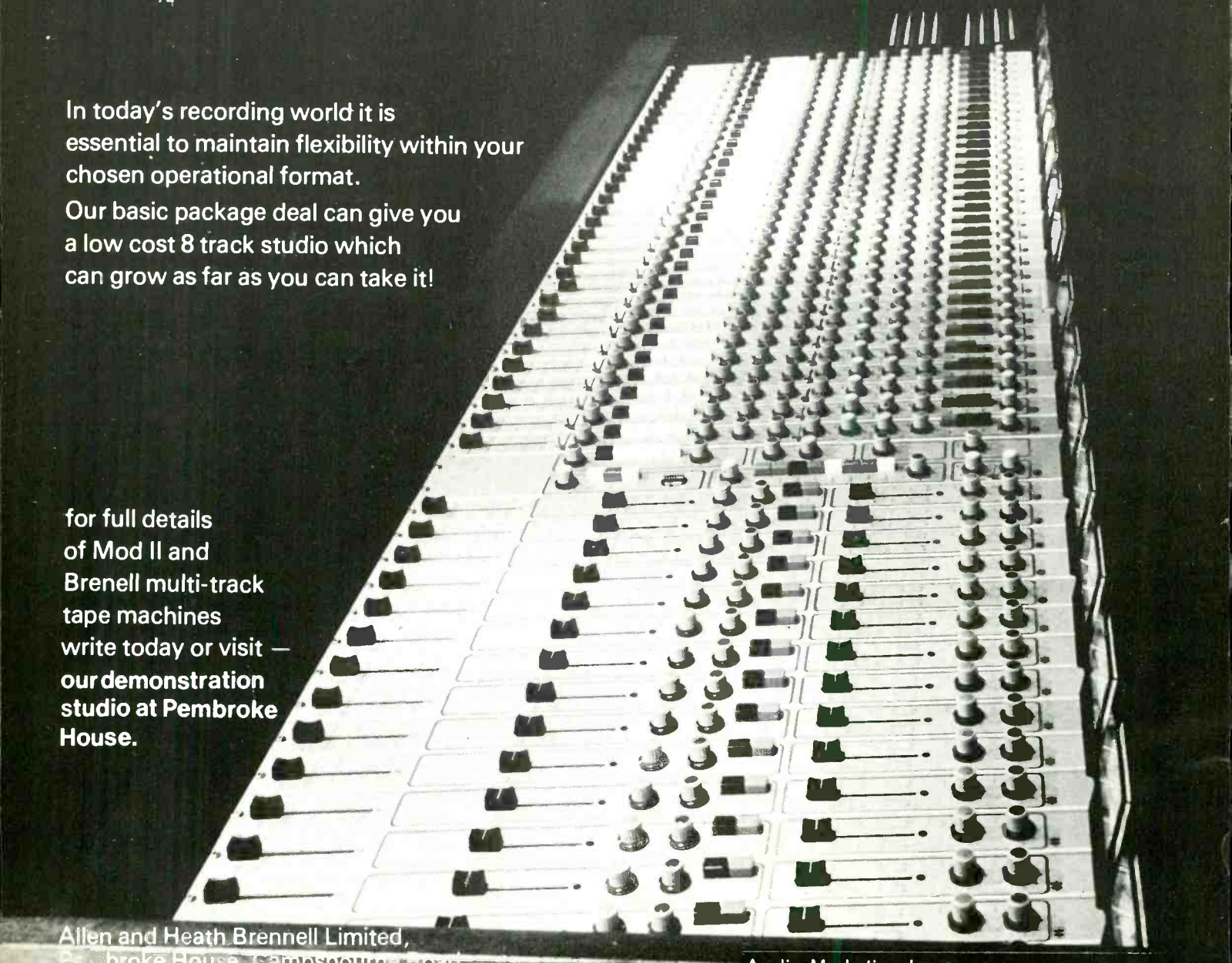

Allen and Heath Brennell Limited,
Pembroke House, Campsbourne Road,
Hornsey, London, N8 7PT.
Telephone: 01-340 3291 Telex: BATGRP 267727

Audio Marketing Inc.,
652 Glenbrook Road,
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ADV 244/E

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USA

Hayden Laboratories Ltd.,
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Bucks. SL9 9EW
Gerrards Cross 88447
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AEG-TELEFUNKEN
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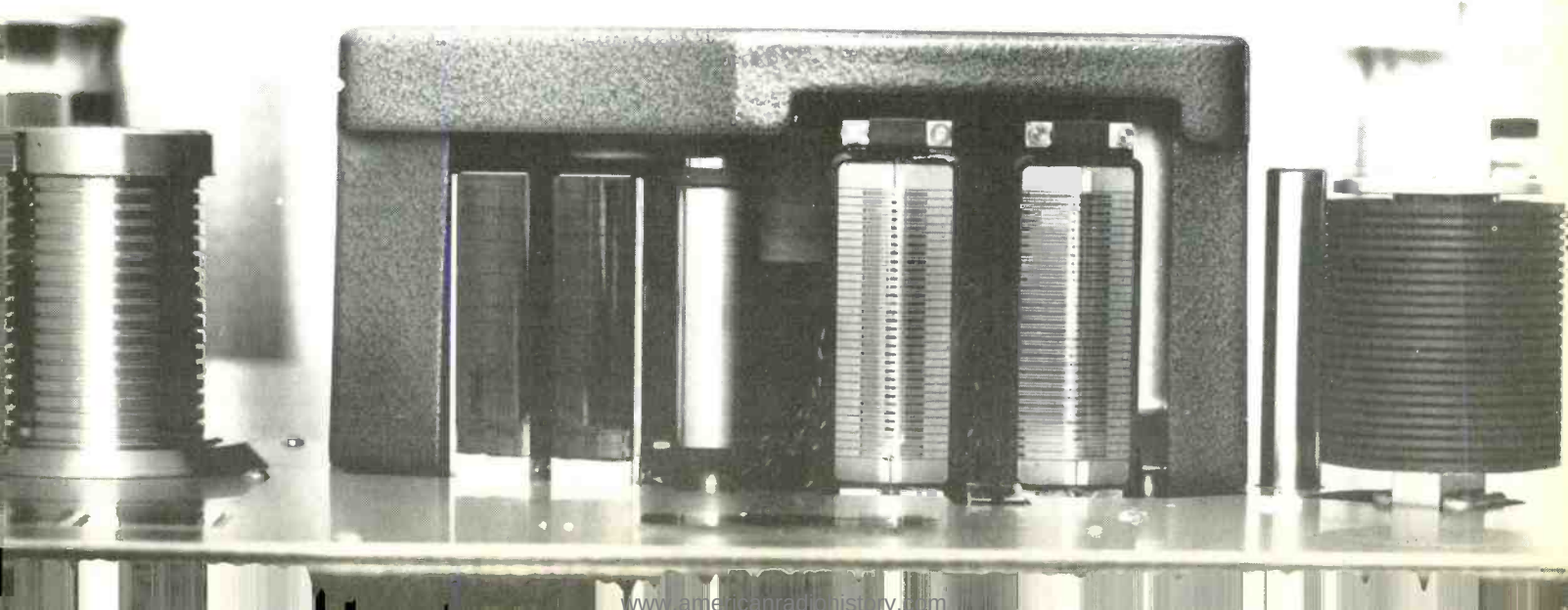

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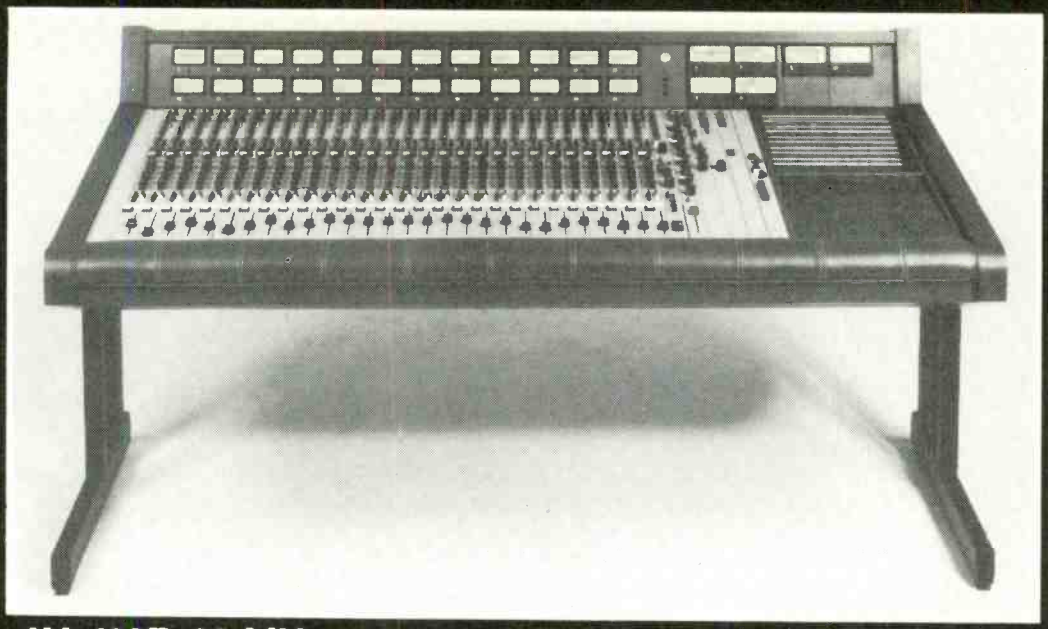

JH-400B-28-VU

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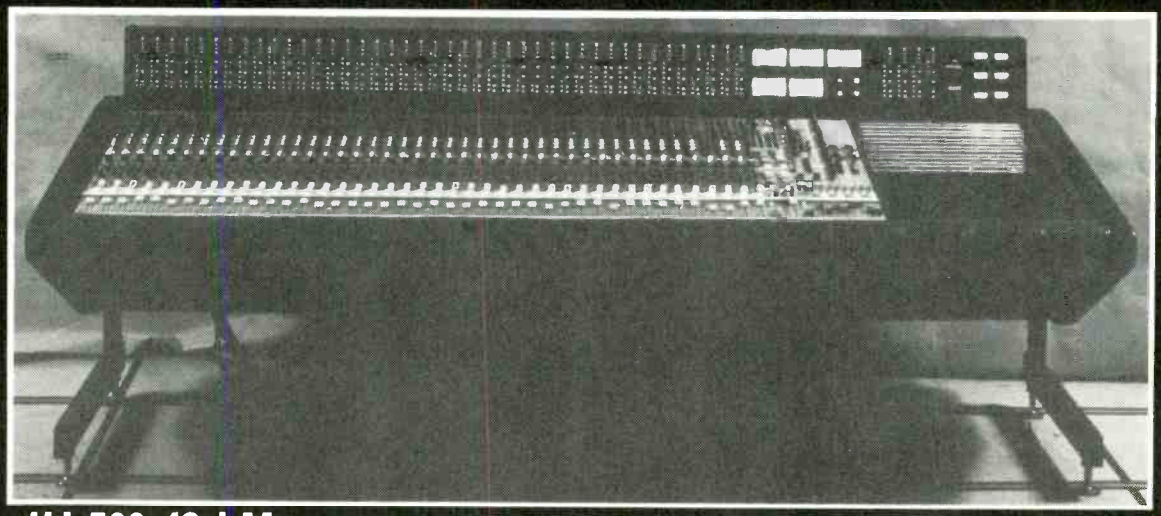
manufacturer of consoles is setting impressive records.

In studios and broadcasting companies throughout Europe, the MCI JH-400 and 500 series of consoles are now recognised as the standard of the industry.



JH-500-42-LM

MCI

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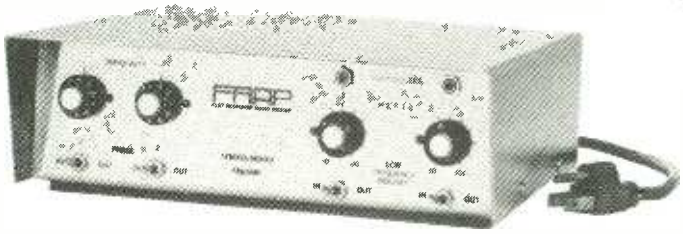
news

Right: *Model PPS-26 pickup pre-amp from Audio Interface*

Below: *FRAP FS-200LL unit for improving the performance of EMT plates*



ADI in UK

Feldon Audio have been appointed UK agents for Audio Development International (ADI) products, including power amplifiers, the model *1500* automatic graphic equaliser and model *1000* spectrum analyser.
Feldon Audio Ltd, 126 Great Portland Street, London W1N 5PH.
Phone: 01-580 4314.
Telex: 28668.

Hayden man

Stephen Jones, formerly of EMI and Ferrograph, has joined Hayden Laboratories as sales manager for professional audio products. He will be responsible for the sales of Nagra, Telefunken, Sondor and Sennheiser gear.

Neumann gun mic

Neumann has brought out a condenser shotgun mic, type *KMR82i*, which exhibits a front-to-back gain of around 25 dB. The directional response is maintained within very acceptable limits down to 125 Hz. The main lobe frequency response is substantially flat to 50 Hz in the flat position. The mic also incorporates a switchable highpass filter to rolloff the low end if required.

The manufacturer quotes a sensitivity of 21 mV/Pa with a signal-to-noise ratio of 75 dB. The usual extras are available including a plug in power supply, windshield, etc.
George Neumann GmbH, 1 Berlin 61, Charlotenstrasse, West Germany.
UK: FWO Bauch Ltd, 49 Theobald Street, Borehamwood, Herts WD6 4RZ.
Phone: 01-953 0091.
US: Gotham Audio Corp, 741 Washington Street, New York, NY 10014.
Phone: (212) 741 7411. ▼

Third-octave analyser

Pyral, a name more normally associated with tape manufacture, also has an electronic equipment division. One of the latter's products is a 28-filter, ⅓-octave analyser measuring from 35 to 22k Hz operating in the real time mode. The 100 point per channel display allows a definition of 0.25 dB on the 25 dB range, or double that figure on the 50 dB range. The instrument claims to conform to all the relevant measuring standards including DIN 45652.

Also included are two memories that appear to operate as a stored analogue charge. Two optional generators can be supplied for swept sinewave or pink noise. The switchable inputs are either floating or grounded. The unit measures 54 x 35 x 23 cm and weighs 1 kg.
Pyral, 47 Rue de L'Echat, BP 34 94001, Creteil, Cedex, France.
Phone: 207 4890.

Upgrade your EMT

The new *FS-200LL* line-level stereo transducer system from FRAP is designed to improve the performance of EMT plates. The new system is a modification of the *FS-200*, which is claimed to increase the output level by 24 dB without sacrificing system noise performance. Included in the system are two FRAP three-dimensional transducers plus a pre-amplifier with both individual and mixed outputs. Price is$750.
FRAP, Box 40097, San Francisco, Ca 94140, USA.
Phone: (415)431 9350.

New Crown / Amcron power amp

The *D75* is a direct update of the well-known *D60* stereo power amplifier, and is capable of delivering 35W per channel into an 8 ohm load or 45W into 4 ohm. Other relevant specifications include: power bandwidth 50 Hz to 20 kHz, ±1 dB; hum and noise 106 dB below rated output; distortion below 0.05% third harmonic to rated output and im below 0.01%; slew rate 6V/μs.

Inputs are on balanced *XLR*s and unbalanced jack sockets. A facility is provided for isolating or uniting chassis and signal grounds. Also featured are the recently-introduced *IOC* (or input-output comparator) distortion and signal-present indicators. The *D75* occupies only 40 mm of standard 483 mm rack space (and extends 20 cm into the rack), weighs 4.5 kg and costs £230.
Crown International, Box 1000, Elkhart, Indiana 46514, USA.
Phone: (219) 294 5571.
Telex: 2942160.
UK: Macinnes Laboratories Ltd, Macinnes House, Carlton Park Industrial Estate, Saxmundham, Suffolk IP17 2NL.
Phone: 0728-2262/2615.

Leevers-Rich in West Germany

Potential customers should contact Hek GmbH, 2400 Lubeck 1, Postfach 1810, West Germany, who have been appointed sole agents for the company's full range of tape machines, accessories and spares in that country.

Phono preamp

The US company Audio Interface has released details of a phono preamp for radio stations, disc mastering and that sort of thing.

The *PPS-26* claims a fully professional spec: gold-plated jack inputs, balanced *XLR* outputs and an equalisation response to within ±0.3 dB of the RIAA curve. The manufacturer quotes an equivalent input noise level of −110 dBm with a thd measured at 0.05% (1 kHz, +20 dBm output).

The preamp is claimed to have a 90 dB dynamic range; it accommodates a 1V input at 15 kHz. Two optional stepup input transformers are available for use with moving coil cartridges.
Audio Interface Inc, 9025 Eton Avenue, Suite A, Canoga Park, Ca 91304, USA.
Phone: (213) 998 1082.

Cathedral Sounds in Belgium

The new sole agent for that country is: Naybies Electro-Acoustics, 88 Avenue de l'Armee, 1040 Bruxelles.
Phone: 734 3138.

Didn't they all do well

As part of a recent £1 million order from the Nigerian Broadcasting Corporation to supply a dozen ob vans, EMI Sound & Vision Equipment specified that each be fitted with an Audio & Design *F600-RS* broadcast limiter. These were fitted exclusively to protect the on-board vhf transmitters. They will be manufactured to EMI's 50μs pre-emphasis specification and in their livery to match.

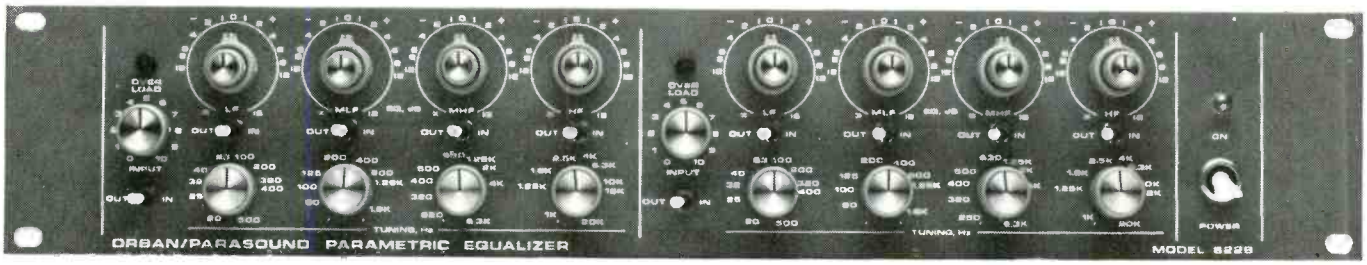
Ampex has received an order from HTV to supply a *MQS-100*

28 ▶

Four of the Best from Orban

Model 245E Stereo Synthesiser
Uses a unique and patented process to create a realistic and mono compatible synthesised stereo from a mono source.

Model 516EC Dynamic Sibilance Controller
Three independent channels of easily adjusted and effective de-essing. Tracking automatically over a wide range of input signals.



NEW Model 622B Parametric Equaliser
Two channels of overlapping four band parametric equalisation with continuously variable tuning, equalisation level and bandwidth. 'Constant Q' rather than reciprocal equalisation curves for musically useful extremes of EQ.

NEW Model 418A Stereo Compressor/Limiter
Variable time-constant H.F. limiter section. Accurately ganged stereo controls. 'Programme controlled' attack and release times. Simple and sensible front-panel controls.

For full information or a demonstration of any of the Orban products, contact:

Scenic Sounds Equipment
97–99 Dean Street, London W1V 5RA. Telephone: 01-734 2812/3/4/5

Sweden: Tal & Ton Musik & Elektronik AB,
Kungsgatan 5, 411–19 Gothenburg Tel: 130 216

synchronisation system and a 16-track *MM1200* tape machine complete with Dolby noise reduction. The microprocessor-based synchronisation system and multitrack will be used at HTV's Bristol studios for post-production sound dubbing of both film and vtr-originated material.

HTV have also ordered a comprehensive intercom system from Seltech Equipment for its Cardiff studio. The 20 x 20 *Series 9000* system includes all input and output amplifiers, cross points and power supply and occupies a not unreasonable amount of 483 mm rack space.

Technics tape machines

In Japan recently Technics launched the *RS1800* tape deck, a professional version of the existing range of semi-professional *RS Series* machines. Like the other *RS* decks the *1800* uses the 'isolated loop' tape transport system which breaks with tradition by using a pair of pinch rollers bearing on a single, very large capstan. Together they isolate a loop of tape which runs round a reversing roller past the record and playback heads. This design is often cited as 'borrowing from video technology', where the tape is looped round the video head drum. But more accurately it borrows from film technology where the intermittent movement of the film through the projector gate is smoothed out in an isolated loop round the sound head drum.

The *RS 1800* has a top tape speed of 76 cm/s but most significantly has automatic bias and equalisation adjustments. These effectively do the job of a service engineer by matching the bias and eq circuitry of the machine to whatever tape is being used! Exact details of operation are hazy but an oscillator is built in to produce test frequencies of 100, 1k, 10k and 20k Hz. For auto-biassing, a tone (presumably of 1 kHz) is recorded at a fixed level while the bias current is swept up until the recorded test signal is playing back off tape at 0.5 dB below the turnover point. The bias current level then latches and bias is set for the tape in use. Next two tones of different frequency are fed on to the tape and divided on playback by a filter. The eq circuits auto-adjust and latch when the divided tones coming off tape are of the same level.

Technics also have a 24-track machine in the pipeline that uses the isolated loop tape transport principle but so far is not equipped with auto bias and eq. Apparently there are problems because dropouts can sometimes confuse the auto-circuits on narrow tracks at low speed.

The isolated loop turns up again in the prototype pcm machine that Technics have developed. Using standard 6.35 mm tape the stereo machine records digital stereo at 38cm/s with fixed (ie stationary) heads. Sampling is at 49 kHz and sample description is by 12-bit logarithmic code. To obviate drop-out problems the tape width is divided into 60 tracks, and the data bits for each channel of the stereo pair are spread across half the available tracks (to be more precise each channel is spread twice over 24-tracks, with parity bits on the other tracks).

Above: *Prototype of the new Technic's 24-track on 50.8mm tape. Machine based on the RS-1800*

Right: *Technic's new RS1800 tape machine, a 'professional' version of the established RS1500 deck*

Another flanger

Here's another way to stretch a point in the time domain. Buy a MicMix *Dynaflanger* and the blurb promises: dynamic doubling, dynamic pitch blending, dynamic freq-e-flanging (*sic*) dynamic envelope flanging, dynamic control voltage output plus a host of other client attractions at normal studio rates.

This month's buzz word is 'dynamic'. The manufacturer claims that the unit will control flanging effects automatically in response to the frequency and amplitude variations of the programme material. Input signals are continuously analysed for spectral content or peak envelope value; the derived control voltages act on the flanging section of the unit.

The interface is to the usual professional standards in terms of signal level and connectors; the latter are *XLR*. The *dynaflanger* can also be used in the normal mode of flanging to produce the more standard range of effects. However, as with all types of sound bending gear, words fail to describe and apparatus is better heard than read about. The unit costs $895 or £492.

MicMix Audio Products Inc, 2995 Ladybird, Dallas, Texas 75220, USA.
Phone: (214) 352 3811.
UK: Scenic Sounds Equipment, 97/99 Dean Street, London W1V 5RA.
Phone: 01-734 2812.
Telex: 27939.

MicMix Dynaflanger special effects unit

Peavey move

Peavey Electronics (UK) Ltd, along with its subsidiary company Stateside Electronics Ltd, recently moved from its Haywards Heath address to new warehouse and office facilities at: Unit 8, New Road, Ridgewood, Uckfield, Sussex TN22 5SX. Phone: 0825-5566. Telex: 957098.

Feedback Instruments Wattmeter

A new electronic wattmeter, the *EW604*, has been introduced by Feedback Instruments Ltd of Crowborough. Measuring wattages in the range 250mW to 10kW, the *EW604* handles voltages between 5V and 1,000V rms and currents from 50mA to 10A over a frequency range of DC to 20kHz. Overload indicators show when input voltage or current is instantaneously 1.5x normal while a fuse protects the current input against overloads of more than 10A. Price is only £133. Feedback manufacture a wide range teaching and test equipment including function generators, variable phase and sine square oscillators and a digital frequency meter.

Feedback Instruments Ltd, Park Road, Crowborough, Sussex TN6 2QR. Phone: 08926 3322. Telex: 95255.

US: Feedback Inc, 438 Springfield Avenue, Berkley Heights, New Jersey 07922. Phone: (201) 464-5181.

Historical Note—Ray Carter, who many will recall from STUDIO SOUND, has been appointed press officer at Feedback Instruments. And yes, he did give us this item . . .

Music Laboratory move

The Music Laboratory, official Revox dealers for London, have moved. The company announce the installation of a 'fully equipped' demonstration studio, and the expansion of stock and service areas. Their new address is 74 Eversholt Street, London NW1, UK. Phone: 01-388 5392.

Profit news from LBC

LBC chairman Sir Geoffrey Cox announced an interesting news item at the company's AGM recently. For the first time in its three years of operation, LBC made a profit in the last fiscal year—£50,000 compared with a loss of £132,000 in the previous year. The figure includes transmitter rental from the IBA of some £200,000, waived in the first 18 months of LBC's operation. And things are looking up with the news that over £100,000 surplus has been generated in the first seven months of the current year. Pats on the back went, predictably, to just about everybody but with particular emphasis on radio sales and marketing, which took over all LBC's sales of national and local advertising at the beginning of the successful fiscal year.

Hill amplifiers

Malcolm Hill Associates introduced a new range of amplifiers at APRS, just after our Amplifier Survey had gone to press last month. Two models are available —the *DX700* offers 310W into 8 ohms, 530W into 4 ohms or 700W into 2 ohms from each of the two channels, while the smaller *DX140* provides 80W into 8 ohms and 130W into 4 ohms, per channel. Distortion at 1kHz into 8 ohms is 0.005% and 0.04% at all levels up to rated output. The amplifiers features a high efficiency toroidal power supply, AC coupled driver stage and only require force cooling when driving into loads of 4 ohms or less. Connectors are XLR for both inputs and outputs. Prices range from £395 for the *DX700* with VU meters to £195 for the *DX140* without meters.
Malcolm Hill Associates, Sales Office, 6 Lillie Yard, 19 Lillie Road, London SW6 1UD. Phone: 01-381 3446.

Sony Broadcast

Having operated briefly from Holland, Sony Broadcast has now moved its European marketing operation to Basingstoke in England. The new headquarters will also house advance research laboratories, sales administration and customer training. A separate warehouse is to be constructed additionally. Although Sony Broadcast are initially concentrated on the new range of high quality *U-Matic* video cassette recorders and cameras for broadcast television, doubtless products of interest to the audio industry will eventually arrive.
Sony Broadcast BV, City Wall House, Basing View, Basingstoke, Hampshire, UK. Phone: 0256 55011. Telex: 858424.

Digital disc

The latest developments from the Philips Eindhoven wizz kids have produced more than a minor stir within the music industry. The talking point is the digital-based *Compact Disc* domestic record replay system which is basically an audio version—albeit with a much smaller 11 cm record—of the Philips video disc system.

Although no one has yet officially heard the system in action, the claimed dynamic range of 85 dB puts it quite a long way ahead of conventional microgroove records. In spite of the small size, Philips states that playing times in excess of an hour are quite possible. Further, heavy bass modulation does not reduce the playing time.

The system encodes the programme material as a 14-bit serial digital code in a linear format; no comparison is employed. There have been no statements about pre-emphasis although it seems likely that a top end time constant is used.

Leaks of information suggest that the pulse train is recorded as a series of vertical depressions on the vinyl playing disc. The system reads these pits in the surface through a process of interferometry using coherent Ga/As laser light. As such, the pickup arm incorporates a mini laser in conjunction with a suitable photodiode. The assembly tracks the radial position of the modulation depressions through purely optical means; the record has no grooves as such. Because there are no grooves, the record can carry a completely flat playing surface. This enables the disc to carry a protective lacquer surface layer making it immune to all the usual things that kill records such as cigarette ash, coffee and fingers.

Playback equipment comprises a turntable which has a varying rotational speed depending on the pick up arm radius; this is to maintain a constant tangential modulation velocity. A digital processor and d-to-a converter sorts out the channels in a stereo format.

Record manufacture is very similar to that of conventional records. One would assume that the usual mastering lathe has to be replaced by an optical laser cutter to place the modulation with sufficient precision. However, the production of a metal mother with the subsequent vinyl pressing follows traditional patterns. There is an extra process to coat the discs with the protective lacquer.

Philips estimates that the cost of the software 'will be comparable to existing microgroove records'. Likewise, the disc player will have a similar price tag to an up-market record turntable. At present the one-hour records are single-sided, although there is a prospect of double-sided software.

If proved viable, the *Compact Disc* system will pose more than a few problems for both recording studios and the record companies. The former will have to invest in expensive—and as yet rather scarce—digital recording equipment, if only to match the apparent potential of the new system. The latter will have to sort out the problems of treble inventory (conventional discs, cassettes, compact discs and did somebody mention quad?) not to mention the extra funding required for new record manufacturing plants.

Most people will have to wait until 1980 before they can make their own subjective judgments on the system. However, it would appear to have much more of a chance than four-channel sound ever had.

Frank Ogden

SAM82 portable mixer

SATT Elektronik AB of Stockholm has introduced a small mixer with eight mic/line inputs and two main outputs which has been finding applications in Nordic broadcasting organisations. Each channel has a female XLR connector, with 48V phantoming, switched sensitivity, phase reversal, low cut, HF and LF EQ, pan, cue output (pre or post), and echo or PA output. In addition to these eight mic/line inputs, there are two echo return channels and two monitoring inputs which feed the monitoring switch. Outputs include two separately floating outputs from each of the two master channels, aux outputs for cue and echo, talkback out and a 32-way multipin connector with bus bars, inserts in master channels, test tone output, inputs to monitoring blocks and internal voltages. Two monitoring blocks switchable to master channels, monitoring inputs or the aux outputs, each have a PPM, XLR output and medium impedance headphone outlet (stereo). Other facilities include a 1kHz test tone generator and optional battery operation from 15 HP2s. Basic price is Swedish Kroner 19,000.
SATT Elektronik AB, Box 32006, 12611 Stockholm 32, Sweden. Phone: 08 810100.

AWA test instruments

Marconi Instruments is now importing a new range of Australian test equipment from Amalgamated Wireless (Australasia) Ltd. The range includes the *G232* low distortion audio oscillator which offers a claimed distortion specification of 0.001% (–100dB) and provides a digital readout of frequency in the range 10Hz to 110kHz, the *F242A* distortion and noise meter featuring fully automating frequency nulling, distortion measurements to below 0.005% and –110dBm to +32 dBm level capability. Numerous accessories are available including weighting networks and AM detectors. Two other units are the *A248* wow and flutter meter which meets DIN, IEC, IEEE and ANSI standards with weighted or unweighted measurements, while the *E247* level meter psophometer reads true rms and quasi-peak for signal level, noise and psophometrically weighted noise and incorporates various weighting networks.
Amalgamated Wireless (Australasia) Ltd, 422 Lane Cove Road, North Ryde, New South Wales, Australia. Phone: 888 811. Telex: 20623.
Marconi Instruments Ltd, Longacres, St Albans AL4 0JN. Phone: 0727 59292. Telex: 23350.

EMS/Feldon deal

The full range of synthesisers and vocoders manufactured by Electronic Music Studios of Oxford are now being marketed in the UK by Feldon Audio, 126 Great Portland Street, London W1N 5PH. Phone: 01-580 4314. Telex: 28668.

studio diary

An open invitation . . .

Studio Diary is about studios. About technical developments and about sessions. Although our team of hacks visit many studios, we still need to hear directly about developments at your end. You don't need to think in terms of a glorious company announcement sometimes mistakenly referred to as a 'Press Release'—just send us the facts and we'll take it from there.

War of the Worlds at Advision

H G Wells novel 'The War of the Worlds' has made it onto disc after two years of recording, re-arranging and rerecording. Writer/producer Jeff Wayne's musical version of the early Wells classic (out on CBS) didn't come easily though. 'A lot of time was spent experimenting with sounds to fit the concept,' commented Roger Cameron, studio manager at Advision, where the album was recorded. 'We linked up two 24-track machines using our *Maglink* system to handle the complex arrangements used.' Early tracks were laid down on a single multi-track machine, a monitor mix transferred to a second machine, and further channels recorded. Machines were locked up only during mixdown on Advision's automated Quad-Eight console.

Why Advision? 'We've worked with Jeff Wayne before,' said Cameron, 'and we do have a very technically sophisticated studio here at Advision.' The album included some 'very complex' synthesiser parts and a full session orchestra, but none too tricky for Geoff Young, who engineered throughout. Despite the fate of War of the Worlds martians, falling as they do to the common cold, it's clear that Advision's patience and facilities are not to be sneezed at.

Jeff Wayne has also been in producing Herbie Flowers single *Don't take my bass away* and album, engineered once again by Geoff Young. Jingle writer Ronnie Bond's creative cup flowed over when he recorded his uplifting single entitled *Secrets*, which he adapted from his popular *Berlei Bra* theme. Produced by Ronnie and Andrew Heath, the single is now out on the Phonogram label. Knockers of the jingle-to-single trend should remember the success enjoyed by singles such as *Jeans on* (Brutus), *Dancing easy* (Martini) and *I'd like to teach the world to sing* (Coke).

Effervescent Harry Secombe dropped in to finish off his latest album while, in contrast, The Stranglers, produced and engineered by Martin Rushent, mixed their *Black And White* album from which the *Nice 'n sleazy* single was taken.

Finally, Brooklyn-based Shirt mixed their new album *The Shirts* for EMI, engineered by Paul Hardiman and produced by Mike Thorne—he used to edit a well respected studio magazine, Studio something or other.

A wet joke at Cherokee?

Imagine for a moment that you were a studio designer and acoustic consultant. The question is—in how many studios would you install a dummy shower? Don't be daft. Well, that's exactly what Cherokee Studios of Fairfax Avenue, Los Angeles did for Rod Stewart when he recorded there recently. Or so says Cherokee owner Dave Donaldson, and we have no reason to doubt him—especially as Studio Sound assistant editor Mel Lambert saw it with his own eyes on a recent visit to Los Angeles. "Rod wanted to record in a shower environment so we built him a shower," said Dave. Strange business this music business.

Cherokee, who count among their chart successes *Rich Girl* (Daryl Hall and John Dates) and *Tonight's the Night* (Rod Stewart), have spent the last year recording music for the new Robert Stigwood feature film, *Sergeant Pepper*. Recently they started mixing the soundtrack for album release. Cherokee have three studios, two of which use Trident *A series* consoles and the third currently working with a Trident B console. "The *B series* console," remarked Dave, "has been brought in as an interim measure while we await delivery of a Trident *TSM* console which is being specially modified to suit our purpose. We shall be automating the mixdown but must be sure that the system adopted fully meets with our requirements. We're rather concerned about speed and flexibility of existing systems and have been doing a good deal of automation research ourselves. We hope to announce some results soon."

Watch the birdie . . . Ginger Rogers (yes, the Ginger Rogers) behind the Neve Necam*-equipped desk at Air Studios London after completing a 'modernised all-time classics' album, her first for EMI. The team behind the action, left to right: engineer Mike Stavrou, Eric Hall, producer Kenny Lynch, Tito Burns, the one-and-only Miss Rogers, and Chris Ellis (who just happens to be a director of Air Studios London).*

Good Earth Productions

Roger Meyers has left Good Earth Productions Ltd on amicable terms, the Dean Street studio will continue under the sole auspices of Tony Visconti. Visconti has recently completed work on Thin Lizzy's double live album *Live And Dangerous* which was released by Phonogram in June, and a new live album from David Bowie taken from his recent performances in America. Work has also begun on a new album with the Radiators whose single *Million Dollar Hero* was also produced by Tony Visconti. 32 ▶

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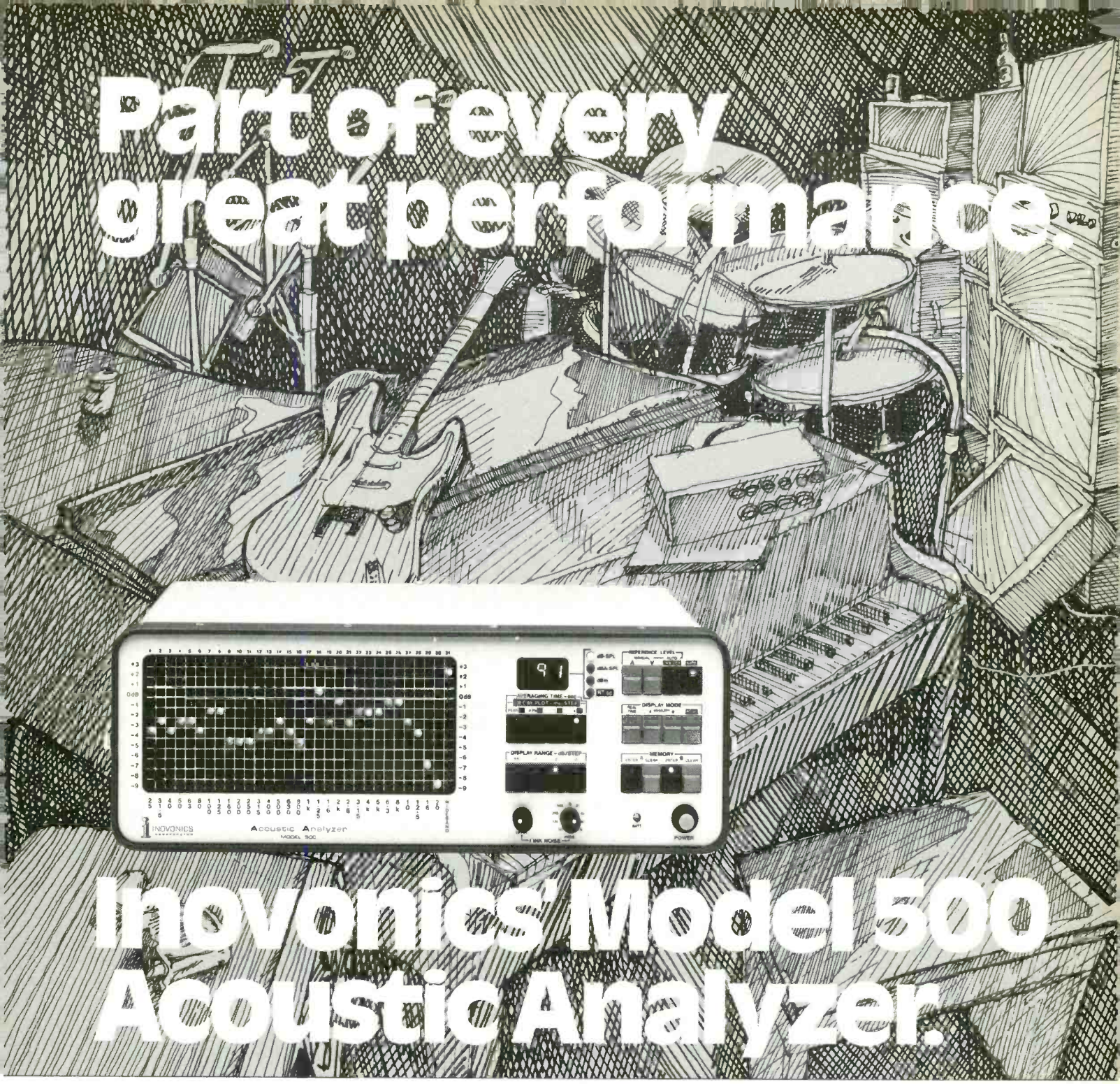

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STUDIO DIARY

Wings Over America

Wings' new film, *Wings Over America*, is pretty certain to be a major box office smash by any reckoning—huge success seems by now routine to a band with the status and prestige of supergroup Wings. But whilst the filmed performance may be assumed to be smooth and professional, the actual filming was another story Problems stemmed from the fact that the film was made without a director. Sounds weird? Read on. Camera crews were hired on a job lot basis, up and down the States, to shoot Wings tour gigs. This was fine—the band were shot from several angles at something like 20 locations. Film rushes were developed, camera crews paid and everybody was laughing. Or were they? Back at the cutting rooms in London, the production team started to notice the absence of a film director. What had happened was that location camera angles had not been co-ordinated. Consequently, soloing instruments had been filmed by luck rather than judgement, if at all. And it didn't end there. On many occasions, again through lack of co-ordination, cameras simultaneously ran out of film, the result being that a whole section of a song would be recorded on multitrack mobile only with no picture available to go with it. Suffice to say the film editor was forced to work with fewer film rushes than he would have liked. The only way he could produce a string of audio and visually documented songs was to edit between different concerts in the middle of songs. Because the Dean Street cutting room was equipped with mag sprocket editing gear, the multitrack had to be transferred onto a number of locked mag sprocket tapes, each holding three tracks, synced to the picture. A further complication arose at this stage—phasing on mag sprocket replay caused by crosstalked sound cancelling between tracks due to the limited sync resolution of the mag sprocket transports. But that didn't matter because after the HF cut-off Academy Curve applied to film sound tracks would remove phasing frequencies anyway; and the effect was only slight. As the picture was cut between locations to continue songs, so was the sound track, to ensure sync picture; the consequent change in sound could be heard quite easily, even by lay ears. An ingenious solution was found to the problem inevitable in concept, but interesting in method. The edited soundtracks from various locations had to be equalised to sound similar. Sound producer Chris Thomas came up with a novel answer employing Kepex noise gates in an unusual configuration. A number of EQ settings were lined up on several mixer channels and Kepexes patched into each channel output. By remotely triggering the gates with white noise, the tape-op was able to watch for an edit passing the heads and furiously key a change of EQ. And the great viewing public need never know.. of course if the film had been planned before shooting rather than after..

Richard Dean

Aubrey Powell's pic taken from the book Wings Over America

Filmways/Heider Recording

The veteran creative music team of Holland/Dozier/Holland were recently hard at work on a new LP at Filmways/Heider Recording in Hollywood. Brian Holland is producing the upcoming Motown release aided by noted engineer, Biff Dawes, and second engineer, Les Cooper.

Also at Filmways / Heider Recording, famed jazz artist Joe Pass has finished mixing his next album for Pablo Records with the label's chief, Norman Granz, handling production along with Paulinko DaCosta. The LP, which was also recorded at Filmways/Heider, was engineered by Val Valentine and Steve Hirsch. Rita Ross (sister of Motown's superstar, Diana Ross) has been recording her own Motown debut at Filmways/ Heider with producer Michael Smith and engineers Grover Helsley and Chris McNary.

A bevy of motion picture and television soundtrack projects have been helping to keep the soundstages and studios at the Filmways/Heider Ivar Avenue complex solidly booked. Country superstar Mel Tillis dropped by to record vocal tracks on the soundtrack for the upcoming Warner Brothers picture, *Every Which Way But Loose*. The soundtrack is being produced in Heider's Studio A by Snuff Garrett with engineers Grover Helsley and Chris McNary. Meanwhile, producer Greg McRitchie has been hard at work in Studio B, recording, overdubbing and mixing the soundtrack to the forthcoming World Wide Pictures release, *No Longer Alone*, with engineers Jimmy Hite and Geoff Howe. Alan Landsberg was in Studio A producing the soundtrack for the TV presentation of *Missing Heirs* with recording and mixdown assistance from engineers Grover Helsley and Chris McNary. Veteran producer Joe Saraceno was in to record and mix the theme to the MCA/ Universal film *Jaws 2*.

Saturday Night Fever and Sergeant Pepper

Although *Sergeant Pepper* songs were recorded at Cherokee, most of the bridge pieces were recorded at AIR London—in fact AIR chairman George Martin was musical director. The music editor John Caper, also edited the music for such films as *A Star Is Born*, *Bugsy Malone* and *Car Wash*. He was telling me about the problems experienced on one of his later films, *Saturday Night Fever*. "We had some complications in syncing sound to film," said John. "Normally a film is edited to music—*Night Fever* was done the other way around, which made things a little tricky at times." In places action was interrupted to cut to dialogue by the film editor, working on artistic rather than syncing considerations, then cut back to action, losing or gaining a beat fraction in the process. In practice this required sound to be synchronised with action, any surplus beat fractions being lost underneath dialogue. You might just notice this if you've seen the film, but all in all, a pretty good job was made under difficult conditions.

Another problem was speed fluctuation of the sound guide track. When action was recorded at the Odyssey discotheque around which the film was based, music was played to the actors on a record player—consequently there was no sync between music and pictures. Inevitably, after the long filming sessions involved, the record deck speed wandered somewhat. When it came to dubbing the music from master tapes, it stands to reason that film action didn't perfectly match music rhythm. John had to advance or retard music tempo slightly to compensate. "All this would have been extremely difficult," said John, "were it not for a new instrument frequency synthesiser by the Glenn-Glenn company, introduced to me by Paramount". In spite of its phenomenal box office success, *Night Fever* was a relatively low budget film—lower for instance than *Sergeant Pepper*. But the film's technical sufferances were apparently more to do with ignorance on location than shortage of cash.

Sergeant Pepper had no such worries. Sound to film sync was achieved perfectly by use of 50 Hz digital metronome throughout. Because the soundtrack was split into six tracks, it was necessary to completely remix the sound for album release in stereo. Other formats in cinema use—mono optical, Dolby SVA stereo optical and 2, 4 and 6-channel magnetic—all had to be catered for by mixing to mono, 2, 4 and 6-channel and dubbing appropriately to optical or magnetic stripe. All in all, quite a bit of work.

"The films I've been involved with recently," concluded John, "indicate a renaissance in popular style films. Modern musicals, if you like, many in the style of modern rock ballet. Films like *Grease*, *Car Wash*, *Night Fever* . . . they all reflect the popular culture of our times." All, no doubt, for some very sound financial reasons . . .

Richard Dean

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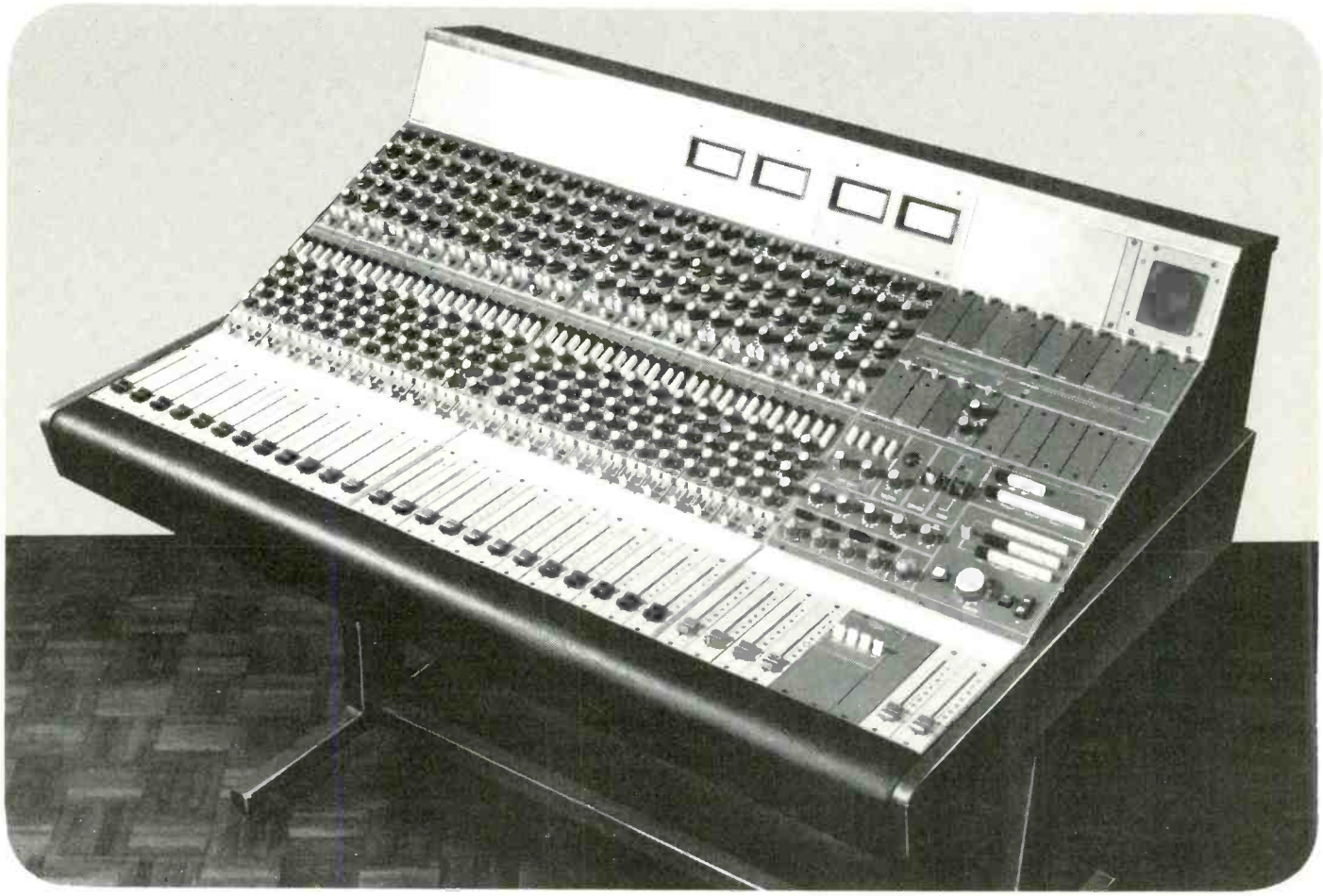

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DDL 7142

Direct cut myths and problems

Adrian Hope

Is it more than coincidence that despite being produced in North America, virtually all direct cut discs are pressed at the same plant in West Germany? Adrian Hope recently visited the Teldec disc pressing plant at Nortorf and here discusses the background to the technical problems of direct-to-disc recording and the economic necessity of using a plant capable of producing high-quality pressings while obtaining maximum usage of mothers and stampers which, for direct cut, are obviously irreplaceable.

ALTHOUGH hard figures are impossible to collate, reliable estimates put the number of direct cut discs currently on the world market at around 100 titles, originating from around 60 companies. The figures speak for themselves—only a few companies issue more than one or two direct-to-disc recordings. Of these few companies, Sheffield and Crystal Clear in the USA and Umbrella in Canada could reasonably be regarded as brand leaders of the western world. The situation is of course continually changing and I mean no offence to East Wind (which is a Japanese company) or all those other companies such as the Great American Gramophone Company who are doing fine work in the west but on a somewhat smaller scale. Umbrella, Sheffield and Crystal Clear (along with GAGC) have two things in common—their discs are currently pressed by Teldec in West Germany and they are distributed in Europe by Quadramail of London NW3. What more fitting enterprises for Quadramail than to gather 40-50 European journalists in Hamburg for a seminar on direct-to-disc recording and a guided tour of the Teldec pressing plant at Nortorf in West Germany?

Apart from making a pleasant break (other firms could learn a lot from the relatively loose schedule arranged by Quadramail—which didn't leave all concerned in a total state of shatter) the event was doubly interesting to me. Firstly I've already reported in *Studio Sound* on the current boom in direct cut recordings. Secondly a year or so ago I visited the Decca pressing plant in South London, which is of course closely related to the Teldec (Telefunken-Decca) German operation. And to the best of my knowledge no major company has regularly entrusted Decca in England with the pressing of direct cuts.

Untouched by human hand

Although many people, including myself, believe that the current fad for direct cut discs will die a natural death in a year or so's time when PCM studio equipment eliminates analogue tape from the recording chain, there is still a massive market for direct cuts. Witness the number of titles available, the extent to which direct cuts have become virtually a standard tool for audio demonstrations and the price which Joe Public will pay for a direct-to-disc recording. In Denmark, an ordinary disc recording costs around £6 and a direct cut around £18—and they still sell like hot cakes.

Quadramail had brought over to Hamburg Jack Richardson and Peter Clayton, the president and vice-president of Umbrella Records. Although neither claims to be an engineer, and both were clearly out of their depth on some of the technical points raised by the assembled press (for instance the maximum velocities cut on Umbrella discs, the stylus cutting angle and the current state of play on PCM encoding) more than enough hard facts emerged to make the trip well worthwhile. The Umbrella operation pays continual respect to the pioneering work of Doug Sax and Lincoln Mayorga. The story goes that in 1959 Sax discovered how some 78's recorded in the thirties sounded better than others made in the forties and how in general 78rpm piano records could sound better than LP equivalents. He found that in 1939 the US recording industry moved over from direct cutting of 78rpm masters to recording onto 40.6cm 33⅓ (standard groove) masters for subsequent transfer to 78rpm—this was the first step in the chain of degradation. Then when the LP came in, analogue tape became established as part of the recording chain and that was the second downhill step. Using a 1935 microphone, a 1929 lathe and a 1947 RCA cutterhead, Sax and Mayorga first recorded a piano. It was the sound of the lacquers direct-cut on that ancient system that lead to the Mastering Lab, which with direct-to-disc facilities opened in January 1968. Later in that year Sax produced the first modern direct-cut disc *Lincoln Mayorga and Distinguished Colleagues*. By the way, if you happen to have a copy of this now extinct recording in mint condition you will have no difficulty in selling it for at least $500.

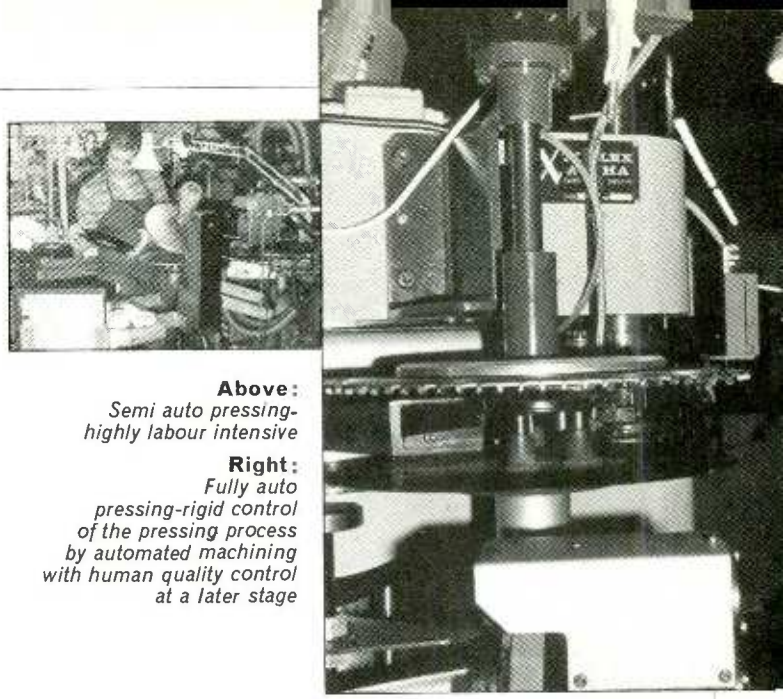
Clayton, Richardson and Umbrella are only engaged in direct cut activities for part of the time, routine studio work helping to finance

the massive investment needed for a respectable direct cut operation. It is of course cheap and easy to produce a direct-to-disc recording, provided that you are not unduly fussy over musical and technical quality. This becomes abundantly clear when you listen to some of those hundred direct cut titles currently available. If the musicians can keep going without breaks or mistakes for the requisite sixteen minutes (less for a 45rpm cut) and not overshoot their time to necessitate a fade-out, direct cutting can be a very quick way of producing masters. Studio time is kept to a minimum and there's none of that tedious mixing down to be paid for. Provided the cutting engineer uses compressors and limiters in the chain to the lathe, he can manage quite well even though there is no automatic groove spacing control to keep the grooves safely apart—but not so wide as to drastically reduce programme length. Unfortunately, recordings made in a hurry with limiters sound terrible, whether cut direct or not.

Umbrella don't work that way. In fact they recently won the Canadian Juno Award for their *Boss Brass Big Band Jazz Album*, the first time that a direct cut has won such an award and they are proud that the album won purely on musical content. The cleanest direct cut sound in the world will do nothing to improve a poor musical performance. The Boss Brass are all top musicians, and Umbrella rehearse the band for three hours on each side of the proposed album and then cut for real. The rehearsal is intended for both musicians and engineers who make some test cuts during the run-through. Programme length is set at around 16 minutes, or 16½ minutes maximum, per side with the cutting engineer and producer working from a musical score to anticipate each musical climax in the manner of a human varipitch control. On Boss Brass there weren't any performance errors but there were technical problems. The fuse in the cutter head blew three times, thanks to the unlimited peaks—three takes were lost but at least the studio saved around $4,000 for a new cutter head each time.

The problems encountered by Umbrella on the Boss Brass album are small compared to those that hit Doug Sax on his recent direct cut symphony orchestra sessions. The whole venture reputedly cost $250,000 and one whole day's work, to the value of between $60,000 to $80,000, went down the drain in a chemical bath. Anyone seriously into direct cutting knows that the lacquer must be electroplated within an hour or so of cutting to avoid loss of high frequencies due to the lacquer plastic 'losing' some of the high frequency modulation by relaxing in shape. Sax had installed three cutting lathes for the symphony sessions but to ensure rapid handling, the masters from all three lathes went into the same electro-plating bath. So one mistake ruined them all. Umbrella have twice lost irreplacable masters during electro-plating. When this happens there is nothing for it but to bring everyone back into the studio for another full batch of sessions and start all over again.

Umbrella have also had problems with cutting styli. Normally they use sapphire of US origin that cost around $30 and last for between 15 and 20 hours. Through Audio-Technica, they secured a diamond stylus of Japanese origin for around $200. This lasted for 150 hours before it degraded even to the point of sounding as good as a sapphire. But the second and third replacements were unusable and the next they heard was that the company had decided not to make any more. Does anyone know a reliable source of diamonds? An interesting incidental point was raised by Jack Richardson during the Hamburg seminar. In seeking to prove how the use of analogue tape in the recording chain degrades performance in more ways than the obvious (like distortion and transient compression), Richardson played dubs from a multitrack tape that had passed, first five, and then 25 times over the playback heads during a multitrack session. Even under the decidedly unideal demonstration conditions in Hamburg there was an audible difference between the bass drum 'edge' and cymbal sound on the tape after five and 25 passes. Richardson says Umbrella noticed this degradation or erosion only a few times when some out-takes (which had passed only a few times through the studio recorder) were spliced in with some sections of tape that had been much more extensively used. Note well that we are talking here *not* about recorded generations but about the purely physical effect of running a tape a few dozen times backwards and forwards past the machine heads to replay some tracks while recording on others. The signs are that there will be HF fall-off after a few dozen passes. But for most pop recording sessions the multi-track tape is run hundreds rather than dozens of times past the heads and so if Richardson's five and 25-pass demonstrations show a difference, what must happen to the average studio tape used for a pop session? Engineers with unplayed out-takes of a session available might like to compare them with the finished master for mix down.



Above: *Semi auto pressing-highly labour intensive*

Right: *Fully auto pressing-rigid control of the pressing process by automated machining with human quality control at a later stage*

Umbrella, and doubtless the other direct cut companies using the Teldec pressing plant, do so for two very good reasons. Firstly Teldec pressings have an enviable reputation amongst the buying public as clean, flat and blemish-free. The factory, to quote Richardson does not suffer from that modern industrial disease "dilution in pride in craft". The other thing going for Teldec is that company's quite legendary ability to get more good mothers, stampers and pressings from a metal master than any other record plant in the Western world. There is currently a great deal of controversy and confusion over just how many mothers and stampers can be grown from the metal plated master and how many pressings can reasonably be run off each stamper. Obviously some companies produce more mothers, stampers and pressings than others because the more you produce the bigger the profits. But the bigger the profits, the greater the fluctuations in quantity, and the more drastic the overall fall-off towards the end of a pressing run. Teldec say the average situation for their ordinary (ie not direct cut) plating and pressing is four mothers from the metal plated master, between 30 and 40 stampers per mother and 3,000 discs pressed from each stamper. This makes a total per master of nearly half a million pressings. And of course if the master is cut from tape, there is no problem over recutting for any number of further and similar runs.

For direct cut pressings there is of course no chance of producing a second metal master because the original lacquer is destroyed by plating, but Teldec reckon to get four mothers and 15, or at the most 20, stampers per mother. The number of pressings per stamper is also less, perhaps down to around a thousand. It seems, to firms like Umbrella, that other companies succeed in growing fewer good mothers and pulling fewer good stampers from each mother. They are thus faced with the choice of either limiting the production run or pressing from sub-standard ie over-used stampers. Either way the firm commissioning the pressing loses out—they get less return on the original recording session or more complaints from the public over poor pressings. Teldec's summing up of the situation is that "anyone can press a good record with the right machinery, but the final product will only be as good as the mother and stampers". I beg to differ. Anyone *should* be able to press with the right machinery, but all too few care—Umbrella for instance found out to their cost how some companies work. One North American pressing plant got through 10 sets of stampers while producing a total of 1,400 pressings, or little more than they should have got from a single stamper. It turned out that the hydraulics of the press were faulty and ten stampers were destroyed before anyone noticed. Because the stampers came from a direct cut session there weren't any more and the whole recording session became a commercial write-off.

The Teldec plant at Nortorf produces around 60,000 singles a day, 35,000 duplicated musicassettes and 100,000 LPs, of which of 36 ▶

course only a relative few are direct cuts. But the plant's reputation is such that around 50% of that output is custom work subcontracted by other firms. One reason why Teldec has achieved its enviable reputation is quality control. Another is the use (for LP production) of semi-automatic presses with a relatively long (32 second) operational cycle. It is with fully automatic, short cycle presses that problems such as warp can start to arise. In fact Teldec is currently moving over from semi-auto pressing to fully automatic production. Swedish Toolex-Alpha presses are currently being installed. These are programmed for a 26 second cycle although they could be run much faster. The Toolex presses work on the injection moulding principle and one operator can control four machines. The semi-auto machines are hand served. During our visit there was an interesting comparison to be made between semi-auto and fully auto presses in the Teldec plant operating virtually side by side on the shop floor. Whereas pressings from the semi-auto machines were being visually inspected with great care by the machine operators, the auto machines were churning out spindled piles of finished pressings with no visual inspection prior to a quality control department to which the pressings are automatically conveyed. This quality control department is clearly diligent but the changeover from semi-auto to fully auto pressing does pose a vital question for those companies entrusting Teldec with their direct cut pressing work. It was clear from what we saw that if one of the auto presses goes hay-wire and starts churning out dud pressings these may well not be caught until they reach the quality control department. By this time a mass of dud pressings may have accumulated and a set of stampers been worn out in the process. This won't matter for an ordinary disc release where there is always another set of stampers available. But what if that set of stampers is the last from a classic direct cut session such as the now extinct early Mayorga recordings? Hopefully Teldec will decide to retain at least a few semi-auto machines for direct cut pressing, but if not they will need to guarantee direct cut firms special on-the-spot quality control for the auto presses.

The word regrind or recycle is often regarded by record producers and record buyers alike as synonymous with poor quality. It is certainly a fact that if the plant simply regrinds all its reject pressings complete with the paper labels, then the regrind or recycled vinyl mix will be of a poor quality. If dirt from the atmosphere or factory floor also gets into the regrind then the overall quality of pressing falls even further. But provided that the centre label portion of each record is accurately stamped out of each reject pressing before it is reground, it is an open question whether recycling vinyl is detrimental or beneficial to pressing quality. Teldec in Germany clearly believe recycling reject pressings *does* degrade quality because they use only virgin vinyl mix for pressing LPs. On the other hand Decca in England believe just the opposite, arguing that the more times you regrind vinyl the more homogeneous the mix and the better the pressing. You pays your money and you takes your choice. Possibly the difference in approach stems from differences between the raw vinyl and chemical mix used by Decca in Germany and in England.

As mentioned above I visited the UK Decca plant at New Malden a year or so ago. At that time Decca was relying entirely on semi-auto pressing with a 40 second cycle and very rigid quality control at the point of pressing. "Do away with the press man and you do away with your most essential quality control point," said the British plant manager. That of course is exactly what Teldec in Germany is now on the point of doing. So I checked when writing this article with Decca UK on the current situation at New Malden. The presses there *are* still all semi-auto and there are *no* firm plans yet to move into full automation. This will make Decca UK one of the few plants in the world still pressing in what big business would write off as primitive fashion. But primitive pressing, coupled with pride in craft, is just what the direct cut companies are always looking for . . . ■

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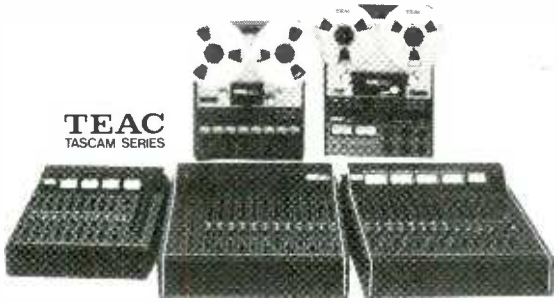

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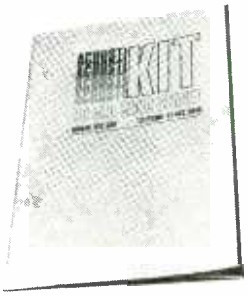

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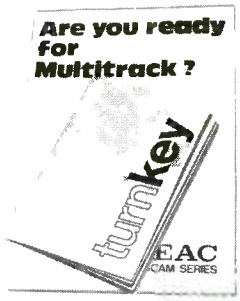

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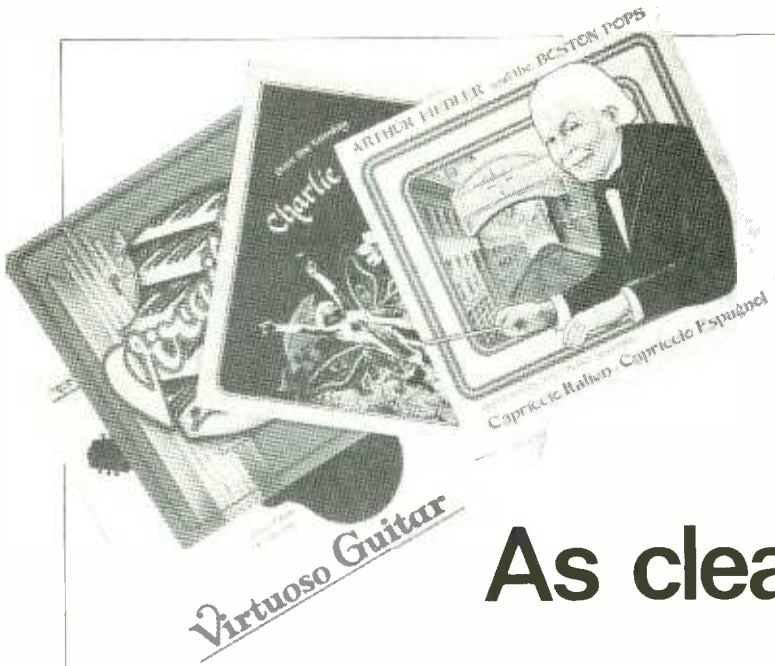


As clear as crystal

John Atkinson

Over the last couple of years, a number of small record companies have emerged using the somewhat anachronistic process of recording direct-to-disc. Advantages claimed are lower distortion, wider dynamic range and better reproduction of transients and both frequency extremes. One of the most recent companies has been Crystal Clear, based in California, who have recently produced some stunning classical recordings. John Atkinson (Assistant Editor Hi-Fi News & Record Review*) talked to Crystal Clear founder and producer Ed Wodenjak at the recent Spring Hi-Fi Show in London.*

Crystal Clear started just under two years ago. Why did you decide that there was a need for another direct-cut disc label?

"Well, I'd been involved with an audiophile-type publication in the States reviewing very expensive equipment, $1,000 preamps and $2,000 amplifiers, $5,000 speakers. If you're going to be thorough about reviewing somebody's amplifier in comparison to another amplifier—let's say you're trying to comment subjectively rather than objectively on the performance of five amplifiers and they all spec out pretty much the same. They all have low distortion when measured in a conventional fashion—ostensibly they all have very flat frequency response—from an objective test standpoint, those amplifiers are all the same and yet most fairly sophisticated audiophiles know that they really don't sound the same. A lot of amplifiers that from a spec standpoint should be very good are terrible, just what we call boat-anchors—this is a comment one of the engineers came up with to describe a fairly high-powered Japanese amplifier that weighed about a hundred pounds and sounded just dreadful.

"So the real problem was finding good records that could be used as a reference. We went through every record we could find and came up with a handful that were reasonably accurate, but it became painfully obvious that the number of recordings available anywhere in the world that were really accurate, and weren't mucked around with, was extremely small. And even the Sheffields, which had good body, good dynamic range, good clarity and so on, had a lot of equalisation so they could not be depended on as a flat reference upon which to judge very expensive equipment. At that point it began to dawn on us that there really might be a market for good quality recordings. We sent out a little flyer to people who were subscribers to the magazine asking them if they would be willing to pay a premium price for a high quality recording and the reaction was overwhelmingly 'yes', so we began, just as a side-line really, to produce the first record. The first disco record was done very inexpensively in costs. I think we raised about $10,000 when we did the recording, obviously costs have gone up enormously since then—but it was a start, though it wasn't really envisaged that it would become a major endeavour for any of us. The reaction to the first record was so good that we did a second one, which was considerably better from a musical standpoint, and there we were. We were off and now have 10 records."

Why did you choose to record at 45rpm?

"Well, we record both at 33 and 45, but we knew early on from our studies that there's no question that 45rpm enables you to eliminate a lot of the pinch distortion which happens at 33rpm, and to record an overall clearer sound because the same energy is cut over a larger area. We have had to record classical music at 33rpm though because when you're recording direct-to-disc you're limited to somewhere in the area of 16 or 17 minutes at 33 and only about 12 minutes at 45. There are works that you can record that are 16 or 17 minutes long, but damn little in the classical repertoire worth doing of 12 minutes or less, so the 45rpm speed for classical represented a great problem.

"There is also the fact that with jazz and pop you're recording a lot of percussion and brass instruments and you're miking them very close—therefore the wavefronts are awfully steep. The extra headroom at 45 becomes a lot more important, whereas at 33, since you're normally miking these instruments maybe three metres away and the wavefronts become less critical in transients and so forth, it becomes possible to do a fine classical recording at 33rpm."

Who operates the lathe? Obviously he's having to do all the pitch spacing by ear, as you haven't got any one second delay?

"Most of the people we hire to do the disc master for us are people who've been in the business a long time. They're people who were doing mastering before the sophisticated computer control systems became all the vogue, and can do it very well. There's always a lot of talk about how tough a direct-to-disc session is on the musician (which it is, without any question) but people really don't think as much about how tough it is on the technical staff, because there's no chance to remix anything. If there's something wrong on the balance, well then it's wrong for ever. If the lathe operator forgets to open up during a tremendous crescendo it's going to overcut and the whole thing is wrong, so there's a tremendous amount of pressure on both the mix engineer and on the disc mastering people. It's exciting and I think everybody gives his maximum effort under these conditions, but it's tough, and you have to have people who can read music—you have to have people who've had some experience at doing manual depth and pitch control."

Some producers I know have said: "Yes, fine, direct-to-disc—you hear it once and it's a live performance; the energy's there and you get carried away. But if you hear it a second or third time, little things start to annoy you, like a horn fluff or the sound of a music stand being hit with a bow or something like that." You start to fix on that and in the end that's all you hear—you're not relating to the performance any more.

"I think that's a really valid criticism of the process and I think all I can say is that the things like small coughs, people hitting stands, rustling of feet and turning of pages are things which a lot of audio enthusiasts like to have in a recording because it makes it more human. One of the problems, I feel, with commercial recordings that are letter perfect is that they get somewhat sterile; you want to say 'hey, somewhere along the line there should be something happening out of the ordinary that says this is real.' It's music that's been programmed by a computer.

"Commercial studio recordings may be letter/note perfect from a musical standpoint but they're sterile—they don't have this interaction of feeling between the musicians which you can get with a direct-to-disc live recording. I guess you have to make a trade; you have to say: 'Do I want that kind of feeling, and am I willing to accept a few little technical problems and a few little muscial problems to get that feeling?' I think that both attitudes are valid. It's like looking at a painting with one little flaw in it—you will see that flaw every time and you will suddenly see the flaw more than the painting and will not be able to adjust, and I think that's a very valid criticism.

"On the other hand, I think I would prefer to have some of these small flaws and mentally tune them out like I tune off a tick or a pop in a recording and be able to experience the feeling. Other people will validly have the other view that to them those few little mistakes are such a problem that they would rather miss some of the feeling of the performance—I think it's an individual choice."

And as you're producer, it's your decision?

"Well, I think it's the decision of the consumer—whether you as a consumer would prefer to have musical perfection but sterility or to have this aliveness, this tremendous feeling and energy that occurs and just tolerate a few little mistakes, as you could tolerate ticks and pops on a record, as a part of the medium. There are always problems with the record medium, and you tolerate them and you don't go 'Oh my God listen to the pops!' If you fix in on ticks and pops and noises then you'll never really be able to listen to the music and if you are that kind of a person, you really have some problems. Probably all you can do is enjoy live music. I would tend to think that the little problems that occur and the little extra noises are things you don't listen to—you tolerate them as part of what you must have to get into the music.

"What we were trying to do when we started this thing was to convince the retailer that a high quality direct-cut record is not a record but really an audio accessory that could help the dealer sell speakers and amplifiers. In fact it was even more than that—it's really the first step because the quality that you hear is really dependent on the quality that's on the software, because if the quality is not there, the quality you hear is not going to be very good, the same as in the computer industry—garbage in, garbage out. If I have a really distorted record, the more accurate the speakers, the more accurate the amplifier, the more accurately it will reproduce the distortion on the source material—so it's really essential to have a record that's as pure as possible and also, for hi-fi purposes, one that's undoctored. This is something that people didn't realise: the Sheffield recordings (which are fine recordings) have a lot of equalisation and they use all of the signal processing techniques, at least in the earlier ones. I don't think they're doing this so much any more, but on the Thelma Houston recording you could hear a lot of equalisation and artificial reverb, in fact on one of the recordings you could hear the spring from the EMT reverb unit. We felt that it was important to produce recordings which were flat.

"Now the commercial record industry produces records for a specific purpose. Crystal Clear recordings, for example, sound very poor on the radio because they're flat, whereas most of the records are cut with a mid-bass boost, a mid-range boost, with the extreme highs and the extreme bass rolled off. They really punch out on the AM radio and our records sound inferior unless they're equalised in the same way. It's not really possible to produce a record in the conventional sense that could be successful from a hi-fi standpoint. The console we've built has no equalisation; we do have provision to stick in some equalisation for a couple of instruments if we need to, but basically, when we designed our studio, our idea was to conceive a studio meant specifically for flat direct-to-disc. All the commercial studios that we've been involved with have been standard pop studios. They do a very fine job within limitations, ie to produce a certain type of conventional product which requires multitrack recording with a lot of signal processing which will be saleable in the mass market, but the result of that is really unacceptable from the audiophile standpoint. So when we started doing our recordings in these studios, we found that we had to design a lot of specialised equipment and it got to the point where we were really building everything—we had our own console, we had our own microphone, and we were really only using the physical space in the studio. This was also unacceptable because of the way these pop studios are designed—they are extremely dry so that there is good separation between instruments and all of the reverberation can be added artificially. If you try to use a studio like that without using artificial reverb, you come up with a very strange kind of anechoic-chamber sound.

"We did eventually find one studio (one of the old RCA rooms in Los Angeles) that was actually quite good—we could work there, but it still wasn't optimum. We decided to put together our own studio—we have two mastering systems that we will be installing as well as, of course, our own 24-channel console and all our own microphones. There are two areas in which we will be able to do recording. One is a studio about the size of a normal pop studio—it would take maybe anywhere from three to six musicians for a small group. The acoustics in that room are not dead, though—they're designed to be BBC optimum for the size of that room so you don't require any artificial reverb. The larger area is where we can do anything up to just short of a full symphony orchestra: in other words we could accommodate 30 or 40 musicians. The ceiling is about 2½ storeys high and the acoustics are excellent, just as they stand. They're very clear, with almost perfect reverberation.

"We have a philosophy at Crystal Clear which is that we try to produce records that sound like live music, not like records. In doing this, we give a lot of thought not just to what the storage medium would be—in other words whether we would do it direct-to-disc or whether we would do it on digital tape or an analogue tape—but rather we look at the whole signal path. We took some special microphones that were extremely good, much better than conventional off-the-shelf microphones, and adapted them to our process. They're flat, within 1dB, from about 10Hz up to 40kHz. We took a look at the board and designed our own board with no transformers anywhere in the circuit, which is very difficult to do, particularly if you're using very fast devices and have a very wide bandwidth. The board is flat from DC to 200,000Hz within 1 or 2dB—it's extremely flat and the distortion is literally unmeasurable. We had an interesting experience with one of our digital recordings—some engineers brought a Sound Technology distortion analyser to use as part of the set up equipment for the digital system, and wanted to measure our board. We didn't care, we knew it was good, but they were suspicious. They were, of course, very objective-test, measurement-oriented people and were concerned what the input would be to their digital tape recorder, so they hooked up their distortion analyser, which has a residual like 0·0001% (I mean it's really one of the best on the market) and they didn't get any reading. They thought there was something wrong so they rechecked everything, hooked it up again, didn't get any reading, and of course John and I and several other people were sitting back there laughing."

Was that John Curl who designed the Levinson amp?

"No, this was John Meyer. John Curl did our circuit design—John Meyer is the fellow who's really responsible for the construction. We were all amused because we knew they weren't going to be able to measure anything because *we* couldn't measure anything, but they couldn't believe it—they kept thinking it was something wrong with their system. They had 40 ▶

AS CLEAR AS CRYSTAL

never found a piece of equipment of any kind that didn't measure any distortion, but this didn't—the residual on our board was far lower than the residual of the distortion analyser. When you are able to design the equipment to be so low in distortion, to be so quiet and to be so fast with such a high slew rate and the frequency response can be so wide, the result is that it's almost a pure through-path—virtually nothing but gain is contributed by the board."

It makes a change from 741 op-amps!

"Oh dear yes! We tested several well known boards and the distortion was really unacceptable and, because of the smearing quality of a lot of those boards, it's rather remarkable that they're able to do as good work as they are, all things considered. I know that a lot of people get really fixated on microphones and I guess probably it's one of the only things that an engineer has choice over, but really most of the problems and the kind of abhorrent quality of commercial recordings are the result of the board more than the microphone because a lot of the Neumann and AKG microphones are basically very fine microphones. It's just that the signal has to go through all those transformers and all of the inferior electronics in the mixing console and then, of course, the recording on 24-track tape which is like a 24-track cassette recorder. I mean a giant cassette recorder is what you're recording on, and small wonder that the quality of sound, with the Dolby-A and everything else that they have to add, is really quite inferior.

'Our next project will be to modify the cutting systems because, good as the Neumann and Ortofon cutting systems are, *they* use a lot of horrendous *741*-type ICs and they use all sorts of FET devices that are incredibly poor in quality. It's rather startling when you look inside some of the electronics, the acceleration limiters and a lot of the crap that they put on them, and realise that every single commercial tape has passed through all of that junk. Most of the mastering facilities will not bypass, they're terrified of damaging a head. But we're *not* terrified; if I'm going to spend $100,000 to make a recording direct-to-disc, I am going to try to bypass all of this equipment. If I run the risk of damaging an $8,000 cutter head, well—what's $8,000 compared with the 100 grand I've already spent? If you go into a standard mastering facility, they are so terrified of the cost of this equipment that they won't do anything, they'll just follow Neumann's regulations and do it the way they're instructed to. That's not acceptable as far as we're concerned because we don't want to lose what we gotten up to this point."

Perhaps more important than the technical problems is the effect of the recording process on the musicians involved.

"I was at a *Billboard* conference in Venice recently and Herbie Hancock was one of the panel as well as performing, and prior to the conference proper he was talking with a lot of record industry people in the audience. He was saying that a friend of his had come to one of his concerts and had recorded his group with just two microphones and had played the result back to them at a later date. He was startled at how good the quality was from just two ordinary microphones and a domestic tape recorder, and, in his opinion, it was considerably better than the horrendous things that had been done by his producer. I have to agree because he was talking about a situation with *eight* microphones on the piano, and can you imagine the phase cancellation and so forth from *eight* microphones?

"The thing that I found impressive was that here is an artist who is certainly not a technical person, but who recognises the problem with this sort of multi-mic crutch. Icaas Stern was also there and he commented on the importance of technical quality and recording things naturally. It was encouraging at that conference to find the artists themselves becoming sensitive to the technical quality with which their performances are being recorded, and preferring to go back to a simple microphone approach, whereas the technical people are going in just the opposite direction! ■

letters

Dear Sir, I have noticed with interest the article written by Adrian Hope on the D'arblay Sound and Sight Workshop Course printed in the April issue of STUDIO SOUND. *In view of the queries ralsed over the nature of the whole project you might like to know that the Company appears to be adopting very unusual sales techniques. A few weeks ago a telephone enquiry was made asking the name of the Professor of Music at this University. A week later a complete course set was delivered with an accompanying letter stating how delighted they were to have us take delivery of an Inspection Copy.*

Three weeks later a further letter arrived stating that 'as arranged' they now had pleasure in enclosing their invoice. The latter document was indeed attached, made out to the Music Department, for a sum of £30 payable within 30 days. We have never at any time placed an order or indeed even expressed an interest in the course and the situation which now arises is obviously a matter of great inconvenience to us.

Yours faithfully, Peter D. Manning, Senior Experimental Officer, University of Durham, Faculty of Music.

Tannoy monitors

Dear Sir, on page 72 of the March '78 issue of STUDIO SOUND, *Adrian Hope describes the experiences of Elen and Chkiantz with low-feedback amplifiers and Tannoy speakers. We are currently rebuilding our studio facilities (three studios, one mixdown suite and three mastering rooms, at a cost of $2 million) and spent a lot of time and research on monitoring before we started construction. Our design parameters were flat control room acoustics and a flat monitor chain; we have gone to a lot of trouble to avoid equalising the speakers to compensate for non-linear rooms.*

The results of extensive a/b listening tests are that we are standardising all facilities with Tannoy Ardens *and Quad* 405 *amplifiers.*

To produce the required spl we are using a fairly close listener-to-speaker distance of 2.3 m and a room design that, except at the extreme bass end, lets the engineer hear only the direct sound from the speakers. This means that with the exception of the extreme bass, the left-hand speaker cannot significantly 'hear' the right-hand speaker, and vice-versa. In this way we do not think we get the speaker-as-microphone problem mentioned in Adrian Hope's article.

As a matter of interest, we have found that the Arden *enclosure housing the* HPD385A *driver is incorrect using Neville-Theile alignment criteria. By modifying the porting in accordance with Neville-Theile, we have reduced the mid-bass hump and extended the extreme bottom end, and also produced a firmer bass.*

Something else we have found, much to our surprise, is that approximately half the Tannoys are delivered out-of-phase with respect to the other half. To date we have taken delivery of 32 in batches of four or six units. Having corrected the phase, we put them in a line, switch pink noise between the units and then mark them as 'best-matched' pairs. To the uninitiated the difference between units can be quite surprising. The best speakers we have found in this respect are the KEF LS5s.

Lastly, something else we have found, is that because Tannoy do not market as aggressively as JBL, we have clients (and an engineer) that regard Tannoys as 'unprofessional' and insist on JBLs. As the client is (nearly) always right, we offer JBLs as alternative monitors.

Yours faithfully, Nigel Wake, General Manager, Studio Recording Division, EMI (Australia) Ltd, 301 Castlereagh Street, Sydney, NSW, Australia.

To the quick

Dear Sir, I was interested to read the Business item in the June issue, entitled 'The unkindest cut'. The total lack of single-sided razor blades has been a problem here for some considerable time. Readers may be interested to hear of the researches I have carried out at the local branch of Woolworths and Boots. There is generally available a very robust double-sided blade, manufactured by The Durham Duplex Razor Co Ltd, and marketed as packets of five Hair Shaper *blades.*

If used as they come there is the usual danger of editing the fingers rather than the tape, but the addition of a piece of folded plastic renders them completely safe and comfortable to use. I hope that this information may help to sustain the recording and broadcasting industry, whilst at the same time, increasing the value of shares in the Durham Duplex Razor Co Ltd.

Yours faithfully, Bernard Whitty, Cathedral Sounds Ltd, Fourways, Morris Lane, Halsall, Ormskirk, Lancs, L39 8SX.

Studio designers and consultants

Dear Sir, I have just received the March 1978 issue of STUDIO SOUND *Magazine and it appears that someone is in need of at least a mild castigation for the survey of studio designers and consultants. The reason is that the information in the survey, while not downright deceptive, is at least misleading. In our dictionary, a 'consultant' is defined as one who gives professional, expert advice or services. In the United States, the National Council of Acoustical Consultants has a very rigid Code of Ethics, which requires that their members must* not *sell any merchandise, nor can they be associated with any purveyor of merchandise. Only in this way can they be completely objective in giving professional advice to their clients.*

Unfortunately, in your listing of studio designers and consultants you did not *give a sharp and clear distinction between merchants and true, independent Consultants. I did notice in the fine print of some that the 'design service' was free, provided that the customer purchased his equipment from that company. This is a very backhanded way of distinguishing between merchants and consultants.*

The studio design business has fallen into the same quagmire as the sound contracting business —at least it appears that both Great Britain and United States have common problems. It is axiomatic that the only way that a merchant can make money is to sell something and the objective of their 'design' is to sell only *the merchandise that they carry; whether it is what the Client needs is immaterial. We see this over and over again when sound contractors are called in, for example, to a church where the congregation has had three sound systems and still cannot hear the sermon. What happens is that they condemn the existing equipment, and sell new equipment which may not work any better because of unfavourable acoustical properties in the church.*

It is also axiomatic that any 'free' service is one of the most dangerous and often expensive commodities known. There are always *some type of attached strings because somebody, somewhere is paying the bill. If there be such a thing as a true free item or service, then it is also axiomatic that the item is shoddy and worthless.*

Returning to your listings, you can correct the situation and perhaps make amends by publishing another listing with two separate headings: 1 true consultants who are not *in any manner affiliated with any equipment merchandiser, and who sell nothing but their advice and knowledge; 2 equipment vendors or manufacturers who do design work for people who buy merchandise from them.*

Perhaps a third heading would be in order for studio contractors who offer a 'turnkey' service, whereby they will design and build and sometimes equip a studio for a customer.

The important thing is not to deceive your readers into thinking that they have retained a consultant to correct a problem, when in reality they have engaged a vendor whose full-time objective is to sell equipment and who may be stealthily seeing what can be sold to alleviate the problem.

Incidentally, I noticed that you omitted two of the leading studio designers and acoustical consultants that I know of. These are: Robert Hanson of New York City and James Moir, who is one of the leading acoustical consultants in the world. Neither of these men sell anything except design services.

Yours faithfully, Melvin C Sprinkle PE, Sprinkle & Associates, Post Office Box 10, Kensington, Maryland 20795, USA.

business

ADRIAN HOPE

Sound plagiarism

FOLLOWING our piece on the D'Arblay recording course and the suggestion that some of the phrases found in the glossary (such as peak up, pot cut, formant, carbon microphone and ionophone) seemed odd inclusions, a couple of readers wrote to me with the helpful suggestion that I check out the glossary of Alec Nisbett's excellent (if by now outdated) manual 'The Technique of the Sound Studio'. This I duly did, with rewarding results. Sure enough all those odd phrases appear in the Nisbett glossary. What's more there is a marked similarity between the glossary definitions as written by Nisbett (first edition 1962—eighth impression 1972) and the glossary definition put out by D'Arblay (1977).

For instance, Nisbett defines formant as: 'A characteristic resonance region; a musical instrument may have one or more such regions, which are fixed by the geometry of the instrument'. D'Arblay defines formant as: 'A region which produces characteristic resonance. An instrument may have one or more of such regions, determined by the design of the instrument'. And while Nisbett defines ionophone as 'a type of loudspeaker which has no moving parts', D'Arblay define it as 'a loudspeaker having no moving parts'.

Now any two glossaries covering the same area are bound to overlap and a couple of coincidences like this are inconsequential. But they aren't the only coincidences by a long chalk. The D'Arblay glossary as offered to the press for review contained around 250 entries. I can only find one D'Arblay entry (that for 'binaural sound') which is not to be found in the Nisbett glossary. From 'acoustic reproduction of effects', through to 'woolly' via terms like 'script rack', 'tent', 'prefade deadroll' and 'lazy-arm', the terms used by D'Arblay exactly echo those used more than a decade earlier by Nisbett.

And it isn't just the glossary headings that echo Nisbett. It's the definitions as well. One could expect two different definitions of 'balance' to be generally the same, even down to 'this is the responsibility of the balance engineer or a programme operations assistant' (D'Arblay), and 'this is the responsibility of a balance engineer or (in BBC radio) a programme operations assistant' (Nisbett). Likewise two different definitions of the term 'beat' might be the same, even down to 'when two tones which are within about 15 Hz of each other are played simultaneously, the effect is that the combined signal will beat at the different (*sic*) frequency' (D'Arblay), and 'if two tones which are within about fifteen cycles per second of each other are played together, the combined signal is heard to pulsate, or beat, at the difference frequency' (Nisbett).

But credibility and coincidence are pretty far stretched when one looks at a less familiar term like 'cod effect'. 'A term used for effects which are exaggerated for comic effect', says D'Arblay. 'Effects which are exaggerated for comic effect,' said Nisbett. Likewise 'clean sound' is defined by D'Arblay as: 'the actual sound of a scene, free from added commentary,' and by Nisbett as 'actuality sound of an event, without superimposed commentary'. 'Vibrato', say D'Arblay in 1977 is, 'rapid variation in pitch of about 5-8 Hz and used as a stylistic device by some singers and instrumentalists'. 'Vibrato,' said Nisbett in 1962, is a 'rapid cyclic variation in pitch at a rate of about 5-8 Hz, used by singers and instrumentalists to enrich the quality of sustained notes.'

The main difference between the glossaries of Nisbett (then) and D'Arblay (now) is that Nisbett's contains more entries and they are much fuller than those offered by D'Arblay. But the D'Arblay glossary does have one thing which is definitely missing from the Nisbett glossary: a copyright notice at the front attributing 'All rights reserved to Cobiron Ltd 1977.'

Is it a bootleg or a pirate?

BURIED in the small print of 'The Times' law reports recently was a legal decision that could matter a great deal to the recording industry. The case involved Island Records and concerned record piracy and bootlegging. To be more specific it centred on the difference between piracy and bootlegging. When a group's public performance or broadcast is recorded illegitimately and copies issued for sale, the result is a 'bootleg'. When a commercial recording issued by a record company is illegitimately copied and reissued for sale then the result is a 'pirate' recording.

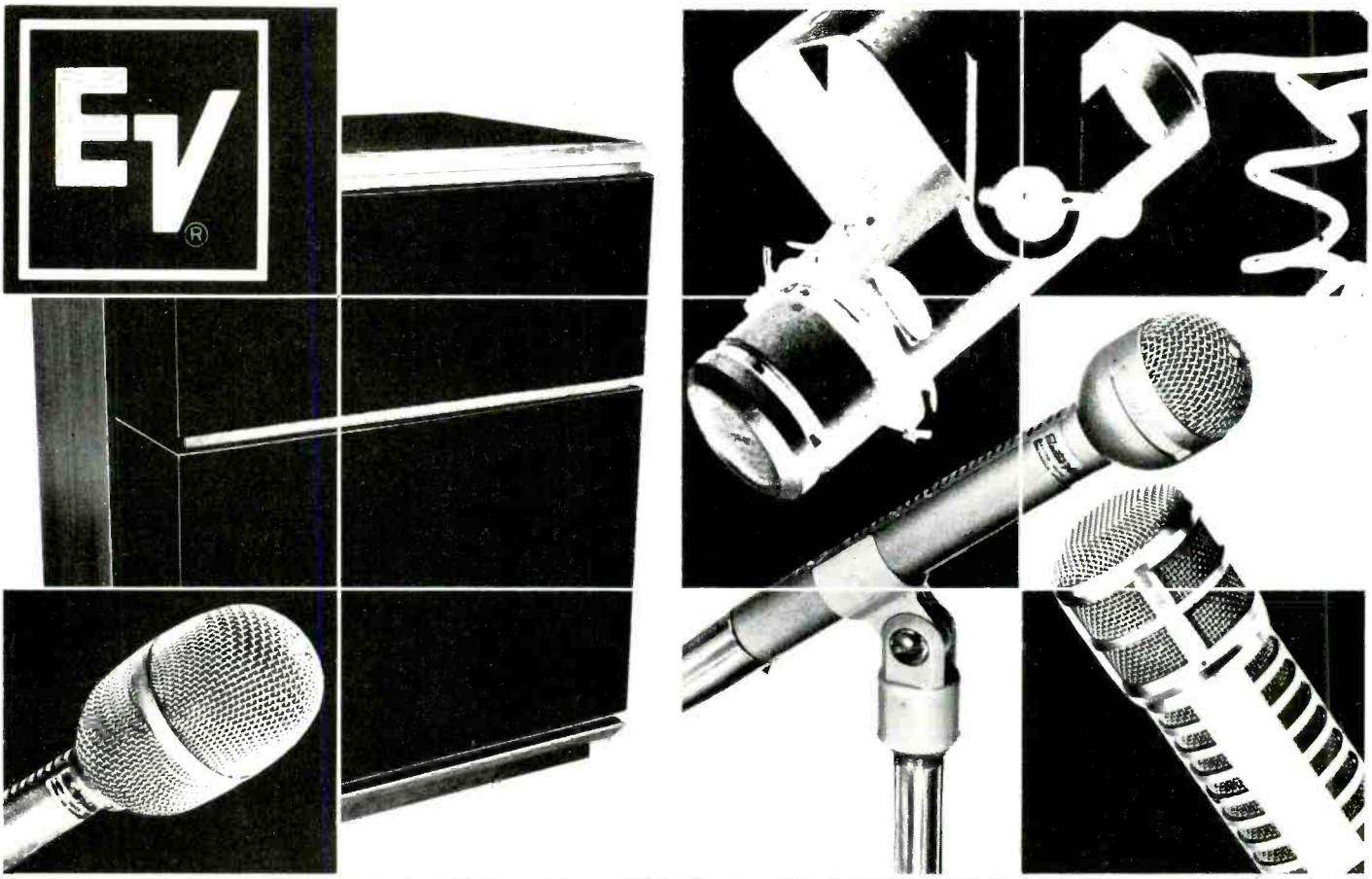
A bootleg recording is illegal and a criminal offence, under the 1958 Dramatic and Musical Performers' Protection Act. But because there is no copyright in an actual musical performance (it is not a tangible work of art like a painting or literary work), the civil matter of copyright infringement in a bootleg is much less clear cut. On the other hand a pirate recording, that is to say a copy of an existing record or tape, is both criminally illegal (under the 1958 act) and an infringement of copyright in the copied recording. So there is subtle but potentially important difference in law between a bootleg and a pirate recording.

A few years ago, when pirate recordings were all the rage, it was difficult in practice to catch the pirates red-handed. Shops found selling one pirate record would simply deny having any more than that one and pass on their stock to someone else. Then came a High Court decision that enabled companies whose recordings were being pirated to get a court order 'freezing' the stock of a record shop the moment piracy is discovered. In legal jargon such orders are called 'Anton Piller' orders, after the case that set the precedent. Anton Piller orders have helped curb piracy but until now they haven't been available to help curb bootlegging.

This is where the subtle difference between bootleg and pirate recordings comes in. Although a pirate is guilty of both a civil offence (breach of copyright) and a criminal offence (under the 1958 Act) a bootlegger is usually only guilty of a crime. In other words a bootlegger is only half as legally naughty as a pirate. Until now bootleggers have had the upper hand because Anton Piller orders against bootleggers have been refused by some judges. The Island Record case was aimed at settling the matter one way or the other, once and for all. The Court of Appeal decreed that, whatever some judges may previously have decided to the contrary, a British court does have the jurisdiction to grant an Anton Piller order against a bootlegger as well as a pirate.

What this means is that if a record company suspects a shop of selling illegitimate recordings, it doesn't matter a hang whether those recordings have been bootlegged from a concert or a broadcast or copied from a commercially-released tape or disc. Either way the record company can apply for an injunction to hit the shop where it hurts most—freeze all stock as soon as the shop is caught selling just one bootleg or pirate record.

The decision will be purely academic for some groups and record companies because they have already solved the problem their own way. One famous foursome is managed by a twenty-stone Goliath with a decidedly unfriendly attitude to anyone ripping off his group. At concerts he stations a crew of roadies with binoculars and walkie-talkies around the stage. 'Uher in row 6, seat 5; Nagra in row 23, seat 4,' transmits Roadie One. 'So sorry,' say Roadies Two and Three as they descend on the requisite rows and 'accidentally' demolish the machines. And should any pirate recording slip through to the shops, their owners can expect a most unsubtle twenty-stone visit. ■



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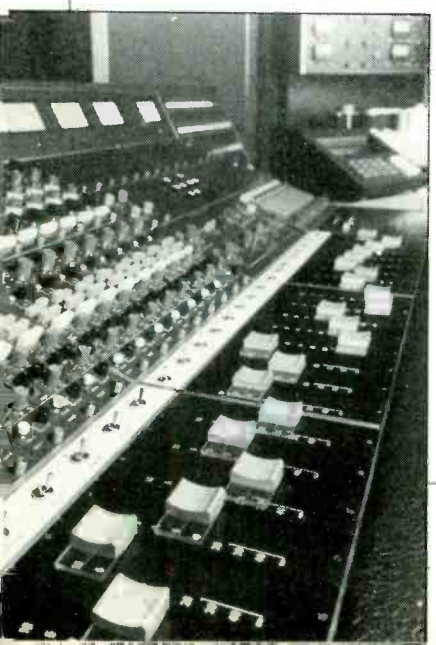
Automated mixing

Richard Dean

In past issues, representatives of companies manufacturing automated mixing equipment have written about the philosophy behind their company's systems. Paul Buff of Allison Research (Oct 75 p82), Derek Tilsley of Rupert Neve (Oct 75 p88) and Robin Bransbury of Cadac (March 77 p32), and Michael Thorne examined the Necam system in a News item (May 76 p14).

Here, Richard Dean takes a detached view of the subject and outlines systems currently available.



Above: Harrison's Auto Set control unit and microprocessor

Left: Neve Necam 'instinctive update' metal fader knobs.

IT'S fair to say that the automated mixing concept is no longer considered to be the eccentric notion of a technocratic minority. That isn't to say the concept has been endorsed by the professional recording industry, doubt and confusion are still abundant even amongst those in the so-called studio big league. Rational objections to the automation argument fall loosely into one of four categories:

1) Don't Believe In It—thou shalt not stand between holy recording engineer and machinery. Don't trust a machine to operate a machine, even if it's only mimicking something the engineer did in the first place.

2) Can't Afford It—everybody understands this one, but would a system attract more custom at a higher rate?

3) Don't Want To Invest In a Non-Preferred System—this is quadraphonic talk. Fortunately compatibility isn't such a criterion or automation would go the same way but forces of competition are particularly creative at the development stage, and some of the studio big boys have put their money where their mixers are.

4) Badly Stung By Shortcomings Of Early Systems—this is only a temporary excuse, although excruciatingly painful at the time. Sooner or later you'll return to the improvement of what you sought in the first place.

That then is a rule of thumbnail sketch of what an American writer might be tempted to call Antagonists Avenue. But whatever the jargon, one inhibiting factor links pundits in both camps—the technology employed in automation systems is borrowed from the specialised world of computer engineering and so represents a completely new subject to us lesser sound engineers. This is a very disorientating experience after a lifetime of accumulating knowledge in a particular field, to then suddenly realise your encyclopaedic head, after many years of careful use, has developed a bald patch.

Automation owes much to the film industry for the essential intellectual leap of controlling one signal with another. Since the introduction of sound to films in the 1926 Al Jolson short *April Showers*, synchronisation of sound to vision (initially mechanical) became necessary. It was only a question of time before the control of the primary medium (the picture) over the secondary medium (the sound) was considered. In 1939 RCA developed an analogical system incorporating thermionic voltage controlled amplifiers. The stereo cartoon epic *Fantasia*

used a control track to pan and attenuate a selection of soundtracks. But it wasn't until the 1960's, long after signal-responding noise gates had replaced programmed methods of soundtrack control, that significant development was possible with the arrival of the transistor, and expansion of digital computer technology. Subsequent progress in integrated circuits and, more recently microprocessors, has made adaption to recording requirements feasible in terms of space and cost.

Even now, some people are uncertain about automation system applications. At the risk of boring you, but dispelling myths and confusion, I shall summarise the automation concept. The most active elements in a mixing session are faders and mute buttons and the automation system is an aid to mixing that remembers fader and mute positions, whatever the engineer might do to them, throughout the mix. When the engineer plays the remembered mix back, the automation system is capable of manipulating the desk controls just as he did. This would be pretty useless but for the fact that the engineer has the option of updating his previous attempt, these modifications also being remembered. The updating procedure is repeated until the closest approach to the desired sound is achieved—a progressive technique synonymous with Calculus in mathematics. A point worth stressing is that a correctly functioning system never makes a creative decision. So much for the role of automation. Now some investigation into the methods employed to achieve this and their respective advantages and disadvantages.

Principles of operation

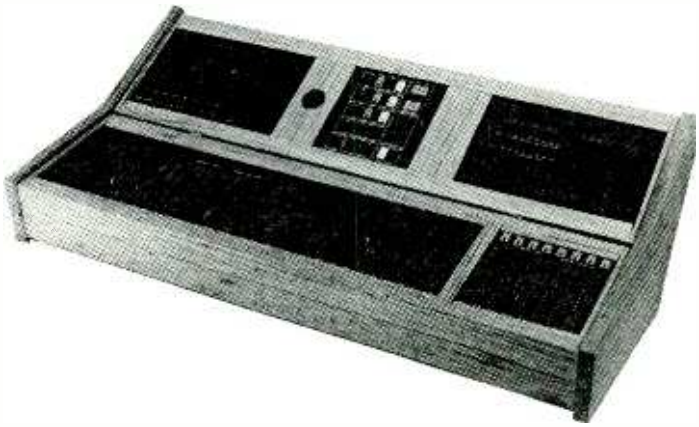
It is obvious that the automation system must be able to tell where faders are positioned at any time during the mix. All systems use linear tracks on the faders for this purpose, to provide a DC voltage proportional to fader position. Before this information can be processed, it is necessary to convert the analogical DC voltage to a digital word using an analogue to digital converter (ADC). This is a device that produces a group of binary pulses or 'bits' corresponding to the instantaneous level of the incoming voltage. The fader position bits are scanned sequentially by a microprocessor—the brain of the system—and so that it knows which is which, each fader is assigned a digital 'address' which prefixes fader position bits. Mutes are addressed similarly. (When a mute is selected, the fader concerned continues to be scanned and the level stored to preserve unmute facility). This initial stage, the scanning and collation of data, is obviously quite crucial, but for the moment, let's stay chronological and look at the way data is stored.

Fader position and mute data are assembled in serial digital form and must somehow be stored. This is achieved in systems currently available by one of two methods. One is to use tracks on the multitrack tape but a minimum of two tracks are required to permit updating by track bouncing. The other method is to use a disc store (a common item of computer hardware) linked to the tape machine with a timecode occupying one track of the multitrack tape. A disc store consists of a flexible (computer vernacular floppy) disc not unlike a 45 rpm record but coated with magnetic oxide. In use, the disc is revolved at high speed and data read or recorded by a magnetic head floating on the air cushion produced by the disc's revolution. Because of the high recording level used, no contact is required between recording head and disc and the store can tolerate a certain amount of environmental pollution (dust) before losing data bits.

The former method, employing tracks of the multitrack tape, offers less operational facilities than a disc, but is cheaper and synchronisation with audio tracks is inherent. For this reason, however, a cumulative update delay is also inherent in the system, caused by analogue to digital conversions, which can be compensated against in disc stores because data is detached from audio tracks. Update delay may or may not be considered a problem. As an example, the MCI system suffers a delay of 1.2 ms per update pass but taking the average human reaction time between hearing a sound and grabbing a fader to be 200ms, 160 update passes could be made before delay approached that figure. Data has to be recorded below saturation level to obviate crosstalk with audio tracks, and this effective reduction in data/noise ratio increases the error rate, relative to discs. One way of reducing the error rate would be to feed in less data per unit time so that signal lost by dropouts would represent only a tiny fraction of a digital word and hence make little or no difference. Taken to extreme this would result in a data rate too slow to keep pace with fader movements. The recording velocity of the tape medium is quite a lot less than that of a disc, which makes for a reduced data rate. Some wonder how the tape method manages to work at all and the answer lies in the acceptance of a certain error rate.

Just as with audio equipment where more is paid for less as you go up the quality scale, so it is with the reduction of error in a memory. A small reduction in error costs a lot in reduced data rate. It follows that by accepting a certain error rate, data rate can be increased substantially. The only problem is how to prevent error data causing havoc by corrupting your original mix commands. An example would be the mute command you had made during the mix, on (say) channel 16, being misread and coming up on channel 15. Let's say channel 16 was a talk-to-tape or other spare mic, whilst channel 15 was lead guitar or vocal. Suddenly this would vanish as though accidentally erased. Very irritating, to put it mildly!

The technique employed on both tape and disc memory systems to prevent corrupt data getting through is called parity checking. This involves adding check bits to the address and information digital words. A parity device counts data bits going into the memory. If the count is odd, '1' will be added to make the total an even number. If the count is even,



Allison Memory Plus console. Faders operate on a unique endless belt principle. A row of LEDS beneath each belt displaying level. Sloped master controls and the equaliser (right).

'0' will appear on the check bit, because the count is already even. Any digital word whose total of '1's is odd will be ignored. This is effective in removing errors, but does result in a certain roughness of control depending on the amount of data being ignored. You can see that a compromise has to be reached between dependant variables in the computer technology sphere, just as in the audio world.

Working with recorded data

The automation system now knows the pattern of the mix on faders and mutes, indexed to time. The problem now is how to communicate this back to the desk and this aspect probably promotes more discussion amongst engineers than equally important considerations of scan rate, memory capacity, error rate and such like. An important discussion point is whether or not control actions should be displayed in addition to being implied by the sound. But first, let's look at the modus operandi.

Data read from memory is sequentially scanned across fader and mute functions in much the same way as during 'read' mode, but in reverse. Mute data is assigned back to

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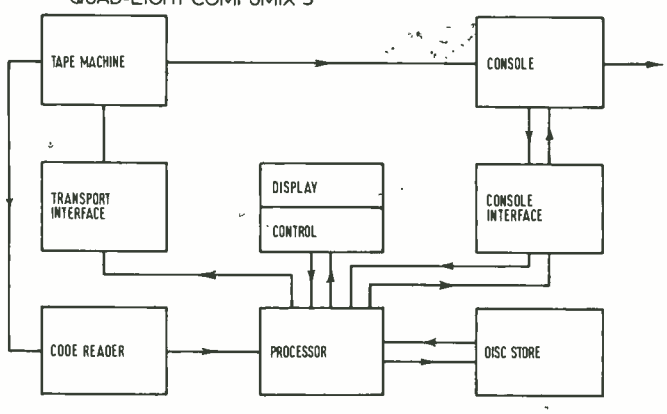
originating channels and converted to one of two states, off or on. Fader information is distributed in a similar fashion, but the methods used to put it into practice vary between systems. Most use voltage controlled amplifiers fed from digital to analogue converters (DAC). Cadac uses its V-CAT voltage controlled attenuators, a variation on this theme. Neve, however, uses motorised faders and are unique in this respect. It is argued that VCA distortion is still too high and Neve prefers to use familiar conductive plastic faders for level control. Here, the memory data is once again converted to analogue, but then compared with the voltage on the linear track, mounted beside the log audio track in the fader module. A comparator device selects motor drive in the appropriate direction until the two voltages are the same.

Allison on the other hand, employs a continuous belt fader (the so-called *Fabulous Fader*) in its *Memory Plus* VCA system. Beneath the transparent belt is a line of LED displays which graphically indicate fader position, or more precisely, the VCA voltage for that channel. In this way, the problem of a fader being in a physical position not corresponding to automation replay level is neatly sidestepped, while graphic representation of fader position is retained. Whilst VCA orientated systems require only a linear track in the fader,

FIG.1 NEVE NECAM, CADAC C.A.R.E., SOLID STATE LOGIC, QUAD-EIGHT COMPUMIX 3

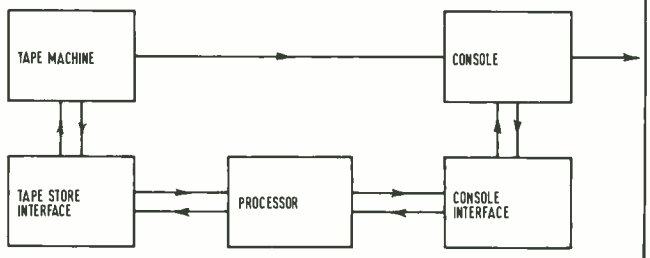


it is noteworthy that Cadac provide a standard audio track in addition for use in the event of automation system failure. **Figs. 1 to 3** show schematics of the three basic automation techniques.

Updating

This is the operational crux (if there is such a thing) of the matter since for the first time man and machine are working together, side by side, towards a common goal and all the rest. It's clear that instructions by the engineer to the automation system to switch out of replay mode and into update must be kept to a minimum. Otherwise, by the time all the buttons have been punched up, and switches thrown, the correct moment of adjustment will have passed. One of Neve's objectives in developing the electromechanical fader for *Necam* was to facilitate what they call 'instinctive update'. Each channel fader is equipped with a metal actuating knob connected to a proximity detecting circuit (an oscillator disturbed by human capacitance). Merely touching the knob in the normal way is enough to switch a channel from replay to update mode and in this mode fader characteristics are normal (as calibrated) not relative to any stored data. Releasing contact, parks the fader until the next change in the data from which the new update is being made occurs on that channel. In the early stages Neve found this meant that faders would jump to meet the initial setting of the next move. Now they have incorporated

FIG. 2 HARRISON AUTO-SET, MC1, SPHERE ELECTRONICS SOUND WORKSHOP, AUTOMATED PROCESSES, HELIOS



a 'relative' mode switchable individually on each channel, where the faders will respond to the next move *from* their parked position in perspective with (or indeed, relative to) the data movement.

Allison build similar 'instinctive' characteristics into their *Memory Plus* system. Here, movement of a *Fabulous Fader* is detected. It is then quantified, added or subtracted from the data level, put into the memory, and displayed graphically on the LED array beneath the fader. A point to bear in mind about the faders is that the engineer is required to look down to ascertain fader level, a measurement he frequently makes by feel, with head in natural erect position.

Thus both Neve and Allison have developed ingenious methods of satisfying permanent display of control position and instinctive update requirements—the 'automatic pilot' approach. Other systems, however, do not take control of faders directly in this way. How then, do fader positions relate to data during update, and how is fader position indicated?

The answer to the first point is encompassed in the key phrase 'update nulling'. The process of updating is very similar to 'dropping in' whilst recording sound. A drop-in section must be lined up to the level of the sound preceding it, if step change in level is to be avoided. So before an update change can be effected, it is necessary to match with the existing level of data at that point. This is called update nulling. Harrison and Sphere use null lights, whilst Cadac's *C.A.R.E.* system has the provision of centre zero meters in each fader module. Fader position matches data level when the meter reads a central 'within 2dB' expanded area on the scale. To update, levels are matched, update mode selected and an update made, levels matched again, and the replay mode resumed. (Mode selection by buttons on the fader module). In this system fader characteristics are normal during update mode. Most of the remaining systems however, convert faders to data trim controls during update. A fixed null point is marked around the middle of the fader scale, representing no change to data level (no update). Manipulation of faders

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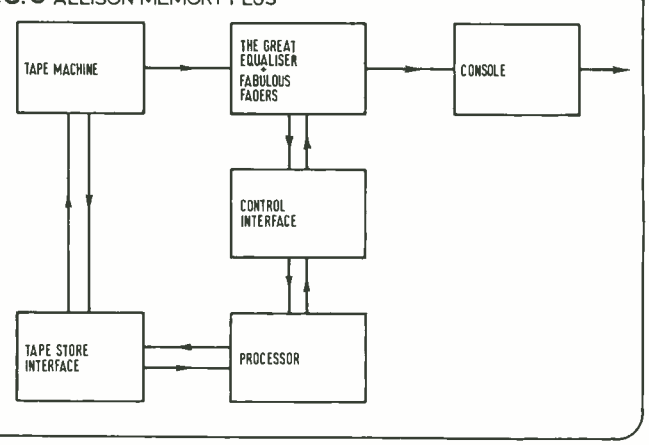
FIG. 3 ALLISON MEMORY PLUS



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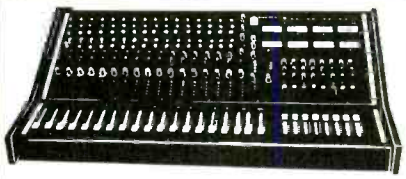

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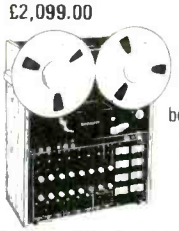

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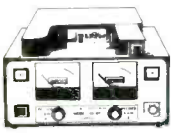

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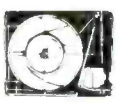

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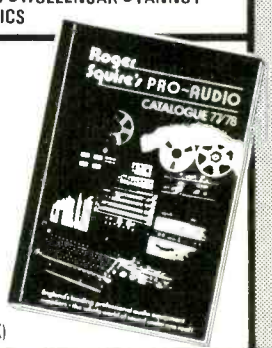

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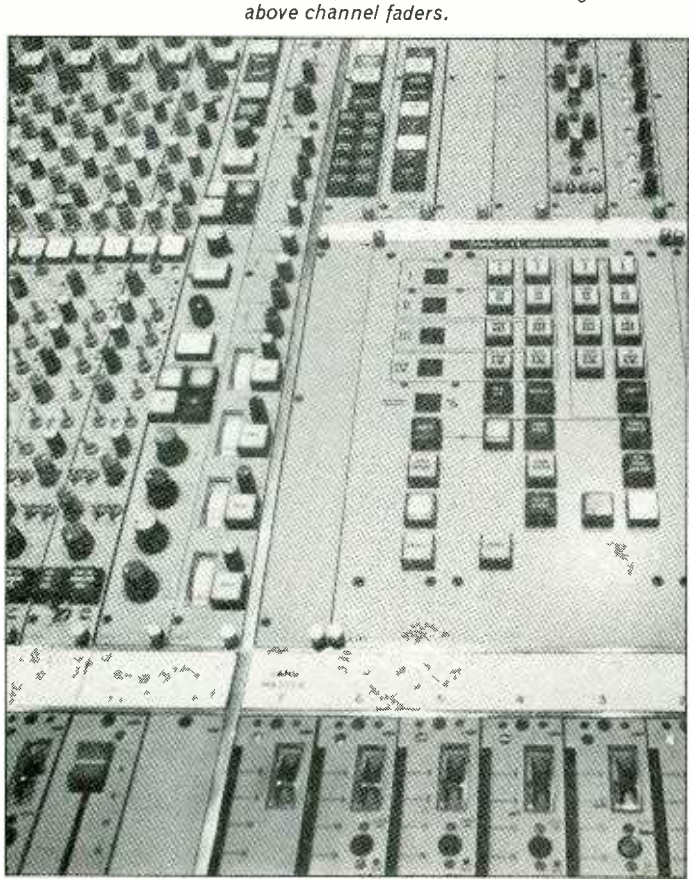
above or below this line increases or decreases the previous mix attempt data level for that channel. Examples are Quad-Eight *Compumix 3* and Solid State Logic, although the latter may be switched to 'absolute' in which case previous data is ignored and the absolute fader level entered. MCI have refined this technique by floating the null point—rather than defining a fixed null point on the fader calibration, they have designed the system to interpret initial fader position at (update commencement) as the null point. The fader retains attenuation characteristics as marked so by positioning a fader in the lower or upper regions of the scale, the engineer selects coarse or fine trimming of data level respectively. When leaving update mode, the MCI microprocessor inhibits mode shift until the fader is returned to its null position thus ensuring level matching with existing data. Mode shift is completed automatically, but this level matching feature can be disabled should deliberate step change in level be required.

Fader position display

Whilst Neve's *Necam*, Cadac's *C.A.R.E.* and Allison's *Memory Plus* systems inherently show actual fader position, remaining systems do not and separate provision must be made for this information to be communicated back to the engineer. Or must it? Not all of the other manufacturers seem to think so. MCI supply a device to enable fader positions to be displayed on their desk's bar graph channel meters (as an optional extra) but simultaneous view of channel level and fader position clearly isn't possible. Solid State Logic build a visual display unit into the control section of their system and this can be used to graphically indicate fader positions. But again, the unit is not dedicated to displaying fader positions. A VDU could be connected to any automation system with a little interfacing, to indicate fader positions, as do Quad Eight (in colour!) on their *Compumix 3* system, and Harrison on their *Auto-Set*.

Cadac C.A.R.E. master control, in-console. Note nulling meters above channel faders.



Memory capacity and facilities

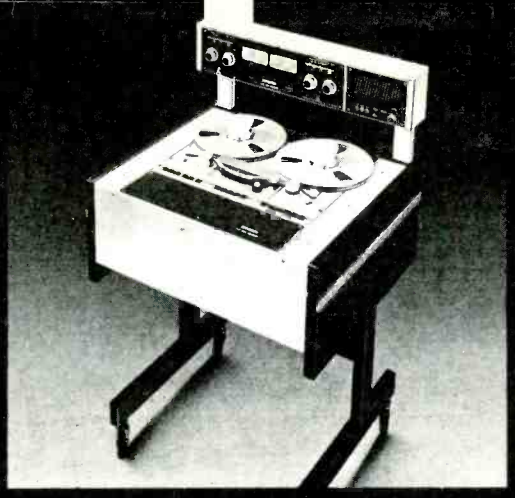
Greatest capacity is afforded by use of a disc store memory, but a disc system is more expensive than a multitrack tape based system. New horizons are opened up however in the area of total system integration. Tape machines can be controlled, in accordance with engineer's instructions, to find particular mix passages on tape. Successive mix attempts can be selectively 'merged' or individual channel data between mixes blended to create a hybrid optimum mix. The addition of interface hardware makes possible the storage and processing of session timetables, accounts and such like. Quite a flexible system without a doubt. The questions prospective studios have to consider are whether they really need all the facilities, whether they could afford it, but most of all, whether they feel they could work better with such a system. The last point goes for any new system and, perhaps strangely, is easily overlooked. Systems of the disc store type are manufactured by Neve, Cadac, Quad-Eight and Solid State Logic. An interesting feature of the Solid State Logic system is the labelling of mix attempts in words. For instance the second guitar break can be labelled as such rather than, say label 27? Abbreviated instructions are also tolerated, *She Loves You* would be entered as 'S'. If *Say a Little Prayer* was also on tape 'SH' would identify the former piece whilst 'SA' would identify the latter. But automation dialogue is a very subjective area; no doubt some engineers would prefer 'label 27'! Quoting respective memory capacities of each system seems rather pointless as each provide ample capacity. Should capacity prove inadequate, continuation discs are cheap and easy to load.

Automation aids

So far we've looked only at real time automation. But there is a half-way stage between this and unassisted mixing—static mix storage. Systems of this nature simply store values of fader position and mute status at the instant a store button is keyed by the engineer. The facility is thus analogous to the engineer writing a series of settings down on a piece of paper. The difference, apart from convenience, is that when recalled, settings are re-created on the desk; particularly useful for setting up mixes in live situations, but equally handy in the studio as many mix configurations can be entered and recalled sequentially during mixdown. Two systems of this type are available, both storing mix data on cassettes, although quite different in their approach.

Harrison includes the facility in its *Auto Set* package. The other system is manufactured by Enertec Schlumberger and called an *Assisted Pre-Mixer*. The Harrison system stores 630 of what they call 'Snapshot Mixes' on 63 alpha numerically labelled files. Mixes would normally be recalled in the sequence they were originally stored, but can be re-arranged to cope with contingencies in a live situation. When storing mixes, it's not necessary to enter intermediate conditions between two extreme mix settings, as you may expect, because provision is made to smoothly fade from one setting to another. This can be done manually on a cross-fader or automatically, cross-fade times of between 0.1 and 9.9 seconds being available. Command data is keyboard entered and displayed on a visual display unit, both installed in a free-standing control console resembling a small computer terminal. In fact, the total system including data cassette store is enclosed in this package. Only cross-fader (which is console mounted) and power supply are separate.

Enertec Schlumberger's *Assisted Pre-Mixer* (*Premelangeur Assiste* or (*PMA 124*) is a smaller system with a significant shift in design philosophy. As such, it is probably better suited to service in a live situation, although doubtless could be of some assistance in recording. Rather than being used to control channel fader functions on the main mixing console, *PMA 124* operates around its own 12/4 VCA mixer connected to four inputs of the main mixing console, hence the term 'pre-mixer'. 24 channel input access is provided by switches selecting inputs A or B on each of the 12 inputs. Up to 15 mix conditions can be stored on the eight data blocks recorded on each cassette. The system comprises free-standing control console, alpha numeric CRT display, electronics card unit and 50 ▶



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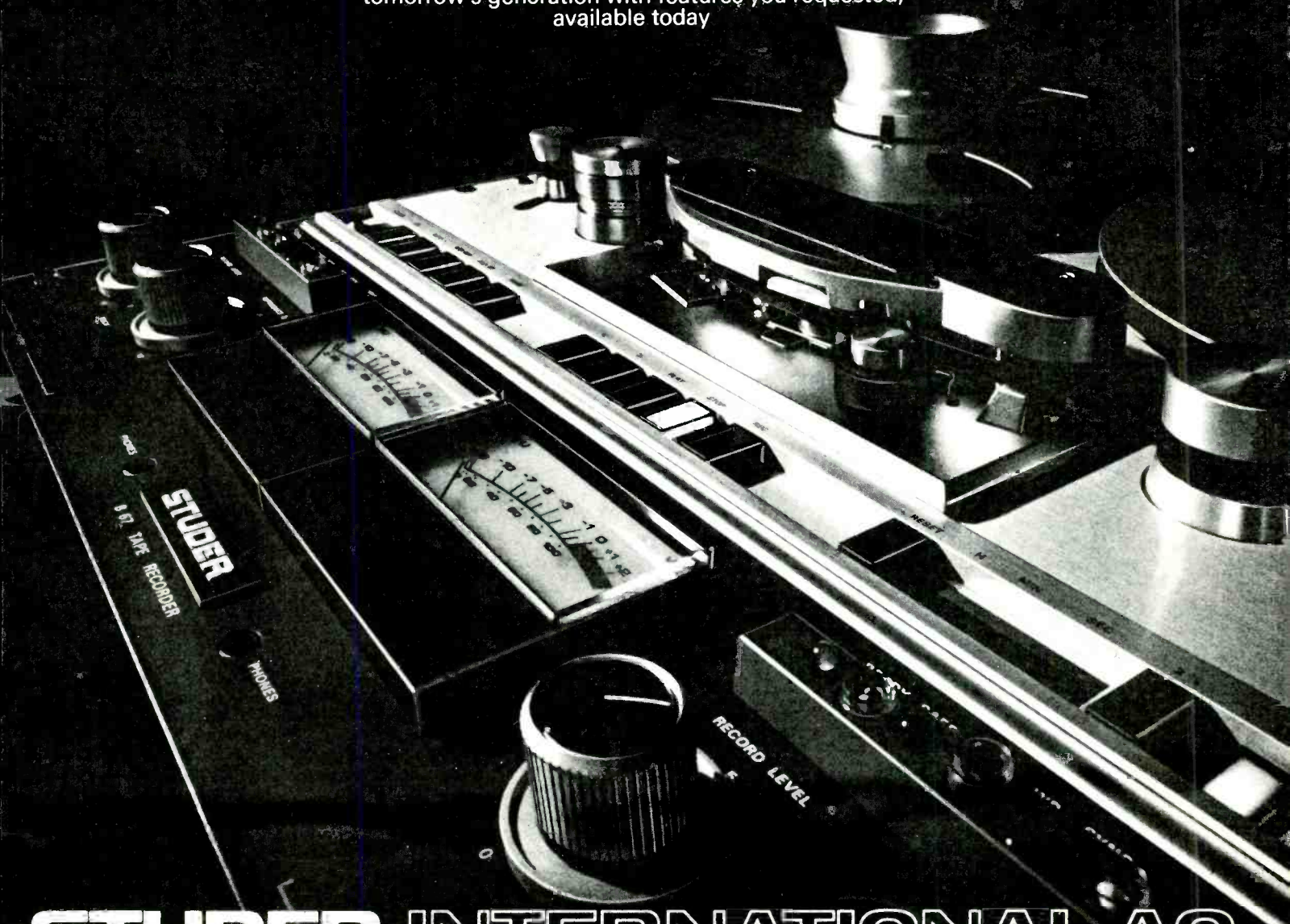

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AUTOMATED MIXING

data cassette recorder. Stored parameters are A or B input fader position (graphic), group (one to four), input level (adjustable in 6dB steps), and highpass filter in/out on each input. The term 'fader position' is perhaps misleading because in fact there aren't any. All channel functions, fader position included, are selected by manipulation of advance/retard buttons on a single control channel, switchable to any of the 12 inputs. Here the CRT display is essential to see what is being done to each channel, there being no other indication, apart, of course, from the sound.

Automated EQ?

Back to real time automation systems. The question is are we content with automating level and mute only, or do we need to start automating other parameters like EQ? Allison seems to think so, since the *Memory Plus* system is unique in this respect. A single EQ control channel is provided, assignable to any channel, made up of a series of advance/retard buttons rather like the *PMA 124* keyboard discussed above. A *LED* display is switchable to indicate EQ status of any channel.

If automated EQ does catch on, the central entering technique employed in *Memory Plus* and *PMA 124* is the one most likely to be used, because of the prohibitive cost and/or impracticability of methods using conventional controls. The two considerations are: do we use EQ actively (during a mix) enough to justify total EQ automation and are we ready to manipulate EQ on advance/retard keyboards that first require channel assignment?

What of the future?

Automation has taken a long time coming, mainly due to difficulties of data manipulation and storage. Now the stage has been reached where systems are able to fulfil principal requirements with reliability. The 'toy' phase has thankfully passed.

Systems employing multitrack tape memories are surely destined to gain widest acceptance in the future on a cost basis alone. Allison, pioneers in systems of this type, are probably better known for the Allison *65k* programmer than for the *Memory Plus* control interface (which also uses a *65k* programmer). The company has scored by providing in the *65k* a compact, rack mounted programmer capable of handling up to 48 channels, 15 groups and master output up to 65,000 bit capacity. Broadly, the high bit capacity is achieved by giving changing levels priority over static levels during fader scanning. The unit interfaces with any automation-ready VCA console. Those studios not restricted financially can choose between disc store systems offering tape control, mix merging and greatest mix option access, as discussed, should they consider such facilities advantageous.

Ultimately, mixing consoles may be reduced to a small panel of channel assignable advance/retard switches, desk status being displayed exclusively by CRT monitor screens—a disc store and microprocessor would stand neatly to one side. All this would require a major change in engineer reflex to sound. Here tradition is arguably standing in the way of the automation designer's most logical ideas on the subject. (See also Stephen Brown of Digital Timing Systems, excellent article *An Alternative Approach to Sound Mixing*, Dec 74 p46).

Automation should assist the engineer by handling the routines so that he is free to concentrate on making creative decisions resulting in the best possible sound product. If it doesn't do that, but rather gets in the way, you're better off with an expanded staff of tape ops. After all, they usually remember what to do, and also make a good pot of tea, fetch food, papers, taxis . . . facilities that, so far, no automation system can provide! ■

The Soundcraft Series 3 console is ideal for 16- or 24-track recording studios demanding technical sophistication at a reasonable cost.
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THD	+4dBv line input to any line output at +4dBv, 20Hz < 0.03%, 1kHz < 0.01%, 20kHz < 0.05% Signal at mic input with 50dB gain (200Ω at source), 20Hz < 0.1%, 1kHz < 0.01%, 20kHz < 0.1%
Frequency response	+4dBv line input to any line output at +4dBv, 20Hz to 20kHz: −1dB Signal at mic input with 50dB gain (200Ω at source), 20Hz to 20kHz: −1dB
Noise	Relative input noise voltage, 20kHz Bandwidth, now −128.5dBv true RMS (200Ω source). Mixing noise, 24 channels routed to mix all at unity gain,< −80dBv (DIN audio weighted)
Input gain	Maximum mic, 85dB Maximum line, 70dB
Output capability	+22dBv into 600Ω (0dBv = 775mV RMS)

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Prices (correct at time of going to press) 24/16 £10,712 $27,426 (FOB New York), 32/16 £13,350 $33,986 (FOB New York). All other territories on request.

APRS Exhibition 1978, a report

Our July issue carried an extremely comprehensive preview of the Exhibition held by the Association of Professional Recording Studios and Christopher Griffin-Beale, gives us his report.

VISITING an exhibition is a bit like browsing in an encyclopaedia. One cannot absorb everything, so everyone makes their own selection, pursuing their own interests but subject to welcome distractions by whatever catches their eye or ear. Something ought to catch one's ear at APRS but, by comparison with other exhibitions, little did. Sound was so very important, presumably, that if everyone had tried to attract us with their wares audibly, the resulting Babel would have done nobody any good—to hear anything, one usually had to don headphones.

My major interest is in broadcasting and, despite APRS's title, I was surprised how prominently broadcasting-oriented-equipment (cart machines, broadcast mixers and monitors) featured in the exhibition. Compared with the showmanship of an American exhibition, most exhibitors maintained an extremely dignified (not to say low) profile, relying on the look of the equipment or one's prior interest. The few gimmicky exceptions such as the apparently traditional hot-panted Eardley girls, or Jacksons Recording Studios' school classroom ("Six whacks if you don't take a leaflet, signed Matron", and Malcolm Jackson himself berobed), seemed out of place and oddly less effective than if they had had more competition. Less eye-catching, but more appropriate, was Dolby's give-away notice for one's door or office wall: "SILENCE—courtesy of Dolby Laboratories" now with self adhesive back.

The displays that did seem to catch a lot of casual attention, perhaps because of the accompanying clunks and clanks, were the various cassette-loading machines. Few APRS visitors could have had immediate motive for checking them out and yet many were caught by the display of high-speed mechanics as the machines wound the required length of tape into a cassette, spliced on leader and expelled the complete blank cassette.

Otherwise, I was not looking for any breathtaking innovations, perhaps wisely, since the general consensus maintained that there was less innovation than at recent annual APRS bashes at the Connaught Rooms. Apart from digital delay lines, there was not a lot of digital recording equipment on display yet for reasons clearly outlined by STUDIO SOUND's former editor, Ray Carter, in his valedictory piece in the July 1978 issue.

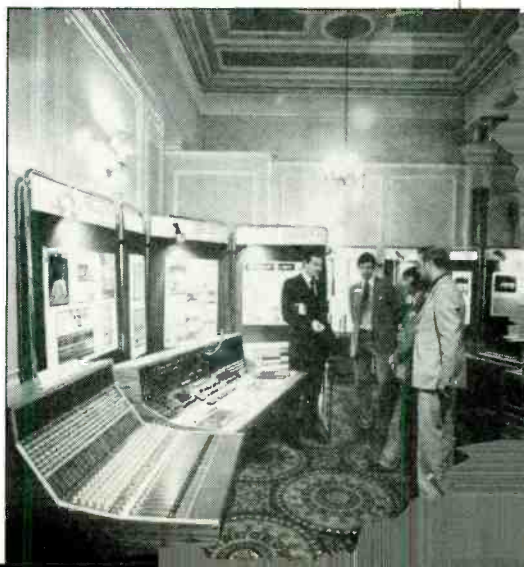
In any case, I suppose the claims of innovation can be overstated. In a special press release for APRS, Dolby Laboratories' international sales manager, Elmar Stetter, was at pains to explain why Dolby was not supplying a list of this year's products, but why, on the contrary, Dolby had just had the best year yet for sales of its ten-year-old Dolby A system. Dolby's noise reduction, he argued, is the sort of 'standard' equipment which a studio doesn't want to change unless there is a very good reason. It is part of the signal storage function, a part of the studio which the producer and the recording engineer should be able to forget. It is the creative side, the signal processing, that attracts more attention and constantly improved black boxes.

Perhaps the most intriguing innovation, new since last year's

Left: *Paul Ford examining the Harrison mixer on Scenic Sounds stand.*

Centre: *Soundcraft Series 1S PA mixer.*

Right: *Audix stand with ITN desk left and BBC Radio desk centre.*



APRS, although it has been seen earlier this year at NAB in Las Vegas, is the Calrec *Soundfield* microphone which adapts technology developed for quad. A single microphone in a fixed position picks up four constituent signals, left minus right, front minus back and up minus down from which a mono, stereo or quad output can be synthesised. If the four constituent signals are recorded on multi-track, in B format, the output can be mixed down and synthesised later. The first production model of the microphone was on the stand and since then, it has been used by BBC radio in recording Genesis at Knebworth, and there is also talk of it being used for this year's Proms at the Royal Albert Hall.

Looking around elsewhere in the exhibition, one could be easily impressed by some of the larger new mixing consoles like Solid State Logic's *SL 4000* automated console and computer mix which was being demonstrated for the first time in the UK. The console's unique Supercue logic automatically provides artistes with correct foldback sources, even during complex drop-ins. And the computer mix recognises, for the first time SSL claims, simple commands in English and the titles of songs or mixes without restriction. Moreover, a 24-line visual display gives a list of tracks and titles, which can also be printed out on a high-speed printer. But it was around this, and similar points in other exhibits, that I was tempted to wonder whether there wasn't an element of technological overkill in some of the facilities. How absolutely necessary is it to have such a computerised list, simply of tracks and titles? (if one was dealing with smaller discrete units, as in video tape, the argument is different). Obviously some studios feel it is necessary because they have ordered it. Perhaps some consoles will eventually dispense coffee too, or something stronger.

But the equipment's technology is impressive enough and certainly one can appreciate the role a computer can play at least in the mixdown process, as exemplified by Neve's *Necam* system (not on display this year, the Neve stand being dominated by smaller, newer consoles). Other automated systems included Cadac's *C.A.R.E.* In-line consoles using floppy disc memories, and Lyrec's new microprocessor-based *Tape Position Controller* which enables searching to three different preset tape positions and recycling between two positions. The *TPC* can also store 16 different tape positions which can be recalled and searched. The controller was exhibited in conjunction with Lyrec's *Model TR532* 24-track recorder, but the *TPC* and remote control unit can be linked to all Lyrec recorders.

The Lyrec multitrack recorder had one reassuring feature for those overwhelmed by computerisation and who wanted the chance for some hands-on control over the tape, by-passing automation—it offers a spot erase facility uncommon in such complex multi-track machines: a removable plate allows one to get at the heads, mark the tape and roll the tape past the heads, with appropriate tracks in record mode, to erase a moment of tape.

A similar instance of reassuring simplicity was offered by Feldon Audio who beside effects equipment boasted single-edged razor blades now available in packs of one hundred—hardly an innovation, but resulting from Adrian Hope's recent Business revelation. Among the many mixers partially or primarily intended for broadcasting, Audix were showing one of a number of consoles ordered by the BBC and specially designed to meet BBC radio studio requirements, while Alice (Stancoil Ltd) showed the Alice Custom Modular (*ACM*) System, which has evolved from the embryo 4-group format demonstrated at APRS 1977 into a comprehensive system ranging from high-quality TV (and CCTV) mono mixers through broadcast quality stereo mobile recording and studio production mixers to 8, 16 and 24-track recording studio consoles. This new system supersedes the original Alice modular system familiar to habitues of many ILR stations (at about two-thirds of the cost) and was shown alongside Alice's new *828* portable stereo mixer.

A number of manufacturers and importers displayed broadcast cart machines and indeed APRS seems a very congenial setting for such specialised workhorses of broadcast audio. Broadcast Audio Equipment, British distributors of Spotmaster cart machines since 1975, were exhibiting at APRS for the first time and found great interest not only in the cart machines themselves, which Broadcast Audio's engineers extensively modify to British requirements (together with a new British-built transformer), but also in the various kinds of cart rack for which this Manx-based firm appears to be one of the few suppliers. BASF again demonstrated the *Unisette* professional 6.25mm tape cassette system.

But one area of growth for broadcast audio, and one in which complexity will soon rival that of the multi-track recording studio systems, is that of television post-production dubbing. As the ease and flexibility of video tape editing has increased, demand has grown for more flexibility in the separate dubbing of sound—certainly more than was traditionally possible by lifting off sound onto a trolley-mounted 6.25mm machine and playing it back through a simple fader system. There was the call, particularly in the US, for audio sweetening, particularly by 'canning' or at least augmenting laughter on audience shows, and the desire for more complex post-syncing of dialogue—a recent example was noticeable in the Elizabethan London street scenes of ATV's Shakespeare series, videotaped outdoors.

What one needs essentially for complex dubbing is a system locking audio recorders to videotape—the video will normally have been edited first and copied to some non-broadcast format, 12.5mm when the BBC installed the pioneering *Sypher* suite at Television Centre some years back, but now more likely to be *U-matic* video cassette. At APRS, FWO Bauch exhibited a Studer controller, intended basically only to lock two Studer machines together with a VTR, via SMPTE digital timecode. Ampex has a synchroniser, the *MQS 100* made by EECO, which was demonstrated at APRS linking together an Ampex *VPR-1* helical 25mm VTR (loaded with *The Muppet Show*) and an *ATR-100* audio recorder. The *MQS-100* can cue or synchronise one, two or three tapes—audio, video or magnetic film. Neve is promising a variant of its *Necam* system, *Necam D*, specifically for post-production video dubbing, though it is not ready yet.

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Left: *Trident TSM console.*

Centre: *Klark Teknik stand with DN70 digital time processor demonstration bay on right.*

Right: *Feldon Audio with Eventide DDL and EMS Vocoder.*

APRS EXHIBITION 1978, A REPORT

Lyrec's *Tape Position Controller* has a facility that is very important for post-production dubbing—the capacity to recycle between two positions to simulate the effect of the recurring film loops used in film dubbing to give actors ample opportunity to rehearse and repeat their speech to fit with the lip movement image, whether the actors are post syncing their own dialogue or dubbing a foreign film.

A Lyrec multi-track recorder is being installed in BBC Scotland's new video dubbing suite, but linked to the latest Maglink control system. This system, originally designed and built in the US, is now entirely British-made: substantial modifications include a completely new control panel. Maglink has already been used, in an earlier version, as the heart of a system which BBC Wales engineers rigged up in Cardiff. What makes Maglink unusual is that it uses its own code which, unlike the digital SMPTE code, is an audio signal at a very low frequency. Compatibility with SMPTE video tapes or other users is apparently little problem since Maglink supplies an SMPTE-Maglink converter. Many audio engineers may prefer an audio-based signal, but a more important argument is that the code can be recorded on any machine without modification, provided the audio or video recorder has a spare track. Moreover, the code can also be detected while the tape is in fast wind *without* the tape being in contact with the head (a special button alerts the Maglink system to hunt for an audio signal that will be higher than normal, given the high tape speed, and which must be detected across the gap between head and rewinding tape).

When dubbing is completed, the final track will normally be transferred onto the audio track of the master edited videotape. Incidentally, the new generation of broadcast-quality 25mm helical VTRs can actually offer *higher* specs for their audio tracks than most traditional quad VTRs. However, stereo simulcasts also require Maglink or a similar system to lock stereo recorder and VTR, and the edited sound may then remain on a separate audio tape for transmission.

A rather unusual clock combining digital time readout with analogue clock-face circle of LEDS enabling seconds to or from a time to be easily observed. Available in 12 or 24 hour versions, quartz, master/slave or Rugby MSF locked, and with countdown, countup and timer options. Manufacturer is Quadrant Electronics Ltd, 14 Hamilton Avenue, Pollock Shields, Glasgow. 041-427 2332.

With *Necam D* in the offing, interest in video post-production dubbing for TV will clearly continue to mount. But a further potential development in TV sound emerged at APRS with the Calrec Soundfield microphone. Just as it can from its four constituent signals synthesise a stereo pair or quad configuration, so it can synthesise a moving mono microphone. A fixed Calrec microphone could therefore simulate the effect of a boom mike with adjustment for tracking or changes of shot. And it could either do this in real time simultaneously with the video recording or the four components could be recorded (as already explained) independently in B-format on four-track recorder, and then adjusted in the post-production mix-down/dubbing session.

Of course, all this increased complexity in TV sound techniques, not to mention the advances in digital recording and transmission of audio signals, will be undermined unless there is a radical improvement in the standard of loudspeakers in TV sets. But that, as they say, is another story . . . ■

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Survey: monitor loudspeakers

Forthcoming surveys include broadcast and pa mixers (December) and multitrack consoles (January 1979). Manufacturers and agents are invited to submit product details for inclusion to reach the editorial office (address page 3) at least six weeks before the issue publication date (preferably a lot earlier).

ALTEC

Altec Lansing International Division of Altec Corporation, PO Box 4730, Anaheim, Ca 92803, USA.
Europe: Altec Lansing International Limited, 17 Park Place, Stevenage, Herts SG1 1DU, UK.
Phone: 0438 3241. Telex: 825495.
UK: Theatre Projects Sound Limited, 10 Long Acre, London WC2 9LN.
Phone: 01-240 5411.

604-8G chassis unit with dividing network.
Impedance: 8 ohm.
Max power input: 65W.
SPL: 100dB at 1.2m with 1W.
Frequency response: 20Hz to 20kHz uniform.
Crossover frequency: 1500Hz.
Diameter: 40.6cm.
Weight: 15.4kg.
Price: £220.

617-8A chassis unit with dividing network
Impedance: 8 ohm.
Max power input: 60W.
SPL: 98 dB at 1.2m with 1W.
Frequency response: 50Hz to 15kHz.
Crossover frequency: 1500Hz.
Diameter: 31.1cm.
Weight: 11.6kg.
Price: £97.

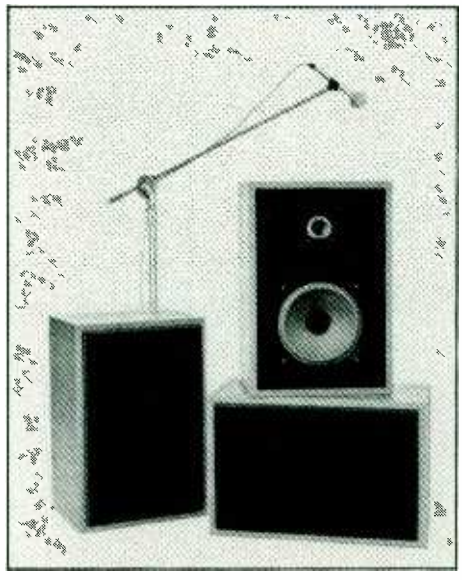
619-8A chassis unit with dividing network
Impedance: 8 ohm.
Max power input: 75W.
SPL: 100 dB at 1.2m with 1W.
Frequency response: 40 Hz to 15kHz.
Crossover frequency: 1500Hz.
Diameter: 40.6cm.
Weight: 12.8kg.
Price: £130.

9846-8A speaker system
Impedance: 8 ohm.
Max power input: 100W pink noise.
SPL: 93 dB at 1W at 1.2m.
Frequency response: 25Hz to 20kHz.
Crossover frequency: 500Hz.
Features: two-way system with 38cm bass speaker and a sectoral horn-loaded high frequency driver unit.
Dimension: 79cmx67cmx60cm.
Weight: 47.6kg.
Price: £495.

9866-8A speaker system with dual-range equaliser.
Impedance: 8 ohm.
Max power input: 65W pink noise.
SPL: (measured at 1.2m, 1W input). 99 dB with shelving controls set at optimum; 102dB with shelving controls fully clockwise.
Frequency response: 30Hz to 20kHz.
Crossover frequency: 1200Hz.
Features: two-way system with 38-cm bass speaker and radial phase plug compression driver, mounted to a sectoral horn.
Dimension: 76.2cmx99.6cmx53.3cm.
Weight: 64.9kg.
Price: £524.

9849-8D speaker system with crossover network
Impedance: 8 ohm.
Max power input: 60W pink noise.
SPL: 94 dB at 1W at 1.2m.
Frequency response: 40Hz to 15kHz.
Crossover frequency: 1500Hz.
Features: two-way system with 30-cm bass speaker and a sectoral horn-loaded high-frequency compression driver unit.
Dimension: 61cmx52cmx39cm.
Weight: 27.2kg.
Price: £330.

Little Red Monitors from Audiomarketing



AUDIOMARKETING

Audiomarketing Ltd, 652 Glenbrook Road, Stamford, Conn 06906, USA.
Phone: (203) 359-2312. Telex: 996519.
Europe: Trans European Music, Koeizijersraat 105, Dilbeek, Belgium 1710.

RED SERIES
These units make use of the *604-E2* loudspeaker, which is designed as a direct replacement for the *604E*. 'Completely redesigned' by Altec for Audiomarketing the *E2* is claimed to handle four times the power and produce 6dB more sound pressure with no change in total quality'. Also incorporated in the design is the Mastering Lab *604/5* frequency dividing network developed 'to correct the deficiencies of the *604E*'. The crossover provides two shelving controls that allow minor room tuning without resorting to graphic equalisation.
Super Red monitors are the largest in the series and comprise a *603E* loudspeaker, *604/5* frequency divider and a 38cm active subwoofer in a 28 litre infinite baffle enclosure. Dimensions: 76x121x45cm. Price: $1115.
Big Red monitors comprise the *604-E2* speaker and *604/5* crossover in a 14 litre tuned bass reflex enclosure. Dimensions: 76x58x45cm. Price: $815.
Little Red monitors are bookshelf versions of the *Big Red*. Price $220.
The *604/5* crossover costs *$215* and the *604-E2* loudspeaker $415.

AURATONE

Auratone Corporation, PO Box 698, Coronado, Ca 92118, USA.
Phone: (714) 297-2820.
UK: Scenic Sounds Equipment, 97-99 Dean Street, London WIV 5RA.
Phone: 01-734 2812. Telex: 27939.
Agents in most countries.

5C SUPER SOUND CUBE
Frequency response: 50Hz to 15kHz 'flat'; 200Hz to 12.5kHz, ±3.5dB.

58. ▶

Expanding the Boundaries of Creativity

New levels of musical imagination present themselves to the creative musician with the application of the MXR Digital Delay. The diverse effects offered by the Digital Delay, when used with individual instruments, vocals, PA and recording mixes, offer a whole new range of musical creativity.

The MXR Digital Delay gives the musician a tool for creative application that is unparalleled in versatility, precision and ease of operation. The MXR Digital Delay is designed for a wide variety of applications including; amplified musical instruments, vocals, PA and recording mixes. The basic unit delays a sound between 0.08 milliseconds and 320 milliseconds, fully variable while retaining the dynamic range of the program source. The delay range is expandable to 1280 milliseconds in increments of 320 milliseconds by means of up to three additional plug-in memory boards. These boards are available from MXR and may be installed by the user.

Effects that can be obtained with fixed time delays include echo, vocal doubling and hard reverberation. The MXR Digital Delay contains sweep circuitry which allows additional effects such as flanging, vibrato, pitch bending and frequency modulation. The MXR Digital Delay is also capable of repeat hold (infinite non deteriorating regeneration).

Rack mountable for sound studio installation, it is also available with an optional road case for onstage use or location recording mixes.

MXR's Digital Delay can lead the way to new possibilities in creative sound at a price considerably lower than any comparable delay.

For more information see your MXR dealer.
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Max power: 30W at 150Hz and up to 60W 'program material'.
Features: 'compact mixdown comparative monitor loudspeaker'.
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Phone: 0903 205611. Telex: 87342.
Agents in most countries.

DM6
Impedance: 8 ohm.
Frequency response: 50Hz to 20kHz ±3dB, 3 metres on axis.
Sensitivity: 95dB at 1m for 7.6W pink noise.
Max power input: 350W rms.
Features: both bass and midrange units are loaded into irregularly-shaped, totally-sealed enclosures. 'Lf contour', 'contour' and 'hf energy' controls. Crossover at 500Hz and 5kHz.
Phase response: ±15° 150Hz to 5kHz, ±30° 100Hz to 20kHz.
Dimensions: 93x41x38cm.
Weight: 36kg.
Price: £250.

DM7
Impedance: 8 ohm.
Frequency response: better than ± 2dB,70Hz to 20kHz on measuring axis (—3dB at 50Hz).
Sensitivity: 10V RMS for an SPL of 95dB at 1m.
Max power: up to 200W RMS rating.
Dimensions: 90x17x38cm.
Weight: 29kg.
Price: £200.

B & W DM7 loudspeaker

BEVERIDGE

Harold Beveridge Inc, 505 East Monte Street, PO Box 40256, Santa Barbara, Ca 93103, USA.
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2SW1 ELECTROSTATIC
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Phone: (201) 836-8741.
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MINIHOUSE
Frequency response: 20Hz to 16kHz, adjustable to ±2dB in a normal studio environment.
SPL: 116dB at 2m from 45W.
Max power: 45W rms, 80W 50% duty in 10s cycle, 120W transient power.
Distribution pattern: 90°h/40°v.
Drive units: 46cm lf, mf compression driver, plus four 10cm hf units.
Dimensions: 116x69x57cm.
Weight: 136kg.

POWERHOUSE
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SPL: 120dB at 2m from 80W.
Max power: 80W rms, 100W 50% duty in 10s cycle, 120W transient power.
Distribution pattern: 90°h/40°v.
Drive units: two 46cm lf, mf compression driver, plus four 10cm hf units.
Dimensions: 266x96x65cm.
Weight: 250kg.

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Frequency response: 25Hz to 20kHz ±3dB.
SPL: 105dB at 1m max output.
Max power: 100W.
Features: reflex resistive.
Dimensions: 76x34.3x38cm.
Weight: 30kg approx.
Price: £510 per pair.

MINI PROFESSIONAL SM
Impedance: 8 ohm.
Frequency response: 35Hz to 20kHz ±3dB.
SPL: 108dB at 1m max output.
Max power: 100W.
Dimensions: 54.5x28x30.5cm.
Weight: 15kg approx.
Price: £230 per pair.

PE1
Impedance: 8 ohm.
Frequency response: 30Hz to 30kHz.
SPL: 108dB at 1m.
Max programme input: 100W.

60 ▶

This tape has been Aurally Excited.

The ®Aphex Aural Exciter is an astonishing signal processing instrument, which brings sound to life and makes it louder without any actual level change.

This is the principle behind it.

Sound waves enter our ears with subtle phase information relating to the location of the sound source–left or right, up or down, front or back, direct or reflected. By using a sum and differencing technique, the brain provides us with our critical aural perception.

But collecting sound, mixing it and then recording it often destroys or masks much of the subtle information resulting in a "flatter sound" than the original.

However, the Aphex introduces phase information in the form of a series of minute delays, whose magnitude depend on frequency.

The formula by which Aphex selectively processes the audio signal is not random; it has been designed after considerable research into the mechanisms of the ear, in particular the reflections and minute time delays caused by its shape.

Aphex is best used on selected channels, normally in the remix stage of production, fed from the echo or foldback send. The output from Aphex is then mixed back into the main signal at about −15 to −30dB.

Aphex is already famous for what it does to vocals. But any instruments with natural sound (ie not electronically produced) like snare drums, cymbals, acoustic guitars, strings and brass sound amazing when Aphexed.

Call it what you will, this effect causes no changes in level, confirming that it is truly a psychological effect.

Because the Aphex principle is young, we expect to replace it continually with new and even more exciting versions, so you can't buy it; you must lease it.

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APHEX

APHEX AUDIO SYSTEMS UK LTD., 35 BRITTANIA ROW, LONDON N1 8QH. TELEPHONE 01-359 0955/6

SURVEY: MONITOR LOUDSPEAKERS

Features: reflex resistive, piezo-electric supertweeter.
Dimensions: 635x279x304mm.
Weight: approx 20kg.
Price: £330 per pair.

STUDIO REFERENCE MONITOR
Impedance: 8 ohm.
Frequency response: 25Hz-30kHz.
SPL: 112dB.
Max programme input: 200W.
Features: resistive reflex, four bass units, piezo-electric supertweeter.
Dimensions: 66x30.5x35cm.
Weight: 34kg approx.
Price: £787 per pair.

CHARTWELL
Chartwell ElectroAcoustics Limited, 2 Commonside, Mitcham, Surrey CR4 1HX, UK.
Phone: 01-648 4494/640 7426. Telex: 847777.

PM450
Available with or without a built-in (modified) Quad *405* amplifier, bass and treble units being fed from separate channels.
Impedance: 8 ohm/600 or 20k ohm into amplifier.
Frequency response: 45Hz to 20kHz, ±3dB.
SPL: 116dB at 1m.
Max power: 300W or —20dB for amplifier.
Dimensions: 76x46x41cm.
Weight: 32kg.

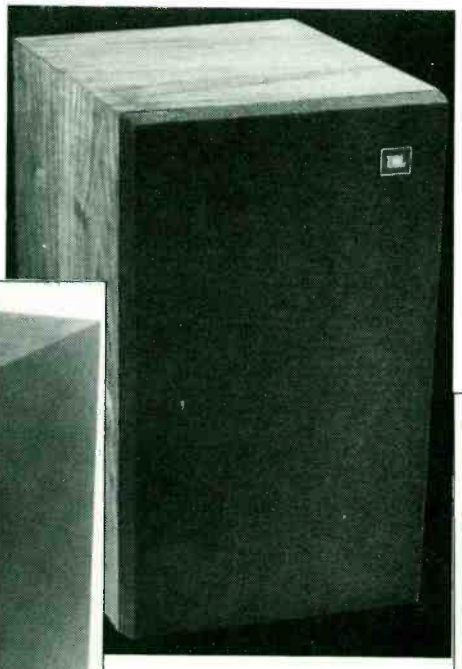
EASTLAKE
Eastlake Audio SA, 21 Avenue Nestle, 1820 Montreux, Switzerland.
Phone: (021) 621944. Telex: 25546.
Australia, Central and South America: Sierra Audio, 21 South Glenwood Place, Burbank, Ca 91506, USA.
Phone: (213) 843 8115.
France: 3M France, Boulevard Serrurier, 75019, Paris.
Phone: 031 6420.
Italy: Studer Italy, Audio Products Intl, Via Gaspare Spontini 3, 20131 Milan.
Phone: 273896/228120.
UK: Scenic Sounds Equipment, 97-99 Dean Street, London W1V 5RA.
Phone: 01-734 2812. Telex: 27939.

TM-3
Eastlake will only supply monitor systems to installations for which they have control over the mounting method. Each cabinet is powered by both channels of a Crown *DC300A* amp fed through a White Instruments *4001* 3-octave filter unit fitted with a 800Hz, 18dB/octave crossover network.
Derived from the Westlake *TM-1*, the present unit has been updated in Europe by Tom Hidley principally by the substitution of a JBL *2405* hf radiator for the original JBL *2420* hf radiator. The choice of Gauss *5831* or JBL *2231A* bass drivers, and Gauss *4000* or JBL *2440* mf drivers is often left up to the client.
The company are currently developing a smaller version of the *TM-3*, to be known as the *TM-7*. This will feature two 30cm bass drivers, in place of the two 38cm units used in the *TM-3*. The monitors are to be used in the Radio Clyde mobile (see July issue, page 38).

FRAZIER
Frazier Incorporated, PO Box 34216, 1930 Valley View Lane, Dallas, Texas 75234, USA.
Phone: (214) 241-3441.

F10W-37UA CAPSULE MONITOR
Impedance: 8 ohm.
Frequency response: 30Hz to 15kHz, ±5dB.
Sensitivity: 94dB at 1.2m from 1W.
Power handling: 30W continuous, 40W peak.
Dimensions: 74x48x41cm.
Weight: 45kg.

HARBETH
Harbeth Acoustics, 2A Nova Road, Croydon, Surrey CR0 2TL, UK.
Phone: 01-681 7676/657 1788.



▲ *New model 4301E from JBL features a built-in low power amplifier*

▼ *A Frazier monitor speaker*

▼ *Celef PE1*

STUDIO MONITOR MK II
Impedance: 8 ohm.
Frequency response: 50Hz to 25kHz, ±3dB.
SPL: 107dB at 1m.
Max power: 100W programme.
Dimensions: 61x33x30cm.
Price: £285 approx per pair.

IMF
IMF Electronics, Westbourne Street, High Wycombe, Buckinghamshire HP11 2PZ, UK.
Phone: 0494 35576. Telex: 83545.

TLS 8011
Impedance: 4-8 ohm.
Frequency range: 20Hz 'to beyond audibility'.
SPL: 98dB at 1m for 40W pink noise.
Max power: 100W.
Features: electric four-way crossing at 350Hz, 3kHz and 13kHz.
Dimensions: 98x41x46cm.
Weight: 37kg.

Mk IV
Impedance: 4-8 ohm.
Frequency range: 17Hz 'to beyond audibility'.
SPL: 96-98dB at 1m for 40W pink noise.
Max power: 150W.
Features: electric four-way crossing over at 350Hz, 3kHz and 13kHz.
Dimensions: 101x43x50cm.
Weight: 46kg.

JBL
James B Lansing Sound Inc, 8500 Balboa Boulevard, Northridge, Ca 91329, USA.
Phone: (213) 893-8411.
UK: Harman UK Ltd, St John's Road, Tylers Green, High Wycombe, Bucks HP10 8HR.
Phone: 049481 5221. Telex: 837116.
Agents in most countries.

JBL make a wide range of chassis lf and hf drivers and horn/lens assemblies, plus crossovers. We list here only complete monitor systems.

4301
Impedance: 8 ohm.
Frequency response: 45Hz to 15kHz, ±3dB.
SPL: 88dB at 1W at 1m.
Enclosed volume: 28 litres.
Max power: 15W 'steady state'.
Features: crossover at 800Hz; *4301E* available with integral 10W power amplifier, 0.5V input sensitivity.
Dimensions: 48x29x34cm.
Weight: 13.5kg.
Price: £170.

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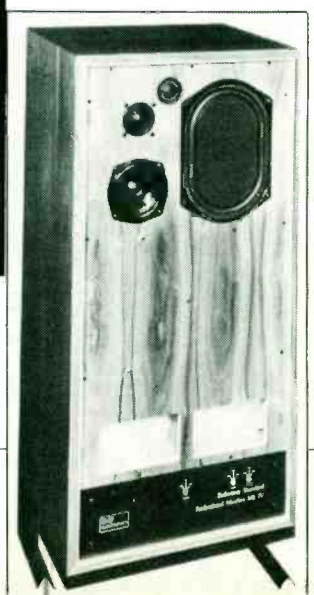


◀ *IMF professional monitor Mk IV*

setting standards

For the full story contact F.W.O. Bauch Limited,
49 Theobald Street, Boreham Wood, Herts. WD6 4RZ

REVOX

SURVEY: MONITOR LOUDSPEAKERS

4313
Impedance: 8 ohm.
Frequency response: 40Hz to 18kHz, ±3dB.
SPL: 89dB at 1W at 1m.
Enclosed volume: 37 litres.
Max power: 40W 'steady state'.
Features: crossovers at 1kHz and 4kHz.
Dimensions: 58x36x25cm.
Weight: 22kg.

4311 A
Impedance: 8 ohm.
Frequency response: 45Hz to 15kHz, ±3dB.
SPL: 91dB at 1W at 1m.
Enclosure volume: 42.5 litres.
Max power: 40W continuous sinewave.
Features: crossovers at 1.5 and 6kHz.
Dimensions: 60x36x30cm.
Weight: 19kg.
Price: £315.

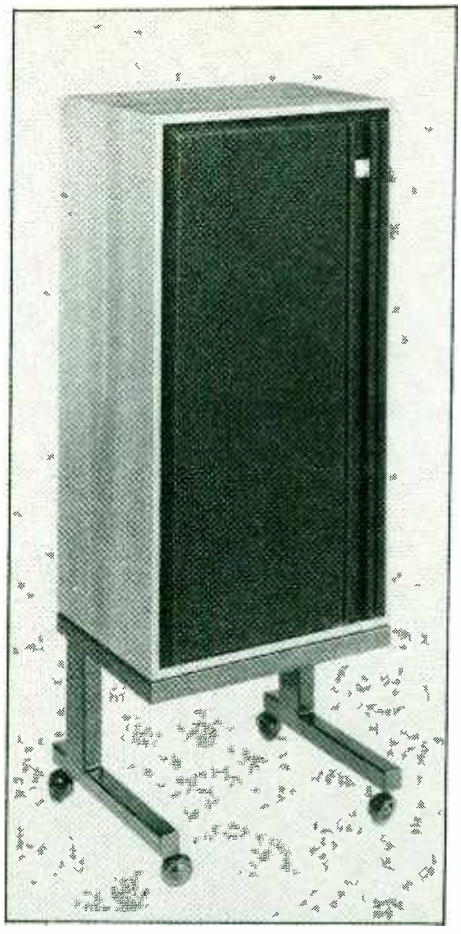
4315A
Impedance: 8 ohm.
Frequency response: 35Hz to 20kHz, ±3dB.
SPL: 89dB at 1W at 1m.
Enclosure volume: 93 litres.
Max power: 60W continuous sinewave.
Features: crossovers at 400Hz, 2 and 8kHz.
Dimensions: 85 x 52 x 33cm.
Weight: 43kg.
Price: £670.

4331A
Impedance: 8 ohm.
Frequency response: 35Hz to 15kHz, ±3dB.
SPL: 93dB at 1W at 1m.
Enclosure volume: 156 litres.
Max power: 75W continuous sinewave.
Features: crossover at 800Hz, switchable for passive operation or bi-amplification.
Dimensions: 78x62x51cm.
Weight: 57kg.
Price: £680.

4333A
Impedance: 8 ohm.
Frequency response: 35Hz to 20kHz, ±3dB.
SPL: 93dB at 1 at 1m.
Enclosed volume: 156 litres.
Max power: 75W continuous sinewave.
Features: crossovers at 800 and 8.5kHz, switchable for passive or bi-amplification.
Dimensions: 78x62x51cm.
Weight: 58kg.
Price: £765.

4343
Impedance: 8 ohm.
Frequency response: 35Hz to 20kHz, ±3dB.
SPL: 93dB at 1W at 1m.
Enclosed volume: 159 litres.
Max power: 75W continuous sinewave.
Features: crossovers at 300, 1.2k and 9.5kHz, switchable for passive or bi-amplification.
Dimensions: 105x63x43cm.
Weight: 79kg.
Price: £1050.

4350
Impedance: 4 ohm at 250Hz, 8 ohm at 250Hz.
Frequency response: 30Hz to 20kHz, ±3dB.
SPL: 95.5dB at 1W at 1m.
Enclosed volume: 269 litres.
Max power: 100W to 200W, depending on impedance continuous sinewave.
Features: crossovers at 250Hz, 1.1 and 9kHz, designed for bi-amplification.
Dimensions: 89x121x51cm.
Weight: 110kg.
Price: £1360.



Above: *Kef model 104*
Below right: *Rogers Export monitor*

KEF

KEF Electronics Limited, Tovil, Maidstone, Kent ME15 6QP, UK.
Phone: 0622 672261. Telex: 96140.

MODEL 103
Impedance: 8 ohm.
Frequency response: 50Hz to 20kHz ±2dB.
Sensitivity: 25W for 96dB at 1m and 400Hz.
Max power input: 100W programme.
Internal volume: 25 litres.
Dimensions: 50x33x22cm.
Weight: 16.8kg.

MODEL 104
Impedance: 8 ohm.
Frequency response: 50Hz to 20kHz ±2dB.
Sensitivity: 12.5W for 96dB at 1m and 400Hz.
Max power input: 100W programme.
Internal volume: 35.5 litres.
Dimensions: 63x33x26cm.
Weight: 19kg.

MODEL 105
Impedance: 8 ohm.
Frequency response: 30Hz to 25kHz (±2dB, 38Hz to 22kHz at 2m).
Sensitivity: 86dB spl for 1W at 1m.
SPL: 107dB at 1m (max).
Max power input: 150W programme.
Features: 20-element crossover at 300Hz and 2.5 kHz.
Directional characteristics: ±2dB of axial response up to ±20° horizontally and ±5° vertically.
Dimensions: 96x41x46cm.
Weight: 38kg.
Price: £330 approx.

K&H

Klein and Hummel, D-7302 Ostfildern 4, Kemnat, West Germany.
Phone: Stuttgart 455026.
UK: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ.
Phone: 01-953 0091. Telex: 27503.
US: Gotham Audio Corporation, 741 Washington Street, New York, NY10014.
Phone: (212) 741-7411. Telex: 129269.

OY
Bi-amplified three-way speaker. Active crossover and 2 x 30W amps built in.
Frequency response: 40Hz to 16kHz, ±2dB.
SPL: 107dB at 1m (max).
Self-generated noise: 10dB at 1m.
Total harmonic distortion: ≤0.25%.
Features: >4.7k ohm input impedance, balanced and floating, —6dB min, plus 8 position eq.
Dimensions: 48x30x23cm.
Weight: 20kg.
Price: £508.

O92
Tri-amplified three-way speaker. Active crossovers and 120W bass + 60W mid + 30W treble amps built in.
Frequency response: 27Hz to 17kHz ±2dB.
SPL: 110 dB pink noise at 1m + 6dBm input.
Features: 4.7k ohm input impedance, 0 or +6dBm, plus 4 position fixed eq and variable plug-in modules.
Dimensions: 80x44x30cm.
Weight: 36kg.
Price: £1455.

KLH

KLH Research and Development Corp, 30 Cross Street, Cambridge, Mass 02139, USA.
Phone: (617) 491-5060. Telex: 921427.

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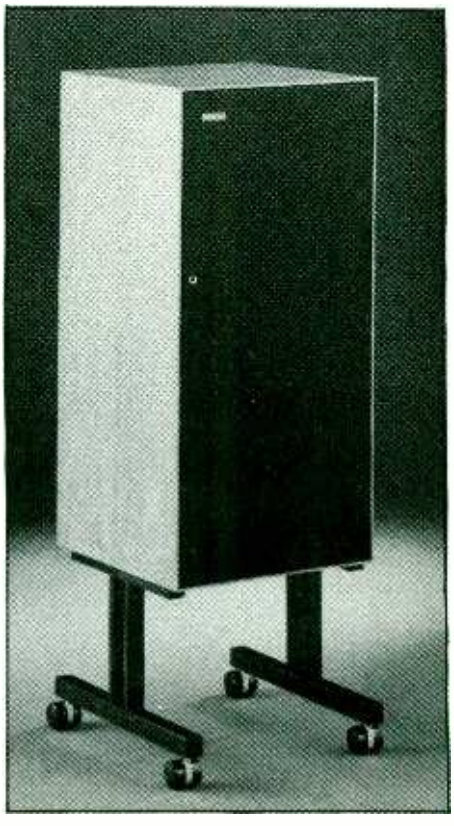
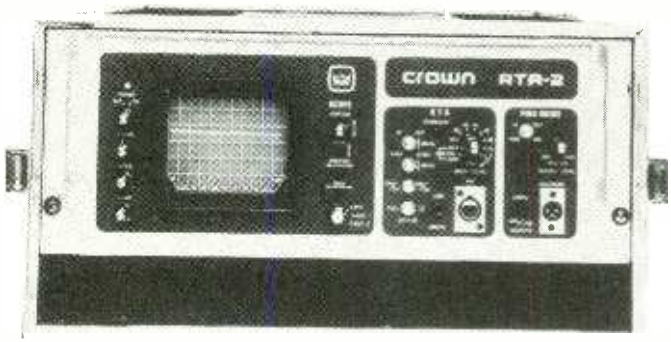


NEW *from* amcron

REAL TIME ANALYSER RTA 2



* 5" CRT Display
* Internal Pink Noise Source
* $\frac{1}{3}$ or 1 octave Display
* Frequency range 20-20 kHz
* Outputs for X-Y Recorder
* Compatible with any microphone
* Price £1960 ex. VAT

The Amcron RTA2 Real Time Analyser is designed as much for use as a production tool as it is for on-site audio analysis of Theatres, and Recording Studios. A flight case is available.

POWER AMPLIFIER D75

The Amcron D75 power amplifier replaces the previous model D60. Employing completely new type circuitry it offers also many new features, but without any increase in the price.

* New Amcron 10C comparator.
* Balanced XLR input connectors.
* Signal presence indicators.
* Separate Signal/chassis earth.
* 45 watts into 8 ohms per channel.
* Price £230 ex. VAT

Other Amcron Products include:

DC300A 500 watts/channel	**£550**
D150A 200 watts/channel	**£350**
VFX2A Crossover unit	**£270**
EQ2 Equaliser unit	**£599**
IC150A Preamplifier	**£260**
IMA Intermodulation Distortion Analyser	**£610**

MACINNES LABORATORIES LIMITED
Carlton Park Industrial Estate,
Saxmundham, Suffolk. Tel. Sax. 2262/2615

Macinnes France
18 Rue Botzaris,
Paris 75019.
Tel. 206 60 80
206 83 61

SURVEY: MONITOR LOUDSPEAKERS

UK: Webland International Limited, Unit 7, 129 Walham Green Court, Moore Park Road, London SW6 2DG.
Phone: 01-385 9478. Telex: 25570.

317
Impedance: 8 ohm.
Frequency response: 45Hz to 18kHz unspecified limits.
Max power input: 100W short duration.
Dimensions: 58x30x25cm.
Weight: 14kg.
Price: £167 per pair.

363
Impedance: 8 ohm.
Frequency response: 30Hz to 22kHz unspecified limits.
Max power input: 150W short duration.
Dimensions: 61x33x32cm.
Features: three-way system.
Weight: 19kg.
Price: £267 per pair.

KMAL
Keith Monks (Audio) Limited, 26-28 Reading Road South, Fleet, Aldershot, Hants, UK.
Phone: 02514 20568. Telex: 858606.

MODEL LS1.8
Contains a built-in 10W power amplifier with balanced 600-ohm input on jack or *XLR* connector. According to the manufacturers 'subjective listening tests indicate that this loudspeaker is suitable for broadcasting or studio listening situations where limited space is a consideration', and suggest that it may be useful for mobile recording setups or small control rooms. The loudspeaker measures just 22x37x25cm and costs £93.

MISSION
Mission Electronics Limited, PO Box 65, London SW7 1PP, UK.
Phone: 01-589 0048. Telex: 8813188.

720
Impedance: 8 ohm.
Frequency response: 50Hz to 20kHz, ±3dB.
Sensitivity: 85dBA at 1m from 1W pink noise.
Power handling: 100W programs, 150W peak.
Dimensions: 67x32x32cm.
Weight: 17kg.
Price: £228 per pair.

730
Impedance: 8 ohm.
Frequency response: 45Hz to 30kHz, ± 3dB.
SPL: 108dB max at 1m.
Sensitivity: 85dBa at 1m from 1W pink noise.
Power handling: 135W program, 200W peak.
Drive units: 25cm bass driver, 105mm mf, 25mm soft dome hf and 25mm nomex hard dome tweeter.
Dimensions: 90x32x32cm.
Weight: 21.5kg
Price: £334 per pair.

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

ELS ELECTROSTATIC LOUDSPEAKER
Impedance: 30 to 15 ohm in range 40Hz to 8kHz, falling above 8kHz.
Frequency response: 45Hz to 18kHz (rate of attenuation asympotic to 18dB/octave).
SPL: 93dB 50Hz to 10kHz, 100dB 70Hz to 7kHz.
Polar response: 70° h/15°v.
Power unit: integral; 120/250V.
Dimensions: 79x88x27cm.
Weight: 18kg.
Price: £225.

Mission model 720

PHILIPS
NV Philips Gloeilampenfabrieken, Eindhoven, The Netherlands.
Phone: 040 79333.
UK: Philips Electrical Limited, Audio Division, City House, 420 London Road, Croydon, Surrey CR9 3QR.
Phone: 01-689 2166. Telex: 946169.
Distribution by company network in most countries.

RH545
SPL: 108dB at 1m.
Enclosed volume: 70 litres (50 litres acoustic).
Max power: 100W.
Features: tri-amplified with motional feedback applied to 50W low-frequency amplifier; balanced line input at 1V with both DIN and XLR connectors.
Dimensions: 44x66x36cm.
Price: £650 approx.

AH487
SPL: 107dB at 1m.
Enclosed volume: 32 litres.
Max power: 110W.
Features: three active drive units and 20-cm abr.
Dimensions: 39x59x22cm.
Price: £70 approx.

REVOX
Willi Studer, CH-8105 Regensdorf-Zurich, Switzerland.
UK: FWO Bauch Ltd, 49 Theobald Street, Boreham-wood, Herts WD6 4RZ.
Phone: 01-953 0091. Telex: 27502.
US: Studer Revox America Inc. 1819 Broadway, Nashville, Tenn 37203.
Phone: (615) 329-9576. Telex: 554453.
Agents in most countries.

BX350
Impedance: 4 ohm.
Frequency response: 30Hz to 20kHz to DIN 45500.
Max power: 80W to DIN45500.
Sensitivity: 3.6W pink noise produces an SPL of 91dBA at 1m.
Dimensions: 52x35x30cm.

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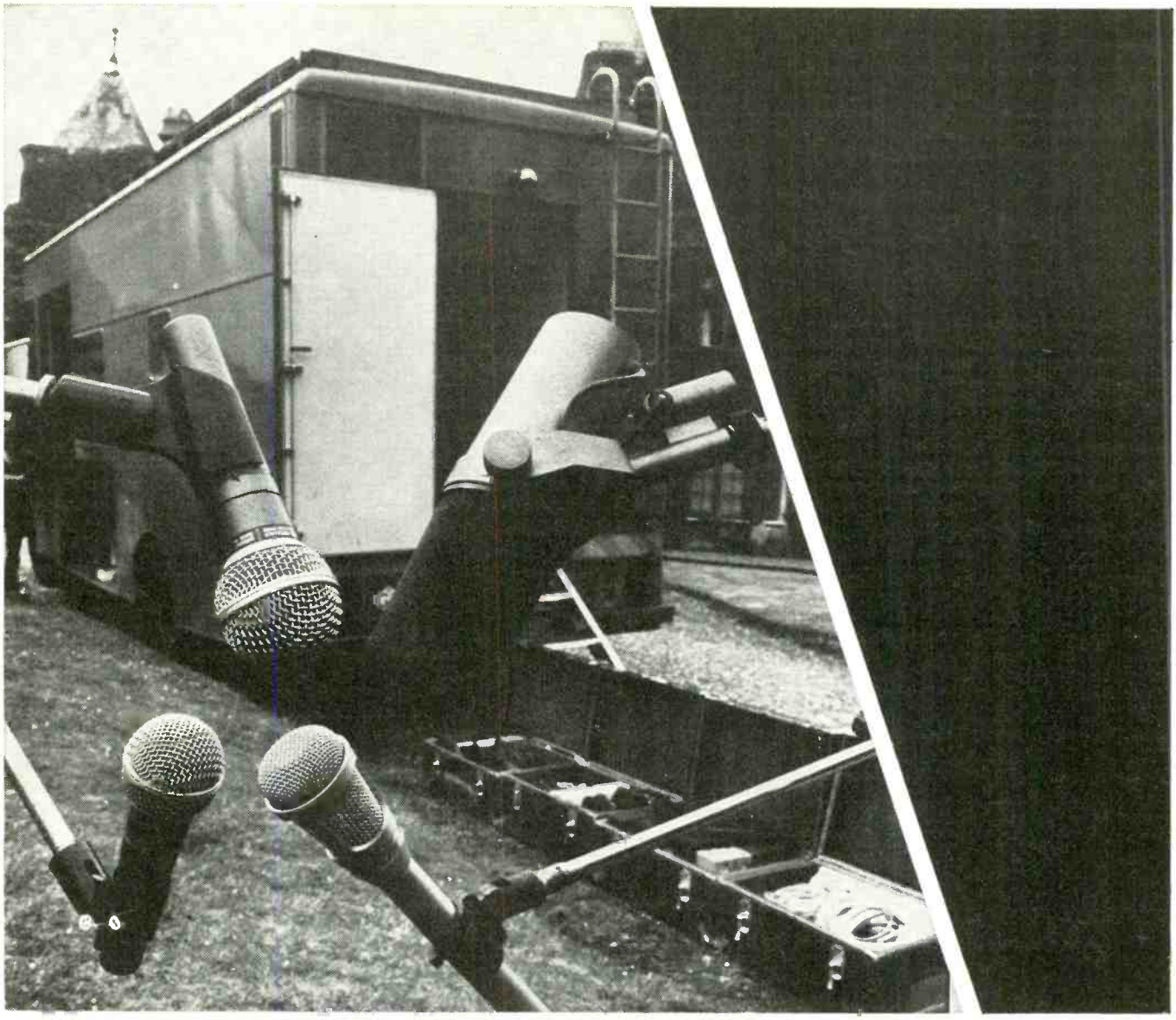

Stones' Rolling Studio

A complete recording studio in a van? For Mick Jagger, it is almost a necessity. Mick and the Stones can be inspired to produce their next hit anytime, but when they're on tour or on vacation, the best recording studios aren't always around the corner. The Stones rely on their Shure-equipped mobile studio for the unmatched recording perfection they insist upon, for these moments of midnight inspiration. Whether in a recording session or on stage, the Stones' SM7, SM58, SM82, SM53 and SM56 microphones are their assurance of consistent quality and natural sound.

Shure Electronics Limited
Eccleston Road, Maidstone ME15 6AU
Telephone: Maidstone (0622) 59881

SHURE®

SURVEY: MONITOR LOUDSPEAKERS

Weight: 14kg (approx).
Price: £140.

BX4100
Impedance: 4 ohm.
Frequency response: 35Hz to 25kHz to DIN45500.
Max power: 200W to DIN45500.
Sensitivity: 2.4W pink noise produces an SPL of 91dBA at 1m.
Dimensions: 79x45x43cm.
Weight: 40kg.
Price: £399.

ROGERS

Swisstone Electronics Limited, 4/14 Barmeston Road, London SE6 3BN, UK.
Phone: 01-697 8511.

LS3/5A
Impedance: 15 ohm nominal.
Frequency response: 70Hz to 20kHz, ±3dB.
SPL: 95dB max, wrt 2 x 10^{-5} N/m^2 at 1.5min'average listening room'.
Max power: 25W speech and music.
Drive units: two; 10cm bass driver and 1.9cm dome tweeter (3kHz crossover).
Dimensions: 18.5x30x16cm.
Weight: 5.5kg.
Price: £166 per pair.

EXPORT MONITOR
Higher-power handling version of well-known *LS3/6*.
Impedance: 8 ohm nominal.
Frequency response: typically 40Hz to 20kHz, ±3dB.
Max power handling: 50W rms at 400Hz; 100W speech and music.
Drive units: three; 20.5cm bass driver. Celestion *HF 1300* derivative tweeter and *HF 2000* super tweeter
Dimensions: 30.5x30.5x63.5cm.
Weight: 14kg.
Price: £239 per pair.

COMPACT MONITOR
Impedance: 8 ohm.
Frequency response: 50Hz to 20kHz, ±3dB.
Max power handling: 50W rms.
Dimensions: 50x28x27cm.
Weight: 11kg.
Price: £169 per pair.

SMC

SMC Loudspeakers, 76 Bedford Road, Kempston, Beds MK42 8BB, UK.
Phone: 0234 854133.

AS 40
Impedance: 8 ohm.
Frequency response: 32Hz to 25kHz DIN (±3dB, 45Hz to 20kHz).
SPL: 108dB max at 1m.
Sensitivity: 96dB at 20W at 1m.
Max power: 100W peak (50W DIN).
Features: 12-element crossover at 500Hz and 4kHz.
Dimensions: 32x63x36cm.
Weight: 18kg.
Price: £234 per pair.

AS 50
Impedance: 8 ohm.
Frequency response: 25Hz to 25kHz DIN (±3 dB, 35Hz to 20kHz).
SPL: 104dB max at 1m.
Sensitivity: 96dB at 15W at 1m.
Max power: 100W peak (50W DIN).
Features: 13-element crossover at 500Hz and 3.5kHz.
Dimensions: 38x74x43cm.
Weight: 34kg.
Price: £494 per pair.

SYSTEMS MAGNETIC

Systems Magnetic Company, 2837 Coronado Street, Anaheim, Ca 92806. USA.
Phone: (714) 632-8400.

MODEL 15
Impedance: 8 ohm.
Frequency range: 30Hz to 16kHz.
Max power: 75W RMS 'long term broadband'.
Sensitivity: 101.25 dBA with *EH800* hf horn or 104dBA with *EH500* hf horn at 1m from 1W pink noise.
Dimensions: 82x67x49cm.
Weight: 57kg.

MODEL 10-2
Impedance: 8 ohm.
Frequency range: 40Hz to 16kHz.
Max power: 75W RMS 'long term broadband'.
Sensitivity: 100.75dBA at 1m from 1W pink noise.
Dimensions: 85x53x34cm.
Weight: 39kg.

TANDBERG

Tandbergs Radiofabrikk A/S, PO Box 9, Korsvoll, Oslo 8, Norway.
Phone: (02) 232080. Telex: 16441.
UK: Tandberg (UK) Limited, Farnell House, 81 Kirkstall Road, Leeds LS3 1HR.
Phone: 0532-35111. Telex: 557611.
US: Tandberg of America Inc, Labriola Court, Armonk, NY 10504.
Phone: (212) 892 7010.

STUDIO MONITOR
Impedance: 8 ohm.
Frequency range: 25Hz to 20kHz.
Sensitivity: 6W to DIN45500.
Max power: 100W continuous to DIN45573.
Features: four-way design with 30cm bass driver, 50mm midrange and two 25mm dome tweeters; crossover frequencies 600Hz and 3.5kHz.
Dimensions: 76x47x34cm.
Weight: 33kg.

TANNOY

Tannoy Products Ltd, St John's Road, Tylers Green, High Wycombe, Bucks HP10 8HR, UK.
Phone: 049481 5221. Telex: 837116.
US: Harman Kardon Inc, 55 Ames Court, Plainview, NY 11803.
Phone: (516) 681 4000. Telex: 230961362.
The company manufacture a range of chassis units, each comprising a direct radiator bass unit and a high-frequency compression driver in a dual gap arrangement. They are supplied with adjustable crossover network.
Tannoy also market a range of enclosures fitted with their drive units.

HPD 385A CHASSIS UNIT
Impedance: 8 ohm.
Sensitivity: 96dB at 1m at 3W for 400Hz.
Max power input: 85W continuous programme.
Features: 20Hz bass resonance, 500Hz horn hf cut off.
Diameter: 38.5cm.
Weight: 14kg.
Price: £130.

HPD 315A CHASSIS UNIT
Impedance: 8 ohm.
Sensitivity: 96dB at 1m at 5W for 400Hz.
Max power input: 60W continuous programme.
Features: 20Hz bass resonance, 500Hz horn hf cut off.
Diameter: 31.5cm.
Weight: 8kg.
Price: £109.

HPD 295A CHASSIS UNIT
Impedance: 8 ohm.
Sensitivity: 96dB at 1m at 7W for 400Hz.
Max power input: 50W continuous programme.
Features: 22Hz bass resonance, 500Hz horn hf cut off.
Diameter: 29.5cm.
Weight: 7kg
Price: £97.

BERKELEY
Impedance: 8 ohm (*HPD 395A* chassis unit).
Sensitivity: 91dB at 1m at 1W (3.1W DIN 96dB).
Max power input: 85W,
Dimensions: 84x54x31cm.
Price: £195.

ARDEN
Impedance: 8 ohm (*HPD 395A* cgassis unit).
Sensitivity: 91dB at 1m at 1W (3.1W DIN 96 dB).
Max power input: 85W.
Dimensions: 99x66x37cm.
Price: £222.

WINDSOR
Frequency response: 40Hz to 20kHz, ±3dB.
Power handling: 120W continuous.
Sensitivity: 92dBA for 1W at 1m.
Dispersion: greater than 100°, 15kHz at —6dB points
Features: a 'smaller' version of the *Buckingham* with a single bass unit and modified crossover.
Dimensions: 58x40x82cm.
Weight: 57kg.
Price: £478 in walnut/£538 in rosewood.

BUCKINGHAM
Frequency response: 35Hz to 20kHz, ±3dB.
Power handling: 200W continuous.
Sensitivity: 95dBA for 1W at 1m.
Dispersion: as *Windsor*.
Features: three-way system with four separate transducers: two 30-cm bass drivers in 170 litre reflexed enclosure; 25-cm midrange driver in 30 litre transmission line enclosure; and a horn-loaded hf compression driver with slant plate acoustic lens.
Dimensions: 60x45x117cm.
Price: £693 in walnut/£765 in rosewood.

UREI

United Recording Electronics Industries, 8460 San Fernando Road, Sun Valley, Ca 91352, USA.
Phone: (213) 767-1000. Telex: 651389.
Export: Gotham Export Corporation, 741 Washington Street, New York, NY 10014, USA.
Phone: (212) 741-7411. Telex: 129269.
UK: FWO Bauch Limited, 49 Theobald Street, Borehamwood, Herts WD6 4RZ.
Phone: 01-953 0091. Telex: 27502.

TIME ALIGNED MODEL 813
Impedance: 8 ohm.
Frequency response: 40Hz to 15kHz, ±3dB.
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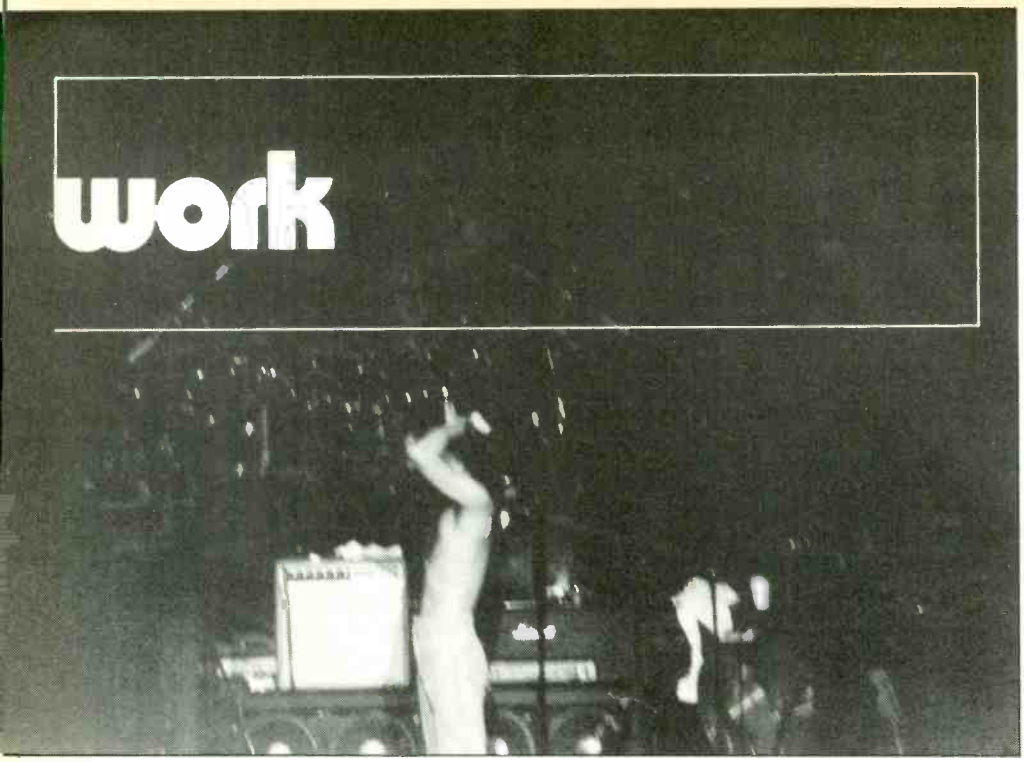


Frank Zappa Live

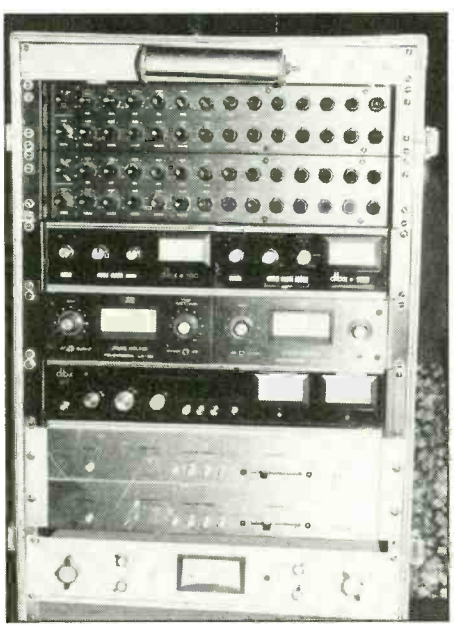
On a long forgotten Mother's Day (in America the 2nd Sunday in May) through creation of The Mothers of Invention, one Frank Zappa did emerge upon the music scene (sic). And for something like 14 years he has continued to provide those who would care to listen, a style of music appropriately removed from the balance of that era . . . and others.

A dissertation upon our guesses at his philosophy and commentaries would be just that—*a guess*; and as we rarely indulge in guessing I shall leave it out. But, it may be worthwhile to mention that with such an uncompromising standard of tone and composition, coupled with relevant 'social comment', it is not unusual to find that same standard prevalent in his pursuit of quality audio reproduction.

I was witness to the four Frank Zappa performance at the Hammersmith Odeon this January, and was able to spend time with his crew and technicians on their return at the end of February. It is note-worthy to add that our conversations took place during the set-up time for the stage and equipment, and hence many thanks are in order to all concerned for allowing me in their way. The offices of Frank Zappa and Frederick Bannister are to be thanked for their cooperation and time, as this article would not have been possible without their efforts.

Al Santos, the production chief greeted me upon my arrival at the Odeon and directed me to the appropriate staff and scene of activity. One comment to 'would-be' stage managers: here is a man dealing with the orchestration of a major performer on the road, who is not afraid of expending a little elbow-grease in the interest of a job well done. And I am sure that the ever present beret is not just to cover the well-earned bald spot.

As the snake was winding its way to the main mixing consoles I began my talks with David Gray, the man behind all the guitars, their effects and amplification. The most interesting piece of equipment must be the 'Blue Box' designed for Frank by Klaus Wiedemann. This is a free standing 483 mm rack of effects used by Frank's guitar, requiring David's full time attention.



Above: *Either side of the main pa desk there are racks of power amps, equalisers and compressor-limiters; this is the right-hand one.*

Right: *The left-hand equipment rack. Note the separate sub-mixer for drums and various percussion, including gongs and xylophone (!)*

As Frank uses no leads for his guitar, the signal is transmitted by much the same system as many advanced wireless mics. I was assured by David that, even at the most extreme distances, they've experienced no loss or degradation of signal. The signal is received at a pedalboard, used to select the desired effect or combination of effects, and travels the snake to the 'Blue Box'. It is then split into four independently controlled signals and met with buffer-amps to maintain signal integrity. The buffers do not make up for any deficiencies in signal, but merely ensure that the signal remains hot at the splitting process.

The signal is then sent to an Alembic preamp for the appropriate routing to the special effects module. Not unlike other equipment used by Frank, this has been modified to add an additional mono channel to encompass one additional effect, in this case a *Harmonizer*. The effects that are used in the 'Blue Box' read like one of our surveys: MXR *Digital Delay*, Big Muff Distortion, *Space Echo*, Eventide *Harmonizer*, Bi-Phase and dbx compression. Nearly every unit has been modified to new specifications by David or Klaus in order to attain matching with other components in the chain, or to alter the unit's function to arrive at the sound Frank had requested. These are all interfaced with other units in a jump-loop, with the signal waiting at each module so as to respond readily to the relay switching employed. It was mentioned at this point that many times 'we just used a bigger cap' to get around some of the obvious problems created by using that method. Other components included in the system are Burwen signal processors modified to encompass the broad range of signal inputs and various use-characteristics, with *Kepex* and *Gain Brains* generally used in a limiting mode. Watching the performances it could be seen that Frank is generally well into the triggering mode of the dbx compressor and my query found that that is part of the subtleties in sound that Frank prefers. (So there, to those who move in hate of these obedient devices.) And finally a complement of Clear Sound modules, again installed to ensure integrity of the signal.

As I mentioned, the signal is split into four outputs, these being 'Dirty Left, Dirty Right and Clean Left, Clean Right' with vcas handling the control of intensity and blend. This splitting is arranged by a Yamaha *4X* mixer in the rear, also allowing input of Frank's vocal mic for use of time-related effects and eq. Amplification is handled by a Mesa Boogie with the eq section modified by David for expanded range, and that is sent to the ever present Marshalls and on to the 4 x 12s.

Seeing and hearing the system in operation, and hearing the tasteful use of effects, the application of such an advanced unit came well into justification. Frank and his staff are

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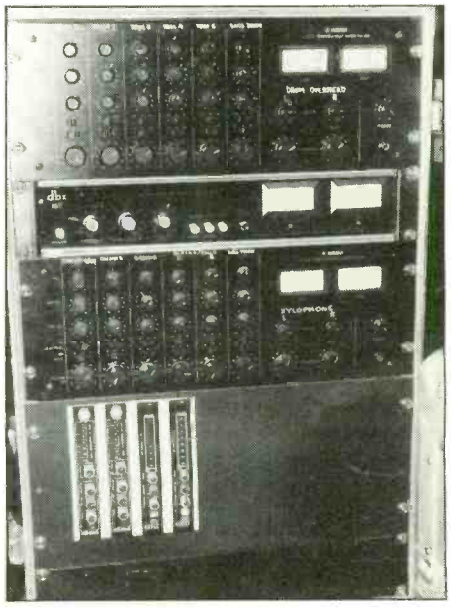

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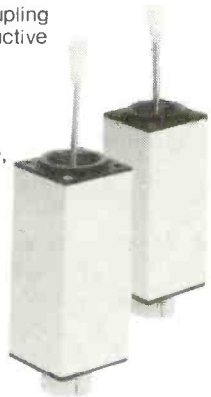

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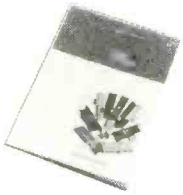

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so fussy about the system that I am told a regular re-patch of the modules is performed so as to search for the desired order of effects; ie trying out new combinations in pursuit of 'that right sound'.

Much to the delight of David Gray, the babysitter for this unit, not much servicing or addition of units has been done while on the road; though, I dare say he had sufficient test equipment and parts to undertake the most dramatic of operation, if necessary. In leaving David, less than an hour had transpired in our conversation and he was bringing out the guitars and preparing for a test of the entire system . . . all 24 modules. And then he moved on to see to the gear used by the bassist and 2nd guitarist, looking after the actual instruments, as well. My next conversation was with Klaus Wiedemann and I found him making a repair to the power amps in one of the main speaker columns. I guess that Klaus is best described as one of genius calibre, having made the original design for the 'Blue Box' and now using his expertise on the pa itself. The drivers and cabinets are to remain unnamed as they are nearing replacement by a custom designed system. This will be commissioned by Frank for Klaus to design and construct, and this is sure to be studied when it makes its appearance.

The basic system, now in use, is front-loaded bass-reflex cabinets with an array of high-frequency ring radiators and one mid-range horn per cabinet. Klaus complains of the relative ineffectiveness of the high frequency units, in comparison with other drivers in the system, and promises a better design in the future. The bins are fitted with individual crossover networks working fairly fast at 12 dB/octave, and though perhaps that rate may be a bit vicious it was quite effective with respect to the levels used.

The repair being carried out during our conversation turned out to be another wiring harness frailty, one that could well have been prevented by the manufacturer. It is funny to find that a unit 'designed for road use' would seem to be conceived with the notion that the road is paved with cotton wool, when more often than not it seems to be rock and boulders. Each power amp in the entire set has been mounted on a new chassis as the weight of the mains transformers was found to rip to bankruptcy many fragile pcbs in the course of getting the stage from van to soundcheck in less than 4 hours. It was quite refreshing to see the abundance of preventive medicine used in this team, and their careful selection of replacement equipment and parts. That night alone a faulty crossover unit was removed from the cabinet and replaced with a similar model, even while the other unit had been consigned to the repair bench.

Klaus and I then discussed the mic techniques used as they seem to contradict most of the common thought in that area. I was informed that Frank had supervised most of the miking and used his ear as the guide, and not some ageing theory. Drums and percussion are given better attention than most *studios* allow; the percussion, drums and both keyboards are submixed at their stations by the player and engineer together, ensuring that greater subjective control remains with the musician, ie where it is most needed.

During the concerts the separation and definition of sound was more precise than I'd thought the Odeon would allow—I noted especially that the bass drums and cymbols sounded like themselves, and not pounded cardboard boxes and dustbin lids. Further, each individual instrument that did utilise more than one input at the main desk, offered the opportunity for a stereo mix. This effect was especially pleasing in the presence of the percussion section and drums, and it was a nice departure from the usual 'everything in mono, they can't hear it in stereo anyway' train of thought.

Leaving Klaus to mutter something in German about bad crossovers I went on to

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Davey Moire at the main pa desk of two Yamahas

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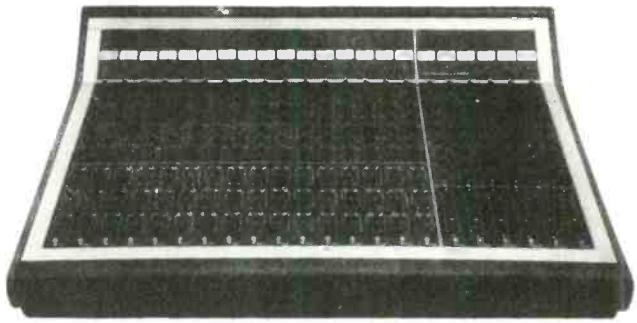

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WORK

Davey Moire, the man in charge of the main pa mix. Most of us will have seen Davey's name on the sleeve of many a disc emanating from the Record Plants in New York and LA, and he is even to be found on Frank's *Zoot Allures* lending a bit of vocal postulation. I have had close familiarity with Davey's work before (Tommy Bolin and others) and find that his goals of accuracy and creative control employed in the studio have certainly prevailed in the more immediate area of live-mixing. He sits at two Yamaha *PM-1000*s, modified to the specifications of Davey's and Frank's use.

It is interesting to note that a previously mentioned error in the panning pot section (see Review, STUDIO SOUND, December '76, p76) has been modified by the Zappa staff to correct that deficiency. Davey told me that the Yamahas were selected after much wrist wrenching with their previous desks, and they are most pleased with the transition. I was told many a story of their reliability and ease of operation including the one about the broken flight case resulting in only a set of four wheel dents on top. One of the key modifications was the addition of a group muting switch, usually employed in the vocal groups so as to allow the minimum of ambient noise to get to the mics not in circuit (for example, during instrumental passages). Here is another man not afraid to move faders in and out of use, even in a live situation, striving for as clean a sound as possible.

Davey interfaces all of the stage with the racks of ancillary equipment and mixer. Everything is miked except the keyboards, some percussion and the di output from the 'Blue Box'. He uses dbx compression for the entire system and several supplementary mixers to control percussion and drum outputs. Again *Kepex* and *Gain Brain* appear, though used sparingly and mostly for limiting purposes. It was found that the dynamic range of the music was more an inherent quality of the playing as opposed to engineering. Here would be the proper place to comment as to how quality sound can only make a mediocre band as good as they are mediocre; it makes an excellent band (ie Frank Zappa et al) brilliant.

Davey then sends four channels of information back to the bins and power amps, with the same mono/stereo mix going to four tracks at 76 cm/s on the venerable Scully. I was told that much of a live disc (absolutely in litigation) was made from that same 4-track machine with little or no overdubs. That shows just how thoroughly they operate.

During the soundcheck Davey and the separate monitor mixer take turns with the White pink-noise generator and their own White equaliser system. The live eq settings run quite flat, with a minor boost (3-5 dB) at the low and high ends, with a slight cut (3 dB) around 150 Hz, which was found to be the resonant frequency of the bins. Davey has discussed the possibility of incorporating pink-noise into the system after the room has filled with people. He feels that while he has established the bulk of his mix during the first three or four numbers, a more objective eq setting should be allowed for the compensation of variances, such as full or semi-full house conditions. During the dynamic eq process he is also adjusting for any

hearing discrepancies that he or those in the area of the consoles may perceive, and recommends all of us to take the time for a professional hearing check. I could proudly state that mine was tested as recently as six months ago, while Davey was anxious after 18 weeks on the road!

During the actual performance I took time out to make an spl reading using a consumer test unit A-weighted; I found that the normal level was in the area of 95-100 dB, with few peaks above 110 dB. No one yelled to 'turn it up' and the sound filled the hall with good separation and clarity. (I took those measurements in a nasty bass trap, under the balcony at the mixing desk.)

All in all the music and quality of the sound were both a pleasure and learning experience. Frank Zappa travels with a most qualified entourage in Messrs Moire, Wiedemann and Gray and I am told that their efforts are treated with a spirit of creativity and autonomy, rarely found in such an environment.

But I think that I will close this story with an answer to an old question of mine. Back in the late Sixties Frank Zappa and The Mothers of Invention released a fine double-album set called *Uncle Meat*. The copious liner notes mentioned that one particular passage contained no less than 64 tracks of percussion and other instrumentation . . . how so in '69? Four SMPTE edit code generators, 'I guess that's what keeps them in sync.'

David Clamage

agony

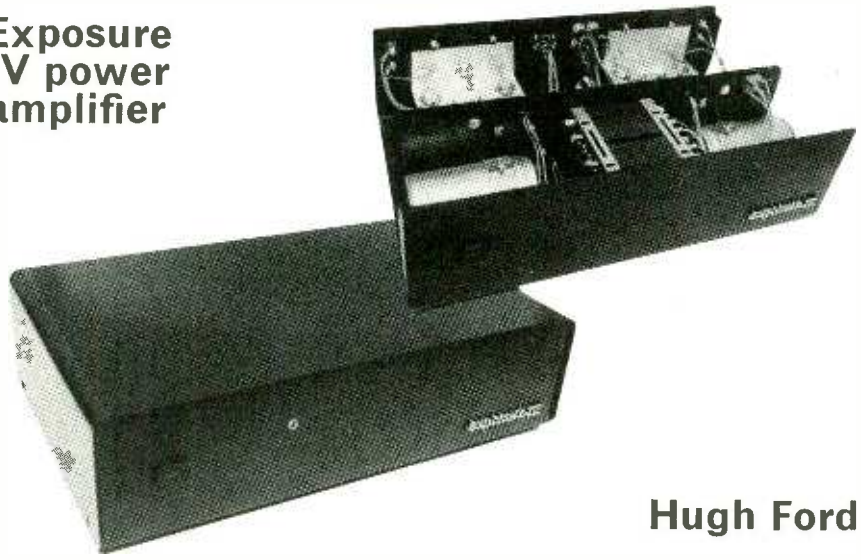
Following a piece that we ran recently on direct cut discs, we were phoned by a reporter on a popular newspaper. He clearly wanted to rewrite the story for his own paper but had a problem. He couldn't understand how direct cuts could be economically viable, even at current prices of around £10 or more each.

'You must have got it wrong,' he said belligerently. 'It must take nearly an hour to record both the sides of an LP and if you add up the musicians' fees and the cost of hiring a studio it must come to more than £10 an hour. So how can they sell the records at £10 a time?'

'Anyway,' he argued as a final thrust, 'the musicians will get very tired making the same record over and over again!'.

reviews

Exposure IV power amplifier



Hugh Ford

MANUFACTURER'S SPECIFICATION
Output offset: less than ±30 mV.
Power output: 50W into 8 ohm (real power 70W rms).
Clipping indication: led indicators on front panel.
Transient capability: greater than 400VA.
Inputs: five-pin DIN and RCA phono connectors.
Stability: unconditional.
Input sensitivity: 1.2V.
Frequency response: 10-20k Hz, ±1 dB.
Input impedance: 22k ohm.
Distortion: one channel driven, typically 0.002%; both channels driven, typically less than 0.01%.
Operating temperature: 0-50°C, thermal cutout at 50°C.
Power: 240/120V on request.
Price: £200.
Manufacturer: Exposure Electronics, Richardson Road, Hove, Sussex, UK.

MODESTLY RATED at 50W per channel into 8 ohm this amplifier, as will be seen, has considerably more 'punch' than its specification suggests. However, the prototype unit reviewed here is rather 'domestic' in mechanical construction and would not take the hard life of mobile use.

The amplifier is contained in a sheet steel box with an internal partition between the mains transformer, rectifiers and smoothing capacitors at the front of the amplifier and the signal electronics sections at the rear. Glass-fibre pcb hold all the electronic components, including the two output devices for each channel. These mount onto the circuit board and also onto an alloy angle bracket that in turn is bolted through the rear panel of the amplifier's case onto a finned heatsink. Access for servicing is consequently excellent, but at this prototype stage no component identifications were to be found on the circuit boards, each of which had two preset potentiometer controls.

The only user control is the illuminated mains power on/off switch on the front panel, which also includes two red led overload indicators—one for each channel. To the rear the output terminals are in the form of banana sockets/terminals on the standard 19 mm spacing. These are not mechanically protected, however, and could be easily damaged in transit. Also at the rear of the amplifier are two RCA phono sockets in parallel with a five-pin DIN socket providing the amplifier inputs at a fixed level. In addition there is the IEC standard mains power connector and five metric fuses, all of which were identified in their rating. One of the fuses is connected in the incoming mains power rail, while the remaining four protect the positive and negative supply rails of each amplifier. These supply rail fuses are normally rated at 2A but were increased to 5A for the sinewave testing.

Power output and distortion

Initially the power output for 1 kHz sinewave clipping with both channels driven was investigated for resistive loads of 16, 8 and 4 ohms, and with a single channel driven into 2 ohm. The results in **table 1** suggest that the amplifier is quite at home with loudspeakers of any type with a rated impedance down to 4 ohm, allowing for a fall in impedance right

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down to 2 ohm. It is worthy of note that the available output power with a single channel driven into either 8 or 16 ohm is about 10% above performance with the both channels driven.

Measurements of total harmonic distortion at the rated power output into 8 ohm and also at 1W into either 8 or 4 ohm gave the results in **table 2**. Also shown is the performance when the load is shunted with 2 μF capacitance. While the distortion performance is generally good—but not in the very best league—under some conditions there are substantial differences between the two channels. It was noteworthy, however, that the distortion products consisted always of harmonics, as opposed to crossover-type distortion which is subjectively more objectionable. Examination of the individual second and third harmonic components at both the rated output of 50W into 8 ohm and at 1W into 8 ohm produced **figs. 1 and 2,** which show that there is no substantial change in the distortion when the output power is lowered, the less objectionable second harmonic being the predominant distortion product.

Twin-tone CCIF intermodulation distortion

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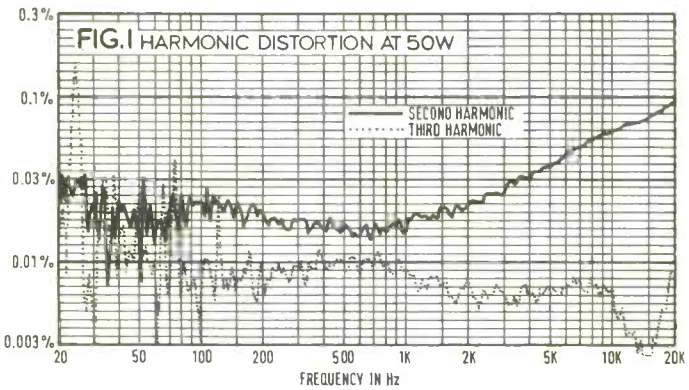
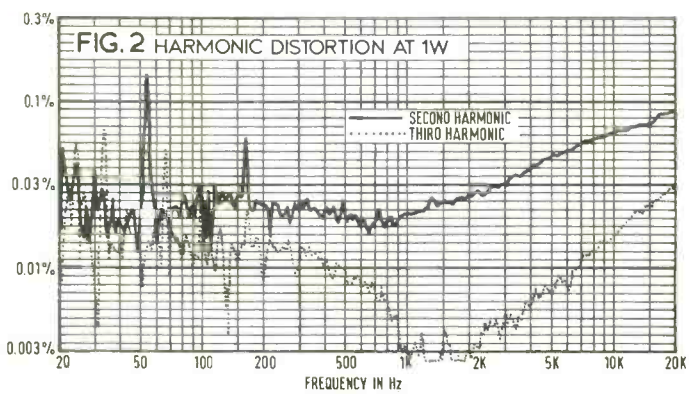
TABLE 1 OUTPUT POWER

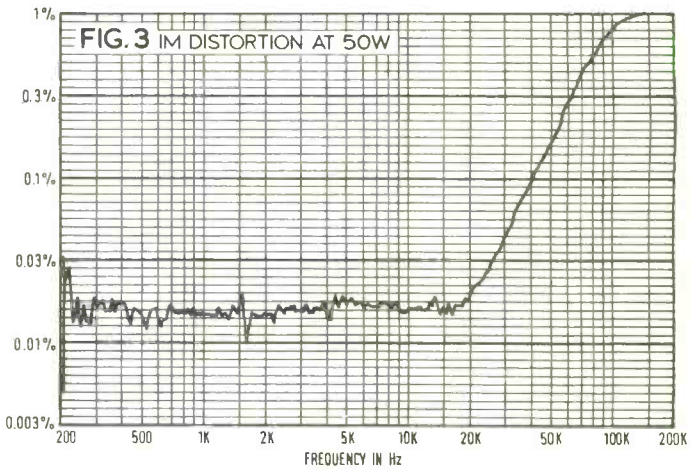
Load	Output at the onset of clipping	
	left	right
16 ohm	39W	40W
8 ohm	63W	66W
4 ohm	105W	110W
2 ohm	120W	150W

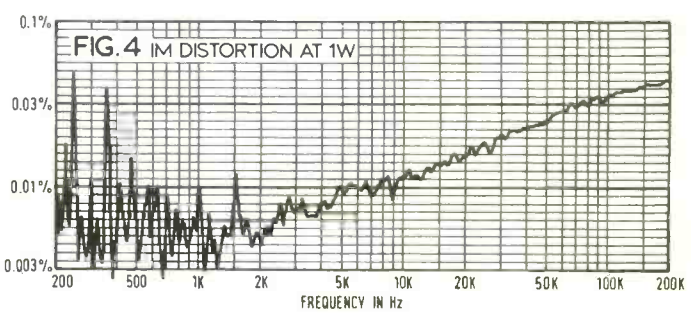
TABLE 2 TOTAL HARMONIC DISTORTION

Output power and load	Frequency	Resistor only		In parallel with 2μF	
		left	right	left	right
50W into 8 ohm	1 kHz	0.02%	0.01%	0.02%	0.01%
	10 kHz	0.075%	0.03%	0.12%	0.04%
	20 kHz	0.10%	0.08%		
1W into 8 ohm	1 kHz	0.036%	0.012%	0.036%	0.012%
	10 kHz	0.087%	0.025%	0.14%	0.042%
	20 kHz	0.11%	0.043%		
1W into 4 ohm	1 kHz	0.065%	0.022%	0.065%	0.022%
	10 kHz	0.17%	0.042%	0.21%	0.18%
	20 kHz	0.22%	0.083%		









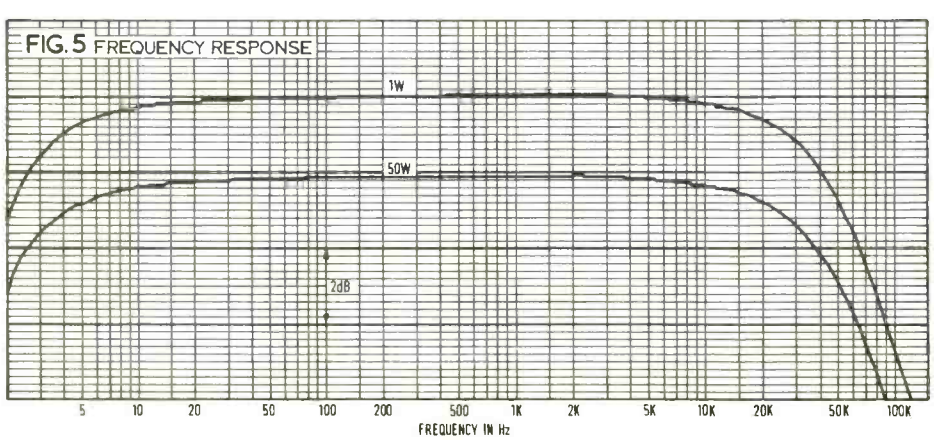
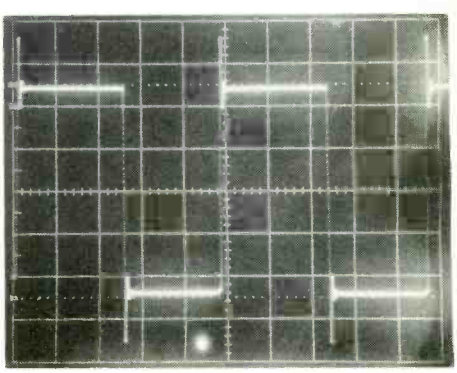


FIG. 7 Squarewave into 8 ohm load plus paralleled 2μf capacitor.



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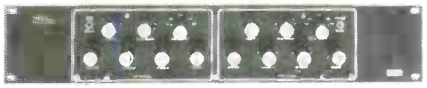

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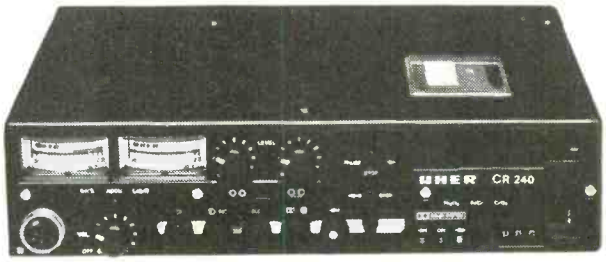

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was examined over the frequency range 200-200k Hz using two equal amplitude tones with 70 Hz separation, while plotting the intermodulation product 70 Hz above the higher frequency tone. The results at 50W peak equivalent sinewave and also at 1W produced **figs. 3 and 4.** At the 1W output power shown in **fig. 4** the distortion remains at a satisfactorily low level at all frequencies, while at the high power output there is a not unexpected rise in distortion above 20 kHz.

Checking the intermodulation distortion to the SMPTE method using a 70 Hz tone and a high-frequency tone in the amplitude ratio 4:1 showed that the intermodulation products were at least 70 dB down (0.03%) with the high frequency tone between 200 Hz and 3 kHz, rising to 0.1% with a mixture of the 70 Hz and 20 kHz.

The power bandwidth for 0.1% total harmonic distortion at the half rated output power of 25W into 8 ohm was found to extend from below 10 Hz for both channels, to 30 kHz for one channel and to 20 kHz for the worst channel—a satisfactory situation.

Frequency response and noise

The overall frequency response of the amplifier was checked at 1W output and also at the rated output of 50W into 8 ohm, the results being shown in **fig. 5.** This shows that the two responses are identical with —1dB points at 4 Hz and approximately 27 kHz, above which there is a sensible rolloff.

Noise at the output was related to the rated power output of 50W into 8 ohm, with the weighted and unweighted figures in **table 3** being measured for each channel. Like the distortion figures the difference in noise performance between the two channels is rather excessive; it is surprising that the manufacturer's specification does not quote noise figures.

TABLE 3 OUTPUT NOISE

Weighting and meter	Signal-to-noise ratio left	right
20 Hz to 20 kHz rms	94.7 dB	97.7 dB
A-weighted rms	107.3 dB	107.7 dB
CCIR-weighted rms	100.7 dB	102.5 dB
CCIR-weighted quasi-peak	93.8 dB	97.7 dB

Sensitivity and impedances

The fixed input sensitivity for both channels was the same for the phono and DIN inputs at 1.09V for an output of 50W into 8 ohm, the input impedance being 17.9k ohm in parallel with 600 pF. As can be seen from **fig. 6** the output impedance remained constant at 40 milliohms up to a frequency of 5 kHz, providing a satisfactory damping factor with the impedance rising as normal up to 100 milliohms at 20 kHz.

Other matters

Checking the amplifier's risetime showed this to be 4 μs with an associated maximum slew rate of only 4V/μs, which is probably limited by the filter at the amplifier's input terminals.

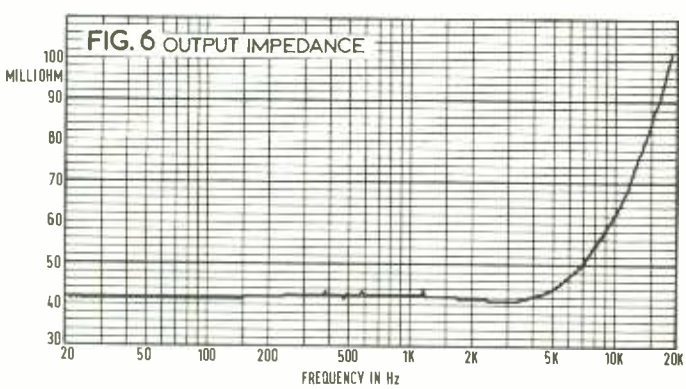
The squarewave performance into a load of 8 ohm in parallel with a capacitance of 2 μF is shown in the oscillogram **fig. 7.** It can be seen that there is a significant overshoot and a slight indication of ringing with the 1 kHz signal used. **Fig. 8** shows the effect of driving the amplifier from half rated power into highly asymmetrical overload conditions with a 20 ms duration burst of 1 kHz tone, the amplifier's recovery being clean without any long term dc offset.

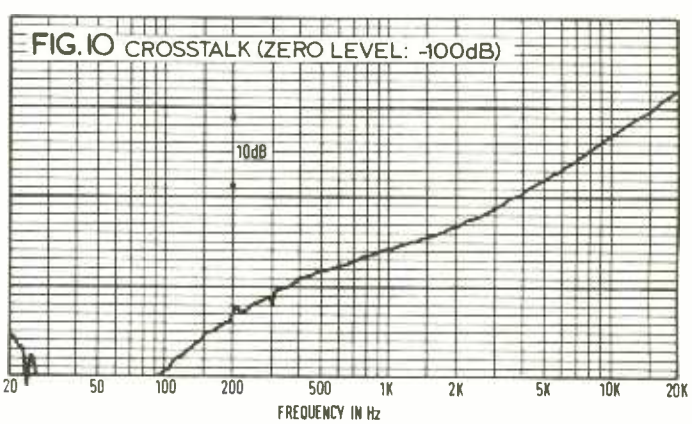
The overall phase shift within the amplifier is small in the band as can be seen from **fig. 9,** which demonstrates a phase shift maximum of 14° at 20 kHz. In practice the amplifier did not show any signs of instability during the review measurements.

Crosstalk between the two channels with one channel driven to the rated output into 8 ohm is shown in **fig. 10,** which demonstrates a highly satisfactory performance within the af band. Finally the dc offset at the loudspeaker outputs was measured and found to be satisfactory at 16 mV and 24 mV for the two channels.

Summary

While it generally demonstrated a good performance the review sample of this amplifier did reveal rather large differences between the two channels from the points of view of distortion and noise. On the latter front it would be nice to see the mains hum components at a lower level, with a resulting better unweighted noise performance. Having regard to the type of mechanical construction and the overall electrical performance, this amplifier can perhaps be fairly described as a good semi-professional unit—if the production version exhibits the performance of the better of the two channels. ■





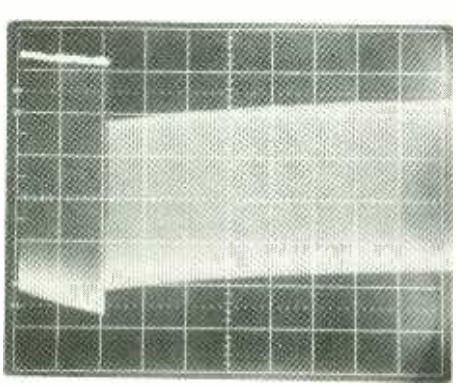
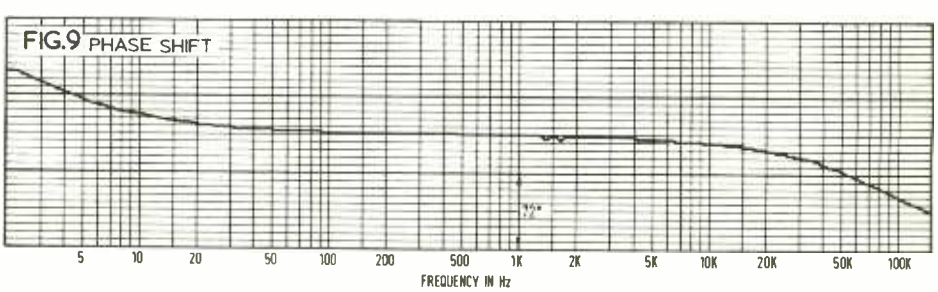


FIG. 8 Recovery from heavy asymmetrical clipping.



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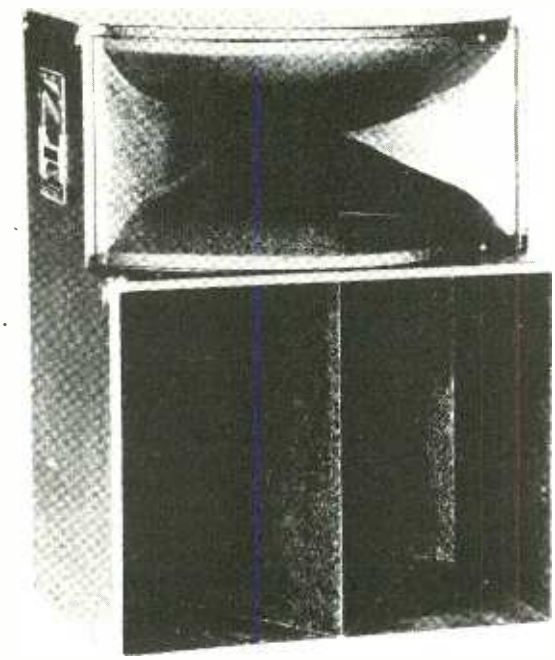

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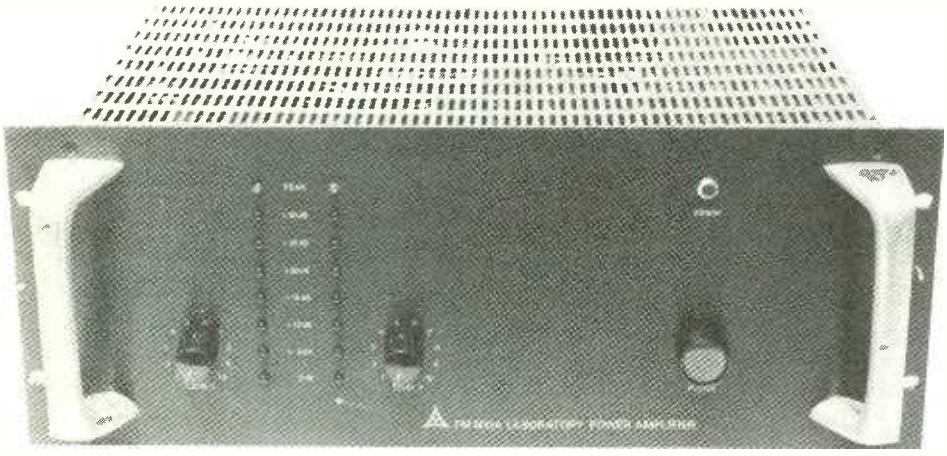
FM-600A power amplifier

Hugh Ford



MANUFACTURER'S SPECIFICATION

Power output rms: more than 300W rms single-channel into 4 ohm; more than 250W rms both channels into 4 ohm; more than 150W rms into 8 ohm single and both channels driven.
Frequency response: 5-100k Hz, +0, —3 dB; 5-20k Hz, +0, —0.1 dB.
Full power response: 20-20k Hz, +0, —1 dB.
Hum and noise: 105 dB below full output typically, 95 dB minimum unweighted.
Distortion: at 1 kHz full power 0.008% typically; guaranteed less than 0.1% at any frequency from 20 Hz to 10 kHz and at any power level between 0.25W and full power into 8 ohm.
Damping factor: greater than 500 at low frequencies.
Slew rate: 20V/μs typically.
Input sensitivity: 0.775V rms for full power into 4 ohm.
Input impedance: 5k ohm at all level settings.
Load impedance: designed for 4-16 ohm systems.
Stability: stable with all speaker loads.
Power consumption: 700W nominal.
Power: 110-240V selectable.
Connectors: input self-locking 3-pin *XLR* type; output 5-way binding posts.
Weight: 18 kg.
Dimensions: (w x h x d): 483 x 177 x 270 mm.
Price: £000.

Manufacturer: FM Acoustics Ltd, PO Box 18, CH-8702 Zollikon-Station, Switzerland.

THE FM Acoustics *FM-600A* stereo power amplifier is rated at 300W per channel into 4 ohm, and is the smaller brother of the *FM-800A* rated at 500W per channel into 4 ohm. Both amplifiers are designed for mounting into a standard 483 mm rack via holes in the front panel, which is also equipped with two substantial carrying handles. These afford a degree of protection for the controls, which comprise two potentiometer-type gain controls and a large illuminated power on/off switch. Further front-panel features comprise a red 'error' lamp that illuminates if the amplifier overheats and a twin vertical led display of output level. This display consists of a yellow led to indicate 'peak' for each channel and a series of seven leds per channel below this 'peak' indicator, the other being coloured red and arranged at 5 dB intervals below +30 dB.

At the rear of the amplifier there are the twin banana socket/terminal-type output connections on the standard 19 mm spacing and a rather short, fixed mains power lead with its associated fuse. The two unbalanced inputs are via locking *XLR* sockets.

The mechanical form of construction is two very substantial side frames onto which the approximately 4 mm thick front and rear alloy panels are bolted. This forms a substantial frame for the amplifier but, unfortunately, the top and bottom covers are of thin sheet metal and easily bent. The mains transformer is directly mounted onto the side frames with the mains-voltage selector on a small sub-panel.

Mounted onto the rear panel are the two large heatsinks that house the output transistors, with the components associated with them being mounted on glass-fibre pcbs. The low-power section of both channels is contained on a third pcb, but components are not identified and no circuit information was provided. Two further pcbs are mounted onto the front panel, which also contains the level display and its components.

The widespread use of push-on connectors means that circuits can be easily replaced or moved for servicing. Good quality components are used throughout the amplifier.

Power output and distortion

The available power output at 1 kHz when driving the amplifier to clipping point with both channels driven was investigated into loads of 16, 8 and 4 ohm, and with a single channel driven into 2 ohm (**table 1**). It was found that the low power available into 2 ohm was associated with a tendency to instability on the negative waveform peaks, as is shown in **fig. 1** for fairly severe clipping to illustrate the performance. Furthermore it is felt that in view of this and the 'collapse' of the amplifier into a 2 ohm load, it may well be unsuitable for some 4 ohm loudspeakers where the actual impedance could approach 2 ohm at certain frequencies.

TABLE 1 OUTPUT POWER

Load	Output at onset of clipping	
	left	right
16 ohm	123W	123W
8 ohm	200W	200W
4 ohm	275W	275W
2 ohm	21W	24W

During high-power investigations it was found that the thermal trip on the amplifier operated regularly and this matter was investigated under programme conditions. The amplifier was loaded with 4 ohm resistors and placed on a flat bench with the ambient temperature at 25°C. The amplifier was then fed with music signal at a level such that the 'peak' indicator very occasionally illuminated. Under these conditions the amplifier tripped after about 15 minutes operation, suggesting that the amplifier must have forced air cooling for high-level operation. Indeed, similar conditions when working into 8 ohm loads also tripped the amplifier.

Measurement of the total harmonic distortion at frequencies of 1, 10 and 20 kHz at the rated output into 8 ohm, and also at 1W into both 8 and 4 ohm, gave the results in **table 2.** This also includes the distortion into the load in parallel with 2 μF at 1 kHz and 10 kHz. While these results generally indicate a good specification, the disastrous performance when

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working at 10 kHz into 8 ohm in parallel with 2 μF at full power gives cause for concern. It suggests that the amplifier may not always be stable into real loudspeaker loads with 'awkward' phase angles.

Examination of **figs. 2 and 3**, the individual harmonic distortion at 150W 1W output into 8 ohm, show correlation with the total harmonic distortion and reveals that the less subjectively objectionable second harmonic is predominant.

The intermodulation distortion performance to the CCIF twin-tone method using two tones of equal amplitude separated by 70 Hz is shown in **figs. 4 and 5** for an equivalent peak sinewave output of 150W and 1W respectively into 8 ohm. It can be seen that the distortion is extremely small at low frequencies but rises dramatically above 20 kHz at 150W output. Intermodulation distortion to the SMPTE method using a 70 Hz low-frequency tone mixed with a tone swept up to 20 kHz in the usual amplitude ratio of 4:1, showed that below 8 kHz this type of distortion was less than 0.03% rising to 0.1% at 20 kHz.

Measurement of the power bandwidth for 0.1% total harmonic distortion when driving 75W into 8 ohm showed that this extended from below 10 Hz to 24 kHz for one channel, and 27 kHz for the other—a respectable performance.

Frequency response and noise

Measurement of the frequency response at 150W and 1W output into 8 ohm showed that from 20 Hz to 20 kHz both responses were within 0.1 dB (**fig. 6**). It is to be noted that at high power the effective bandwidth falls, but this is not of significance for af applications. A peculiarity of this amplifier was a 'kink' in the ultrasonic frequency response, this effect also being observable in the phase response.

TABLE 3 OUTPUT NOISE

Weighting and meter	Signal-to-noise ratio left	right
20 Hz to 20 kHz rms	91 dB	92.5 dB
A-weighted rms	101 dB	100.5 dB
CCIR-weighted rms	100.5 dB	100.5 dB
CCIR-weighted quasi-peak	93dB	92.5 dB

The noise performance related to the rated power output of 150W into 8 ohm was measured weighted and unweighted using both rms and CCIR quasi-peak metering (**table 3**). While the manufacturer's noise specification is not absolutely clear, it would appear that this sample does not meet the specification. Furthermore, it is apparent that the noise performance is not particularly good. So far as unweighted noise is concerned, mains hum made a significant contribution and it appeared that there was some peculiarity in the earthing at the input. Even with the level controls at minimum, paralleling the inputs made a substantial difference to hum levels.

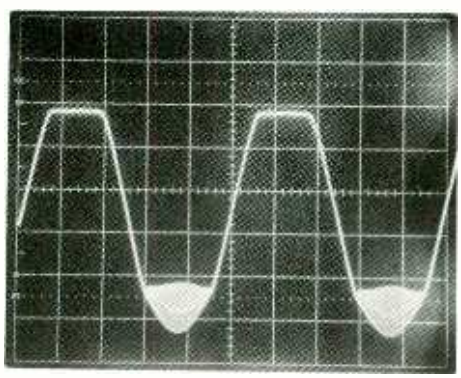

FIG. 1 Instability into 2 ohm load

Sensitivity and impedances

The input sensitivity at maximum gain for delivering 150W into 8 ohm with both channels driven was found to be 1.04V into an impedance that varied slightly with the gain setting. At minimum gain the input impedance was 4.78k ohm in parallel with 250 pF, changing to 3.78k ohm in parallel with 600 pF at maximum gain. These impedances are on the low side for convenient matching. As can be seen from the plot of output impedance against frequency in **fig. 7**, the output impedance at low frequencies was very low with a consequently very high damping factor.

Other matters

Testing with squarewaves showed that the risetime of the amplifier was very fast at 1.8 μs, but that the maximum slew rate did not follow this pattern and was only 10 V/μs when working into 8 ohm. Loading the amplifier with 8 ohm in parallel with 2 μF produced severe overshoot and ringing. This is shown in **fig. 8**, which shows the worst of the two channels. Driving the amplifier at half power at 1 kHz and then bursting it into heavy asymmetrical overload for 20 ms produced the satisfactory overload recovery pattern shown

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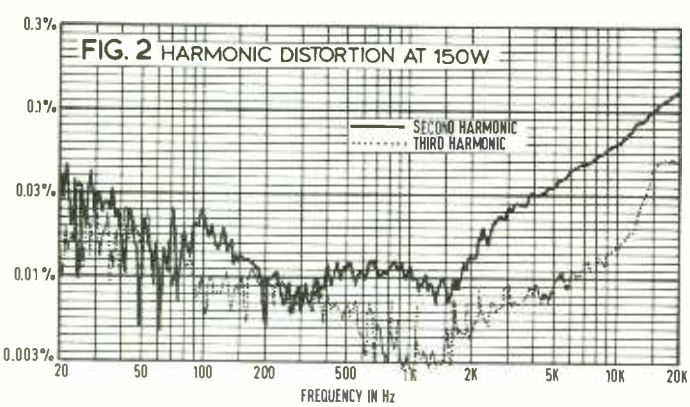
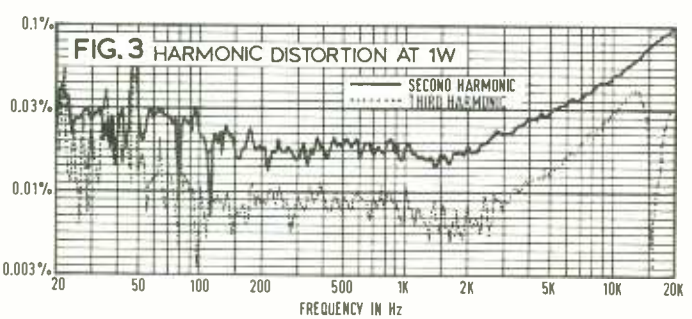
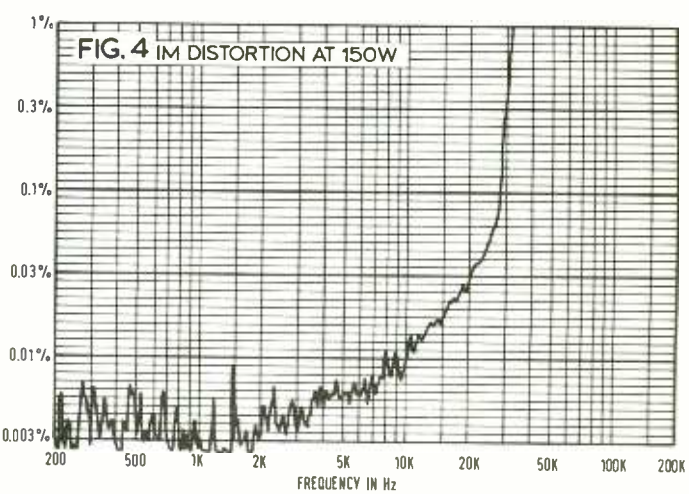
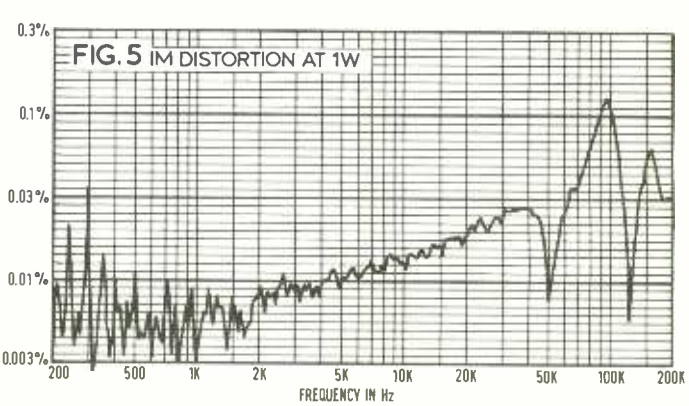








If you aren't thinking about this you shouldn't be buying a console.

Solid State Logic Ltd. Church Rd. Stonesfield Oxford England. Telephone (099 389) 324.

U.S.A. — Australasia: Sierra Audio Corp. Burbank California U.S.A. Telex 691138.

in fig. 9.

As is to be seen from the plot of phase shift against frequency when driving 1W into 8 ohm (fig. 10) the phase shift at af is small. It will be noted, however, that there is a peculiarity in the phase shift pattern just above 100 kHz and, as previously mentioned, the frequency response exhibited a similar discontinuity.

Crosstalk between the channels when driving 150W into 8 ohm (fig. 11) shows very good performance at high frequencies, but not the best performance at low frequencies. The dc offset at the output was found to vary slightly with temperature and was in the region of 90 mV.

Finally, the level metering was investigated and found to have a response time of 20 ms without any hold circuitry—it being rather difficult to see the yellow 'peak' led indicator operate on short-term overload. Because the level indication was not compensated for the amplifier load, the peak indicator corresponded to 190W into 8 ohm or 375W into 4 ohm; the latter power ran the amplifier into severe distortion.

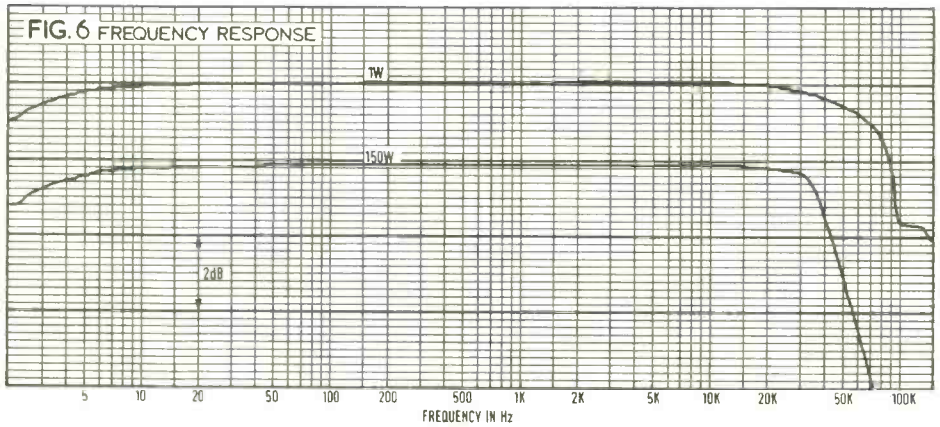
Checking the increments between level indicators (nominally 5 dB) showed that only the step between the indications of 5 and 10 dB was correct, the remaining steps being 6 dB within 0.2 dB—something awry here!

Summary

While from some points of view this amplifier has much to offer, I do not feel happy about a number of matters. Going through this review reveals various small points such as the instability into 2 ohm loads which give cause for concern. Perhaps for a professional point of view, the ease with which the amplifier overheats, even on programme material and trips puts it out of court for some applications? ■

TABLE 2 TOTAL HARMONIC DISTORTION

Output power and load	Frequency	Resistor only		In parallel with 2μF	
		left	right	left	right
150W into 8 ohm	1 kHz	0.0075%	0.011%	0.0075%	0.011%
	10 kHz	0.045%	0.045%	0.25%	0.27%
	20 kHz	0.065%	0.010%		
1W into 8 ohm	1 kHz	0.03%	0.025%	0.03%	0.025%
	10 kHz	0.045%	0.032%	0.07%	0.063%
	20 kHz	0.053%	0.16%		
1W into 4 ohm	1 kHz	0.04%	0.035%	0.04%	0.035%
	10 kHz	0.077%	0.065%	0.10%	0.09%
	20 kHz	0.093%	0.11%		



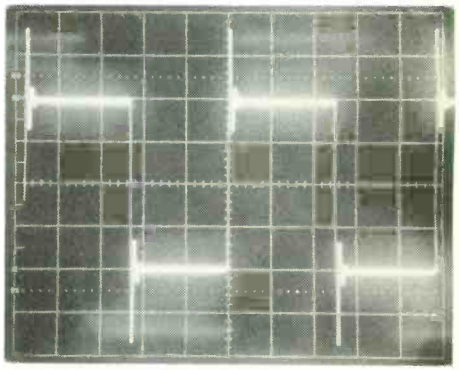
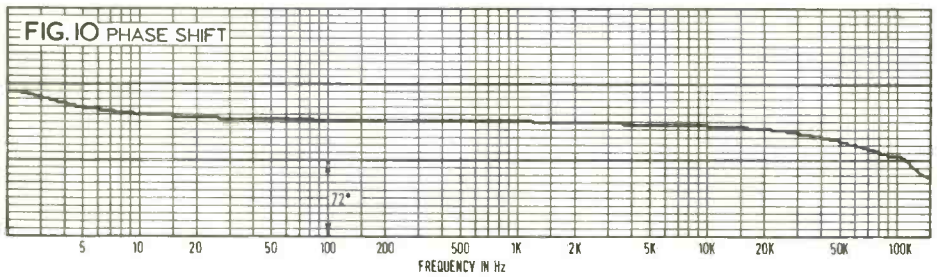


FIG. 8 Squarewave into 8 ohm load plus paralleled 2μF capacitor.



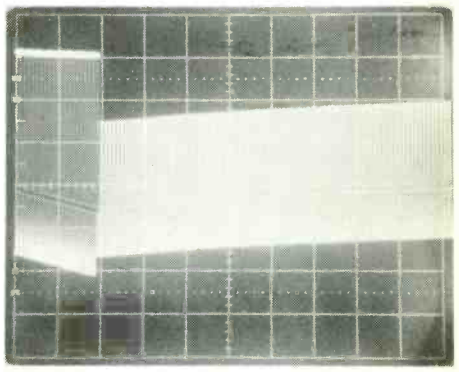
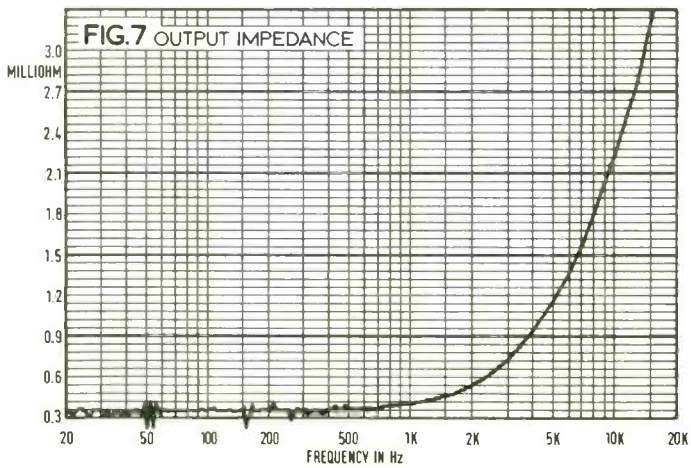
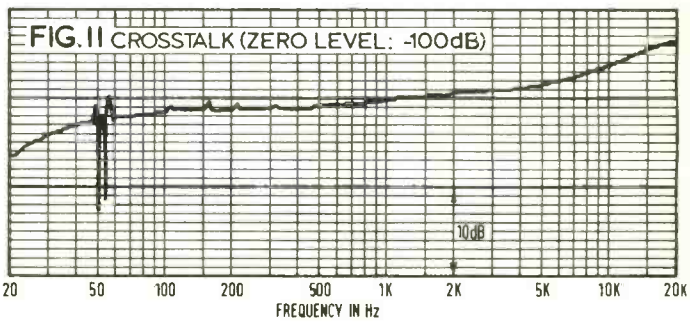


FIG. 9 Recovery from heavy asymmetrical clipping.





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Hugh Ford

MANUFACTURER'S SPECIFICATION

Power output: 150W minimum rms per channel*, both channels driven into 8 ohm from 20 Hz to 20 kHz with less than 0.05% thd.
Power bandwidth: 5-70k Hz at less than 0.05% thd into 8 ohm, both channels driven simultaneously at 75W per channel.
Frequency response: from less than 4 Hz to greater than 40 kHz, ±0.5 dB at less than 0.05% thd.
Squarewave rise time: better than 3 μs.
Phase shift: less than 0.5° at 20 Hz, less than 12° at 20 kHz.
Slew rate: greater than 30 V/μs.
Total harmonic distortion: less than 0.05% from 250 mW to 150W rms, both channels driven simultaneously into 8 ohm (20-20k Hz).
Intermodulation distortion: less than 0.05% from 15 mW to 150W.
Hum and Noise: better than 100 dB below 150W.
Damping factor: greater than 300:1.
Input impedance: 10k ohm.
Input sensitivity: 1.25V for 150W.
Inputs: one RCA phono terminal per channel.
Outputs: instrument-type binding posts; accept speakers from 4 to 16 ohm.
Dimensions (w x d x h): 483 x 356 x 235 mm.
Weight: 24.9 kg.
*The unit is internally bridgeable for monaural operation and provides 300W driven into 16 ohm from 20 Hz to 20 kHz with less than 0.05% thd.
Price: £620.
Manufacturer: Harman/Kardon Inc, 55 Ames Court, Plainview, NY 11803, U.S.A.
UK Agent: Harman (Audio) UK Ltd, St John's Road, Tylers Green, High Wycombe, Bucks.

RATED AT 150W per channel into 8 ohm the Harman/Kardon *Citation 16* is a very heavy massive-looking amplifier. However, as will be seen this rating is a conservative figure and the amplifier has many virtues. Mechanically the amplifier is of solid construction with two carrying handles on the front panel that afford a degree of protection for the controls. The amplifier is designed for mounting into a standard 483 mm rack without removing the handles.

The front-panel controls and facilities include a pushbutton mains power switch adjacent to two red indicator lights that show power is available to each of the two channels. The remaining two front-panel controls consist of a pair of rotary switches associated with the led level display. This display, which has a rather gimmicky 'domestic' look, consists of eight led indicators for each channel. The upper two leds are red and illuminate at 0 and −3 dB; the next lower leds are coloured yellow and are illuminated at −6 and −9 dB; the remaining leds are green and indicate levels of −12, −18, −24 and −30 dB. One of the previously mentioned rotary switches controls the display sensitivity, such that the 0 dB level can correspond to 4, 16, 64 or 160W. In addition it provides a 'display-off' position and a test position in which all leds are illuminated. The second rotary switch has two positions that adjusts the display only for either 8 or 4-ohm working.

This rather complex and, I consider, unnecessary display completes the front panel features. On the rear of the unit are the fixed power cord plus input and output connections. The inputs are unbalanced RCA phono connectors, while the outputs are in the form of terminals that cannot be used with banana plugs. Also to the rear of the unit are the two large finned heatsinks, each of which house ten output transistors. Presumably these heatsinks are necessary because the unit is said to be a Class A amplifier.

Internally each amplifier is mounted on a clearly laid out glass-fibre pcb with good component identifications for servicing. In addition, connections to the boards comprise

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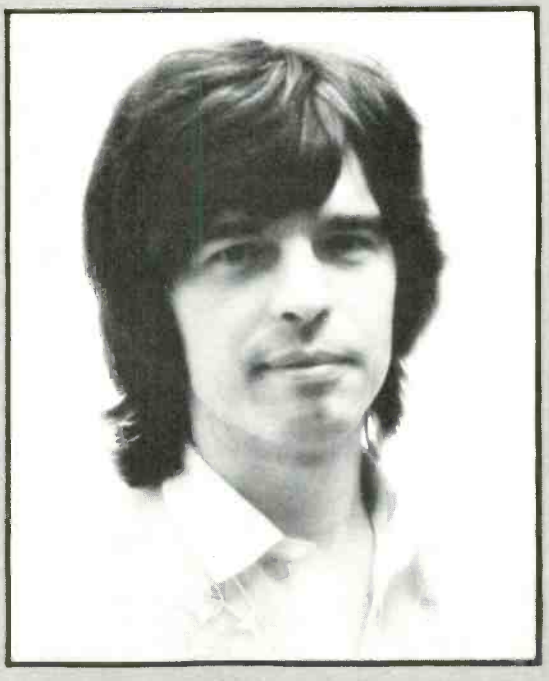

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slide-on or pin connectors such that the boards can be easily replaced without soldering. A third pcb houses the relay associated with the delayed and thump-free switch-on.

Overall the construction of the amplifier was to a very high standard from both the mechanical and the electrical points of view, with tidy wiring and good workmanship throughout.

Power output and distortion

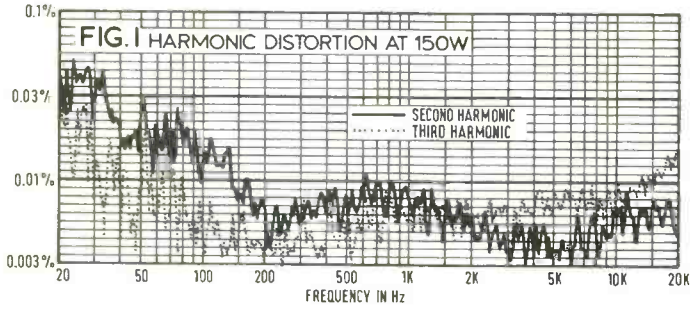
While the amplifier can be operated in the bridge mode no information was provided about making the necessary connections. Hence only the normal two-channel mode was investigated. The available output power at the onset of clipping at 1 kHz was investigated with both channels driven into loads of 16, 8 and 4 ohm. And into 2 ohm with single channels driven. The results are shown in **table 1.** And it would appear that the amplifier is suitable for loudspeakers having nominal impedances of 8 ohm or above, but that the use of loudspeakers of nominal 4 ohm impedance may be marginal if the actual impedance falls much below this value.

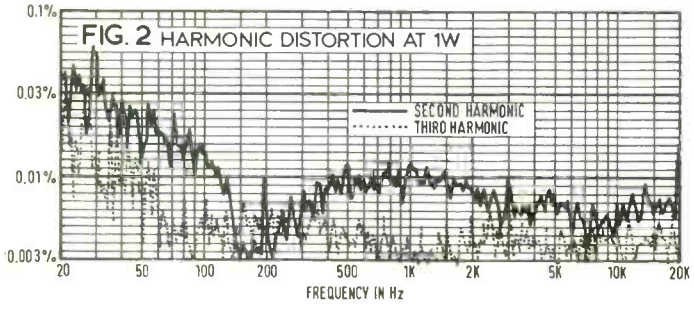
Total harmonic distortion was measured at the rated power output of 150W into 8 ohm, as well as at 1W into both 8 and 4 ohm, at 1, 10 and 20 kHz. In addition, the total harmonic distortion was measured at 1 and 10 kHz with the load shunted with a 2 μF capacitor (**table 2**).

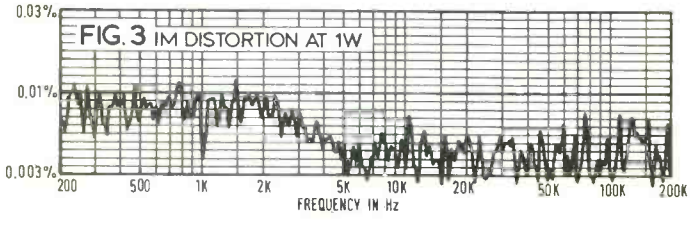
TABLE 1 OUTPUT POWER

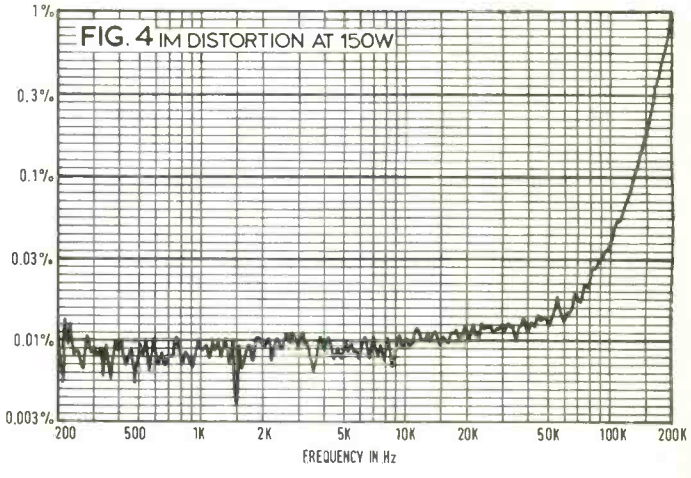
Load	Output at onset of clipping	
	left	right
16 ohm	150W	148W
8 ohm	250W	246W
4 ohm	335W	270W
2 ohm	100W	75W

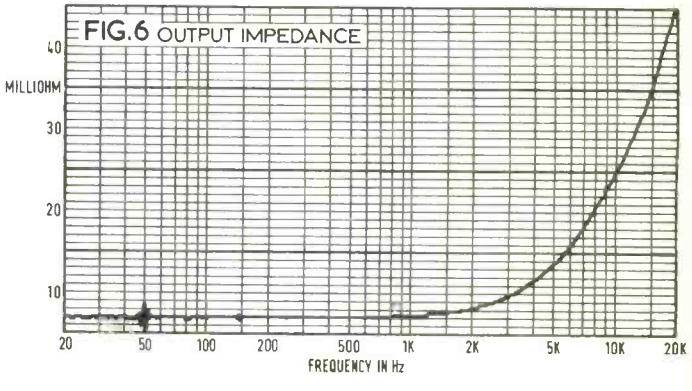
Attempts to measure the individual harmonic distortion at 150W into 8 ohm and at 1W into 8 ohm produced **figs. 1 and 2.** These are very close to the residual distortion of the testgear, confirming the excellent measurements made on the total harmonic distortion. Furthermore, attempts to measure the twin-











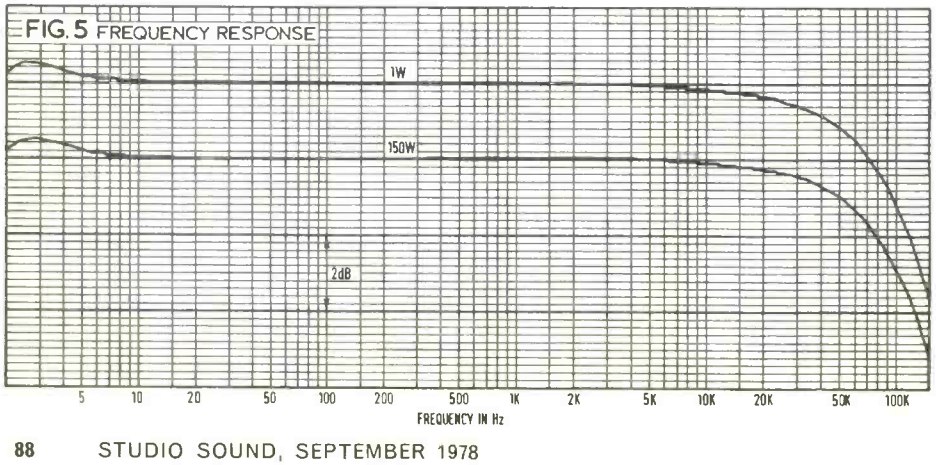
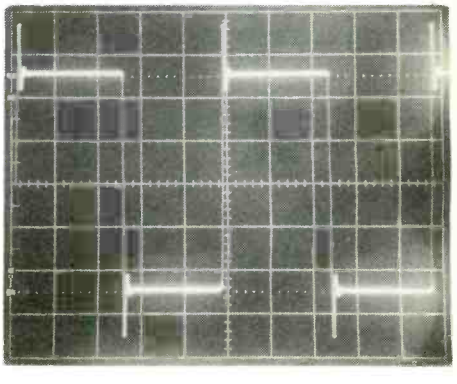


FIG. 7 Squarewave into 8 ohm load plus paralleled 2μf capacitor.



tone CCIF intermodulation distortion at 1W output into 8 ohm merely plotted the residual distortion of the testgear, as shown in **fig. 3.** At 150W peak equivalent sinewave the results were little different up to 50 kHz, as shown in **fig. 4.**

Similarly the intermodulation distortion to the SMPTE method using a 70 Hz low-frequency tone showed less than 0.01% im distortion, with the high-frequency tone swept up to 20 kHz at the usual 4:1 amplitude ratio.

The power bandwidth for 0.1% total harmonic distortion at the half rated power of 75W per channel into 8 ohm was also excellent, with both channels performing from below 10 Hz to above 90 kHz. It follows that this amplifier is a really excellent performer from the point of view of all types of distortion.

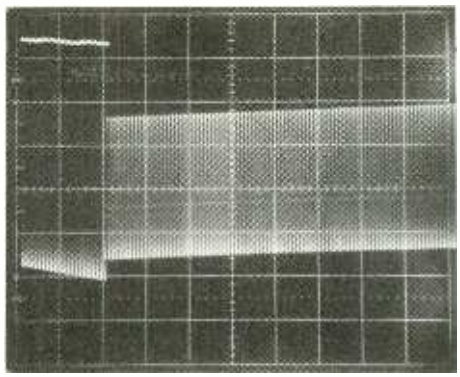
Frequency response and noise

Inspection of the frequency response plots in **fig. 5** for both 1W output and 150W output shows that both curves are effectively identical. Response in the af band from 20 Hz to 20 kHz is in both cases within +0, –0.3 dB, falling to –3 dB at 100 kHz.

Noise in the output was measured relative to the rated output power of 150W into 8 ohm (**table 3**).

Sensitivity and impedances

The fixed input sensitivity for both channels to drive 150W into 8 ohm was found to be identical at 1.26V at 1 kHz, with an input impedance of 21.9k ohm in parallel with 170 pF in both cases. The output impedance was very low below 2 kHz, as is shown in the plot of output impedance versus frequency in **fig. 6.**



▲**FIG. 8** Recovery from heavy asymmetrical clipping.

TABLE 3 OUTPUT NOISE

Weighting and meter	Signal-to-noise ratio left	right
20 Hz to 20 kHz rms	106.8 dB	107 dB
A-weighted rms	115 dB	115.5 dB
CCIR-weighted rms	108.5 dB	108.5 dB
CCIR-weighted quasi-peak	98.5 dB	97.4 dB

TABLE 2 TOTAL HARMONIC DISTORTION

Output power and load	Frequency	Resistor only left	Resistor only right	In parallel with 2μF left	In parallel with 2μF right
150W into 8 ohm	1 kHz	0.006%	0.007%	0.006%	0.007%
	10 kHz	0.013%	0.012%	0.027%	0.09%
	20 kHz	0.020%	0.017%		
1W into 8 ohm	1 kHz	0.005%	0.0035%	0.005%	0.0035%
	10 kHz	0.0045%	0.0035%	0.0075%	0.014%
	20 kHz	0.0047%	0.004%		
1W into 4 ohm	1 kHz	0.006%	0.0045%	0.006%	0.0045%
	10 kHz	0.008%	0.005%	0.012%	0.014%
	20 kHz	0.0095%	0.007%		

Other matters

Squarewave testing showed that the risetime of the amplifier was fast at only 3 μs with also a very high slew rate of 25V/μs. This would partially account for the excellent high-frequency intermodulation distortion performance. Driving squarewaves of 1 kHz into a load of 8 ohm in parallel with 2 μF produced **fig. 7** for a 1 kHz signal; it can be seen that there is some overshoot and also a degree of ringing.

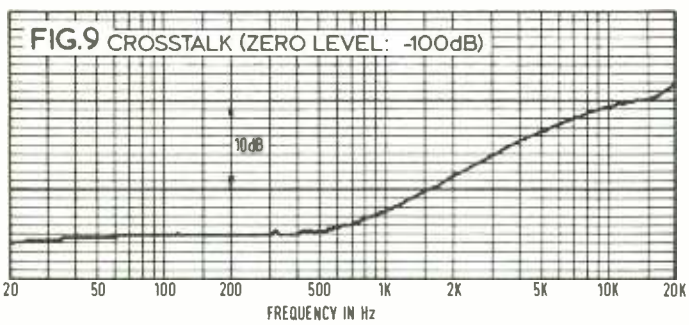
The overload performance when continuously driving the amplifier at half power and applying a highly asymmetrical toneburst of 20 ms duration well into overload is shown in **fig. 8.** It can be seen that the amplifier's recovery is clean without excessive dc offset, the normal dc offset in the output being very small at 3.5 and 1.5 mV for the two channels.

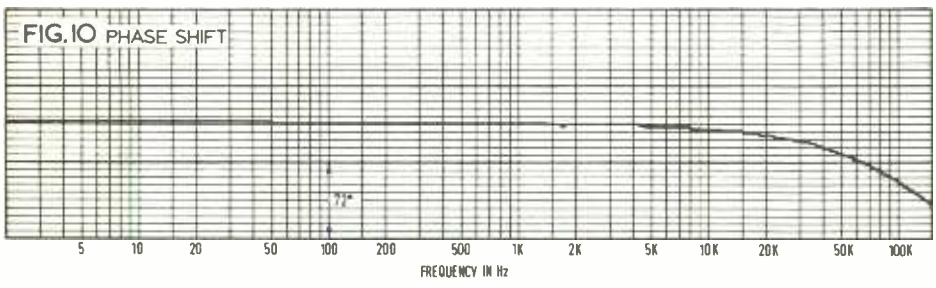
As can be seen from **fig. 9** the crosstalk between channels with one channel driven at the rated power output is unusually small, this being due in part to the use of separate power supplies. It was also noted, as shown in **fig. 10,** that the overall phase shift was negligible within the af band.

So far as the front-panel power level indicators are concerned, these were found to be fast acting peak-reading devices which provided an useful indication within 1 ms. But, as already stated, there seems to be little virtue in including a display of this type.

Summary

While this amplifier has many characteristics of a 'domestic' unit its performance was found to be excellent from all points of view, and has more than adequate power for driving 8 ohm monitor loudspeakers. The standard of construction is beyond reproach. Furthermore, it is understood that there will be available a version without the level display, which is, I feel, an unnecessary gimmick. ■





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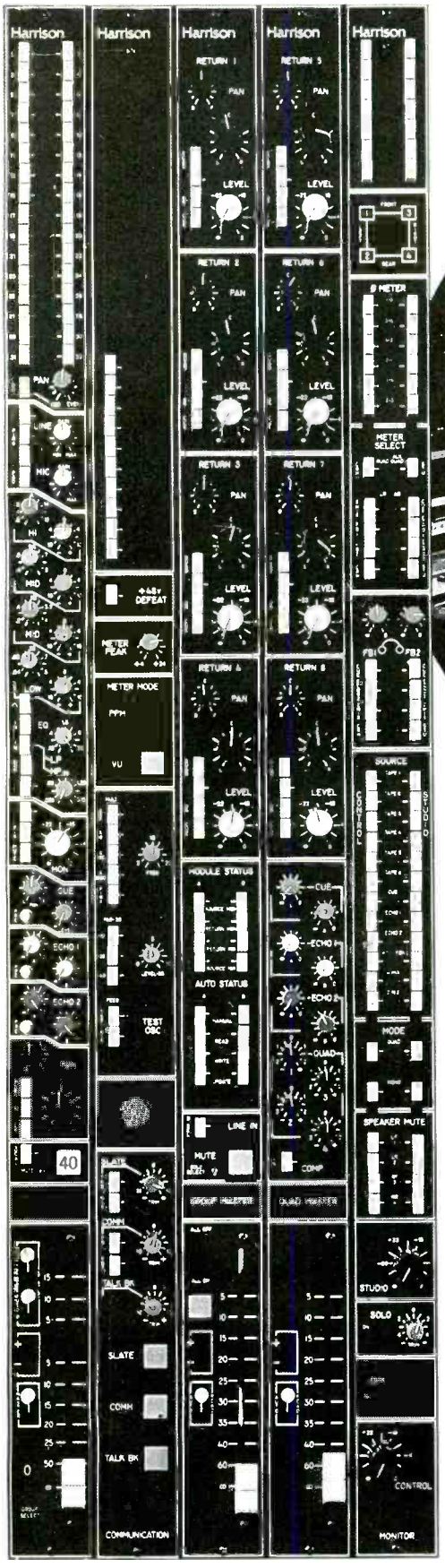

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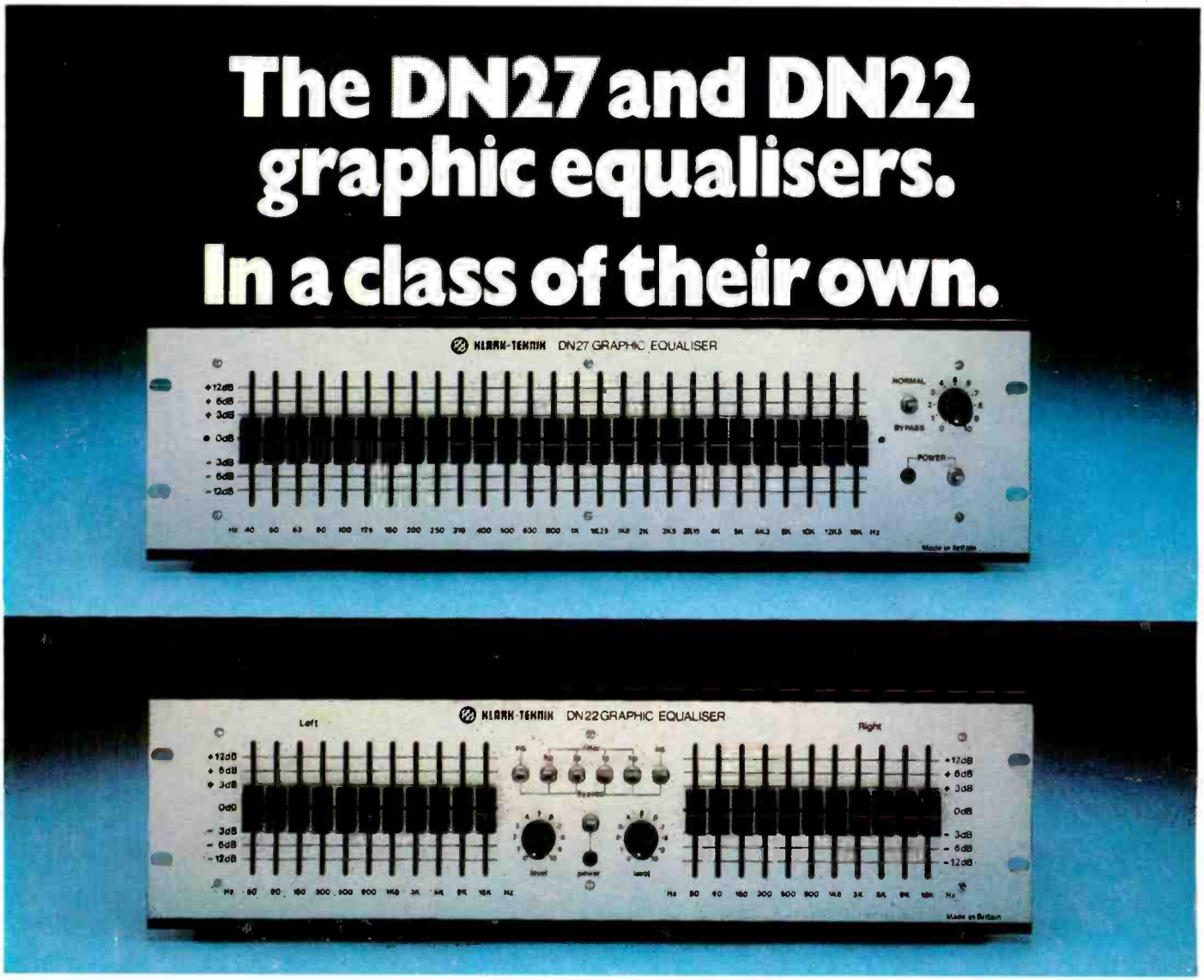

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