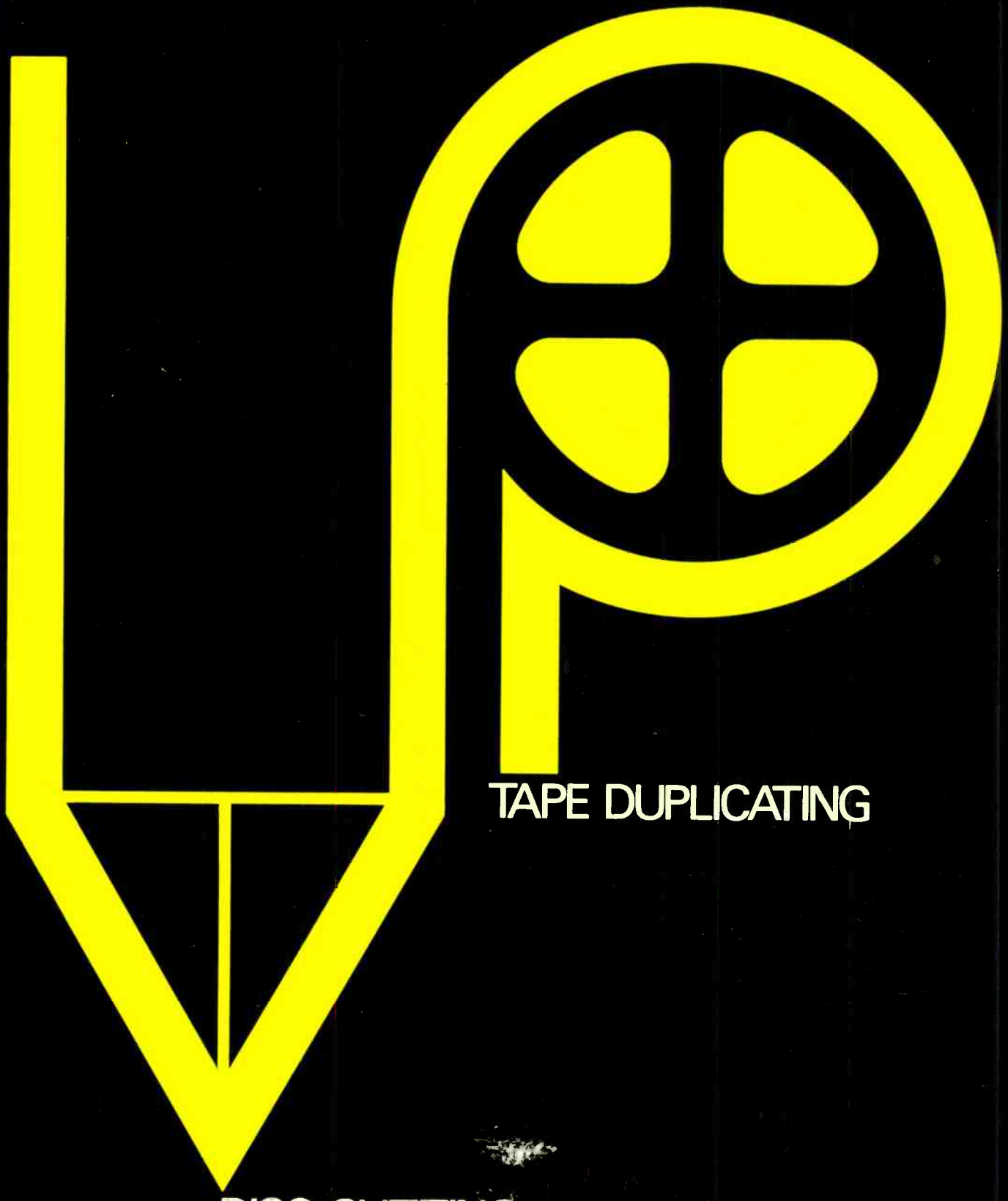
studio sound

July 1975 25p

AND BROADCAST ENGINEERING



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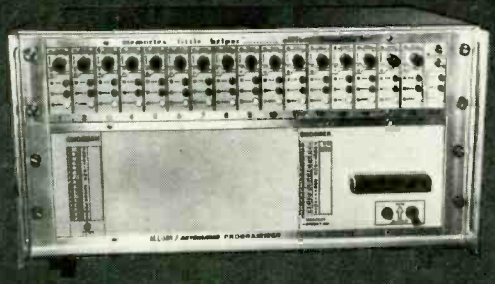

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studio sound
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COLUMNS

DISTRIBUTION

STUDIO SOUND, published monthly, enables engineers and studio management to keep abreast of new technical and commercial developments in electronic communication. It is available without charge to qualified readers: these being directors, managers, executives and key personnel actively engaged in the sound recording, broadcasting and cinematograph industries. Non-qualifying readers can buy STUDIO SOUND at an annual subscription of £5.52 (UK) or £5.56 overseas.

CORRESPONDENCE AND ARTICLES

All STUDIO SOUND correspondence should be sent to the address printed on this page. Technical queries should be concise and must include a stamped addressed envelope. Matters relating to more than one department should occupy separate sheets of paper or delay will occur in replying.

BINDERS

Loose-leaf binders for annual volumes of STUDIO SOUND are available from Modern Bookbinders, Chadwick Street, Blackburn, Lancashire. Price is £1.25 (UK and overseas). Please quote the volume number or date when ordering.

JULY 1975 VOLUME 17 NUMBER 7

THE recent UK Budget introduced for the first time the requirement to pay VAT at more than one rate, not including the academic zero rated items. The thinking, both social and economic, which led to such a decision may be discussed from both left- and right-wing standpoints. That, however, is a subject better dealt with elsewhere, for while a specialist paper might permit itself the liberty of a particular stance, such a subject is too wide for its coverage. Thus, the application of 25% to domestic luxury items such as hi-fi is taken for granted, as is the 8% rating on records. Unfortunately, the application of such legislation places recording studios in a confusing fringe area. Further woolliness is introduced when items are defined by function. For example, while a cheap stereo system is bought by a recording studio in the same way as a domestic consumer, its use as a grot-box monitor places it in the same category as a big mixer: a tool. Disc players and cassette recorders suffer the same schizophrenia. Previous anomalies under the old purchase tax were the other way round: the function was defined by the equipment, so that a very clear distinction was made between, for example, 25 cm (domestic) and above (industrial) loudspeaker drive units, whatever the final application.

For Vatman to make a clear decision, he must understand the operation of the record business. This is more than the legislators managed. There is a suspicion that, to the civil service outsider, a recording studio is simply some kind of glorified stereo system. Recording and ancillary equipment has more in common, functionally, with factory machinery or farm vehicles than with domestic hi-fi. Perhaps electricity is to blame, for it appears branded as modern and disreputable. If you plug your instrument into the mains it costs 25%; if not it's a bargain eight, and this despite the fact that a greater proportion of electric people play professionally. 'Electric' guitar strings are 25%, but buy them for a steel-string acoustic and the apparent rate should be 8%.

It has been mentioned that the VAT is reclaimable or passed on anyway, so that there is no overall financial loss. This first thought overlooks to some extent the liquidity situation of a studio. Since studio time is sold at 8%, the balance must be carried for some time if a 25% rate is applied earlier in the purchasing chain. The situation is aggravated when a master is for export and consequentially zero-rated.

Since the declared principle behind the split ratio is to inhibit luxury consumption, it is obvious that as a product moves towards completion and final sale, the rate must only remain stationary or increase. The simplest position for increase is at the retail stage or the one before. Viewing record production overall, the recording studio is so far back in the manufacturing process as to be almost invisible . . . but records remain at 8% anyway, the non-luxury category.

At the time of writing one hopes that reason prevails as usual, although signs are not encouraging. But even if the obvious is made clear, a lot of time and effort will have been wasted in a bureaucratic paper chase which could have been avoided with a little forethought. Even if the studio business is a drop in an economic ocean to the Treasury, it still feels quite big down here.

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

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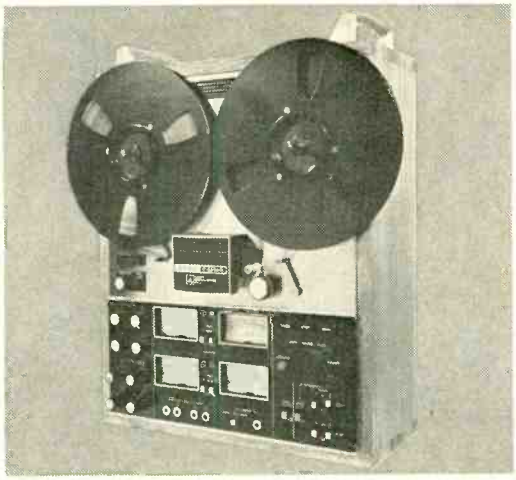

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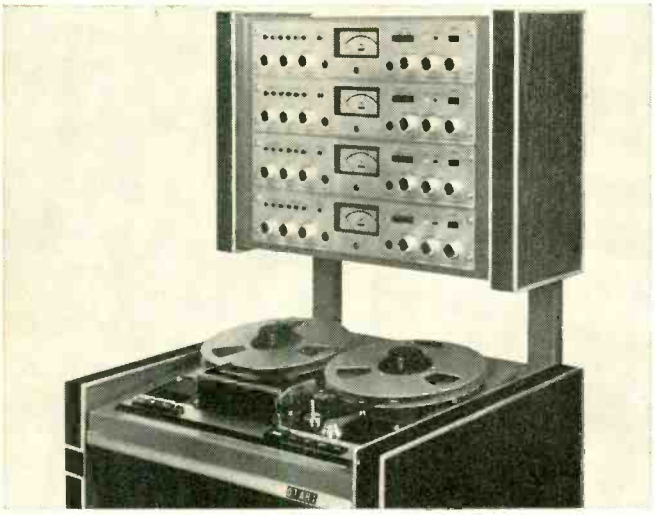

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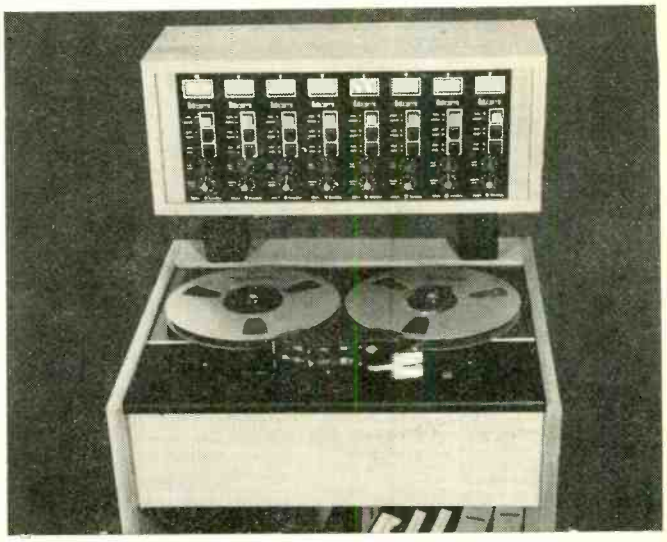

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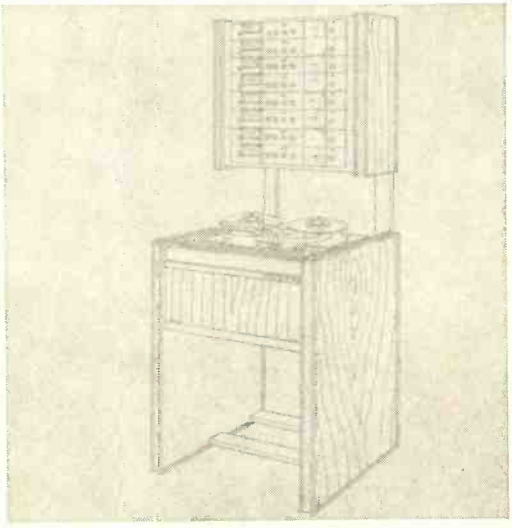

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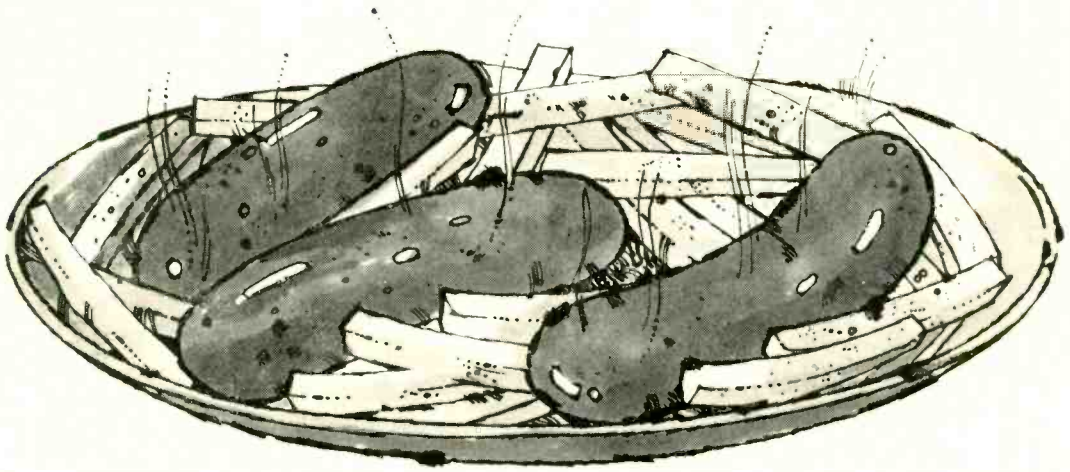

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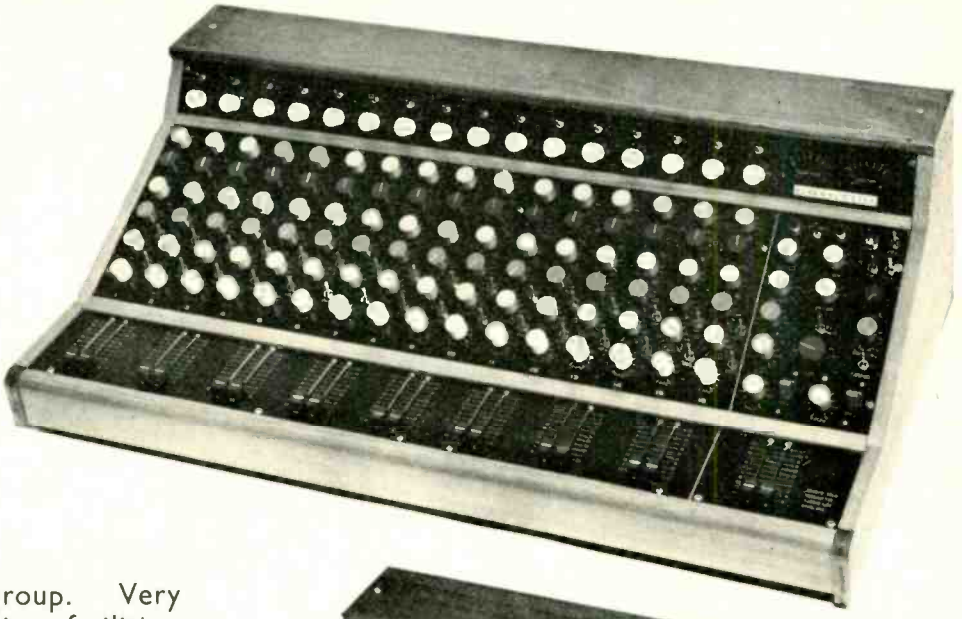

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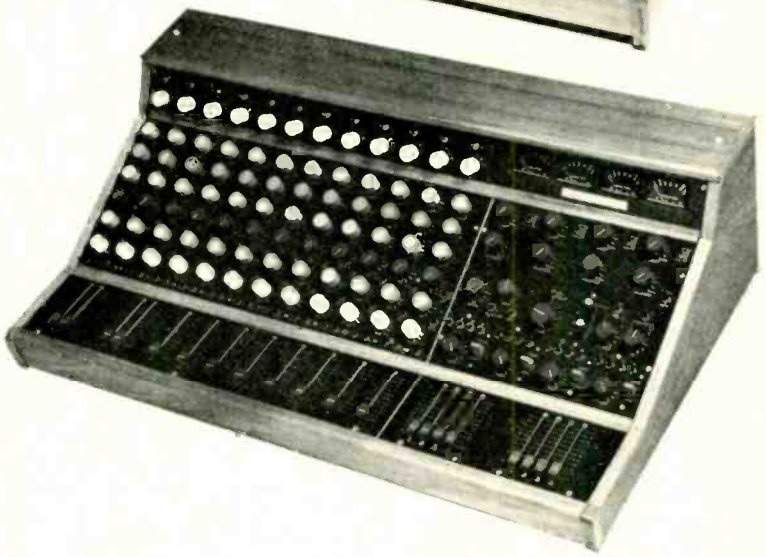

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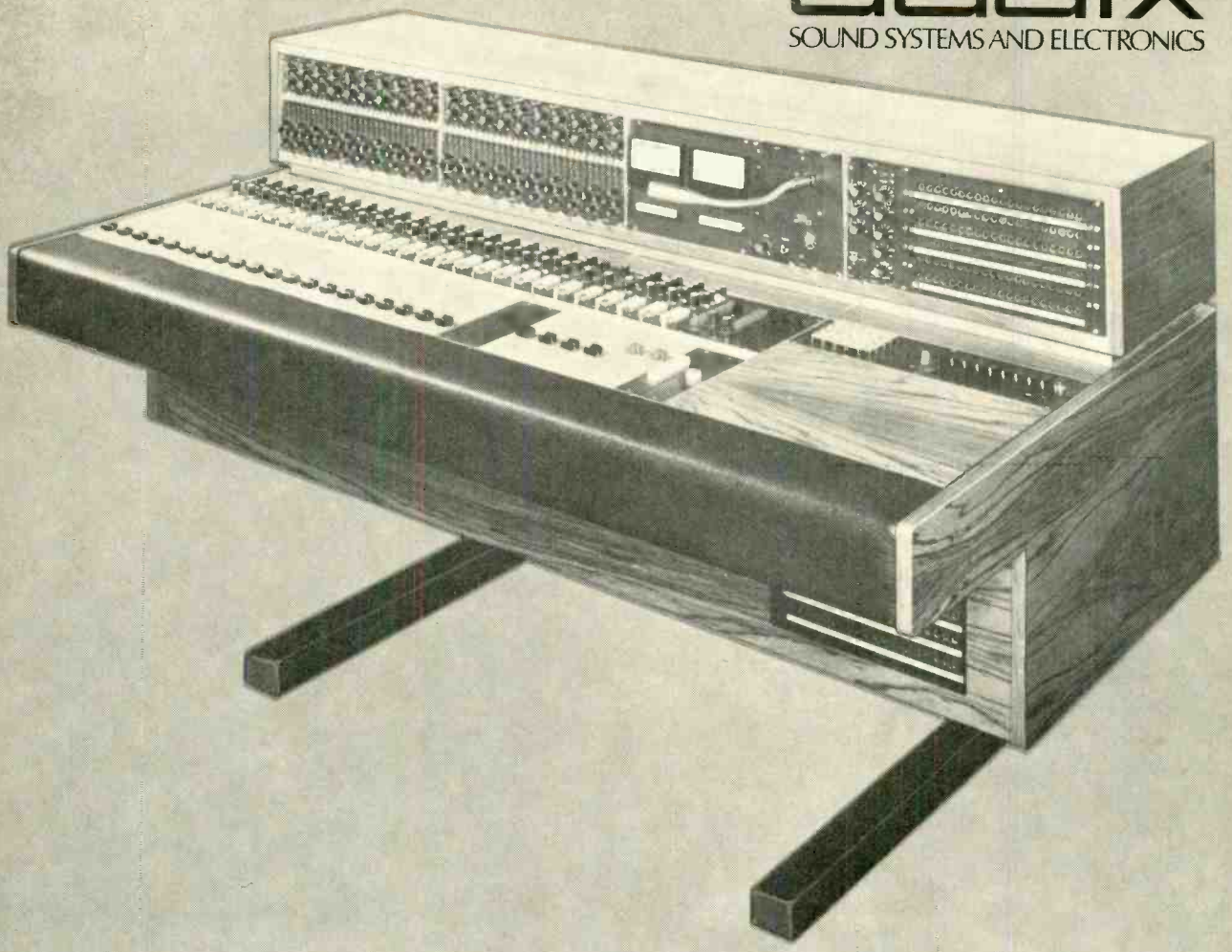

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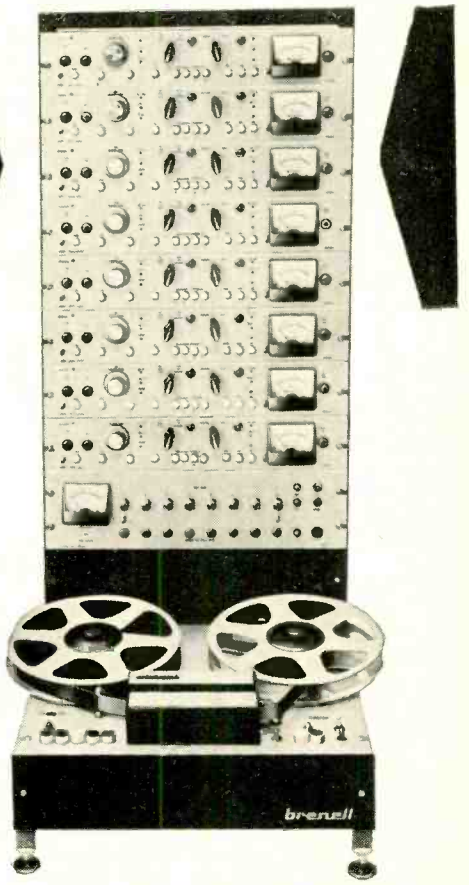

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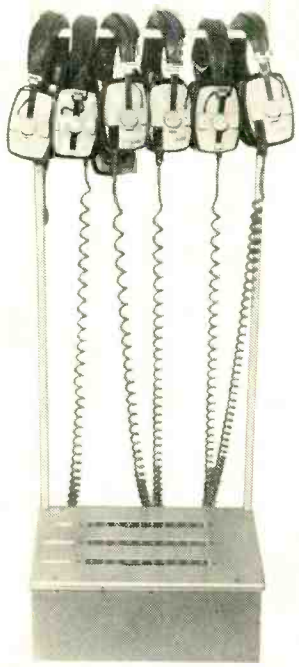

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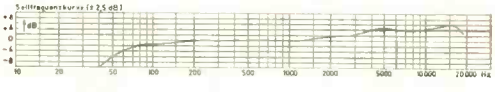

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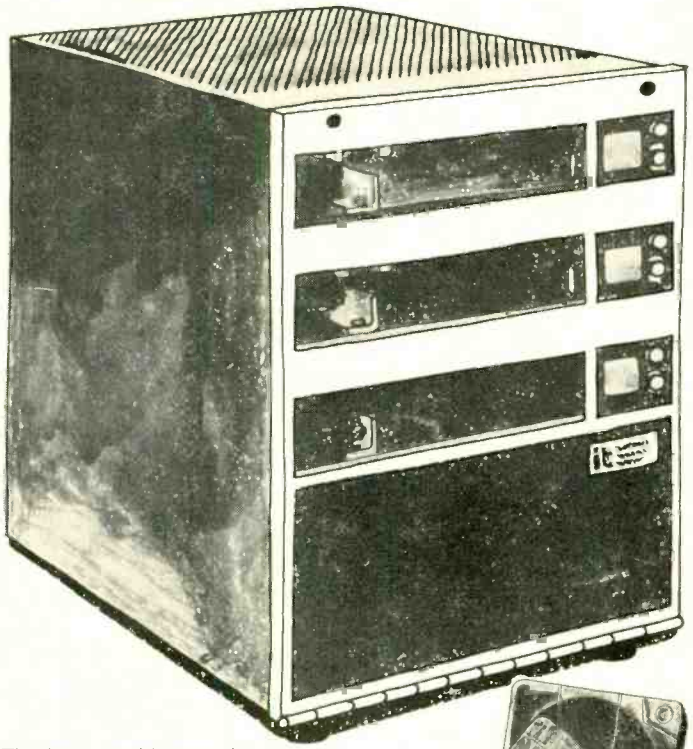

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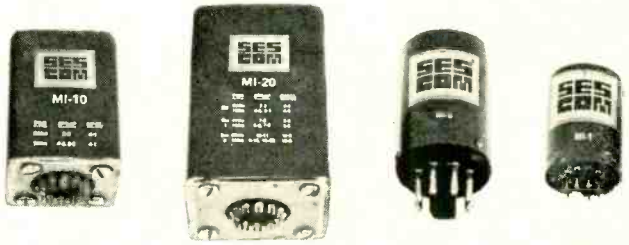

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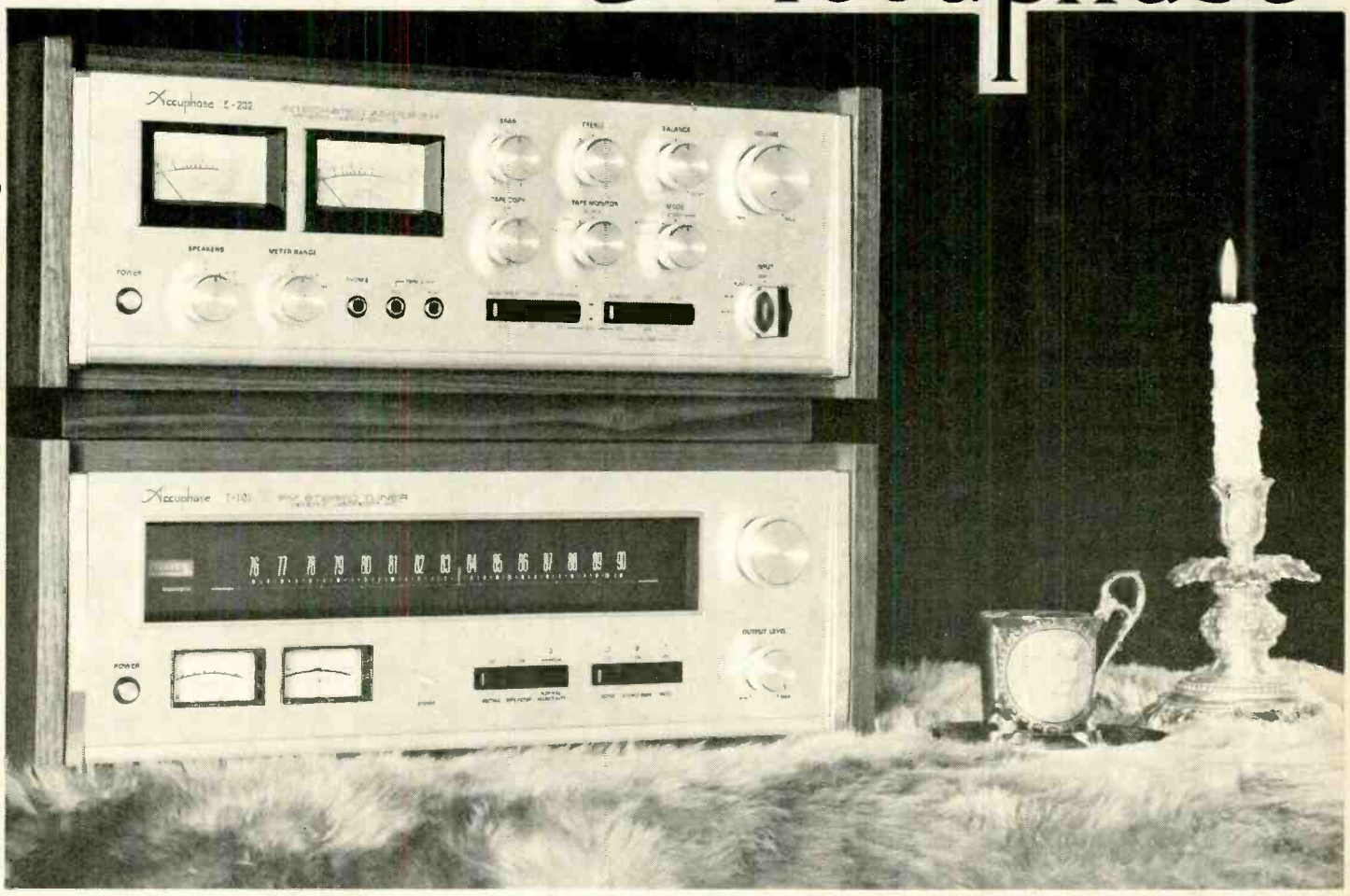

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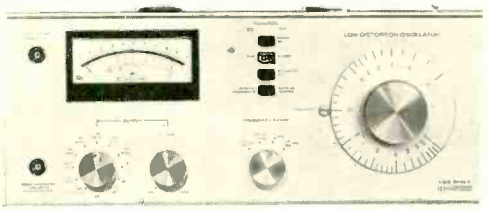

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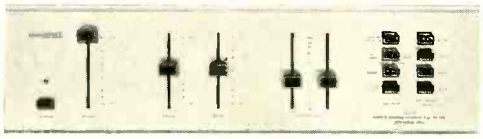
AUDIO AMPLIFIERS

HR AUDIO



FOR THE PROFESSIONAL

Illustrated is the ZD22 Pre-amplifier from a range of audio amplifiers including two new power amplifiers in the ZD range having virtually zero distortion at rated operating levels.

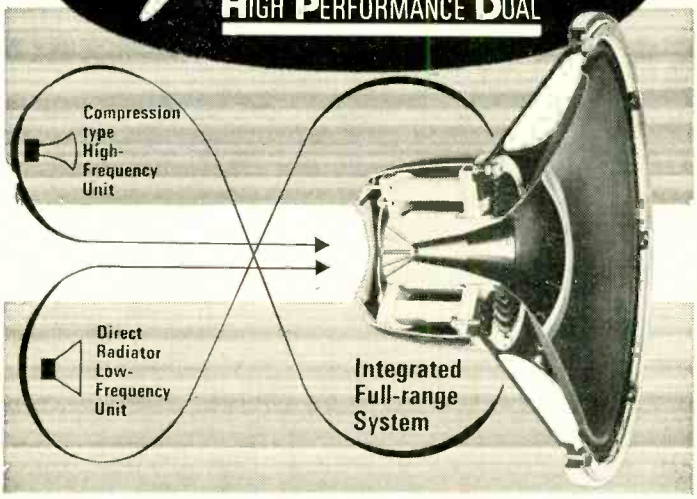
ZD100 Power amplifier (75 watts into 8 ohms, 125 watts into 4 ohms)

ZD200 Power amplifier (125 watts into 8 ohms, 250 watts into 4 ohms)

Hedley Radford Instruments Ltd.
Hedley Radford Audio Ltd.,
Ashton Vale Road, Bristol BS3 2HZ
Tel. 0272 662301

THE New TANNOY Monitor

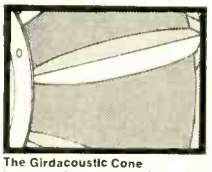
HIGH PERFORMANCE DUAL



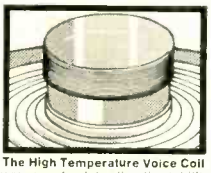
The Monitor H.P.D. represents a further outstanding improvement of a loudspeaker system which has become regarded as a quality standard over the last 25 years by Recording Studios throughout the world. There is a very good chance that your favourite records and tapes were monitored on Tannoy Dual Concentric loudspeakers, and to select these superbly engineered, individually hand-assembled speakers for *your* music system assures you of the same professional performance.

	260 mm 10″	310 mm 12″	410 mm 15″
Power Handling Capacity*	50W	60W	85W
Frequency Response	27-20,000 HZ	25-20,000 HZ	23-20,000 HZ
Intermodulation Products	less than 2%	less than 2%	less than 2%
Impedance via Crossover network	8 ohms (5 ohms min.)	8 ohms (5 ohms min.)	8 ohms (5 ohms min.)

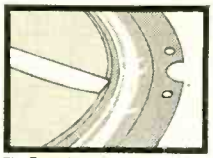
*INTEGRATED PROGRAMME MATERIAL



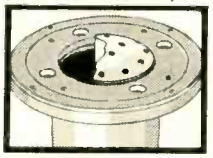
The Girdacoustic Cone improves frequency and transient response, gives much increased power handling capacity and greater mechanical stability.



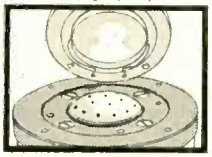
The High Temperature Voice Coil assures absolute climatic stability and great mechanical strength together with much improved power handling capacity.



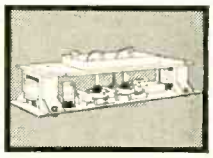
The Tanoplas Surround gives low bass resonance with excellent mechanical stability and freedom from edge reflections.



Patented Magnetic Shunt combined with specially treated and selected steel gives maximum magnetic flux in the unique Tannoy twin gap system. Improves sensitivity and damping.



Unique High Frequency Unit with separate diaphragm and voice coil coupled to the horn by a 19 element phase-matching system.



High Power Crossover Unit with solid dielectric condensers throughout, combined with treble and roll-off controls.

Designed to sound better—naturally...

TANNOY®

NORWOOD RD. WEST NORWOOD SE27 9AB
Tel: 01-670 1131 Telex: 949755

Ferrograph Professional Studio 8 Console

Full logic control. Tape motion sensing. Two speeds. Servo-controlled capstan. Constant tape tension. Direct-reading tape timer (minutes and seconds). Three editing modes. Provision for synchronisation, remote control and remote display panel. Available for line-in/line-out or with mixing and monitoring facilities. IEC or NAB equalisation. Full or half-track mono, dual track or stereo. Easy access for maintenance. Also available in transportable and rack-mounted versions.

For full details contact Ferrograph Professional Recorder Company, 442 Bath Road, Slough SL16BB. Telephone Burnham (06286) 62511. Telex 847297. Cables Britferro, Slough.

amcron

800 SERIES RECORDER

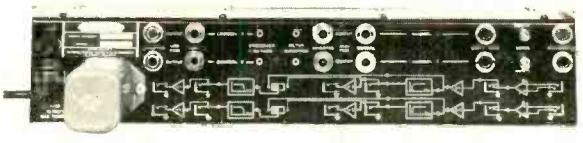
* Computer Logic Control. Prevents tape breakage by providing fool-proof operating controls.
* Feather touch push-button mode controls.
* Photo-cell, automatic shut-off in all modes.
* Take-up reel motor shut-off switch for editing.
* Motor shut-off switch (electronics remain on).
* Cue lever for controlling tape-to-head contact.
* Professional styling and colour combinations.
* Fully remote controllable.
* Patented electro-magnetic brakes.
* Plug-in modules for all functions: mic modules optional.
* Built in remote record (CX-800's) for no thumps on tape at beginning or end of record mode.
* Echo controls built in.
* Front panel bias adjustment.
* 3-speed equalization.
* Treble and bass controls with "flat" detents.
* Available with 600 or 250 ohm balanced XLR cannon inputs and outputs as an accessory.

AVAILABLE IN
MONO, STEREO, OR
FOUR TRACK IN-LINE

NEW

VFX-2
DUAL CHANNEL CROSSOVER/FILTER

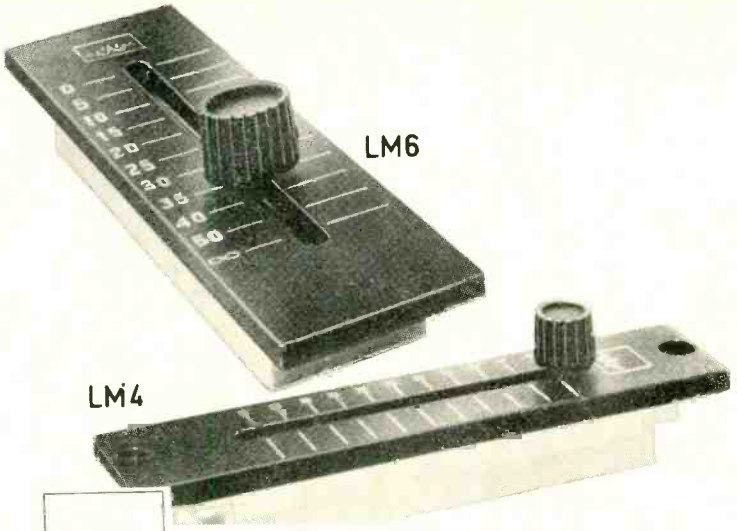
The Amcron VFX-2 provides continuously variable filters which can be used to perform either crossover or band pass functions. The dual channel unit employs two filters per channel, each continuously variable from 20 Hz to 20k Hz. Filter rolloff is at a fixed 18dB/ octave.



Our London stockists for all AMCRON equipment are REW (Audio Visual) Ltd., 146 Charing Cross Road, London WC2. Tel. 01-240 3883, and also at 10-12 High Street, Colliers Wood, London SW19. Tel. 01-540 9684.

or Direct to sole agents:

MACINNES LABORATORIES LTD.
MACINNES HOUSE, CARLTON PARK INDUSTRIAL ESTATE, SAXMUNDHAM, SUFFOLK IP17 2NL
TEL: (0728) 2262 2615



The choice of professional audio controls for use in studio equipment has always involved a series of complex compromises of noise, life, "feel", accuracy, and price. Waters Manufacturing has developed a complete line of attenuators for the professional audio field all of which feature MystR®, a proprietary conductive plastic resistance element, and precious metal contacts.

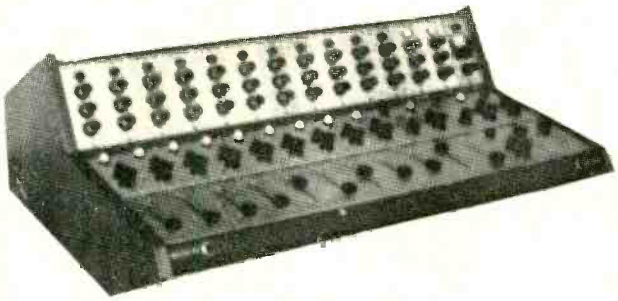
MystR's glass-hard, smooth wiping surface eliminates noise problems and gives long life, trouble-free performance in fader applications. Truly "stepless" attenuation is achieved with Waters computer-controlled curve-shaping technique which actually tailors the attenuator resistance element assuring superior tracking accuracy.

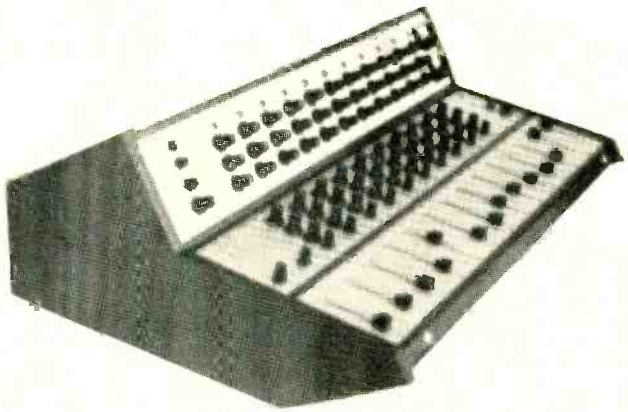
Waters Manufacturing, Inc.
SOLE UK REPRESENTATION:

SOUNDCRAFT ELECTRONICS LIMITED

4th Floor
5/7 Sutton Street, London EC1
Tel.: 01 251 3631/2/3

SOUNDCRAFT ELECTRONICS LTD SOUND SENSE





FOR

SOUND SENSE

MIX WITH

PARTRIDGE ELECTRONICS

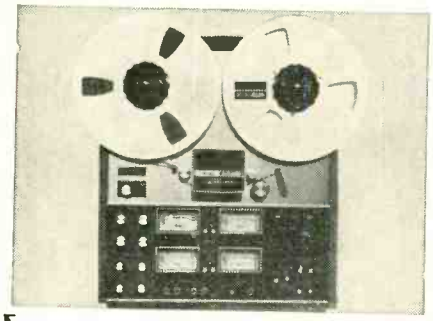
MANUFACTURERS OF AUDIO MIXERS FOR ALL PURPOSES

VISIT US ON STAND 21
A.P.R.S. EXHIBITION

21-25 HART ROAD · BENFLEET · ESSEX SS7 3PB

REW AUDIO CONTRACTS

LONDON'S LEADING CONSULTANTS AND DISTRIBUTORS FOR P.A., STUDIO AND PROFESSIONAL AUDIO EQUIPMENT



NEW TEAC 3340S INDUSTRIAL
The Teac A 3340S professional model is a very high quality, 4 track (separate) recorder. Operating at 7½ and 15 i.p.s. with full built-in sel-sync facility. Potential 8 input source (4 line and 4 mic) incorporating separate mixing controls on front panel. In stock.
NETT PROFESSIONAL PRICE ON APPLICATION

MICROPHONES

REW Audio Contracts are able to offer the following microphones at professional prices (subject to stock), to bona-fide pro users.

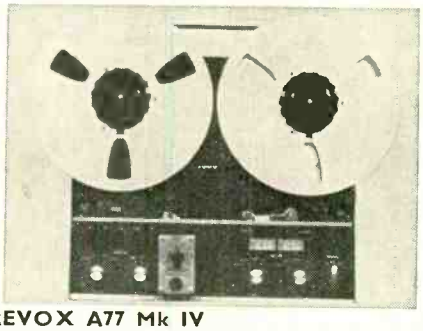
AKG
SHURE
CALREC
BEYER
RESLO
SONY
ELECTROVOICE
DAN GIBSON
SENNHEISER

Phone for a fantastic quotation!

4 CHANNEL PRICE BREAKTHROUGH!

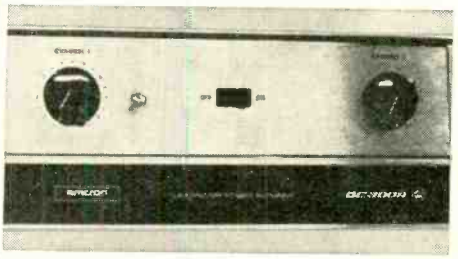
New Dokorder 8140 Multi-Sync Recorder

Similar facilities to Teac 3340. Three motors, 3 heads, solenoid operation, electronic echo. Speeds 7½ and 3¾ i.p.s., 7in. spools. Mic and linemixing.
PROFESSIONAL PRICE ON APPLICATION
also available Model 7140. Details on request.



REVOX A77 Mk IV
The world famous A77 1102 Series III semi-professional recorder, available in 3¾ and 7½ i.p.s. or 7½ and 15 i.p.s. speeds+sel-sync and varipatch conversions. This machine proves a long standing favourite with the REW Audio Contracts range of mini-studios. In stock.
NETT PROFESSIONAL PRICE ON APPLICATION

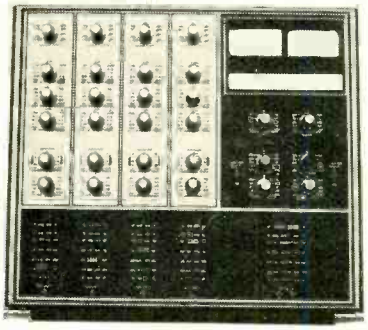
AMCRON AMPLIFIERS
Sole London Distributors



AMCRON DC300A	AMCRON D60	NEW MODEL M600
200+200W rms	40+40W rms	750W rms mono
AMCRON D150	AMCRON VFX2	PHONE FOR LOWEST
100+100W rms	Electronic Crossover	PROFESSIONAL PRICES

BRITAIN'S WIDEST RANGE OF MIXERS

All models ex stock



SPECIAL OFFER FAMOUS MIXER

This high quality inexpensive 4/2 mixer incorporating 3 band eq, pan pots, faders, limiters and echo send controls make it a good starting point for the basic mini studio set up.
R.R.P. £139+VAT
REW Nett Pro Price
£99 + VAT
Power supply extra

STRAMP
of Germany

Latest line of high quality mixing desks. Models available from 6/2 + 2 F/B Groups to 16/2 + 2 F/B Groups. Can be supplied with electronic crossover and built-in talk back mic. Complete in flight case.

Nett Professional Prices from £590 + VAT

ALLEN & HEATH POP MIXER 16/2. ALLEN & HEATH MINI MIXER 6/2. ALLEN & HEATH MON MIX. BOX 5/2. SOUNDCRAFT 12/4. SOUNDCRAFT 16/2. ALICE AD62 6/2. AUDIO TECHNICS MM42 4/2 SONY MX16 8/4. LAMB PML422 4/2 (PROVISION FOR 8/4)

MAIN LONDON STOCKISTS FOR QUAD AMPLIFIERS INCLUDING 303, NEW 303J and 50E.

REW Audio Contracts, 146 Charing Cross Road, London WC2. Tel: 01-240 3064/5

VIDEO, INDUSTRIAL AND STUDIOS AT

REW Video Contracts, 10-12 High St., Colliers Wood, London SW19. Tel: 01-540 9684/5 Telex 896194

NEWS

Paris show

THEY SAY THAT Paris in the spring is a beautiful place producing bemused elation in tourists. The 17ème Festival International du Son (March 10 to 16) bemused visitors for rather different reasons. For some, the Festival could be termed the greatest show on Earth; about 400 exhibitors occupied three floors of the Centre International de Paris, the enormous monolith at Porte Maillot to the north west of the city. To others, it might have appeared an overstatement. Whatever the ethos, it provided a spectacle totally unparalleled by any British consumer audio show. Moreover, the unwieldly machine functioned in a way calculated to bring shame on the administration of many lesser events. It wasn't just the numerous convenient facilities (perhaps more a function of the building) but the concise brochures with directions that really worked, the stand layout and, most important of all, the large and operationally excellent demonstration facilities.

Of the object of the exercise, there seems little new to tell; hardware manufacturers appeared to use their energy in consolidation of existing product lines without major concern with the peripherals such as multiphonic sound. However, the big four fired interesting broadsides with their respective systems without attracting much obvious interest from prospective purchasers. The only notable exception to regressive marketing policies of the major manufacturers is the growing collection of high quality cassette recorders available to the record buying public. Which poses an interesting question to a number of interested parties: what will they record? One would have to be very naïve to suggest solely babies and the amateur dramatic presentation of *Last Tango* . . . It would appear that those concerned with disc hard and software have nothing to fear.

And so to lunch at the exhibition cafeteria on the third floor. The British grumble about the 8p cup of BR tea or the 40p expo special sandwich. To the French must go the credit for pioneering the £2.50 'assiette Anglais'—three leathery slices of cold meat washed down with a piece of lettuce.

Better things were to be found on the second floor. Manufactured by Magneplanar, wafer loudspeakers driven by a battery of 250W Audio Research valve amplifiers produced richness and transparency of sound unequalled by any other demonstration at the show. These speakers aren't new by any means, but considering the performance, the principle deserves a small mention. Looking like an old fashioned 'modesty screen' the concealed motor system comprises a mylar diaphragm bonded to copper parallel conductors. The 180 x 20 cm radiator operates in a planar open flux magnetic circuit following the path of the conductors. The total effect is to produce a driving force proportional to the applied emf across the conductors uniform over the entire area of the diaphragm. In the Magneplanar system, a conventional crossover divides the input between high and low frequency sections. The actual difference in the drivers is limited to the gauge of conductors used. At the show demo, a total power of 750W was used—the sensitivity of the system is low.

JBL suggested that every living room needs a pair of *4350*s; judging by the number of ooing and aahing hi-fi enthusiasts, such a speaker in such a room forms part of every true blooded Frenchman's dream. Lots of interest was shown in another stand equipped with pro recording gear—a contingent from a studio called 'Red'. Apart from demonstrating to Parisiennes how to do a mix down with an Ampex *1100*, the purpose of the exercise was unclear. In any event, the crowd surged towards machine and desk, the front runners reaching out in a frantic effort to twiddle any thing within grasping distance. The inevitable happened. While the tape op's back was turned in an attempt to offset a charge from the rear, a hand at the front shot out in a straight grab for the fast forward button. Because the machine had been fitted with a one inch block, the raised take up spool offered plenty of scope for a loop to fall off causing the master tape to graunch its way around the spool platform adaptor plate. Considerable consternation and tears followed.

Live music broadcast by ORTF staged at the Festival du Son

UK gear in US

AUDIOTECHNIQUES OF STAMFORD, Connecticut, announce plans to distribute the Allen and Heath range of modular mixing consoles. Designed to meet the needs of a compact recording studio, the mixers are available in a variety of configurations between eight in/two out to sixteen in/eight out. Because of the modular nature of the consoles, the system permits rapid expansion.

Special features on each channel include parametric eq on the middle, hi and lo eq, phantom powering and echo plus cue send. Standard fixtures on group are separate monitor mix section, full size patch bay, overdub sync capability, cue mix, slate/talkback and calibration vfo. Allen and Heath Ltd, Pembroke House, Campsbourne Road, Hornsey, London N8. Phone: 01-340 3291. USA: Audiotechniques Inc, 142 Hamilton Ave, Stamford, Conn 06902, USA. Phone: (203) 359-2312.

Mini mixer

PARTRIDGE ELECTRONICS offer a low price range of 'box' style mixers with a wider than usual range of facilities. These include pfl on channels, afl on mixer output, bass and treble eq and vu meter monitoring. Up to five input channels may be simultaneously and individually mixed with long travel slider faders.

The complete mixer, with optional power supply, is housed in a robust, stove enamelled case. It is available as a basic mono or stereo five channel unit, with some or all of the facilities outlined above. Partridge Electronics, 21/25 Hart Road, Benfleet, Essex. Phone: 03745-3256.

APRS meeting

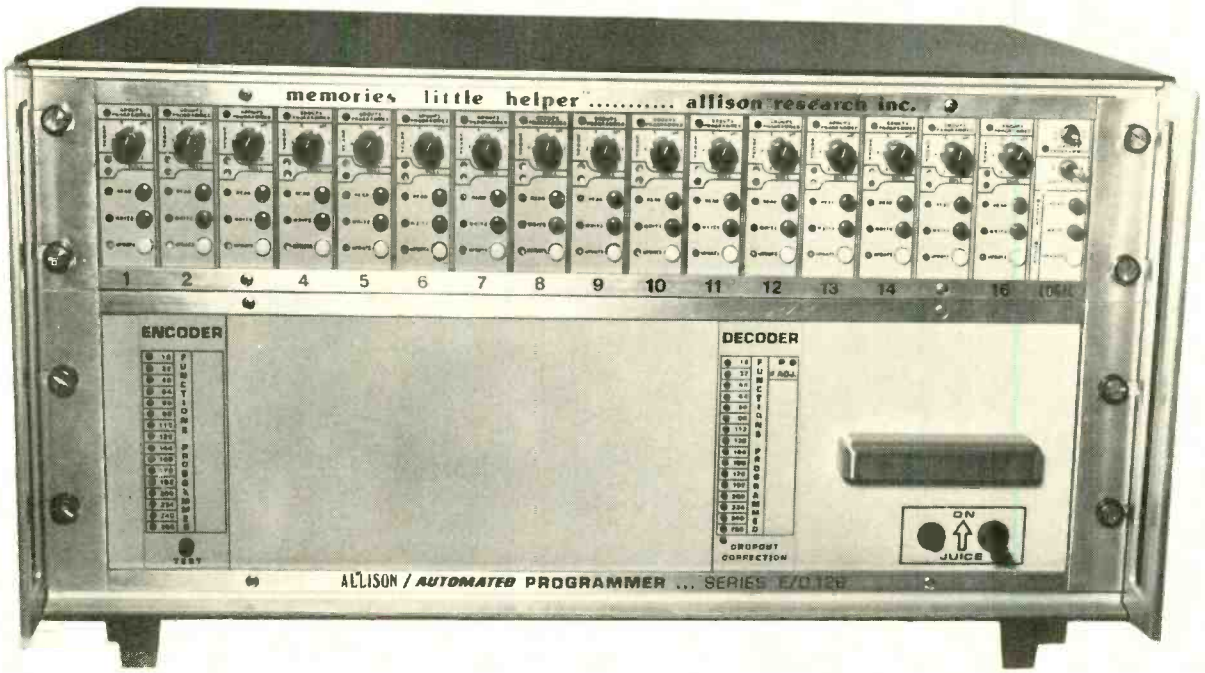
THE CHAIRMAN and secretary of the executive committee of the Association of Professional Recording Studios held a meeting at the Connaught Rooms, London, on April 25 to discuss 'the future of the recording industry'. Over fifty engineers and studio managers attended, though the number declined as the afternoon wore on. The subjects discussed included VAT. The position as it affected studios was unclear at the beginning of the meeting and no clearer at the end. Jacques Levy said he would obtain a ruling on the matter. This may have the effect, despite Mr Levy's best efforts, of obtaining a ruling against the industry where more beneficial results might be obtained by leaving individual studios to treat with their local Vatman.

During the discussion on mechanical copyright, Mr Ellis of the MCPS said that a parliamentary committee was discussing an increase in the royalty and whether a copyright fee should be payable

24 ▶

If you don't think there's a need for Automated Mixdown, you haven't had a session like this yet.

"All you've got to do now is take out the strings on the second eight of the first verse, raise the horns on the 'Do Dum Dums', bring up the vocal group on the 'La Las' and keep them down on the 'Lu Lus'. As the lead voice is flat on the first eighth of the second verse, take him up there and bring out the flugel horn. The bridge seems weak so let's restructure the whole mix at the second eighth note of bar two. You know – bass, guitar and drums up, strings and horns out and start panning everything else in circles. Watch the 'La Las' and 'Lu Lus' very carefully here and by the way..."



Allison Research Inc.'s Memories Little Helper System. Have it incorporated in your next **Cadac** or other fine mixing console or build it in to your existing mixer. It takes less than a day and costs less than you think.

For further information on Memories Little Helper, contact the U.K. agents:

Scenic Sounds Equipment
27-31 Bryanston Street,
London W1H 7AB.
Phone: 01-935 0141.

or Allison Research Inc.,
2817 Erica Pl. P.O. Box 40288,
Nashville, Tennesee 37204, U.S.A.
Phone: 615-385.1760.

NEWS

on tape recorders or tape at the time of buying them, since the public seemed determined to record from the radio and records. Secretary Edward Masek asked if this was the Annan Committee.

A discussion followed on the non-payment of debts, and a Mr Wills, who gave legal advice to the APRS, said that studios ought to cover themselves against bad debts by including in their terms and conditions a clause stating that they would hold on to all master tapes until outstanding debts were paid. Some discussion followed about the starting of a blacklist. Mr Wills said that the APRS had tried to start a system some time ago whereby anyone with a bad debt should phone a central point and anyone with a doubt about a potential customer should phone him to find out if someone else had complained that the potential customer was a bad payer. Wills said the system should have worked but that they had had no response. 'All trade organisations have this sort of system'. It was perfectly legal, he said. No one raised the question as to whether putting someone on such a list might not open them to a charge of slander.

One engineer at the meeting described it afterwards as a joke. Another told me he thought it a waste of time. Another comment was that all but a few of the committee members had been conspicuous by their absence. 'It seems to many people that the whole thing was a recruiting exercise.' Both members and non-members had been invited and Levy had mentioned that a list was available of all the achievements of the APRS over the last year or so.

One man present thought a meeting of this type should be held in secret unless otherwise stated, and was 'furious' when he discovered the press was there. On the assumption that he had had something worth listening to he demanded that his name be withheld in any account of the meeting. We agreed, and in any event, the problem doesn't arise. But we must give due notice that any future meetings we attend officially will be reported in full with who said what—if, that is, the meeting is considerably more successful than this one. The meeting would have been less costly and a great deal more effective if it had been held round the pub.

Telefunken move

THE COMPANY REPORTS a change of address from the erstwhile Clerkenwell Green and Chancery Lane offices to new premises at 202 Kensington Church Street, London W8. Phone: 01-229 9244. Telex: 22795.

Ampex to market Burwen

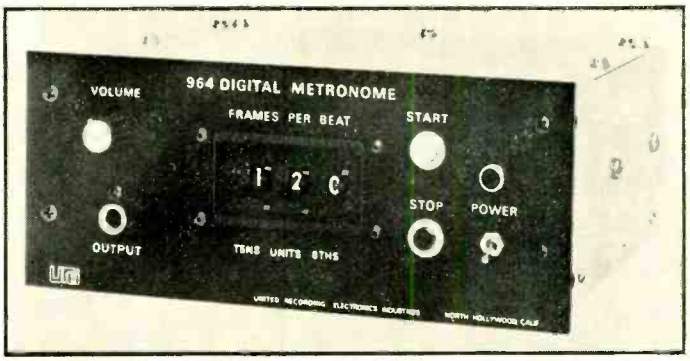
MARKETING AGREEMENTS have been reached between Ampex and Ohmtec Inc, the parent company controlling Burwen Laboratories. The contract gives the former the exclusive distribution rights in all countries except the USA, where the rights are non-exclusive.

The product range includes professional noise reduction hardware comprising *DNF1500A*—10 to 8k Hz bandwidth for use on class A telephone lines, *DNF1500D*—250 to 4 kHz bandwidth for use with class D lines, *DNF1100*—claimed to offer 14 dB of noise reduction for master tapes, cutting channels and programme lines. Ampex International, 72 Berkeley Avenue, Reading, Berks. Phone: 0734-55341.

Very tall loudspeaker

IT IS CALLED the *Beveridge Cylindrical Sound System*, is over 2m high and costs $4000 for stereo pair in oiled walnut. Ignoring the manufacturer's torrential description, the basic motor unit appears to be an electrostatic transducer running the height of the column, loaded by an enclosed rear cavity and radiating through a phasing slot at the front.

Hard facts offered by the makers include an im figure via the internal power amplifier of 0.1%, a transducer capacitance of 5000 pf, peak power transfers of 1k VA and a frequency response over a 180° arc of 40 Hz to 15 kHz +2 dB. There is no indication of spl within the six pages of blurb. Harold Beveridge Inc, 442 North Milpas Street, Santa Barbara, CA 93103, USA. Phone: (805) 966 9031.



Digital metronome from Urei

Digital metronome

MANUFACTURED BY UREI, the type *694* provides an accurate tempo for use in producing live music arrangements on film sound tracks. Fourth generation from the original *960* introduced in 1963, it produces tempos independent of power line variations and can be synchronised to other equipment by a start pulse or contact closure.

The tempo beats correspond to multiples of the film frames, based on the standard rate of 24/s; three thumbwheel switches select the speed variable from 1 frame/beat to 40 frames/beat in 1/8 frame steps. United Recording Electronics Industries Inc, 11922 Valerio Street, North Hollywood, CA 91605, USA. Phone: (213) 764 1500.
UK agents: FWO Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts. Phone: 01-953 0091.

Inter Navex 75

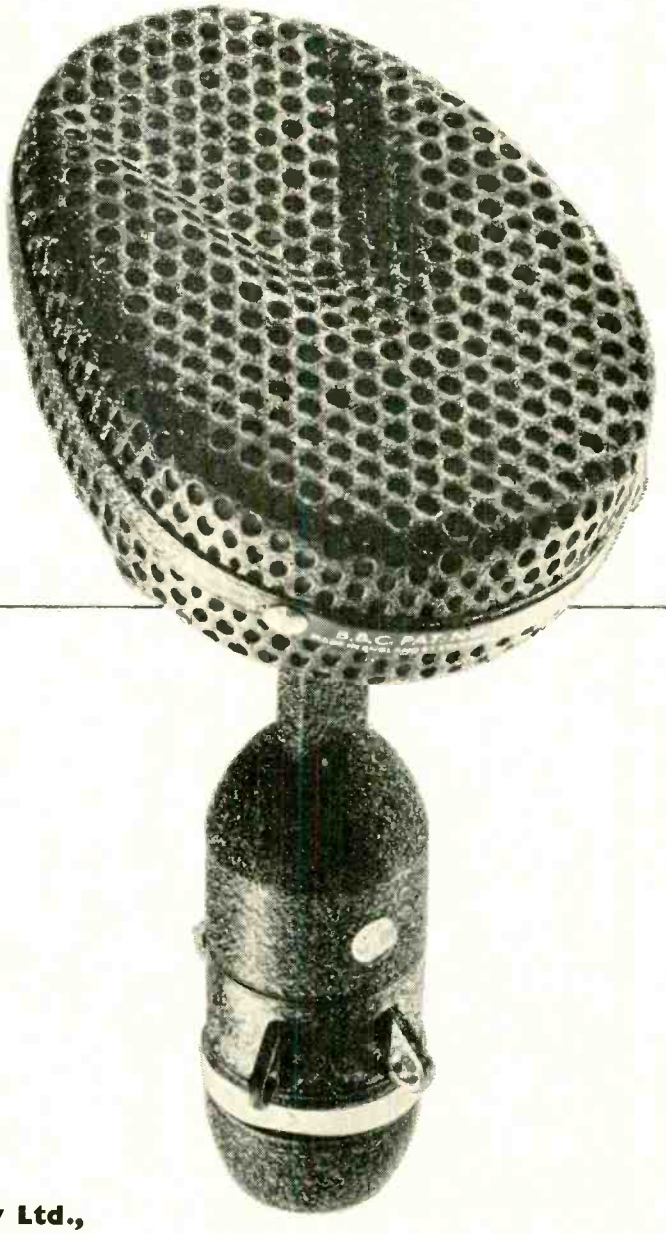
THE LONDON SHOWCASE for the audio-visual aids industry will take place at the National Hall, Olympia from July 8 to 11. Organised by Brintex Exhibitions Ltd for the National Committee for Audio-Visual Aids in Education and the Educational Foundation for Visual Aids, the exhibition will feature over 80 companies and related organisations. Further details from the organisers at 178/202 Great Portland Street, London W1N 6NH. Phone: 01-637 2400. 44 ▶

WORLD BROADCAST STANDARDS SET BY

The CE4038

Bi-Directional Ribbon Microphone

For recording and broadcast studios where sound quality is the only consideration.



*Formerly made and distributed by STC.

For detailed specification of this microphone and other specialist application CE microphones—

WORLD WIDE DISTRIBUTORS

HHF

Hampstead High Fidelity Ltd.,
91 Heath Street, London NW3. 6SS.
01-435 0999 or 6377.

PATENTS

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

April 3

1393743 International Standard Electric Corporation.
Narrow band digital speech communication system.
1393777 Siemens AG.
Telecommunications exchange systems.
1393793 Hell GmbH, Dring Rudolf.
Methods for amplitude-quantitising an analogue voltage produced by electro-optical scanning of picture originals.
1393796 Philips Electronic & Associated Industries Ltd.
Shut-off device for a record changer.
1393807 Nautical Electronic Laboratories Ltd.
Beacon transmitter.
1393827 Philips Electronic & Associated Industries Ltd.
Loudspeaker mounting fixture.
1393828 Pronter-Werk, Alfrend Gauthier GmbH.
Magazine for the simultaneous projection of slide pictures and the reproduction of sound.
1393847 Ricoh, KK.
Magnetic recording and reproducing apparatus.
1394113 Staar Development Co Sa.
Audio-Visual device for displaying transparencies in sychronism with the reproduction of corresponding sound recordings.
1394251 Philips Electronic & Associated Industries Ltd.
Magnetic recording head.
1394376 Thomson-CSF.
Device for imparting an alternating rotary motion to a body about a mechanical axis.
1394466 Datagraph AG.
Device for setting the position of a mobile processing station relative to the tracks of sheetlike record carriers.

April 9

1394611 Tiefenbrun, J.Y.
Gramophone record playing apparatus.
1394696 International Business Machines Corporation.
Magnetic recording systems.
1394713 Matsushita Electric Industrial Co Ltd.
Magnetic recording devices.
1394744 Philips Electronic & Associated Industries Ltd.
Filtering spatial frequencies.
1394793 Siemens AG.
Fault detection arrangements in PCM telecommunications systems.
1394858 Hammond Corporation.
Integrated circuit synthesis and bright wave organ system.
1394862 Post Office.
Telephone instruments.
1394878 Dole Electro-Systems Inc.
Sectional laminated structual system for area distribution of electrical power, and signal energy.
1395015 Sony Corporation.
Gamma correction circuit.
1395017 International Business Machines Corporation.
Method of making a magnetic head.
1395032 Philips Electronic & Associated Industries Ltd.
Electrical circuit arrangements including radiation energised circuit elements.
1395059 International Business Machines Corporation.
Methods of manufacture and magnetic transducers made thereby.
1395168 Beaumont, D.
Devices for turning leaves of books, music and the like.
1395171 Matsushita Electric Industrial Co Ltd.
Pick-up display system.
1395172 Matsushita Electric Industrial Co Ltd.
Image display system.
1395204 Philips Electronic & Associated Industries Ltd.
Electrical amplifier.
1395230 Schirmer, K.
Method and apparatus for recording audio frequency signals on a magnetic tape.
1395241 Hanlon, T. F.
Black and white image control by ultrasonic modulation of nematic liquid crystals.
1395244 EMI Ltd.
Chord construction indicator device.
1395256 Agence National De Valorisation De La Recherche.
Electrets.

April 16

1395471 Ljudmirsky, K. L., Forshtator, G. M. and Shkurovich, Y. S.
Methods of testing characteristics of magnetic signal recording equipment and apparatus for effecting said methods.
1395477 Sansui Electric Co Ltd.
Sound signal-converting apparatus for use in a four-channel stereophonic reproduction system.
1395496 Post Office.
Voice frequency transmission circuit.
1395513/4/5/6 Post Office.
Communications system.
1395565 Philips Electronic & Associated Industries Ltd.
Secret transmission system.
1395569 RCA Corporation.
Charge transfer circuits.
1395667 Soc Italiana Telecomunicazioni Siemens Spa.
Wobulator.
1395825 Agfa-Gevaert.
Film cassettes.
1395865 Astro Music Co Inc
Guitar servicing tool.
135878 BSR Ltd.
Record players.
1396069 Arvin Industries Inc.
Magnetic recorder provided with a recording arm safety lifter.
1396093 Reticon Corporation.
High density photodetection array.

April 23

1396135 Siemens AG.
Frequency division multiplex carrier frequency communication systems.
1396148 Freeman, A. B.
Chorus and ensemble animation rate compensation system.
1396172 Honeywell Inc.
Visible recorder apparatus.
1396228 Telefonbau Und Normalzeit CmbH.
Time multiplex telecommunication exchanges.
1396352 CBS Inc.
Apparatus for reproducing quadraphonic sound.
1396353/4 CBS Inc.
Sound reproduction systems.
1396433 Post Office.
Optical communication systems.
1396486 Matsushita Electric Industrial Co Ltd.
Display apparatus.
1396585 Philips Electronic & Associated Industries Ltd.
Noise reduction in receiving apparatus.
1396600 Motorola Inc.
Selective signalling apparatus with storage of call signals.
1396704 Hatfield Instruments Ltd.
Noise suppression system for HF SSB radio telephones.
1396824 Gibson Inc.
Electrical transducer for a musical instrument.
1396828 Thomson-CSF.
Electro-optical modulations employing chromatic polarization.

April 30

1396870 Evans-Pughe, J.
Electrophonic musical instrument.
1397117 International Liquid Xtal Co.
Display devices utilizing liquid crystal light modulation with varying colours.
1397228 Flachglas AG Delogdetag.
Optical display units.
1397318 International Computers Ltd.
Magnetic recording apparatus.
1397411 Plessey Co Ltd.
Evaluation of the duty ratio of a curved-flank pulse-width-modulated wave form.
1397412 General Electric Co Ltd.
Communication systems and apparatus for use in such systems.
1397437 Compagnie Honeywell Bull.
Ventilation device for a magnetic disc unit.
1397524 Teledyne Inc.
Amplitude-to-frequency converter.
1397527 Philips Electronic & Associated Industries Ltd.
Combined magnetic head for recording and playback.
1397561 Thorn Electrical Industries Ltd.
Circuits for transmitting periodic signals.

It makes sound sense to invest in Neve's new 8024

This is the year when money really counts. You want to get the best that money can buy. That is why it makes sound sense to invest in Neve's new 8024.

We have put a lot of value in to this console. The 8024 has the standards of technical performance, reliability and quality that you have come to expect from Neve. It is designed to provide comprehensive recording and mixdown facilities for up to 24 tracks in a minimum of space with a maximum of flexibility that makes sense to the smaller as well as big studio concerned about real economy.

A few sound points about the 8024

- 24 fully equalised input channels with outputs for up to 24 track recording
- 8 auxiliary mixed outputs for reverberation, cue, sub-grouping and other auxiliary functions
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- Channels switched by single control from record to playback
- Every channel equipped with a quadraphonic panning system
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- Solo system automatically switched to the auxiliary meter
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APRS Exhibition 1975: a preview

MICHAEL THORNE

THE EIGHTH EXHIBITION of the Association of Professional Recording Studios will be held on Thursday and Friday June 20 and 21. Admission by trade card, or by ticket from the Secretary, Edward Masek.

As usual, the venue is the Connaught Rooms, Great Queen Street, off Kingsway, London WC2. Holborn underground station; parking difficult. Given below is a list of exhibitors and brief details of what they expected to show when asked in mid-April.

Agfa-Gevaert will exhibit their full range of commercial recording tapes, cassettes and cassette tape. The *PEM* series will be demonstrated, possibly with others.

AKG will be exhibiting their complete range of dynamic, electret condenser and condenser mics. Particular attention is to be given to talkback mics for mixing consoles, including new electret capsules *CE1* and *CE2* to be used with the *SE5* feeding unit. The new *D140* is a 'super *D190* and will be of interest to the thousands of *D190* lovers'. The new *TDU* digital delay line will be conventionally complemented by the *BX20* reverberation unit, now available with minimum decay time 1.5s.

Alice will be represented by their full range of equipment contributed by the three divisions of the company as 'Broadcasting', 'Mixers' and 'Instrumentation'. The first will include the modular mixing consoles *AM82/B*, turntable units, audio switching matrix and other rack mounting ancillary units. The mixers extend from the largest *AM* modular series, designed for extensive recording applications, down through the *SM* portable series to the budget series of small, self-contained mixers. An updated version of the *AD62* becomes the Alice *62-3* stereo. The 'Instrumentation' range of Alice is the audio noise measuring test set conforming with the IBA independent radio stations code of practice. As well as gain/resolution controls, the response may be set to CCIR standard, flat or patched to external filters.

Allen and Heath exhibit a number of new mixer systems. The *Mod 2* modular series can be up to 16/8 with 16 track monitoring. Another staple is the Quasi mixer, an 8/4 or 10/2, from which the new Pop mixer is derived, to be used in sound reinforcement systems. Inputs balanced, monitoring 'wide', the whole is in a portable form. The new version of the Minimixer is to be used in conjunction with complementary modules; in this way a 'variable and flexible system' may be constructed. Other modules include power supply, mic transformers, monitor mixer and 'aux box', with limiter.

Allotrope: no information received.

Amity Schroeder will be showing versions of their multitrack tape transports, in both 50 and 25 mm versions. These remain substantially as before, with minor modifications. Four cartridge machines will be on display. Although electronics are unchanged, the mechanical system has been completely redesigned, offered as simpler and more reliable in difficult situations. There is no preload necessary. The start is begun normally, except that when the pinch roller is some 15° to 20° away from the vertical and the capstan, its power is cut; it then coasts to the contact and after a preset elapsed time the power is reapplied. Thus, it is claimed that fast start times are achieved with unusually low noise.

Ampex intend to show two examples of the multitrack *MM-1100* recorder, in conjunction with the Time Code Synchronising equipment which locks in either play or search mode and by which they may be cued simultaneously within 0.2s. Reflecting the recent acquisition of the Burwen agency for the UK, the stand will also feature the appropriate noise reduction units for 'all types of reproducting equipment, including Class A and D telephone lines'.

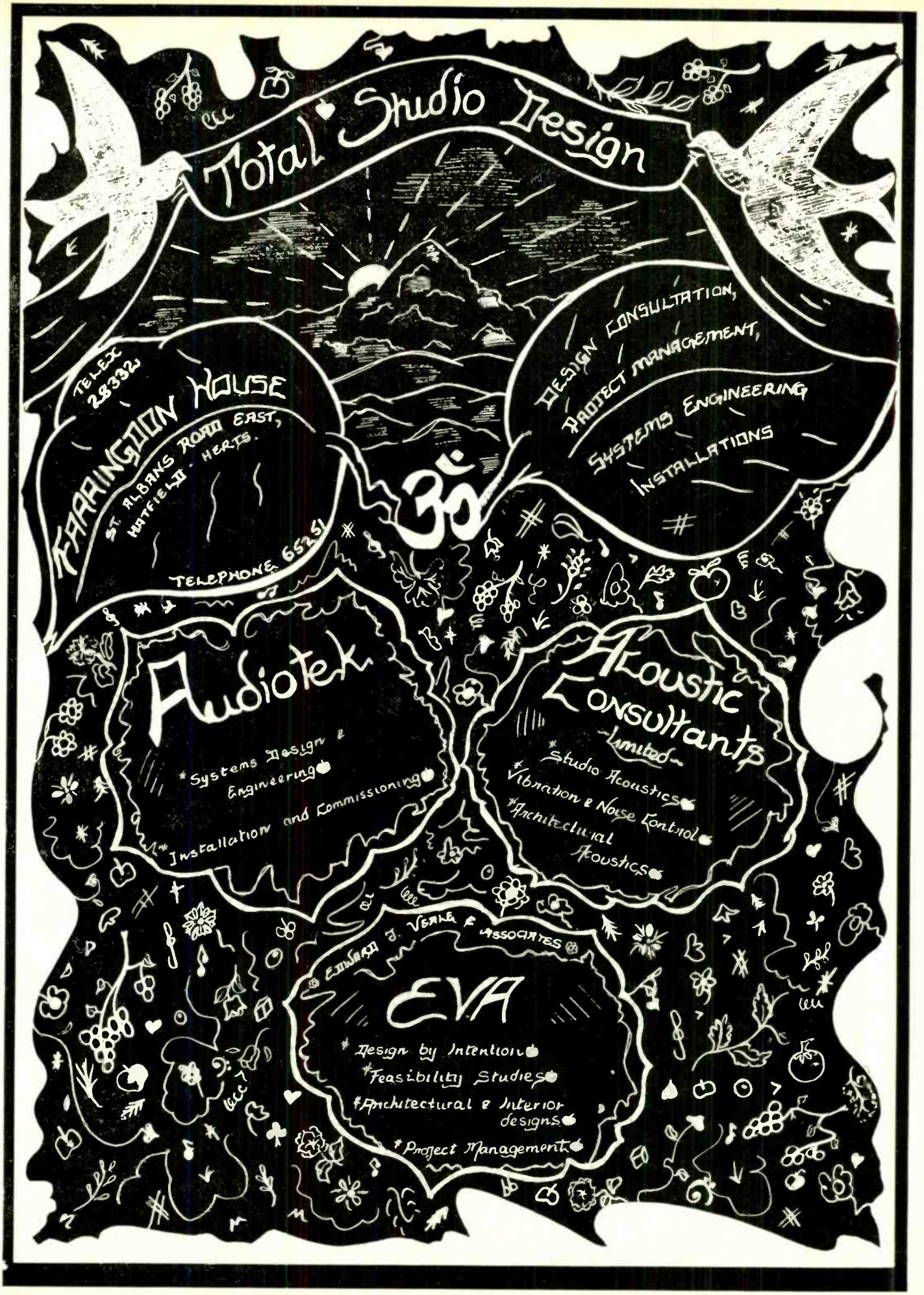
Audio and Design will show their usual range of limiters, compressors and band selection units. Additions include an expander/gate card module with rms and peak-sensing side chains. Designated the *F300*, they are available in any number; for example, 16 may be rack mounted. The *E520* parametric equaliser incorporates two sections of lift/cut and bandwidth variable between one fifth and five octaves. Frequency centre is swept through the whole audio band. The unit may also be set up as a hi/lo pass filter, and each section has its own overload indicator. An as yet unnumbered tape delay system will provide delays continuously variable over the range 30 to 500 ms.

Audio Developments show the addition to their portable mixer range. Basically 16/4, it remains in compact format. All channels P&G fader-fitted, with 'comprehensive' monitor and submix talkback, four compressors, four ppms or vus and four tape return feeds. Other products will include the *AD007* Mini Mixer and *AD031* Micro Mixer in 8/4 and 8/2 basic shapes, together with various other modules such as compressor/limiter, ppm and distortion analyser.

Audix show their new series of mixing equipment. Known as the *B100* series, they will be in typical formats and configurations. In par-

30 ▶

Allen & Heath Mod 2 series



ticular, *B102* 10/2 and *B102* 16/4/2 free standing consoles and the portable *B103* 8/2 will be exhibited alongside radio continuity desks and some recently introduced items including master intercommunicaton and stereo spread control modules. A rack of additional signal processing gear will emphasise their new range of signal switching matrix and distribution amplifiers. Finally, the various other parts of the Audix range, such as the monitor amplifiers and the *MXT/200* and *800* modular mixers will be available.

AV Distributors are agents for the range of Stellavox and Stellamaster recorders, mixers and accessories. At APRS they will be showing the *SP7* miniature recorder and the *SM*, both of which are up to two tracks. The *SQ7* puts four tracks on 6.25 mm tape with full sync. The *AM148* mixer takes five input channels with usual facilities. The *ABR* attachment permits use of spools up to 30 cm diameter and the *ARU* sychronizer interfaces with film or vtr.

FWO Bauch will be showing a range of imported equipment which is, as usual, so extensive that a simple list takes a lot of compiling. From Studer will be shown the *B62* 6 mm recorder, the *A80/R* 6 mm, the *A80/R-TQ* 12 mm four track, the compact version of the *A80/VU* 50 mm 24 track with tape position locator system. Studer's mixer system will be a quadraphonic, 16 group console, with 22 quad pots and remote control for the associated *A80*. The usual range of Neumann condenser microphones and disc cutting gear will be on view. From EMT is a range of equipment much beyond their standard reverberation units: in addition to the *240* gold foil and *440* digital delay system will be the transcription turntable *928*, the *421* wow and flutter analyser, the *116* 'portable tuning tone', the *803* slow speed logging recorder, the *156* and *256* pdm compressors and audio frequency cables. Further assorted equipment on show will include: Universal Audio *UA-1176* limiter, digital metronome, 'Little Dipper' filter set, graphic equaliser, 'Cooper Time Cube' delay line, 'Sonipulse' acoustic analyser, graphic room equaliser, feedback (howlround) suppressor, and the 'Modulimeter'. From other companies come the Teletronix *LA-3A* limiting amplifier, Switchcraft *QG* audio connectors, Allison Research Kepex keyable program expander and 'Gain Brain' limiter, ARP music synthesizers, Klein and Hummel monitor speakers and parametric equalisers, Magnetic Reference Laboratory (MRL) test tapes, Gotham digital delay system, Lexicon varispeech tape time expander and compressor, Danner faders, Seydel faders and Albrecht magnetic film recorders.

Beat Instrumental: no information received.

Bias Electronics will show their familiar range of 6.25 mm recorders. In addition will be the *BE1000* portable version, in Mark Two guise. In a steel framed case, with teak veneered wooden sides, it is offered for either vertical or horizontal operation and has appropriate carrying attachments. Increased cabinet size permits choice of twin vu or ppm mastering, built in monitor amp and variable track formats. Critical modules are accessible from the front panel with all normal presets readily adjustable. While the electrical specification remains as the Mark I Series, the new electronics have improved bias and eq range. Also on display will be the slow speed logging version of the *BE1000*.

Brenell show the 50 mm tape transport they introduced in mock-up at the AES London convention exhibition. In redesigned format, it is single speed standard at 38 cm/s, although other speeds are available to order. Spool size up to 35 cm. The headblock is fully adjustable for azimuth, back and forward tilt and rotation and is interchangeable for 16, 24 and 32 track working as required. Tape position indicator is a mechanical four digit unit calibrated in minutes and hundredths, although digital display is optional and both may be in feet or centimetres. Usual function controls extend to slow 'inching' facility for cueing, in both directions, although hand operation is also possible. Back tensioning system is electronic after the damped sensing arm. Alternative mountings are available, the unit being capable of vertical or horizontal installation. Price of the basic transport is £1850; with heads etc range is from £2498 for 16 track to £3209 for 32 track.

Cadac will have several consoles to reflect their various lines. The new *E* range, developed specifically for the medium price market will be shown; the claim is that these offer facilities normally confined to the more expensive versions, such as three-way midrange eq covering nine frequencies in all, to the switching necessary for tape recorder interface incorporating sync facilities. Also on view will be an example of their portable console, an improved version of the speaker monitor system, a new monitor amplifier with integrated crossovers and a digital clock system providing real and elapsed time readings. On a smaller scale, their thick film gyrator used in their eq modules will be shown. Cadac also offers a consultancy service dealing with comprehensive studio installation.

Calrec Audio will show examples from their capacitor microphone range, which now includes an internally powered option giving over 1000 hours' use on one 1.5V mercury cell without the need for electret capsules. The heads in this new range are completely interchangeable with the others, as are the ranges of extension tubes and accessories. Calrec's new range of big mixers will be represented by that ordered by the BBC for their Bristol tv studios, a 16/4 version; another version, not on show but destined for Lime Grove tv studios, is 36/4. The consoles are oriented towards both music recording and broadcasting and are known as the *L* series.

Capitol Magnetics, the UK subsidiary of the American firm and formerly known as Audio Devices (UK) Ltd, offer a range of magnetic and disc basics. Their studio mastering tape claims high output/low noise and they emphasise its low print properties. Audiopak broadcast cartridges offer an improved guide system and tape storage areas to maintain performance in adverse usage. Other related products are cassette tape and backcoated lube tape, as well as audio disc blanks.

Cetec: no information received.

Emitape will be featuring their new cassette duplicating tape type *152* among their new range of commercial recording tapes and lacquer blanks. Principal among these are the ubiquitous *815* standard play and its matt backed counterpart *816*. Roy Taylor, EMI senior tape applications engineer, will be in attendance.

Farnell-Tandberg will display their new *10XD* stereo tape deck, which incorporates 'Dolby circuits and full monitoring facilities' and is in 38 cm/s, 285 mm spool format. The Series *II* professional battery portable recorders appear with associated equipment, enabling film sync operation. Although uncertain at the time of

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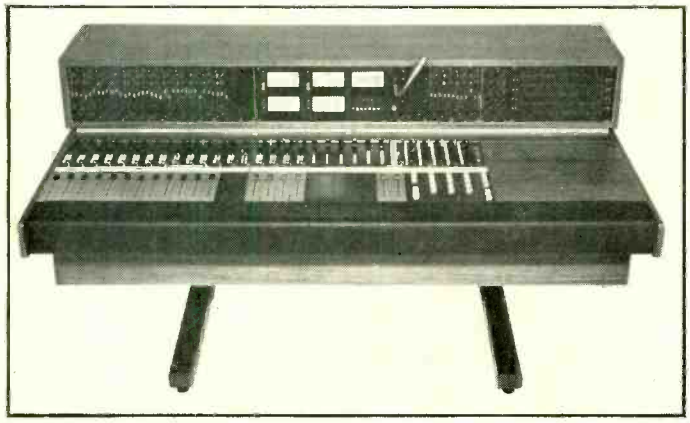
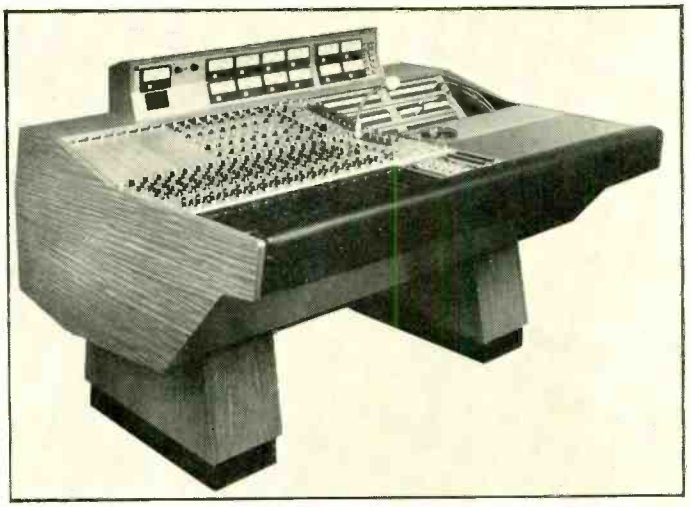
Below: *Audix B102*
Right: *Cadac M341*



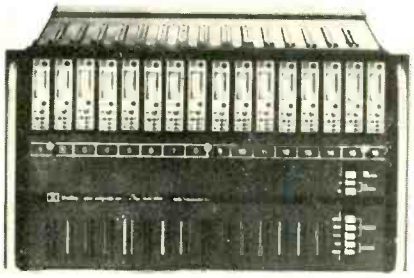


There is a Dolby noise reduction unit for every professional application

Professional Recording and Transmission Applications

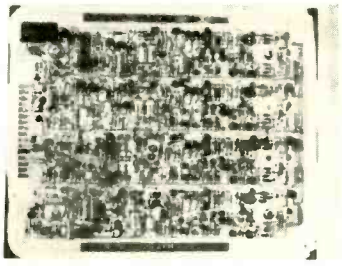
360
The Dolby 360 is a basic single-channel A-type noise reduction unit for encoding or decoding. This unit is normally used in a fixed mode such as in disc cutting or landline sending or receiving; the operating mode is manually selected.

361
The Dolby 361 is similar to the 360, providing a single channel of A-type noise reduction, but with relay switching of operating mode and tape recorder connections. The changeover can be controlled automatically by the recorder.



M-Series
The Dolby M16H A-type unit is designed specifically for professional multi-track recording, and incorporates 16 channels of noise reduction in a compact chassis only 10½ inches high. The similar M8H is an 8-track version, and the M8XH allows simple extension of the M16H for 24-track use.

Noise Reduction Module

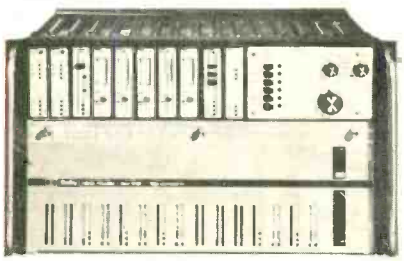


Cat 22
The Dolby noise reduction module, Cat 22, is the basic functional unit employed in all A-type equipment. The Cat 22 is available as a spare or in quantity to OEM users for factory installation. A half-speed version of the module (Cat 40) is also available.

Motion Picture Industry

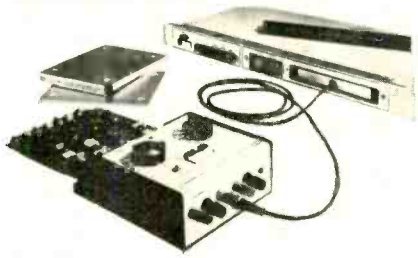
364
The Dolby 364 Cinema Noise Reduction Unit is intended primarily for use with Dolby A-type encoded optical sound-tracks. The 364 also includes a standard 'Academy' filter for conventional tracks, a clean-up circuit for old or worn prints, and provision for playback of magnetic sound-tracks with or without Dolby system encoding.

E2
The Dolby E2 Cinema Equalizer is a companion unit to the 364, and has been specifically designed to solve the response equalization problems of cinemas. Used with the 364 and Dolbyized optical sound-tracks, the E2 enables most cinemas to achieve modern sound reproduction standards without replacement of existing equipment.



CP100
The Dolby CP100 Cinema Processor is designed for the reproduction of all current and presently foreseeable film sound-track formats including conventional optical and magnetic tracks, Dolby encoded monaural optical tracks, Dolby encoded magnetic sound-tracks and the new stereo optical release prints. Up to three noise reduction modules can be incorporated. Typically, three channels of theatre equalization, as in the E2, will be incorporated, but facilities exist for five channels of equalization and the connection of an external quadrophonic decoder.

Test Set (A-type)



Cat 35
The Dolby NRM Test Set, Cat 35, permits rapid verification of performance of Cat 22 Noise Reduction Modules without their removal or the need for additional test equipment.

Professional Encoders for Consumer Media

330
The Dolby 330 Tape Duplication Unit is a professional quality unit with B-type (consumer) noise reduction characteristics. The unit is used for encoding duplicating master tapes in the high-speed duplication of Dolbyized cassettes, cartridges, and open-reel tapes. The 330 is a two-channel unit.

334
The 334 FM Broadcast Unit allows broadcast stations to encode stereo FM broadcasts with the Dolby B-type characteristic. The unit also provides for a reduction of high frequency pre-emphasis to 25 microseconds; this reduces the need for high frequency limiting, thus allowing a significant additional improvement in reception quality.

If you have any queries or problems, please call us at 01-720 1111

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NV Delta Equipment SA, Brussels 5 ☎ (02) 376 6034

Denmark and Finland
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writing, Tandberg hoped to show a new studio monitor loudspeaker system.

Ferrograph will be emphasising their Studio *8* series of tape machines. These are available in transportable, console and rack-mounting dress. Optional two-speed operation is available, in standard 38/19 or 19/9.5 cm/s choices. The basic transport and record/replay electronics can be augmented with simple integral mixing and monitoring facilities. Particular design techniques are a system incorporating fibre optics light guide for tape motion sensing, led position indicator in minutes and seconds, and interlock on related functions. Additional links are available for remote control and display and for tandem operation. The Audio Test Set *RTS2* and its Auxiliary Unit *ATU1* provide balanced in/out connections for measurement of frequency response, input sensitivity, output power, s/n ratio, distortion, gain, wow, flutter, cross-talk, drift and erasure.

Future Film: no information received.

Grampian will be showing a range of equipment reflecting their particular approach to sound reinforcement and distribution. In particular is the Series *7* range of modules incorporating the *730* and *7301* self powered mixers together with the 'Basic Type *73*' and 'Extended Type *73*' rack systems. Custom installations are also catered for. The separate modules will be exhibited, together with various versions of the Series *7* power amplifiers. Also: microphones, loudspeakers, reverberation units and ambiophonic units.

CE Hammond: no information received.

Hayden Laboratories will introduce a number of new items from the European manufacturers that they represent. For the first time at APRS will be the miniature Nagra *IS* recorder, smaller than the *IV* series for specialised applications in which size and lightness are paramount. In addition, new Kudelski accessories for other Nagra tape recorders will be shown. From Sennheiser comes for the first time in the UK their recently introduced range of phantom-powered condenser microphones. Thus, the phantom adaptor is not needed, as it was on the AB powered range previously. For some microphones, improved performance specifications are claimed in addition. It is anticipated that the new Telefunken 50 mm tape transport will be on view, in its 24 track console version. A particular Telefunken feature will be a complete master/slave cassette tape duplicating system which is newly introduced by the Milan branch for application to the medium run sector of the market.

Helios Electronics: no information received.

H/H Electronic have extended their range of amplifiers and related equipment since last year. Amplifiers remain staple diet: on the stand will be the *TPA 100D* given as '250W into four ohms'; others are the *50D*, *25D* and the *25DM* at 100, 75 and 75W into four ohms respectively. All have plug-in output stages and in addition the *TPA 100D* has a plug-in driver stage circuit board. The *AM8* amplifier is designed for BBC local radio station use. The *DM12* audio distribution amplifier is in a 47 cm subframe and each section gives 12 balanced outputs at 75 or 300 ohms, or 36 in all. Also on show will be a new 12/2 portable mixer offered for recording applications or high quality pa, and the new echo unit, for single or multiple delay with variable time constant.

Industrial Tape Applications will be showing a fair range of new and established equipment, centred round tape transports. The Itam *805* is a new eight channel 12.5 mm recorder offered at £1790 complete with modular electronics, servo capstan drive with optional varispeed, full level sync replay, 600 ohm outputs and others. Low price is ascribed to 'large scale production techniques'. Itam mixers are available in various formats, with control over 'input sensitivity', bass/mid/top eq, fb, es, stabilised power supply and monitor circuits. Again, prices are low at £647 for 10/4 and £1260 for 10/8. Additional 10 inputs come at £550 and delivery is claimed ex-stock. From Otari comes a number of new machines, principally the *MX 5058* in eight channel format on 12.5 mm tape. Basis is the deck and electronics of the *5050* stereo 6.25 mm, a portable recorder with motion sensing, logic control, *XLR*s, sel sync and additional quarter track replay head. The *MX 7308* is the eight track 25 mm version at £3695 including console. Delivery, again, from stock. The *DP 4050* is a new two speed version of their reel to cassette copier. Also on display: Revox *A77* Mark *IV*, Revox *A700* and Teac *A3340*.

Jackson Recording will have Malcolm Jackson's list of studio equipment for sale. Festivities culminate in a competition to find the most unusual item of recording equipment, running concurrently with that of APRS. Entries to be submitted to the stand, where the winner receives a prize from Miss Norma Stitz.

Klark-Teknik launched their range of graphic equalisers this time last year, since when they claim to have been doing remarkably well. New models this time round are designated *27*s, Dual *11*s and *11*s, the numbers reflecting the level of band splitting. In addition, a new preamp graphic unit will be introduced. For the first time at APRS, the *SM2* stereo recorder will be shown in its console version. This utilises Teknik's established design approach, with electronic servo control throughout of the dual capstan transport. On view: broadcast version in metal cabinet and studio version in wood consoles.

Lee Engineering will exhibit some of their range of imported broadcast-oriented equipment. From Scully/Metrotech comes the *280* series tape recorders, with the new *284B-8* machine in eight channel format with 'high performance' electronics. And from ITC come the *RP*, *3D* and *SP* series of cartridge machines, available in mono/stereo and with up to three cue tones; NAB or CCIR eq. Also Gates turntables, Scully/Metrotech pipe and cable locator, Audiopack cartridges, and the Metrotech *400L* Series Broadcast Logging recorder.

Leevers-Rich will show the Proline *2000*, their latest 6.25 mm master recorder, with servo capstan and tape tension controls also operational in spooling mode and utilising optical coupling. Interlock is standard, with a 'spill function' facilitating editing. Additionally, the K-line of heavy duty cassette transports are offered for broadcast, recording and educational applications. Comprehensive remote facilities are available, and both broadcast and deck forms will be on view. Familiar products will

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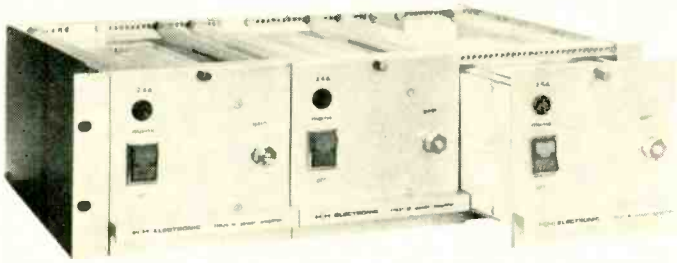
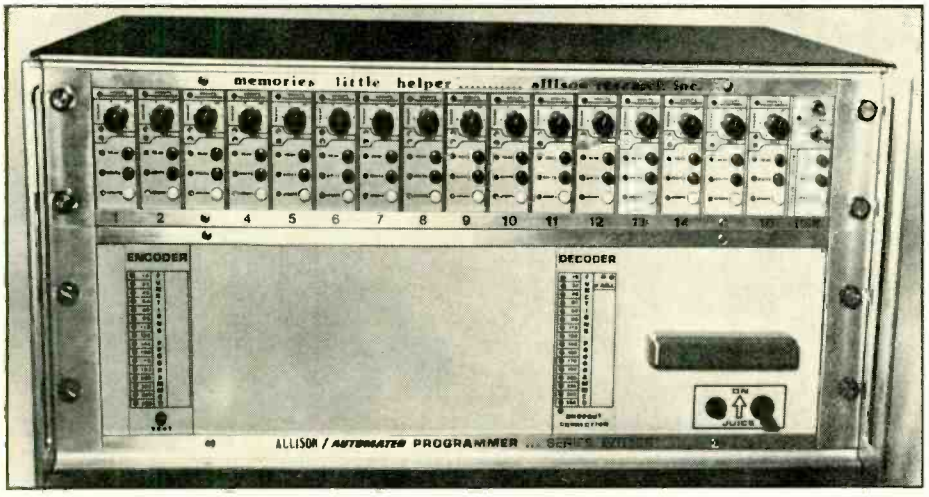


Bottom: *Scenic Sound's memories little helper.*
Left: *H/H Electronic's TPA 255-M power amp*
Right: *NTP's ppm 177-800.*



APRS PREVIEW

also include the *E200* master recorder and the *LR70* and *71* bulk erasers.

Lennard Developments, the UK agents for Woelke, will be showing that company's *ME 102C, ME 104C* and *ME 105* wow and flutter meters as well as the *ME 301* low frequency wave analyser. Also, five types of DIN test records will be available. Their newest product is the Asona cassette labelling machine, capable of a throughput of 300 cassettes per hour and therefore appropriate for small to to medium sized runs.

Jacques Levy Professional Recording Services distribute Audiodiscs and Emidiscs, blanks for mastering and playback, and Capps mastering styli suitable for various cutterheads. Fairchild equipment on display will include the Reverbertron, the Auto-Ten attenuator, a light-coupled gate system, and the Model *663* compact compressor. Also on view: PTMA custom built magnetic heads, and broadcast cartridges and Audio Magnetic cassettes.

Lockwood will show their complete range of monitoring loudspeakers, particularly the free standing Major and Universal Major. The Miniature Monitor is offered for cramped locations. The Lockwood speaker protection device may be used in conjunction 'with any speaker'. The company say they will release specifications of new models at the exhibition.

Macinnes Laboratories, as agents for the Amcron power amplifiers, will be exhibiting the full range. The new *M600* provides power up to 1500W, with the familiar *DC300A* and *D60* amplifiers yielding appropriately more modest amounts. The uprated *D150* is dc coupled throughout, will operate into impedances down to one ohm and offers an improved heatsink arrangement; thus, it is claimed that the bass end is improved to a level approaching that of the *DC300A*. Also on show will be the *RTR* bass driver, with its free air resonance at 12 Hz and power capacity of 'several hundred watts'.

Magnetic Tapes Ltd: no information received.

Midas will be showing three main ranges of modular system mixers which cover the specific requirements of broadcast, recording and sound reinforcement. The portable range includes bass, treble eq and hi pass filters. Monitoring is by ppm led meters. The mixer spec can include optional limiters.

Studio options include full parametric eq, 8 or 16 output groups, plastic track Penny & Giles faders and full monitoring facilities. At present, the company have a 32/24 format mixer under construction for a Dutch recording studio which will include quad mixdown capability.

Millbank Electronics will have their full range of commercial and industrial sound equipment on show. In particular are three new products. The 100W power amplifier, a conventionally constructed device, measures 390 x 210 x 95 mm. The basic noise generator *EQA 16* produces switchable spectra described as white, pink, 'green' and 'blue'. Intention is for use in noise conditioning fields, but is offered on a more versatile basis. In line with their extensive pa equipment lines, the TTL conference/council chamber sound system handling up to 999 delegates (sic) requires only six links between each delegate; all functions are transmitted through these. The system is offered for both temporary and permanent installations, with an emphasis on system simplicity.

3M will exhibit both their own manufactured equipment and that of Automated Processes (API) whom they represent in the UK. In the former category is the *M79* series of multitrack tape transports, at the centre of the hardware display which also covers their range of test equipment including wow and flutter meters and tape recorder test sets. Tape exhibits will centre on their recently introduced *250* recording tape, claiming 4 dB over previous types in dynamic range, with the staple *296* and the *262* intended for broadcast purposes. From API will be the Maglink and Minimag synchronisers and their mixing consoles, extending over the Automix, the automated console offered at a competitive price.

Music Week, who have a stand as usual, will

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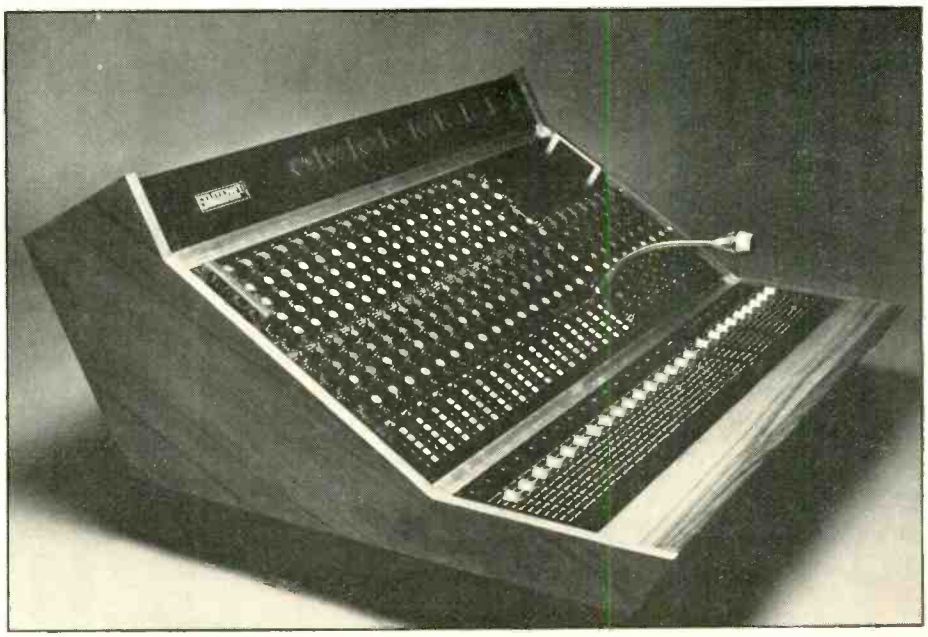

Soundcraft's 16 into 8

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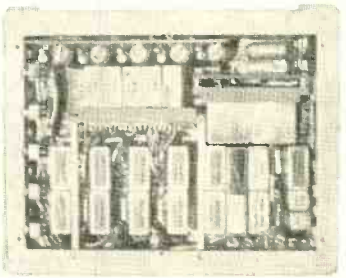

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SS/7/75

APRS PREVIEW

also promote *Billboard* together with associated studio directory, the *World Radio and Television Handbook '75* and the *Music Week* yearbook.

Neve will display their new standard range of consoles. At the centre of the exhibit will be the *8034* 20/4 'multipurpose' console with metering and monitoring for 'up to 16 track recording'. The portable Melbourn and Kelso units use the *3000* 'slimline' series modules with 12 and 10 channels respectively.

North East Audio Ltd, better known for their NEAL trademark, introduce several new cassette deck products. The *104* is a replay only, heavy-duty machine intended for rough environments such as encountered in public replay and disco situations. The *110* is intended for av use, in standard format. Also the model *111*, described as a 'stereo audio visual control centre', has built in sync oscillator, stereo direct projector control, input and replay mixing noise reduction and the Neal Varitape system. A mark two version of the standard *102* cassette recorder, also available with Varitape option, will be exhibited.

NTP Elektronik of Copenhagen by now have a remarkably extensive range of metering devices, and provoked much interest last year with their 24/4 ppm crt display. More modestly, this year sees a new reasonably priced ppm. The two channel system is based on a bar graph display with 100 increments per channel. Full scale sensitivity 1V, accuracy/stability given as 1%. The full range of NTP meters will be demonstrated, together with their compressor/limiter, filter module and stereo monitor oscilloscope.

Partridge Electronics offer custom built mixers for studio use and also in pa circumstances. Centred on the company's standard sub frame, they may be built to requirements from standard and special modules. Sub assemblies on display include mic, disc and specialised preamps, virtual earth mixers, autofades, limiters, line amps, metering/monitoring, and power supply units.

Penny and Giles appear at the APRS exhibition for the first time, showing their wide range of studio faders. Various models are available, one slider controlling up to four individual channels directly. The company recently was awarded the Queen's Award to Industry 'for its work on the development of conductive plastics in the UK'.

Pyral intend to launch a new studio mastering tape, designated the *CJ 87*. Classified, inevitably, as low noise, high output, it is available in formats from 6.25 mm to 50 mm and is matt backed. Also on display from Pyral: lacquer discs, helical video tapes, general purpose tape and compact cassettes.

Racal-Zonal plan to exhibit their standard range of tapes, unchanged from the previous exhibition.

Radford Audio expect to show two new power amplifiers in the *ZD* commercial range in addition to the already available *ZD22* preamplifier. The power ratings are given as 120W into four ohms (*ZD100*) and 250W into four ohms (*ZD200*). The Radford Instruments display will include a new range of audio measuring instruments; the Series *3* ldo will be exhibited working with its complementary distortion measuring set, and power amplifier measurement will also be shown. The *PPO1* portable precision oscillator is battery operated and designed for routine testing, with mains power available as standard option. The new audio voltmeter *HSV1* has full scale sensitivity 10 μV and integral weighting networks.

Raindirk offer three ranges of mixing consoles. The smallest is the Mini Mixer, specifically designed for small studios and ob operations and available as between 10 and 20 into four groups. Available options include eight track monitoring and limiting/compression. The Series *II* is intended for multitrack recording in 'low budget studios'. Fully modular, it can be presented to customer requirements. At the top is the Major range, which is fully custom built, with a wide range of claimed innovations such as an extra channel mute buss facilitating muting of more than one channel from one control, or the interlock of tape machine and monitor to speed overdub setting up. Also: a new range of ppm meter drive cards and an led ppm indicator to BS ED 1477.

Richardson Electronics: no information received.

Rola Celestion introduce a new range of loudspeakers, known as the *UL* range. These vary from the *UL-6*, a three unit system with a quoted power handling of '20W rms continuous sine wave' and frequency response 35 to 28 kHz, to the *UL-10* at 50W and 20 to 40 kHz. In the latter, five drive units include the *HF 2000* super tweeter, *IMD 700* pressure dome midrange unit and 254 mm bass driver. In between, the *UL-8* is 25W with frequency response 30 to 28 kHz. Sizes vary from 292 x 412 x 222 mm to 673 x 317 x 380 mm.

Rugby Automation introduced their range of plug-in modules two years ago, since when they report extensive interest. Originally introduced to aid construction of one-off mixers, they are also offered as a tool for repairing and extending desks of any manufacture. Mixers can be built to order from the basic modules. New products this year are extensions to the range of 50 and 100W power amplifiers, usable in various mountings with provision for 100V line working.

Scenic Sounds Equipment will show an extensive range from their American and German agencies, much increased over last year. Schoeps Colette range of compact condenser microphones will be complemented by their numerous auxiliary units such as the active extension cable, 5m long; Head of Design at Schoeps, Herr Wuttle, will be on hand. In attendance to discuss his studio design and building services will be Tom Hidley, President of Westlake Audio Inc of Los Angeles, with whom Scenic Sounds have signed an exclusive UK representation agreement. DBX will be represented by the full range of professional and semi-professional equipment, together with the newly introduced *160* and *161* compressor limiters. From DBX—Larry Blakely. Other Scenic Sounds equipment will include the Allison Research *MLH* automated mixdown system, Amber Electro-Design's *4550* spectrum display unit (see Reviews), the range of Master Room reverberation units, now including a variable decay version, Orban Parasound's Model *516E* dynamic sibilance controller and the *621B* two channel parametric equaliser.

Shure Electronics intend to show their complete new range of sound reinforcement units and systems, the *SR* series. Designed specifically for basic commercial uses, the available modules include master console, power amplifier, electronic crossover, wide range speaker system, portable column speaker, 'all-weather' column speaker with wall-mounting attachments together with all carrying cases and other accessories. In other directions, the Model *SE22* is a stereo transcription preamplifier for commercial use; the unidirectional *SM82* complements the existing range of Shure studio microphones, being intended for broadcast applications.

Sonaplan introduced their range of acoustic screens at last year's APRS and continue with same in 1975. Model *A* at full height is designed for greatest separation, Model *O* incorporates a window and Model *S* is half height. All are steel framed, castor mounted and are available in a variety of colours etc. Non-standard screens will also be manufactured. The Series *79* tape timer is designed for use with the 3M *79* series tape transports and shows minutes and seconds on an led display. It is also hoped that an autolocate unit suitable for 3M and other manufacturers will also be shown.

Soundcraft Electronics will show their established range of two and four channel consoles and an example for their new Mark *5* modular series which can accommodate up to 32/24 formats. Of particular interest in the latter is individual channel limiting with led readout showing degree of limiting, for critical situations. The fixed format 'Sixteen into Eight' is quasi modular, has four band eq with variable bass cut, three foldback subgroups on all inputs and monitor and a 'flexible' limiter on every output. Inputs are routable directly to the monitor mixing, thus giving a straight through 16 track capability. Also on the stand will be Waters conductive plastic faders and audio controls. Associated with Soundcraft is Dennington Acoustics, loudspeakers systems specialists, with Stephen Court available for interrogation.

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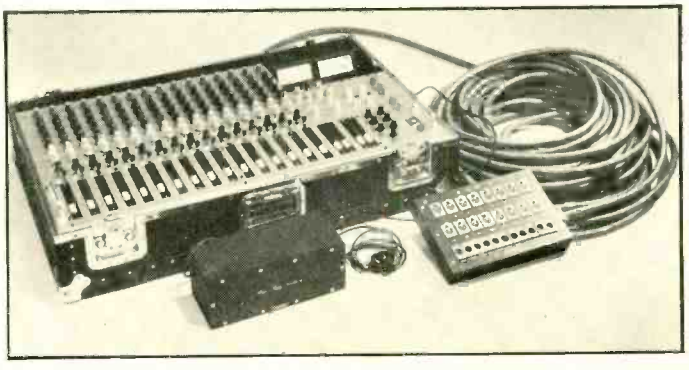

Turner TPS 16/2 mixer

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Sound Developments are to exhibit for the first time, and will be showing a range of one-off items produced by them for particular clients during applications to systems and hardware design work. The details of their consultation service will be augmented by modular mixing equipment for studio production and live stereo broadcasting, distribution amplifier, and a range of extender cards 'to suit most professional tape recorders'. Also: a new electronic digital clock and a 'special purpose' mono mixer designed for the BBC.

Surrey Electronics will exhibit their steadily increasing range of specialised products for studio and stage use. These now include: ppm meter drive circuitry; frequency shifters for pa howl reduction, in both kit and unit forms; stereo disc preamplifier for commercial usage; ten outlet distribution amplifier; spectrum shifter, range from 0.1 to 1 kHz; and a microphone preamplifier with balanced inputs and two channels accommodating 30 to 600 ohm working.

Tannoy have introduced an extended and improved version of their familiar drive units since last year, and will be exhibiting them in both chassis and cabinet forms. Now designated the *HPD* series, they are available in 25 cm, 30 and 38 cm versions, with nominal power handling capacities of 50, 60 and 85W respectively. Improvements to the older series provide cone stiffening, improved power handling and heat dissipitation characteristics in both voice coil and crossover unit. Unit prices are £88.93, £69.87 and £68.61 plus VAT.

Triad were uncertain about eventual final plans, but expected to display 'an *A* and/or *B* range console'. The former is intended for multitrack studios requiring the largest systems, features emphasised including graphic 16 frequency eq for each channel, four independent fb circuits, six push-button selected es groups and dual-scaled vu/ppm selection. The *B* series offers system compromise in line with reduced cost, although electrical specification is identical. Prewired consoles can be prepared to accommodate later expansions. Newly arrived is the parametric equaliser type *CB 9066*, including hi and lo pass, continuously variable cutoff filters with slopes to 22 dB/octave and a three band equaliser giving ±15 dB band facility, both bandwidth and centre selectable by continuous control.

Turner will show their extending range of stereo power amplifiers, modular and non-modular sound mixers, and a monitor speaker system. The *A500* and *A300* form the 'professional monitor' series, the *B300* and *B200* the 'professional' series. The five-way loudspeaker system offers high-power, low distortion monitoring; drivers by Gauss and JBL. The mixer section includes the *TPM* modular series and the *TPS* series, intended for medium sized studios and equipped with sub grouping, monitor and talkback facilities. Channels up to 24. The non-modular series is offered in formats up to 16/2, and is directed towards mobile recording work.

Tweed Audio make their first APRS appearance with a range of mixers and amplifiers. On show will be a 16/8 studio mixer with 16 track monitoring returns, designed for BGS Productions in Glasgow; a version of their standard 10/4 portable mixer which is offered for mobile or recording/broadcast studio use at specifications comparable with those of their custom consoles. The Type *CL 601* compressor/limiter uses optical feedback coupling and is intended primarily for studio use. Their new stereo monitoring amplifier claims '100W per channel into eight ohms' with short circuit protection, overload indicator and calibrated variable gain. Rack mounting is standard.

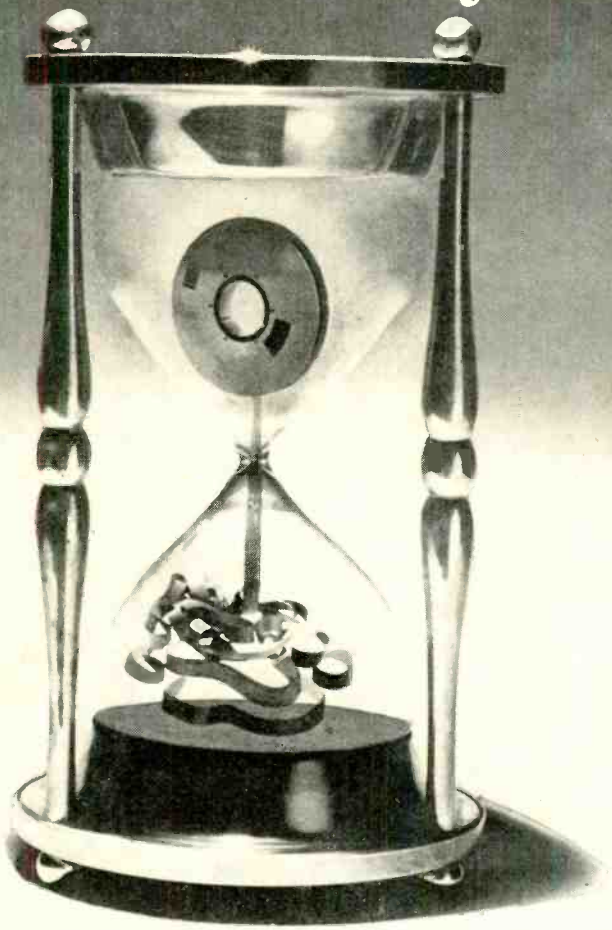
Vitavox, in line with their established pa position and complementary range of sound equipment, introduce and concentrate on their new 'Thunderbolt'. This is designed specifically for group use in high power situations, as befits the name, and has been under development for some time. Also on display will be their wide range of other pa and sound reinforcement products.

AGONY COLUMN

The record reviewer seemed to have had some difficulty in adapting to stereo. His two speakers were connected out of phase and there was a certain amount of mains hum coming out of both, although the polarity helped reduce this.

The cartridge presented a real problem, for he did not have a stereo amplifier. Thus, the stereo cartridge could only be sampled one channel at a time. If he could tell the difference, the record was praised for its 'good stereo separation'.

Time is money...



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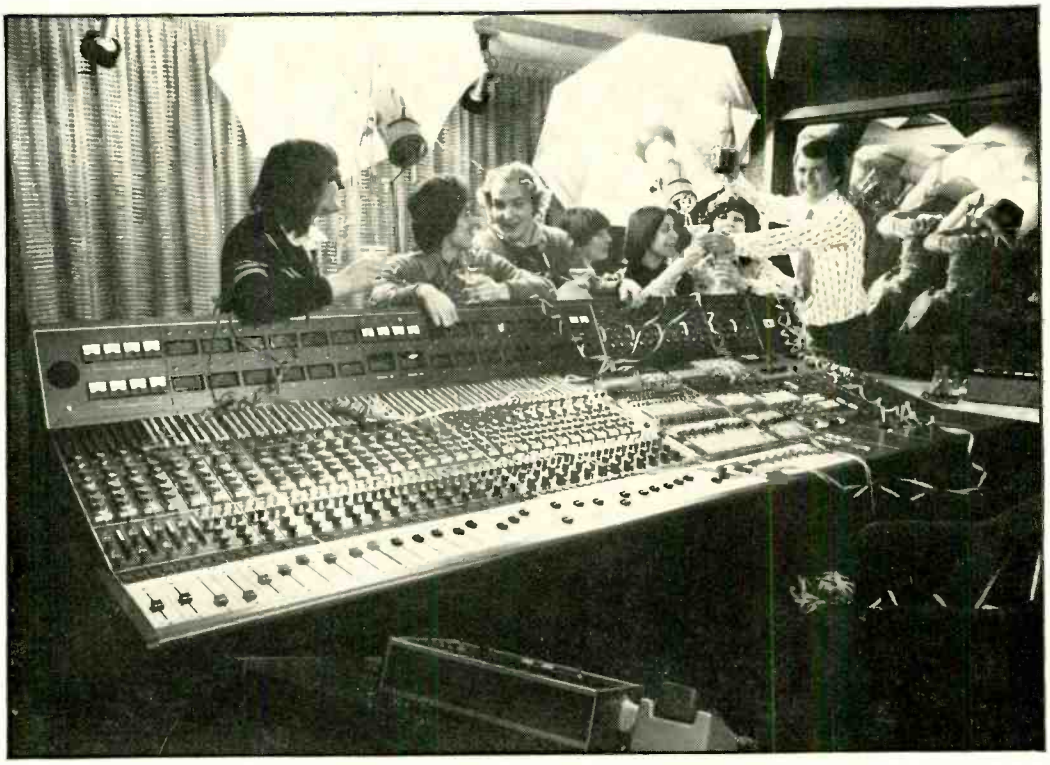
R G Jones

A YEAR AGO, it wouldn't have been considered. Now, Robin Jones, founder of the Wimbledon recording studio, wouldn't be without it—and mostly because 'it got to the stage where I was running out of holes until it wasn't a joke'. Poor old Robin. Never mind; along came Neve, in the style of the 5th US Cavalry, and delivered a custom-built desk of 32 / 24 format solving all his problems.

The former desk, a Neve 24/16, just wasn't big enough, and with the option to go 24 track at the forefront of his mind, the larger desk seemed a very logical step. The new console is 'L' shaped to accommodate a much enlarged patch panel, one of the shortcomings of the previous desk. Everyone at the studio feels that the desk will service all requirements well into the future.

Regarding work, the studio seems on the up and up. Robin reports recent attendance by a fair cross section of the names including Peter Shelley, Alvin Stardust, Cilla Black, Gene Pitney and others that would take up too many column inches to mention here.

Due to the space/time continuum, the author was unable to visit the studio at the time of writing the above—the facts were reported blind via the telephone. The situation has now been rectified.



Left to right: Henry Edwards, Gerry Kitchingham, Nick Sykes, Chantal Jones, Paula Kennett, Gregg Cutler and Robin Jones being very silly indeed.

It was all there including a pair of JBL *4350*s fitted with an active crossover driven by an Amcron *DC300A* for the bass units and a *150* for treble. But apart from that, the Neve desk looked more impressive than the comprehensive paper specification. Like the four channels on the extreme left of the desk which can be patched in to provide all the available mic channel facilities for foldback, echo, plate and adt etc. There were other features that make the engineer's job easier such as the fader backstop pfl and the switchable afl on every mic channel in addition to the individually switchable afl available on all the output groups. Perhaps these appear little things, but when considered with the blink switches coloured according to function, the whole adds up to some very thoughtful practical design.

Robin and freelance engineer Nick Sykes together with the tech engineer Henry Edwards also have additional tape machine hardware assistance, and spoke about the 'Selectake' used with the *M79* machine: 'the basic tape recorder is very good, although a good tape op is always faster than the locator on sessions', which, one supposes, is just as well for human selectake Greg Cutler. The problem seems to be that their machine can cause the desired tape position to overshoot resulting in an oscillatory situation which must be cut short by the tape op zapping the stop button at the appropriate moment. 3M comment: 'At the price, we don't see this as a fault'. On the lighter side, the studio sports several drum/vocal booths. The most interesting of these was created from the remaining structure of the old control room, now resited at the opposite end of the studio floor. It had been chopped in half, one part of which was scrapped while the other, containing the now removable window, has been rebuilt to provide a suitable area with acceptable acoustics. No one could describe the total effect as 'flash', but the pleasant disarray and occasional bare joinery gives the studio a homely look enhancing the working atmosphere sometimes lacking at other nameless, and perhaps more expensive, places.

Delightful confusion struck when the STUDIO SOUND man-on-the-spot put in a request to take pix of resident working superstar Cilla Black laying down tracks at the studio. Polite exchanges continued between Robin Jones and producer Dave MacKay resulting in a verdict of foul play. Or in the words of one anonymous bystander: 'she'll probably come in again dragged up in her working clothes complete with curlers.' Can one's childhood dreams be shattered so easily?

There can few jobs more tedious than tape op/engineering sessions for recorded English lessons directed at foreigners. Robin Jones likes them. He should do. He's got a separate studio especially for them. It's a couple of miles down the road from the main studio adjacent to his pa hire shop. Fitted with a twin track Studer, home brewed desk, Neumann mics and thick carpet, the facility offers a self contained packaging arrangement for lessons and now forms an appreciable part of the complex turnover. Bill Foster, the engineer, must be a man of very special calibre. He has to be. After all, sitting down all day to such gems as: 'we were going to the station', or 'the porter will be angry tomorrow' must surely rot a lesser man's mind.

Bob Auger 2

HE SAYS IT'S just coincidence. To make it clear who's who, Bob signs his correspondence 'Robert M Auger'. Even so, the situation is confusing, just as it must have been to the staff of Granada where both once worked at the same time. This Bob relates funny stories about that Bob and the vast expenses incurred by one and paid to the other. In any event, the experience must have been beneficial; he left Granada to found, with erstwhile partner Dave Kent-Watson, the eminently successful Indigo studio. He has since moved on to create the new Manchester-based Arrow Sounds studio, the object of this particular literary exercise.

The hardware complement of the new studio reflects very much

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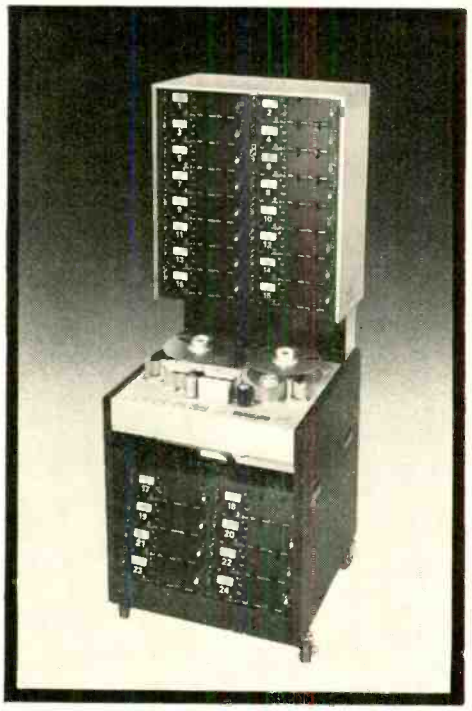

STUDER

STUDER A80 24 Track

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APRS '75 Stand No.1

the *raison d'être* for its existence—Ampex *AG440C* four track, Teac four track, Raindirk desk, Sparta quick start turntables and an ITC stereo cartridge machine. Perhaps not big enough for the Floyd, but it sure goes down a wow with Noddy and Big Ears. Which provides a clue to the sort of work that Arrow Sounds handles. Using the film dubbing and transfer facility at the studio, one of the first jobs was the sound track for the tv serialisation of the famed duo, although the staple diet includes a large amount of agency work providing adverts and jingles for Piccadilly Radio, the Manchester ilr.

Having commenced operation in February, the studio employs a basic staff of four people—producers Bob, Mac McCartney, Emma Wilson and general factotum Hilary Rose. Mac, an American, has many years of experience in Stateside commercial radio, some of them as station manager of KYAK and WHIM in Alaska. In 1971, he won the press award for best radio documentary. To date, about £17 000 has been spent on the studio, but the eventual bill is expected to exceed £50 000.

Frank Ogden

Top: *Bob Auger—the invisible man on session.*

Below: *Apple control room.*

Rotten apple

APPLE STUDIOS, including the cutting room, have closed with the rest of the Apple organisation. The staff of Apple Corps met for the last time in a pub near St James's Street on May 2. Three were left in the studios, including former manager Malcolm Davies, until May 16. None of the equipment is being sold and none of the Apple companies are being wound up. A few staff have been left to do accounting work. No date seems to have been set for their leaving.

While the closures may have seemed 'logical' to Apple's general manager records and publishing, Bernard Brown, it must have seemed strange to Davies, who has just seen the studio redecorated, the reception area refitted and some of the studio's working areas, apart from the studio itself and its recording and cutting room, altered. The cutting room has always been busy and was turning away work.

The closures seem to be a consequence of a settlement in the high court announced in January, dissolving the links between the four ex-Beatles. The writ had been sought by Paul McCartney in 1971. The Apple staff have been dismissed and the accountants left in following legal advice so that the assets of Apple could be assessed and divided, equally or otherwise, between the four. Bernard Brown would not confirm this, and chief executive Neil Aspinall, who had been with the Beatles since the early days in Hamburg, was unavailable for comment. All Brown would say was that since the four boys had split up finally after the court settlement, there was no logical reason for continuing the operation.

Although the four ex-Beatles' contracts with EMI, under which

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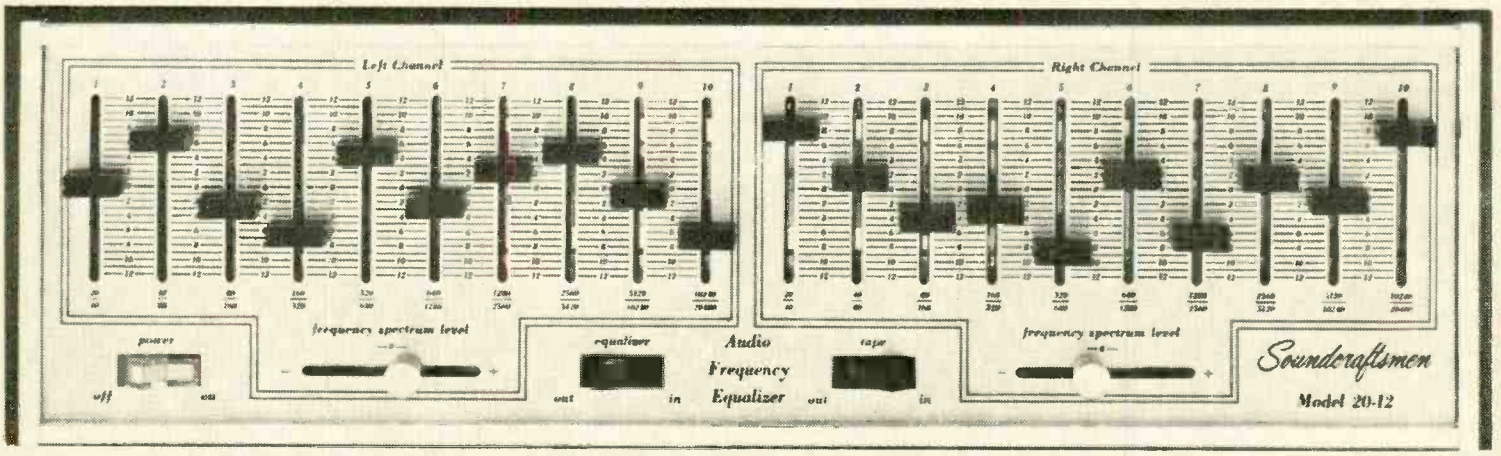


ROOM EQUALIZATION, SPECIAL EFFECTS, PLAYBACK and RECORDING

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

COMPUTONE CHARTS: After you have achieved the equalization of sound that you prefer use the Computone Charts, supplied with each Equalizer, to mark the settings, so that you can duplicate the settings easily.

SPECIFICATIONS and SPECIAL FEATURES

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

Send for FREE BOOKLET: "Why's and How's of Equalization"
Plus list of Franchised Dealers to Sole UK Distributor:

Soundcraftsmen Dept SS
Gale Electronics & Design Limited
23 Bruton Place Berkeley Square London W1X 7AB

WORK

their Parlophone product goes out under the Apple label, expires in February next year, it's still possible, according to Bernard Brown, that the Apple label will continue after that date even though the Apple organisation won't be functioning. Nevertheless Ringo Starr has formed Ring O' Records, and George Harrison Dark Horse, and the record companies are likely to be putting in strong bids for the other two.

It's said that Apple began in the flat of John Dunbar, Marianne Faithfull's ex-husband and friend of John Lennon. It was started with £800,000 after the Beatles had been told that, if they wanted to avoid paying excessive taxes, they had to spend some money. There were to be five divisions: electronics, films, publishing, records and retailing.

In the first year they lost £400,000. Most of the money went to freeloaders, and dreamers like 'Magic Alex', who sucked Beatle money through the electronics division. According to the unofficial history of Apple, 'He brought them an electric apple which pulsated light and music and a 'nothing-box' which had twelve lights, ran for five years and, as its name suggests, did exactly nothing.' Apple accounts were incomplete and late, but when the first set arrived, Magic Alex had been paid £1000, which probably went to buy yet another of the motor cars that Apple unwittingly showered on the public.

What with all this, and the tangled state of Nems and its holding company Nemperor Holdings, later gobbled up by Triumph Investment Trust, John Lennon announced in early 1969 that he wanted Allen Klein to sort out his and, preferably, the others' business affairs. Paul McCartney, influenced by his wife Linda Eastman (daughter of Lee Eastman, formerly Epstein) disagreed with the choice, even though, according to George Harrison, McCartney had complained in 1967 that the Rolling Stones were earning more money than the Beatles. At that time, Klein managed the Stones.

Klein had persuaded the other three that he had turned the Apple round to being profitable when, according to many, all he had done was to sell their shares in Northern Songs. Since, until the contract with EMI was renegotiated in January 1967, most of the Beatles' income, particularly that of John and Paul, was from song publishing through Northern Songs, this was less shrewd a move than it appeared.

In early April 1973, Allen Klein announced that his company Aboko, was cutting all its links with Apple and the three ex-Beatles John, George and Ringo. Later Klein and his company were sued by the three, Yoko Ono and 28 English and American companies associated with the Beatles. According to *The Times* of 29th October last 'The claim seeks to set aside an agreement, and a subsequent variation to it, which gave Mr Klein and Aboko a substantial increase in commission.' Klein's attempt to waive their suit in the High Court was dismissed in October last year.

Apple's premises in Saville Row are worth at least £2 million, according to one estimate, and being freehold, possibly a great deal more. The other assets are also considerable. With the partnership dissolved finally, the legal costs that have arisen over the last seven years will have been equally considerable. The studio may be sold as a business, if it is sold, for a high cash value. Another possibility is that, when the assets are distributed one of the four might wish to take the studio as part of his share for his own use and for commercial hire.

None of the four ex-Beatles has appeared at Apple since the staff were given their notices.

John Dwyer

NEWS

New NAB cartridge

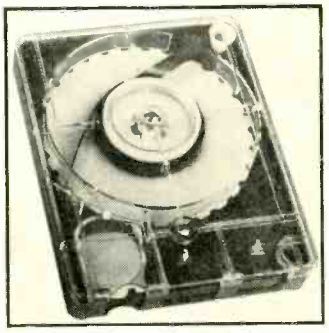
INTRODUCED BY FIDELIPAC, their new product claims to offer tape guidance past the heads in a manner independent of the cartridge. The manufacturers state that the improved nature of the tape transport relates to a complete redesign of the tape wind path within the cartridge and offers the same results from cartridge to cartridge with any make of machine.

Known as Master Cart, it is generally available worldwide through Fidelipac distributors in a variety of lengths in the standard A size package, at a price 'slightly above that of similar lengths in the *300* series. Fidelipac, 109 Gaither Drive, Mt Laurel, NJ 08057, USA. Phone: (609) 235-3511.

Vitavox people

NEIL YOUNG, managing director of Vitavox Ltd, has now taken over responsibility for the Company's sales division. The decision follows the departure of Roger Dyer, the sales manager for the previous four years, in order to spend more time on his own business interests. There are no plans to appoint a new sales manager from the outside in the immediate future.

The company report that the 1975 order book stands at the highest level for 40 years, most of which constitutes export sales.



Master cart, Fidelipac

Cartridge machine

INTRODUCED AT THE Las Vegas NAB Convention, the *4000* series Spotmaster machines claim to offer the 'ultimate' in performance from this type of hardware. The series includes the 'Phase Lok 3' head bracket allowing fine adjustment of azimuth to cancel out phasing effects between the stereo tracks when played in mono. The deck is equipped with direct drive, automatic release of cartridges and an air damped engage solenoid. Many variations of the basic unit are possible: cue tones, track format, record/playback or playback only and an internal tape fault/splice detector (record models only). Broadcast Electronics Inc, 8810 Brookville Road, Silver Spring, Maryland 20910 USA. Phone: (301) 588 4983.

UK agents: Broadcast Audio (Equipment) Ltd, PO Box 31, Isle of Man. Phone: 0624-4710.

Cadac men

CHANGES HAVE OCCURRED at the Cadac (London) Ltd boardroom caused by the departure of Charles and John Billett to pursue 'interests outside the company'. Adrian Kerridge, Landsdowne Studio supremo, takes over as chairman of Cadac; Clive Green continues at his former post of managing director relinquishing production, finance and general management to new appointee Jim LaHaye.

Canadian console man

LITTLE KNOWN IN the UK but well known in Canada for quality studio and broadcasting gear, Ward-Beck Systems Ltd announce the appointment of Arthur J Schubert jr as director, engineering. Mr Schubert comes to the company with 12 years of experience in the industry, 9 of which were spent with CBS tv enginnering. More recently, he served as chief development engineer for Neve, the England based pro audio manufacturers.

Updated amplifier

AMCRON HAS RECENTLY detailed changes to their *D150* amplifier which result in a 'greatly improved' heat dissipation characteristics enabling load specification identical to the larger *DC300A*. Totally dc coupled throughout, it will operate into output loads as low as 1 Ω; at 2.5Ω, the amplifier produces 200W rms/channel. All the *D150*'s sold in the UK are now of the new type. Macinnes Laboratories Ltd, Macinnes House, Carlton Park Industrial Estate. Saxmundham, Suffolk. Phone: 0728 2262/2615.

Sub miniature microphone

USING AN ELECTRET capacitor insert, a phantom powered tie pin mic claims a frequency response within 6 dB from 30 to 15 kHz. The unit can be powered from its parent equipment or by a small adaptor supplied with the microphone. The manufacturers claim 'a very low noise level' and, measuring only 24 x 10 mm with a weight of 7.5g, a wide variety of applications. Lawtronics, 139 High Street, Edenbridge, Kent TN8 5AX. Phone: 073 271-5191/2.

Musical directory

THE LATEST EDITION of Kemp's *Music and Recording Year Book* is now available. The tome offers information on most facets of the musical business including studios and professional recording, record distributors, labels, agents, writers, hardware, promotion, pr, consultants and equipment hire. It is available direct (£3.75) from: The Kemps Group, 1/5 Bath Street, London EC1V 9QA.

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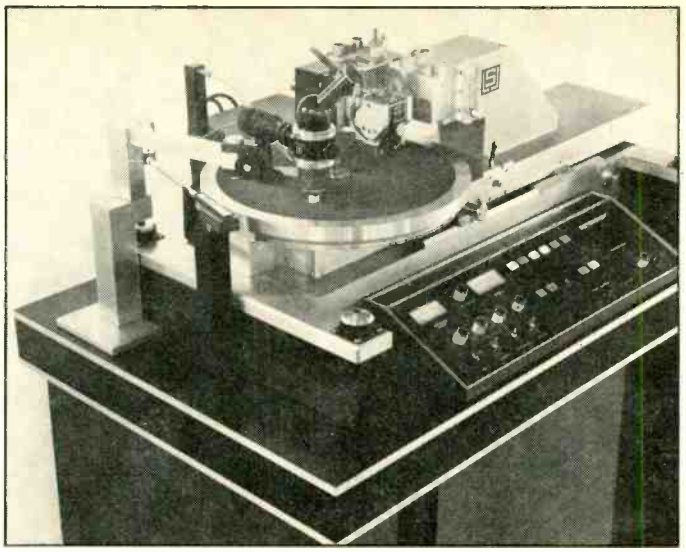
0438-3241

Survey: part one disc cutting equipment part two tape duplicating equipment



Left: *Ortofon cutting head for carrier quadrophony*

Centre: *'The Lathe' from L. J. Scully*

Right: *Westrex 3DIIa cutting head attached to Scully lathe*

MSR
MSR Electronics Ltd, Meeting House Lane, Balsall Common, Nr Coventry, Warwickshire. Phone: 0676-32468.

SERIES 2000 DISC CUTTING SYSTEM
Comprises two matching consoles—lathe console incorporating turntable, drive, cutterhead suspension, lead screw with gpi meter, vari-pitch, cutting depth control unit, stylus heating and metering unit, operator's control panel, microscope, control and power units and vacuum pump.

The programme control console incorporates twin ppms, vari-groove offset attenuator, programme level setting attenuators, phase correlation meter, two Ortofon cutting amplifiers, power supply for same and two monitor amplifiers.

SPECIFICATION
Turntable: cast alloy, dia 40.6 cm, weight 17.9 kg.
Vacuum indexing: for 18, 25, 30, 33, 35.5 cm blanks.
Speeds: 16, 22, 33 and 45 rpm. To BS, DIN and NARTB.
Long term speed stability: better than 0.005%.
Wow and flutter: 0.02% weighted, to DIN 45507.
Rumble: better than 70 dB below recorded velocity of 10 cm/s (weighted) to DIN 45539.
OFF DISC PERFORMANCE (manufacturer's) using Ortofon cutting amp GO 701/GE 701 and cutting head DSS 661.
Frequency response: ±3 dB 10 to 36 kHz, ±1 dB 20 to 18 kHz.
Harmonic distortion: 1 kHz recorded at 25 cm/s, 2nd order 0.4%, 3rd order 0.2%, higher orders 0.05%. For 30 Hz at 1cm/s, the corresponding levels are 0.6%, 0.5% and 0.1%.
Intermodulation: 6.6 and 7 kHz recorded to 8 cm/s peak velocity, 0.07%. At 12.2 and 12.6 kHz recorded to 2.8 cm/s peak velocity, 0.1%. Both im product levels measured in terms of 400 Hz residue.
Max recording velocity: 30 cm/s

DESCRIPTION
The turntable is driven direct by a servo controlled dc motor. A transducer, mounted on the motor shaft, generates pulses relative to the motor speed; these are compared against a reference pulse train derived from a crystal controlled clock. The error signal provides speed compensation. The motor shaft and turntable incorporate channels providing the vacuum to retain the recording blank. Another line serves to collect swarf from a point directly behind the cutting stylus. Indexing for different recording blank sizes is achieved by sliding the top half of the turntable relative to the lower half.

The cutter head suspension and mounting is intended for the Ortofon *DSS661*. Other makes can be used with the appropriate interface. Front panel controls operate the stylus lift mechanism, at the same time switching out the stylus heating element in the raised position.

The lathe uses a series of interlocks to minimise the possibility of operator errors. Measuring instruments on the front panel monitor groove pitch and depth of cut, signal level and stylus heater current. Special mounts isolate the lathe bed from the console reducing the amplitude of vibrations coupled from the cutting room floor. Similar mounts isolate the turntable from the bed. The lathe incorporates a Nikon x150 microscope, illuminator and calibrated graticule.

NEUMANN
Georg Neumann & Co, 71 Heilbronn/Neckar, Fleinstrasse 29, postfach 2120, Germany. Phone: 8 22 75.
UK agents: F. W. O. Bauch Ltd, 49 Theobald Street, Boreham Wood, Herts WD6 4RZ. Phone: 01-953 0091.

MASTERING LATHE SYSTEM VMS70
The machine is intended for cutting mono and stereo records of all diameters and speeds. It utilises computer controlled vari-pitch for optimum packaging of programme material within a given disc surface. The cutting process is largely automated: start and stop of the tape deck, lowering and lifting of the cutting head, automatic lead in and lead out to concentric end groove.

The lathe system comprises lathe *AM66*, lead-screw drive unit *VA66*, drive control unit *AS66*, control amplifier *SV66*, power supply *NG70* and lathe console *ZT70*.

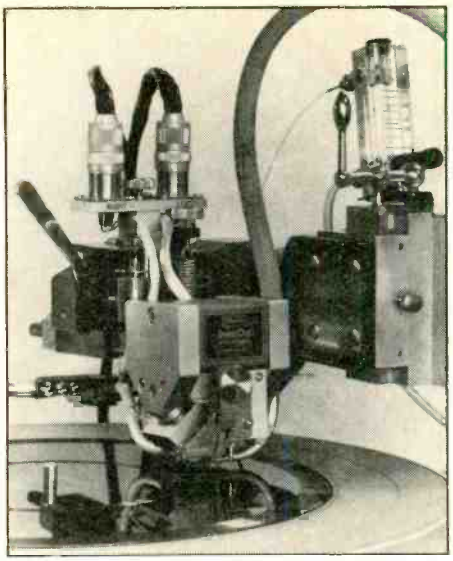
SPECIFICATION
Turntable speed: 16.6, 22.5, 33.3, 45, 78 rpm.
Turntable diameter: 36 cm.
Vacuum chuck: for blanks up to 36 cm.
Wow and flutter: 0.03% DIN 45507.
Rumble: 70 dB below 10 cm/s velocity at 1 kHz, DIN 45539.
Cutterhead suspension: full auto lift, stylus switching, electrically controlled depth of cut, dashpot with variable damping.
Cutterhead mounting: standard fit for Neumann heads, adapter plates available for most other makes.
Lead in/out: fully adjustable pitch.
Stylus heat current: 1.5A.
Microscope: type *203*, illuminated with calibrated graticule.
Power requirements: 100 to 240V ac, 500W.

STEREO CUTTING HEAD SX74
SPECIFICATION
Frequency response: (9 dB of motional feedback at 5 kHz) 15 to 16 kHz ±0.5 dB, 10 to 20 kHz ±1 dB, 7 to 25 kHz ±3 dB.
Cross talk: better than 35 dB from 40 to 16 kHz.
Feedback range: 7 to 14 kHz.
Feedback capability at 5 kHz: greater than 12 dB.
Maximum velocity, lateral: at 10 kHz, continuous air cooled 16 cm/s, helium cooled 28.5 cm/s, tone burst 105 cm/s.
Sensitivity: 1 cm/s/0.106A.
Max stylus excursion: 150 μm.
Drive coil resistance: 4.7Ω dc.
Impedance at 10 kHz: 7.5Ω.
Feedback output level: 3.5 mV/cm/s.

CUTTER DRIVE LOGIC SAL74
Comprises cutter adjustment modules, RIAA equalisers, feedback amplifiers, playback amps, automatic high frequency limiters, tracing error simulators, drive amplifiers, circuit breakers and monitor amplifiers.

SPECIFICATION
Output power: 600W/channel.
Load impedance: 9.5Ω.
Max output current: 8A.
Distortion: measured at feedback monitor output 1 kHz, 30 cm/s 2nd order 0.12%, 3rd order 0.2%.
Im distortion: 500 Hz and 8 kHz, ratio 4:1 at 10 cm/s sum 0.1%, diff 0.08%.

PROGRAMME CONTROLLER SP272
The unit offers correction and control of both the



main programme signal and the preview for the vari-pitch/depth of cut. In addition, facilities are provided to operate the cutting lathe from the control desk. An automatic banding unit is included.

MAIN CONTROL FUNCTIONS

Metering: dual light beam peak indicator, two vu meters, stereo correlation meter and phase monitor oscilloscope.
Disc level: relative disc level control for presetting the desired cutting velocity while maintaining given baseline on meters.
Preview offset: alters signal level to vari-pitch.
Equalisation: three way system.
Filters: Hi, lo, bandstop and shelving.
Eliptical equalisers: offer reduction of low frequency vertical components to provide improved mono compatibility.
Banding: provides spirals, selection counting and leadout; initiated by optical sensor on master tape machine.
Line up: five position test oscillator.
Push buttons are provided for: phase reverse, *Dolby*, eq insertion, mono/stereo, 150/300 Hz compatibility turnover frequency, cutter on/off, 14 dB test cut increase, monitor and A/B comparison.

Neumann supply a modified Telefunken tape machine *M15* for use with the disc cutting system. Fitted with additional preview head and playback circuitry, the model no is *MT72*.

ORTOFON

Ortofon Manufacturing A/S, II B, Mosedalvej, DK-2500 Copenhagen-Valby, Denmark. Phone: (01) 46 24 22.
UK agents: Feldon Audio, 126 Great Portland Street, London W1N 5PH. Phone: 01-580 4314.

CUTTING HEADS

DSS 731 extended response for carrier quadraphony
DSS 732 standard stereo.

The *DSS 731* has been designed for half speed cutting and is said to possess a very flat phase response in the range from 15 to 25 kHz. This has been achieved by careful selection of materials in construction with a view to decreasing the wave propagation times between the drive coil via motional feedback sensor to the stylus. Throughout the operating frequency range, the separation is claimed to be in excess of 30 dB between carriers.

The *DSS 732* is a more 'rigid' version of tre *731* covering the frequency range up to 20 kHz. The manufacturers state the unit meets all 'reasonable requirements' for high quality stereo recording.

Both models have a considerably higher stability reserve than the earlier *DSS 661*; typically, they may be operated with more than 18 dB of feedback at 5 kHz. Over the same model, both units enable 3 dB of improvement in cutting velocity at high frequencies. In addition, they claim cutting capability of at least 5 cm/s lateral throughout the specified requency range. Up to 13 kHz, the minimum velocity is 10 cm/s. Both use helium cooling.

SPECIFICATION

Drive coil resistance: 8.5Ω.
Max constant current: 0.8A (air cooled), I.IA (helium cooled).
Cutting level/amp: 10 cm/s lateral at 12 kHz.
Feedback coil resistance: 135Ω.
Feedback coil voltage: 8 mV/cm/s lateral.
Level response f/b ratio at 5 kHz: 12 dB (*731*), 10 dB (*732*).
Feedback turnover point: >25 kHz (*731*), 20 kHz (*732*). Max excursion, 45° direction/channel: 100μm.

CUTTING AMPLIFIER GO 741

Supply voltage: ±40V.
Input impedance: 5 kΩ balanced, sourced to 50Ω.
Input level: 0 dBm nominal.
Motional feedback input: 10 kΩ, unbalanced.
Max cutting power: 500W at 20 kHz.
Assumed load: 9Ω, 150 μH.
Output: balanced to ground.
Monitor amplifier: switchable to feedback of pu eq RIAA, output 0 dBm nominal.
Metering: cutting current and drive coil temperature.
Controls (push button): cutter, monitor state, emphasis, power limiter (8W approx), cutout.
Adjustments: input level, motional feedback level, emphasis and thermal cutout temperature (head).
Power supply: *GE 741* suitable for operating two *GO 741* amps.
Typical performance (manufacturer's) using GE 741/GO 741/DSS 732
Peak velocity: 30 cm/s at 20 kHz.
Motional feedback: recommended 10 to 12 dB, max 16 to 18 (5 kHz).
Distortion (measured on mfb line): 0.5% at 1 kHz, 25 cm/s.
Im distortion: 6.6 + 7 kHz at 8 cm/s, 0.1%. 12.2 + 12.6 kHz at 2.8 cm/s, 0.1%.

CORRECTION AMPLIFIER CPS 741

The self powered unit serves as a link between the tape master/preview machine and cutting amplifiers. Incorporating hi and lo pass, mid range, bass, treble, image width, balance and level correction, the two channel unit operates on the preview and cutting signals simultaneously on a left/right basis. Output facilities are provided for external monitor and metering amplifiers.

SPECIFICATION

Bass: ±15 dB at 70 Hz.
Treble: ±15 dB at 12 kHz.
Midrange: ±10 dB parametric switchable centres. 440 to 3520 Hz.
Balance: ±4 dB relative.
Width: up to 100% cancellation of equal magnitude in-phase components.
Lo pass: 50 Hz at 18 dB/octave.
Hi pass: switchable 8, 10, 12, 15 kHz at 18 dB/octave.

STEREOSCOPIC MICROSCOPE SM 721

Custom built for cutting head stylus examination and alignment. It incorporates a calibration graticule.

FILTER STL 732

When controlled by a dc voltage proportional to the stylus cutting current, the unit inserts a lo pass filter in the signal path having a turnover frequency proportional to the control voltage, eliminating unmanageable treble components in the signal to the cutting amplifiers.

The two channel unit incorporates a threshold control for adjustable standoff, attack/release and meter monitoring of turnover frequency.

SPECIFICATION

Input/output: standard 0 dBm line.
Power supply: self powered.
Tuning range of filter: 200 to 20 kHz.
Filter response (controlled): 3 pole Bessel.
Control input impedance: 50 kΩ assymetric.
Tuning voltage: 75 mV/octave.
Attack time: 0.3 to 100 ms.
Release time: 3 to 1000 ms.

L. J. SCULLY

L. J. Scully Manufacturing Corp, 138 Hurd Ave, Bridgeport, Conn 06604, USA. Phone: (203) 368 2332.

The following, taken from preliminary specification sheets, offers a description of a lathe to be introduced later this summer.

'The feed and depth systems of the new lathe utilize a proven sample and hold approach to generate multiple bit digital information as to the frequency and level content of the programme material. The use of a high bit sampling rate allows minute changes in pitch and depth to occur many times a revolution. A dc closed loop servo motor provides the feed screw drive for all programme and fixed pitches . . . Provisions are included in the depth system of the lathe that increase the depth of cut during lead-in and finish. The same facility exists to increase depth during the band mode . . . Banding may be initiated by leader spliced into the master, or by punching a small hole into the tape at the correct position. The turntable weighs 18 kg.'

The following push button controls are provided on the front panel: feed, lead-in, tape, audio, band, finish, rapid advance, turntable, lift and drop. Other facilities include stylus heating element control and meter, turntable speed change which also selects disc diameter for automatic operation, auto/manual band time selector, expand time with selection of pre or pre/post expansion, the depth control with associated meter and voltage adjustment and mode switch for manual/automatic operation.

'The cutter head suspension system is designed to accommodate both the Westrex and Ortofon cutter heads. Two screws effect placement of the cutter in a predetermined position. This feature eliminates the necessity of cutter head realignment and provides ease of stylus replacement. The lathe incorporates a self-contained variable vacuum swarf removal system.'

WESTREX

Westrex division of Litton Industries Inc, 390 North Alpine Drive, Beverly Hills, CA 90213, USA. Phone: (213) 274 9303.
UK: Westrex Company Ltd, 152 Coles Green Road, London NW2 7HE. Phone: 01-452 5401.

CUTTING HEAD 3D MK 2A

SPECIFICATION

Motional feedback: 29 dB before resonance. Feedback level —27 dBm (0.035V) at resonance (1k Hz) at 3.5 cm/s.
Cross talk: approx 35 dB, 50 to 10 kHz.
Max cutting level: 74.8 cm/s peak lateral using 120W cutting power.
Cooling: helium.
Drive coil impedance: 10Ω, 90 μH.

CUTTING AMPLIFIER SYSTEM RA 1700

The system comprises two *RA 1703* input amplifiers, two *RA 1704* feebback/monitor amplifiers, two *RA 1702* power amplifiers and one *RA 1701* power supply.

48 ▶

■ SURVEY DISC CUTTING

SPECIFICATION

Input: 0 dBm normal line level.
Output power: 120W to cutting head.
Monitor level: +4 dBm for 3.5 cm/s peak velocity.
Record: RIAA or flat. Within ±3 dB 30 to 20 kHz.
Amplifier distortion: 0.2% thd 30 to 20 kHz at 120W.
Distortion from cutter: intermodulation products 0.8% from mixture 40 and 7 kHz at 3.5 cm/s peak velocity.
Signal/noise ratio: 80 dB referred to 3.5 cm/s peak velocity.
Power requirements: 115 or 230V ac.

DISKMASTER SYSTEM

The electronic mastering circuits and operational controls are provided on a mastering desk. All recording, monitoring and operating functions can be controlled from there.

Two channels of programme and two channels of preview are processed in an identical manner. The programme lines from the desk feed the *RA 1700* cutting amplifiers, which in turn feed the cutting head. The preview lines connect up with the vari-pitch on the Scully lathe recommended by the manufacturers. A recessed patch panel allows re-routing of signals and testing at intermediate points in the circuits.

CONTROL FUNCTIONS

Slider attenuators ganged to preview. Three stage eq on ten centre frequencies/stage ±10 dB. Hi and lo pass filters, five frequencies ganged to preview. Low frequency crossover ganged to preview. Limiters with switchable matrix for vertical/lateral control. Adjustable over a range of attack/release values. Phase reverse. Blend ganged to preview. Line master fader ganged to preview. Cutting level ganged to preview. 33/45 speed change. Stereo/mono switch. Test oscillator, six frequencies. Vu metering on programme, feedback and limiters. Monitor source switch. Phase monitor oscilloscope.

Part two

AMPEX

Ampex Corporation Audio-Video Systems Division, 401 Broadway, Redwood City, California 94063, USA.
UK: Ampex Great Britain Ltd, 72 Berkley Avenue, Reading RG1 6HZ. Phone: 0734 55341.

BLM-200 DUPLICATOR SYSTEM

The system consists of the *BLM-200* bin loop master and up to 20 slave units of the *3400* series. Running at 600 cm/s, the master reproducer provides programme to enable duplicating at 32 times the normal speed. The machine features easy loading and automatic cueing; a photo cell assembly mounted in the tape path automatically counts the number of master passes and injects a 120 or 320 Hz tone on the copies for cutting points.

Working master tapes for all slave formats are recorded on 25 mm tape with 1.5 mil backing, recorded at 19 cm/s NAB equalisation.

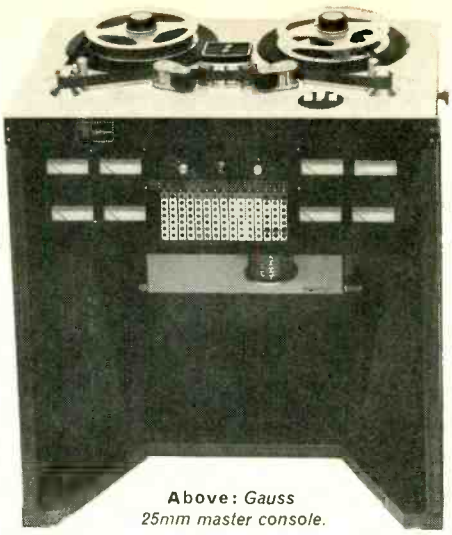
The *3400* series slave transports feature turnround guides with 150 mil or 6.25 mm guides for ease of tape conversion. Automatic tension control is provided.

Plug in head assemblies for both 4-track cassette and eight-track cartridge systems use a ferrite core for maximum life. Integral with the head block, individual bias and record level presets are provided for each track ensuring interchangeability throughout the system. No wiring changes are required when changing slave head format.

3400 series slave head assemblies for all standard open reel formats are also available.

DUPE CHARACTERISTICS

Frequency response: cartridge 50 to 10 kHz ±2 dB. Cassette 50 to 8 kHz ±2 dB.
Wow and flutter: duplicating system will not introduce more than 0.1% rms (NAB weighted) onto the dupe.
Crosstalk: below 50 dB between adjacent tracks.
System noise: better than 10 dB below a blank, biased Ampex *404* low noise tape; 30 to 5 kHz at final copy speed.



Above: *Gauss 25mm master console.*

Below: *Ampex bin master and slave production line.*

BRANCH & APPLEBY

Branch & Appleby Ltd, 42/42a High Street, Harrow-on-the-Hill, Middlesex HA1 3LL. Phone: 01-864 1577.

The company custom build tape duplication equipment covering from 4 track on 150 mil cassette tape to 8 track on 6.25 mm tape. Systems for compact cassette vary from 'in cassette' duplication at four to eight times recorded speed up to jumbo pancakes duplicated at up to 32 times normal play-back speed.

Duplication accessories manufactured by the company include multiple high speed cassette rewind units and bulk erasers.

ELECTRO SOUND

Electro Sound Inc, 725 Kifer Road, Sunnyvale, Ca 94086, USA. Phone: (408) 245 6600.
Europe: Audio Automatic Corporation, 4 Rue Ficatier, 92400 Courbevoie, Paris, France. Phone: 333.30.90.

6000 SYSTEM

This is a 32:1 system operating at a master speed of 600 cm/s into slaves running at 150 or 300 cm/s. The system consists of a master reproducer, rack mounted with automatic reel to reel or continuous loop bin; four or eight amplifiers are included together with a bias generator and an automatic tape control unit. Other features include two panel meters, two attenuator pads and two interchangeable eq record amplifiers to comply with various dupe formats.

With up to ten slaves in a system, the manufacturers claim the change over time between slave tape formats is less than one minute/slave due to the plug in head block and tape guides. They also state that cumulative wow and flutter on dupes is less than 0.1%. For cueing purposes, the system injects appropriate tones to activate tailoring gear.

4000 SYSTEM

This offers the same basic facilities as the *6000* series with the fundamental difference that it operates and duplicates at half the speed.

GAUSS

Cetec Inc, 13035 Saticoy Street, North Hollywood, Ca 91605, USA. Phone: (213) 875 1900.

50 ▶

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SURVEY TAPE DUPLICATING

UK: Cetec UK, Sapphire House, 16 Uxbridge Road, Ealing, London W5 2BP. Phone: 01-579 9145.

1200 SYSTEM

The system produces loaded reels and pancakes for both cartridge and cassette duplicated up to 32 times normal playing speed. This requires the masters, recorded at 19 cm/s, to be replayed at 600 cm/s. One *1210* master, with or without the *1260* tape bin, will drive up to 20 slave *1200* machines. This represents a total production capacity of up to 4000 copies of a 30 min programme every hour.

Other potential uses of the *1220* series include time compression of programme material transmitted via microwave and coaxial wide band links—a two hour programme could be conveyed in 2.75 min.

DUPE CHARACTERISTICS

Frequency response: 30 to 14 kHz within 3 dB.
Signal to noise: bias noise does not exceed bulk erased noise by more than 2 dB. (Weighted to ASA curve A.)
Equalisation: NAB (others to order).
Wow and flutter: 0.05% rms.
Tape speed accuracy: within 0.2%.

OTHER FEATURES

The master loop bin holds up to 550m of tape. The slave bias frequency is crystal controlled at 10 MHz to eliminate programme interaction. Slave tape format is rapidly interchanged.

OTARI

Otari Electric Co Ltd, Otari Building, 4-29-18 Minamiogikubo, Suginami-ku, Tokyo, 167 Japan. Phone: (03) 333-9631. UK agents: Industrial Tape Applications 5 Pratt Street, London NW1 0AE. Phone: 01-485 6162.

DP-4050

Produces six cassette copies from 6.25 mm master, recorded at 9.5 cm/s replayed at 76 cm/s (8:1 copy speed).

DUPE CHARACTERISTICS

Frequency response: 30 to 10 kHz +3 —6 dB.
Signal to noise ratio: better than 50 dB.
Crosstalk: below 45 dB.

DP-6000 SERIES

Produces pancakes for cassette and eight track format from 12.5 and 25 mm masters respectively. Using a bin master/slave console arrangement, the master is recorded at 19 cm/s and played at 600 cm/s (32:1 copy speed).

DUPE CHARACTERISTICS

Frequency response (cassette): 30 to 10 kHz +1.5 —6 dB. (Cartridge): 50 to 10 kHz +1.5 —6 dB.
Wow and flutter: less than 0.25% rms.
Signal to noise ratio: 45 dB (NAB SRL).

DP1900A AND B

Loaded cartridge test set to check operation and set tape at beginning. Runs ten tapes (A type) or five tapes (B type) at approx 4 to 8 times tape speed.

DP-6750

This cassette tailoring machine is specifically designed to wind cassette pancakes into empty cassette cases fitted with leaders. It automatically cuts the leader and splices the tape onto it, then proceeds to wind the cassette at high speed and cuts at the appropriate point. The machine controls tension and measures the length of tape wound on. The machine will wind any length up to C120.

The standard *DP-6750* is fitted with an audio sensing head enabling the exact length for pre-recorded tapes to be wound on. The manufacturers claim that the machine will load in excess of 100 C60 cassettes an hour.

TELEFUNKEN

AEG-Telefunken, Fachabeilung Magnetbandgerate, 775 Konstanz, Bucklestrasse 1-5, West Germany. Phone: 07531-601 2495. UK agents: Hayden Laboratories, Hayden House, 17 Chesham Road, Amersham, Bucks. Phone: 0243-5511.

Limited information received.

TELEX

Telex Communications Inc, 9600 Aldrich Avenue South, Minneapolis, Minnesota 55420, USA. UK agent: Avcom Systems Ltd, Newton Works, Stanlake Mews, London W12 7HA. Phone: 01-749 2201.

CASSETTE COPIER

The copier is available in two configurations. The cassette copier 1 (master) provides all controls and makes one copy from the original. It has add on capabilities for copier 2 (slave modules). Each copier 2 makes two copies but relies on the copier one for all power and control. The cassette copier 2 is equipped with a single emergency stop button. Both units are identical in size and styling.

SPECIFICATION

Duplicating speed: 76 cm/s.
Track selection: either of both by selective erase.
Copy time (C-60): 2 mins.
Rewind speed: 152 cm/s.
Automatic stop: at end of tape or faulty cassette.
Rewind: automatic at end of pass; manual override.
Frequency response: 30 to 10 kHz.
Signal to noise ratio: better than 46 dB.
Wow and flutter: 0.2% rms.
Crosstalk: below 50 dB.
Price: Both model one and two £575 each.

300 SERIES DUPLICATORS

The telex duplicating system can consist of any combination of open reel or cassette master and slave transports. Each transport features two operating speeds and is available for any standard power requirement or head configuration. Systems are controlled from the master console for simultaneous start, stop and record. To expand on a basic system, a total complement of up to ten open reel slaves or 18 two channel cassette slaves (six modules) can be added with simple modifications.

WOLLENSAK

Mincom Division, 3M Company, 3M Center, St Paul, Minnesota 55101, USA. UK agent: Fraser-Peacock Associates Ltd, 94 High Street, Wimbledon Village, London SW19 5EG. Phone: 01-947 2233/1743.

2770 AV

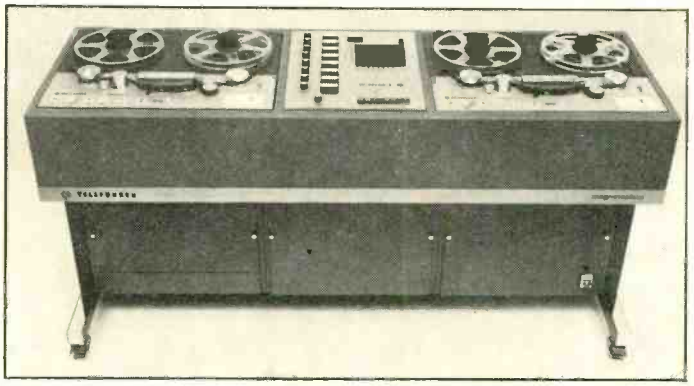
This machine is a compact cassette to cassette high speed transfer unit featuring two copy positions and one master bay. Automatic end of tape or end of programme sensing—switchable on the front panel—causes the master and slaves to rewind and stop.

SPECIFICATION

Design format: desk top.
Tape format: two track.
Duplication speed: 76 cm/s (16 times normal).
Wow and flutter: additive 0.15% max.
Timing accuracy: within 1%.
Frequency response: 40 to 10 kHz ±3 dB.
Signal to noise: within 3 dB of master.

Left: *Telex 300 duplicator*

Right: *BKM6 master console—part of the AEG-Telefunken range. This machine operates with two 25 mm masters providing continuous duplication at 32 times playing speed for both 8 track and cassette production*



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Progress in tape duplication equipment has not always kept pace with consumer demand in terms of quality at a price competitive with that of disc. However, recent improvements are permitting better overall results. These are discussed in the context of basic system techniques, with particular reference to the compromises involved in high speed duplication of cassettes and cartridges.

Tape duplication

ANGUS McKENZIE

PRE-RECORDED TAPES have been available on the domestic market for over 20 years, but reel to reel format never really caught on. The average consumer dislikes threading up, and the cost of production has been so high that when high speed duplication of cassette and cartridge was introduced, the latter appeared more economical and became a commercial success almost immediately. There is still a place for reel to reel tapes in special applications such as language laboratories, and there is clearly a requirement for short runs of a few hundred copies of master tapes, but because of space this article will deal only with the high speed duplication of cassettes and cartridges.

In the early stages of cassette duplication, Philips used banks of separate machines which were soon found to be uneconomical, and despite the immense difficulties, a few manufacturers of duplicating equipment were encouraged to look into the problem. Gauss produced one of the first high speed models, and they were followed by GRT and others once some of the problems had been overcome. Metrosound, an independent duplicator having some years of experience with Lyrec equipment, were the first to buy Gauss in the UK, and were followed by Decca, Trident and others. Precision tapes chose GRT but have recently added a completely new production set up of equipment designed and built by themselves, and giving a better standard than that obtained previously from their GRT. EMI at Hayes use Gauss, and were amongst the first to install ferrite heads.

In cassette duplicating, since a flat response up to 10 kHz is mandatory it becomes necessary to think in terms not only of wavelengths of the highest frequencies that have to be recorded, but the actual frequencies themselves. Most high speed duplication plants record even the most difficult programmes at a 32 times speed-up and this demands flat response of the entire equipment to at least 320 kHz with a usable response up to 500 kHz. There are many problems in enabling such exceptionally high frequencies to be recorded on to conventional cassette tape, and these will be outlined in turn.

For technical reasons, it has been conventional in the past to have a bias frequency at least five times higher than the highest audio frequency that is required to be recorded, and hence even the most modest modern domestic recorders have bias frequencies of at least 100 kHz. High speed duplicators require a bias frequency ideally at least as high as 2.5 MHz, although a few run with only 2 MHz bias. This very high frequency has to form a bias current through a record head, and since normal heads have an inductance usually between 4 mH and 10 mH it will be realised that not only would the impedance be ridiculously high at such frequencies, but the head would also form a tuned circuit with the capacity of the input wiring almost certainly far below bias frequency. This would involve such high bias powers that not only would the head overheat but the high voltages would cause severe problems to the record head driver amplifier. It is thus necessary to use record heads having an extremely low inductance, usually between 100 μH and 250 μH. Such heads have to be made especially for the purpose, and are extremely expensive because of the immense amount of work load that they must carry and the high speed of the tape; it is virtually imperative to use ferrite heads, or heads using materials with extremely good wear characteristics. The output from the bias oscillator section of the electronics usually feeds the head circuit through co-axial cable, and it is important for users to remember that they are dealing in effect with short wave radio frequencies which exhibit very different properties to audio signals. Earth loops must be avoided completely, for a particular earth path that may only have a few milliohms impedance at audio frequencies may turn out to have a few tens of ohms impedance at rf frequencies. Difficulties thus caused could induce radio frequencies into the modulation amplifiers, and cause serious blocking problems which would result in a limitation of maximum output level.

Some users have modified older high speed duplicators to run at a higher speed, increasing the bias frequency, if necessary, although problems can arise. In one particular case examined, an installation had a maximum available recording level at 333 Hz some 5 dB below the expected figure. After much investigation it was decided that the record head must be faulty in some way, and on examination it was found that the inductance was 1 mH. It was further found that the record windings fortunately were centre tapped, and thus feeding the centre tap instead of the complete winding reducing the effective inductance to 250 μH. When an internally rewired head was tested again on the production line, a 4 dB increase in record flux was available at the same distortion that had been noted previously at the lower level and thus the product duplicated on the modified equipment sounded very appreciably better.

The actual nature of the pole and gap faces of the record head is significant, since head to tape contact has to be far more intimate than on normal recorders. Since head wear is a problem, the entire duplicator tape transport has to be of an exceptionally high standard and guides and bearings must be maintained very regularly. Duplicating equipment has to be kept spotlessly clean, since one foreign particle lodged in the record head gap can write off a complete pancake of recordings, and since it is not normal to test every pancake for quality, serious complaints would of course be received from users, which could harm the reputation of the product's distributor.

In their latest duplicators, Gauss supply a wiping post including a glass fibre tape, which to a degree ensures the minimum of oxide shedding across the record head gap. However, the oxide shedding problem can be very serious for anyone and no fully satisfactory oxide surface cleaning mechanism yet exists to my knowledge. The latest Gauss duplicators also use the remarkably high bias frequency of 10 MHz and some years ago introduced a focus gap head, which projects the bias field to the relevant area of the tape's oxide as it passes the main gap. The focus gap principle includes small shims in the gap itself and allows, it is claimed, improved penetration into the oxide and a better general high frequency performance of the end product. Naturally, Gauss heads have an exceptionally low inductance but their equivalent record gap width is approximately 5 μm on the wide side. While a normal narrow gap allows a lower bias current to be used,

Facing page, left: *custom-made bin master and slaves manufactured by and operating at Precision Tapes.*
Centre: *close-up of a slave.*
Right: *loading cassettes at Metrosound with King high-speed loaders.*
Following pages: *Gauss duplicating line at Metrosound.*

enabling better high frequency performance, the inherent compromise means that they have in the past given poorer performance at low frequencies. Conversely, a wider record gap enables low frequencies to be recorded deep into the oxide but this condition requires a higher bias current which therefore tends to reduce the maximum operating high frequency level. The choice of record head gap must, therefore, be subject to such compromise, since different gap widths will be found optimum for different types of programme. A gap width of around 3 μm is probably a feasible optimum for high speed duplicators.

Ferrite heads have been developed by Gauss, after much pressure from the industry, and at first these heads were subject to gap fatigue after only a few hundred hours. The latest ferrite heads, however, show considerable promise, since theoretically, once the metal fatigue problem has been overcome, they should last much longer than ordinary iron types. At the moment, iron record heads are still being supplied in both focus and normal gap configurations. EMI at Hayes have been able to carry out many interesting tests on duplicator heads and claim that ferrite types allow several dB more high frequency level to be achieved on cassette and cartridge than appears to be available from iron heads and since the high frequency performance of cassette tape is even today relatively poor, it seems that ferrites must eventually completely take over. It is probable that the improved performance results from the more intimate contact between the tape and the gap field and furthermore more reliable narrow gaps can be made with ferrites. Gauss are now claiming a response typically within ±2 dB ref 333 Hz up to 14.5 kHz when a duplicated cassette is played back at normal speed. Remember that this is, in fact, claiming a performance at high speed extending to 470 kHz, which is remarable enough. However, some users are experimenting with a 64 times speed-up on their Gauss equipment for specialised purposes and some even more remarkable short wave length performances have been noted.

One serious problem in duplication is that of running up time, since the master sending tape has to reach a speed of over 6 m/s while the slaves run at approximately 3 or 1.5 m/s. The sending machine employs a loop bin, which allows a programme to be repeated as often as desired. Each programme is preceded by a very low frequency cutting tone, so that operators or automatic equipment, detecting the tone before each commencement of programme on the copies can cut the tape appropriately for mounting in the cassette or cartridge. The master playback machine contains electronics to give the correct equalised output for transfer to the slave machine's electronics. All interconnections are made with coaxial cables to avoid high frequency losses and in the slave machines preset equalisers and comprehensive metering allows the correct record equalisation to be achieved. For example, a master oscillator on each Gauss slave drives up to eight independent bias amplifiers arranged in pairs on printed circuit boards; current measuring resistors in the earth returns from the different sections of the record head allow the bias wave form and amplitude to be preset.

Gauss recommend that the 'Audio' equalising should be achieved by presetting 320 kHz level to be 13 dB boosted with respect to 10 kHz, as detected across the current measuring resistor. For cartridge duplication, the relevant frequencies become 420 kHz and 16 kHz respectively. The slaves are fitted with a probe monitor head, whose height can be set as required to monitor any track. This head drives a special repro amplifier having both a vu type meter and an oscilloscope fitted to facilitate bias and equalisation setting. The bias current is set on the plateau on which the 10 (16) kHz signal is near peak, such that a higher frequency records with an optimum response compatible with a reasonable biassing point. Such procedure is open to discussion: I feel that equalisation and biassing should be regarded separately, the latter being done first and the former adjusted for a flat response. It is well known that the biassing point does not necessarily coincide in overdrop with its equivalent at real-time speed; some lengthy research on this problem by an independent team would pay dividends to the entire industry.

The time constants, chosen originally by Philips for the cassette system, are reasonable at the high frequency end but have now been changed to a repro time constant of 3180 μs at the bass end to replace the original 1590 μs roll off. The latter curve required some 7 dB bass boost on record and thus caused serious lf distortion to appear on most programme material, especially pop music. Some duplicators, in advance of the official change, rolled off to the new recommended curve anyway but there are probably many duplicators in use today that have not been modified. Since most cassette recorders made in the world today have play back equalisation between 3180 μs and no bass roll off at all, copies made on unmodified

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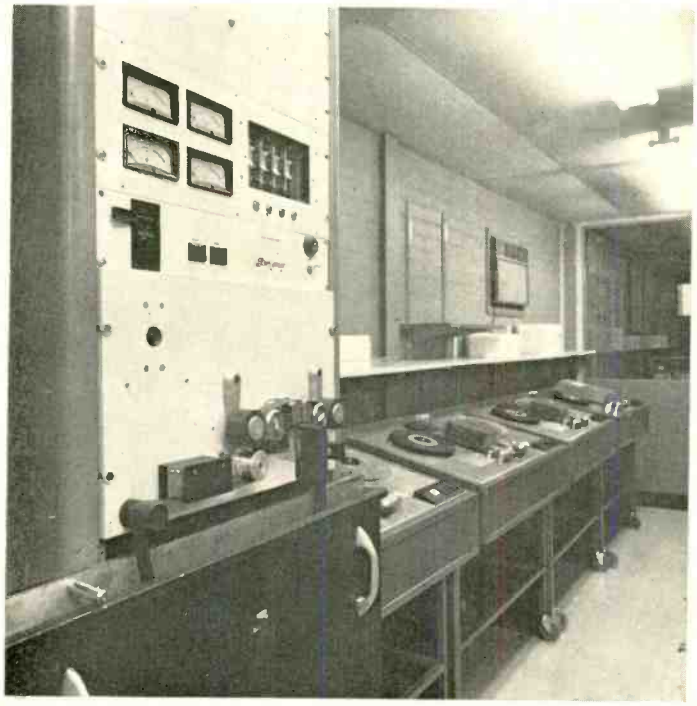
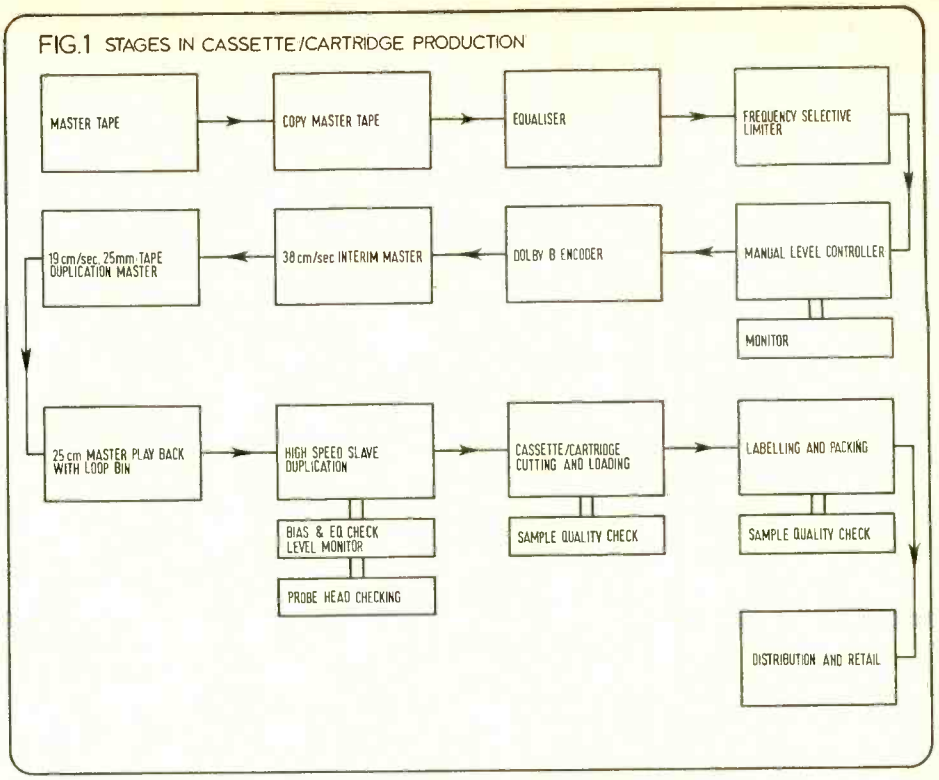


equipment would clearly reproduce with a ridiculous amount of audible bass boost.

The average duplicator record head is of far higher quality than those used in almost all cassette recorders. Therefore, higher levels are in general achieved on cassette duplication. Unfortunately though, even when ferrite heads and focussed gaps are used, a higher frequency performance is largely determined by the cassette tape itself and so the ratio between the maximum operating level at 333 Hz to the level permissable at 10 kHz becomes rather greater. This results in almost all pre-recorded cassettes having severe high frequency 'squash' and intermodulation distortion. Only with improved cassette duplicating tape can any significant advance be made in the future. Some recent types do show promise. EMI have developed their *X1000* duplicating tape which has a far superior performance to their earlier type, but at the same time samples are reaching my laboratory of foreign competition, including the new BASF Super *LH* and Maxell *UD*, showing great promise. This treble squashing problem can be considerably reduced in its severity by much more careful preparation of the interim masters which are usually made on 6.25 mm tape at 38 cm/s. These have to be transferred on an accurate 1:1 basis to 19 cm/s on 25 mm masters, subsequently used to send the programme on the play back/loop bin machine. It is clearly better to control the amount of high frequency energy electronically with discretion than to use the high speed cassette tape recording as a means of hf limitation, since in the latter case the sound quality can become most objectionable to the listener. The process of preparing interim masters for duplication is one that must be performed with great care by an engineer, who should have the appropriate musical knowledge. It is very easy to go wrong at this stage. In the last year I have checked for various clients about 150 miscellaneous pre-recorded cassettes and cartrdges and some very serious faults in production have been noted from virtually all companies, some companies showing different characteristic faults to others.

FIG.1 STAGES IN CASSETTE/CARTRIDGE PRODUCTION



It is clear that even majors sometimes pass the output from a master tape through an ordinary high quality limiter, apply a small amount of equalisation and then Dolby B encode onto an interim master. Such an automatic process can lead to marked anomalies on the product sold. I have run for example, a prerecorded cassette in sync with the equivalent record and subsequently noted up to 16 dB limiting at the top end of the dynamic range on the cassette as compared with the record. On classical music, such sound becomes ludicrous, giving the effect of the entire programme continually hitting the listener in the stomach at full volume. Sometimes when the original master had audible tape noise anyway, noise pumping was also evident. There also appeared to be an inconsistency in peak recording level between similar types of programmes from different manufacturers but with little apparent variation of peak distortion.

It is obvious, therefore, that manufacturers recording lower peak levels are either taking insufficient care in production or have equipment that is physically not capable of better results and good results are now demanded by the public.

Since I have indicated that automatic normal compression or limiting is not good enough, particularly for demanding classical music, the dubbing engineer must face the fact that manual gain control is almost mandatory and this can only be done by following the score, if necessary with a music producer. Quiet passages must be brought up in level to a certain degree, but short quiet passages interspersed with loud peaks must have their short term dynamic range retained, in parallel with standard balancing practice. Automatic compression can never do this adequately, but there is one further aid that is exceptionally useful. A year or so ago the BBC introduced a variable pre-emphasis limiter with a delay line, incorporated in their pcm link systems. If a high frequency peak occurred with too much energy, the normal 50 μs pre-emphasis curve is shifted up in turnover frequency so that if necessary no pre-emphasis at all exists for the duration of the hf energy peak. The detection of the peak is measured on the input to the equipment but

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KLH

The Natural Choice

The new CBS recording of Schoenberg's massive "Gurre-lieder," winner of the French Grand Prix du Disque, involved musical forces of 500 singers and players. To capture the detail as well as the magnitude of such a recording, producer Paul Myers selected, as always, KLH speakers for the recording sessions. The complexities of such a task have again called for the finest assembly of men and technology. When only the best will do, KLH loudspeakers are the natural choice.

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since the operational control is performed after the time delay, no distortion is apparent and a surprising amount of pre-emphasis change can occur without audible detection. Such a system does not alter the energy at bass and middle frequencies and thus allows a higher peak level to be achieved than at high frequencies. If the output of the equipment was then de-emphasised, or the internal parameters are changed, the system would be excellent for the preparation of interim masters.

Audio and Design have already supplied several band width control/limiter combinations which allow crossover points to be chosen at will, so that signals in one band will pass straight through the system while signals in another band are limited, compressed or even expanded in another band. This equipment in particular has been used by my company to prepare cassette interims of very difficult material and I therefore recommend this type of processing. Alternative equipment which would probably give similar results is available from FWO Bauch Ltd, but I have not had an opportunity of testing its performance.

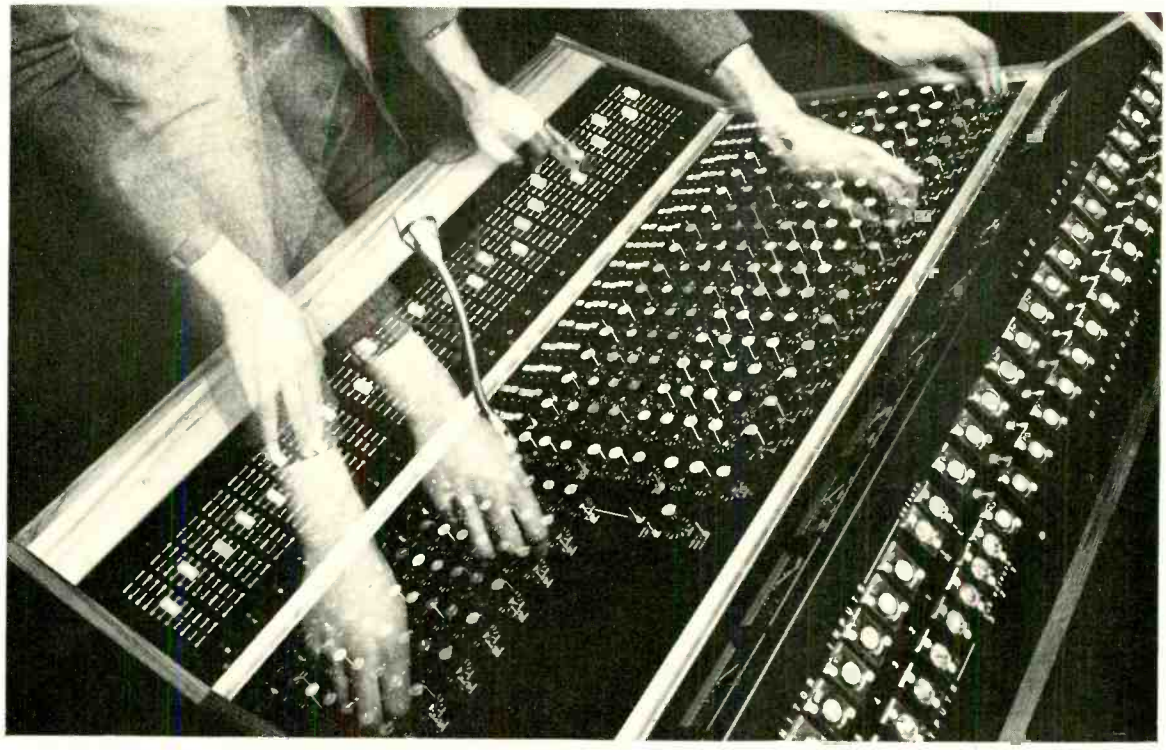
Many of the cassettes that I have heard have had either Dolby level or serious equalisation errors and, surprisingly, too much as well as too little treble has been detected. Bad head-to-tape contact has also been noticeable but have usually occurred on only one track. Some eight track cartridges have had one or more tracks to 8 dB down in relative level, but the response has been more or less correct. I have rarely detected crosstalk problems on cassette, but cartridges usually have detectable crosstalk from one stereo track to another. It appears on investigation that it is partly caused by crosstalk occuring at the 25 mm tape stage due to inadequate screening in the record or play back heads. When choosing an eight track recorder for the purpose this must be considered, and some very expensive machines not designed specifically for the purpose leave a lot to be desired. It is particularly important for each stereo track pair to be copied on to the 25 mm tape separately, since the worst types of cross talk usually result when different tracks of an eight track head are being fed with two programmes simulataneously. Such crosstalk can be caused by inadequate screening between the separate head laminations but may also be caused by bias linkage problems.

Dolby level errors have often crept in when an interim tape is being dubbed to the 25 mm master. If the Dolby B process is introduced before the interim, the levels must be kept constant throughout the dubbing process and the level by which the programme exceeds Dolby level must be measured with a peak programme meter and not a vu type, since at this stage an engineer must be concerned with peak flux level and not average listening level. On today's cassette tapes it is unwise to peak higher than 4 dB above Dolby level at middle frequencies, although 2 dB or so higher levels can be recorded on cartridge.

Pancake play back stereo machines are very expensive, most of them costing around £2000. A new and very promising one has just been introduced by AEG/Telefunken of Milan and despite the expense all duplicators should have a machine such as this available at the factory for continuous quality checking. Telefunken have also recently shown (at the AES Convention in London) a high speed duplicator based on their *M12* deck. (See May STUDIO SOUND for review of the standard *M12* tape recorder.)

Finally, it is only with the help of automation that production prerecorded cassettes and cartridges can really compete strongly with records. The latest Gauss equipment has an automatic start sequence, which allows the master machine to run up to a speed in 30s and at the appropriate time the slaves are also automatically started. After initial setting up, the operator only has to replace the recorded pancakes with new ones and clean the heads before a new run is undertaken. New machines can now cut, leader and prepare the complete product and even insert cards and labelling can now be automated. Small runs are just not economical though, and so there is still a continued demand for eight times speed up duplication as performed by several manufacturers' machines (see survey). For reasonable quality, though, the master send must be at least at 19 cm/s; unfortunately, some smaller equipment just copies cassettes from a master cassette, producing rather poor quality copies. Perhaps we shall see in the future a high quality eight times speed up duplicator working direct from 6.25 mm to *C60* or *C90* cassettes in one or two runs, which would be a great advantage for market survey work, as well as for many specialised purposes.

WELL WITHIN REACH....



Not only is the new 16 into 8 well within reach physically but also financially. It offers 8 track recording with facilities for 16 track recording and monitoring at a price that even the most economically based studio can afford.

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The actual application of disc cutting principles to a client's master tape can cause problems if the recording engineer has not thought carefully about the disc limitations themselves. The cutting stage has only recently become acknowledged as a critical part of the recording process, as a result of extending recording techniques. Customer relations is another tricky problem, since a tape which sounds good in the control room will not necessarilly transfer well to disc.

Disc cutting in practice

TONY BRIDGE*

*The Master Room, London

THE MID-SIXTIES saw the beginnings of a sharp increase in studio techniques applied creatively to music. The Beatles, of course, starting mainly with the *Sergeant Pepper* album, set the standards of studio recording for years, and together with their engineers, Geoff Emerick, made possible today's remarkable flowering of technique-conscious musicians. Studios themselves have been forced into continual reappraisal in terms of equipment and so on, in an effort to keep pace with the demands of record producers and musicians, while musicians quickly absorb any new product or technique that studios can offer.

While the initial recording became recognised as the most important link in the record-making chain, the transfer of the master tape to disc was for a long time looked upon as merely a back-room operation. Even when cutting the most important record, the transfer engineer was usually left alone to work on the tape by himself and not many producers at that time were aware of the processes involved. A typical comment of the time was the one made by a member of a well-known group, who said in a newspaper interview, 'When we got the pressings (of their latest record) we thought the cut didn't sound as loud as the tape did in the studio.' No wonder—not many people have the same monitoring facilities as a studio control-room; but the tape itself may have been unsuitable for cutting at a high level anyway. However, producers eventually realised that there was another area of recording where 'magic' could be wrought.

Until this time, say four or five years ago, the final master was generally expected to be an exact representation of the master tape. This is still the case with most recordings of classical music—the balance engineer, producer and artist between them spend a long time obtaining an internal balance within the orchestra, or between the soloists, and the mastering engineer will often find that he can transfer the tape to disc with the minimum of alteration. One well known impresario/producer, however, was well known for sometimes cutting up to 20 different versions of a record—after hearing the latest cut, hot off the press, he was known to demand an extra ½ dB lift at 3.8 kHz (no more, no less) at bar 82.

However, pop music usually demands a different approach. The original recording is made on to a multitrack tape machine, with the intention of altering certain sounds and balances on the final mixdown to stereo (or quad or whatever). Now, when the mastering engineer is working on the final tape, although he will endeavour to transfer it to disc as mixed, he may find that certain signals on the tape will not transfer satisfactorily. Creative musicians and producers (and, of course, balance engineers) will constantly be trying new techniques on their recordings. So the mastering engineer is presented with new sounds all the time, most of which will transfer, some of which will not. A compromise has to be reached with those that do not work and sometimes the producer will reject these sounds altogether and record a new section (this is quite rare nowadays, as more experience is gained in recording techniques, but a few years ago it was rather common).

An example of a sound that is difficult to transfer is that of breaking glass. While modern cutting heads can cope with quite large currents, they could easily distort when presented with a high level sound such as this. (High frequencies generate large amounts of electrical current, and it will be obvious that breaking glass contains mostly high frequencies in its frequency spectrum.) So if this particular effect is used with music on a tape and is mixed to the foreground, so that its level is comparable with the music, the combined signal would probably become impossible to transfer at a high level.

This is when compromise becomes necessary. Either as much of the offending high frequencies as possible are filtered out of the tape, thus keeping the same volume, but at the same time losing top from the glass (and the music), or the cutting engineer can drop the volume, or level, of the effect (and again, the music) so that the current generated is not so great as to become a problem to the cutter head. This is only a particular example, and the same problem might arise with, for instance, a loud cymbal crash, or any of a million and one other sounds or combination of sounds. As an example, photo 1 shows the groove cut from a tape with exaggerated high frequency content. The sharp white peaks are the high frequency

Photo 1: *Exaggerated hf content.*

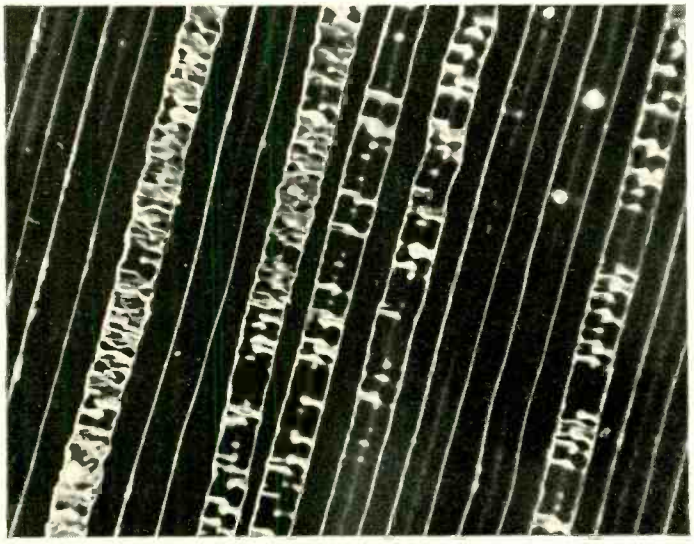
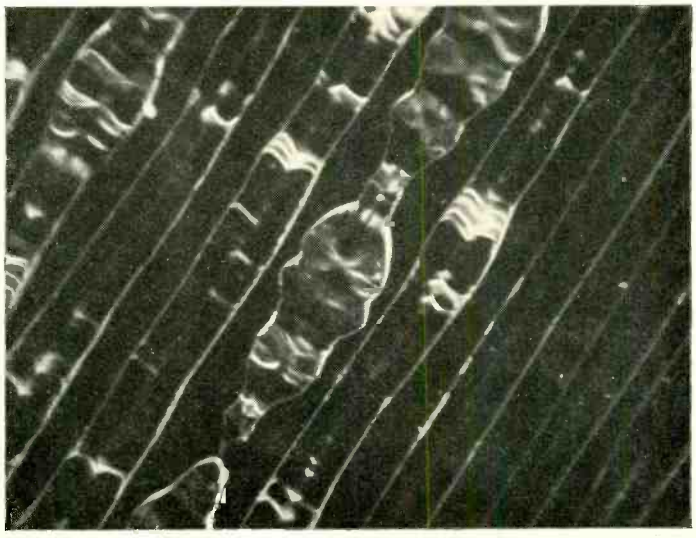


Photo 2: *Out-of-phase signal 'string of sausages'.*



excursions. (All the photographs were taken with the kind assistance of CBS Records, from my own specially prepared cuts.)

Another effect that can cause trouble is an out-of-phase signal. The cutting head in this case will move in a vertical plane and given a signal of sufficient amplitude will produce the 'string-of-sausages' seen in photo 2. The level of the out-of-phase signal seen in photo 3 was enough to lift the cutter head completely from the surface of the lacquer during its 'negative' phase. Obviously, on most equipment this would produce a jump, but strangely enough, some cartridge/pick-up arm combinations might track this kind of groove formation, and the listener might not be aware that there is actually no groove at this point!

Photo 4 illustrates another problem that is often met in modern rock recordings. Balance engineers often bring the bass guitar well forward in the mix so as to recreate a 'live' sound on the record. The grooves illustrated show what happens if the bass signal is cut at peak level. The wide swings cause the grooves to over-cut into each other—when the playback stylus reaches the point in the centre of the photograph, where the grooves collide, it will cross over, ie a jump will occur.

It is sometimes possible to equalise an offending sound so keeping its flavour while losing the troublesome frequencies. This might be the case, for instance, with a heavy bass guitar, which might benefit from having its low frequencies around 20 or 30 Hz filtered or sloped a little, and its higher frequencies, say 100 or 150 Hz boosted. The essential quality of the sound is retained, at the same level, but the risk of jumping, or skipping is lessened. The same treatment might be given to a very sibilant voice, which might otherwise distort, but this time the very high frequencies present in the signal are filtered out and the lower ones boosted. The signal could, of course be heavily limited, but will sound very 'squashed', and is not usually advisable. To see the effect, look at photo 5, which is of a cut that has been highly limited. The signal is the same as can be seen in photo 4. Compare the very straight groove with the very wide swings seen with the non-limited bass.

There are, of course, many different sounds that can give trouble to the mastering engineer, and many ways of dealing with them. However, it's obvious that it is easier for the balance engineer to clean up these sounds when recording the original tape. It's a good idea, therefore for the balance engineer to have a basic knowledge of disc cutting—it will always be easier for a mastering engineer to work on a tape that has been mixed by an engineer who has an understanding of the things that give trouble on a cut.

The mastering engineer will be looking at these problem sounds while setting up the tape prior to cutting, using his experience to spot signals that might prove troublesome. He will also be looking at the level, or volume, of the master tape and adjusting the transfer level to suit the particular programme. In general an lp will be transferred about 2 or 3 dB lower in level than a single, although occasional peaks may go well above normal single level and some singles may have to be cut at the lp level. The mastering engineer will use his experience in the first instance to decide what sort of level to use when transferring the signal to disc. He will know what to expect from some sounds in the way of groove formation, while others will have to be cut, probably as a test cut, before he knows if they will give any trouble.

To facilitate in setting levels, all master tapes should have level tones at the start although many submitted, unfortunately, do not. If they are not included, extra work is made for the mastering engineer, as he then has to work through the whole tape to find any isolated peaks. These tones should consist of a few seconds of a 1 kHz tone at standard operating level (sol), a bass tone at sol, around 100 Hz, to check alignment of the cutting room tape machines and coincidence of record and playback machines, and a high frequency tone, say 10 kHz, also at sol to check azimuth.

Azimuth is very important in transferring a tape to disc. The mastering room will usually be accepting tapes from many studios, and the tapes will not be recorded with the same head azimuth. If the head alignment of the original tape machine is not quite the same as that of the cutting-room machine and no adjustment is made, there will be a phase shift when cutting. This will be noticeable in mono as a loss in top and level, and in stereo as an additional blurring of phantom images between the speakers. Corrected adjustment of azimuth is critically important when transferring matrix-system quadraphonic tapes, which rely on phase information for their correct reproduction and this demands much tighter tolerances.

If the tape has been recorded through a noise reduction system, it will need to have a reference tone to the same level at which the original system was driven. It's surprising how often this is not included, for without it the mastering engineer will be working in the dark. It is vital to know at which level to drive his playback system. Another aid which can be very useful as a double-check, is a series of quick burst of tone, to identify right- and left-hand channels—say two for left and three for right. All these tones are of great help to the mastering engineer and allow him to play back the tape in exactly the way it was recorded, without having to rely on intelligent guesswork based on the signal itself.

One of the most important aids in cutting, and one around which much research and development has been centred, is the vari-groove system. Before this was introduced, records were cut at fixed pitch, which is to say that the grooves are all of the same depth, and the same distance from each other, as they move across the surface of the disc. This puts a limit on what can be cut on the disc.

To understand this, an explanation of 'pitch' is required. Running time on a record is dictated by the pitch, and vice versa—the finer the pitch (the closer together the grooves are), the longer the record will run. For a 12 in, 33⅓ rpm record, a fixed pitch of 300 grooves to the inch yields a running time of 30 minutes, 200 grooves to the inch 20 minutes, and so on. Unfortunately, the wide swings of the modulation on a loud cut can only be accommodated by using a coarse pitch (or widely-spaced grooves), so it is possible only to have a long, quiet record, or a short loud record.

With the advent of the vari-groove system, in its various forms, this was all changed. The system allows the pitch of the cut to be altered during the cutting. Basically, the pitch closes up

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Photo 3: *Cutter lift on out-of-phase signal*

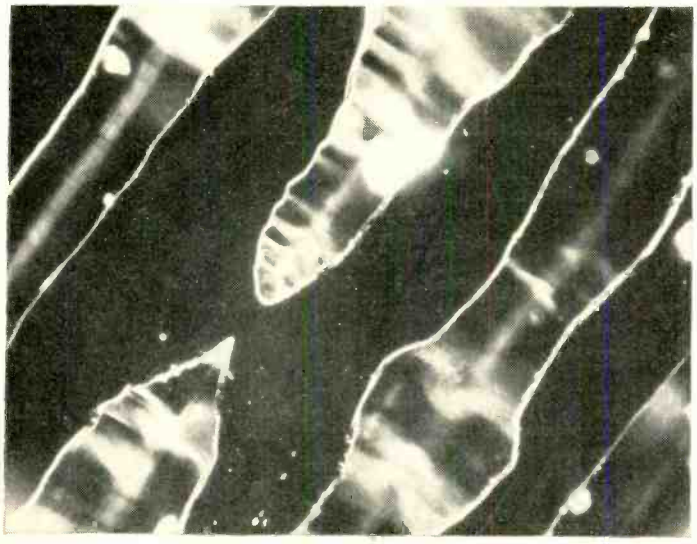


Photo 4: *Peak level bass signal causing overcut*

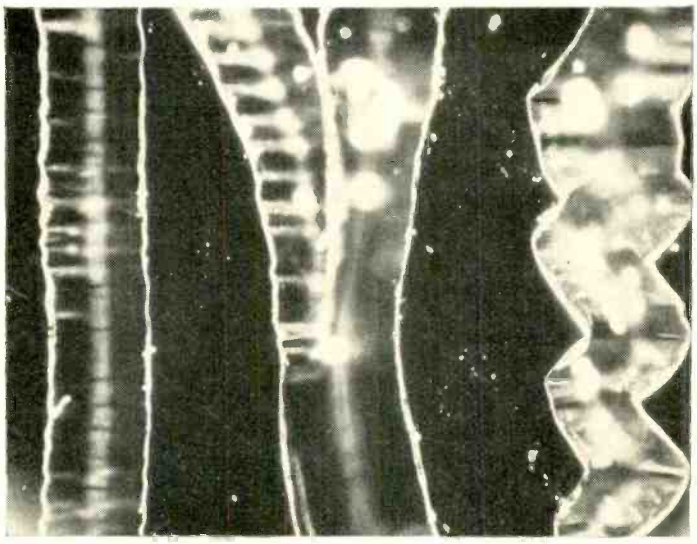
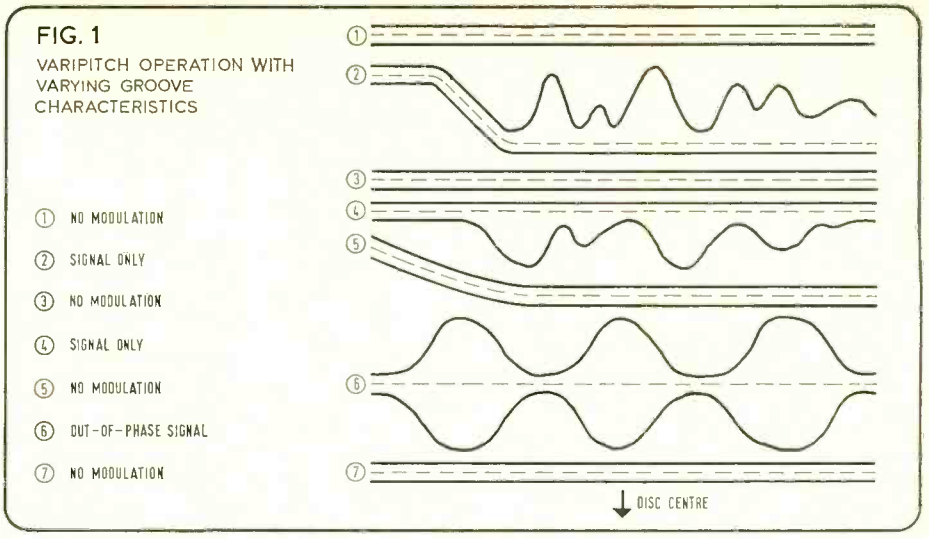


FIG. 1
VARIPITCH OPERATION WITH VARYING GROOVE CHARACTERISTICS



in quiet passages with little modulation, while in loud passages the pitch opens up to accommodate the wide swings of the groove. The system also deepens the groove if a large amount of out-of-phase information is present in the signal (see previous paragraphs for more detailed analysis of these effects).

The tape machine used in the transfer chain has two play-back heads. The tape passes over the advance head 42 cm before the main play-back head (in the case of a 12 in, 33⅓ rpm cut), and the signal from the advance head is fed to the cutting lathe pitch system half a revolution (or more exactly, 0.6 revs) ahead of the main signal. While there is no signal, or a low-level signal on the tape, the grooves are allowed to close up, saving space—when a high-level signal passes over the advance head, the grooves open up, and, if there is any out-of-phase information, will deepen. (See photo 6 for an illustration of this operation. Moving from the right, the grooves are close together to start with, as there is a quiet signal being cut, but in the centre of the photograph, a louder bass signal is being cut, and the grooves are opening up. Toward the left the grooves are resuming the basic pitch.)

This is the operation of a basic system, and is fine for cutting a mono signal, which has a symmetrical groove formation; the vari-pitch system described in the previous paragraph opens the pitch for the same amount after the heavily-modulated groove as before it. So while it is an improvement over the fixed-pitch system, and is the ideal for mono cutting, it is still wasteful of space when cutting a stereo signal which, of course, will usually have asymmetrical groove formation.

Figure no 1 is a schematic diagram showing the operation of a particularly flexible system. Groove 1 is unmodulated, and is at the basic pitch. In groove 2, a right-hand signal only appears, and the pitch of the grooves has opened before the start of the signal to accommodate the modulation. Groove 3 has no modulation, and the lathe has resumed the basic pitch. Groove 4 has a left-hand signal only. Groove 5 has no modulation, but the pitch opens to allow for the modulation in the preceding groove 4. Groove 6 shows the deepening to allow for the exaggerated vertical modulation associated with out-of-phase signals, while groove 7, being unmodulated, returns to the basic pitch.

Any equalisation carried out on the master tape is duplicated through the pitch system. (To appreciate the precision of the system, it is worth realising that the sum of the cut groove and the land, or uncut lacquer, between the grooves is an average of 2.5 mils, or 60 μm—the thickness of a human hair. All the operations described above therefore take place with an accuracy of a fraction of a hair.)

The vari-pitch system is usually of more help in transferring classical music, which has a wide dynamic range and is generally quite lengthy. In recent years, of course, rock music often has acquired as wide a dynamic range as classical music. Using the automatic pitch system to its fullest, therefore, the mastering engineer might well be able to obtain higher peaks on, say, a 25 minute side of a Yes lp than on a 16 minute out-and-out rock 'n' roll album.

Obviously, the vari-pitch system is not of such importance in transferring a pop single, which is usually more or less the same level for three or four minutes, though there are the occasional singles such as Elton John's *Lucy! n The Sky* which would benefit from judicious use of the system. This particular single was six minutes long and, luckily, had a wide dynamic range. As a result, the pitch could be closed up for the quiet verses and allowed to open up for the louder choruses. Because of this, the peak level of the single was not much below that of a normal single (with a tape of similar length, but sustained high level peaks, the cut would have to be much lower in level).

In the physical cutting process itself, a blank disc is used, usually an aluminium disc coated with a lacquer of cellulose nitrate. The disc has to be very flat, as any surface imperfections will be reproduced on the final pressings or, if large enough, damage the cutting stylus. The lacquer coating is about 0.15 mm thick, and contains lubricants, plasticisers and other

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DISC CUTTING IN PRACTICE

materials to prolong cutting stylus life and give a quiet cut. During the history of disc cutting, several other materials have been used for blank discs, such as glass, and even paper, but none have had the requisite quietness and uniformity of the lacquer/aluminium combination. A cutting stylus made of some industrial gem such as diamond, ruby or sapphire is used and to facilitate a quiet cut it is wound near its tip with a heating wire so that the point of the stylus is heated as it travels through the lacquer.

The condition of the stylus is of prime importance to the final amount of noise on the cut. A worn stylus will give a cut with a high level of surface noise, or hiss, and the same will be true if the stylus is fitted incorrectly into the cutterhead. If the heating wire is too taught, the stylus will be physically restrained from moving as freely as it should, with a resultant loss of top on the cut. The swarf cut from the lacquer is usually carried away from the stylus by a vacuum tube positioned alongside or behind the cutting stylus, into a jar or box behind the lathe. The cutter head assembly is moved across the blank by a screw-thread, operated by the pitch controlling system which we have discussed.

Each channel of a stereo cutting head will be driven by an amplifier of up to 100W rms, although the new generation of heads such as the Ortofon *732* or the Neumann *SX 74* may be driven by amps of 600W rms. These can deliver so much current to the head that instantaneous peaks may create up to 3k of heat in a space of 25 cc. Some kind of cooling system is therefore advisable, and this usually takes the form of a stream of helium passing over the feedback coils in the head, and subsequently dissipating the heat into the air.

The only direct function that an engineer will have to perform during the cut, apart from setting levels, eq, and so on, is to put scrolls on the record to mark different tracks, if needed. On an automatic lathe, he presses a button which speeds up the screw thread (opens the pitch) for a predetermined length of time (0.25 to 0.75 of a second is the usual). If there is silence between the tracks, he will also make the pitch rather coarser just before and just after the scroll, to overcome pre- or post-echo. This is caused by the deformation of an unmodulated groove by an adjacent modulated groove. By opening the pitch slightly, the engineer is making sure that grooves are well away from each other. This particular fault can also be caused by bad pressing, but this, of course, is out of the engineer's hands.

Many of the tapes that pass through the hands of any cutting room will require, as we've seen, some equalisation, limiting or level changes. Occasionally, as in the case of a compilation album or one recorded in several different studios, each track may require different adjustments. Also, level and eq changes are needed during the course of an individual track. This is when a production copy of the master tape, with all the adjustments, is made. This copy is then used for mastering, and all subsequent copies are made from this tape.

This is the leisurely, ideal way of mastering tapes which need a lot of changes. But every cutting engineer will have mastered many records, the producers of which insist upon using the original master tapes and which need a vast amount of changes while being cut. The engineer will really be earning his keep with these tapes, as a single mistake means scrapping the lacquer and starting all over again. While writing this article, I worked on an lp under these circumstances, that needed (or so the producer thought) over 80 changes of equalisation and level: and this is by no means the first—and, I hope, not the last!

Most cutting engineers thrive on challenging tapes. They will obviously have more pride in a record that is more unusual than the normal run-of-the-mill record. There are many examples I could quote, but the one that stands out is the last Monty Python lp. The producers of the record decided to carry on the traditions of the Flying Circus by having two records on one side, meaning that the person playing this particular side would have no idea which sketch the pickup would play. Practically, this meant that two sections were recorded in the studio, each of a maximum eight minutes length. This was one case where the cutting engineer—in this case George Peckham—was consulted *before* the recording!

The first section was transferred at the coarsest pitch available (in this instance 75 grooves to the inch). The groove was cut with a very shallow depth, so that the ratio between groove and land was about 20:80, rather than the more usual 60:40. When this cut was finished, the cutting head was returned to the beginning of the blank, the stylus dropped onto the land between the first cut, and the second section of the record transferred to the disc, with the second groove running concentrically with the first. The main difficulty was in overcoming the mechanism of the vari-pitch system, which tended to try to open and close the pitch, as we've seen in previous paragraphs. Thus, the second groove would start moving into the first, with the engineer frantically adjusting the pitch manually to keep the two grooves away from each other.

The cut took quite a few hours, and a lot of wasted lacquers to achieve. The final result, however, was very unusual, if not unique; the technique was used some years ago in America. It was used, in this case, to make a record of a horse race. A fixed-pitch machine was obviously used, at 78 rpm, and several commentaries were cut concentrically. Each one ended with a different horse winning, and bets were made on the outcome of the race.

The final process in cutting is inspecting the lacquer and packaging. The engineer looks at as much of the groove as is possible, through a microscope, to check that there are no overcuts etc, and to check the quality of the stylus. If all is well the matrix, or catalogue number of the record, is marked on the edge of the lacquer, and the lacquer placed in a box ready for shipment to the factory.

In this article I have only been able to touch the surface of this subject. Every tape that a mastering engineer receives is different and unique in its own right, and an engineer has to learn different techniques every day to cope with the various problems with which he is presented. It is, of course, impossible to lay down any hard and fast rules for cutting—the basic operation of the machinery is easily learnt; but to learn the ways in which to use the gear to good advantage can only come from practice.

Photo 5: *Signal highly limited*

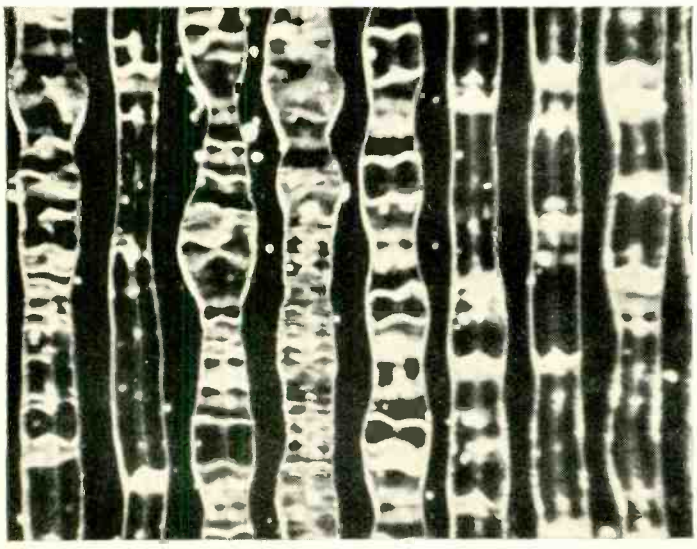
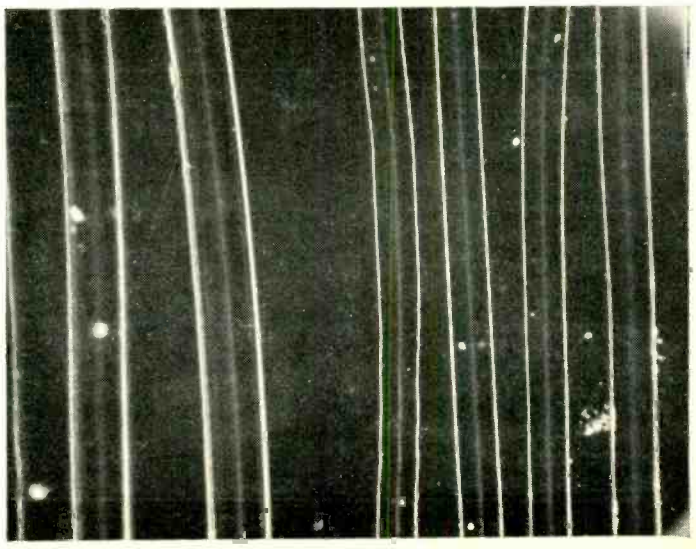


Photo 6: *Varigroove operation*



All photos courtesy of CBS Labs.

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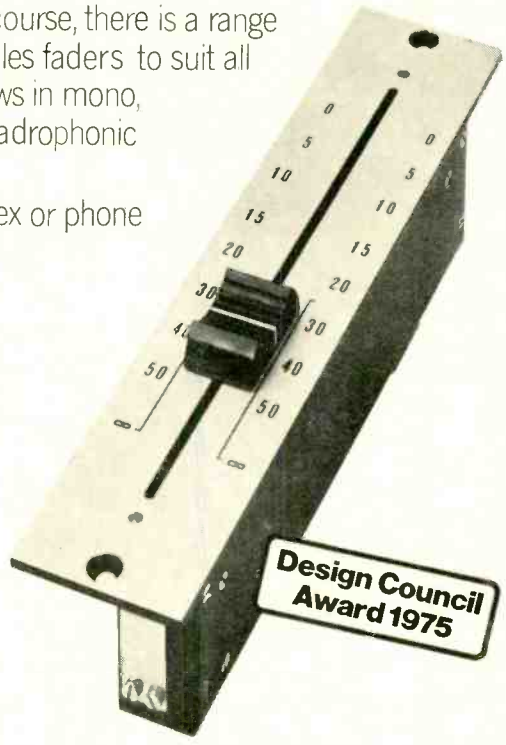

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Disc recording involves a close interrelation between cutting and playback for optimisation, by which their distortions can be reduced to very small values. It is not possible to consider sections in isolation; all parts in the chain are important, from lathe to pickup system. Theoretical aspects are discussed, particularly those distortions inherent in the medium which can be rationalised geometrically.

Disc cutting in theory

HUGH FINNIMORE*

FOR PRACTICAL CONVENIENCE a recording characteristic is applied to the normal flat audio signals from the master tape before processing the program on to disc. The recording characteristic assists in (a) economy of disc surface, and (b) low background noise (surface noise) on replay.

Together with the power limitations of a practical cutter head, conditions dictate that an approximation to constant amplitude recording characteristic is desirable. If a flat recording characteristic were applied, the result on disc would, in effect, be a constant velocity modulated groove, since velocity is proportional to applied voltage at the cutter head. However, this approach would yield very large amplitudes for low frequencies and extremely small amplitudes for high frequencies, which might then sink below the inherent noise levels: it can be estimated that disc surface roughness exists at an amplitude in the region of 10^{-5} mm (10^{-2} μm) peak-to-peak from photographs, which is confirmed by actual noise level tests.

On the old 78 rpm discs, the standard recording characteristic used was a first approximation to a 4 dB per octave boost towards the hf end of the spectrum. As a result of considerable American research in the early 1940s, the RIAA Characteristic of **fig. 1** was introduced with the launching of the new 33⅓ rpm microgroove discs. This and other general recommendations have since been adopted as international standards, relevent details being fully incorporated in British Standard Specifications BS No. 1928 (1961) and all later BSS. (BS 1928 (1961) is possibly one of the most concise and complete short documents on the subject.) This recording characteristic (fine groove in BS) was devised to fit the new system principally because of American spectra analysis findings prior to 1940, covering all typical program material.

Fig. 2 is a representation of the Standard Spectra Curve 'A' which fits the original RIAA conditions applied to a 30 minute program on one side of a 33⅓ rpm disc; constant program level is assumed, together with the use of a 25 micron (25×10^3 μm (micron) = 1 in) tip radius stylus for replay. It is convenient to represent such spectra as volts versus frequency, since this is one step nearer to the more useful result of plotting recording velocity versus frequency—transformation to actual recording velocity from voltage involves applying the recording characteristic to the original curve.

Original research was very carefully performed on the basis of measuring the true acoustic pressure levels that would be experienced by a real audience when listening to a real live performance, such as will be simulated when using distant microphone placing technique. However, with modern close microphone techniques the Standard Spectra Curve 'A' will not necessarily apply. This subject is discussed later.

Fig. 3 shows the Standard Spectra Curve 'B' which is curve 'A' with the recording characteristic applied. The BS Recording Characteristic is also shown as a reference. Thus, if the Standard Spectra Curve 'A' applies to the program in question, maximum cutting velocities are likely to occur in the region of 2 kHz.

The Mechanical System

Practical disc cutting requires a cutting chisel preferably made of sapphire or artificial sapphire (certain other similar gem stones such as ruby are acceptable. Diamond has not been used until very recently for a number of reasons but principally because of the cost.) A suitable shape for a sapphire cutting chisel is shown in **fig. 4,** which applies for both mono and stereo.

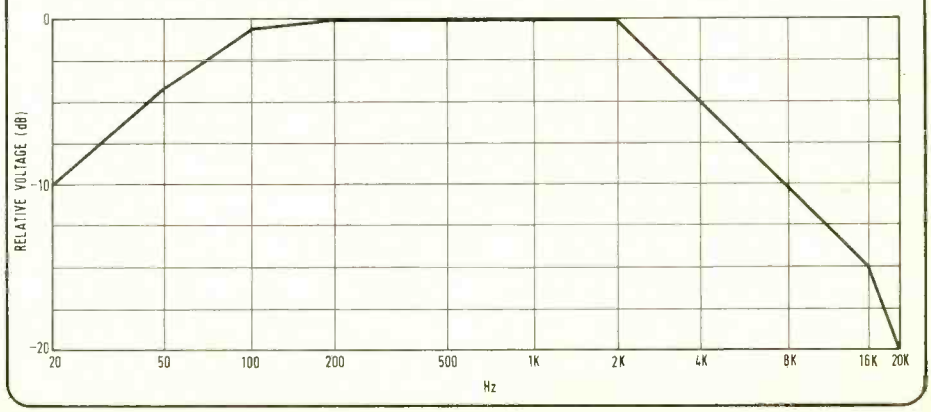
The chisel is vibrated by a magnetic drive motor system (somewhat similar to a centre zero voltmeter movement). In mono, the stylus is vibrated laterally about a near-horizontal axis lying tangential to the groove at a height about 1 cm above the point of the chisel, and research indicates that the chisel should cut the disc at a trailing angle of about 88°. A trailing angle of less than 90° is essential to exclude the possibility of the chisel digging into the disc surface. Simple mono systems are shown in **figs. 5** and **6.**

For stereo, the stylus requires a double actuating drive motor system giving 45° motion in a near-vertical lateral plane, as shown in **fig. 7.** As can be seen in this simplified drawing, a stereo cutterhead is exceedingly complicated and difficult to make. For stereo, research indicates that the chisel must cut the disc at a trailing angle of about 75° as shown in **fig. 8.**

The reasons for the different trailing angles for mono and stereo are discussed fully later, as are the subsequent problems of pickup optimisation.

For replay, a conical stylus having a tip radius of 25 μm was the standard type assumed to be available and used under the original

FIG. 2 STANDARD SPECTRA CURVE 'A'



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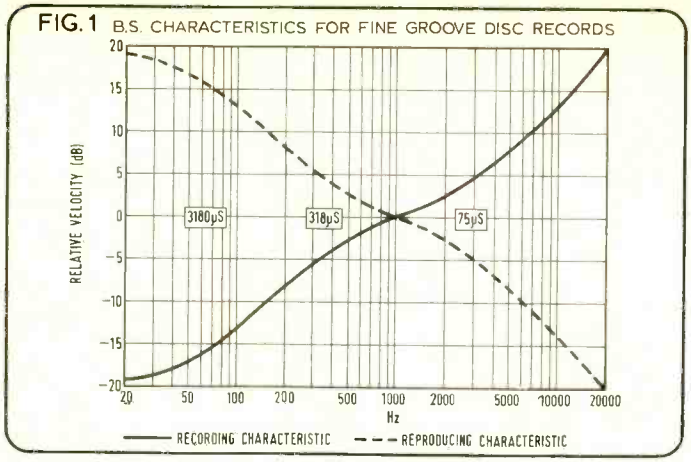

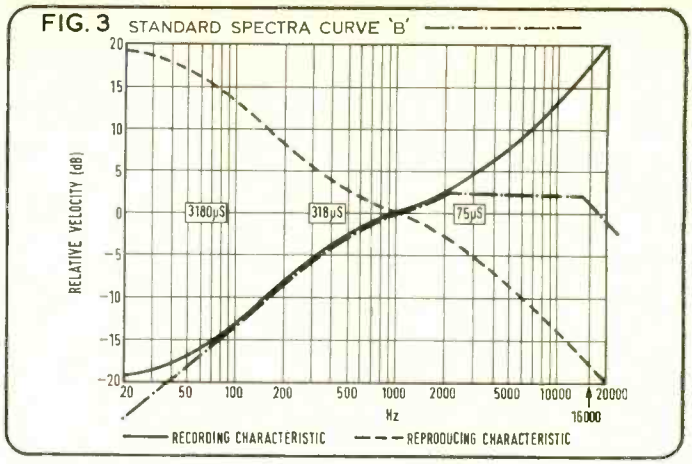

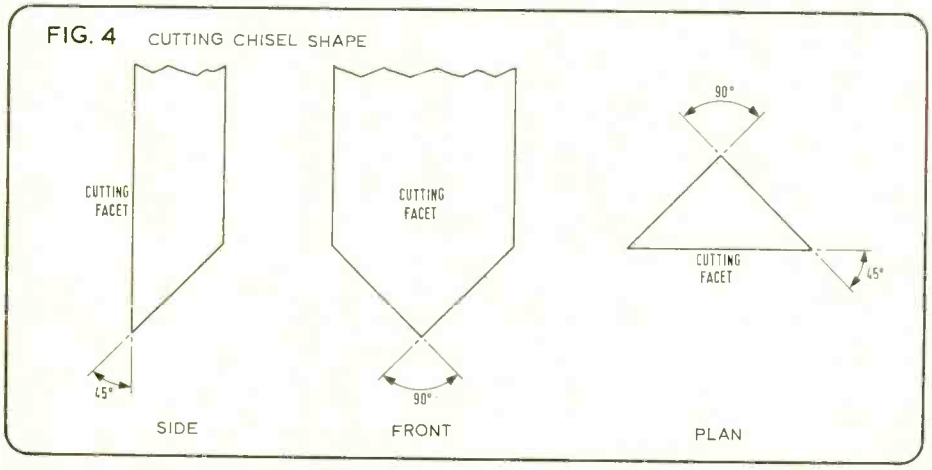

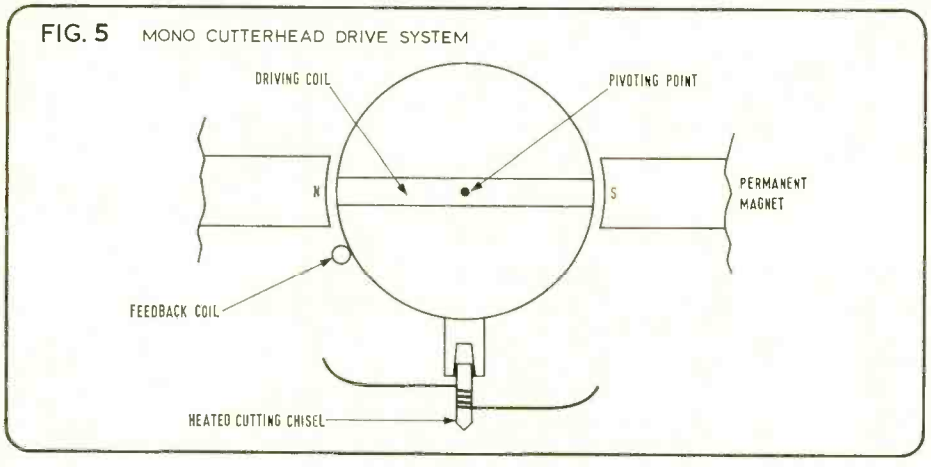

RIAA format conditions, as in **fig. 9**. Various smaller radii conical styli have developed and since been available, down to a radius of about 17 μm. However, while it is possible to make a conical stylus with a smaller radius than this, it becomes more practical to use an elliptical section. Elliptical styli are now generally available with an effective tip radius down to 8 μm, with the major radius kept at around 17 μm. This shape is somewhat difficult to show without a large number of sectional drawings; however, the lateral section is drawn in **fig. 10** to show the effective tip radius and major radius combination. The purpose of an elliptical shape is to achieve a very small tip radius while retaining as much possible material in the stylus tip area to provide strength to withstand normal usage.

Initial research indicates that for stereo the minimum trailing angle of the replay stylus arm should be about 15° as shown in **fig. 11**. For mono, the trailing angle can be zero. These angles are determined by the physical design of a practical magnetic type stereo transducer in the pick up unit. For best results, the stylus arm should be kept as straight as possible, since it is then possible to make a stylus arm much lighter in weight with adequate strength.

Peak Recording Levels

There are three principal limitations on recording levels in disc recording: those of amplitude, velocity and curvature.

It could be argued that there is no absolute limit to amplitude, since any automatic or manual adjustment of groove spacing during cutting procedure could overcome this problem. However, norms of cutterhead design make it inadvisable to allow amplitude to exceed around 75 μm.

In practice, amplitude limit, assuming constant program level, is defined purely by the program running time, provided the recommended absolute limit is not infringed. Since the recommended groove width measured at top of groove is not less than 50 μm for 33⅓ rpm conditions (and 120 μm for 45 rpm short play), typical 25 minutes program time implies 250 lines per inch, or 100 lines per cm groove spacing on the disc surface. Assuming constant spacing, this produces a distance of 100 μm between groove line centres. If the groove width is 50 μm, the remaining space between grooves is 50 μm. Hence, the maximum amplitude possible without cutting into an adjacent groove becomes 25 μm.

The amplitude limit characteristics are given by the following equation, which is derived later:

$V = 2\pi af$

In real terms

$V = 2\pi \times 10^{-4} af$

Where V = peak lateral cutting velocity in cm/s.

a = amplitude in μm.

f = frequency in Hz.

The absolute limit of amplitude has been shown as 75 μm.

With a = 75 μm

f = 100 Hz.

Hence V (limit) $= 2 \times 10^{-4} af$

$= 2 \times 10^{-4} \times 75 \times 100$

$= 4.7$ cm/s.

Similarly, with a frequency of 1 kHz, the absolute velocity limit becomes 47 cm/s.

To plot the guide limit for a 25 minute program, put a = 25 μm and f = 100 Hz

Hence V(25) $= 2 \times 10^{-4} \times 25 \times 100$

$= 1.57$ cm/s.

At 1 kHz, the corresponding value is 15.7 cm/s.

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DISC CUTTING THEORY

There is a very precisely defined velocity limit caused by the shape of the disc cutting chisel. As shown in fig. 4, the chisel cutting facet has edges exhibiting 45° acute angles. Hence, there is a practical limit to the lateral crossing angle the chisel can achieve without the back hitting the cut groove wall, as in **fig. 12.**

In mono, the crossing angles occur in the lateral mode only, and the velocity limit occurs at a lateral crossing angle of 45°. In stereo, the maximum crossing angle limit is also 45° in the lateral mode as for mono, but crossing angles can now occur in other planes between the horizontal and 45° inclinations on either side at smaller values for the same peak values of lateral velocity when signals differ instantaneously.

Due to the diminishing groove radius, the conditions producing 45° crossing angles in lateral mode will alter gradually from start of program to end of program. A 45° crossing angle occurs in mono when the lateral recording velocity V_R reaches the linear speed of the groove V_G.

Hence at start of mono program on a 33⅓ rpm lp disc, where the radius of groove from centre of disc is 14.5 cm

$$V_R = V_G \text{ cm/s.}$$
$$= 2\pi rf$$
$$= 2\pi \times 14.5 \times \frac{33\frac{1}{3}}{60}$$
$$= 50 \text{ cm/s peak.}$$

As discussed, the maximum crossing angle in stereo is the same as in mono (for the same peak velocity). Hence stereo $V_R = 50$ cm/s peak. At the end of program in mono and stereo, by the same calculation, $V_R = 20.6$ cm/s peak. Velocity limits for 45 rpm discs work out as 39.4 cm/s and 23.5 cm/s for start and end of side respectively.

It should be noted that these calculated velocity limits cannot be exceeded, being defined geometrically rather than in a relatively arbitrary practical way as for amplitude.

It is helpful to limit mono cutting velocities to 90% (or less) of the permitted maximum velocity; that is, a margin of 1 dB minimum should be allowed. In practice this is only a significant factor on 45 rpm discs. Stereo cutting velocities should be kept well below velocity limit, for reasons which are discussed later under the heading 'Tracing Problems'.

The curvature limit is the limit most likely to cause confusion unless the principles are fully understood. It is useful to derive the formula for maximum curvature of a groove from first principles.

An unmodulated groove is assumed to be a straight line in the immediate vicinity of cutting chisel or replay stylus, since the radius of curvature due to its helical form on a disc surface is relatively very large in comparison to the radius of a stylus tip.

In **fig. 14,** if a point P is moving with constant velocity V_1 in a circle of radius r and the system is also moving with a velocity V_2 in direction D, then this point P will trace out a sine wave.

The motion of point P about the line CD is as follows:

Displacement y = SP
= r sinα
= r sin ωt cm (where ω is angular velocity (radians/s) and t is time (s)).
= r sin 2πft (where f = revolutions per sec, or frequency in Hz).

FIG. 6 MONO CUTTERHEAD TILT

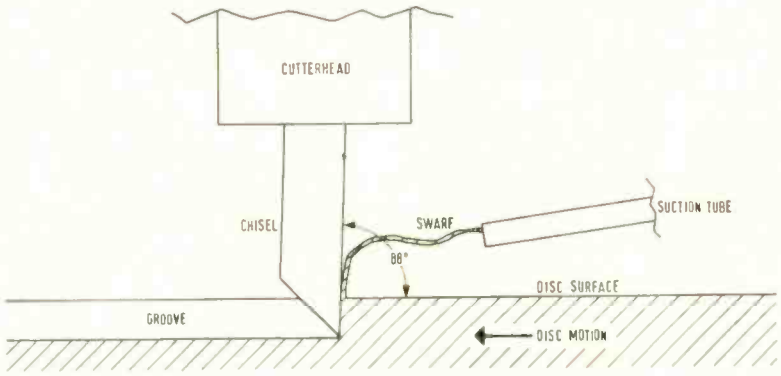


FIG. 7 STEREO CUTTERHEAD DRIVE SYSTEM

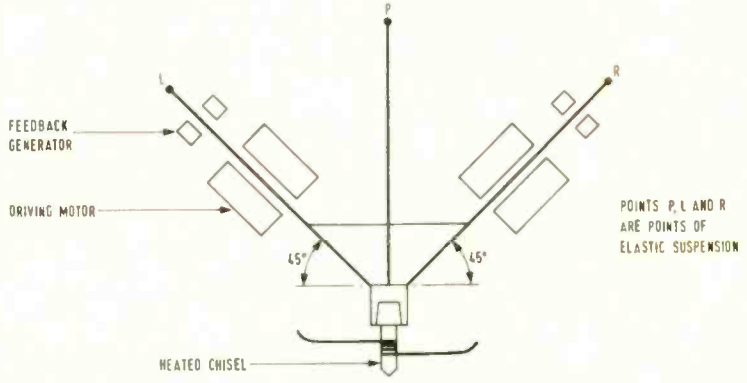


FIG. 8 STEREO CUTTERHEAD TILT

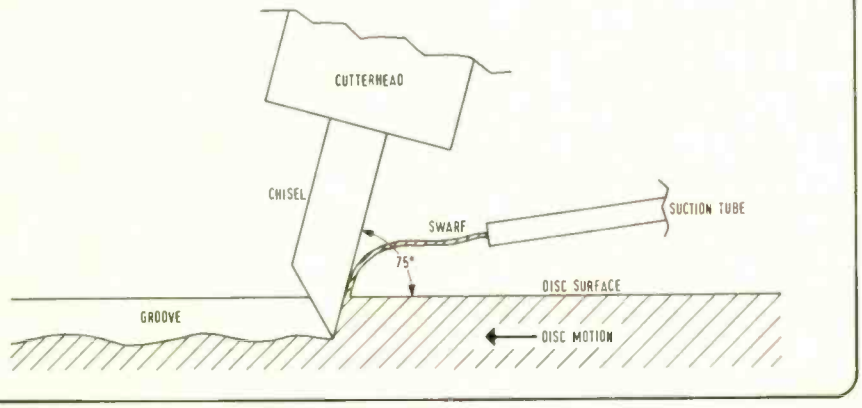
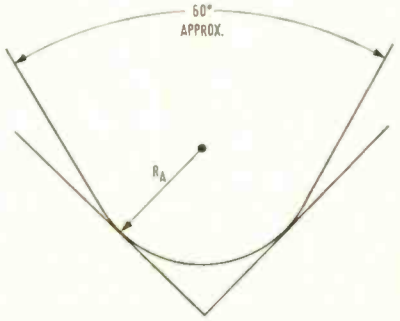


FIG. 9 CONICAL STYLUS TIP



Peak displacement occurs when $\sin \omega t = \frac{SP}{CP} = 1$

Hence, peak displacement = r

Velocity (lateral velocity of P about line CD)

$$V_L = \frac{dy}{dt}$$
$$= r w \cos \omega t$$
$$= 2\pi r f \cos \omega t$$

Peak velocity occurs when $\cos \omega t = 1$

Hence, peak velocity $= 2\pi r f$
$= V_1$

Acceleration (lateral acceleration of point P about line CD)

$$a = \frac{d^2 y}{dt^2}$$
$$= -r\omega^2 \sin \omega t$$
$$= -r(2\pi f)^2 \sin \omega t$$

Peak acceleration occurs when $\sin \omega t = 1$.

Thus peak acceleration $a_p = -4\pi^2 f^2 r$

(The minus sign can be ignored in later calculations since its meaning simply indicates direction in which acceleration takes place.)

In the special case where $V_2 = V_1$ the maximum curvature of the sine wave is physically r by inspection and from the equations above we have maximum curvature $= r$

$$= \frac{V_1^2}{a_p}$$

However, if the writing speed V_2 is varied, it is obvious that the physical curvature of the sine wave will change in accordance with this equation.

Hence the general formula for curvature of a sine wave becomes

$$\text{Curvature} = \frac{(\text{writing speed})^2}{\text{acceleration}}$$

Hence, the formula for maximum lateral curvature R of a groove becomes

$$R = \frac{V^2}{a} \text{ cm}$$

Where V = linear speed of groove in cm/s.

a = peak lateral acceleration of groove in cm/s.

By inserting the value of $a = 4\pi^2 f^2 r$ in the above

$$R = \frac{V^2}{4\pi^2 f^2 r}$$

from which

$$f = \frac{V}{2\pi\sqrt{Rr}}$$

Before proceeding to solve this, it should be noted that the curvature seen by a stylus is not the lateral curvature but the 45° inclined curvature, as in fig. 14. Hence to correct for this it is necessary to substitute the apparent tip radii for R when solving to find f, because R is the lateral groove curvature at the curvature limit. See fig. 15, where NM is the apparent tip radius since it lies in the plane of stylus/groove contact, and hence NM = LM cos 45°.

For the purposes of this investigation only three tip radii need be considered, as follows: elliptical tip stylus having a side radius of 7.5 μm; general purpose conical tip stylus having a radius 15 μm; and original RIAA specification conical tip stylus with radius

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FIG. 10 LATERAL SECTION OF TYPICAL ELLIPTICAL STYLUS

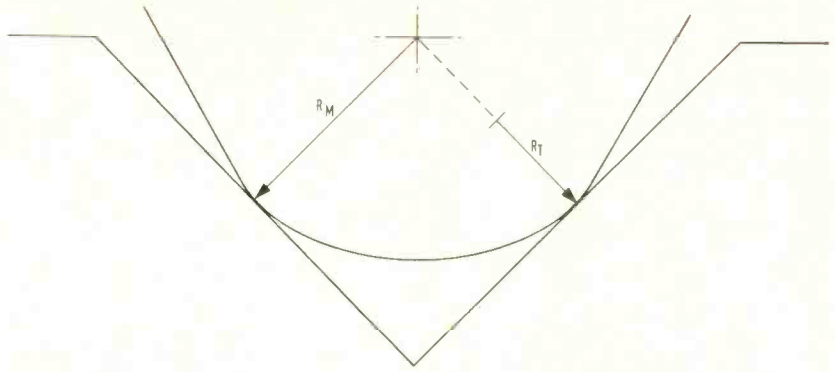


FIG. 11 THEORETICAL TRAILING ANGLE FOR STEREO REPLAY STYLUS ARM

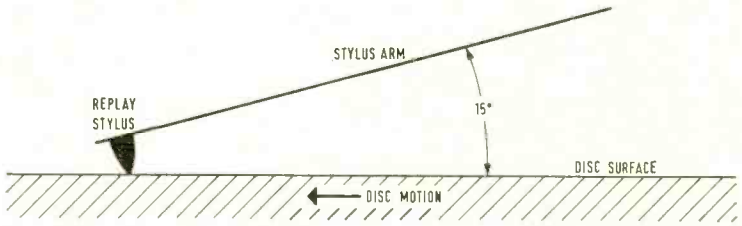


FIG. 12 PRACTICAL LIMIT OF LATERAL CROSSING ANGLE

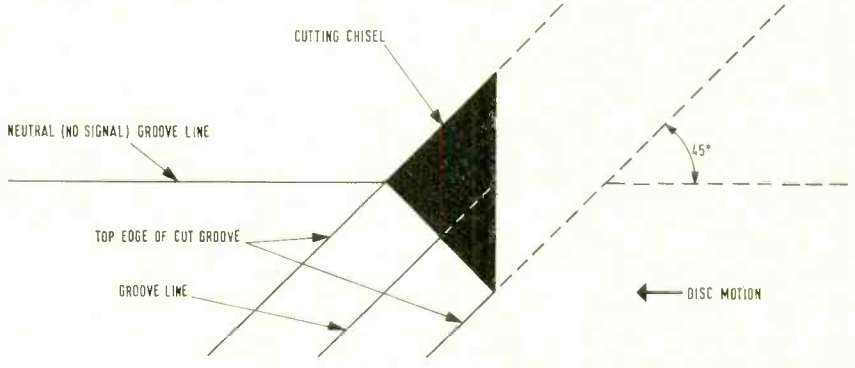
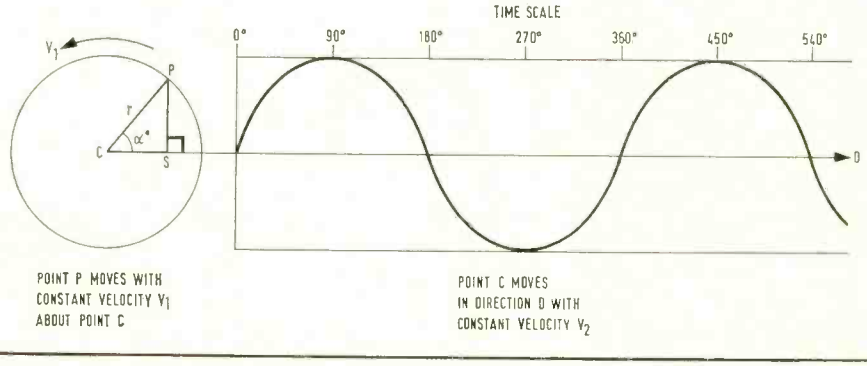


FIG. 13 GRAPHICAL SINE-WAVE CONSTRUCTION



DISC CUTTING THEORY

25 μm. By substituting the apparent radius for these styli we find that, for amplitude (r in this case) of 25 μm, corresponding frequency limits are 11, 7.8 and 6 kHz respectively, at the start of the side. Obviously, the lower the amplitude r, the higher the limiting frequency. Thus, maximum program frequency defines a maximum value for r.

At the end of the disc, the corresponding frequencies become 4.5, 3.2 and 2.5 kHz. It can also be seen that if the frequency is doubled the velocity is halved in order to retain the same curvature.

Plotting of a curvature limit line is therefore quite easy once the point for a required line is established by solving the respective value of f and marking this off on the particular amplitude limit line r = 25 μm. By the same processes the curvature limit lines can be constructed for 45 rpm conditions.

Short cuts can be used since it is usually only necessary to calculate start and end of disc condition for one tip radius.

For 45 rpm, elliptical stylus:

V(start) = 39.4 cm/s.

V(end) = 23.5 cm/s.

$$f(45) = \frac{39.4}{2\pi\sqrt{(.0025 \times .7 \times .0003)}} = 8.7 \text{ kHz.}$$

$$f(45) = \frac{23.5}{39.4} \times 8650 \text{ Hz} = 5.2 \text{ kHz}$$

The other limits for the larger tip radii will differ in the same ratios as for 33⅓ rpm.

In passing, it is interesting to calculate the lateral accelerations on the 33⅓ rpm curvature limit lines.

Start of disc conditions for elliptical stylus:

$a = 4\pi^2 \times .0025 \times 11\,000^2$ cm/s/s

= 12 000 000 cm/s/s

= 12 250g approx.

where g = 981 cm/s/s, the acceleration due to gravity.

Similarly, for the others we find 6125g and 3660g respectively. End of disc conditions for the three styli again yield 2050g, 1150g and 630g respectively.

In practical disc cutting there is an arbitrary limit to the lateral acceleration that is reasonable to apply to a cutting chisel in the region of about 2000g, principally due to the practical limit in drive power due to cooling needs. The final disc recording velocity limit graphs for 33⅓ rpm and 45 rpm are shown in **fig. 15** and **fig. 16.** In these graphs, the SSA Curve 'B' has been overlaid to show the typical maximum recording velocities which would occur on disc for programs of various different running times. (Note that SSA Curve 'B' is Curve 'A' corrected for recording characteristic.) In practice there will be some deviation from the expected shape of the SSA curves in any particular program depending purely on program content: for instance, a solo bassoon would exhibit very little sound energy above about 2 kHz, while a flute solo would have little below 200 Hz. The SSA curves are fundamentally only a guide to the expected peak levels for any frequency on a relative basis in a given acoustic environment.

It is the sound balancer who defines ppm readings (volts) and he is free to adjust the volume and tone controls etc as he thinks fit; that is, he can alter the apparent acoustic environment and hence the energy spectra at will. This environment existing in a program is rapidly changed when any device such as a compressor (or limiter) acts; incorrect use of compression facilities or poor compression electronics can cause quite excessive hf peaks of short duration which may escape notice on listening to the master tape. However, even allowing for moderate electronic compression of program material, the SSA Curve 'A' is still a very accurate guide to the maximum relative hf content that will actually occur in relation to peak program level, for all types of musical program properly recorded. Hf problems may arise with vocal performance, especially where close microphone technique is used and a singer

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FIG. 14 APPARENT TIP RADIUS OF CONICAL STYLUS

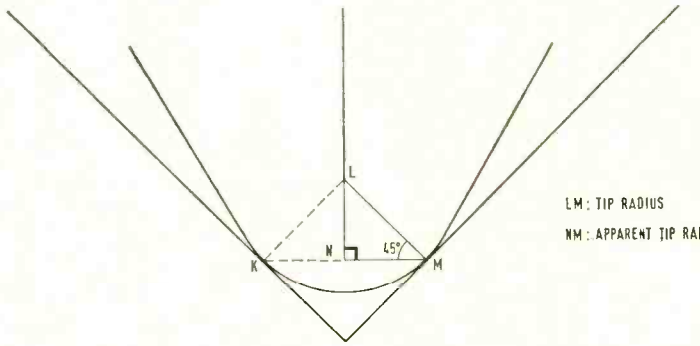


FIG. 15 33⅓ RPM VELOCITY LIMITS

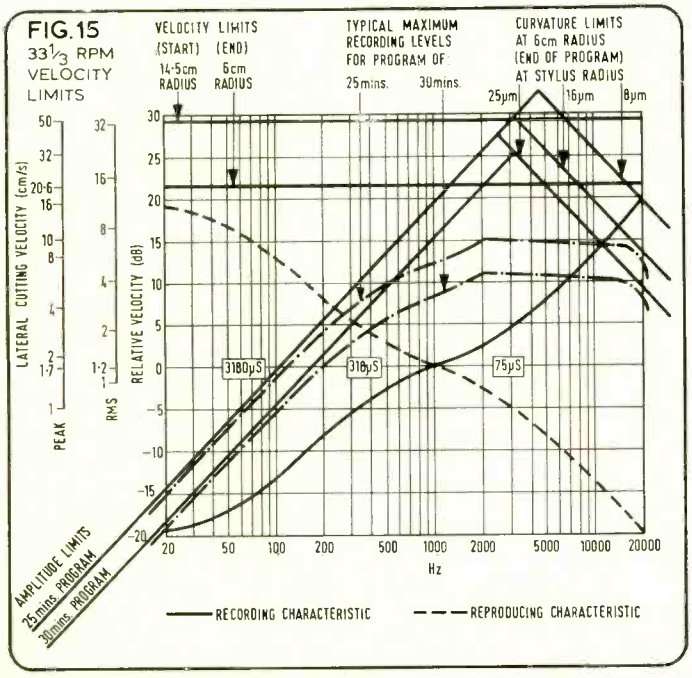
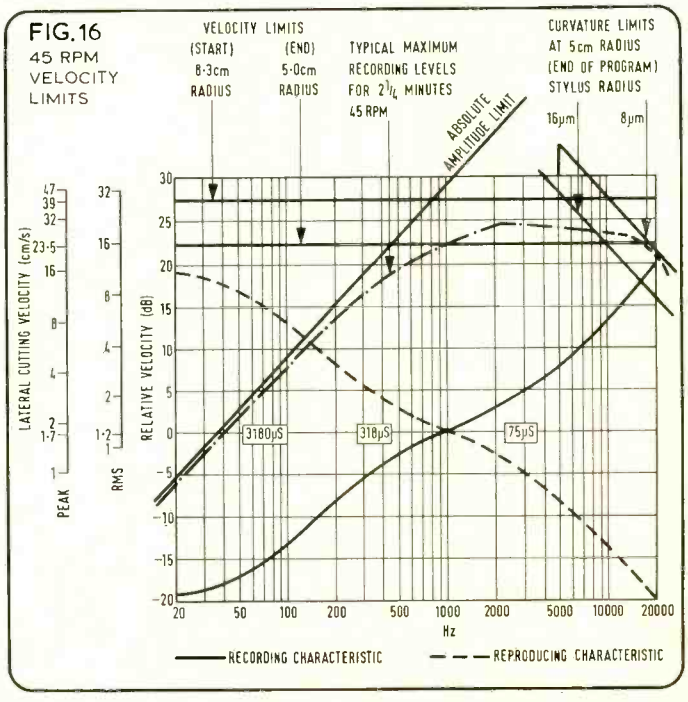


FIG. 16 45 RPM VELOCITY LIMITS



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exhibits excessive sibilance. Whistling and some other vocal sounds will also tend to produce excessive hf content with close microphone techniques.

Tracking

The term 'tracking' covers the subject of the geometric alignment of a pick up unit in the horizontal plane only. The optimum setting of a pick up unit in a conventional pick up arm (see **fig. 17**) will produce tracking angle errors for 33⅓ rpm no worse than those shown in **fig. 18.** Distortion produced by small angles of geometric tracking error is virtually pure second harmonic.

For small angles of tracking error (up to 2°) the following formula for geometric distortion η due to β degrees tracking error will apply, where a is amplitude and λ the wavelength (which depends in this case on frequency, groove radius and disc speed).

$$= (2\pi a \tan\beta \sin 45° \cos 45° \times 100)/\lambda \ \%$$
$$= (100\pi a \tan\beta)/\lambda \ \%$$

This is obtained by simple examination of the geometric construction of the distorted waveform.

The worst disc distortion for a given tracking error will take place at the slowest groove speed where the shortest wavelengths will occur for a given frequency, this being a 6 cm radius on disc for 33⅓ rpm. The groove speed at 6 cm radius is 20.6 cm/s. In this case, a 1k Hz peak signal will have an amplitude of 15 μm and at 6 cm radius a wavelength of $\frac{20.6}{1000}$ cm, or approximately 200 μm.

Hence, distortion for a tracking error of 1° is

$(100\pi a \tan 1°)/\lambda$ %

or 0.41%

To find the audio distortion we correct for the recording characteristic on replay, which provides a loss of 2.6 dB at 2 kHz (which is the second harmonic of 1 kHz); this reduces the final distortion to 0.31%. Note that from the formula and from the optimum tracking errors which should be obtained, the effective tracking error on disc should not amount to any more than the equivalent of 0.8° at 6 cm radius. Hence, typical maximum audio distortion at 1 kHz is 0.8 × 0.31%, or 0.25%.

From the formula above it is obvious that distortion for lower frequencies under 1 kHz will reduce proportionally. On the other hand it is evident that distortions for higher frequencies may be somewhat greater than at 1 kHz, although in practice these are reduced.

Maximum distortion at 2 kHz where the RIAA characteristic is −4 dB is (0.8 (−4 dB) $100\pi \tan 1°)/\lambda$ %, or 0.27%.

Similarly at 4 kHz, with reduced amplitude in accordance with spectra analysis and RIAA at −5.3 dB, we have (0.8 (−5.3 dB) $100\pi a \tan 1°)/\lambda$ % or 0.23%.

At 8 kHz, a similar figure is obtained. Hence the harmonic distortion would be practically zero, although problems could arise by excitation of harmonic resonance in other parts of the cutter system.

If the audio distortion figures are worked out for a 9 cm radius, they will be identical to the figures obtained for 6 cm radius in the typical example situation (where the tracking error is taken as +1.2° at 9 cm, and −0.8° at 6 cm). Similar calculation for start of disc at 14.5 cm radius, assuming typical tracking angle errors, will be about half the worked out values as above. Where actual tracking angle errors are different from the example figures then they should be adjusted to suit, bearing in mind that low tracking distortion is highly desirable towards end of program since all other forms of distortion tend to increase rapidly as the groove radius diminishes.

In addition to this fundamental geometric tracking angle error, there is a further geometric tracking error caused by dynamic thrust on the stylus point due to friction between stylus and groove.

The frictional force acting on the stylus point pulls the stylus point in the direction of groove motion with a force of about 25% of the playing weight. This transmitted thrust is equivalent to a force of about 0.2g applied at the pick up, which pushes the arm towards the centre of the disc (assuming a playing weight of 2 gm and the usual offset angle of pick up unit in the arm of about 24°). The effect on the stylus point is to pull it towards the disc centre relative to the pick up unit, thus causing a small offsetting angle.

If a pick up unit has a horizontal compliance $c = 30 \times 10^{-6}$ cm.dynes and the dynamic side

FIG. 17 PLAN OF CONVENTIONAL PICK-UP ARM SYSTEM

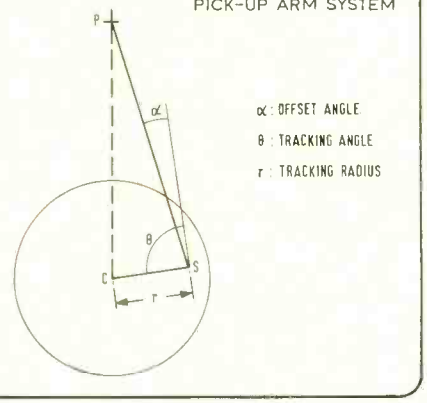


FIG. 18 TYPICAL OPTIMISED TRACKING ANGLE ERRORS FOR 33⅓ RPM

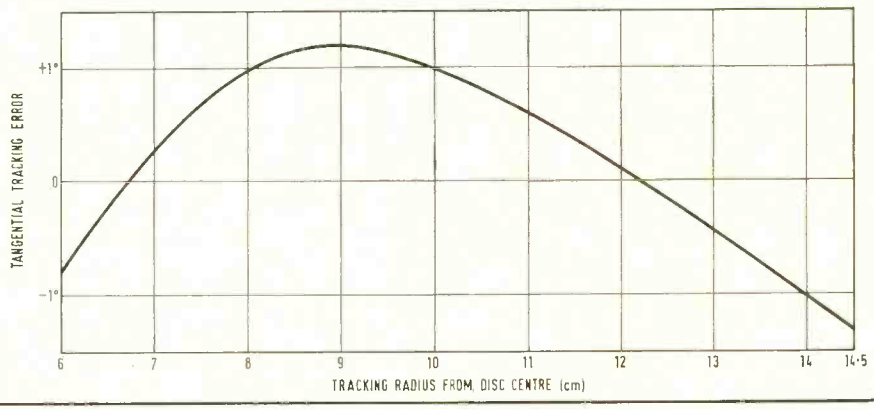


FIG. 19 CURVATURE LIMIT

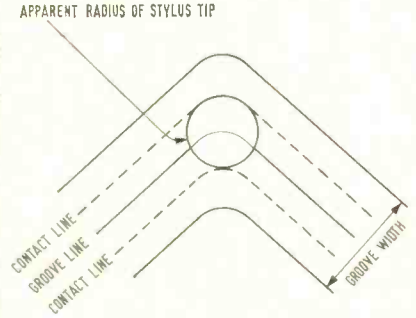
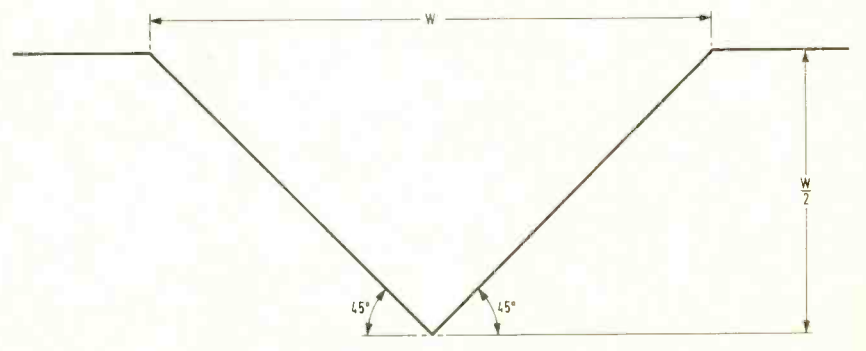


FIG. 20 LATERAL SECTION OF UNMODULATED GROOVE



thrust p = 0.2 gm, or 981 × 0.2 dynes,

then d = pc

= 981 × 0.2 × 30 × 10^{-6} cm

= 59 μm.

If this deflection d causes an angular displacement

$$\sin\gamma = \frac{d}{\text{effective stylus arm length}}$$

Typical stylus arm length is approx. 0.6 cm.

$$\text{Hence, } \sin\gamma = \frac{0.0059}{0.6}$$

= 0.01 approx.

or, $\gamma = 34'$

This offset would produce fairly pure second harmonic distortion.

The peak shift at 25 μm amplitude is then 25tanγ μm, or 0.25 μm.

For 1 kHz at end of disc,

$$\text{Peak shift} = \frac{0.000025}{0.02} \times 100\% \text{ of } \lambda$$

= 0.1% of λ

This indicates an approximate level of audio distortion amounting to 0.3% (and correspondingly greater for higher frequencies) at end of disc conditions. The audio distortions due to dynamic thrust are inversely proportional to radius.

These dynamic thrust distortions can be reduced to near zero by the application of a balancing force called a bias correction. This force can be applied by various means. One way of applying it is by a small weight on a piece of string attached to the counterweight end of the pick up arm. The string runs over a small pulley, and the apparatus is arranged to provide an outward pressure tending to push the arm away from the disc centre with a force of about 0.2g (with adjustment for different playing weights).

The investigation of dynamic thrust demonstrates that excessively high compliance in a pick up unit is not an advantage, since the result only leads to serious complications demanding more bias correction procedures.

Obviously, a disc player turntable and pick up arm system works best when set up horizontally. The tilt required for bias, if this method were used, would amount to nearly 9° for 2g playing weight. Such a tilt would severely upset practical trackability.

Tracking distortion in respect of any given frequency and radius occurs on a linear basis, ie the distortion is a certain percentage of the signal whatever its size, whereas virtually all other disc distortions tend to occur on a higher order basis such as the square of signal amplitude.

Tracing Distortion

In the replay system, tracing errors concern the problem of a spherical contact stylus tip exploring a V groove as cut by a flat faced chisel. The three basic problems in tracing are: incompatible replay stylus and cutting chisel shapes; pinch effect at crossover; peak shift effects due to the different modes of operation of cutting chisel and replay stylus. As already discussed the replay stylus is effectively a circle of apparent radius 0.7 of the actual lateral tip radius at the surface of contact (this applies for conical or elliptical tips—in the case of an elliptical tip each lateral end is considered separately). The cutting stylus, however, is a 90° V-shaped chisel, and a stylus of apparent radius 0.7R cannot enter a curvature greater than this value cut by a V-shaped chisel. This limit is the curvature limit, as in **fig. 19.** In practice, it concerns high frequencies only above about 8 kHz on 33⅓ rpm discs.

If the curvature limit is exceeded in mono, then the theoretical result on replay will be symmetrical wave top clipping. The distortion produced is odd order harmonic; thus for distortion occurring on an 8 kHz fundamental the distortion product would be principally inaudible third harmonic of 24 kHz. The audio result as heard by a listener would be a slight loss of volume which is virtually unnoticeable in practice if less than 2 dB.

In stereo, if the curvature limit is exceeded in one wall (or both walls equally), the result is one-sided wave top clipping on the descent of the wall under consideration. Thus, for an 8 kHz fundamental, there will in principle be a tendency for even order harmonic distortion products to appear if the curvature limit is exceeded, with consequent distortion at 16 kHz. However, due to the near imperceptibility of this distortion product (assuming ideal conditions) subjectively a slight loss of volume only is noted of the fundamental, again only if the loss exceeds about 2 dB. (Any audible sizzling noises produced under such conditions are probably caused by imperfections in the pick up unit or its use.)

The pinch effect is a reflection of change of groove shape as modulation occurs in the groove. The lateral section of an unmodulated groove is as shown in **fig. 20.** The lateral velocity limit in cutting procedure occurs with a crossing angle of 45°, see fig. 12.

At a crossing angle of 45° in a modulated groove, the cross section as seen by the replay stylus is as shown in **fig. 21.** In mono, this change of groove shape, or pinch, causes no theoretical or practical hindrance to an ideal replay stylus in following the centre line of the grooves, assuming the stylus point is of such small dimensions that the groove can still contain the stylus point within the walls and the velocity limit is not exceeded. In stereo, however, the pinch effect is (in the final analysis) probably the most serious distortion component. It can be deduced that the pinch effect causes 45° groove wall modulation which causes even harmonic distortion appearing at and near crossover points, in contrast with other forms of tracing distortion. With 33⅓ rpm program material, it is highly unlikely that actual velocities attained would exceed about 6 dB below velocity limit, even at end of disc under typical conditions. The velocity limit therefore, is not a matter of any concern at 33⅓ rpm. Many 45 rpm mono pop discs have recording velocities in excess of the velocity limit. Note that the 45 rpm short play stereo is in principle somewhat impractical, due to velocity limit restrictions if a sound level comparable with typical mono discs is required.

Assuming a 20° crossing angle in stereo, the groove shape will become as shown in **fig. 22.** The top of groove width reduces to Wcosβ where β is crossing angle, from which

$$\tan\alpha' = \frac{\frac{W}{2}}{\frac{W}{2}\cos 20^\circ}$$

or, $\alpha' = 46^\circ 46'$.

With no pinch, α is 45° so that the extra angle of lift α″ is 1° 46′.

Assuming a 150 μm stylus radius, the lifting corresponds to a stereo amplitude of ½Rtanα″ μm, or 0.23 μm.

(The calculations for peak pinch distortion values have assumed a 20° peak crossing angle, which in practice is not likely to occur except probably on the last few grooves of a 33⅓ rpm program.)

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FIG. 21 LATERAL SECTION OF GROOVE AT 45° CROSSING ANGLE

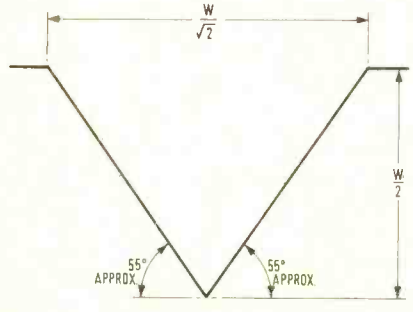
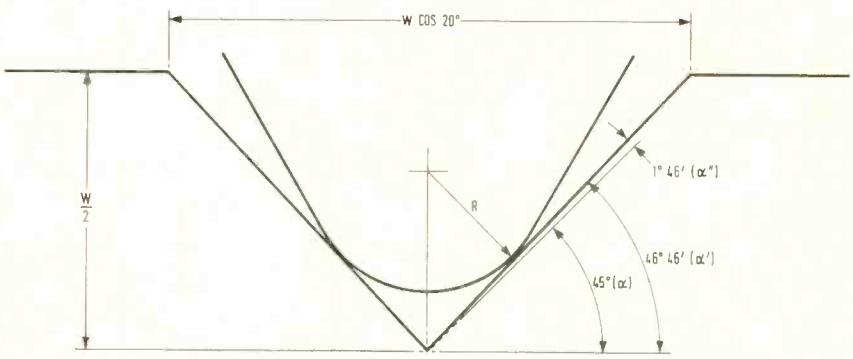


FIG. 22 LATERAL SECTION OF GROOVE AT 20° CROSSING ANGLE



DISC CUTTING THEORY

This figure would also apply for a typical 7.5 μm elliptical stylus since the point of contact on a groove wall is defined by the radius of the longitudinal axis (or major radius) which will be a figure around 15 μm typically. The pinch effect is relatively insignificant for all frequencies under 200 Hz due to the very low crossing angles. However the problem escalates from about 1 kHz. If η is the peak geometric distortion product,

then $\eta(f)$ is $100d/0.7a\%$, where f is frequency, d is pinch amplitude, a is peak lateral amplitude at the frequency and 0.7 is the correction factor for 45° inclined groove wall velocity.

Note that at 1 kHz a correction factor of 0.73 has to be applied in respect of the recording characteristic. From 2 kHz upwards the correction factor for recording characteristic and standard spectra analysis can be regarded as unity. Thus, η (1 kHz) is 1.8% approx.

Pinch distortion is even order harmonic distortion containing about 66% second harmonic product. For approximate calculation purposes, it is reasonable to assess it as being equivalent to 80% second harmonic at audio output, including recording characteristic correction. Hence we find values of 1%, 1.7%, 2.8% and 6% approximately at frequencies of 1, 2, 4 and 8 kHz respectively.

Pinch distortion is approximately proportional to the fourth power of groove velocity, where crossing angles exceed 15°. Hence it is obvious that if a producer requires high level at end of program on disc, it is desirable to end at a radius greater than 6 cm. At 7 cm, for example, the producer could safely use a recorded level some 4 dB higher than at 6 cm radius for a given level of permissible distortion, since the calculated increase in pinch distortion from 7 cm radius to 6 cm radius is a factor of nearly two for the same program level.

Also, pinch distortion for a fixed groove speed is proportional to a power slightly in excess of the square of the crossing angle, and is thus approximately equal to $V_R^{2.5}$, where V_R is the recording velocity. Hence, if the recording velocity is dropped 1 dB the peak possible pinch distortion will drop by about 25% at any particular radius.

In practice, the effects of pinch distortion are not as bad as the basic calculations might indicate, for a variety of reasons as follows.

(a) Pinch distortions are mechanically relieved in the cutting process by about 10% due to the very slight cutter lift at extremes of amplitude.

(b) Stereo program implies that the signals in the two channels are not similar. The dissimilarity results in reduction of lateral crossing angles below the theoretical values obtained by assuming in-phase relationships for given lateral recorded velocites in each channel (as has been assumed in the calculations above in order to find peak possible distortion products).

In stereo it can be expected that low frequencies under 400 Hz in the two channels may exist at nearly the same level, and in-phase, thus causing quite high crossing angles for the frequencies concerned. However, low frequency crossing angles at 200 Hz and below will not exceed about 5° even under end-of-disc conditions; hence the pinch distortions so produced would be quite insignificant at under 0.1%. Higher frequencies in stereo are less likely to appear at either the same power or in the same phase relationship, so that actual lateral crossing angles will rarely reach even 80% of the possible maximum. Hence, where a calculated peak crossing angle of 20° might appear, it is in practice unlikely for real crossing angles in excess of about 16° to occur, which indicates a typical reduction in peak distortion products by a factor approaching 0.4. Hence, typical peak distortion products are unlikely to exceed half the above calculated figures for end-of-disc condition. If program is terminated at 7 cm radius, the typical peak distortion products are highly unlikely to exceed 25% of the above calculated figures. Alternatively, it is necessary to curtail high frequency power towards end of disc playing time in order to contain pinch distortion to a low figure.

A peak shift effect occurs in a practical replay system due to the finite and rather short

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FIG. 23 ADVANCED PEAK EFFECT DUE TO STYLUS OPERATION

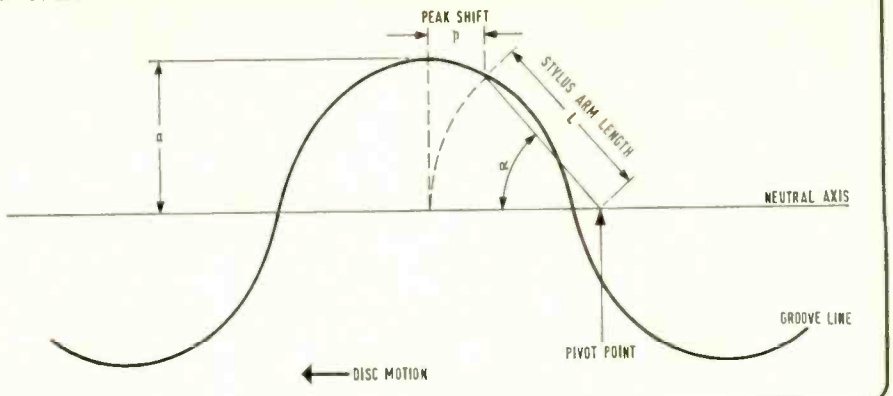


FIG. 24 DELAYED PEAK EFFECT DUE TO CUTTERHEAD TILT (PLAN)

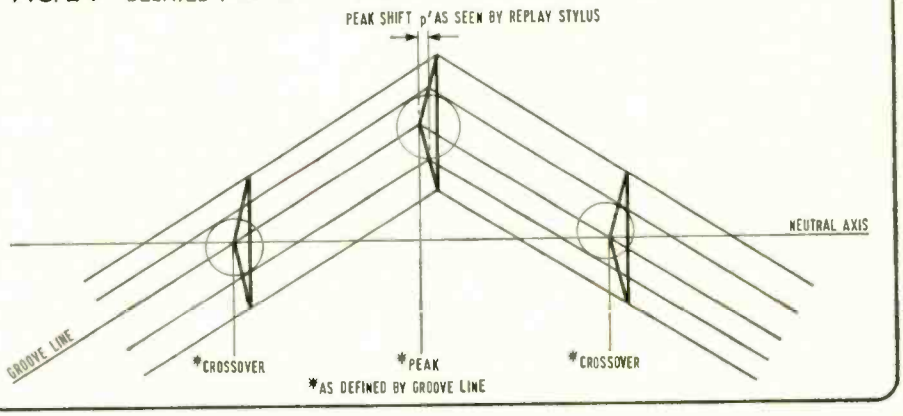
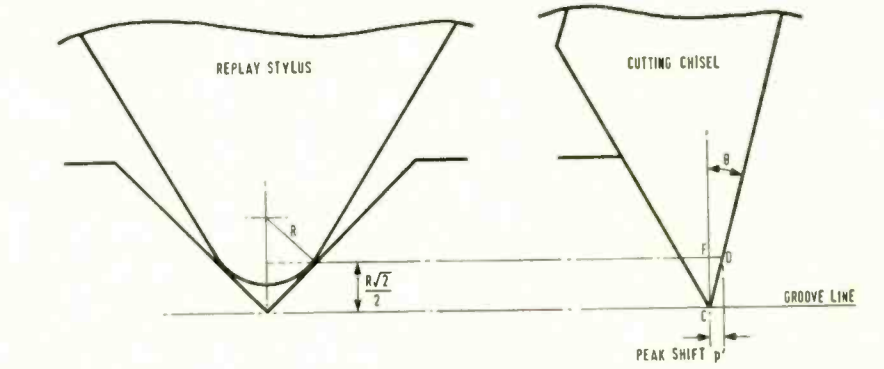


FIG. 25 DELAYED PEAK EFFECT DUE TO CUTTERHEAD TILT (ELEVATION)



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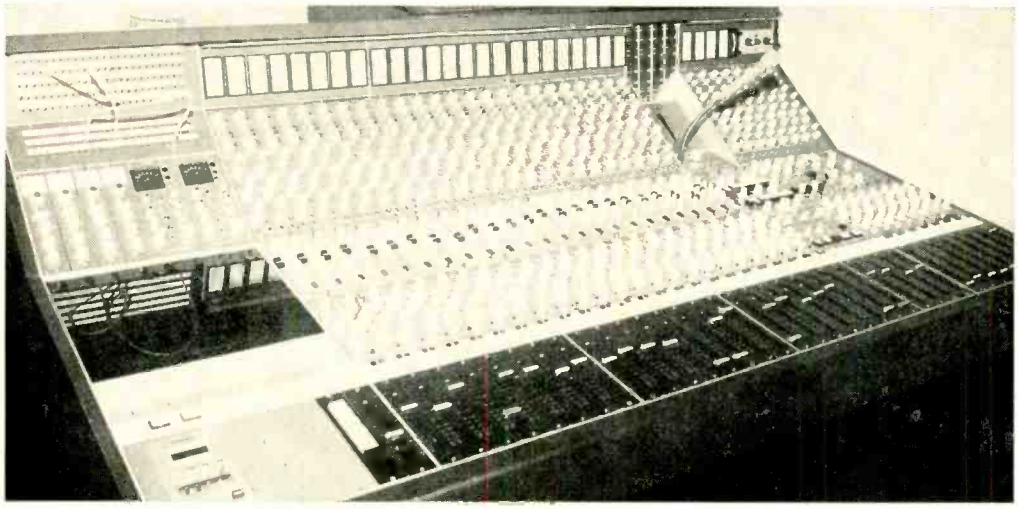

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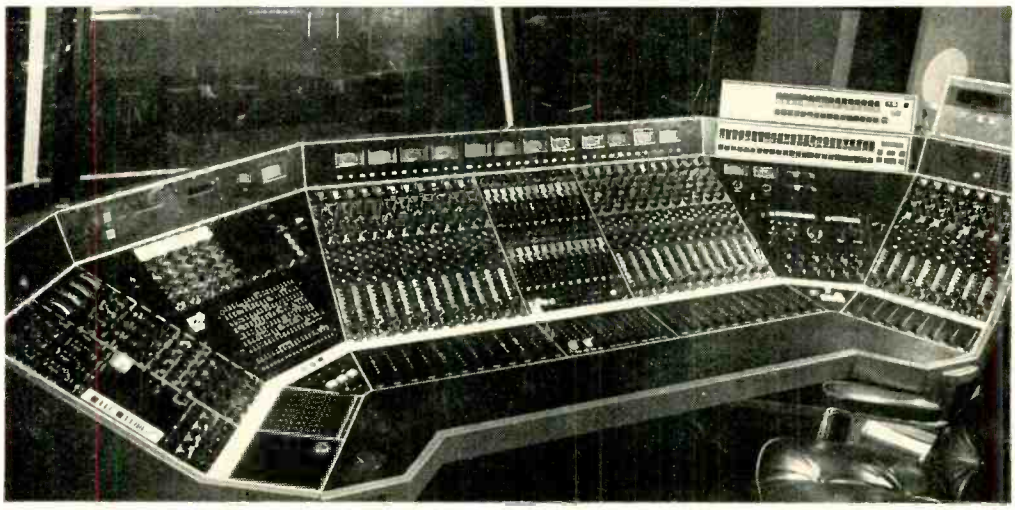

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arm of the stylus. On examination of this effect it is clear that the peak shift causes leading peaks to be seen by the replay stylus, as in **fig. 23.** With a lateral amplitude of 27 μm and an effective stylus arm length of 0.6 cm (6000 μm) typical value (stylus arm vertical tilt can be ignored initially, since the effect is merely shortening of actual arm length in lateral mode) In the figure, sinα is a/L or .00417 approx, from which α is 14′ approx. The peak shift p is as in α, or. 1 μm approx, with peak shift proportional to the square of the amplitude (a^2/L) and is virtually pure second harmonic distortion.

A mono 2° (88° from horizontal) cutting chisel tilt will introduce a fixed theoretical delay as seen by the replay stylus, as in fig. 24 and **fig. 25.**

The delay $FD = FC\tan\theta$

$$= \frac{RV\sqrt{2}}{2} \tan 2^\circ$$

$$= .37\ \mu m \text{ approx.}$$

Hence the theoretical cutting chisel shift error in mono cutting procedure is a constant amount. However, the geometric shift, on careful examination, cannot be immediate at very small amplitudes; thus the shift effect must grow from nothing as amplitude increases (this applies in stereo as well as mono). Also, as modulation occurs, there is an appreciable amount of effective cutter head spring back as the cutting chisel sees material on the disc in front of it, which has not been compressed due to the presence of the cutting chisel in the position of no modulation (or crossover position where modulation exists). Cutterhead spring back causes signal advance, which appears at quite high level as soon as amplitude commences, in much the same manner as cutter chisel tilt causes signal delay. It appears that spring back is a complex function of velocity, greater for high frequencies than low at small amplitudes. This happens to be highly desirable in practice.

In a mono cutterhead, it is possible that the cutter chisel spring back is very small indeed, and virtually insignificant due to the very rigid mounting of the cutting chisel in the groove line axis. The effective hf shift errors in mono are approximately in accordance with **fig. 26** for a typical mono system. The shaded area is the residual signal error for any amplitude concerned.

In stereo, since the replay system arm is to be tilted at about 15° as a matter of physical convenience, it is the replay configuration which dictates the required stereo cutter chisel tilt angle in the first instance of around 15°.

The motions of a stereo cutting chisel are better followed when considered in two parts, lateral and then vertical. The lateral mode is very similar to the motion of a mono cutting chisel for mono signal, ie both channels at equal level and in-phase. The differences as compared to a mono system are that the cutter head spring back effect is much greater due to the flexible mounting of the chisel in a stereo cutterhead (as compared to the relatively rigid mounting of a mono chisel). The cutterhead tilt implies a theoretical constant peak delay effect p is FCtan 15° or 2.8 μm approx. Typical hf shift effects in the lateral mode are represented in **fig. 27.** The residual lateral shift errors are shown shaded for various amplitudes. It can be seen that these residual shift errors are comparatively small when corrected for final audio output on replay.

FIG. 26 TYPICAL HF MONO SHIFT EFFECTS

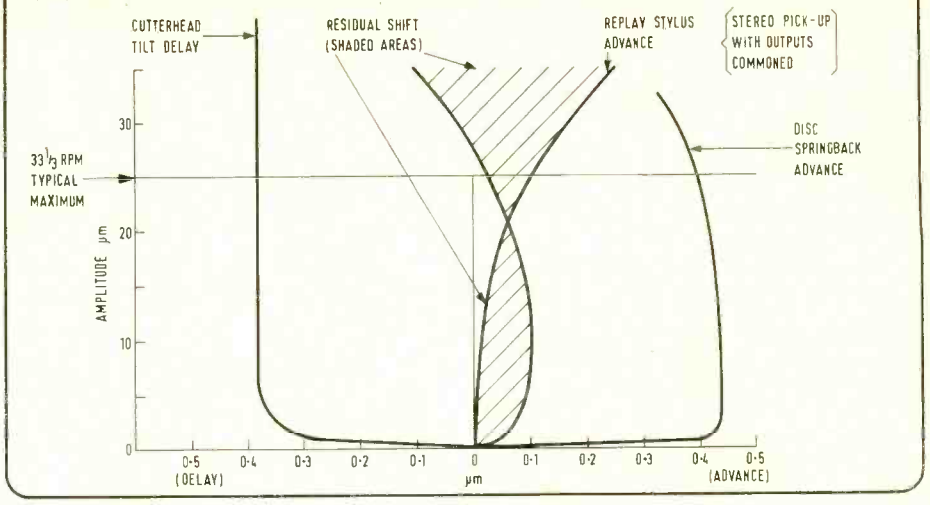


FIG. 27 TYPICAL HF STEREO LATERAL SHIFT EFFECTS

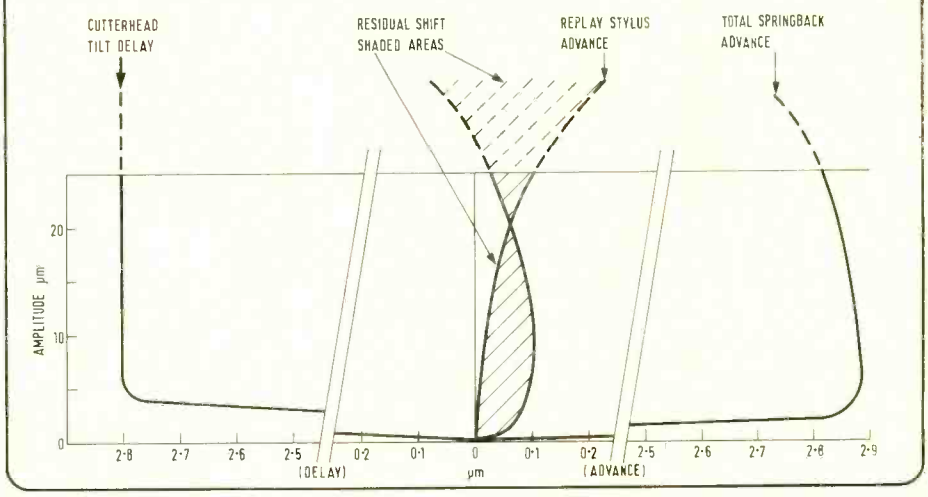
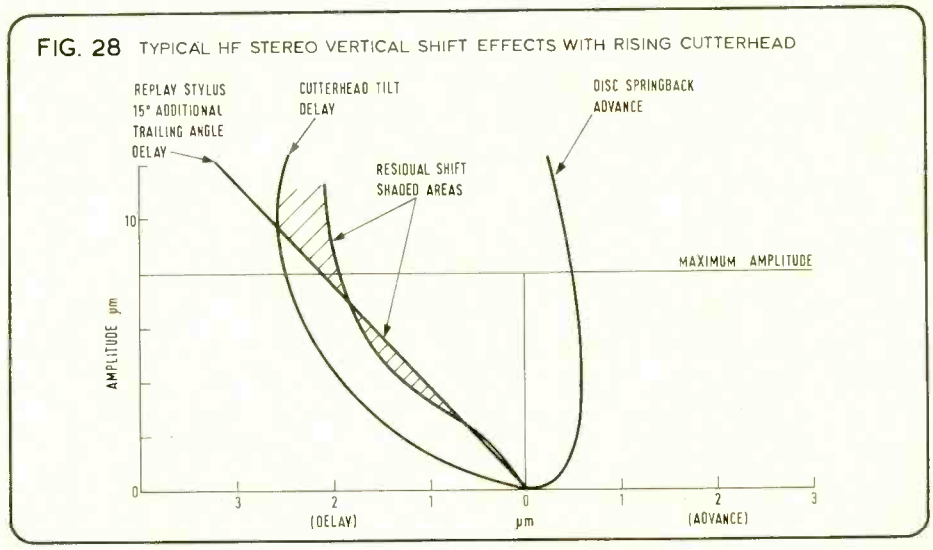


FIG. 28 TYPICAL HF STEREO VERTICAL SHIFT EFFECTS WITH RISING CUTTERHEAD



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DISC CUTTING THEORY

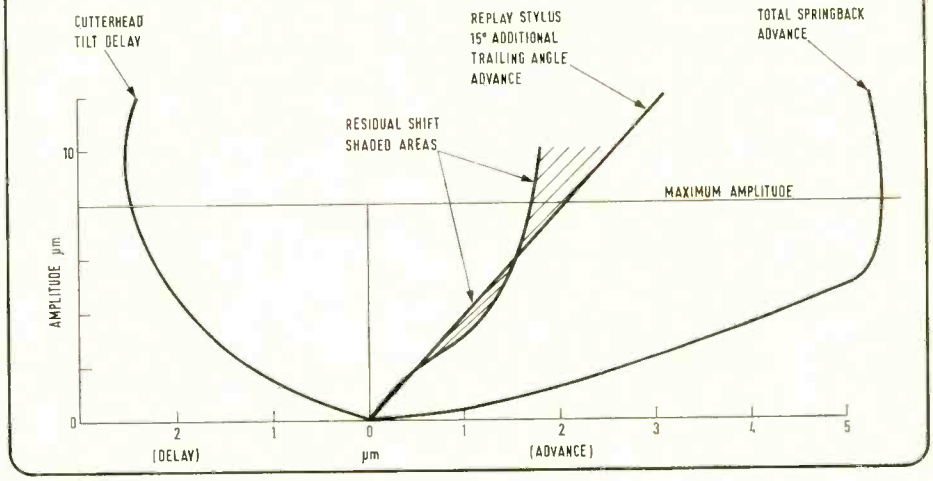
The vertical mode is very much more difficult to appreciate than the lateral. Fortunately, due to the special need in cutting a stereo disc to control the resultant vertical amplitude of the replay stylus to a figure no greater than about 8 μm (in order to leave enough top of groove width to contain the replay stylus) the vertical motion problem is considerably alleviated. When the cutting chisel rises from its neutral position, this produces signal advance proportional to amplitude; likewise, when the cutting chisel descends, this produces a signal delay proportional to amplitude. On tracing the signal, the replay stylus will rise and cause a signal delay. It is evident that cutterhead component of spring back effect does not occur when the cutting chisel rises.

If the cutterhead tilt is 15° backward out of vertical, and if the replay stylus tip is tilted 15° forward out of horizontal in relation to the linear motion of the groove, then the signal advance caused by the motion of cutting chisel exactly cancels out the signal delay caused by the motion of the replay stylus for any small vertical displacement upwards from the neutral position so far as groove line tracing is concerned, except for a component of disc material spring back effect. However, while the same result is achieved from first principles for any vertical motion downwards, there is the additional effect of cutterhead component spring back. From basic geometry, vertical displacement downwards will create about twice the spring back effect in the cutting chisel than for the same amount of purely lateral amplitude. Any vertical displacement of the cutting chisel causes a variable peak delay due to the cutterhead tilt when considering that the actual points of contact of a replay stylus will not be on the groove line. The typical hf vertical shift effect due to cutterhead tilt, spring back (as it applies) and replay stylus operation are shown in figs. 28 and 29.

Summing the various shift effects in both rising and descending motion indicates that an adjustment in the replay stylus arm trailing angle could effect a very significant reduction in the residual shift errors. It appears that the suitable adjustment in the trailing angle of the replay stylus arm is to increase it to about 30°. This necessary adjustment is confirmed in practice, since most manufacturers of high quality stereo pick up units now set the trail of the replay stylus arm so that in playing condition it is in this region. It can be seen from figs. 28 and 29, where the lines representing the additional 15° of trail of the replay stylus arm have been drawn, that the final residual shift errors in vertical mode are now very small, being of the same order as the lateral errors.

This revised 30° trailing angle in a replay stylus arm has very little effect on the lateral shift error at small amplitudes affecting high frequencies, and relatively insignificant effect on larger amplitudes affecting low frequencies. Overall, it can be seen from the various signal shift graphs shown here that the worst residual errors occur around amplitudes of 4 μm, at a maximum dimension of about .2 μm, in vertical mode of operation; the corresponding shift errors in lateral mode are smaller. Hence, the typical worst condition is for a fundamental frequency of around 4 kHz existing at peak level and out of phase in each channel (which is hardly likely to occur in practice). Thus, a peak shift of .2 μm corresponding to a linear distortion of about 1.6% at 4 kHz will result in an audio distortion after correction for recording characteristic of somewhat less than 1.2% at 6 cm radius.

FIG. 29 TYPICAL HF STEREO VERTICAL SHIFT EFFECTS WITH DESCENDING CUTTERHEAD



It should be noted that the actual amount of spring back effect introduced by a stereo cutterhead is a function of its design. Hence, the actual cutterhead tilt in any particular case can be trimmed by a small amount to produce the desired effect of minimum overall distortion product, on a standard test replay chain using a compatible replay pick up unit (preferably with a 30° trail).

Claims by many disc recording companies indicate that for typical 33⅓ rpm program material, the overall disc replay audio distortion can be well under 1% provided their discs are replayed on equipment which is strictly compatible with their test replay conditions. There is no doubt that such claims are fully justified under test conditions, and that very low audio distortion on replay of discs is attainable provided suitable replay equipment is used correctly.

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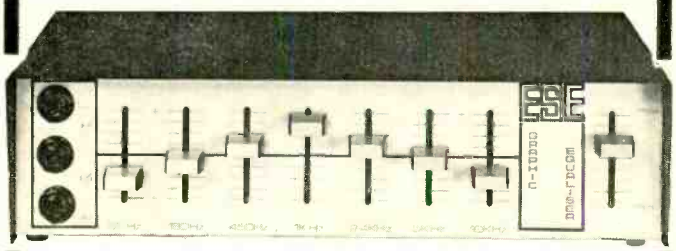

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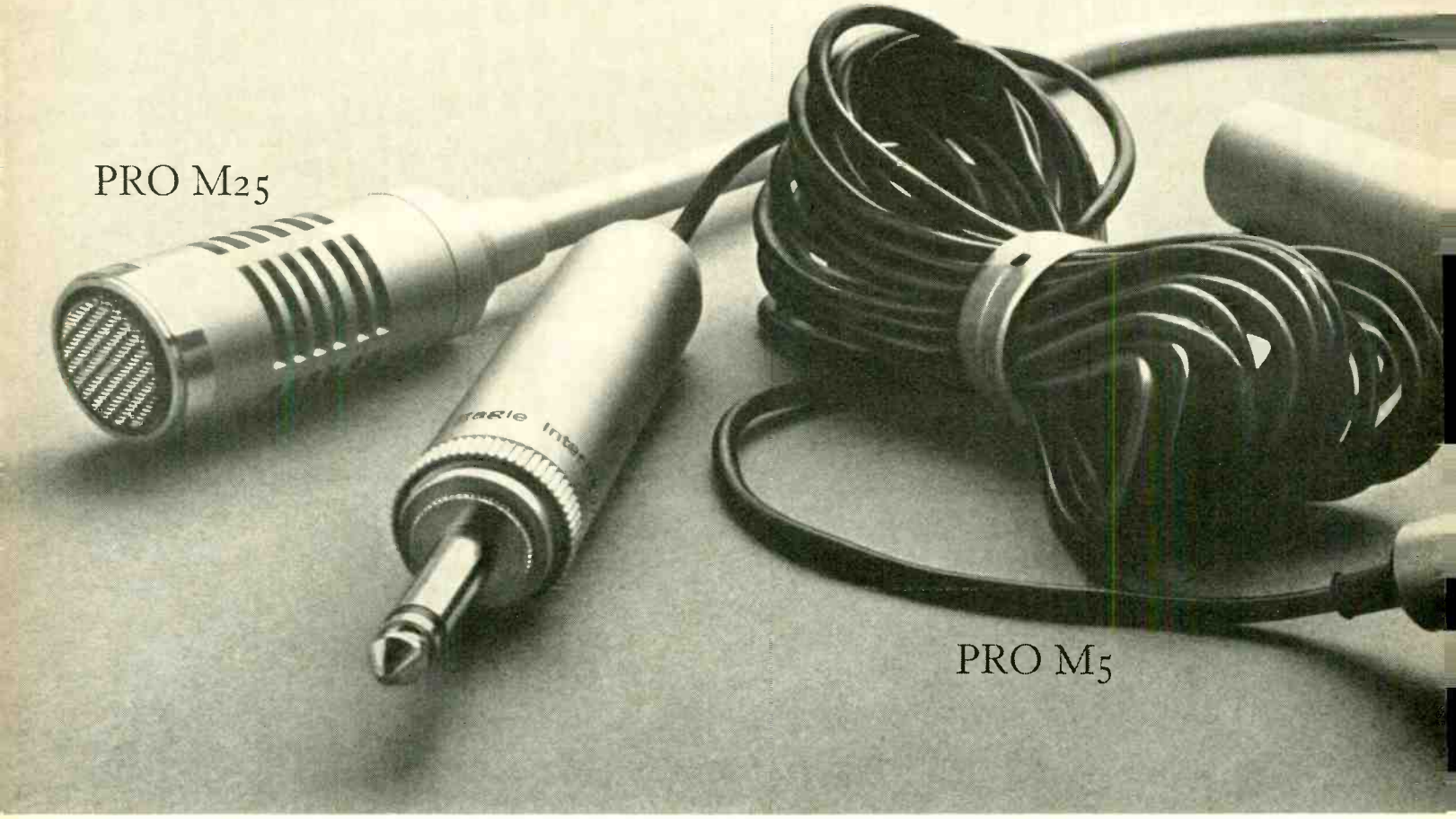

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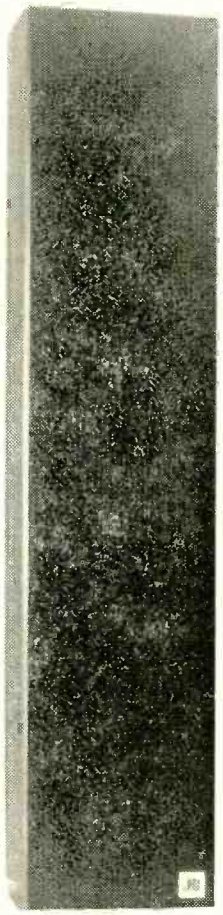

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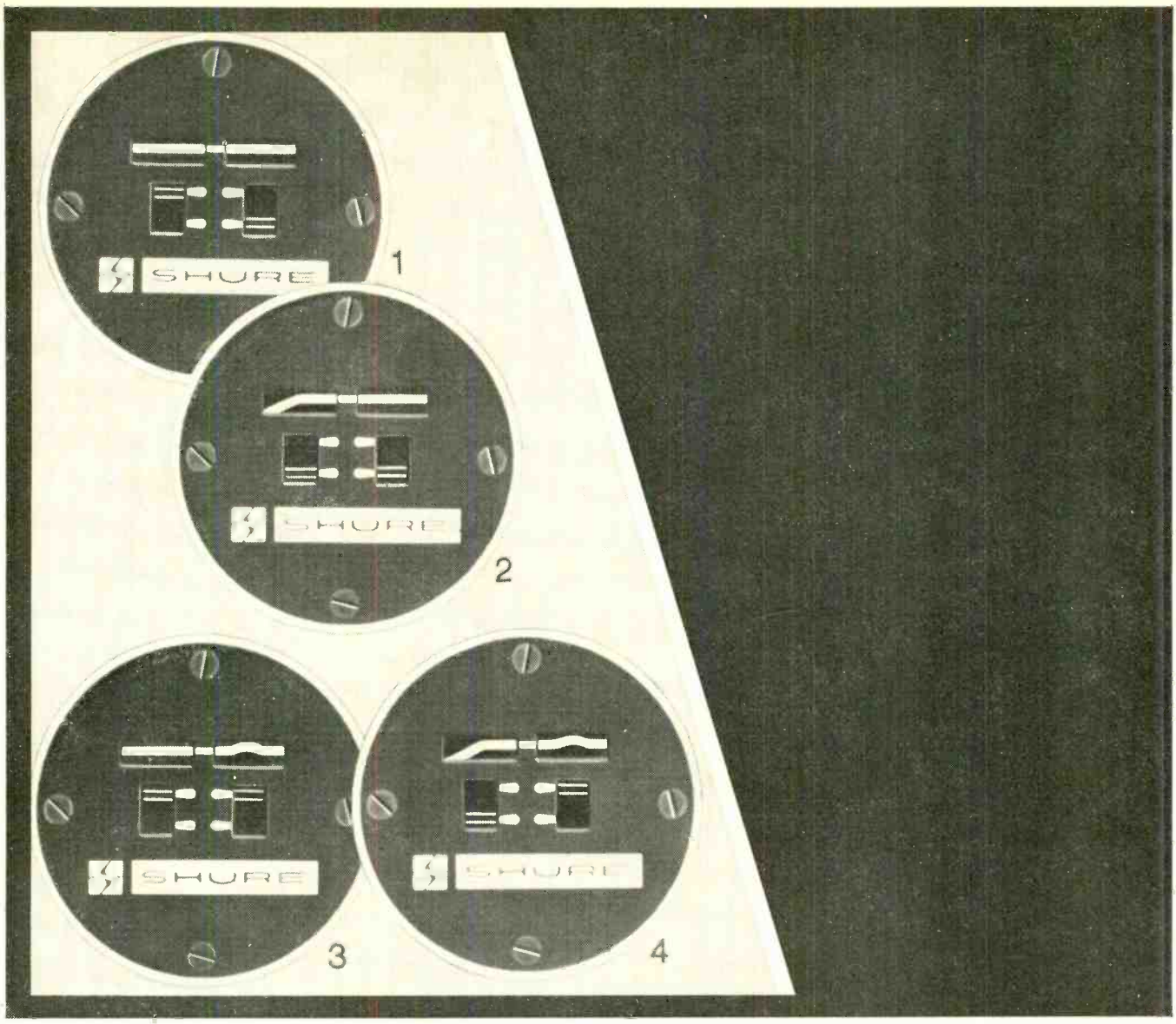
AND DRAW YOUR ATTENTION TO OUR: COLUMN LOUDSPEAKER WITH LINE SOURCE CHARACTERISTICS

JB24

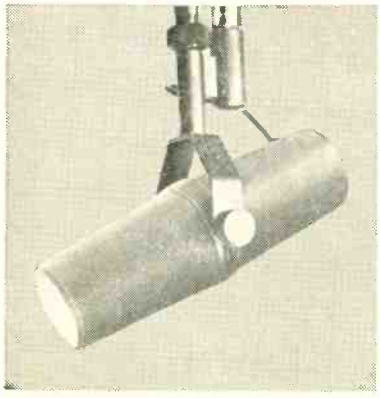
INPUT: 24W RMS. 100V Line
RESPONSE: ± 6db 100 Hz - 15 Khz
FRONT TO BACK RATIO: 14 db
VERTICAL BEAM: 9 db @ 45° off axis
HORIZONTAL BEAM: 2 db @ 45° off axis
SIZE: 1270mm x 280 x 165 depth
WEIGHT: 18 Kgs.

For details of this and other columns, wall mounting speakers, mic stands, etc.

JOHNSON BRODY MARKETING CO.,
394, Northolt Road,
South Harrow,
Mddx. Tel: 01-422 1863/4825.



What you see is what you get.



The extraordinary Shure SM7 professional microphone features something you've never seen before: a *built-in Visual Indication Response Tailoring System* that offers you four different frequency response curves—and shows you the curve you've selected with a graphic readout (see above) at the back of the microphone! Choose: 1. flat response; 2. bass roll-off; 3. presence boost; 4. combination of roll-off and presence. And there's more: the SM7 delivers exceptional noise isolation with a revolutionary pneumatic suspension mount . . . an ultra-wide, ultra-smooth frequency response . . . an integral "pop" and wind filter . . . and a cardioid pickup pattern that looks "text-book perfect." The Shure SM7 Studio Microphone was extensively field-tested in recording studios and broadcasting stations! Write:

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

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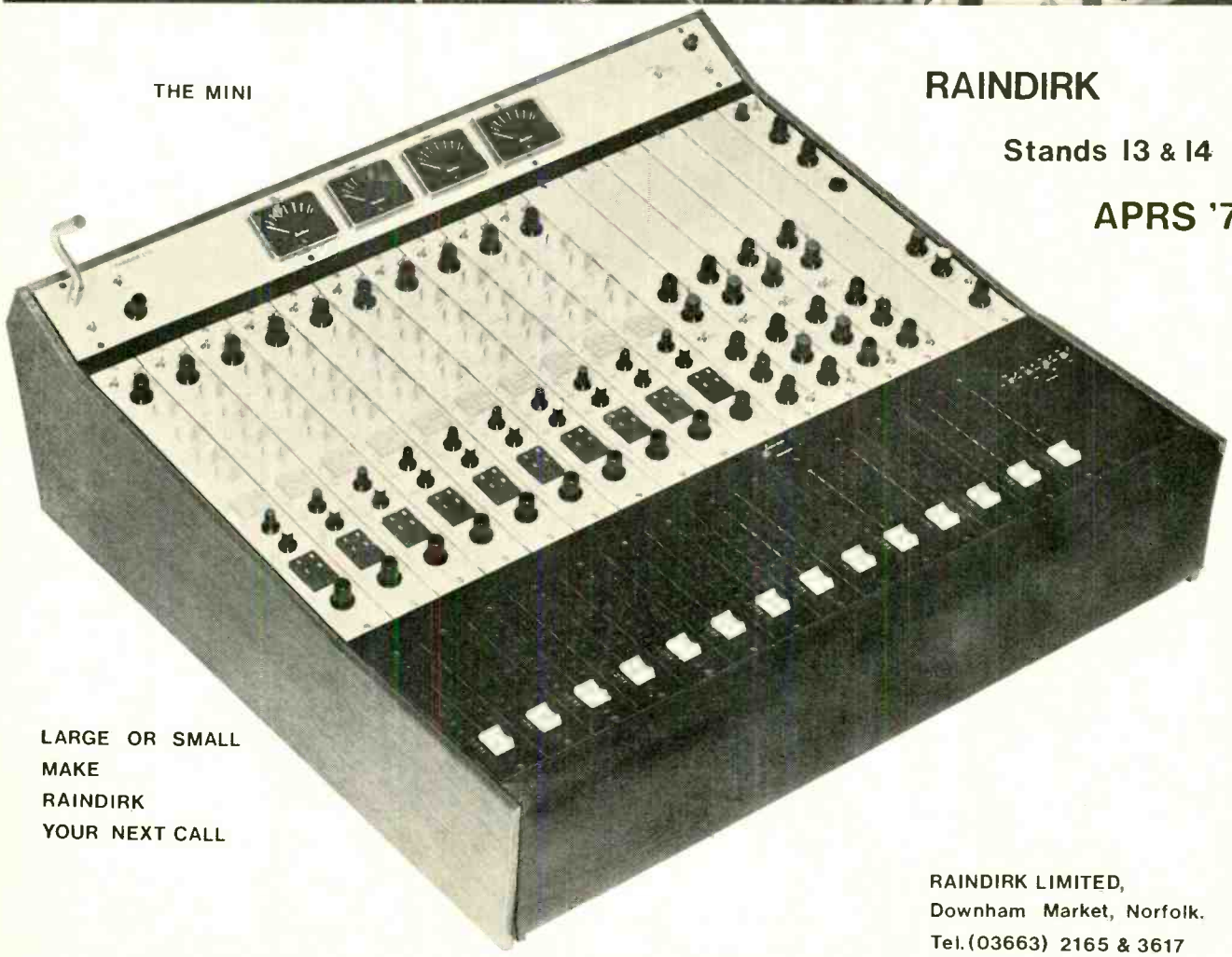

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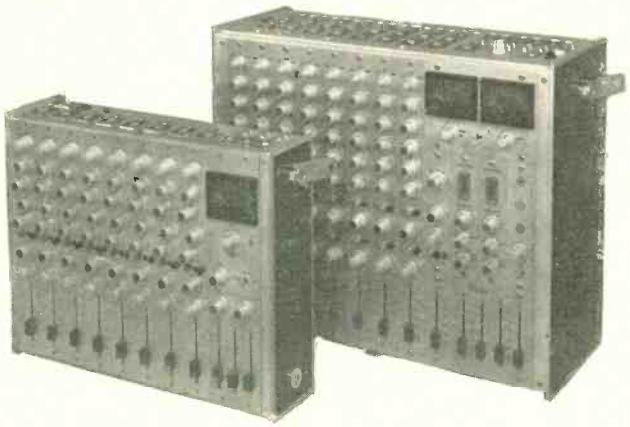
PORTABLE MIXERS



AD 031 and AD 007

The Portable Mixers with the professional qualities and the professional performance.

Both have 8 inputs that drive into 4 or 2 groups.

All inputs and outputs balanced using XLR connectors throughout.

Peak Programme Meter to BS 4297/1968 specification. (V.U. meter optional).

Auxiliary for use on either echo or foldback.

Stereo linkable compressors on the AD 007.

Extender Units that can incorporate 10 extra input modules.

Size: 540 x 480 x 225 mm AD 007
420 x 335 x 127 mm AD 031

Weight: 22.7 Kg AD 007, 10 Kg AD 031

Modular construction to promote serviceability.

Hire facilities of both types are available.

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Selective Band Processors
Sweep and Parametric
Equalisers

see them at

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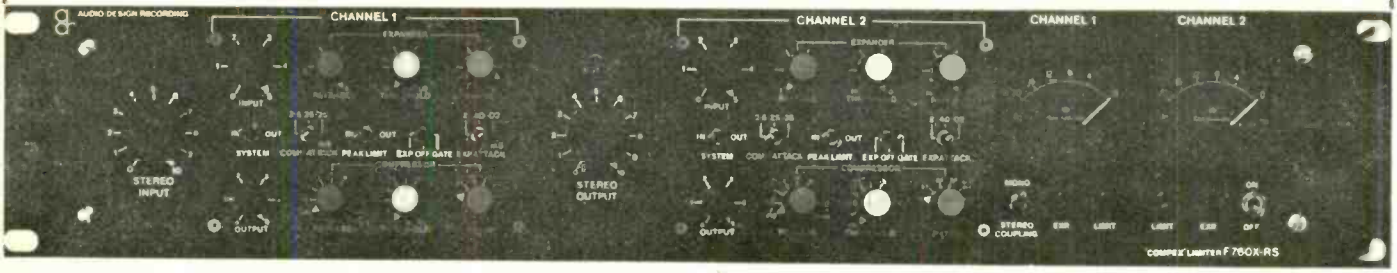
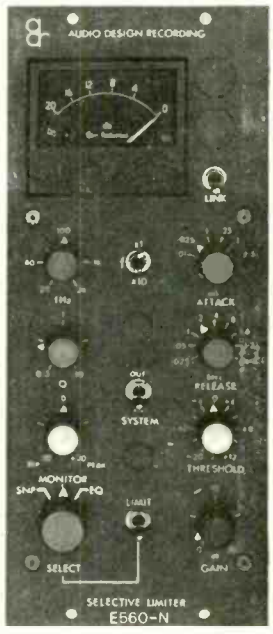


E900 Sweep Equaliser

Continuously variable four section frequency sweep equaliser: Audio bandwidth covered twice: at 'Q' of 1.5 and 'Q' of 3. 40dB control range on each section with preselect facility for momentary effects. Phasing effects possible by rotating frequency controls during programme. Superb technical spec. Rack mono, stereo and modular units available.

The Unique E560 Selective Limiter

The E560 provides a limiter that can *selectively attenuate* almost any part of the audio spectrum. LF content, sibilant areas or static pre-emphasis can be momentarily attenuated without modulation effects on remaining programme content. Besides *dynamic equalisation*, it gives *static parametric* lift of 20dB or > 30dB cut, over the whole audio range; with variable 'Q' from 1/10th to 5 octaves broad. Available in modular or rack formats.



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Alice AM 82B Series II Broadcasting version of the AM series II Range.

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Fitted with sprung, hinged lid to protect socket when not in use. Drilled to fit standard type conduit box.

Material: Brass

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(Cable Connector to be purchased separately).

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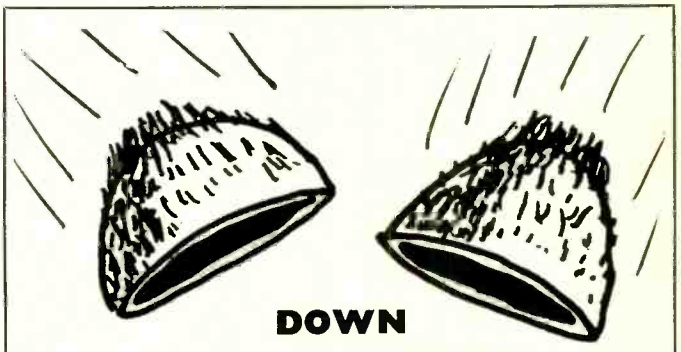

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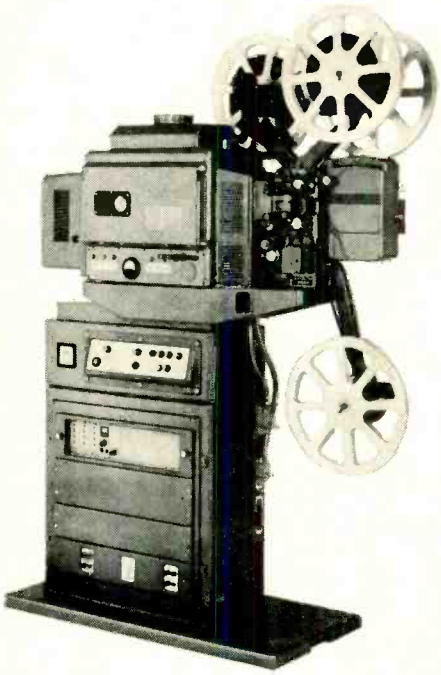

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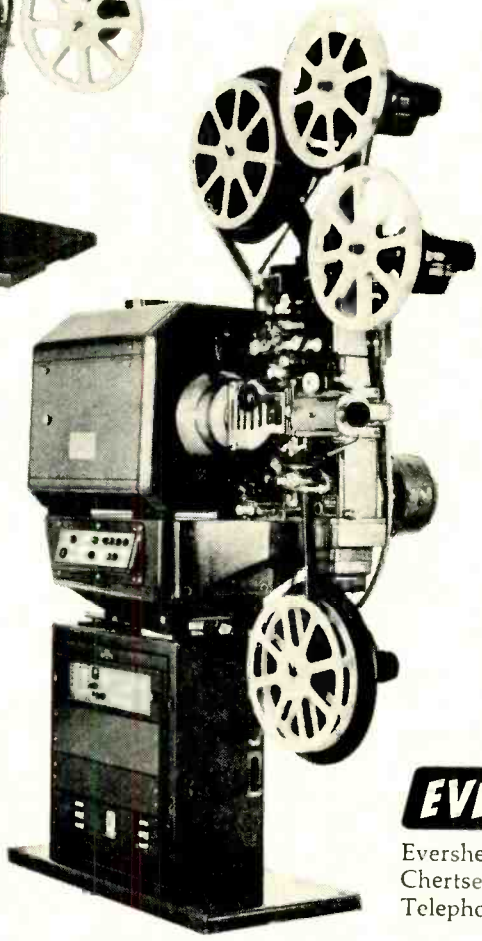

B14 studio 35mm
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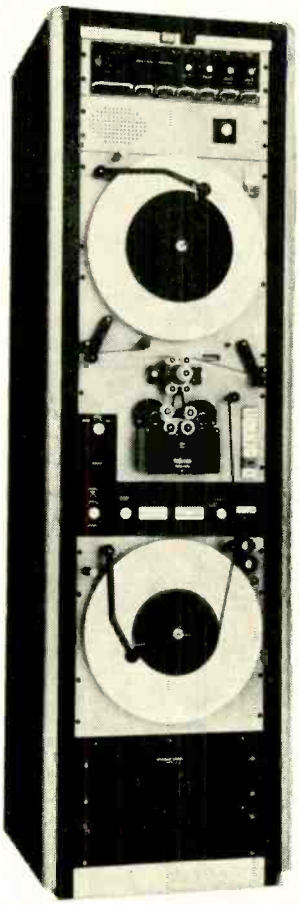
Perfectone



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NOTE: Advertisement copy must be clearly printed in block capitals or typewritten.
Replies to Box Nos. should be addressed to the Advertisement Manager, Studio Sound, Link House, Dingwall Avenue, Croydon CR9 2TA, and the Box No. quoted on the outside of the envelope. The district after Box No. indicates its locality.

STUDIO FACILITIES

★**Fanfare Records.** Tape - disc pressings, demo's, masters, any quantity. Studio/mobile Neumann disc cutter. S.A.E. brochure. 1 Broomfield Close, Rydes Hill, Guildford. Tel. 0483 61684.

★**County recording service** stereo and mono masters and lacquer discs from your tapes. Telephone Bracknell 4935. London Road, Binfield, Bracknell, Berks.

★**For hire** Revox A77 (HS+LS, NAB+CCIR, Vari-Pitch, Vari-Speed etc), AKG, BX20 Quad 303, Revox A78, Spendor speakers, Teac four channel, mic stands, etc. Radio Recordings 01-586 0064.

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Custom-built mixers for groups, P.A., hospital broadcasting, recording, discos, etc.
RAC plug-in audio modules for building your own mixers.
Sony, Akai, TEAC, Tandberg, Marantz, Lux, Nikko, Dual, Quad and Armstrong dealers. Shure, Calrec, AKG mikes and stands, etc.
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also 200 kHz version for high speed copying:
Drive circuit, 35 x 80mm, for 1 ma L.H. zero meters to BBC ED 1477. Gold 8-way con supplied.
Complete kit **£12.** Built and aligned **£17.**
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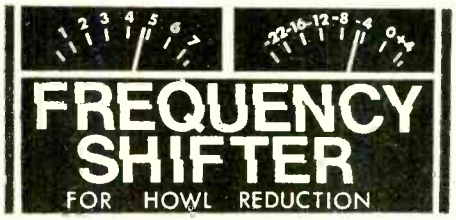

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In any public address system where the microphones and loudspeakers are in the same vicinity acoustic feedback (howl-round) occurs if the amplification exceeds a critical value. By shifting the audio spectrum fed to the speakers by a few Hertz the tendency to howling at room resonance frequencies is destroyed and an increase in gain of 6-8dB is possible before the onset of feedback.
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PRICE	**£58**	**£68**	**£84**

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We are suppliers to many well-known companies, studios and broadcasting authorities and were established in 1941. Early deliveries. Competitive prices. Large or small quantities. Let us quote.
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Telephone 0473 52794

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Primary windings for 600 ohm, 200 ohm and 60 ohm with Secondary loadings from 2 K ohm to 10 K ohm. Frequency response plus/minus ½dB 20Hz to 25KHz. Contained in well finished Mumetal box, 33mm diameter by 22mm high with colour coded end leads. Low distortion. DELIVERY (small quantities) EX STOCK. HIGHLY COMPETITIVE PRICE. FULL DETAILS ON REQUEST.
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★**8 track mixer** with full E.Q., P.P.M.S. sync talkback foldback, 2 echo's, pre-fade mike line, three graphics, three power supplies, packfield oscillator, compressors, etc. £2000. Box No. 701.

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Scully/Haeco Automated Lathe
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Haeco GW 120 Amplifier
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Fairchild 600 Conax high frequency Limiter
AVP/Auto-Band Amplifier and Head Assembly
McIntosh MC-60 Monitor Amp
PRICE $10,000.00

All you need to add is your monitor speaker and tape transport and the system is ready to go.

The above system is set up and still handling a daily production load.
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Please call Dan Tynus, Chief Engineer, for an appointment.

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NEUMANN Type LV60

Valve Power Amplifiers with GV2a Feedback Amplifiers separately or in VG1 or VG2 rack or complete mono lathe.

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★**Lockwood Monitor** Majors Tannoy 15in red Matched pair, £300 o.n.o. Tel. 01-866 0671.

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selling 8 Track and 4 Track machines with Desk Patch Bay and associated equipment at a very reasonable price.

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½ inch 4-track (self-sync.). Perfect condition used in private studio which has now gone 8-track. **£750.**

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★**Dutch audio engineer,** 34, married, no children, returns from project in Lima, Peru. Measuring techniques, boom operator, commentaries for radio and TV, news exchange, sales in stocks and real estate. Musical theory, recordings from mono to 24 tracks, studio lay-out, etc. Training programme, running record plant. Current job: Management advisor record factory Lima. 200 people. Languages: (Dutch), French, German, English, Spanish fluently, completed course in Portuguese. Can teach course in audio in four languages. No objection against being sent abroad again, or transferred to adjacent working field. Available around August. Salary negotiable. Write to Tonko Tonkes, Calle Luis Arias Schreiber 161/163, Dept 103, Urbanizacion Aurora, Miraflores, Lima, Peru.

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Balance Engineer

with excellent knowledge of advanced recording techniques and a degree of experience in the audio field.

High qualifications essential.

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Polydor London Studios, 499 8686

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The salaries will be in a range which will reflect the applicant's qualifications and experience.

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