July 1974 25p

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AND BROADCAST ENGINEERING

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Peak Programme Meters Surveyed

Around the Studios : Strawberry, Manchester

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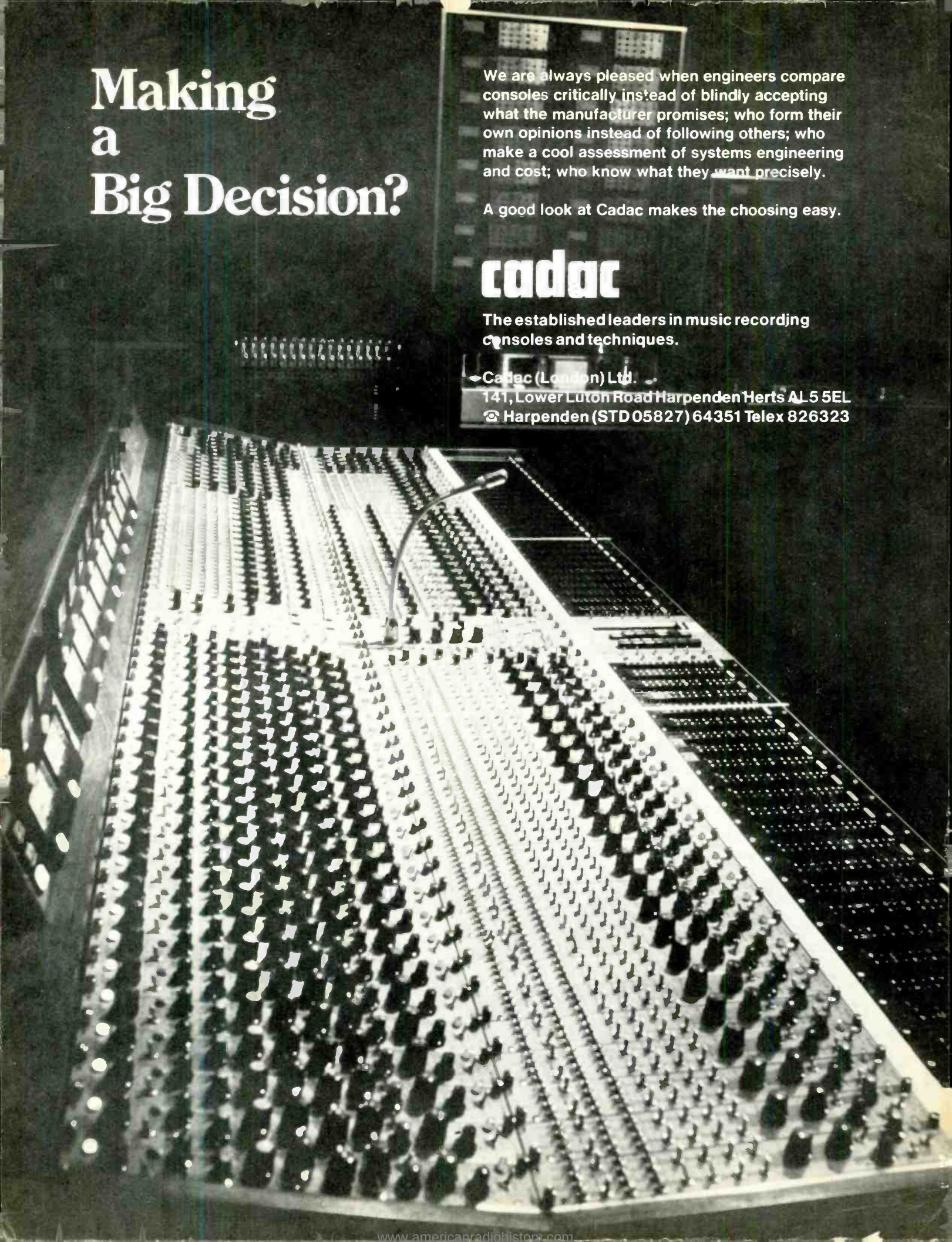

studio sound
AND BROADCAST ENGINEERING

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JULY 1974 VOLUME 16 NUMBER 7

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SUBSCRIPTIONS
STUDIO SOUND, *published monthly, enables engineers and studio management to keep abreast of new technical and commercial developments in electronic communication. The journal is available without charge to all persons actively engaged in the sound recording, broadcasting and cinematographic industries. It is also circulated by paid subscription to manufacturing companies and individuals interested in these industries. Annual subscription rates are £3 (UK) or £3·30 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 (UK) or 95p (overseas). Please quote the volume number or date when ordering.*

BUGS AGAIN. Several pages of them, reproduced by kind permission of the Audio Engineering Society of America and penned by our equipment reviewer Hugh Ford.

When the Watergate affair emerged into the full glare of public scrutiny, few observers can have imagined the incredible fashion in which self-bugging would backfire on the holder of the most powerful office in the western hemisphere. Not being particularly political animals, we spurned an inclination to contribute anti-Nixon texts and rejected several very titillating anti-Nixon cartoons. It would all be over by the time we were in print, we thought, and in any case there were quite enough people on that particular bandwagon.

But it is not all over. The echoes of the Watergate bugging episode will be heard long after Richard Nixon's departure from office. In the short term, Nixon may have harmed the stature of the American presidency. In the longer term, however, the Watergate affair should increase public hostility to the technical chicanery made possible by microelectronics.

It could be argued that the only significant difference between Genghis Khan and Adolf Hitler was that Adolf had a bigger gun. It can certainly be proved that a man's behaviour is dictated largely by the tools available to him. Nixon was not the first American president with access to miniature microphones, disguisable tape recorders, and the less obvious stock-in-trade of electronic spying. Only a fool would imagine him the first president to use this equipment; he was merely the first to get caught.

The most worrying aspect of electronic spying is the prospect of its widespread use by the very government departments that are, at the moment of writing, chastising their leader. It is a short step from Watergate—a president spying on his political opponents—to the opposite phase of his opponents eavesdropping on him. And if this should occur, the final phase of government departments spying wholesale upon the public is inevitable.

The practical realisation of *1984* is threatened not by Communism, nor by Fascism, nor indeed by less extreme political ideals. It stems from the inexorable progress of technology that on the one hand produces the pocket calculator and on the other hand the edible radio transmitter. Unless the great general public come to terms with the immoral application of electronic devices, firmly outlawing at least their obvious misuse, George Orwell's gloomy predictions could easily become reality. We are only a year or two away from the cheap mass-produced miniature television camera. Now if Richard Nixon had used video tape. . . .

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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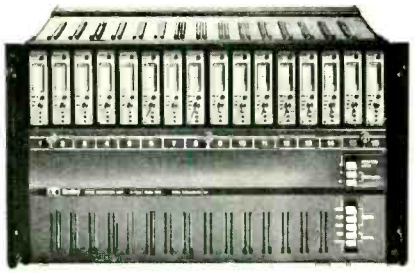
Total average net circulation of 7,641 per issue during 1973.

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.



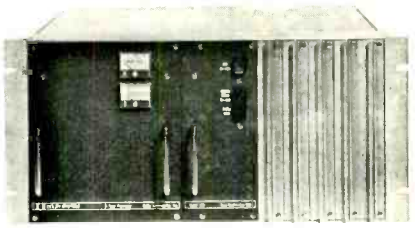
M-Series
The Dolby M16 A-type unit is designed specifically for professional multi-track recording, and incorporates 16 channels of noise reduction in a compact chassis only 10½ inches high. The similar M8 is an 8-track version, and the M8X allows simple extension of the M16 for 24-track use.

Motion Picture Industry

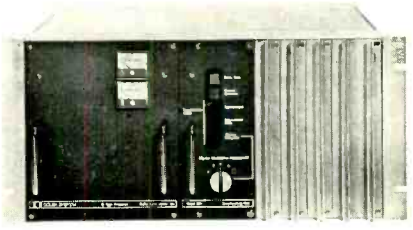
364
The Dolby 364 Cinema Noise Reduction Unit is intended primarily for use with Dolby A-type encoded optical sound-tracks. The 364 also includes a standard 'Academy' filter for conventional tracks, a clean-up circuit for old or worn prints, and provision for playback of magnetic sound-tracks with or 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.

Professional Encoders for Consumer Media

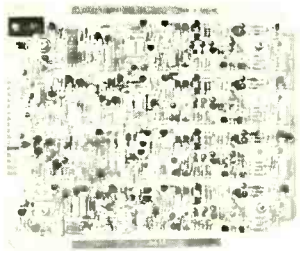


320
The Dolby 320 Duplication Processor is a professional quality unit with B-type (consumer) noise reduction characteristics. The unit is used for encoding duplication master tapes in the high-speed duplication of Dolbyized cassettes, cartridges, and open-reel tapes. The 320 is a two-channel unit.



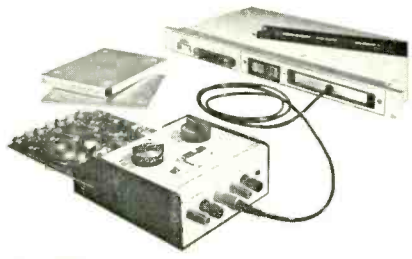
324
The 324 Broadcast Encoder allows broadcast stations to encode stereo FM broadcasts with the Dolby B-type characteristic. The unit provides for an optional reduction of high frequency pre-emphasis, reducing the need for high frequency compression, and thus allowing a significant additional improvement of reception quality.

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.

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.

For detailed information contact
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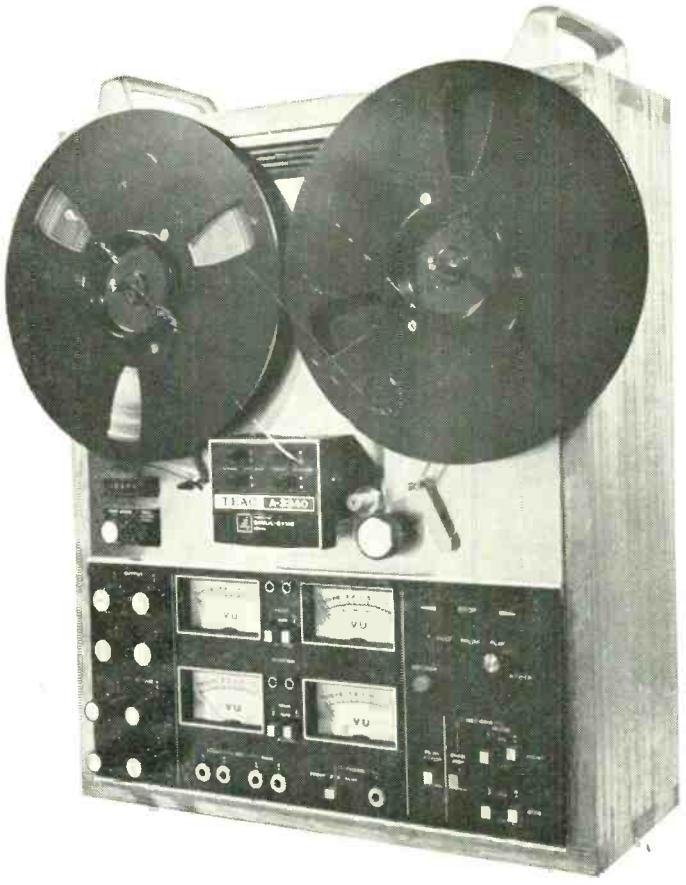

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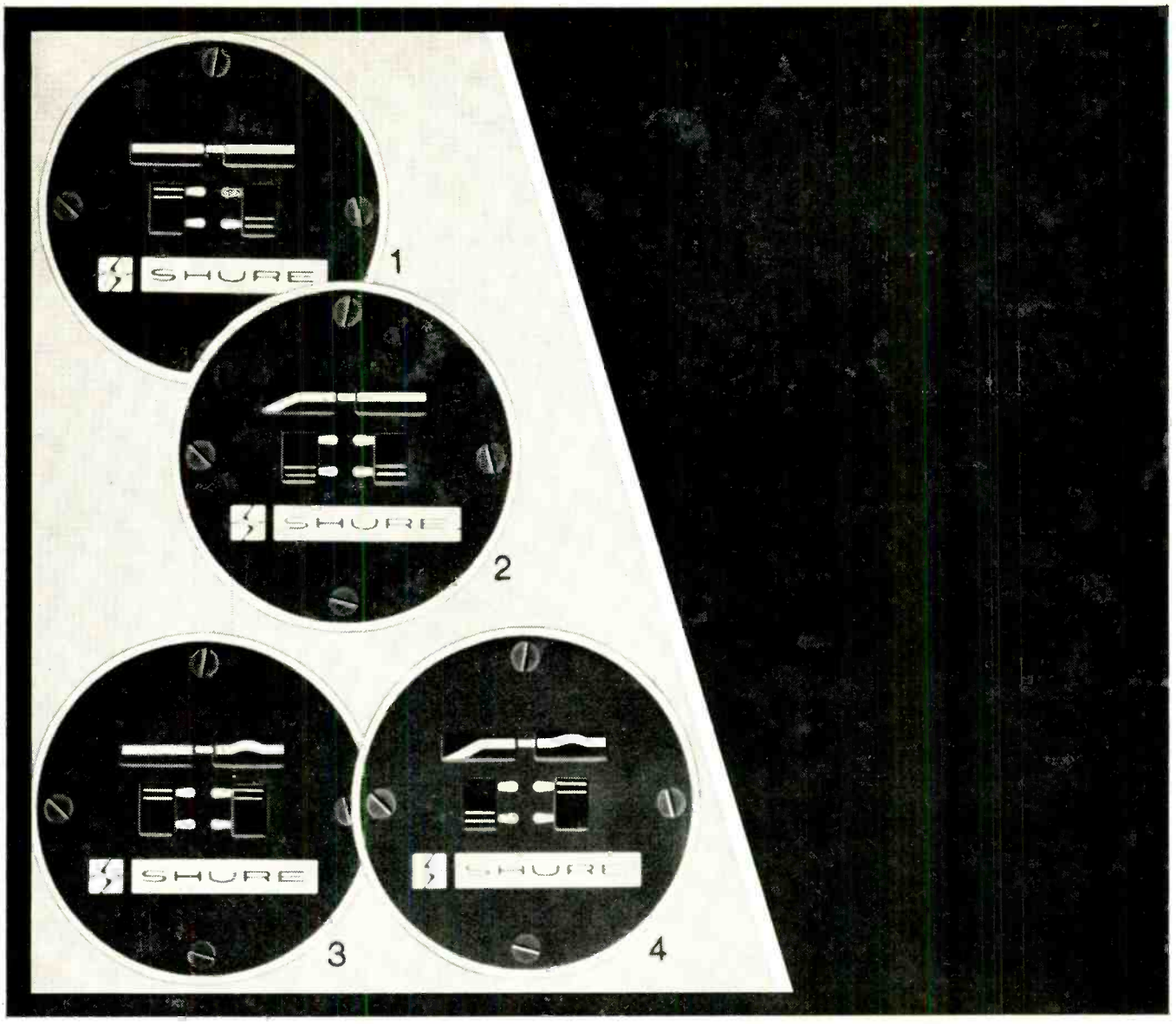
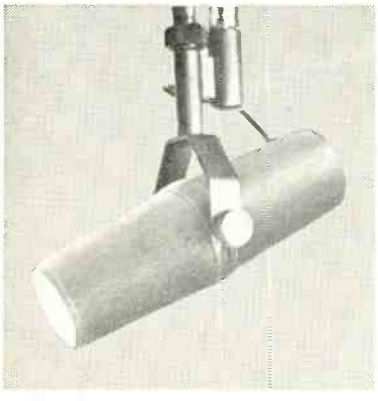


What you see is what you get.



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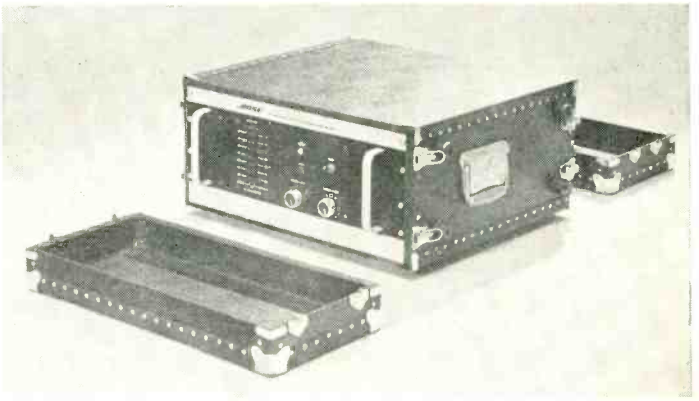

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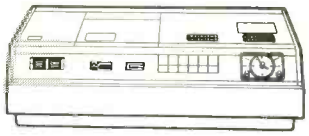

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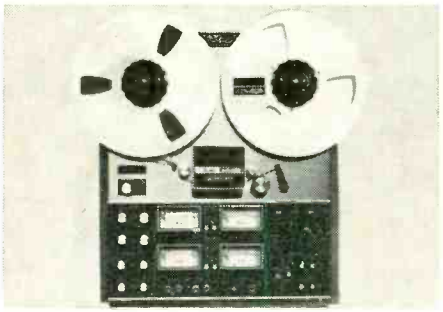

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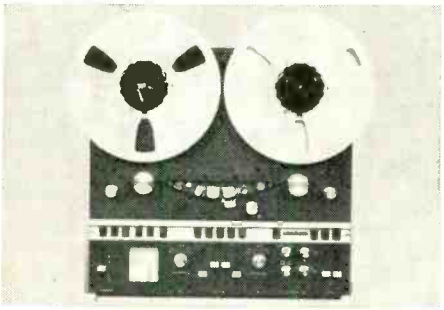

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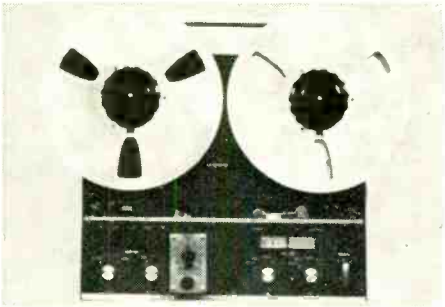

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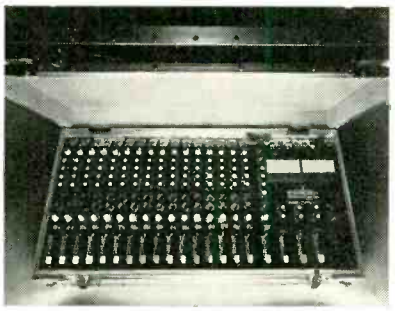

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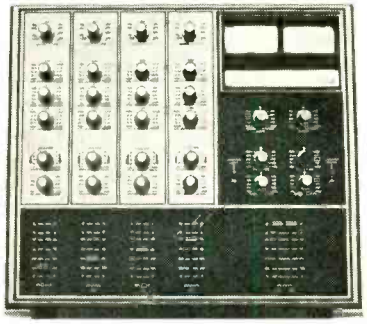

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D12	D2000	565		M101	M69	
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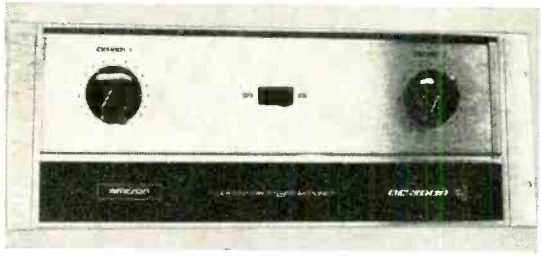
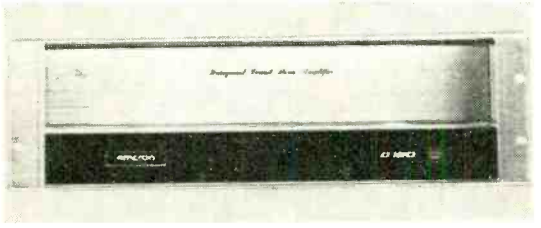
Superiority in quality, reliability and integrity, all Amcron equipment offers the highest standards in design, technology and the absolute ultimate in product performance. Over the past 20 years the Amcron epitome in sound reproduction has been continuous and unending. A brief guide to Amcron's triology of power is as follows:—



The standard for P.A. amplification, industrial and laboratory use. No fancy gimmicks or fragile meters on the DC 300A, just plain solid functional design.

Frequency response ±0.1 dB dc to 20k Hz; Power response +1 dB —0 dB dc to 20k Hz; 1 HF output 420W RMS into 8 ohms, 800W RMS into 4 ohms; IM distortion less than 0.05 % from 0.01W to 150W RMS, typically below 0.02%. less than 0.01% at 150W; Hum and noise 110 dB below 150W RMS, typically 122 dB (unweighted) input sensitivity 1.75V ±2% for 150W into 8 ohms.

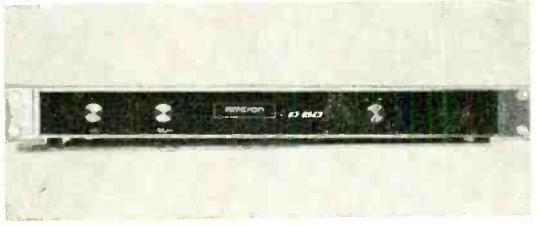
NETT PROFESSIONAL PRICE ON APPLICATION



The D150 is engineered to provide maximum total performance in universal adaptation. Two massive heat sinks and entire chassis are utilised to prevent thermal failure, the predator of most high power amplifiers.

Frequency response ±0.1 dB 20-20k Hz; power response ±1 dB 5-20k Hz; power output 75W RMS per channel into 8 ohms 20-20k Hz at rated distortion, typically 100W RMS per channel at 8 ohms, 140W per channel at 4 ohms; IM distortion less than 0.05% 0.01W to 75W, harmonic less than 0.05% 0.01W to 75W 20-20k Hz.

NETT PROFESSIONAL PRICE ON APPLICATION



Same quality retained but an amplifier of ccmparatively smaller power the $1\frac{3}{4}''$ high Amcron D60 is becoming a major consideration for many audio buyers.

Frequency response ±0.1 dB 20-20k Hz; power response ± dB 5 Hz-30k Hz; power output 40W per channel into 8 ohms, 60W per channel into 4 ohms, typically 52W per channel at 8 ohms and 80W per channel at 4 ohms. IM distortion less than 0.05% 0.01W to 30W RMS into 80 ohms, less than 0.01% at 30W (typically below 0.02% and 0.03% respectively) harmonic below 0.05% at 30W into 8 ohms.

NETT PROFESSIONAL PRICE ON APPLICATION

NOW AVAILABLE. The long awaited Amcron tape deck and latest addition to the REW Audio Contracts family of mini-studio high quality recorders. Amcron are able to offer this 800 and 700 series of decks with choice of CX or SX electronics.

PRO 800 TRANSPORT FEATURES:
Computer logic control, feather touch push button mode controls, photo cell automatic shut off in all models, take up reel motor shut off switch for editing, motor shut off switch, cue lever, remote control facility, electro magnetic brakes.

CX ELECTRONICS FEATURE:
Plug in modules for all functions; mic modules optional, built in remote record for no thumps on tape, built in echo controls, front panel bias adjustment, 3 speed equalisation, treble and bass controls, available with 600 ar 250 ohm balanced XLR Cannon in/out and host of accessories making this an exceptionally versatile machine.

NETT PROFESSIONAL PRICE ON APPLICATION

FULL RANGE OF AMCRON EQUIPMENT ON PERMANENT DEMONSTRATION AND FOR PROFESSIONAL SALE OR HIRE IN LONDON AT

REW Audio Contracts, 146 Charing Cross Road, London WC2. Tel: 01-240 3883

It needn't break the bank.

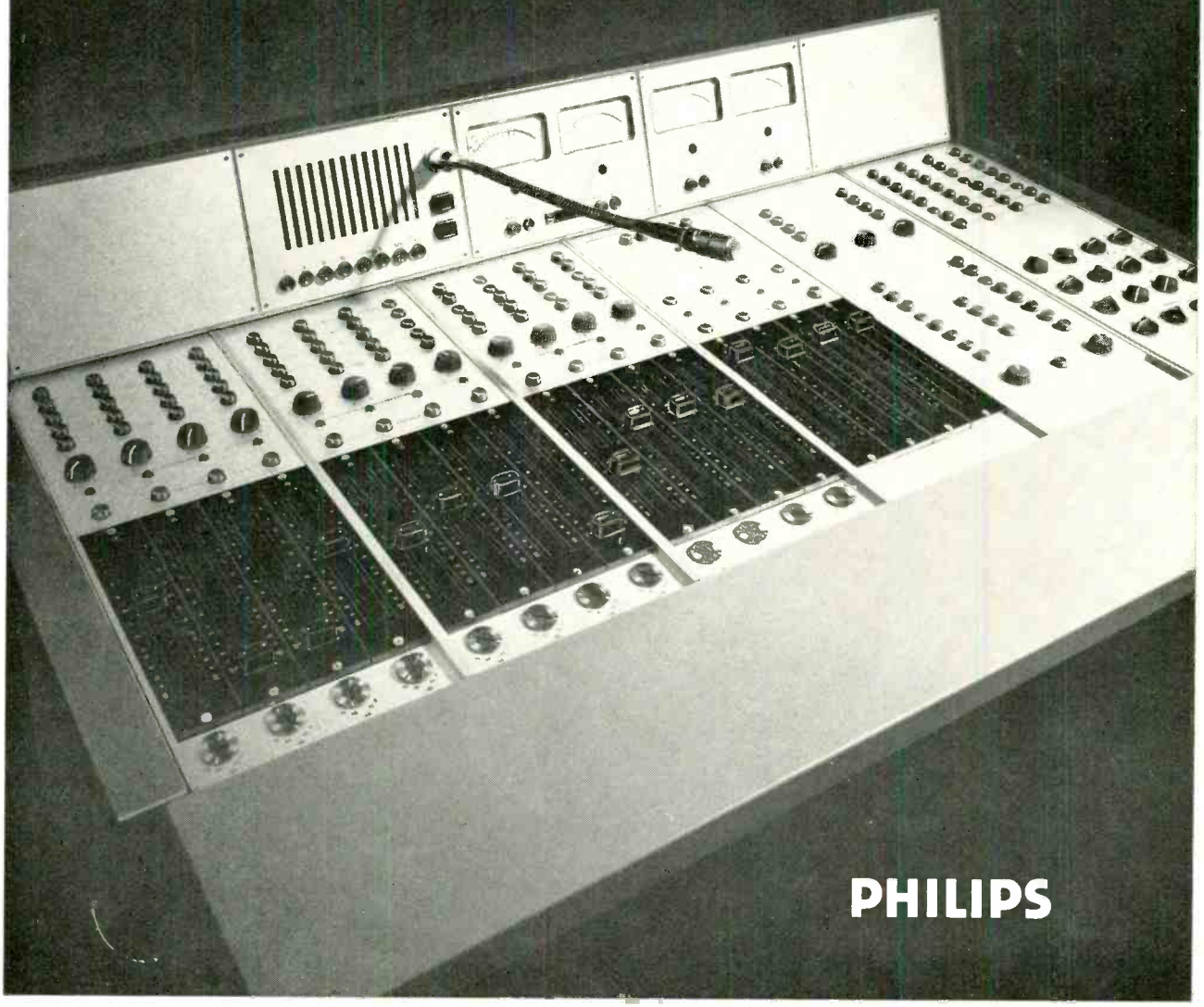
The Philips MD is a range of high performance standard mixing desks at realistic prices.

They have been used all over the world for years and years, which just proves their reliability and excellent quality.

A kind of all risks insurance. So keep it in mind.

You need more information? Contact Mr. Jan Gerrits or Mr. Bram Potappel, N.V. Philips' Gloeilampenfabrieken Electro-Acoustics (ELA) Division, Broadcast Equipment, Building SAQ II, Eindhoven - The Netherlands.
Tel. 040-733793 or 732646, Telex 51121.

PHILIPS



PHILIPS

How to make a hit record

Of course there's no infallible formula (or secret ingredient).

Some musicians use voodoo, trogs, black cats, lucky pixies and other paraphernalia to keep away evil spirits, then maybe touch wood and pray that it all happens.

To be serious, you need a good sound recordist—but even he has to contend with temperamental equipment and the idiosyncracies of his recording media.

And that's where Racal-Zonal multi-track tapes come in. They have an established reputation for quality, durability and, most important, dependability.

Here's what Paul Dallas and all the guys at Scorpio Studios have to say: "Time is money in the recording business. When you bring a lot of busy people together for a recording session, there is no room for tape failure. That's why we always use Racal-Zonal's multi-track. It gives first class reproduction, it stands up to any amount of punishment, and it's British made, so there are no supply problems."

Paul Dallas, just one of the people in studios up and down the country using Racal-Zonal's professional standard multi-track tape.

Racal-Zonal

the professional approach to magnetic recording media

RACAL The Electronics Group

Racal-Zonal Limited, Holmethorpe Avenue, Holmethorpe Estate, Redhill, Surrey.
Telephone: Redhill 67171. Telex 43108

Flexibility en route.

The Philips MP4 portable 4 channel mixing unit has been specially designed for flexible operation on location.

If you are looking for studio quality and a reasonably-priced, small flexible unit that complies with professional specifications, then the MP4 is what you need.

Not only can the MP4 be used as a portable unit but it can also be integrated in existing studio-installations.

You need more information? Contact Mr. Jan Gerrits or Mr. Bram Potappel, N.V. Philips' Gloeilampenfabrieken Electro-Acoustics (ELA) Division, Broadcast Equipment, Building SAQ II, Eindhoven - The Netherlands.
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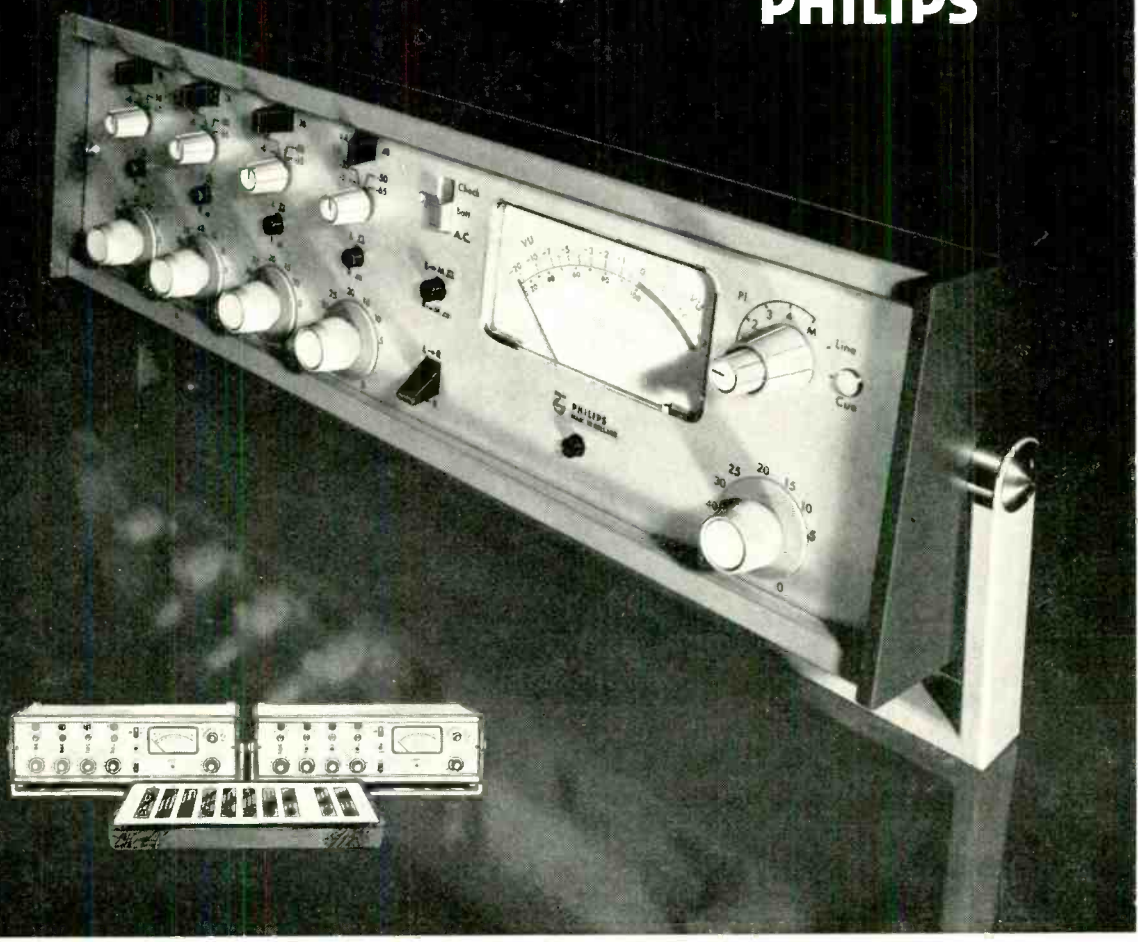
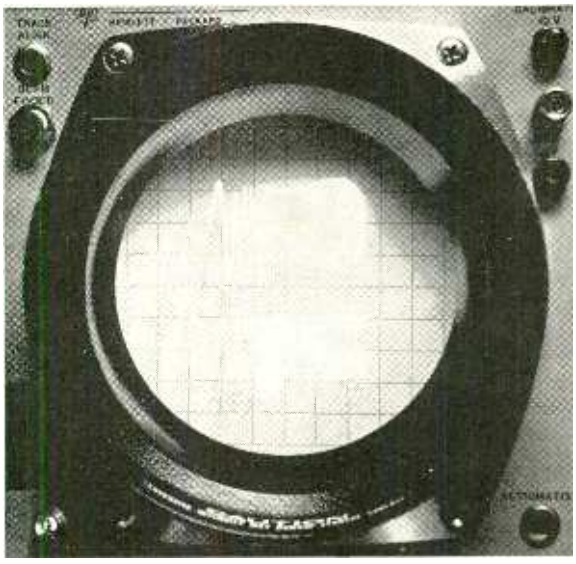
PHILIPS



What would you do if your tape was so good nobody believed you?



You have to see our sound to believe it

That's the situation we found ourselves in, with our Ultra Dynamic formulations. Audio demonstrations weren't enough. People refused to believe their ears. We had to *prove* how good we are. So, we developed a visual demonstration of sound that enables people to see the difference between our UD tape and any other tape they choose. By looking at an oscilloscope screen, they can compare energy output, range, distortion, signal-to-noise ratio and presence of dropouts.

Our first big public screening was in 1971. Since then, we've been touring with our demonstration. And since then, people have started to believe their ears as well as their eyes. If you don't have an opportunity to see one of our demonstrations, try the Maxell Ultra Dynamic tape, and try to believe your ears!

Technicalities

We use a Hewlett Packard dual trace storage oscilloscope and a Hewlett Packard audio sweep generator. The lower trace on the oscilloscope provides a view of the output signal of the sweep generator. The upper trace provides a view of the same signal having been recorded and played back so you can see the performance characteristics of the tape. In the picture above, Maxell Ultra Dynamic tape is shown against the sweep generator trace. The flare at the right indicates extended high frequency response. The uniformity of the trace indicates an extremely accurate overall response.

Maxell Ultra Dynamic Tape

Frequency Response (dB)	
1,000 Hz	+1.0
7,500 Hz	+6.0
12,500 Hz	+8.0
15,000 Hz	+10.0

Output Uniformity (dB) 7,500 Hz	0.2
Distortion (%)	3.0
Dropout	0
Saturation Level (dB)	+15.0
Signal to Noise Ratio (dB)	63
Erasure (dB)	69

ULTRA DYNAMIC TAPE

UD 35-7 (7" reel) 1800ft.	£3·60
UD 35-7VP (7" reel in vinyl case) 1800ft.	£4·75
UD 35-10 (10½" NAB reel) 3600ft.	£8·25
UD 50-7 (10½" NAB reel) 2500ft.	£7·25
UD 50-10 (½" tape in 10½" NAB reel) 2500ft.	£9·25
UD 50-10 (1" tape in 10½" NAB reel) 2500ft.	£18·35

LOW NOISE TYPE

LNE 35-7 (7" reel) 1800ft.	£3·15
LNE 35-5 (7" reel) 900ft.	£1·75
LNE 25-7 (7" reel) 2400ft.	£3·80
LNE 25-5 (5" reel) 1200ft.	£2·00

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Vandalism at its worst

RADIO WHITTINGTON, Whittingdon Hospital, Highgate Hill, London N19 (part of the North London United Hospital Radio Services) recently had their studio equipment stolen and the premises wrecked.

The vandals made off with a record collection, turntables, cassette recorders, mics and even the studio clock, leaving a bare shell in need of extensive repair.

Barry Mason, head of Radio Whittington, telephoned Capital Radio to report the hospital's loss and has had an encouraging response, both from the public and from manufacturers.

Mr Ken Lasky, joint managing director of Laskys, has given Radio Whittington a choice of equipment to the value of £125. Further help has been offered by Philips, Tripletone, and Lugtons of Tottenham Court Road. The public have already contributed records and cassettes.

It will take Barry Mason and his helpers a number of weeks to find their feet, as they are in need of carpenters, bricklayers, electricians and anybody else willing to lend a hand. The only service Radio Whittington can give, at present, is a phone-in round the wards.

Racal Mobilcal record

RACAL MOBILCAL, suppliers of mobile communications equipment to the army and to commerce, have become the first Racal company to reach £10 million turnover. At a press luncheon, Racal's chairman, Mr E. T. Harrison, said that a few years ago such a turnover would have been a magnificent achievement for the whole group. He emphasises that Racal Mobilcal had achieved good profit on their £10,000,000 turnover.

Racal's turnover three years ago was about £15,000,000. It is now around £40,000,000.

Consumer audio statistics

FIGURES NEWLY released by BREMA show that 261,000 audio stereo systems were delivered by member companies between January and April of this year. This is a fall of 12 per cent below the same period of 1973 (371,000). Deliveries of colour television receivers during the first four months of 1974 amounted to 600,000 and were ten per cent down on last year's equivalent (663,000). Locally manufactured monochrome tv receivers fell further, by 44 per cent, from 371,000 deliveries in January through April 1973 to 208,000.

Discotheque systems

A NEW RANGE of discotheque entertainment consoles is now available from the Wiltshire-based company —Citronic. The *Stateline* series comprises a twin turntable mono *Delaware* and three stereo systems: twin-turntable *Kansas*, triple-turntable *Texas* and two-turntables-plus-cassette *Iowa*. All are based on Garrard *SP25* turntables and employ Citronic *P50* 75W power amplifiers. All but the *Delaware* employ the *SMP505* control unit illustrated, embodied in a sloping front panel. **Manufacturers: Citronic Ltd, 7 Market Place, Melksham, Wiltshire.**

Appointments

DR J. M. WESTHEAD was appointed managing director of Pye TMC Ltd and chairman of Pye Telecommunications Ltd with effect from June 1. Dr Westhead relinquishes the managing directorship of the latter company and is replaced in that post by the new chief executive Mr W. F. Hawes.

Inter Navex 1974

THIS YEAR'S Inter Navex audio-visual aids conference and exhibition will be held at the National Hall, Olympia, from July 16 through 19. The exhibition is organised by the National Committee for Audio-Visual Aids in Education (33 Queen Street, London W1M 0AL) and will be open from 09.30 to 18.00 except on the last day when it will close at 16.00. Of particular interest this year should be a display of stereoscopic projection television, the effect being obtained by viewing through polaroid lenses.

Ex Feldon, now designer

AFTER NEARLY four years as JBL sales manager, Stephen Court has left Feldon Audio to do consultancy and design work. He said that, in live performance and studio monitoring work, it was becoming virtually impossible to satisfy every engineer/environment with one 'omnipotent off the shelf system'. Each situation must be treated as highly individual in order to maintain some sort of consistency in the final product. His company, Dennington Acoustics, hope to provide a service to both these fields including equipment manufacturers with system design and construction as well as offering top quality components. When asked if customers wouldn't rather go direct to the suppliers of this equipment he said that, unless he was physically building the system, they would do that anyway. His service on that side would be to recommend the right units for the job without being biased toward any particular manufacturer. The address of Dennington Acoustics is 50 Dennington Park Road, Hampstead, London NW6. Phone: 435 0532 or 734 2571.

New sales engineer

ITT ELECTRONIC Services have appointed Mr Alan Swift as internal sales engineer for passive components. Mr Swift recently studied marketing and electronic engineering at Newcastle Polytechnic.

Donation of Synthesiser

ARP HAVE donated an electronic music synthesiser to the Pacific Hospital of Long Beach, California. The presentation, made at the Home Organists' Festival, was sponsored by the Long Beach Pro Organists Club and the Organist Magazine.

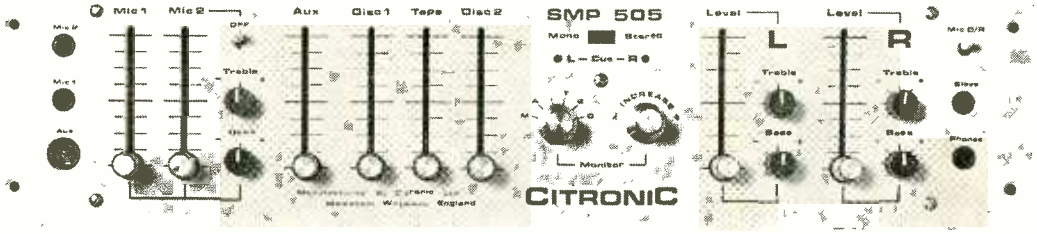
Bonochord name change

BONOCHORD LTD, parent company of Neve and Livington Hire, have changed their name to Energy Services & Electronics Ltd. The change was announced on April 19 and took effect from that date.

Boxes

ALBOL ELECTRONIC & Mechanical Products Ltd are offering two new ranges of ABS plastic boxes. The first range, in four sizes, is for electronic/electrical circuits and controls. The boxes are described as antistatic, easily punched or drilled, able to withstand 100°C, and available in blue, orange, grey and red. Type 1000 boxes, for casing, have lids that can be screwed with self-tapping screws, sunken, flush or flush with one edge overlapping. The boxes were intended for bulk order purchasing but Albol expect there will be considerable interest in small-quantity orders. Albol can supply them, initially, with samples at the 1,000 off price. The boxes vary in price: Type 1000 from 44p to 83p.

The SMP *505* mixer/preamp discotheque unit by Citronic Ltd.



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Boreham Wood Herts
Tel: 01-953 0091

STUDER A80

STUDER B62

STUDER 189 QUADRO

APRS 74 Stand No 1

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 3rd

1353617 EMI Ltd.
Electronically steered aerial arrays.
1353618 Marconi Co Ltd.
Colour television camera equipments.
1353627 Siemens AG.
Liquid crystal display screens.
1353693 Mullard Ltd.
Privacy transmission system.
1353778 Svejsecentralen.
Method of marking and subsequently localising identifying and recording physical objects and an electronic marking device for use in carrying out the method.
1353812 Siemens AG.
Holographic systems.
1354010 Western Electric Co. Inc.
Multifrequency signal receivers.
1354013 Philips Electronic & Associated Industries Ltd.
Magnetic head unit.
1354072 Siemens AG.
Tape transport systems.
1354218 Ampex Corporation.
Magnetic transducing head and drum assembly.
1354266 Standard Telephones & Cables Ltd.
Facsimile line standard converter.

April 10th

1354379 Matsushita Electric Industrial Co Ltd.
Continuous signal producing system.
1354407 Keio Giken Kogiyo KK.
Keyboard type electronic musical instrument.
1354409 Siemens AG.
Cathode ray tube display devices.
1354430 Matsushita Electric Industrial Co Ltd.
Colour camera tube having colour strip filter consisting of colour strips and index strips sandwiching the colour image pickup system employing the colour camera tube.
1354496 Mullard Ltd.
Imaging systems.
1354681 Sanders Associates Inc.
Cathode ray tube apparatus.
1354715 Eastman Kodak Co.
Film advancing mechanism.
1354747 International Standard Electric Corporation.
Deflection circuit.
1354805 Standard Telephones & Cables Ltd.
Pulse time coding arrangement.
1354854 Motorola Inc.
Integrated circuit decoder responsive to two sequential tones with group call provisions.
1354923 Elliott Bros (London) Ltd.
Limiter circuits.
1354947 Stiftelsen Institutet For Mikrovagsteknik Vid Tekniska Hogskolan I Stockholm.
Identification systems and identification transmitters therefore.
1354948 Motorola Inc.
Voltage controlled multivibrator.
1355011 Philips Electronic & Associated Industries Ltd.
Control device for a recording and/or playback apparatus.
1355015 Sony Corporation.
Magnetic recording and/or reproducing apparatus.
1355053 EMI Ltd.
Duplication of magnetic recordings.
1355069 Siemens AG.
Automatic equaliser systems for phase-modulated data signals.
1355111 Soc Honeywell Bull.
Magnetic disc apparatus.
1355118 Wander U Goltermann.
Circuit arrangement for producing a calibratable datum line in an intensity-modulated display device.
1355120 Licentia Patent-Verwaltungs GmbH.
Electron-beam fluorescent screen picture tube arrangements.

April 18th

1355151 Sony Corporation.
Magnetic recording and reproducing apparatus.
1355275 Commissariat A L'Energie Atomique.
Liquid-crystal cell.
1355279 Licentia Patent-Verwaltungs-GmbH.
Aerial arrangements.
1355336 British Aircraft Corporation Ltd.
Aerials for the reception and transmission of electromagnetic waves.
1355363 Electroacoustic GmbH.
Method of and system for transmitting a measurable quantity.
1355450 Information International Inc.
Method and apparatus for forming halftone images.
1355540 Hell Gmbh, Dr-Ing Rudolf.
Methods of and apparatus for reproducing pictures.
1355648 British Broadcasting Corporation.
Timing or retiming in electrical pulse systems.
1355649 British Broadcasting Corporation.
Videotape machines.
1355650 British Broadcasting Corporation.
Helical-scan videotape machines.
1355691 Eastman Kodak Co.
Strip cartridge.
1355692 Eastman Kodak Corporation.
Strip magazine.
1355724 De Staat Der Nederlanden Tedezen Vertegenwoordigd Door De Directeur-Generaal Der Posterijen Telegrafie En Telefonie.
Control circuit for ensuring synchronisation between the operation of a gas-discharge lamp and that of an image pickup tube.
1355741 Magnetic Head Corporation.
Multiple track single gap magnetic heads.
1355756 Bolex International SA.
Procedure and device for synchronising cinematographic cameras with projectors.
1355782 Motorola Inc.
Cartridge locking mechanism.
1355788 Muirhead Ltd.
Facsimile apparatus.
1355835 Telefunken Patent-Verwertungsgesellschaft MbH and Teldec Telefunken-Decca Scahllplatten GmbH.
Pressure pickup arrangement.
1355895 Philips Electronic & Associated Industries Ltd.
Method of copying magnetic recordings.

April 24th

1355904 International Business Machines Corporation.
Display system.
1355975 Pusch, G.
Monitoring apparatus.
1356005 Zerox Corporation.
Magnetic recording head.
1356032 EMI Ltd.
Data retrieval.
1356035 Hewlett-Packard Co.
Methods of filtering light and light apparatus.
1356039 Benderovsky, V V and others.
Mechanism for transporting an information carrier.
1356109 Sperry Rand Ltd.
Flight data acquisition and recording systems.
1356120 American Cynamid Co.
Electrochromism and devices therefore.
1356187 Xerox Corporation.
Reversible colour display device.
1356193 British Broadcasting Corporation.
Processing and/or distributing television signals.
1356202 Philips Electronic & Associated Industries Ltd.
Method of directing a transmitting aerial towards a receiver.
1356205 RCA Corporation.
Squeeze film bearing servo system.
1356357 Sony Corporation.
Magnetic recording and/or reproducing apparatus.
1356414 Elliott Bros (London) Ltd.
Digitally operating graphic display system.
1356478 Branson Instruments Inc.
Oscillatory circuit for ultrasonic cleaning apparatus.
1356554 Wilkinson Sword Ltd.
Radiation sensitive arrangements.
1356596 Philips Electronic & Associated Industries Ltd.
Optical relays.
1356604 Philips Electronic & Associated Industries Ltd.
Colour display cathode ray tube apparatus.
1356644 Matsushita Graphic Communication Systems Inc.
Facsimile scanning apparatus.
1356645 Standard Telephones & Cables Ltd.
Speech processor.
1356773 Sony Corporation.
Magnetic recording and/or reproducing apparatus.

28▶

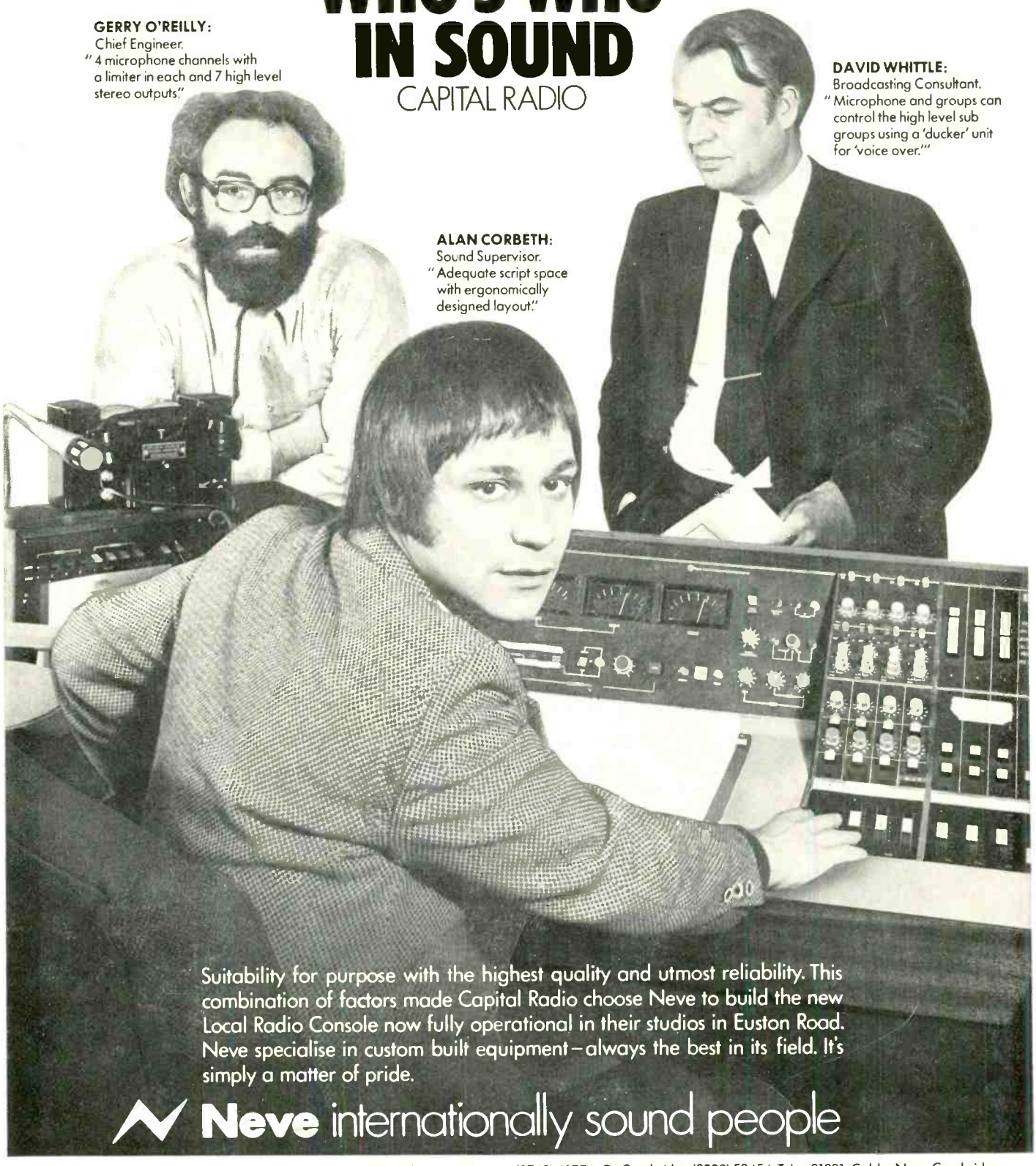
WHO'S WHO IN SOUND

CAPITAL RADIO

GERRY O'REILLY:
Chief Engineer.
"4 microphone channels with a limiter in each and 7 high level stereo outputs."

DAVID WHITTLE:
Broadcasting Consultant.
"Microphone and groups can control the high level sub groups using a 'ducker' unit for 'voice over.'"

ALAN CORBETH:
Sound Supervisor.
"Adequate script space with ergonomically designed layout."



Suitability for purpose with the highest quality and utmost reliability. This combination of factors made Capital Radio choose Neve to build the new Local Radio Console now fully operational in their studios in Euston Road. Neve specialise in custom built equipment – always the best in its field. It's simply a matter of pride.

Neve internationally sound people

Rupert Neve, Cambridge House, Melbourn, Royston, Herts. Telephone: Royston (0763) 60776. Or Cambridge (0223) 53454. Telex 81381. Cables Neve Cambridge.
2719 Rena Road, Malton, Ontario L4T 3K1, Canada. Telephone: 416 677 6611. Telex 0696 8753.
Berkshire Industrial Park, Bethel, Connecticut 06801, U.S.A. Telephone: (203) 7446230. Telex 969638. Hollywood Office: Telephone: (213) 465 4822.

Quadraphony

WE HAVE HAD our collective attention drawn to a United States patent (2,849,540) in the name of Kenneth R. Hamann of Parkview, Ohio. This was applied for way back in 1954 and finally published in 1958. It reached the shelves of the British Patent Office on September 17, 1958, and is highly interesting in the context of current four-channel fervour.

The Hamann invention was titled 'Binaural System' and was concerned mainly with squeezing two channels of sound on to one recording channel and then unscrambling the result for playback. Astute readers will already have realised that if you double the Hamann invention you end up with the means to record and play back four channels of sound with a two-channel system. [*Anyone for octophony?*—**Ed**]

Fig. 1 shows in block form how two microphones 14, 15 feed two amplifiers 16, 17 of which the outputs are passed through lowpass filters 18, 19. These filters chop off anything above a predetermined crossover frequency (e.g. 15k Hz). One of the trimmed signals is fed direct to a wide band amplifier 22 and the other trimmed signal is combined at 26 with a fixed frequency (e.g. 30k Hz) produced by an oscillator 25. The heterodyne output of mixer 26 is fed via a band pass filter (15k Hz to 30k Hz in the present example) to the other input of the wide band amplifier 22. The output of the amplifier thus includes a first channel of 0 to 15k Hz and a second channel of 15 to 30k Hz with a steady 30k Hz carrier tone impressed on it.

Playback is via the system shown in **fig. 2**. Detector 38 (e.g. a tape head or gramophone pickup) passes the multiplex signal to wide band preamp 40 which feeds a lowpass filter 42 and a highpass filter 44. The lowpass filter lets through the 0 to 15k Hz signal (the first channel) and the filter 44 lets through the 15 to 30k Hz plus carrier tone. The latter is used at 54, 55 to control a local oscillator 48 which produces the necessary 30k Hz decoding tone. This tone is mixed at 47 with the output of the highpass filter 44 to decode the second recorded channel.

Hey presto! Two discrete channels out of one recording channel. Or, more to the point, four out of two.

The question of whether or not any current discrete four-channel record system infringes the USA patent is for a USA court to decide. If there is a British equivalent to the Hamann patent it will almost certainly no longer be in force (and once a patent is no longer in force, whatever it discloses is public knowledge). Moreover, the fact that the USA patent was on the British library shelves in September 1958 means that legally speaking its content has been known in this country since then. We are drawing no conclusions, just clarifying the facts.

Likewise we are reporting but not speculating on the legal significance of a pair of recently-published British patents which also relate to four-channel recording. British Patents 1,328,141 and 1,328,142 are in the name of Peter Scheiber, New York, USA, who was one of the pioneers of four-channel matrixing as we now understand it. The Scheiber patents were lodged in the USA in August and December 1969 and, for reasons of world patent law the two British Scheiber patents may well be entitled to the USA 1969 dates. Together they contain some of the clearest descriptions of matrix coding and decoding techniques available in print, and much of what Scheiber says in these patents sounds very similar to much of what has been said by others since then. Certainly anyone interested (or for that matter worried) about patent protection held in the field of matrixing should order copies of the two Scheiber patents post haste.

FIG. 1

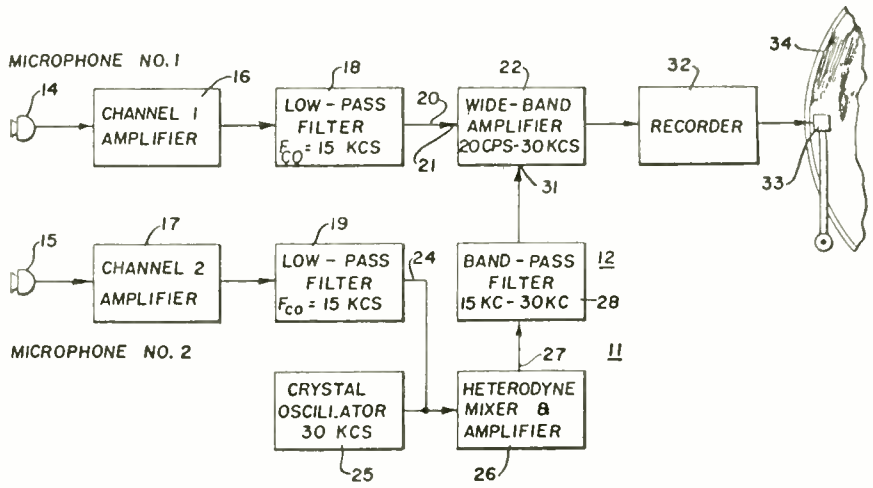
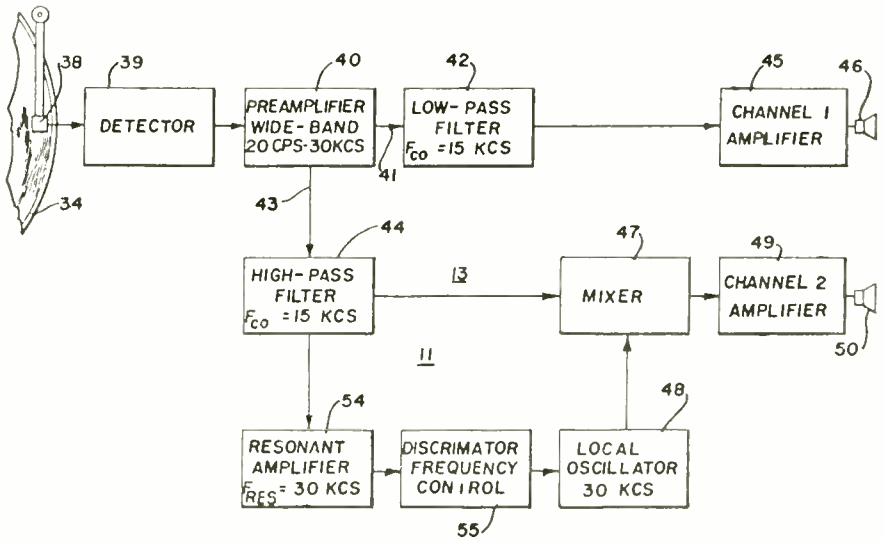
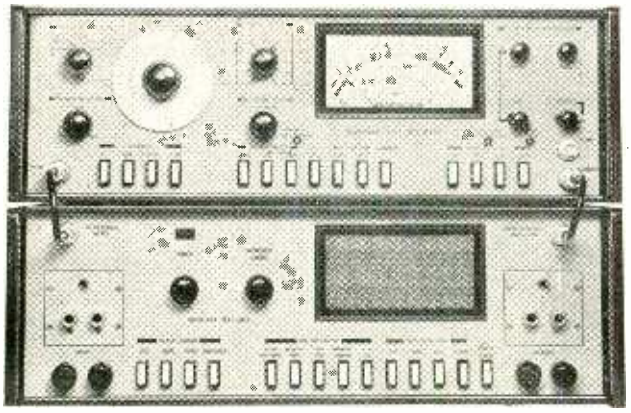


FIG. 2



Audio Test Set



for amplifiers, mixers tape recorders

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drift
erasure
sensitivity
output power
gain
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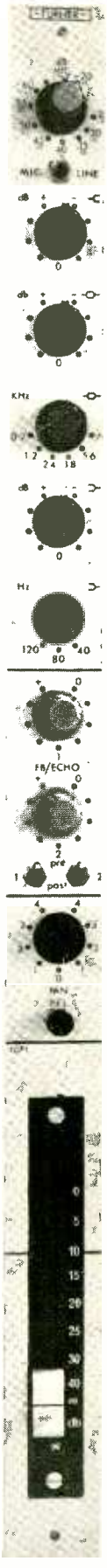

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DIARY

by John Dwyer

I SPENT a very entertaining lunch hour with Lou Hanks the other day. Lou runs Universal Sound, a 16 mm film dubbing setup in Perivale. He is a modest man and claims it was pure accident that he was around to see at first hand some of the great advances in 16 mm film sound recording techniques. I'm still trying to twist his arm into a writing position so that readers will have the benefit of some of the interesting, amusing and—when you consider how casually some of these things occurred—frightening tales of the old days.

Universal Sound are associated with the Universal Film Laboratory of Braintree Road, Ruislip. The reason they decided to put the dubbing theatre at Perivale, on the industrial estate, was that central London is a little harrassing to drive through and park in.

The theatre itself is quite small. It measures 6m by 5.5m. But then Universal do only 16 mm work, no features, and for television work a large theatre can be a bit of a handicap. Lou spent some time discussing the value of realistic monitoring levels: 'You must mix at the level at which the track will be played back'. He told me he had often heard mixes made with high monitoring levels. The effects and music would be quite audible under the dialogue under those conditions but when the finished product was replayed on a tv set at domestic level the effects were inaudible.

Next to the theatre is a small commentator's booth equipped with two cctv screens: one for the picture and another for the footage counter. The microphone is an AKG *C451* and the foldback speaker (Lou has standardised on these throughout the studio) is a Spendor *BC1*. A window in the cubicle allows the commentator to see the engineer. Although the air conditioning, which is used in the theatre as well as in this small room, was working I couldn't hear anything. Lou told me that the ventilating company had had to put attenuators just about everywhere in the trunking to make it satisfactory. The soundproofing between here and the theatre is first rate—the walls and ceiling are independent of the rest of the building, though it hadn't been possible to isolate the floor.

Rod Guest at the mixing desk.

'We've standardised on the Spendor *BC1*. We wanted to find something that would be very flat, particularly on speech. We're not interested in high volume, though we discovered it is boomy if used on the stand supplied. If you lift the stand and speaker off the ground it improves and, because we get a lot of work for the BBC, we wanted a sound that BBC producers are used to listening to'.

The desk in the theatre is by Helios who were recommended by GTC. Some other mixer manufacturers said "Here's our standard module". The knobs were usually far too small and you couldn't get your hands into them'. The layout on the standard desks was not suitable for film dubbing.

The desk has 12 channels and two main groups. There are 12 line and four microphone inputs, and there are 14 special equalisers which have continuously variable frequencies, plus a low frequency roll-off filter with continuously variable turnover frequencies. Channels one to four have outputs which pass to two equalisers each; the one in use is selected by a pushbutton. A lamp on the equaliser shows which one is operating. Channels five to 12 have one equaliser each. There are two Audio & Design (Recording) *F760X* compressor-limiter-expanders which can be patched in as they are needed. The first four tracks have their faders in the middle of the desk and are normally connected to the four main sprocketed film reproducers. The rest go via a jackfield, to two Rusco disc players, a Bias tape recorder, and two cassette recorders which are let into the desk console. There are four microphone amplifiers built into the desk and these can be patched into any channel. There are also tie lines to the nearby transfer room to enable any of the equipment installed in there to be patched into the mixing theatre.

There is one foldback and one echo send potentiometer per channel and there are overall echo and foldback send level controls. Monitoring is on two Spendors driven by HH power amplifiers. Helios have built an AB comparison system whereby, in position A, the left speaker is fed with mixer output One and the right speaker is fed with either output One or Two or patched-in-signal. In the B position each speaker is fed with any of a number of signals' such as that from the film recorders, selected by a rotary switch.

In the transfer room is a Bias three channel mixer. There is also a Bias tape deck which is used to replay Nagra and BBC pulsed tapes, and a TRD: 'It's not a fully professional machine but it has all the odd speeds. We bought the Thorens *124* turntable, too, because it was the only one we could find of that quality which had 78 rpm'. The Bias tape deck, as much else, was modified by GTC of Hamburg.

The film transport system is a KEM duplex system with GTC amplifiers. It can be converted to record on to 35 mm magnetic, 16 mm full track magnetic, or 16 mm striped prints and replay from 16 mm optical, 16 mm edge track, or 16 mm centre track from 35 mm magnetic or 17.5 mm tracks. The six film machines are Keller (or KEM) transports fitted with GTC amplifiers. I noticed that they were horizontal, which I thought was a little unusual. Lou suggested that the only reason film machines were vertical was that the design had derived from early optical reproducers which were like projectors, without the picture mechanism. Four of these machines are replay only and the other two are full track 16 mm recorders, thus five tracks can be recorded on to one or four on to two. The KEM machines will roll back or run forward at double or quadruple speed, which is useful if you're doing commentary to picture and there's a long wait between paragraphs.

An unusual arrangement for resyncing ill-fitting commentaries has been built into the system. It has been christened 'slip sync'. A button on the desk, when pushed, isolates one channel, from the sync lock: the track on this head can then be rocked back and forth from the desk without moving the other tracks or picture. The amount the commentary track has been moved from normal sync is displayed on a frame counter on the desk. When the offending paragraph has been rerecorded on to the mix, in its new position, the machinery can be stopped and the commentary track returned to its original sync, by watching the frame counter return to zero.

'We made good use of the device recently when a commentary track had been shot on location at 24 frames/s for a 25 frames/s tv film. The commentary head was run at the correct speed to maintain the correct voice pitch while the recorder and projector were operating at 25 frames/s. Obviously, the commentary began to 'creep' but using the 'slip sync', we were able to pull it in at each sync point'.

For me the most interesting piece of equipment was the 16 mm film projector, which has no intermittent motion. Lou Hanks explains: 'The full potential of Keller equipment is not always used because normal projectors fitted with intermittent movements cannot follow the rapid changes of the dubbing machine. Neither do conventional projectors take kindly

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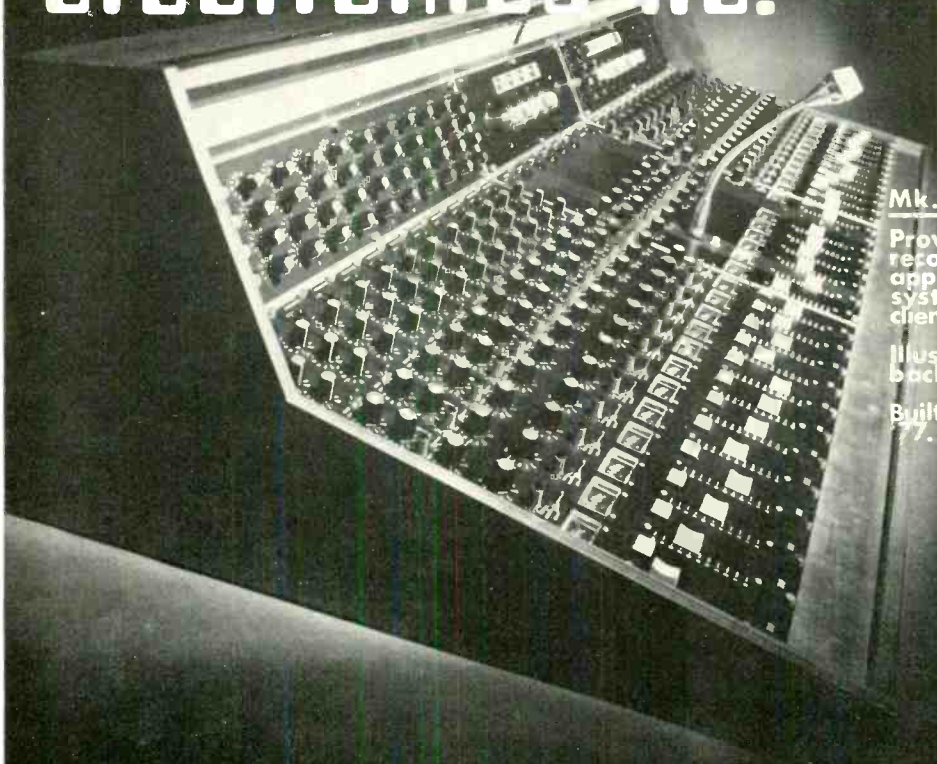

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DIARY

to the damaged and much used cutting copies normally brought to recording sessions. Some earlier installations overcame the problems by using a prism system linked to a closed circuit tv chain. However, the picture quality was poor, the size of the screen limited, and the picture was seen in black and white.

GTC have developed a projector based upon a Danish prism system which projects a bright flicker-free picture on to a normal projection screen. The projector handles damaged prints with no difficulty and the mechanism can follow the rapid speed and direction changes of the recording channels with ease'.

The screen they have used at Universal is a highly directional one which allows a high ambient light in the theatre and also means that the projector which is fitted with a low power lamp, can be used to display stop frame without burning the film. The film can be inched forward frame by frame from the desk—useful for checking sync.

Other facilities include an AKG *B2X0* spring unit, again modified by GTC. An extra head has been fitted to one of the film machines in advance of the normal head so that dubbing mixer Rod Guest can 'see' the commentary that is about to come in. For cueing the sound, a row of lights on the desk brighten from left to right. They start at the left as the sound reaches the advance head and light up in sequence until they reach the right hand light, at which time the sound reached the normal head. Another feature, which was due to arrive any day when I went to see Universal, was a 16 mm Picot optical recorder for the transfer room.

Extra effects can be done on the spot, as I saw for myself when some poor guy was detailed to go into the commentary booth and make blowing noises. He emerged somewhat breathless. Universal Sound is at 16 Aintree Road, Perivale and the telephone number is 998 1619.

It has seldom been my privilege to witness such prosperity as seems to be apparent at R. G. Jones's studio in Wimbledon. Both Robin Jones, the manager, and Gerry Kitchingham, the engineer, were wearing immaculately tailored apparel when I went to see them, and it is a long time since I tasted a meal like the one they gave me in a nearby restaurant.

I was very amused when, over lunch, they told me about one of the most recent happenings at the studio, which concerned a lady scribe from the local blatter and a band known as Will Flascher and the Raincoats, who performed their music in the studio recently without the benefit of raiment of any kind. The lady scribe, who had been instructed by her superiors to write 500 words of nonsense about a bunch of streakers who were going to make a gramophone record, blushed when she saw these scenes and, sad to tell, she left hurriedly, unable to complete her task. For all we know the only thing she wrote was her notice.

R. G. Jones have one of the most solid reputations of any studio in London, perhaps because their studio is one of the oldest-established. Yet until recently it was also one of the smallest. I reported on their activities in October '72, when they were eight track. They had, as many studios have, a massive studio and a tiny control room, and if I had a quid for every studio I've come across who have made the belated discovery that it makes no sense to have a cramped control room (the working area for the guy-who-counts, the producer) and a massive, but empty, studio, I'd be able to afford a Healey ice cream.

Not that R. G. Jones have ever been empty. Recent work has included sessions by Alan Price, the Tremeloes, the Equals, Paul and Barry Ryan (without mother), Billy J. Kramer and the aforesaid Willie Flascher.

Now their control room is a decent size, 4.4m by 5.2m, and they have fitted themselves out with a Neve desk—16 track wired for 24 track and also for quad pots—and a 3M 16/24 track. They also have a Studer eight track and two stereo Studers. The previous control room, down at the other end of the studio, is now used as a drum booth, and there is room for another booth on the other side of the old control room, so there's no need to worry about separation. Robin Jones told me the only thing was that the decor of the studio was a little old-fashioned. I suppose the place would look flashier if they put in a suspended ceiling, but as far as the sound goes the canopy they have up now seems to work.

The studio wasn't quite finished when I called, the tape store was still under construction but the control room was finished and working, and a band were in the middle of a session. The wiring is in for four speakers. Monitoring is on Tannoy *Reds* in R. G. Jones cabinets, driven by Quad *50E* amps. Robin told me they would probably put Crown *D150s* in. There are also two Ditton *120s*, which they use for domestic hi fi reference. All the lighting is dimmable and diachroic lights have been fitted above the console. The separation between the control room and the studio has been measured as 45 dB. Among the other facilities are double loading doors straight into the studio, and a limiting circuit on the headphones to prevent their blowing up.

They have a Dolby *M16* unit as well as four *361* which can be punched up for mono or stereo and can also be used on the eight track. All the Studers can be remote controlled as well as the 3M machine and all the microphones come up on the patch bay. There are four distribution panels in the studio, each with six microphone points and four foldback outlets. There are also panels in the booths. Direct injection is also available and the studio has a Countryman phasing unit, an EMT stereo plate and, on the desk, Neve limiters and noise gates. Robin said they had only started thinking about making all the changes to the studio in mid-September last year and the order for the console was placed around October. The desk was ready to install by Christmas. They lost no studio time because of the improvements, since there was a short overlapping period when both control rooms were operational at once. Robin told me they had had minor teething problems—a fuse blew in the middle of a session, for example, causing a little consternation but nothing too serious. 'We're very pleased with the way things have gone', he said, and judging by the tailoring I would say they are.

The studio is only one part of their operation. They have an equipment hire service for public address equipment which must be one of the biggest around. They recently did the Eurovision Song Contest and have lots of other projects on the cards, including a new speech studio in Mitcham. Their phone number is 542 4368.

Overall shot of the theatre.

Finally, and this time I mean it, I have been writing this column since September 1972. After a time thumping out the thousands of words such a task entails you begin to find it a little harder each time to say something new, something interesting without stooping to describe the merely sensational. Therefore I have decided I'd like to put my quill to work at something a little different. As I tie up my traps in a red spotted handkerchief and wander off down the road to fame and fortune with my bundle on the end of a stick I wish you all well and hand over to someone else. I may yet haunt such places as the APRS exhibition and, if I see you, maybe you will let me buy you a lemonade. Hey, not all of you.

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The London Broadcasting Company are nothing if not productive, operating round the clock throughout the week. Jeff Barron outlines the equipment and some of the planning that went into their studios, located just off Fleet Street.

This is London Broadcasting

LONDON BROADCASTING were set up by the IBA as a commercial radio station incorporating Independent Radio News, who would provide news for other commercial stations and operate a 24 hour news service in London together with other topical programmes. Thus in the LBC studio complex there are only small studios intended for talks programmes.

Communications House, in Gough Square, is a convenient situation for the station as it is near to Fleet Street although I'm not sure if this was intentional. The hub of the station, the newsroom and studios are in the basement. Although this is convenient for sound insulation, there is no daylight. However, night ceases to have much relevance when broadcasting 24 hours a day.

The newsroom is typical, containing the basic ingredients of any newsroom: teleprinters, telephones, copy-typists and of course editors. The studios are attached to the newsroom and consist of two production studios and three self-op studios provided for news presentation.

Most of the equipment on the station was supplied by the Canadian firm McCurdy, who have considerable experience in the USA of this kind of installation. Firstly the two production studios—there is a 12 channel mixer in each studio, the stereo faders all having inputs permanently wired, two per fader, selectable by a switch. Visual monitoring is on three peak programme meters reading mono, left and right, and McCurdy speakers with built-in amplifiers are mounted above the desk.

Each studio has a cartridge stack, three players and one record/replay, all with remote starts made by International Tapetronics. The three replay machines have a common capstan which simplifies construction and reduces cost per player. Two *B62* tape recorders are built into consoles which can be arranged around the desk to suit personal taste.

The presenter sits in the studio opposite the control room window, at a specially shaped desk: upon this is a small control panel with an intercom, microphone on/off switches and the profanity pushbutton (more later). AKG *C414*, *C451* and *D202* microphones are used and boom stands are available because although not a music station, LBC occasionally entertain musicians in the studios, which holds about eight people.

The self-op studios have a six channel mixer with comprehensive monitoring facilities and of course the usual cartridge stack. There is also a Leevers-Rich *Series 6* tape recorder for playing 6.25 mm tape inserts into the bulletins, although contributions are normally transferred to cartridge. Above the mixer is an Anglepoise boom stand with a *D202* on its end and there is another *D202* on a table stand for interviews.

The mixer in the master control room selects which of the various studios are fed to the transmitters. As a standby, there are also cartridge machines and two McCurdy turntables; two *B62* tape recorders continuously record station output for programme purposes as opposed to logging recordings for the IBA. The two machines have been recording alternately since last October which must say something for Studer workmanship.

The apparatus bays are also situated in the master control room and consist of jackfields, communication amplifiers, and other ancillary equipment. Looking from left to right on the six bays, the equipment is as follows:

Bay One: Communication amplifiers, Gent master clock, and two Pye limiters to avoid the transmitters and line equipment being over modulated.

Bay Two: More amplifiers, three ppms monitoring station output, two selectors associated with mono and stereo landlines to the more commonly used outside broadcast points.

Bay Three: This has four cartridge machines associated with the profanity delay, and a jackfield with incoming and outgoing lines etc.

Bay Four: There are two Revox *A77* tape recorders, also associated with the profanity delay, and a Metroteck *400* logging recorder.

Bay Five: Three Hes telephone balance units, a Universal Audio limiter, and another Metroteck logging recorder. These are four track and record LBC output as follows. Tracks One and Two vhf off-air left and right, Track Three, medium wave off-air, and Track Four, the time signal TIM. The machines run at a speed of 2.375 cm/s ($\frac{15}{16}$ inches/s) and there is quite a story behind their purchase. In this age where more and more firms are using computers to improve marketing, the original orders for the Metroteck machines were computerised and somehow, the computer lost the one in front of the 15, so the factory went ahead and built two machines running at a speed of $\frac{5}{16}$ inches/s. I'm not exactly sure what the IBA use logging tapes for, but I don't think they used those particular tapes for quality checking. Incidentally, Scully, the parent company of Metroteck, built two more machines running at the correct speed and shipped them over from the USA. LBC still have the original machines in order to replay early tapes.

Bay Six: Automatic monitoring facilities for the transmitters; digital signals are modulated and superimposed on programme, and a decoder in this bay indicates any possible faults. A McMartin crystal controlled receiver provides a quality check for the Croydon transmitter and the engineer in the master control room usually monitors this receiver output. Audix receivers are used for the other vhf and medium wave transmissions, and Motion Electronics equipment for tv sound reception.

As is common practice in the broadcasting industry, the station has a multiplicity of radio links. LBC have a radio car, originally constructed by Pye, but now extensively modified. An Audix sound mixer is mounted in place of the front seat in a station wagon, with a Pye uhf transmitter. There is also a Motorola transceiver working on a number of channels around 141 MHz and this is used for two-way communication with the radio car. There are three reception points for these links which are the Croydon transmitter, the Millbank Tower and Epping Green, and there is a range of approximately 24 km from any of these sites.

There is another system, basically intended for the reporters, and this consists of a Motorola base station on the London Hilton hotel and a number of hand walkie-talkies. These are again two-way devices and the range of this system is approximately 10 km from the Hilton. These sets are used for on-the-spot

reports but, since the microphone is only low quality, the quality is more likened to a telephone. However, while experimenting with these sets, LBC's engineers discovered that the electronics are capable of higher quality so hopefully better microphones will be substituted soon.

Reports of a less urgent nature are recorded on Sony cassette machines; the thinking goes that reporters are usually in a hurry so let's give them something foolproof and simple to operate. Cassette recorders fulfil these requirements. The system works in theory but the recordings have to be played back on the originating machine otherwise head alignment would be very critical. So the recordings are transferred to either 6.25 mm tape or cartridges for use in the news bulletins but here another problem arises—the miniature jack to PO jack transfer leads regularly disappear, rather complicating the transfers.

LBC have other small studios situated around London. Near the upper press gallery in the House of Commons is a small studio with an Audix mixer used presumably for parliamentary reports. The GLC also have a specially built studio with an Audix mixer. There are small studios in the Weather Centre, the Automobile Association, New Scotland Yard, and the *Financial Times* building. These studios have small Shure mixers and are connected to Gough Square by PO landlines. Another essential item for a radio station is a standby generator and LBC's starts up in 11s.

The phone-in programmes are more complicated than is generally realised. There are eight telephone lines arranged in a hunting system, in other words when the number 01-353 8111 is rung, the exchange will try all eight lines before telling the caller that the line is engaged. It has to be admitted that the PO are not keen on phone-in programmes since their exchanges tend to get drastically overloaded when hundreds of people all try to call the same number, and it probably overloads their engaged tone generator. The lines appear on two small PO switchboards in Studio A. The first board enables the output of a cartridge machine to be returned down the line if there is no phone-in programme taking place and this identifies the station and asks the caller to try again later. The second switchboard enables the producer to converse with the caller and determine whether or not the call is sincere.

The great problem with programmes using telephone calls, is to obtain studio quality from the announcer's microphone which also doubles as the telephone transmitter.

By their nature, telephones are two way devices without isolation between send and receive paths, and bandwidth is only 3.5k Hz due to line bridging. If the microphone were fed directly into this phone system, the resulting

Control room

News room.

bandwidth would only be 3.5k Hz since it would also be picked together with the caller from the phone line. Instead, the phone line is fed together with a compressed clean feed from the mixer into a Hes telephone rejection unit, which is an expensive box of electronics that provides only the caller as its output.

After the call has been accepted, the caller is asked to turn his or her radio off and studio output is returned down the phone line enabling the caller to hear programme. When it is the caller's turn to go on the air, another switch is selected and the line is fed to the Hes balance unit which now returns studio clean feed down the line, while the announcer listens on headphones and never even reaches for a telephone.

It is an IBA requirement that a delay should be available in order that obscenities, slander and libel are not broadcast. This is known as the profanity delay and, as originally installed, consisted of a modified cartridge machine with a 7s loop. An associated cartridge machine has a 7s jingle loaded. When the system is set in action, the jingle is played first but at the same time the announcer starts his programme. This is recorded on the modified machine and, when the jingle ends, the output of this machine is switched to air. If for any reason the profanity button is pressed the jingle is again played instead of the tape, thus losing the last 7s of programme. There was however one slight problem here; during a six hour programme the loop would perhaps rotate 1,500 times, so there wouldn't be much oxide left at the end. In practice, it lasts about 20 minutes and at £2.50 a time is an expensive way of delaying a programme.

Two Revox *A77* tape recorders were then obtained and mounted above one another in the bay. One machine records studio output and the tape passes around guides arranged to provide a 10s delay before the tape is replayed on the other machine. The machines are linked in a similar way to the 10s jingle and the only drawback is remembering to rewind the tape every halfhour while the news is being broadcast.

The LBC engineers are now in the process of developing a new switching system which, when complete, will be submitted to the PO for approval. A Revox has also been modified to provide the delay on one machine and when this new system is working it is hoped to reduce the delay to something like 5s, which ought to be adequate and cause less inconvenience than the present 10s.

Finally, I should like to thank Mike Barton, Ron Pickup, and the rest of LBC's staff for their help during my visit.

The seventh APRS exhibition of industrial sound recording equipment opens at the Connaught Rooms, off Kingsway, on Friday June 21.

APRS 1974 preview

DAVID KIRK

FOR THE PAST few years, it has fallen my annual lot to preview the Association of Professional Recording Studios Exhibition. This year I find myself writing the introductory paragraphs after completing the main body of text and thus well placed to comment on the trend of this year's developments. Audio mixers remain the staple diet though the non-modular mixer is now a rare beast. Little progress in the direction of automatic remixing is apparent although an increasing number of companies are turning their attention to tape motion clocking in one form or another. Nothing in the exhibition's title rules out optical equipment but even the occasional video tape machine glimpsed in earlier times seems likely to be missing for 1974. Nor is the youthful face of pseudo-quadraphony to be seen in the pages that follow, not least because Sansui weren't sure of their plans for June when we went into type mid-May.

One factor that makes this preview a pleasure to write is the excellent response derived from the inital request for information from exhibitors. This varies enormously from one exhibition to another and the APRS event has long been the most responsive in this respect. The exhibition itself reflects the sincerity of the majority of participant companies in the relaxed but dedicated atmosphere achieved during the two day event. Which concludes the sermon; to business.

The seventy annual exhibition of industrial sound recording equipment will be held under the aegis of the Association of Professional Recording Studios on Friday June 21 (10.00 to 21.00) through Saturday June 22 (10.00 to 18.00). As last year, the location is to be the Connaught Rooms, Great Queen Street, London WC1. Entry is by ticket, available free to all who work in the electronic communications industry. Nearest underground station to the Connaught Rooms is Holborn, the air below London being generally preferable to that in its main streets. Temperature: London itself is usually hot in June and the exhibition rooms in particular subjectively hotter.

Tickets again. These may be obtained from the APRS secretary, E. L. Masek, 23 Chestnut Avenue, Chorleywood, Hertfordshire WD3 4HA.

AGFA-GEVAERT will display their wide range of audio tapes, compact cassettes, bulk 3.81 mm tape and related accessories. The company hope to demonstrate the qualities of a new series of studio tapes designated *PEM*.

Of particular interest on the **AKG** stand this year, apart from the usual assortment of decorative mammaries, will be the *C451 CMS Modular System* microphone. This is now available with a *CK8* hypercardioid capsule which is claimed to give particularly good separation for multi-microphone recording. The CMS range is now extraordinarily flexible, as can be seen from the adjacent photo. The *CE10* miniature lavalier microphone will be one new face among a series of electret units on show. This will be seen alongside the *C414* variable pattern capacitor microphone based on a *C12* capsule. AKG claim continuing popularity for their double-system dynamic microphones—the *D202* and *D224*. 'If there are still any sound recordists left who have not used them, AKG would love to hear from

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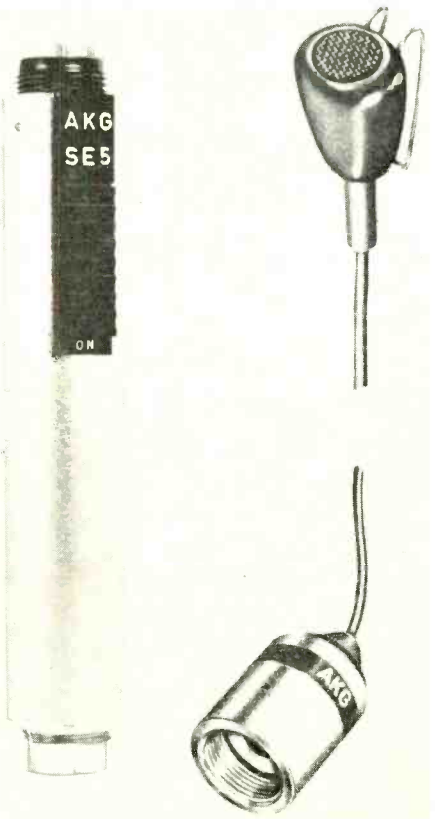
Above: AKG *C414* variable pattern capacitor studio microphone.

Below: AKG *CE10* miniature electret lavalier microphone.



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*FERROGRAPH
FUTURE FILM
FAYLON ELECTRONICS
*FELDON AUDIO
*GRAMPIAN REPRODUCERS
*HELIOS ELECTRONICS
*H/H ELECTRONIC
*HAYDEN LABORATORIES
INDUSTRIAL TAPE APPLICATIONS
*JACKSON RECORDING CO
*KLARK-TEKNIK
*LOCKWOOD & CO
*LENNARD DEVELOPMENTS
*JACQUES LEVY. PROFESSIONAL RECORDING SERVICES
LEE ENGINEERING
*LEEVERS-RICH EQUIPMENT
*MILLBANK ELECTRONICS GROUP
*M.S.R. ELECTRONICS
MACINNES LABORATORIES
*MAGNETIC TAPES

EXHIBITORS

KEITH MONKS
MIDAS AMPLIFICATION
"MUSIC WEEK/SOUNDSCENE"
*3M UNITED KINGDOM
*RUPERT NEVE & CO
N. TØNNES PEDERSEN
*PYRAL
PARTRIDGE ELECTRONICS
*J. RICHARDSON ELECTRONICS
RACAL ZONAL
*ROLA CELESTION LTD.
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*SHURE ELECTRONICS
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***APRS MEMBERS**

Alice *AM85B* mixer.

APRS PREVIEW

them'. Interesting to see AKG entering the digital audio delay field; a delay line designed to complement the *BX20* reverberation unit will be exhibited for the first time.

A stands for **ALICE** which in turn stands for Stancoil Ltd. In the past year, this company have formed a subsidiary organisation specialising in broadcasting installations: Alice Broadcasting. The *AM82B* mixer illustrated here is one of two new items from this division. A variant of the *AM* design, it incorporates several facilities not normally required in a mastering studio. These include complex lighting and function interlocks for disc-jockey operation, monitoring of off-air and all desk functions, elaborate talkback facilities and clean feed for phone-in productions. The *AM82B* is designed to fulfil IBA technical requirements and, in standard form, features three mono mic/line inputs, four stereo inputs, and additional inputs for telephones and reverse talkback. Separate stereo and mono outputs are fitted for clean feed, logging, loudspeaker monitoring, and headphone monitoring. Another Alice Broadcasting exhibit will be the *GU100* American turntable. Alice claim for it the fastest start of any commercial turntable and will be offering the *GU100* ex-stock. Output is on balanced line, stereo, a cueing amplifier and loudspeaker being accommodated within the cabinet.

The pure Alice side of Alice are expected to show four items from their product range. These will include a mixer from the *SM* range, available in configurations from six to 18 channels, feeding one, two or four groups. All normal studio facilities can be organised at the design stage. Less elaborate but very much cheaper is the *AD62*, a six channel two group mixer for use with semi-industrial recorders. Largest mixer in the present Alice range, an *AM* desk will be exhibited in 16 channel eight group form. As already explained, this is the design from which the *AM82B* was derived. Special features of the *AM* series include ic construction and interference-free electronic switching.

A mixer from their *Modular* series, another from the *Quasi* range, and a selection of peripheral units will be exhibited by **ALLEN HEATH.** This company has several years experience in the production of highly compact mixers and the *Quasi* design comes within that category. Constructed on a steel chassis with teak side cheaks, it accepts up to 12 input modules working into two or four output groups. Facilities available on the input units consist of variable sensitivity, three-band equalisation, echo and cue outputs, linear fading, panpotting and routing. The larger *Modular* design amounts to a compact desk, now revised to suit low-budget multitrack operation. The version illustrated permits 14 channel into eight group working. Peripherals from this stable cover a multitude of accessories varying in complexity from a quadraphonic panpot—four rotary pots mounted at 90° in one plane and operated by a joystick. Shortage of type numbers here: the A & H noise gate is designated *Noise Gate*. This can be used for noise reduction, automatic remixing, feedback prevention, or for cross modulation between, say, bass guitar by a bass drum. A reverberation spring in a small suitcase, a nine-frequency graphic equaliser and a 6:1 ratio compressor complete the A & H selection of peripherals.

ALTEC in Britain means Theatre Projects, at least so far as studio products are concerned. Main emphasis this year will be on the *9846BX* by-amplified loudspeaker. The same driver units with a passive crossover are available in the shape of the *9846-8A*, currently being used in all Island studios and, at the moment of writing, being evaluated for the Rolling Stones mobile. Here is one company quite prepared to disclose prices. Model *9846BX* is listed at £327.61.

AUDIO DEVICES, based at Elstree Studios, plan to display mastering tape, magnetic film, lacquer master discs and Audiopak broadcast cartridges. Slight cross-representation here as the lacquers will also be seen on the Jacques Levy stand and the cartridges on the Lee Engineering stand.

A.V. DISTRIBUTORS agents for Stellavox, should attract considerable interest to their stand by demonstrating the *SQ7* four channel 6.25 mm battery tape recorder. This machine is perhaps best described as a double-deck version of the stereo *SP7*—two sets of electronics surmounted by a four speed tape transport. The *CEI* recorder is a straight stereo variation optimised for 38 cm/s. A matching film synchroniser is available—the *ARU*.

AUDIX LTD have just announced further contracts for sound broadcasting equipment following the completion of a complete audio control system for Birmingham Broadcasting. The new orders have been placed by Sound

40▶

TM 50 MK2 SERIES AUDIO MIXERS

Single or multi-output mixers with up to 100 input channels made to professional standards and incorporating the following features:

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- ☐ 180° self-evident dials
- ☐ Back contacts
- ☐ 'Channel on' lamps
- ☐ Peak programme meter
- ☐ +12 dBm floating output
- ☐ 0-30-60 dB input attenuators
- ☐ 0-30 dB preset channel gain
- ☐ 30Hz-20kHz +2 dB

OPTIONAL FEATURES INCLUDE:

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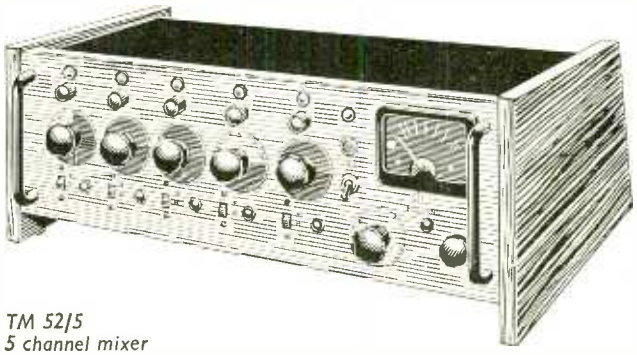
- ☐ Extra PPMs
- ☐ VU meters
- ☐ Disc and tape inputs
- ☐ Limiter/compressors
- ☐ Battery operation
- ☐ Portable field units
- ☐ Rack mounting units



TM 52/5
5 channel mixer

CTH also manufacture a range of modular mixing units consoles, distribution amplifiers, studio disc player units, speaker amplifiers, cable drums and many other items of studio equipment.

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Merseyside and Radio Hallan, who respectively obtained the IBA franchise for Liverpool and Sheffield. A recent overseas sales tour has brought several similar orders to equipment broadcast stations in Africa and the Middle East, including a complete system for the National Broadcast Training Centre, Malaysia. A contract from the New Zealand Broadcast Corporation brings the value of Audix (Broadcast Division) operations to £240,000 over the past nine months. Not surprising, therefore, that Audix are concentrating their APRS '74 display on a free-standing continuity console plus 10/2 and 14/4 mixing desks which form the basis of the new *B100* series. This equipment is to be exhibited together with associated distribution amplifiers, line equalisers, limiters and monitoring amplifiers.

BASF are this year to display a new low-noise high-output *SPR50 LH* tape with non-conductive matt backing and a claimed low print. Other products of this stand will include *LGR30 P* tape, 3.81 mm cassette feeder, *P16* magnetic film and a selection of calibration tapes and cassettes.

F.W.O. BAUCH now enjoy almost enough agencies to run an exhibition of their own: Studer, Neumann, EMT, Universal Audio, Teletronix, Switchcraft, Allison Research, ARP, Klein & Hummel, ITI, Magnetic Reference Laboratory, Gotham and Lexicon. From the Studer camp, the *189 Quadro* quadraphonic mixer will make its debut. Features include 22 quadpots and remote control for the 16 track *A80* master recorder. The mixer and a 6.24 mm *A80/R* are illustrated here. The latter will be exhibited in the company of the new *A80/R-TQ* 12.5 mm quadraphonic tape machine.

Neumann. Capacitor microphones and disc cutting equipment are to be shown. Nothing new this year.

EMT recently announced the *424* flutter meter. Several unusual design features here, including a solution to the problem of reading shaky flutter registration. In the *424*, flutter is sampled over a 5s period and a reading then registered as a steady deflection until a cancelling button is pressed. A light beam unit indicates drift and permits an alternative check of flutter content while a switched-frequency filter allows the flutter rate to be defined. Other **EMT** equipment to be displayed includes the new *803* logging recorder, *116* portable tuning reference, *928* gram turntable, *440* digital delay line and *240* reverberation foil.

Universal Audio are the American originators of the Cooper *Time Cube* delay line, the *Little Dipper* filter, *1176N* limiter, a digital metronome and graphic equaliser.

Teletronix, and we're still on the Bauch stand, will be represented by their *LA-3A* limiting amplifiers; Switchcraft by the *QG* range of audio connectors, Allison Research by the Kepex keyable programme expander, and ARP by one of their wide range of voltage-controlled electronic music synthesisers.

Klein & Hummel monitor loudspeakers are to be exhibited together with audio equalisers from that company; these in turn will be alongside ITI parametric equalisers. Magnetic Reference Laboratory produce test tapes in 6.25, 12.5, 25 and 50 mm widths for studio system calibration. The tapes are individually calibrated and come complete with relevant certification. MRL employ no correction during manufacture, instead using a graphic level recorder to keep continuous check of tape flux: the tape is then rejected if it falls outside the specified tolerance. The complete range of MRL tapes is now available ex-stock from Bauch.

Lastly on this very crowded stand grouping, a digital delay system from Gotham and the Lexicon *Varispeech* tape time expander and compressor allowing speech rate to be varied without changing apparent pitch and vice versa.

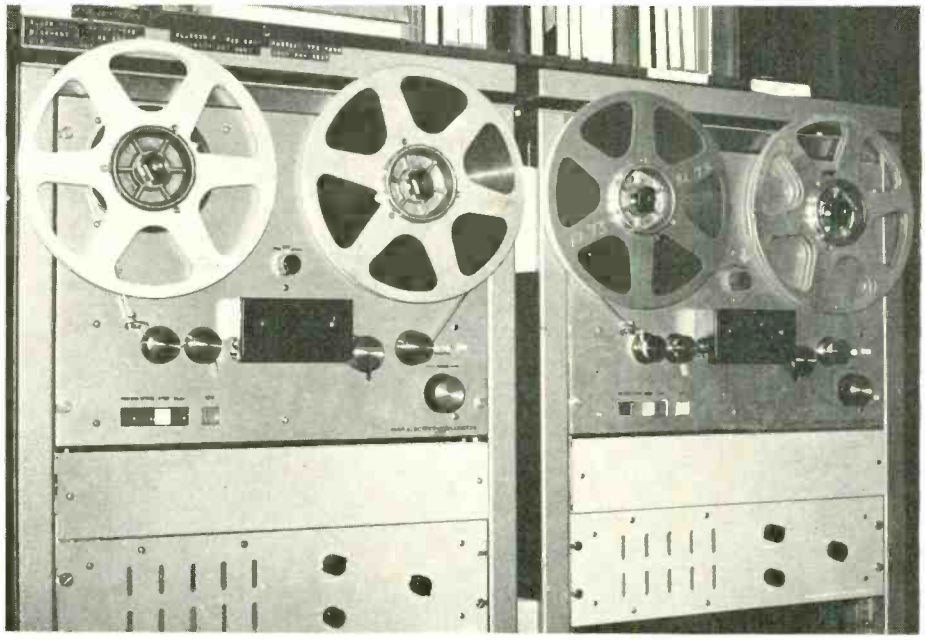
BE1000 and *BE2000* recorders, respectively 6.25 and 12.5 mm, will be the collective main exhibit on the **BIAS ELECTRONICS** stand. Two versions of the *1000* are to be displayed, suffix LR denoting a design evolved to meet local radio requirements—fader start, ferrite heads, output faders and internal monitoring. The *100 Logger* runs at 2.375 cm/s and can be used as it stands or in parallel with a second machine. In the latter event, a tape breaking or ending, or the failure of bias or dc supply, results in automatic switchover. A transportable version of the four track *BE2000* will be seen for the first time, together with specimens from the Bias range of audio mixers.

The eight track 25 mm and four track 12.5 mm **BRENELL** tape machines will be seen on Stand 76. The Brenell range includes a relatively low cost heavy duty tape transport—*Type 19*—available with speeds of 165 cm/s down to 3 mm/s dependent on application. Two and four speed selection can be accommodated. The transport has recently been improved with redesigned tape tension and brakes. Full and half track mono *Mark 7* recorders will be seen for the first time together with the stereo *IC2000*. Both the latter designs operate at 38 and 19 cm/s and have 27 cm NAB spool capacity with wrap-round head layout.

CADAC hope this year to demonstrate a 36 into 24 quadraphonic music console in con-

42▶

EMT *454* flutter meter.

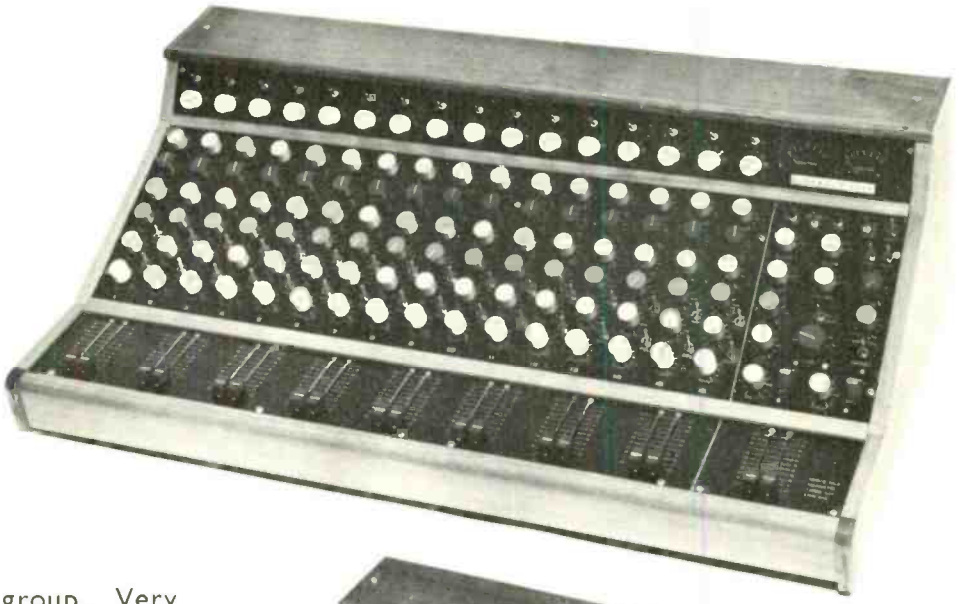


Bias Electronic *BE1000* logging machines.

CHILTON M16-2

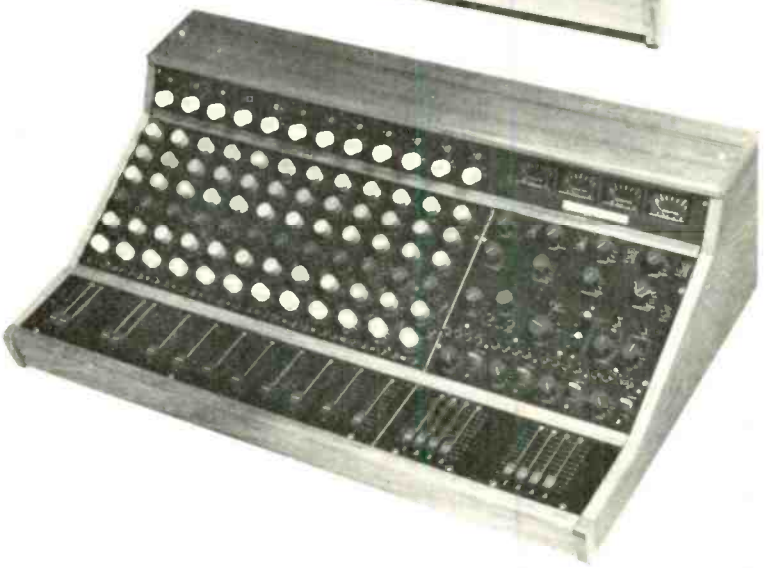
16 Input 2 Output group Comprehensive monitoring facilities. Shown with Mid Boost, 2nd Aux and Limiters fitted. Channel faders can be in pairs or equally spaced.

M10-2 Version as above 10 Inputs, 2 Outputs.



CHILTON M12-4

12 Inputs 4 Output group. Very comprehensive monitoring facilities. Monitor faders with independent mixing. Input channel panning across any 2 output groups selected.
Shown with Mid Boost, 2nd Aux. and Limiters fitted. Push button channel routing to output groups available. Also additional auxiliaries.



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Cadac music console.

APRS PREVIEW

junction with a 24 track tape machine. Several new items should be on display: notably a portable broadcast mixer, and a transportable monitor loudspeaker. Cadac also expect to attract interest in a thick film circuit produced for them as an alternative to wound inductors.
Main feature of the **CELESTION** exhibit is expected to be *12/50* loudspeaker drivers of 300 mm diameter and 50W continuous rating. *Powercel* units handling 100W and 125W (300 and 380 mm diameter respectively) are also to be displayed while customers for complete speaker systems will find the *Ditton 66*.
One new exhibit to be expected on the **CETEC** stand is the *Copy-Class 2*, a fully automatic high speed cassette duplicator. Operating instructions are straightforward enough: load it and leave it. The unit accepts a master cassette and up to 15 virgins, copying at 50 cm/s. Four channel heads permit single-run duplication of two stereo programmes. All within the confines of 407 x 407 x 140 mm. And it comes in a choice of six colours. Cetec should also be showing the *Gauss 1200* high speed open reel copier and *1260* loop bin.
Three audio control desks are produced by this division of Computer Equipment Corporation —the Electrodyne *200*, Cetec *20LM* and Cetec *10*. The *2000* is available in formats up to 32/16 while model *20LM* handles up to 30 inputs and eight outputs. The much smaller *10* is essentially a 20/2 desk but wired as a 10 input stereo system. Two identical power supplies are incorporated, one for preamplifiers and line amplifiers, another for relays and monitor amplifiers. In the event of one supply failing, the entire mixer may be powered from the surviving source at the flick of a switch.
Lastly in this divers range of products, Cetec loudspeaker drivers. The basic range comprises models *40*, *41* and *42*, all rated at 200W continuous.
Illustrated in the photo overleaf is model *TM53/4*, one of the *TM50* range of audio mixers to be displayed by **CTH**. Accompanying these will be CTH crystal controlled digital clocks suitable for use as session timer and capable of feeding remote displays. Cable drums, distribution amplifiers, circuit boards, peak programme meters and a console-format audio mixer are also to be shown.
Most elaborate of the noise reduction systems to be displayed by **DOLBY LABORATORIES** is the *M16*, a compact modular system which can be expanded from eight track to 24 track working. Models *360* and *361* are lowline single-channel modules while the *364* and *E2* form Dolby's *Cinema Package*. Model *364* reproduces Dolby-encoded release prints during projection and the *E2* endeavours to equalise the cinema loudspeakers to the auditorium acoustics. Units *320* and *324* both function to Dolby *B* characteristics, the former being for use in software duplication and the latter for encoding fm broadcasts.
The Bose *800* loudspeaker and *1800* power amplifier will be seen on the **ELECTROSONIC** stand. Their virtue is compactness; four speakers and one amplifier between them form

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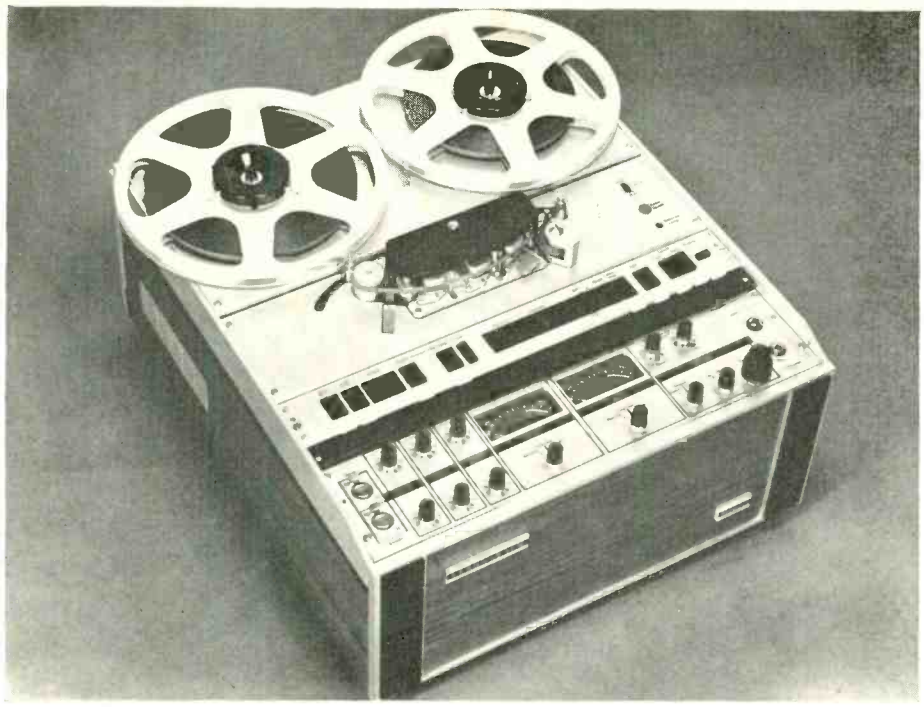

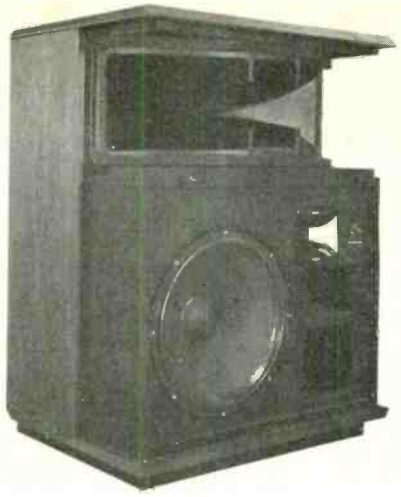

Left: Ferrograph Series *8*.

Above: Electro-Voice Sentry *3*.

Below: CTH Electronics *TM 53/4* mixer.

APRS PREVIEW

a 1 kW amplification system that will fit into any car. Electrosonic themselves have produced a time division multiplex programmer that allows up to 240 discrete control functions to be handled simultaneously on one track of an audio recorder. A range of studio mixers and related equipment will be on display, including the *Intermediate* mixer and new *Mini* mixer. Now being used in 'virtually every large audio-visual studio in Britain', the Electrosonic *Multiplex Clock* converts one track of any multitrack audio recorder into a synchronisation channel and gives immediate off-tape readout of tape position during play without need for reference calibration. Identification is thus retained irrespective of tape stretch or, less obviously, editing.

ELECTRO-VOICE, represented in Britain by Gulton Europe Ltd, are expected to display the *Sentry 3* loudspeaker, designed for studio monitoring, illustrated here without grille. Two microphones have recently been added to the Electro-Voice catalogue: the *671* cardioid and *660* supercardioid.

EMI, more specifically EMI Tape Ltd, will show their current range of studio and domestic tapes. This now consists of *815* low-noise low-print standard play mastering tape, a matt-backed version designated *816*, and a long play equivalent of *815* designated *825*. For home use, hi-dynamic tape is being produced in open reel and cassette formats.

Wilmot Breeden recently formed a new division of Ferrograph whose aim will be obvious from their title: **FERROGRAPH PROFESSIONAL RECORDER COMPANY.** The *Studio 8* 6.25 mm two track tape recorder will make its debut on Stands 30 and 31. It is to be produced in portable, trolley, console and rack forms and features full solenoid control, 27 cm NAB spool capacity, line and microphone inputs—the latter through two Cannon *XLR* sockets set in the main control panel. Two audio test sets are to be demonstrated: the *RTS2* and its companion *ATU1*.

Multitrack versions of the Telefunken *M15* recorder, series *ABE* are to be displayed this year by **HAYDEN LABORATORIES** who comment that former price barriers have now been breached. The recorders are available in eight, 16 and 24 track versions housed in a mobile console complete with ppms and control panel. Record and replay circuitry is by the Konstanz company ABE Electronic. Alongside this, a 'revolutionary studio cassette recorder'. The AEG 'cassette' employs a single core carrying 6.25 mm tape which is laced automatically on to a take-up spool within the transport. Also on display will be a complete AEG tape duplicating system and a cartridge splicing machine.

Still on the Hayden stand, proof that Nagra have finally gone 27 cm. The *QGB* extension unit may be fitted to any Nagra *3* or *4* and incorporates separate spooling motors and an elaborate servo speed control. And from Sennheiser, further proof that dummy head techniques are enjoying a fresh revival. The *MKE 2002* stereo microphone comprises two electret transducers worn more or less like headphones to utilise the recordist's head as an acoustic loading.

TPA Series D studio monitor amplifiers will form the basis of the **HH ELECTRONIC** exhibit. The present HH product range includes the *TPA 100D* 100W into 4Ω power amplifier, *TPA 50D* and *25D* with corresponding output power, an *AM8/12* amplifier designed for BBC local radio, and the *DM12* audio distribution amplifier. The latter delivers 12 balanced outputs at 600Ω or 36 outputs at 75Ω.

ITA means Otari, QRK, Revox, Teac . . . and ITA. Under their own label they will be displaying a modular audio mixer, the *10-4*,

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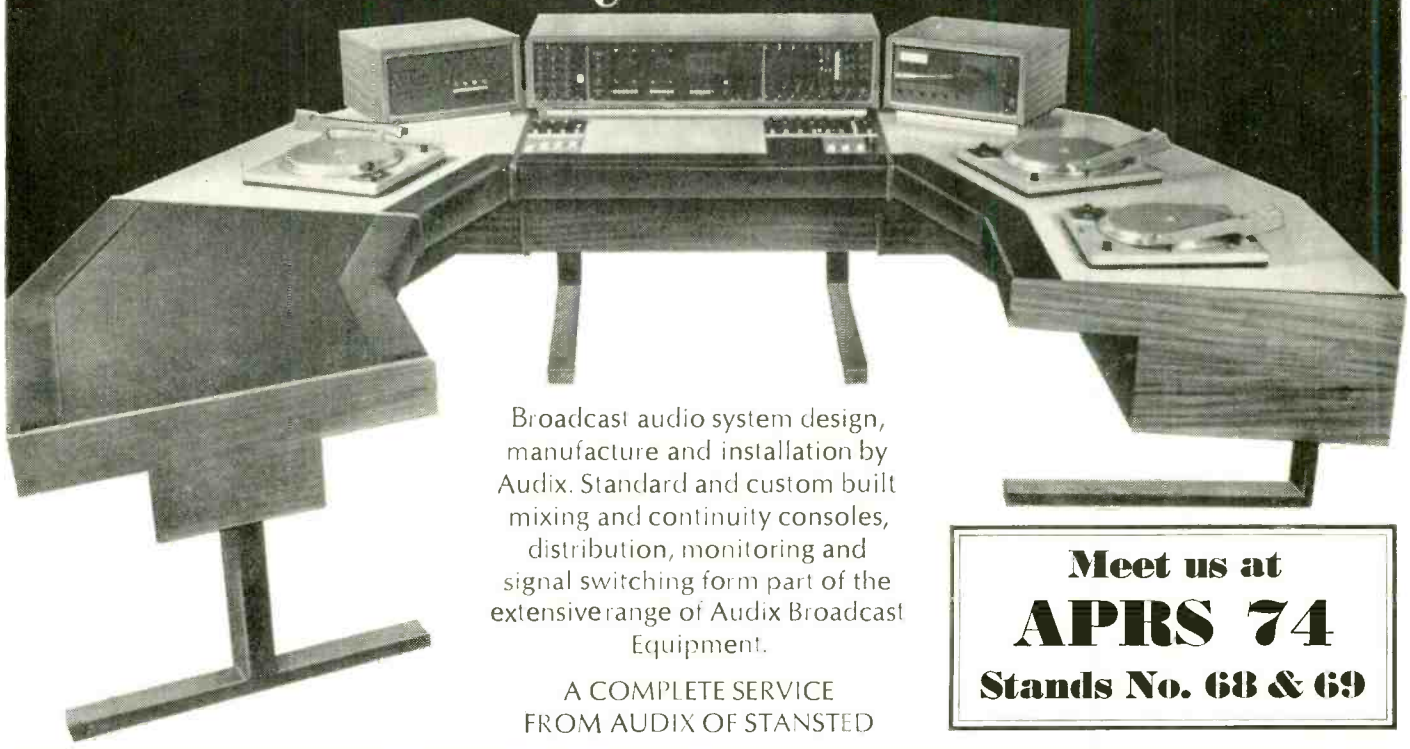
audix

SOUND SYSTEMS AND ELECTRONICS

Broadcast Systems



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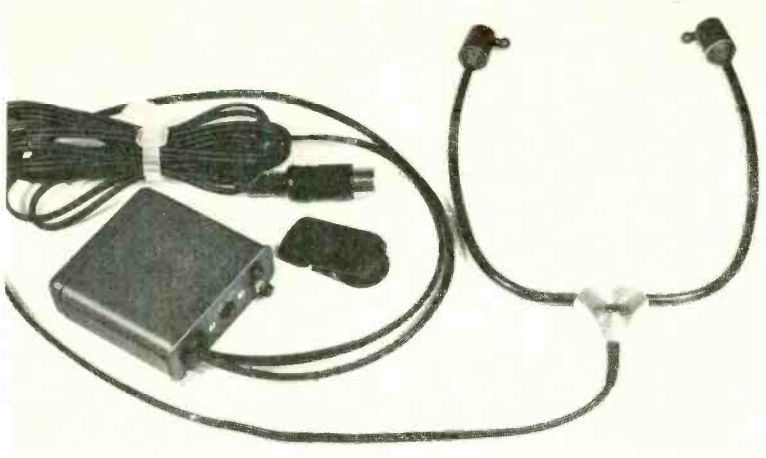

Sennheiser Triaxial microphone MKE *2002*.

APRS PREVIEW

with all the facilities expected of a small studio desk: three-frequency equalisation, four limiters, foldback, echo send and return, and headphone monitoring. Price £590. Space permitting, the entire range of Otari high speed duplicators will be exhibited. This includes a high speed loop bin master operating at 32:1 above normal speed and a new cassette tailoring machine—the *DP-6750*. From QRK, a quick-start broadcast turntable and series of NAB cartridge machines designed to accept *A*, *B* and *C* formats. Every conceivable version of the ubiquitous *A77* Revox will be shown, as will several configurations of *A700* including a 76, 38 and 19 cm/s model. From Teac, two versions of the *A-3340* four track tape machine; facilities here include sel-sync.

Audiodiscs and Emi discs, Capps mastering styli, Pultec equalisers, Smiths timers and stop watches, and two dynamic controllers from Fairchild are handled by **JACQUES LEVY PROFESSIONAL RECORDING SERVICES.** The Fairchild Reverbertron reverberation synthesiser incorporates suppression against rumble and microphony. Prolongation of the reverberation effect is achieved by means of a compressor. The unit is light and portable, measuring 90 x 483 x 254 mm. From the same stable, the *Audio-Ten* automatic attenuator is designed to permit interference-free switching, dynamic compression, expansion and equalisation. Heart of the system is an ldr (light dependent resistor) array driven by plug-in incandescent bulbs.

Over the past few years, the **KEITH MONKS AUDIO** range of microphone stands has grown in complexity until it is now claimed to be the most comprehensive series available. New this year are a wall/ceiling microphone suspension, a folding legged floor stand and a selection of cable drums. This equipment is detailed in a comprehensive eight page leaflet which will be available on request. The Keith Monks disc cleaning machine will be seen in the company of audio mixing units by Rodek.

As well as their existing range of loudspeakers, **LOCKWOOD** plan to show their new *Gemini* series comprising models *Major* and *Minor*. The former is rated at 80W, the latter at 160W, and both are understood to accommodate four drivers. Somewhat smaller is the *Mini-Monitor* which can be supplied with internal 25W power amplifier if required. For both home and studio applications, the Lockwood *Academy*. Lockwood's recently designed *LPD* loudspeaker protection device should arouse the interest of all who have lately lost cones. Briefly, Lockwood declare, it is an active delayed action latching positive temperature coefficient element . . . and adjustable at that. Programme quality is claimed to remain unaffected below the preset sensor level.

In addition to Amcron power amplifiers, **MACINNES** are this year to show a selection of Klipsch loudspeakers for which they are now the sole British agents. Headphones by Telephonic and Maclab's *High Power Driver* loudspeaker will also be seen.

Getting press information out of Tom Reps, alias **MAGNETIC TAPES**, is like squeezing blood out of a stone. 'Haven't you seen our advert?' comes the question. Negative—separate offices, separate floors, separate brains; editorial/advertising collusion helps nobody. Having said which, details of the proposed Magnetic Tapes APRS exhibit may be found in their advertisement elsewhere in this issue. Two points they don't mention are the fact that Chilton mixers are available on express delivery at £25 above list price. Secondly, that the company are not pushing their 27 cm NAB tape machine this year as too many orders could be embarrassing.

A new mixer input module with three-band equalisation, echo send and pan is to be displayed by **MILLBANK.** Rack mounting power amplifiers in the *C* series are also offered by this company in 30, 50 and 100W formats. Millbank claim a unique overload protector for this series and have indeed demonstrated this at past London exhibitions. The established *MCC Mk 3* ten input modular mixer and *MEX 1021* mains/battery integrated 100W amplifier will be displayed together with a new broadcast announcement machine.

3M, who we unforgivably overlooked in last year's APRS exhibition report, are not to be so treated again. As well as their established Scotch recording tapes, 3M(UK)Ltd are to show several developments new to this country. As representatives for Automated Processes, they plan to demonstrate a four channel API automated mixing console. API's *Maglink* synchroniser will also be shown; this is capable of storing up to 1,200 cues with an offset capability of 31 hours and can synchronise up to six slaves. From 3M themselves, a stereo/two channel console version of the *M79* will be seen. Adding sound to extant broadcast video recordings usually requires investment in a quadruplex vtr. 3M's new 50 mm layback head avoids the need for this expenditure (see photo) and will be displayed alongside two items of audio test equipment: a flutter meter and tape recorder test set.

MSR are currently developing a quadraphonic version of their *2000* disc lathe though this is not expected to be ready for this year's exhibition. Main features of the *2000* are a 406 mm direct-drive servoed platter and varigroove facilities. An Ortofon *G0701/GE701* cutting amplifier and *DSS661* stereo cutterhead are incorporated, operating to DIN and RIAA standards.

As last year so this year **NEVE** will occupy stands 50 and 51. The company hope to

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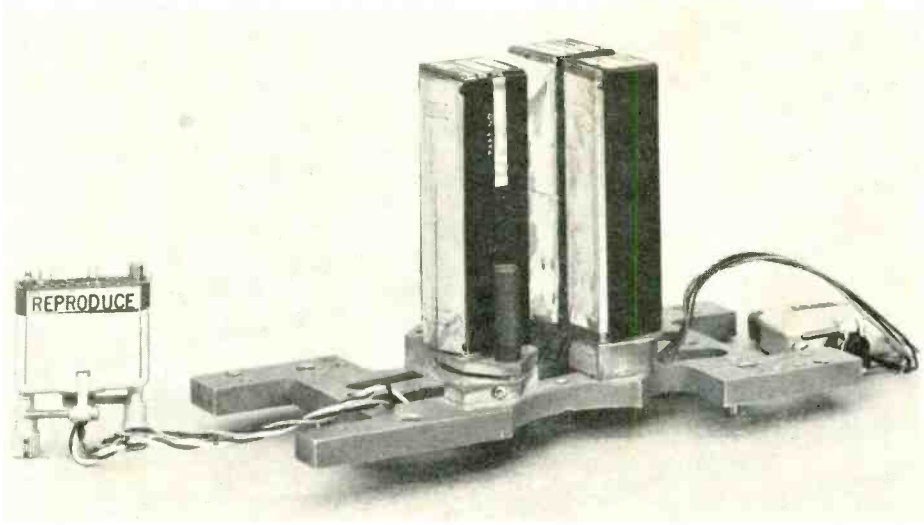
3M's new layback head.



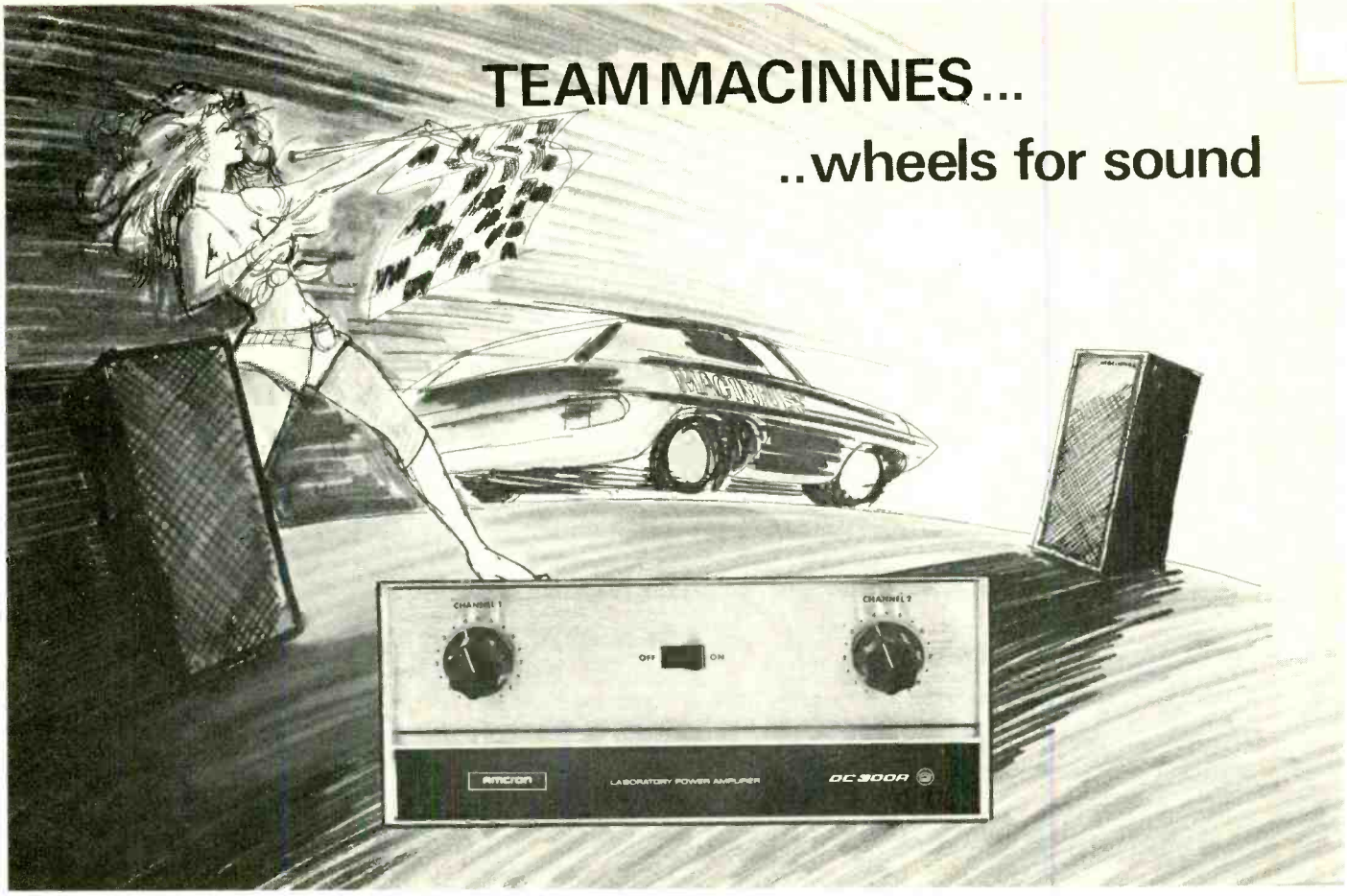


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exhibit a newly designed console for installation in outside broadcast vehicles, based on modules in the *3000* series. A 44 channel console incorporating these modules was supplied recently to the BBC (see photo).

NTP manufacture modular audio mixers ranging in complexity from music mastering desks to compact communications systems. The latter are in turn of modular construction and are supported by a range of active units including the *330-500* microphone amplimiter, *330-700* test generator, *177-600* ppm and *330-600* loudspeaker amplifier.

CJ86 is the designation of a new studio tape to be introduced at APRS '74 by **PYRAL.** Described as a low noise tape of exceptional stability and consistency, *CJ86* is being produced in 6.25, 12.5, 25 and 50 mm nominal widths. Also on show will be the Pyral range of video tapes, audio cassette feeder and lacquer discs.

A 30 input 24 track mixing console in the new *Series 2* family will be exhibited by **RAINDIRK;** APRS '74 visitors wishing to see a custom-built Raindirk desk in action will be able to arrange appointments for the 200m trip to Kingsway Studios. The m is metres, not miles. For location work, Raindirk have developed a compact console having facilities for 10 or 20 inputs and four output groups.

A new series of audio mixing modules is to be exhibited by **RICHARDSON ELECTRONICS.** Improved construction has resulted in a smaller and lighter plug-in assembly 'without sacrificing the well-known performance'. Richardson believe their design will set a new standard (see photo), the elimination of cables 'making servicing quicker and easier if this should ever be necessary'. Other Richardson products to be shown include a tape transport control module and a series of audio power amplifiers.

Custom-built mixers for small studios, public address and hospital broadcasting are the **RUGBY AUTOMATION CONSULTANTS** speciality. RAC are also geared to supply low-cost small-quantity audio modules. New to this series are a test oscillator and limiter/ducker.

Two new items in the **SHURE** selection of compact audio processors. The *M625-2E Voicegate* holds microphone output at a level some 16 dB below unity until the voice channel is excited, thereby reducing ambient noise and the risk of feedback. Model *SE30-2E* is a gated compressor/mixer providing up to 40 dB compression with a ratio in the region of 10:1. Pumping problems are minimised by a memory circuit which holds the compression at a fixed ratio in the absence of the desired signal. The unit has three balanced inputs suitable for microphone or line, plus a 1k Hz oscillator. Power is derived from 240V ac mains with automatic switchover to internal battery in the event of mains failure.

Acoustic screens are the speciality of **SONAPLAN,** a newly formed company attending their first APRS exhibition. Taking the premise that a brick wall makes the best acoustic isolator/absorber, they have developed a variety of high density acoustic screens.

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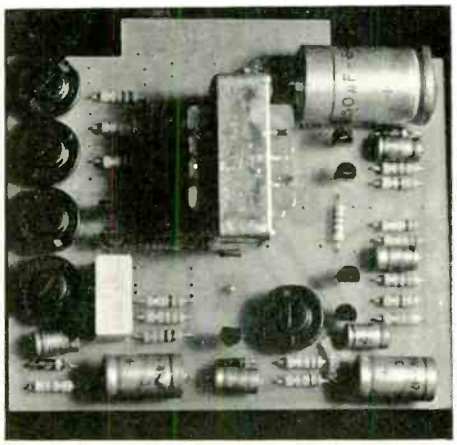
Above: Neve's 44 channel console.

Right: Richardson's plug-in assembly.



Below: Electrosonic custom-designed sound control suite for Arena Theatre, Sherman Theatre, Cardiff (to the specification of Theatre Projects Consultants Limited).

These comprise sisal fabric covered (both sides) inserts mounted on 50 x 25 mm 16 and 22 gauge rectangular steel tube with a 'spray and bake' finish. Three formats will be available: Type *A* being 2.4 x 1m, Type *O* 2.4 x 1m with 1 x 0.8m observation window, and Type *S* 1m².

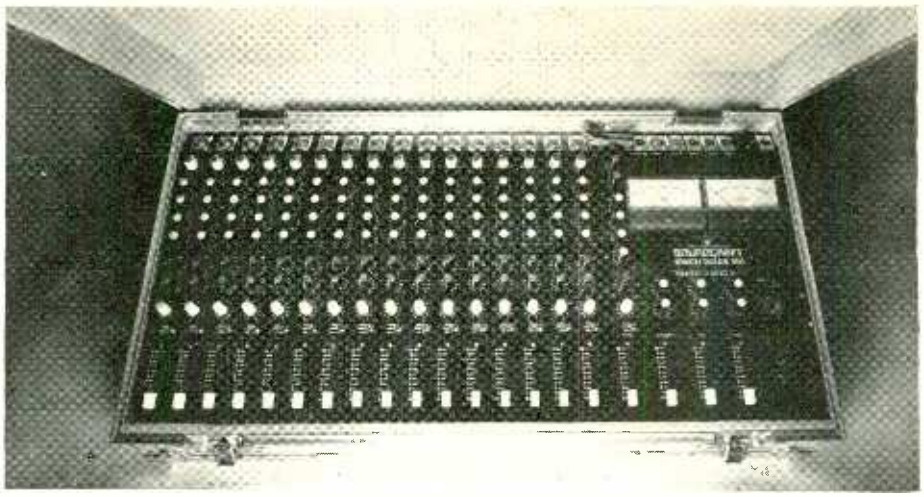
Three sound console systems are to be displayed by **SOUNDCRAFT ELECTRONICS.** A *Mark 6* modular design for 16 and 24 track installations will be seen alongside the already established *Mark 3* available in formats up to eight track. For the location sound and public address engineer, Soundcraft's *16/2* semi-modular mixer includes four-band eq on each channel, one foldback group, one echo send, and VU metering of all inputs and outputs. Price is £975. Teak consoled 10/2 and 12/4 versions are planned for early production.

SOUND TECHNIQUES are this year concentrating their attention on the *System 24* free-standing console, self-contained apart from the stabilised power supply. All audio connections are made through Cannon *XLR* connectors—plugs supplied—to permit rapid installation. VU metering is supplied as standard (16 movements on the *18-8* version), with the option of ppms. An 18/4 monitoring mixer is incorporated, and the desk is designed to permit simultaneous production of independently balanced stereo and quadraphonic recordings.

No new loudspeakers from **SPENDOR** this year, though a company new to the APRS Exhibition. Based in South Nutfield near Redhill, Surrey, Spendor produce two basic designs: the 635 x 300 x 300 mm *BC1* and 800 x 400 x 400 mm *BC3*. The former is rated at 40W input and the latter 70W. Between them is the *BC2*, a 50W derivation of the *BC1*. Prices go from £72 (basic *BC1*) up through £78 (*BC2*) to £148 for the (*BC3*). Internally amplified versions are available at extra cost.

Multitrack tape recorders of elegant external appearance are the **TEKNIK** line, varying from the stereo *2000/2* at £1,500 through eight track *B8* at £5,950 to a *B24* at £12,900. Remote control facilities add £150 to these prices while autolocate adds £500. Tape transport is controlled by two servo capstans in conjunction with dc spooling motors. A 3.81 mm stereo version for cassette quality control is available in the shape of the £2,250 *A2*. Same thing in eight track cartridge formate is the *A8* at £2,500.

The eight track Teknik *2000* fills 781 x 616 mm of floorspace, rising 991 mm. Seven and nine frequency graphic equalisers from the same company run several shades smaller at 152 x 95 mm panel area, 135 mm deep (plus McMurdo connector). Prices here are £165 (seven band), £185 (nine band). Larger and more versatile equalisers are also offered, an example being the *27S* offering 27 third octave bands at £325.



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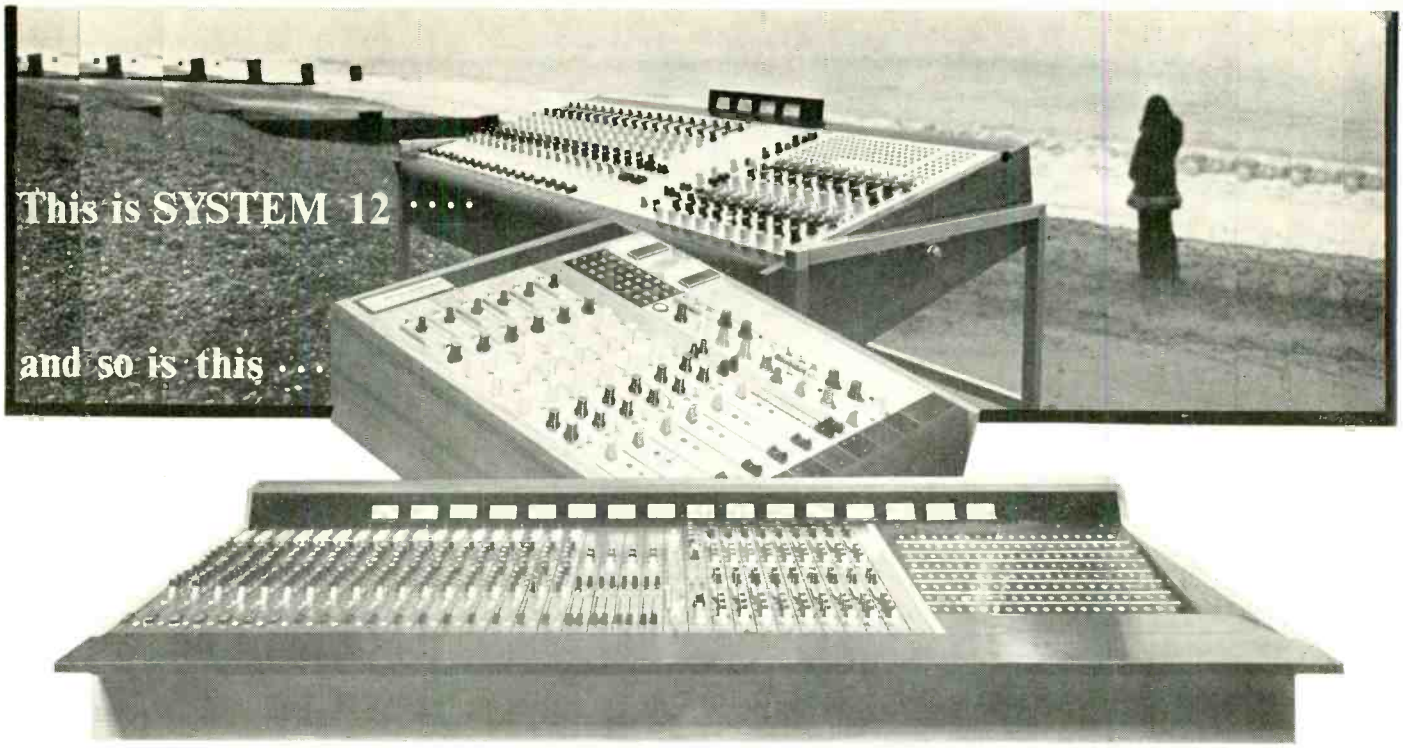

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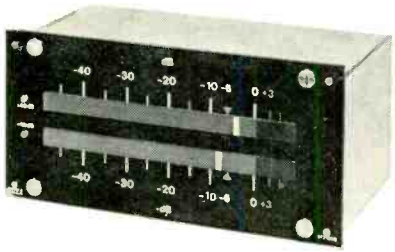

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Some countries accept magnetic recordings as evidence in their courts of law; others do not accept magnetic recordings. This paper reviews some of the problems of detecting recordings which have been tampered with, and in particular the problem of detecting copies of recordings. It is concluded that while some forms of tampering can, be detected, others cannot, with the result that magnetic recordings should be treated with great caution in evidence.

Magnetic recordings as evidence in law*

HUGH FORD

* *Reproduced by kind permission of the Audio Engineering Society of America. Volume 22, No. 4 May 1974.*

DURING THE past year the Watergate Tapes affair in the United States has produced a considerable interest in the viability of magnetic recordings in the courts of law. The press have published the opinions of various 'experts' on the possibility of detecting edits in recordings, which have ranged from looking for discontinuities in the recorded hum to detecting deviations in the reverberation characteristics of the location where the recordings were (alleged) to have been made.

Before examining the possible methods of detecting edits or other forms of tampering with the intelligence of recordings, it is first of all essential to consider the methods by which recordings presented in courts of law are made.

The original recording

The first matter which has a considerable effect upon the possibility of tampering with a recording and upon the chance of detecting tampering is the method by which the recording was made. To an audio engineer the first thing that comes to mind is a recording made in a proper studio under ideal conditions and using first class equipment—I have never heard of such a recording being challenged in court.

In practice I have come across a few recordings made using the Nagra *3* with professional microphones and radio microphones. The British police are using Nagra *SNN* recorders. However, in my experience, the common equipment standard is something like a pocket dictating machine being carried up and down the main shopping street in a briefcase full of rattling keys, rustling papers and anything else that one can think of that makes a random background noise! Just to make life really difficult, it isn't unusual to have an intermittent connection that puts clicks on to the tape or randomly disconnects the microphone. Finally, to add to the difficulties, the recorder's batteries run down during the recording.

I'm not exaggerating the difficulties out of proportion; I have come across all these difficulties and others, but perhaps not all in the same recording. There are of course some recordings that reach a reasonable amateur standard, but the normal quality is poor with unintelligible speech in at least some parts and excessive background noise, which more often than not has a wide frequency spectrum and a large dynamic range.

The law about tapes

At the time of writing the English law allows magnetic recordings as evidence in courts of law, provided that two conditions are observed: (1) Either a tape must be an original recording, or there must be some good reason why the original cannot be produced in court; (2) The continuity of handling of a tape must be fully accounted for from the time of the recording to the time of production of a recording in court.

These two essential requirements originate from the law about the use of photographic evidence and do provide a certain amount of protection against the use of edited recordings or other forms of tampering. However, in practice it is the continuity of handling that bears great weight in court—and this factor depends upon witnesses, who may not be above suspicion, telling the truth.

This is where the expert witness comes on the scene and is faced with the problems of deciding whether or not a recording is in fact an original recording, and in either case whether the recording has been altered in any material way. He may also be faced with other problems such as assisting with making a written transcript of very poor recordings, providing cleaned-up versions of the original tape for replaying to the jury, and most important, advising upon the shortcomings of any recording methods that may have been used.

The latter problem is in my opinion extremely important if proper justice is to be done, because there are circumstances where the likelihood of tampering with a recording is remote, but the method of making a recording can produce deceptive results. For instance, I was recently involved in a case where the police had recorded a conversation in a Rolls Royce car, using a recorder with automatic gain control and the microphone attached to the shirt of one of the two policemen involved. A relatively clear recording was made of the conversation between one alleged culprit and the policeman armed with the recorder and sitting in the back of the car with him. The other alleged culprit was driving the car and said that he did not hear the conversation in the back of the car and did not know what was happening—if he had known he would probably have been found guilty of bribery.

If this recording had been replayed in court without any technical advice, the jury would have been convinced that the conversation was clear and would have been heard by all the persons in the car. But an explanation in court of the function of automatic gain controls and microphone characteristics convinced the jury that the conversation might well not have been heard by the driver; on this evidence he was found not guilty.

The importance of this type of evidence is that the simple explanation of the function of an automatic gain control can not only save a man several years in jail but has also probably affected the pattern of the rest of his life.

Magnetic recordings are not yet very common in the English courts of law and those that do appear have usually been made by amateurs in the field of tape recording. However, while magnetic tape is used by the British police as an *aide memoire*, there is a movement towards using magnetic recordings for interviewing suspects and for recording their statements. It is my opinion that considerable care must be taken if this procedure is to be adopted as, while we are blessed with a relatively honest police force, there are criminals within the police who might be tempted to tamper with evidence.

The final legal aspect that I would like to mention is the likely penalty for tampering with magnetically recorded evidence. At the moment the production of falsified evidence is treated as perjury—that is producing false evidence under oath, which carries fairly severe penalties. Consideration is however being given to the possibility of treating the production of falsified magnetic tapes as forgery which attracts far more severe penalties, because the act of forgery is essentially premeditated.

The problem of tape copies

As has already been said, the English courts of law do not accept copies of recordings

unless the original cannot be produced for a good reason. On the assumption that copies can be detected, this gives a degree of protection against edited tapes being produced, as it eliminates the conventional method of editing with a razor blade and splicing tape.

But—can you detect a well made copy? First consider what you would expect to find if you are presented with a recording which has been made using a new tape on a battery-operated recorder, equipped with the usual automatic gain control. **Fig. 1** shows a pattern of events which is typical; the magnetic tape has a non-magnetic leader and trailer attached by factory-made splices and of standard lengths and colours. The noise level replayed from the tape both before and after the recorded section should correspond to the bulk erase noise for the particular tape type, and the recorded section will commence with a recorded click when the recorder was switched on and terminate with a double recorded click when the recorder was switched off. The recorded signal level will not exceed a certain limit and will be consistent throughout the recorded section. The recording will not contain any underlying tones such as power supply hum, or contain any clicks of an electrical nature.

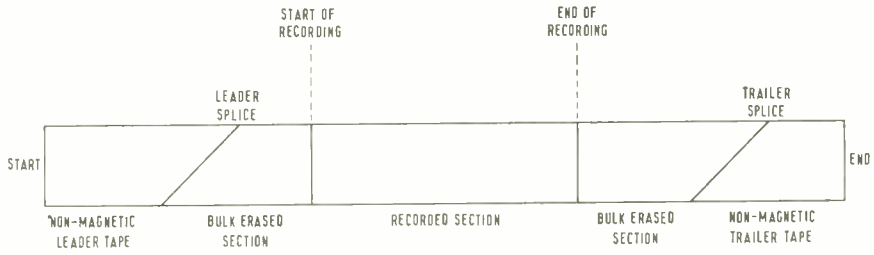
At first sight it may appear to be easy to make a copy tape which will comply with this format; however one must also take into account the circumstances of any given recording. Firstly, it is usual for the make and type of original recorder to be known, and every recorder leaves some individual clues on its recordings. Secondly, recorders do not switch on and off by magic—a person is required to actuate the switch which is usually near the microphone, so there will be a recording of the person moving to the switch and actuating it at the end of the recording, and possibly some similar event recorded at the beginning of the recording.

Provided that a recording sounds as if it is complete in these respects, we are forced to use the following lines of investigation: (1) Do the start and stop patterns align with the recorder used? (2) Are the recorded noise levels right? (3) Does the recording contain hum or other recorded tones? (4) Are the recorded levels right? Is the bias frequency right? (5) Is the recorded format that of the original recorder? (6) Does the tape contain recorded electrical clicks or other signs of interference?

Start and stop patterns

With the exception of some high quality studio recorders, all recorders leave a click pattern recorded on the tape when the machine is started or stopped in the record mode, this pattern differs to a great extent from one type of recorder to another; it can therefore be used to identify a particular type of machine. **Figs. 2** and **3** show the start and stop patterns of a high quality portable recorder and it can be seen that the stop pattern is of particular importance as this gives a clear indication of the mechanical spacing between the record and erase heads of the particular machine. Furthermore, the tape noise around the stop pattern is of particular interest because the noise in the gap between the record and erase heads is bias/erase, and the noise after the erase head is bulk erase noise if the tape in question has not previously been used.

FIG.1 THE EXPECTED TAPE FORMAT



There are several techniques available for recording start and stop pattern click waveforms and the head configuration is not critical on the replay machine for this exercise, the main requirements being that the tape speed should be accurately known and that the oscilloscope or oscillograph should have an accurately calibrated timebase. It is then a simple matter to deduce the tape length between the record and erase heads from the time between the associated clicks.

A storage oscilloscope is a very useful tool for investigating small sections of the recorded waveform, but its use tends to be rather tiresome because of the problem of triggering the timebase at precisely the right time. Possibly an ultraviolet recorder is in many ways a more useful tool. I commonly use a high speed ultraviolet recorder which has a flat frequency response from dc to 25k Hz and a maximum paper speed of 1.6 m/s together with timing markers available at down to 10 ms intervals. Such a device saves much time investigating waveforms because of the virtually unlimited length and rapid availability of the record.

The only shortcoming of the ultraviolet recorder is that the available timebase speeds are too slow for analysing fast transients. For this purpose one has to resort to the storage oscilloscope, the use of an analog/digital store, or to using photographic cinematograph film in an oscilloscope camera. The latter is however a very tiresome occupation because of the problem of rapidly processing the photographic film.

There are however various tricks for triggering an oscilloscope at precisely the right time without having to interfere with the original recording, which is normally strictly forbidden. The basic trick is to place an optically opaque marker on the periphery of one of the tape spools and to use a photoelectric pickup to detect the position of the marker. It is then possible to move the photoelectric pickup to a convenient place around the periphery of the spool, and to use its output to trigger the oscilloscope or other recording device. Using this technique it is possible to trigger within a few tens of milliseconds of the desired point without undue difficulty. A further refinement is to use this technique in conjunction with a delayed timebase oscilloscope. It is then possible to select the desired trigger point within a millisecond or so, in spite of variations in tape winding tension and stretch.

Using these techniques it is an easy matter to determine the start and stop waveforms, and to determine from the latter the record/erase head spacing. The actual shape of the stop waveform is also significant because it varies not only from one recorder to another, but also gives some indication of the type of erase head used (such as single or double headgaps). The type of start waveform is somewhat more difficult to analyse, but here it is possible to compare the waveform with a typical start waveform of the type of recorder which was

FIG. 2

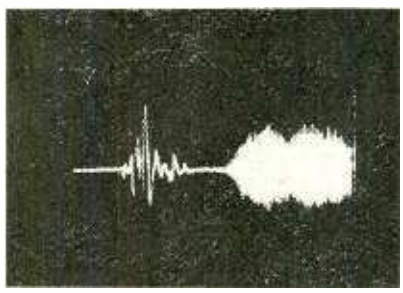
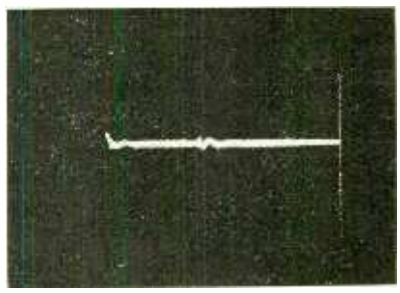


FIG. 3



said to have been used for the original recording. Not only must regard be given to any click waveform present, but it is also quite feasible to obtain some idea of the start time of the recorder.

So much for the actual waveforms; the next matter of great importance is the recorded noise levels both within the apparent recording and around the stop pattern.

Are the noise levels right?

When analysing a tape recording for originality you are concerned with a number of different noise levels. These are: the bulk erase noise of the tape used; the bias/erase noise which is the noise level from tape when it has been passed over the record and/or erase heads of the recording machine alleged to have been used and when it is in the record mode but without any audio input signal; and finally the recorded background noise throughout the audible recording.

The relation between bulk erase noise and bias/erase noise is fundamental to the analysis of recordings and should be clearly understood. The bulk erase noise level is the noise level commonly found to exist on new and unused tapes and it is consistent to fairly close limits within a tape type. Bulk erase noise is the tape noise resulting from passing a tape in an open magnetic circuit through a saturating alternating current magnetic field which is slowly reduced to zero intensity. These conditions are met by the common types of tape bulk eraser which erase tapes out of contact with the ferromagnetic circuit. Bulk erase noise is always less than bias/erase noise which is added by passing a tape through a slowly decreasing alternating current magnetic field in a closed magnetic circuit—such a condition is met when a tape is in contact with the erase or the record heads of a tape recorder set to the record mode and without any audio input signal.

In practice the tape recorder may also add further noise from two sources: firstly, many erase oscillators have a significant even harmonic distortion content which in effect records a direct current signal on to tape with the resulting addition of modulation noise; secondly, it is not unknown for the tape recorder's record amplifier to add further noise. For the purposes of this paper the total measured noise resulting from the tape being recorded with no audio signal input will still be called bias/erase noise, but it is important to note that this bias/erase noise will vary in level from one recorder to another. It is also useful to note that the bias/erase noise introduced by a recorder is normally at virtually the same level when the tape has passed over both the record and erase heads, or when it has passed over either head alone.

Depending upon the alleged history of a recording it is necessary to decide upon the significant points for analysis, but rather surprisingly the unused section of a tape is an extremely important part. As I have already said, it is no easy matter to make a tape copy with the correct stopping conditions, and one way to eliminate this problem is to copy a tape in its entirety and subsequently to remove the bias/erase noise after the off click of the original recording. At first sight it would appear to be virtually impossible to bulk erase a tape up to the point precisely coincident with the off click. There is, however, a very simple way in which this may be done, but it may leave a footprint.

All parts of a tape which should contain bulk erase noise should have a graphical recording of the noise made throughout their length, using a replay machine with the correct replay head width and a good replay amplifier with an adequate margin in signal-to-noise ratio. The use of other replay track widths may also give valuable results. The resulting plots of tape noise should naturally be consistent in level and exhibit a tape noise level which agrees with the bulk erase noise of the tape type. It is then vital to look in further detail, and it is my practice to do several third octave spectrum analyses along the length of the unused section of a tape and to make sure that they are consistent. Any inconsistency must be investigated in further detail, and **fig. 4** shows what may be found—periodic bursts of 30 Hz tone along unused tape!

In this instance the tape manufacturer was able to find several other reels of the same batch of tape, but none of them showed the 30 Hz bursts. Other tapes involved in the same court case did have 30 Hz bursts in the alleged unused sections which should have shown only bulk erase noise, so this became a great puzzle, particularly because the bursts were at a level well below bulk erase noise.

After much experimentation we were able to reproduce this peculiar feature by copying tapes on Nagra *3* recorders (which had been used for making the alleged original recordings) and by removing the bias/erase noise after the off click by passing the tape over the recorder in the record mode, but with a layer of adhesive tape over the erase head and the record head bypassed. The latter operation produces bulk erase noise because the tape is in an open magnetic circuit, but the strength of the erasing field is such that it does not completely erase long wavelength recordings, such as the 30 Hz. The 30 Hz originates from the servo system of the replaying Nagra *3* and is present in the replay output in burst depending upon tape tension and is, of course, copied on to the copy recording made by the second machine.

This theory of copying produced much consternation in court, but the only explanation that the other side could offer to explain the 30 Hz tonebursts recorded on apparently bulk erased tape was that they were the result of a 'little leak'.

While a defect in a recording such as this is completely inaudible at the normal tape speed, it is clearly audible at higher tape speeds. It is therefore always a wise precaution to replay tapes throughout their length at both higher and lower tape speeds than the nominal speed, as this will make infrasonic or ultrasonic tones audible—this precaution includes listening in the fast wind mode at really high tape speeds.

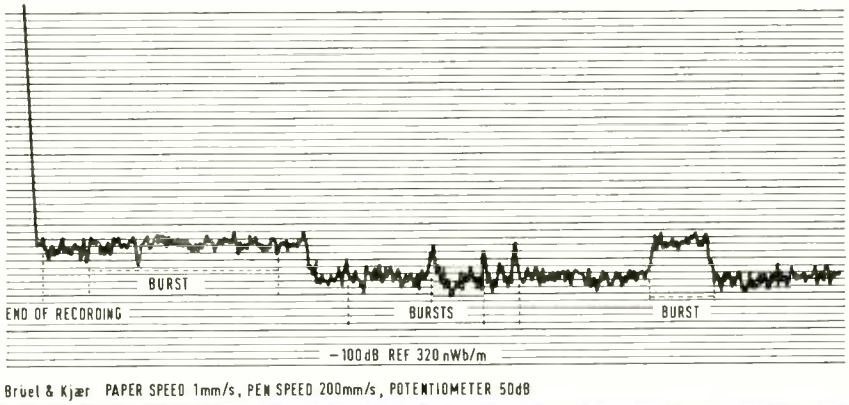
This leads to the problem of determining the noise level between the off clicks of the record and erase heads; at the correct tape speed this gap occupies a very short time, with the result that measurement of the noise level may be virtually impossible even when using a high speed level recorder. However, operation at a lower tape speed will normally solve this problem so that the expected bias/erase noise can be checked. Another method that is useful for investigating the noise level near large amplitude signals is to run the tape backwards so that the section of tape of interest occurs before the large amplitude signal, thus avoiding saturation of the measuring equipment.

The background noise level within the recorded section of a tape should also be checked throughout the recording by making a continuous recording of level with a high speed pan recorder, and using a lowered tape speed to investigate any sections where there are any short-term drops in level. Should the noise level drop below the expected bias/erase noise level at any time this is a clear indication of some form of interference with the recording, if the tape coating is intact at the point of interest.

Hum or tones within the recording

At first sight a recording which has been made with a battery-operated recorder away from the public electricity supply should not contain 50 Hz hum—this however may not be the case. In fact many recorders use capstan servo systems which operate by using tachometers in conjunction with various forms of frequency comparison, and it is not uncommon for tones from these systems to be recorded at very low level on to tape. Such tones are normally at extremely low levels in the record section of a recorder, but at much higher levels in the replay output; it follows that the presence

FIG. 4 TONE BURSTS REVEALED AS THE RESULT OF NARROW BAND ANALYSIS



of such tones under a recording is a very important matter when investigating recordings and provides a useful tool for detecting copies.

Because of the low level at which these tones are present on tape any analysis requires the use of very narrow band filters which must also have a wide dynamic range so that they do not overload during heavily modulated passages of the audio recording. However, there is a limit to the minimum bandwidth that can be used because of the inherent wow and flutter in any recording, which may put originally constant frequencies out of the filter bandwidth.

A further matter which always warrants investigation is any mains frequency hum within a recording but this line of attack must be approached with great caution as it is all too easy to come to incorrect conclusions about the characteristics of the recorded hum. For instance, a change in hum level coincident with a phase change in hum may be regarded with great suspicion. However, a little thought shows that this can be a result of perfectly normal circumstances, such as the total recorded hum being caused by a number of hum sources and one of them being switched off. Similar apparent defects may also be caused by variations within the public electricity supply as a result of changes in supply routing or switching of heavy motors. It follows that the detection of sudden changes in level or phase or recorded hum are not in themselves indications of tampering with a recording, but do indicate points in a recording worth further investigation by other means. Cyclic changes in recorded hum level are a slightly different matter and can be the result of adding hum when copying a recording which already contains hum, but here again there are quite innocent origins which must be considered, such as the mains frequency beating with the recorder's tape speed servo tones—naturally such investigations demand the use of replay equipment which itself introduces negligible hum or other tones in its replay output.

Recordings of telephone calls present the worst difficulties in these respects, as telephone systems commonly have fairly high inherent hum levels which may or may not bear any relation to the hum which is often simultaneously induced from the public electricity supply, at very high levels if an inductive pickup coil has been used.

Recorded levels and bias frequency

The analysis of the recorded level in terms of a standard reference level is best carried out by means of a high speed level recorder, and it is my practice to make up to four runs of the tape so that unweighted level and 'A' weighted level are recorded on paper in such a manner as to show both the recorded peaks and the minimum recorded levels with a clear resolution of better than 1 dB. From these results it is possible to note any sudden changes in level which do not correlate with the conditions of the alleged original recording; in particular any breaks in the recording where the noise level approaches either bias/erase noise or bulk erase noise become clear so that further investigation can follow. Such apparent breaks in continuity can be investigated in detail by operating at reduced tape speed, which is particularly valuable if the breaks occupy a very short time.

Normally it is quite clear from listening tests if any automatic gain control has been used during the recording, but a combination of a level recording and listening tests is certain to decide if this is the case.

Where it is apparent that an automatic gain control has been in use the peak recorded levels should be consistent if adequate record gain was available at the time of recording, and this matter can be readily confirmed if one has knowledge of the original recording conditions and the equipment used, if necessary by simulating the alleged original conditions and making sound level measurements.

In some instances a statistical analysis of the recorded level may serve to confirm changes in the long-term recorded level, where it is apparent that an automatic gain control was in use and that adequate sound pressure levels were available at the time of the original recording.

Finally, there is the matter of the recorder's bias frequency, and while I have seldom found this to be a useful matter to investigate, it is worthwhile to attempt to extract the frequency of the recorded bias waveform by running at lower tape speed. Should it be possible to determine the bias frequency, which is unusual where the recording speed was less than 19 cm/s, this may be used as a further check upon the authenticity of a recording. Furthermore, the bias frequency should be sensibly constant throughout a particular recording if it was made with a single machine without breaks.

The recorded format

The recorded track width and the possible presence of a pilot tone track (as used for synchronous film recording) is one of the more obvious factors that may be confirmed, but only to reasonable accuracy without using destructive methods of investigation.

The safest method is to use a magnetic tape viewer which is a commercially available item and consists of a suspension of ferromagnetic particles which are contained behind a very thin non-ferrous diaphragm. The entity is placed on the coated side of the tape, with the result that the ferromagnetic particles align with the recorded flux, thus giving a visible indication of the recorded format depending upon the recorded level and wavelength, but it is a particularly useful method where black coloured tape coatings are involved because they form a poor background for observing by other methods.

A more accurate method is to apply a mixture of carbonyl iron and a rapidly evaporating liquid which must not be a solvent to the tape coating. This then leaves a deposit of carbonyl iron particles aligned with the recorded flux on the surface of the tape and shows the precise location of the recorded tracks; however caution is necessary to ensure that the tape coating is not damaged, and some visible marking may be left on the tape at the point of investigation.

Clicks and other forms of interference

As any recording engineer is well aware there are two sources of audible clicks; those from electrical interference, and those associated with poor editing. So far as tape copies are concerned either of these may occur, and there is a third form of click that may be introduced at the stage of either the original recording or that of the copy—this is an audible click that is associated with sudden variations of level together with the use of poor automatic gain control or limiter time constants.

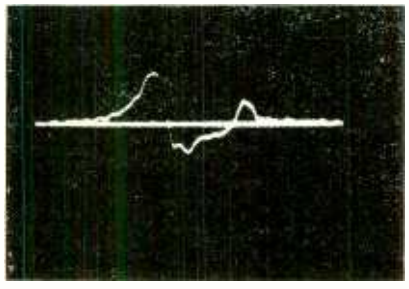
During the analysis of any form of audible click it is vital that the replayed risetime should correspond to the original recorded risetime, hence the correct replay equalisation time constants must be used and the replay azimuth must be as near as possible correct. The latter factor implies that the minimum available track width should be used for replaying the tape, consistent with a reasonable signal-to-noise ratio.

It is then possible to photograph the rise time of the recorded click with a good degree of accuracy, and should the rise time be outside the bandwidth of the original recorder this would be grave cause for suspicion. For this type of analysis it is of course vital that the original recording should be used, because any attempts to define click rise times from copy tapes are meaningless.

Other matters giving cause for suspicion are highly asymmetrical click waveforms which cannot form a part of music or speech (which has a worst case of asymmetry in the order of 8 dB), and click waveforms which form single cycles of a frequency which is alien to the adjacent waveform.

The methods for the analysis of clicks are identical to those for the analysis of the start and stop patterns; however the associated bandwidth must be somewhat larger to accommodate the fast risetime wave forms that are associated with purely electrical clicks which can be introduced by some forms of editing. It may however be surprising that even 90 splices made with a magnetised razor blade give a slow waveform in comparison with normal music or speech waveforms (fig. 5).

FIG. 5



The genuine (?) original tape

The previous tests give a reasonably good chance of detecting a copy tape, but I am sure that someone with a knowledge of these and other techniques could produce a copy that would pass as an original unless it were subjected to an extremely time-consuming examination which would not normally be financed by the courts of justice.

The conventional professional form of editing implies splicing a tape, and such a splice involves about 12 mm—hence the common methods of editing require that a

58▶

copy tape be made, and there is a good chance of detecting such a copy.

Assuming that professional editing methods cannot be used, one resorts to amateur editing methods, which when they do not employ splicing are concerned with starting and stopping the recorder at appropriate times. If this has been done without any precautions, substantial clicks will be left on the tape at any points where the recorder has been switched into or out of the record mode. Such clicks can be readily analysed by the methods already described and are obvious signs of tampering. However this form of editing can be easily accomplished without leaving recorded clicks on the tape. This is done by using the pause control which is fitted to many recorders—the desired editing point is marked on the tape with a wax pencil and the tape moved by hand a few centimetres in the forward direction; the recorder is then put into the record mode and the pause condition and the tape rewound by hand to the desired editing point with the result that the clicks produced when the machine was switched into record are erased. The recording is then started by releasing the pause control, which with many recorders gives a remarkably fast start time in the order of only a few milliseconds.

If this type of editing is carefully done it can be extremely difficult, if not impossible, to detect. As with other types of edit the clue lies in any variations of recorded level, noise or tones, at the editing point. Furthermore, it is wise to make a careful inspection of both sides of the tape at any point where editing is suspected, as well as observing the recorded tracks with a tape viewer or carbonyl iron suspension. **Fig. 6** shows the result of the inspection of a tape which was involved in criminal proceedings. It was found that the location of an editing mark with respect to the defects in the recording bore a precise relationship to the spacing between the heads of the recorder which was known to have been used.

Other forms of deception that may be used are the removal of parts of a recording by erasure, simply switching the recorder on and off, and finally the loss of complete reels of recorded tape which, while not exactly in the province of engineering, provides a very effective form of editing.

Overall it is necessary to treat each particular recording on its own merits, and to devise checking methods that are appropriate to each case. However, while carefully made copies of an alleged original tape may be used for limited investigation, it is vital to check every parameter on the alleged recording, because any copying process must essentially produce some degradation of the recorded quality, such as degradaton of signal-to-noise ratio, distortion of the frequency spectrum which alters the risetime of click, addition of hum and loss of bias frequencies.

During the examination of alleged original tapes every possible precaution must be taken to avoid any form of interference with the recorded signals. It is therefore vital that replay machines must be in good mechanical condition and have their tape path demagnetised every time they are used. Furthermore, the record function should be permanently inhibited. I refuse to examine any recording which is involved in court proceedings unless there is a responsible witness present while the tape is in my possession. Likewise, the British police do not permit examination of tapes that are in their safe keeping unless they are accompanied by a police representative.

Generally your own ears provide the most powerful tool for investigating recordings, and any points that sound wrong or in any way suspicious should then be subjected to detailed analysis by other means. Even then there may be endless argument about the interpretation of results, the classic case being the apparently truncated word which sounds wrong. This can be the subject of every form of analysis including oscillograms and spectrograms (voice prints), the sole effect of which is to produce a heated debate between speech experts who will fail to agree whether or not the decay rate of the waveform is natural, but agree that identical results could be produced by a 45° splice in the tape.

Should tape be used in evidence?

It is my opinion that magnetic recordings should never be considered as being reliable evidence, because I am convinced that it is not very difficult to produce edited recordings that will pass the most stringent tests without edits being located.

This opinion is supported by all the engineers with whom I have worked in this field, and is further supported by the only experimental trials that have to my knowledge been undertaken in this field. These trials were undertaken by the Canadian Broadcasting Corporation and involved a number of experts in Canada and the United States. The outcome was that some edits were detected, and some edits that did not exist were 'detected'.

In the light of this knowledge I hope that those countries that have so far not arrived at the stage of accepting magnetic recordings as evidence in courts of law will take the precaution of rejecting magnetic recordings as any reliable form of evidence.

Unfortunately, many countries have accepted magnetic recordings as evidence in courts, with the result that police forces and other official bodies are tempted to make use of magnetic recordings for obtaining evidence and for recording interviews with suspects. Where such use of tape cannot be avoided it is important that recordings should be made to make the investigation into the authenticity of such recordings a straightforward operation.

If only investigators would commence their recordings with a recorded message of day, date, time and place, end their recordings with the same identity without any break in continuity, and use new bulk erased tapes, the verification of tapes would be much easier.

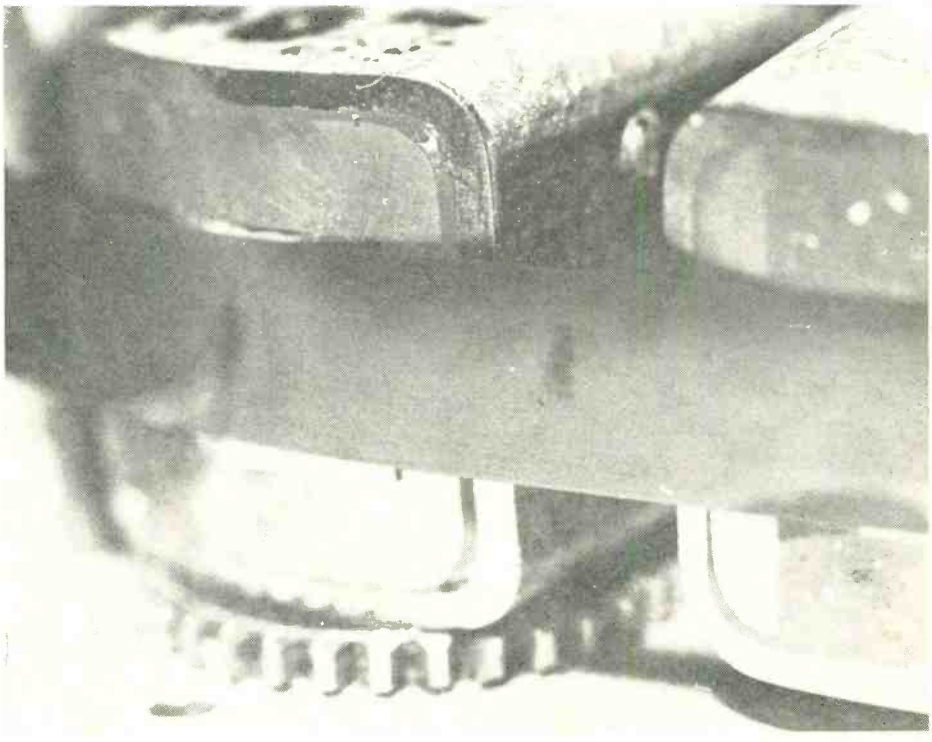
Conclusion

In this paper I have outlined some of the methods which I have found from experience to be valuable tools for investigating the authenticity of magnetic recordings.

The methods presented are by no means a complete summary of the techniques that I have found to be useful, but do present the major methods that should be considered for use on any recording. Individual recordings which have been made on various types of recorder will dictate the use of other methods, with the result that it is essential to treat each tape on its own merits.

Finally, I emphasise that no claim is made that edited tapes can be detected—some can, but my colleagues and I are firmly of the opinion that it is currently impossible to detect some edits.

FIG. 6



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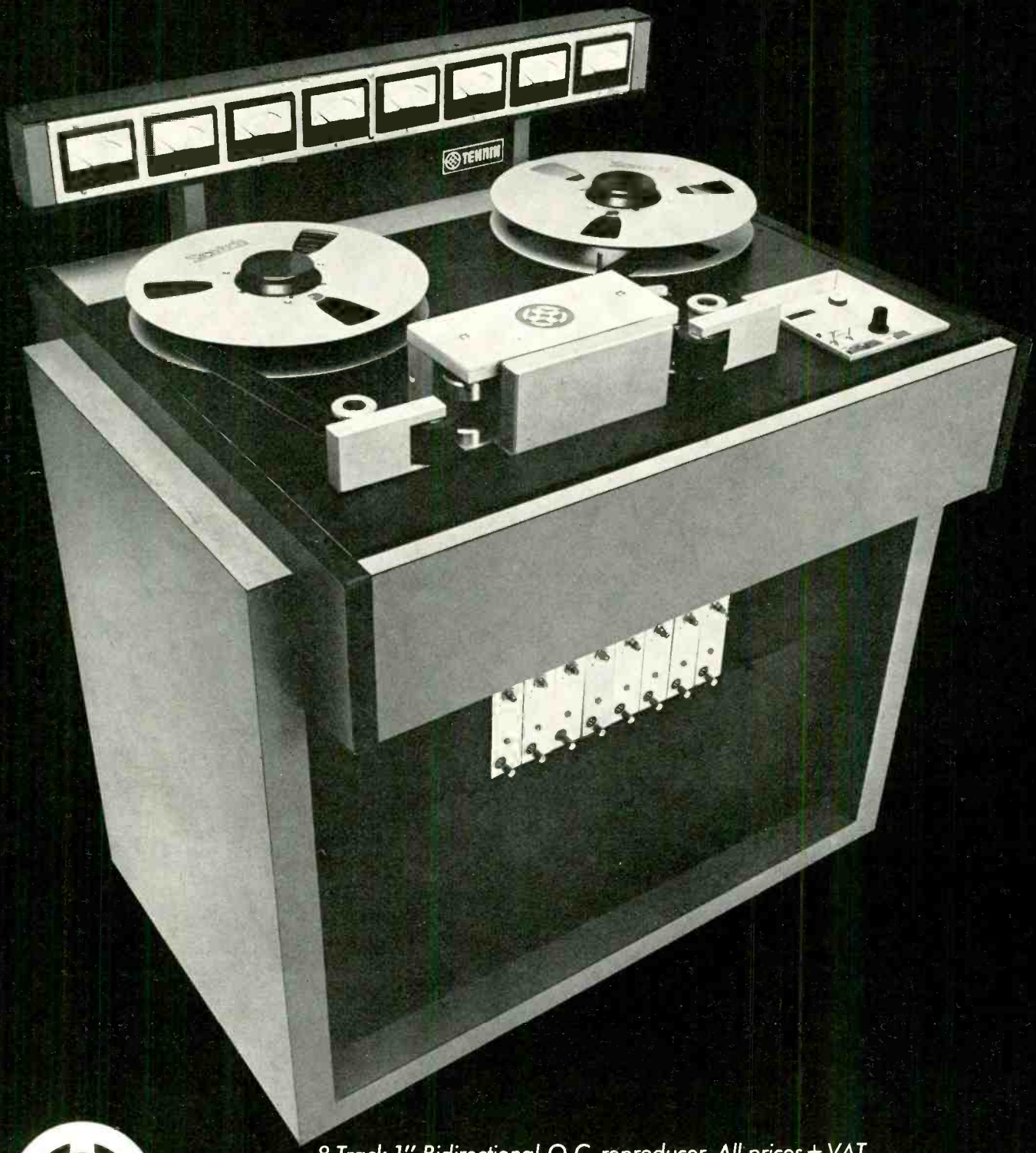

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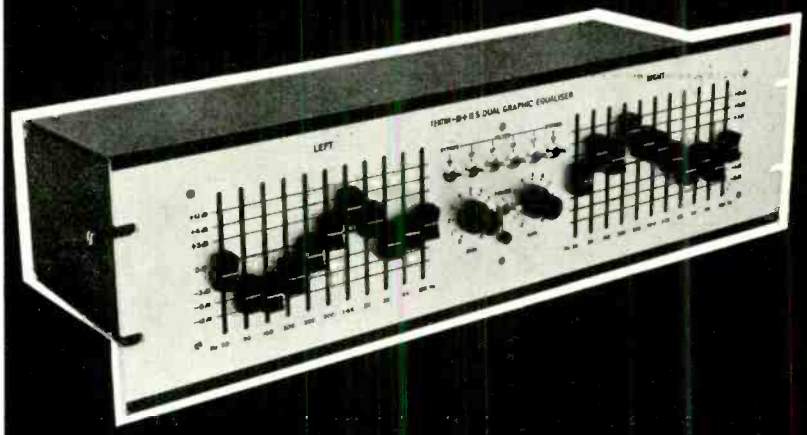

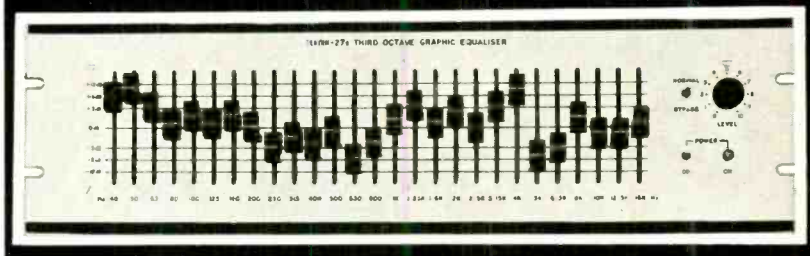

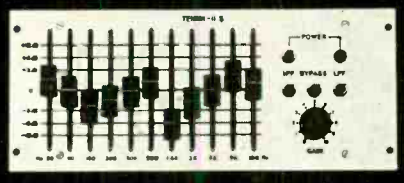

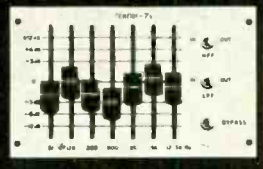

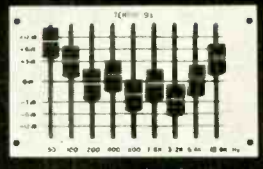

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Phone: 0480 64388.

Peak programme meter

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Power requirement: 24V, 20 mA.
Input: —20 to 0 dB at 20 kΩ unbalanced.
Movement: Ernest Turner *702* or *703.*
Meter markings: Black dial with white markings and pointer. Printed wiring board mounts directly on meter terminals.
Dimensions: 76 x 112 x 58 mm deep.
Price: £42.

KEY

Key Electronics, PO Box 7, Bournemouth Hampshire BH7 7BS.

PPM1a driver

Specification: 1 mA full scale deflection into 600Ω meter movement to BBC *ED1477* or BS *4297/1968.*
Power requirement: 24V, 20 mA.
Input: 16 kΩ impedance in series with 1 μF or 600Ω ±5% with input resistor connected.
Dimensions: 89 x 43.5 mm printed circuit card x 18 mm deep. 3 mm fixing centres at 79 x 53.5 mm.
Price: £15.60 (1 to 9) or £14 (10+).

PPM2

Specification: BS *4297/1968.*
Power requirement: 24V, 12 to 15 mA.
Input: 25 kΩ impedance from 40 to 15 kHz (transformer isolation).
Movement: Ernest Turner *643.*
Meter markings: Black dial with white markings and pointer. Optional BBC or EBU scale.
Dimensions: 112 x 78 x 60 mm.
Price: £42 (1 to 9) or £37 (10+).

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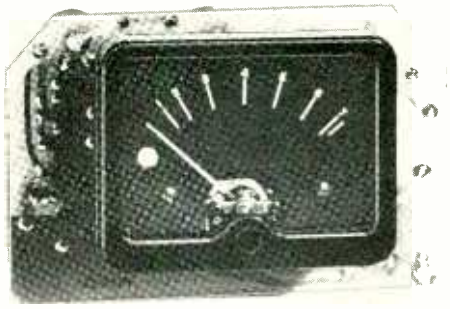

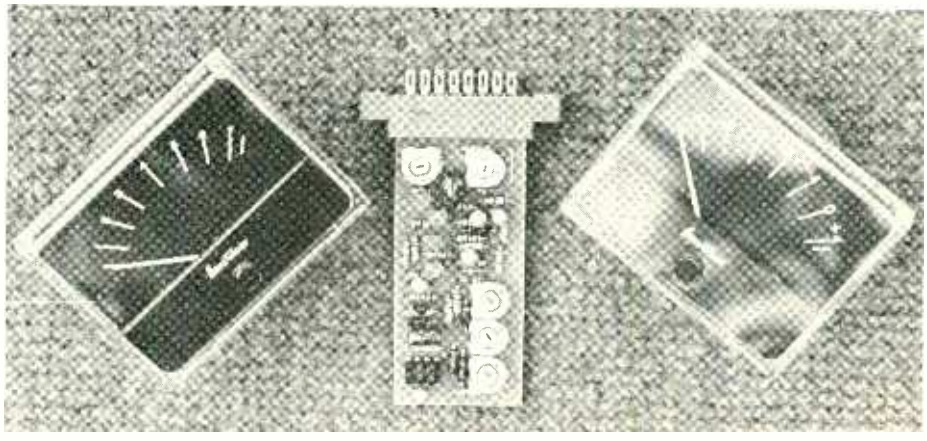

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Right: Key ppm.
Adjacent: Surrey Electronics ppm.

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PPM 74

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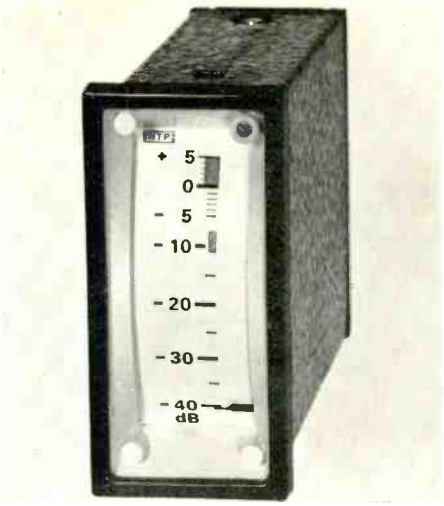

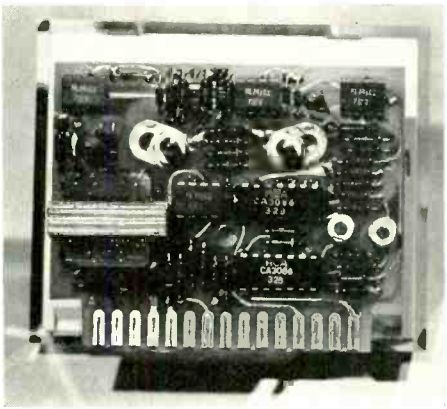

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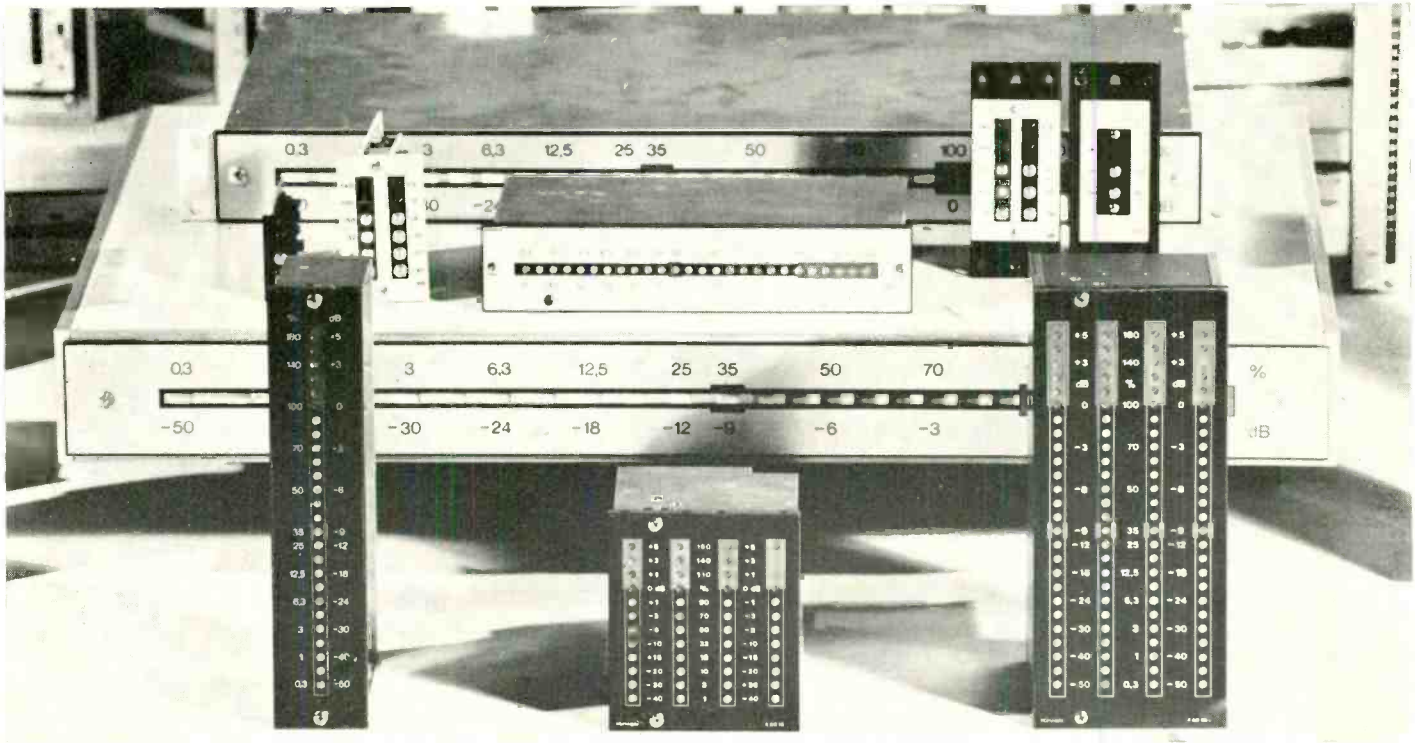


More nonsense has been written on the subject of ambisonics than on any other aspect of audio. Absurd ideas have even been put into commercial practice—typically the deployment of four independent audio channels to create a 360° surround on just one plane. Three channels can easily be proved to suffice for this purpose, leaving the fourth channel either redundant or free to carry vertical information. Which leads inevitably to the question: Who wants it anyway?

The synthesis of n-channel ambisonic sound

JAMES CRABBE

THE CONCEPT of 'ambisonics' may briefly be stated as giving the listener the feeling that he is immersed in the actual performance of a piece of music, and comes about through the realisation that naturalness in a recording is determined more by the directional qualities of the reverberant sound than by the spatial positioning of the performers. Thus, using the definitions of n-dimensional sound that I have suggested previously (ref. 1) (see **table 1**), one could say that theoretically either monophonic, pantophonic or true stereophonic sound could be ambisonic; however, as monophonic sound is reproduced in only one dimension, pantophonic or true stereophonic sound is much more effective in reproducing the qualities of directional ambience. That is not to say that monophonic sound cannot be treated to give it a greater ambisonic atmosphere, and this article hopes to show some ways whereby music recorded in mono, or two channel stereo, can be electronically processed to create a more vivid impression of naturalness in the recording.

Attempts at reprocessing old mono recordings into two channel stereo pressings are rarely, if ever, successful. Unfortunately, it became more commercially viable to sell stereo records than mono re-issues, so companies produced the electronically reprocessed mono records. Most of these, even some recent ones produced in the last year or so, sound as if treble boost had been applied to one channel, and bass boost to the other, giving a most unnatural disembodied quality to the sound. With such recordings, the original mono pressing sounds much better.

To approach a more reasoned way of making recording appear more natural, it may be useful to consider three aspects of sound production:
(1) Frequency ranges of instruments, (2) characteristic frequency spectra of instruments, (3) the required ambient setting of each instrument or group of instruments in any given piece of music, paying due regard to the period and style of playing.

Table 2 shows frequency ranges (including harmonics) for the violin, double bass, trumpet, tuba, clarinet, flute and xylophone. One can see at a glance that the double bass produces sounds lower in pitch than the violin, and the same applies for the tuba and trumpet. However, what is more important in determining the sound of an instrument than ranges of frequency is the instrument's acoustic spectrum. **Fig. 1** shows the acoustic spectrum of a B♭ clarinet playing 233 Hz (ref. 2). This frequency is the dominant one in the spectrum, although there are many prominent odd harmonics. **Fig. 2** illustrates the spectrum of a transverse flute playing 392 Hz, showing a strong fundamental with regular harmonics diminishing at a uniform rate, thus giving the flute its characteristic clear pure tone quality. By contrast, **fig. 3** gives the acoustic spectrum of a tuba playing 49 Hz, which shows that this instrument has very rich harmonics. Thus,

TABLE 1

ONE DIMENSION	TWO DIMENSIONS	THREE DIMENSIONS
MONOPHONIC SOUND	PANTOPHONIC SOUND	STEREOPHONIC SOUND
SINGLE CHANNEL	4 CHANNEL QUADRAPHONIC SOUND	TETRAHEDRAL AMBIOPHONY
	TWO CHANNEL STEREO	
	4 ls SURROUND SOUND	
	6 ls SURROUND SOUND	
	7 ls SURROUND SOUND	

TABLE 2

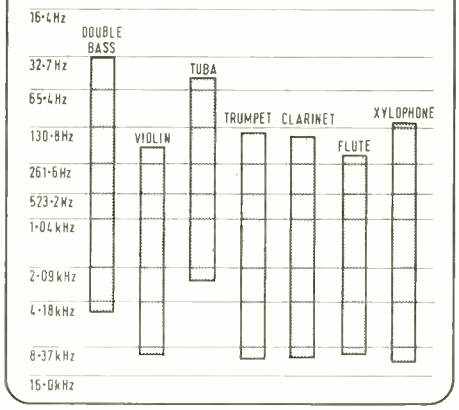


FIG. 1

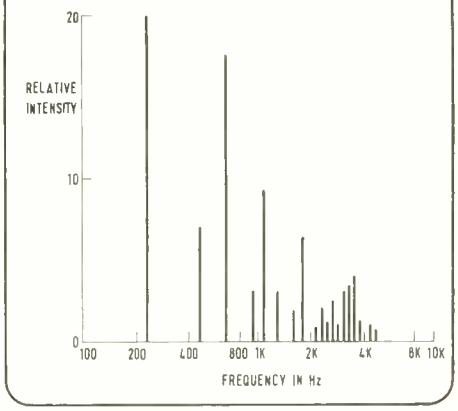


FIG. 2

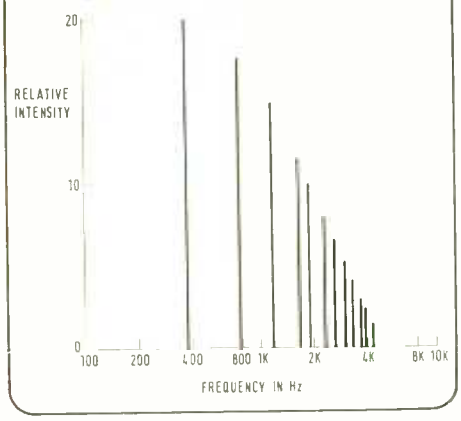
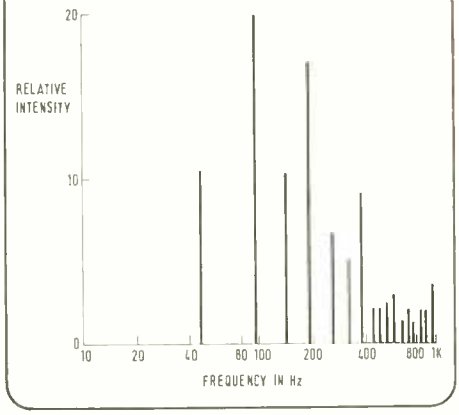


FIG. 3



while each instrument may cover similar frequency ranges, each will differ in the spectrum of the sound that they produce.

A consideration of these two features can be used to devise an electronic device to produce electronically processed recordings for two channel stereo or four channel quadraphonics, by arranging a series of tuned amplifiers with variable cut-off frequencies and slopes (in series) each with its own volume control. The output would then be fed to a panpot, for two channel stereo, or, as in **fig. 4** to a quadpot, which then feeds the appropriate number of amplifiers or tracks on a tape recorder. The number of tuned amplifiers would depend to some extent on the complexity of the material to be transcribed, but four and six would probably be about minimum. In each amplifier channel one would have control of volume, low frequency cut-off, low frequency slope, high frequency cut-off and high frequency slope. **Fig. 5** shows a typical frequency response diagram for an amplifier tuned to about 100 Hz, with a sharp low frequency cut-off, and a gentle high frequency cut-off. By suitable adjustment of the controls for each amplifier channel, as well as the panpot or quadpot, one could achieve a reasonable synthesis of instrument positioning across or around the sound stage.

Such a device, however, doesn't take into account the third criterion on our list; the ambient setting for each group of instruments. To obtain a true ambisonic sound synthesis, one must feed suitable acoustic information into the final mixdown that will enable the listener to orient himself spatially with regard to the instruments and the acoustic required by the music. It would appear that reverberation plays a very big role in the determination of spatial positioning of sounds, and so by using a reverberation delay line in each tuned amplifier channel, as in **fig. 6**, control of the acoustic perspective for each part of the sound spectrum as determined by the filter controls on the amplifiers will be achieved. Obviously, the same number of delay lines is required as the number of tuned amplifiers, the illustration showing six. By careful control of the amount of direct sound and delayed sound for each amplifier channel an accurate spatial perspective could be achieved which at best would allow groups of instruments or singers to appear set in their correct acoustic.

Conventional delay lines almost always add some degree of coloration to the sound, as well as introducing deficiencies in frequency response. One technique which could be used in the delay lines is the orthogonal matrix feedback device as described by Michael Gerzon (3). By the modification of Schroeder and Logan (4), which adds a direct path and a feedback path to a unity gain network, a new unity gain flat frequency response device (i.e. a monophonic reverberation device) is

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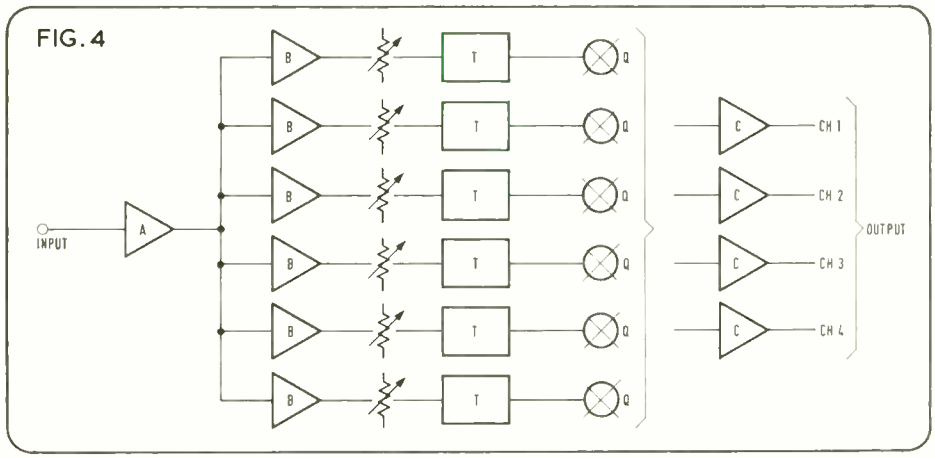
FIG. 4



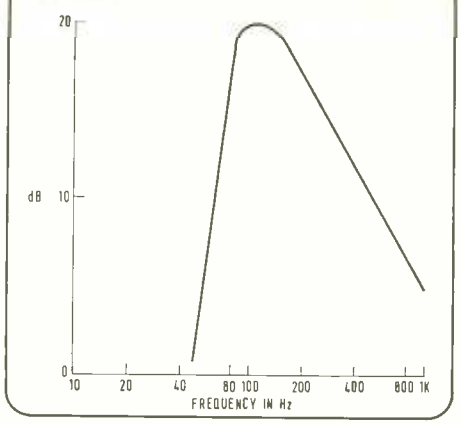
obtained. By cascading such devices one can alter the amount of direct to reverberant sound while still maintaining a flat frequency response.

Thus one could incorporate an n-channel reverberation unit into the ambisonic synthesiser to obtain a very high quality device suitable for master pressings. Mono recordings, even those made for 78s, could be processed with ambisonic reproduction specifically in mind. For pantophonic reproduction, either a four-loudspeaker, or better, a six-loudspeaker (5) monitoring system could be used.

The recordings would, of course, be compatible with conventional two-channel stereo. Processing for true stereophonic reproduction, incorporating the dimension of height, would be more difficult, but by using a tetrahedral monitoring system (such as that shown in **fig. 7**) some effect of height could perhaps be obtained by suitable adjustment of the controls on the synthesiser.

So far, we have dealt with systems for producing ambisonic sound from existing recordings, but there is no reason why one cannot produce original recordings with ambisonic reproduction in view. (Recording companies please take heed!) For multitrack master production, particularly in the Pop scene, one would probably need a more advanced type o mixing console, incorporating premix memory, tuned amplifiers with variable cut-off frequencies and slopes. Cascaded n-channel orthogonal matrix delay lines in every channel together with playback systems that could cater for two channel stereo, four or six loudspeaker pantophonic sound and tetrahedral ambiophony. To cut down on the size of such a mixing desk, visual monitoring could be accomplished by means of light emitting diodes (6) or cathode ray tubes (7).

FIG. 5



Hopefully in the future ambisonic reproduction will replace the chase-it-round-the-room type of quadraphony. Certainly the recording companies have the technology available to develop and advance natural and creative recording and reproduction, which can only be to the advantage of the consumer. In a future article, I hope to describe my own recordings which have been specifically produced with ambisonic reproduction in mind.

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(5) J. Crabbe. 'An audio system for six channel surround sound'. *Hi-Fi News*, Oct 1973.
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FIG. 6

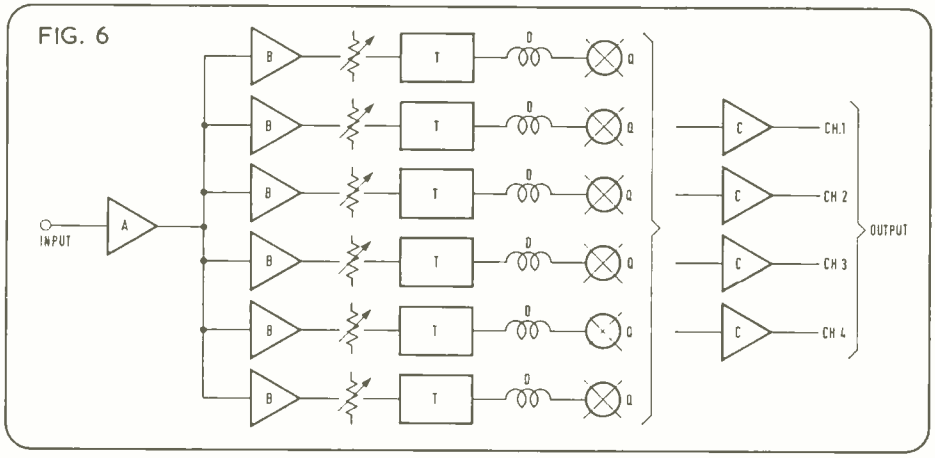


FIG. 7

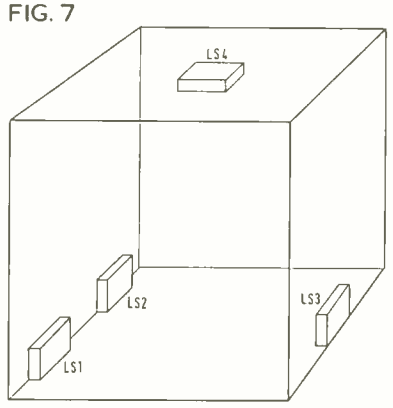


PHOTO 1

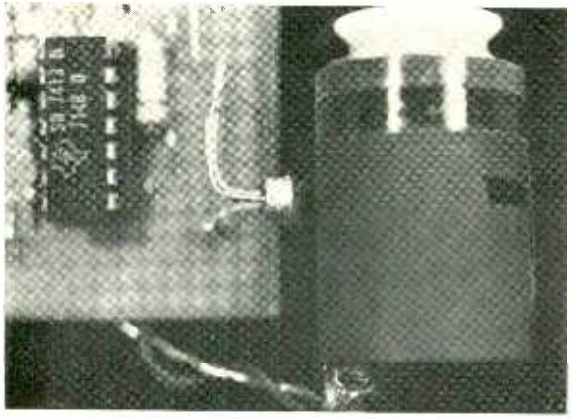
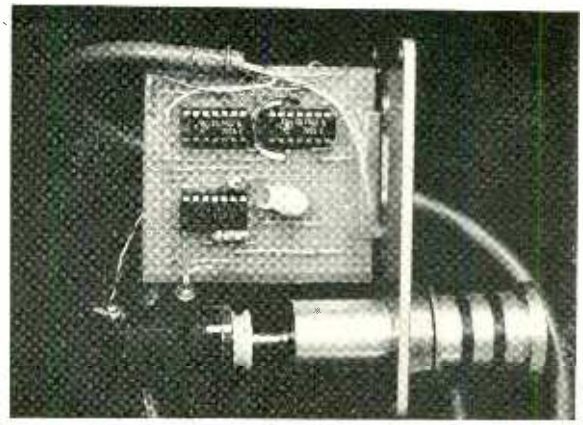


PHOTO 2



Postscript to 'Constructing a Digital Tape Timer (June STUDIO SOUND). **Photo 1** shows method of head construction. **Photo 2** shows the sensing head and electronics layout.

STRAWBERRY, MANCHESTER

By John Dwyer

PETE TATTERSALL says people thought he was mad when he said he was going to open a studio north of Wormwood Scrubs. Quite a way north, actually—Stockport. 'Who's going to record there?' they asked him. 'We will', he said, We then being himself and Eric Steward, now with 10cc.

Eric and Peter now run Strawberry Studios. Eric's career had started with Wayne Fontana's Mindbenders. Their first hit, you may remember, had a lot of 'Ums' in it and went into the charts on the last day of October, 1964. It eventually went to number five. When Wayne Fontana went solo in 66 the Mindbenders did the same. Successful, too. Before the band split towards the end of 1968, they had had hits with *A Groovy Kind of Love* and *Ashes to Ashes*.

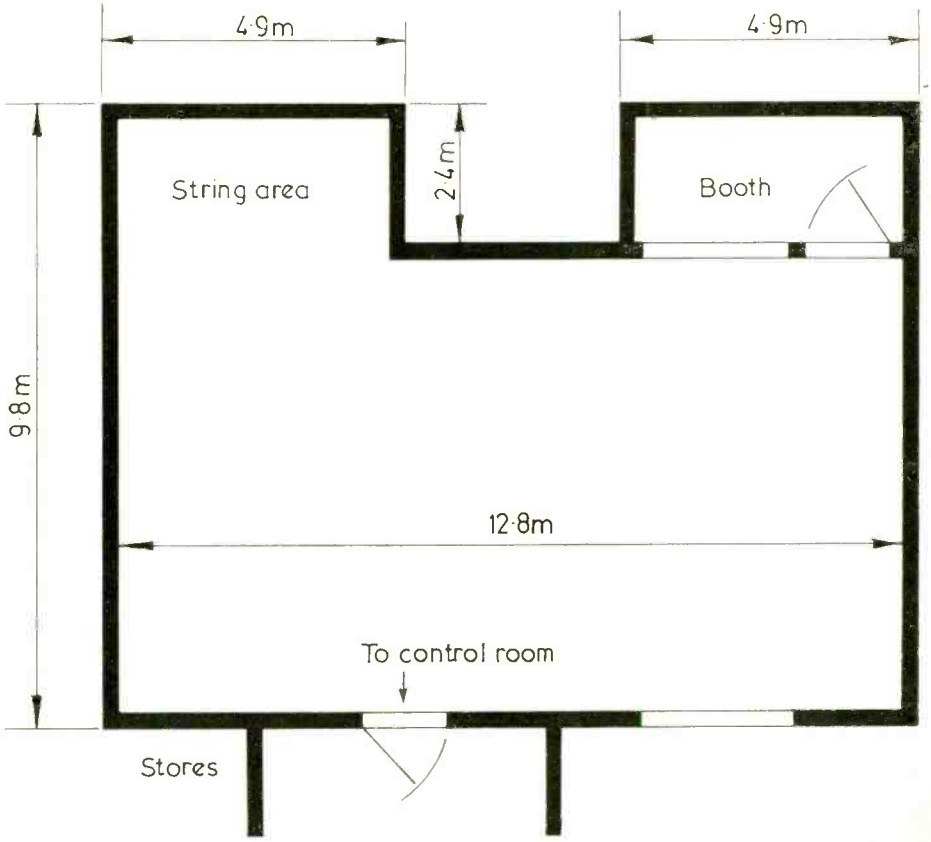
Graham Gouldman, another member of 10cc, is also a partner in Strawberry, and 10cc's agents, Kennedy Street, have an interest in the studio. Graham is a talented songwriter. He began by writing 'For Your Love' for The Yardbirds, a big hit for them in March 1965. After that he wrote many more hits including 'Bus Stop' and 'Look Through Any Window' for The Hollies, 'No Milk Today' for Herman's Hermits and 'Pamela Pamela' for Wayne Fontana.

Before Graham joined the band, 10cc were known as Hotlegs. They had a hit with 'Neanderthal Man', and then they did a tour with the Moody Blues after which nothing seemed to happen. Graham had joined them by this time and the band wrote 'Donna', which they took to Jonathan King. King relaunched the band, changing their name to 10cc, and 'Donna', good girl that she is, earned them a silver disc.

Which brings me back to Strawberry, where 10cc do all their recording. When I was there—I must confess it was a long time ago—they were in the process of finishing an album, which many regard as one of the best albums in years, perhaps because it was conceived as a collection of singles at a time when people had had pretentious 'concept albums' up to the back teeth.

Pete Tattersall used to work for Brian Epstein. 'I got interested in recording when I was down in London with him. We used to spend a lot of time at Abbey Road. I left Brian Epstein, came back up to the North and said "There ought to be a studio up here". I took over a tiny little demo studio above a record shop which only had mono and stereo and a right joke of a desk'. He had known Eric when he had been with The Mindbenders and they talked about having a proper mastering studio. 'He came in with me, then we left that

Above: Kevin Parrot of 'Oscar' in the studio.
Below: Floor plan of studio.



place, took a lease on this building and started doing it properly'. After that, in 1968, Graham Gouldman joined them. 'When we opened this place we got four track in, and a guy made a desk for us. We had a big hit with 'Neanderthal Man', which was very helpful, because we got eight track, as soon as we got a hit'.

Strawberry have all the ground floor, half the basement and half the first floor of a building in Stockport's Waterloo Road. When they built the studio the building had been occupied by offices. They stripped back to the walls, floor and ceiling.

The building has had a long and varied career. At one time, long ago, it was an illegal boxing ring. After that they built parts of Sir Henry Seagrave's world record breaking speedboat in it. During the war the building was used to make detonators for shells. Pete Tattersall told me that an extra wall had been built all around the building to strengthen it when they were making the detonators. The floor is just as sturdy: on top of the main joists are two sets of floorboards and a layer of red asphalt. The asphalt only partly covered the floor when they came to build the studio, and they put down a final layer of black asphalt 25 mm thick when they moved in. On top of that they put the carpet, leaving one corner with a hard floor for the string section.

Eric told me they had rebuilt the studio a number of times now. Initially the control room had been in what is now the studio, and what is now the control room, had been two rooms: a disc-cutting room and a largely-unused directors' office. They hadn't liked their first attempt so they had put in a false ceiling and better soundproofing. When they went eight track they did it all again. Then when they decided to install 16 track they thought it better to take no chances. They called in Sandy Brown and asked his advice. He tested the studio and Pete told me he (Pete) had been surprised by how little needed changing.

The walls are now covered by 11 cm of Stillite, and two layers of plasterboard, plus acoustic absorbers. The studio was shut for five weeks while the necessary gear was installed and the studio redecorated. Eric, Pete and Rick designed the colour scheme and did it in industrial-grade fireproof paint. They reopened on March 28 last year.

Without help

Pete is proud of the fact that they went from mono to 16 track in just four years without anybody's help. And since changing to 16 track Strawberry have had through their doors such people as: Paul McCartney, Neil Sedaka, Barclay James Harvest, Scaffold, The Strawbs, Syd Lawrence Orchestra, 10cc, The Drifters, Hot Chocolate, Lindsey de Paul, Tony Hatch and Roger Coor.

Not every studio has an Eric Stewart, though, and I asked Eric why (a) he didn't like working in other studios, and (b) he had a studio up here. 'I worked in studios down in London and the atmosphere was really bad. There's the big time-factor thing and you're herded in and out'. This explains why, at Strawberry, there isn't a clock in the place.

It must be a great attraction for a client to know that a musician of the stature and experience of Eric Stewart is not only involved with the studio but may be manning the faders.

'Oscar' recording.

Neil Sedaka recorded his last two albums and singles at Strawberry and he persuaded 10cc to work with him. Pete is pleased about that: 'When you think about it, he could have any rhythm section or studio in the world'.

Sedaka also likes the Strawberry Sound. Pete said he couldn't explain the sound, though clients are aware of something special. Half-seriously he wondered if it might be something to do with the moist air—Strawberry is, after all, not far from Manchester. 'We always try and get a good sound in the studio, the way we arrange the guitars and amps and so on. Plus, we set up brass differently, I think, to everyone else. We set them two and two, facing one another, and we sling a *U67* in the middle on figure-of-eight. Then we take a section balance. All the MD has got to do is get the band to play a built-up chord and then say "Lead, move out a bit" or "Third, move in a bit" or whatever and, once they're sitting in the right positions that's it'.

This was a technique, Pete said, that Strawberry had developed over countless sessions with the Syd Lawrence Band. Up to a year ago they had made eight albums with Syd—all the big band revival albums including the first, in the Glenn Miller style, for which Syd got a gold disc.

The separation in the studio is obviously good (Sandy Brown saw to that). For the Syd Lawrence Band they would put two half screens around the drummer, next to him the acoustic guitar and the bass, then the trombones, arranged two and two, the trumpets, arranged two and two, and the saxes, arranged two and two and one—the baritone at the end. 'Now, virtually because the trumpets and the trombones are blowing at each other, blowing directly at the mic, one sound counteracts the other. The musician himself is acting as a screen in a way, so we don't screen between them at all. Of course the separation isn't perfect. The only way to get absolutely perfect separation is to put each musician in a soundproof booth, but you can't do that because they can't play that way. This way they can hear themselves properly and consequently the timing and rhythm are just spot on. I can't remember which one of us thought that up'.

The control room is between the reception area and the studio, so the studio is a good distance from the road. When I stood in the studio I didn't hear a sound from outside even though Pete told me they were more or less on the flight path of Manchester airport.

Pete and Eric have nothing but praise for Dick Swettenham: 'our favourite man', as Pete called him. Dick had given them a great deal of help when they went eight track. He redesigned their old four track desk for them. The new 24/16 Helios desk curves round the engineer, with channels one to 16 in front of him, 17 to 24 to the right and echo, pre and post fade and all the other insertable ancillaries on the left. Pete told me they normally used the right hand channels for strings and acoustic instruments.

The desk has a number of extras, including special equalisation. Pete told me that whereas the normal treble boost starts at 10k Hz, they had other curves put in at 12 and 15k Hz. They also tried out different curves at the top end which they put on channels 17 to 24 to try

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out. They liked them and had them put on the other remaining channels. Pete said they were sharper than the curves normally used. For extra equalisation two Audio and Design equalisers are available on the patch bay, from which you can plug in two Kepex units. Push-button routing is fitted so that one channel can be routed to as many tracks as they want.

The 16 channel monitoring mixer allows them to record straight from the monitor: 'By the time you've finished your 16 track recording you've usually got all your monitoring faders set to a fair balance, so to do a quick mixdown you can listen to it and record from monitor, which is a great idea instead of having to set up for a mixdown . . . We've used it quite a bit. You can put echo on it or pan pot echo on the monitor without it going on to the track'. All you had to do for mixdown, Eric added, was flick over a switch and the whole desk was ready to mix without any patching.

The echo units also have equalisation, and Helios designed a unit for mixing tape echo and plate echo. Various degrees of tape echo are available at various delays. There are also two EMT stereo plates. The tape loop can be fed into the plates by plugging into and from the stereo machine via the tape delay module.

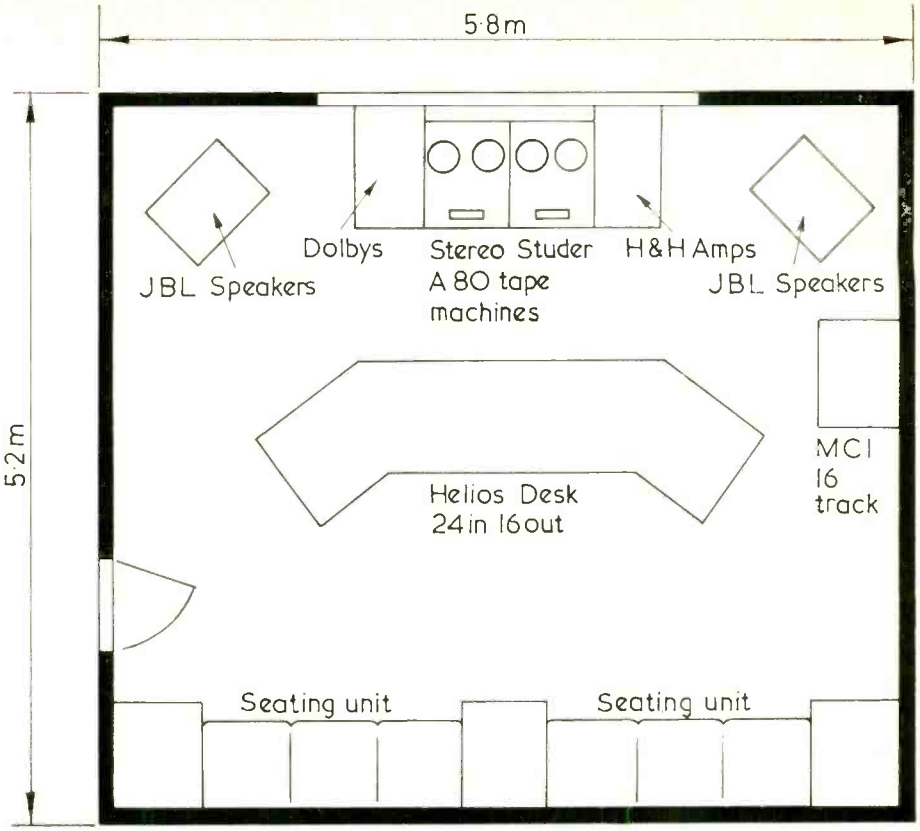
Machine playback is selected on a monitor board: 16 track, four track, stereo one, stereo two, stereo mono comparator switch, two mono machines and an external source, for a disc player.

Other features of the desk include a digital clock, a cassette recorder, an automatic phasing unit, an oscillator, a variable fuzz unit, a wa wa unit, a tremelo unit, a cigarette lighter and a device for opening the front door.

The desk has jack sockets for direct injection, which Eric later used to great effect to do a guitar overdub for the 10cc album. While he was doing it he also made good use of the remote locator control for the MCI 16 track machine. Pete described this as their 'deaf and dumb tape jockey', and Eric said he couldn't imagine life without it. 'It's wonderful', Pete said. 'Set your logic, finish your tape, press autolocate and forget it. It winds back, stops, and starts itself, which is marvellous because you can get on with doing other things'. He told me he had once left the control room during a session having set the machine to wind back. He had peeped round the corner at the frightened faces of those left in the control room, who were waiting apprehensively for the tape to come flying off the end. Then the machine just stopped and started to play. 'They all stood and looked at it in amazement'.

The monitoring is in stereo, and all the foldback comes off the monitors as well as the channels if required. The speakers here and in the studio are JBLs. The desk is also fitted with two squawk boxes which Pete told me they used every mix. He said they were going to get a number of speakers so that they could switch from one to the other on various units between the JBLs and the squawk boxes. All the meters are ppms.

Eric designed a unit for mounting the Dolbys. All the amplifiers they use are by Crown—for foldback, talkback and speakers.



Left: (above) Floor plan of control room.
(Below) Geoff Gill, Pete Tattersall and Martin Lawrence in the control room.

Above: (left) Close-up of the tape machines.
(right) MC1 16 track machine.

The studio, as you will see from the floor plan, is big. Peter told me it would hold 35 musicians but I would have thought that was an underestimate. There are 24 mic lines, arranged in four groups. One group of eight is in the drum/vocal booth, another group of eight is in the hard-floored string section of the studio, and there are two more groups of four each in the main part of the studio. An additional feature is the main microphone board near the control room. All the microphone points round the studio come up on this one board, and then to patch in you simply use a link. Or you can go straight in there.

On every mic board round the studio there are headphone sockets. Altogether there are 36 headphone points, including a set on a floating board that could be moved round the studio. There are two foldback groups and, when I visited the studio, they were thinking of installing separate foldback mixers for each musician.

Some years ago Keith Wicks wrote a piece in this magazine about Strawberry's ring foldback system, whereby an electric loop went round the studio and everybody within the loop could pick up the foldback in an earpiece. This avoided the necessity for any trailing wires. Pete told me they had had to think again about the scheme, which had been devised by Formula Sound's Tony Cockell, to provide 10cc's drummer/vocalist Kevin Godley with foldback during stage appearances. 'We tried it, and experimented with it. It worked. But it picks up everything within the loop and in the end we were redoing the studio and we thought "No, let's just do it as per normal", we may try it again . . . but I would hate to put something into the studio and rely on it alone—I think that's fatal. It worked great on stage', he added. Really great for groups—I can't think why other people don't use it'.

The foldback headphones are Beyer *DT480*. They have been modified by the fitting of a heavier cable and a plug and socket at the headphone end fitted with a screw. Thus they can stand up to a great deal more rough treatment than they used to. The amp used to drive the foldback is a Crown *D60*, so there's plenty of headroom there. Two JBLs provide speaker foldback or playback from the control room. These can be wheeled about the studio on little trolleys. They can be plugged in at two points, and the aim in buying these was to let lazy musicians stay in the studio and hear their tracks played back.

The microphones are the usual Neumanns—*U47*, *U67*, *KM88*, *KM86*, Beyers—*M160*, *M88*, *M201* and *AKG*—*C28*, *C451* and *D202*. Pete told me they were particularly pleased with the Beyer *M201* 'You wouldn't believe the sound that comes out of it. We use it on snare a lot, because it gives a certain edge'. They used the *D202* on bass guitar and bass drum.

The ground at the back of the studio slopes away about 2m to the ground at the back of the building. A good sized, fully soundproofed, lift carries musicians and their gear right into the studio.

There is some spare land next door which Pete told me they were keeping their eye on for future expansion, but it was well into the future. 'We're happy enough at the moment'. There was also the possibility of moving into other parts of the building.

One of the reasons they chose Stockport instead of Manchester was that parking here is so easy. There is the waste ground nearby and a garage forecourt they could use at night.

Pete didn't think the studio was too remote: 'It's 3½ hours drive from London, 2¾ hours on the train, and 35 minutes by plane, ten minutes from the airport and two minutes from Stockport station.

There's only one thing Pete envies the London studios—the large pool of talented session musicians they can draw on. Not that they're doing badly in Stockport with the Halle Orchestra, the Northern Symphony Orchestra, the Northern Dance Orchestra and the Syd Lawrence Band—they have a pretty good selection. But he told me there is a shortage of girl backing vocalists.

Pete enjoys working with professionals and particularly the recent Paul McCartney sessions. 'Paul was so into studio techniques, it was a pleasure to work with him'.

'I like this business, you know', said Pete. Because everyone in it is so friendly and always trying to improve things. We all more or less had to start at the bottom and work our way up. It is a weird business though, the hours are crazy and if you didn't really enjoy it, it would drive you mad. Everyone is enjoying it at Strawberry and we've all got a lot in common. That means we're happy. I think it's one of the best businesses anyone could possibly work in'.

It is hardly necessary to explain the motives behind Mike Anthony's parody of quadraphony jargon except to warn the pseudo-technical that these are pseudo-facts—in a word, fiction. Hugh Ford's parodied specification was contributed quite independently but carries a similar message.

Audio jargon; a nonsense alphabet

MIKE ANTHONY
AND HUGH FORD

THERE HAS been considerable confusion and misunderstanding as to what various technical terms used in connection with quadraphonic sound actually mean. The following glossary is an attempt to define the meanings normally given to various commonly-used words and phrases in this field.

AMBIENCE. A sort of muddiness added to sounds to make them less clear.

COINCIDENT MICROPHONES. An arrangement of directional microphones which are spaced apart by more than five wavelengths of the highest audio frequency.

COMPATIBILITY. A property of quadraphonic systems that ensures centre-back sounds are not reproduced in mono and that stereo reproduction gives either narrow or lopsided images.

CONCERT-HALL RECORDINGS. A type of recording in which all sounds appear to be in the middle of an echo plate.

CONSUMER. The technical term for an animal used for laboratory experiments in quadraphonics.

DISCREET SYSTEM. The same as a discrete system.

DISCRETE SYSTEM. (1) Any four channel system that uses four channels. (2) A system that uses four mutually related and interdependent channels. (3) The opposite of a discreet system.

FOUR-CHANNEL SOUND. A recording containing only one dimension (a circle) of sound.

4. (1) A symbol meaning two.
   (2) The Japanese word for death.

LOGIC. A method of doing the impossible in an unsystematic manner.

MATRIX. Any system that achieves full discreteness by cheating. Also known as a four-channel system.

MONO. A system of recording sounds from all directions, capable of producing an illusion of spaciousness and depth.

PHASE MATRIX. A system of reproduction using four loudspeakers in which sound positions are determined entirely by the amplitudes of the sounds from the four loudspeakers.

QUAD. Any modern sound reproduction equipment not made by the Acoustical Manufacturing Company Ltd.

QUAD POT. A method of not positioning sounds very well.

QUADRAPHONY, QUADRASONICS, QUADROPHONY. Any system of recording originating on eight or 16 tracks, transmitted through two disc channels, and reproduced through 12 loudspeakers (including woofers, midrange units and tweeters). Note the curious use of Quadri or Quadru roots.

QUADRAPHONIC HEADPHONES. Stereo headphones that cost twice as much.

QUADRAPHONIC SEAT. The only position in a room from which it is not domestically practical to listen.

READY FOR QUADRAPHONICS. Ready for stereo.

SEPARATION. The meaning of this term depends on the laws of logic, which vary from moment to moment.

SHIBATA STYLUS. A method of determining how much dust has collected at the bottom of your records' grooves.

SIDE SOUND POSITIONS. This term has no meaning.

SQUARE SPEAKER LAYOUT. A type of speaker layout that does not fit into domestic listening rooms.

STEREO. An obsolescent term meaning a hi-fi system in which two speakers are missing.

SUBCARRIER MODULATION. (1) A spluttering sound on discs audible to your wife and children. (2) A method once proposed to prevent anyone from taping discs.

SURROUND RECORDINGS. A type of recording in which all sounds seem to be in the middle of your head.

TETRAHEDRAL REPRODUCTION. A system in which one of the loudspeakers is positioned so as to endanger the listener's life.

ULTIMATE IN SOUND RECORDING. Any system not yet including any height information.

VARIABLE MATRIX. A method of making matrix recordings discrete, which uses the fact that you can't tell that a sound is coming from a given direction if it is coming from the opposite direction.

VIDEODISC. A method of obtaining hexadecaphony on gramophone records.

All solid state. Seized controls and cross threaded screws included.

Constructed with Military Grade components. Made in 1936.

Designed to meet standard 1234. We would like to meet standard 1234 and its half the price of the competition who succeed.

Distortion is eliminated by . . . You'll be lucky if you can find the fundamental.

Electronic overload protection. I²R smell.

Specification: Copywriter's imagination.

It will receive more stations than brand X. Image rejection and selectivity are zero.

Low distortion at every sage (sic) *Wireless World P48* (Dec 1937). The dictionary says: distortion, a twisting or writhing motion. Sage, a wise man. The mind boggles.

Note the smooth loudspeaker response curve. They took at least a week fiddling the pen speed for this one.

Signal-to-noise ratio of 156 dB. It only measured 50 dB unweighted but using a 3 Hz bandpass filter this figure can sometimes be met.

Solid state circuitry. High distortion.

Tested with the world famous Bruel & Kjoer equipment (sic). A five year old might make a better job of it least the spelling but it looks good.

This equipment uses an integrated circuit too expensive for other manufacturers to use. . . NASA lost a bomb putting them on the government surplus market at 3p each.

Using the latest computer techniques for advanced design. A mathematical muddle.

With VU meters for accurate level control. We thought we'd put VU on the scale when we printed our trade mark.

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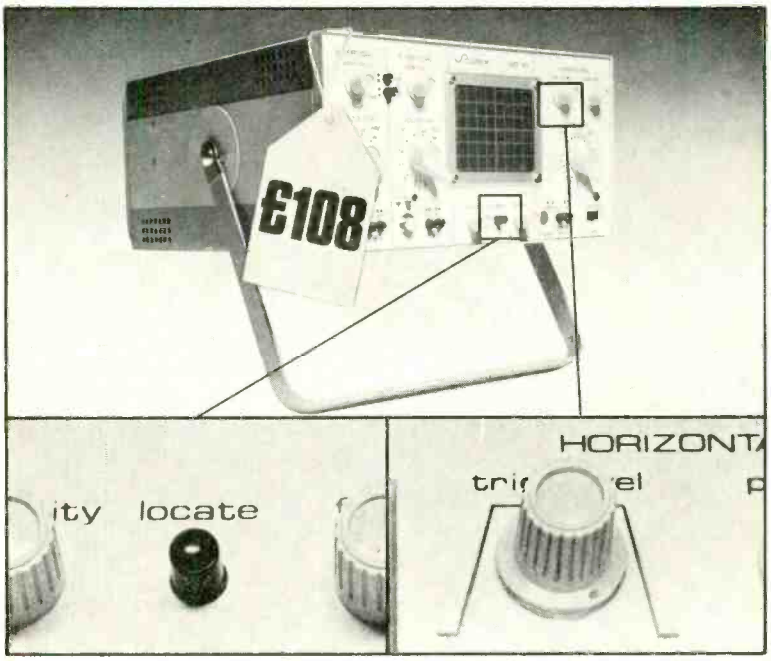

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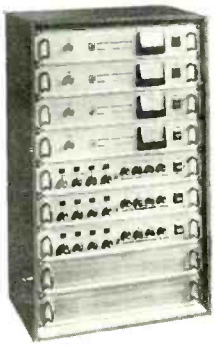

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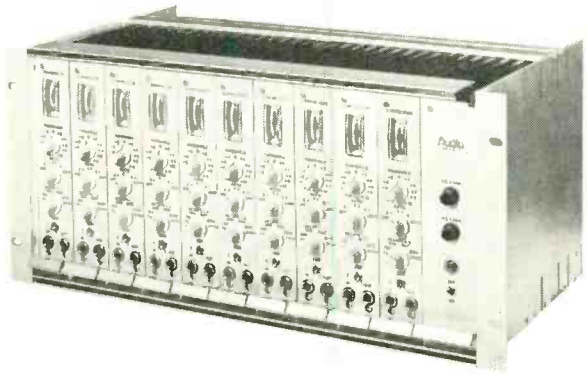

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SCOPEX 4D10 OSCILLOSCOPE

By Hugh Ford

MANUFACTURERS' SPECIFICATION
A and B vertical
Sensitivity: ±5% 10 mV/cm to 50 V/cm (12 calibrated ranges).
Bandwidth: to —3 dB points, dc coupled ac coupled dc to greater than 10 MHz less than 3 Hz to greater than 10 MHz.
Risetime (calculated): 35 ns (approx).
Overload protection: max 400V (dc + peak ac to 3k Hz).
Input impedance 1MΩ ±3% and 33 pF approx.
Modes: 'A' Channel only. Alternate. Chop (approx 100k Hz).
Horizontal
Sweep speeds: ±5% 1μs/cm to 100 ms/cm (16 calibrated ranges).
Magnifier: +5% five times.
External sensitivity: 1 V/cm approx (200 mV/cm magnified).
External bandwidth: dc to 500k Hz.
External input impedance: 1MΩ approx and 35 pF approx.
Max external input: 250V (dc + peak ac to 1k Hz).
Trigger circuit
Sources: external input—'A' channel—power line frequency.
Sensitivity
Internal: 5 mm minimum 10 Hz to 1 MHz rising to 3 cm at 5 MHz.
External: 300 mV peak to peak 30 Hz to 5 MHz. 600 mV peak-to-peak 10 Hz to 10 MHz.
Input impedance: 150 kΩ approx and 25 pF approx.
Max input: 250V (dc + peak ac to 1k Hz).
General
Display size: graticule ruled 6 cm x 8 cm.
Power requirement: 210 to 250V ac 50 to 60 Hz. 25 VA approx. (105 to 125 USA).
Dimensions (hwd excluding handle): 153 mm x 312 mm x 350 mm.
Weight: 7.71 kg.
Ambient operating temperature: +40°C max.
Price: £98.
Manufacturer: Scopex Instruments Ltd, Pixmore Industrial Estate, Pixmore Avenue, Letchworth, Herts.

THE SCOPEX type *4D10* oscilloscope is a basic instrument without any frills but incorporating calibrated amplifiers with a useful sensitivity and a calibrated time base. The two Y axis amplifiers are completely independent and can be operated in either an alternate sweep mode or in the chopped mode with a chopping frequency around 100k Hz.

The mechanical construction of the instrument is reasonably sound and while its appearance is perhaps a little old fashioned this is probably due to the lack of the multitude of knobs one associates with most oscilloscopes. Internally, the vast majority of the components are mounted on a single printed board which occupies the whole base area of the instrument, both the board and its components being to a good class domestic standard. Accessibility to the majority of components is very good and the cabinet work is so designed that the oscilloscope can be used with the screen vertical, horizontal or angled on the bench; the substantial hinged carrying handle being used in the latter position. A rack mounting version of the instrument is also available at extra cost.

Layout of the front panel is extremely clear, the two Y amplifiers being on the left, the tube and its controls in the centre and the timebase section on the right. The two Y amplifiers are identical with, for some reason, the 'B' channel on the left and the 'A' channel on the right—I find this layout rather irritating. Each amplifier has its rotary Y shift control, a switched attenuator covering 10 mV/cm to 50 V/cm in a 1:2:5 sequence without any variable control and a twin pushbutton switch for selecting ac coupling, dc coupling or earthing the amplifier input, without earthing the instrument input. The input sockets can be ordered as either bnc or uhf types and an auxiliary banana socket is fitted as an earth terminal to each amplifier.

Between the two Y amplifiers are two further pushbutton switches for selecting the operating mode to alternate sweep, chopping operation or such that the A amplifier only is in circuit.

In the centre of the instrument the display tube is provided with a graticule ruled in centimetre squares, but with 2 mm divisions marked on the X and Y axes. No viewing hood is provided, but the tube brilliance was found to be quite adequate for examining repetitive waveforms encountered in audio equipment. Underneath the tube there are the usual intensity and focus controls, and a very effective trace location pushbutton.

The timebase controls are minimal with a rotary range switch providing calibrated sweep speeds from 1 μs/cm to 100 ms/cm in a 1:2:5 sequence and a trigger level control which is used to select the triggering position on either positive or negative edges of waveforms. Twin pushbutton switches select the trigger source as either the 'A' channel amplifier, the mains power frequency, or an external source fed to the adjacent banana socket. In addition to the above there is the X shift control, which when pulled out provides times five magnification to the X amplifier.

To the rear of the instrument there is the fixed mains lead which supplies the power supply via an internal fuse, and three banana sockets providing an earth terminal, a sawtooth sweep output and an X input (which is selected by an extra position on the timebase range switch).

The Y amplifiers

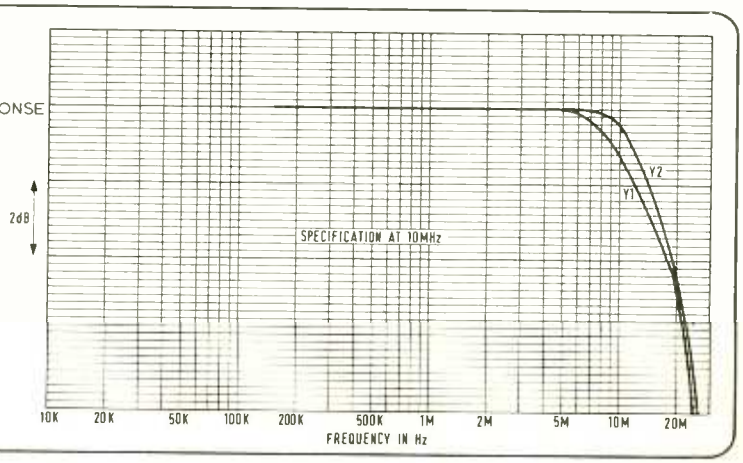
The attenuator accuracy of both the Y amplifiers was well within the specified ±5 per cent, the 'A' channel being generally within 3 per cent and the 'B' amplifier generally within 2 per cent including reading errors. While the accuracy was not directly checked at radio frequencies, examination of fast risetime pulses at all attenuator settings did not suggest any deficiencies, and both amplifiers gave a measured rise time of 40 ns which is substantially to specification.

Fig. 1 shows the fall-off in response at high frequencies for the two channels, both of which are far better than specification, to such an extent that this could quite justifiably be called a 15 MHz oscilloscope!

Amplifier stability was in all senses very good, drift in gain and dc conditions being more than adequate even when the mains voltage was lowered to the specified lower limit of 210V, and the display of very fast pulses showing little perturbration.

The shift controls gave an available trace shift of about plus or minus two screen diameters without any sign of waveform distortion over their range of operation and the linearity of the display was generally all that is required on both the X and Y axes.

FIG. 1
SCOPEX 4D10
Y AMPLIFIER
FREQUENCY RESPONSE

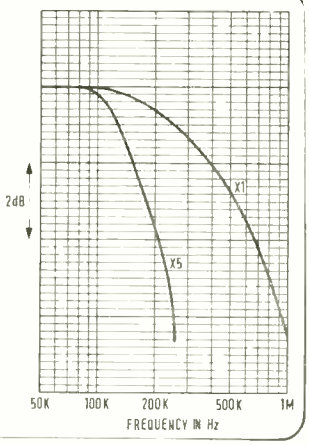


The measured input impedance of the two Y amplifiers was precisely 1 MΩ in parallel with 43.4 pF for one amplifier, and 986 kΩ in parallel with 43.8 pF for the other. While the resistive component is to specification, there appears to have been a slip of 10 pF in the capacitive component of the specification; this is however of little concern for most applications.

The Timebase and X amplifier

Time measurement accuracy was, in the worst case, found to be a 3.8 per cent error and the display linearity was excellent. However some astigmatism at both edges of the X axis was apparent. The use of the times five facility on the X amplifier did not produce any measurable error in time calibration, but did have a substantial effect upon the X amplifier frequency response as shown in **fig. 2.**

FIG. 2
SCOPEX 4D10 X AMPLIFIER FREQUENCY RESPONSE



Triggering in the normal mode of operation was good once the timebase had locked, but there was a disconcerting effect when setting the trigger control such that the timebase seemed to stop and think for a little time before locking; once one got used to this all was well. In the normal mode the timebase free runs in the absence of a triggering input, but the insertion of a link within the instrument stops the free running and turns the timebase into a genuine triggered timebase so that waveforms with a low repetition rate may be examined with more convenience.

A satisfactory timebase lock could be obtained with extremely small displays in the internal trigger mode, and any art of the waveform was readily selected. In the external trigger mode a lock could be obtained with 100 mV into the external input (impedance 216 kΩ and 14 pF) at audio frequencies. In all triggering modes there was a timebase delay, such that the timebase did not start until approximately 200 ns after the start of the Y deflection, which of course means that it is impossible to examine the leading edge of low repetition rate fast waveforms.

When using the external X input the sensitivity was found to be 1.06 V/cm into an input impedance of 973 kΩ in parallel with 39.6 pF when the X amplifier is in the times one mode. The times five switch increases the external input sensitivity by a factor of five, but has no effect upon the input impedance.

The last facility of the timebase section is the timebase output which is in the form of a 10V peak-to-peak sawtooth waveform which is in fact dc coupled and offset by 8V positive so that its actual level is from +8V to +18V from a low source impedance.

General

The instrument gave a fine display at the centre of the screen with more than adequate brilliance for audio frequency work in normal room lighting without the use of a hood. The display stability was generally good, but some jitter was evident in the alternate mode of operation and in the chopping mode the chopping frequency was not particularly stable, which might lead to some confusion.

Generally, operation of the instruments was simple and clearly identified; however, there was on this sample one very annoying defect in that the timebase range switch pointer always pointed between two range calibrations so that one had to wind the switch to its end stop to discover which range was in use!

Summary

Acknowledging the price of the Scopex *4D10* there is no doubt that it offers very good value for money, and if the sample reviewed is anything to go by the instrument is sold against a very conservative specification, such that many manufacturers would call it a 3 per cent accurate 15 MHz oscilloscope!

The only respect in which it may fall short for the common maintenance of audio equipment is that of Y amplifier sensitivity—10 mV/cm is all right for high level equipment, but I prefer to have at least 1 mV/cm available for inspecting the waveforms in low level amplifiers and tracing noise and hum.

Naturally, as this is a very basic instrument it may not offer the facilities required for any particular application but if the specification fits the job in hand I have no hesitation in recommending this instrument.

BURWEN 1000 NOISE FILTER

By Hugh Ford

MANUFACTURERS' SPECIFICATION

(Typical @ 25°C with 10k load unless otherwise specified.)

Channels: Prewired for one, two, three, or four. For stereo operation channels one and two use common bandwidth control and three and four use common bandwidth control. Modules may be plugged into any channels and operated without modification or adjustment.

Input: Level 0 to +20 dBm, 1.1 to 11V instantaneous peak @10 dBm, 3.4V instantaneous peak optimum. Impedance 100 k Ω bridging. 600Ω ±1% termination available via rear panel switch. Common mode rejection. 85 dB minimum dc to 1k Hz. 65 dB minimum with 600Ω source unbalance. 70 dB minimum at 10k Hz. Common mode impedance. 2 MΩ each input to ground. Overload input. ±25V dc or rms.

Output: Open circuit. +20 dBm, 11V instantaneous peak. 600Ω load. +18 dBm, 9V instantaneous peak. 150Ω load. +16 dBm, 3.4V instantaneous peak. Output impedance. Less than 0.5Ω dc to 100 Hz 10Ω @ 20k Hz. 60Ω ±1% series resistance available via rear panel four channel switch. Short circuit protection included. Connections. Single ended, common grounded to chassis.

Frequency response: Minimum bandwidth. —25 dB @ 30 Hz. —22 dB 10k Hz. Maximum bandwidth. ±0.2 dB max 20 Hz to 20k Hz. —37 dB @ 100k Hz.

Harmonic distortion: Worst case 0.1% max 20 Hz to 2k Hz @ +10 dBm input. 0.1% @ 10k Hz @ 0 dBm input. Wideband 0.01% @ 1k Hz @ +18 dBm into 600Ω.

Gain: Wideband. 0 dB ±0.1 dB at any load from 150Ω to open circuit. With 600Ω series resistance and 600Ω load. —6 dB.

Internal noise: Narrowband. —80 dBm, 77 μV rms 20 Hz to 20k Hz.

Controls: Low frequency sensitivity, high frequency sensitivity, high frequency cutoff. These are friction ganged coaxial potentiometers. Outer knob channels one and two, inner knob channels three and four. Automatic—wideband, four channels ganged. Power on—off.

Power input: 115V or 240V ±10%, 50 to 60 Hz, 20 VA per four channels.

Mechanical: Sing e 483 mm x 44 mm rack panel for one to four channels. Depth behind panel 360 mm. Panel gold anodised.

Input connectors: D3F Switchcraft. Mating connectors required (one per channel) A3M Switchcraft or *XLR3 12C* Cannon.

Output connectors: D3M Switchcraft. Mating connectors required (one per channel) A3F Switchcraft or *XLR3 11C* Cannon.

Pin connections: One, shield and shell. Two, common. Three high.

Price: £2,000.

Manufacturers: Burwen Laboratories Inc, 209 Middlesex Turnpike, Burlington, Massachusetts, USA.

Distributors: International Instruments Ltd, Cross Lances Road, Hounslow, Middlesex.

THE BURWEN MODEL *1000* dynamic noise filter in essence consists of a variable lowpass filter and a variable highpass filter, both of which are controlled automatically by the programme content. As with the Dolby system, the Burwen relies on the masking effect of the ear which is such that the presence of any frequency tends to mask the presence of noise at adjacent frequency bands. In the dynamic noise filter the performance of the highpass filter is controlled by the low frequency

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BURWEN 1000

programme content, and the performance of the lowpass filter controlled by the high frequency content of the programme: thus, high frequency programme content automatically increases the filters bandwidth at high frequencies, and low frequency programme increases the bandwidth at low frequencies.

Manual controls are provided to preset the sensitivity of the two filters, so that a sensitivity may be obtained where a compromise is reached between noise reduction and programme degradation. In addition to these two controls a variable (and not automatically controlled) lowpass filter is provided for reducing high frequency noise from very noisy programme sources. The only remaining user controls are an automatic/wideband toggle switch, for switching the dynamic noise filters, noise reduction section in and out of circuit, and the power on/off switch.

The mechanical aspects of the dynamic noise filter and its standard of construction are identical to the Burwen noise eliminator reviewed in the February/March edition of STUDIO SOUND, as are the input and output arrangements with the exception of a further toggle switch which provides either low impedance or 600Ω output impedance. I will only reiterate that the standard of design and construction is really excellent in these respects.

Initial investigation into the performance was done with the filter controls in the flat position which confirmed a third harmonic distortion of less than 0.05 per cent at +18 dBm out at 100 Hz, 1k Hz and 10k Hz when feeding a high impedance load. Output clipping occurred at +21 dBm at 1k Hz into a high impedance, or at +18.6 dBm into 600Ω—a quite satisfactory performance. Noise in the output was measured as follows in the automatic and in the wideband modes of operation:

	Automatic	Wideband
Unweighted	—78.0 dBm	—79.0 dBm
'A' Weighted	—80.0 dBm (A)	—83.0 dBm (A)
20 Hz to 20k Hz	—78.5 dB	—82.0 dB

In the above cases the mains hum level was well below noise level, being −100 dBm at 50 Hz and −99 dBm at 150 Hz, the higher and the second harmonic of mains frequency being so low as to be insignificant.

The frequency response was found to be within ±0.1 dB over the range 20 Hz to 20k Hz in the wideband mode, without any form of deterioration of tone bursts at either

FIG. 1 BURWEN 1000 FREQUENCY RESPONSE WITH ALL CONTROLS MINIMUM AS A FUNCTION OF INPUT LEVEL

PEN: 100 mm/S
PAPER: 3mm/S

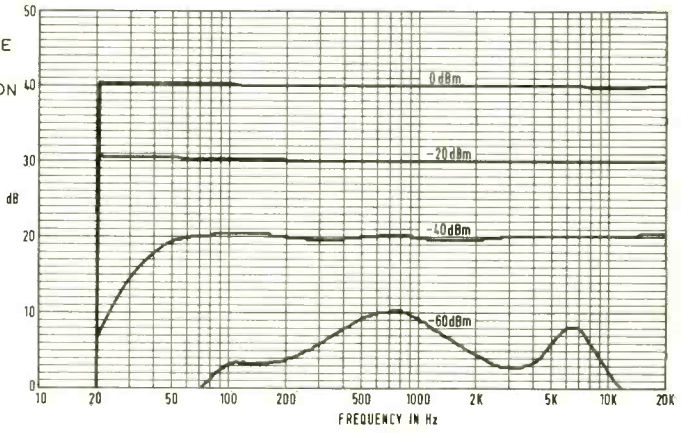
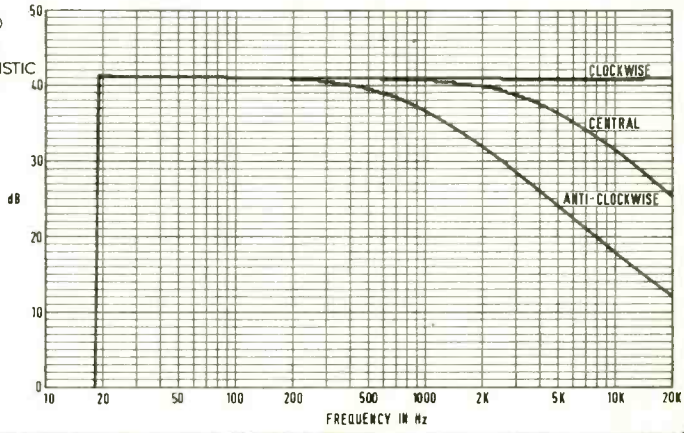


FIG. 2 BURWEN 1000 DYNAMIC NOISE FILTER HF FILTER CHARACTERISTIC HF AND LF SENSITIVITY CONTROLS MINIMUM

PEN: 100mm/S
PAPER: 3mm/S



high or low frequencies.

However, in the automatic mode with all controls set for minimum effect the story is rather different: fig. 1 shows the frequency response at input levels of 0 dBm, –20 dBm, –40 dBm and –60 dBm and demonstrates that the response deteriorates in the bass at –40 dBm and then becomes most peculiar at –60 dBm with a 6 dB lump at 800 Hz and a further 5 dB lump at 6k Hz. I also noticed that, while tone bursts themselves did not suffer from visible distortion of the waveform, there was a clearly audible low frequency overshoot after the burst.

FIG. 3

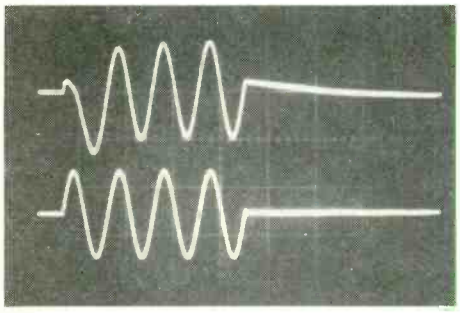


FIG. 4

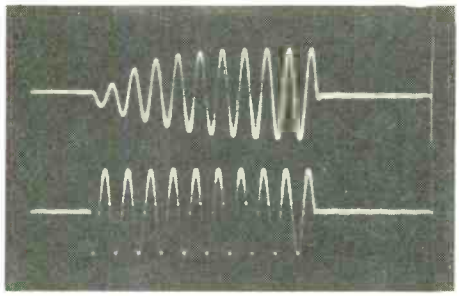


Fig. 2 shows the effect of the high frequency filter control which is not automatic in operation. It can be seen that this control has an ultimate attenuation of only 3 dB per octave, which by itself would appear to be rather inadequate, however it is to be remembered that this control would normally be operated in conjunction with the automatic high frequency filter and then provide a substantially greater effect. On the other hand the high frequency filters 3 dB point can be varied from 700 Hz upwards, which offers more than adequate variation.

Before dealing with the intended function of the highpass and lowpass filter sensitivity controls it should be reiterated that they have no effect upon the dynamic noise filters internal noise, which is good anyway, but they were found to effect distortion. Generally, distortion remained below the good figure of 0.1 per cent, but figures of 0.7 per cent at 1k Hz and 0.5 per cent at 10k Hz at +18 dBm input were measured under the worst obtainable conditions, which may be a bit unfair.

The further aspect of distortion in the automatic mode is the deterioration of sinewave tone burst waveforms which was found in all settings of the automatic mode. As is only to be expected the deterioration increases as the filter sensitivity is increased. **Fig. 3** shows the input and output waveforms of a 100 Hz toneburst with the low frequency sensitivity control at mid position, and demonstrates very severe distortion of the initial half cycle accompanied by the introduction of substantial harmonic components. Similarly, fig. 4 shows deterioration of the rise time of a 10k Hz burst with the high frequency sensitivity control at mid position.

The system is intended to work on the principle that the dynamic noise filter's bandwidth varies with the input signal level at high and low frequencies (as is shown in **fig. 5**) where the swept frequencies level was kept constant at -20 dBm and a 6k Hz pilot tone (which was filtered out) was used to control the dynamic noise filter. But this was not found to be the case when the high and low frequency sensitivity controls were at their extreme position which produced the identical frequency response curves shown in **fig. 6.** The complaint particularly applied to the low frequency noise filter, which in practice is the less important function because of the fact that common system noise is white noise of constant spectral density, and that the ear is very insensitive to random low frequency noise as was shown by Fletcher and Munsen.

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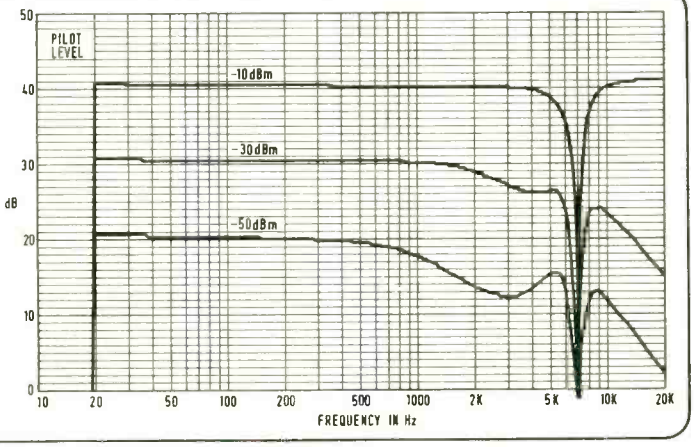
FIG. 5 BURWEN 1000 FREQUENCY RESPONSE AT –20dBm SIGNAL WITH 6KHz PILOT. MAX HF SENSITIVITY TO MIN HF SENSITIVITY

PEN: 100mm/S
PAPER: 3mm/S



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A & M Records, Hollywood, Studio D
Compumix™ Recording & Mixdown Console
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33 inputs, 3-section (Music, Dialog, Effects)
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32 inputs, 24 outputs, VCA sub-grouping

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Professional Recording Systems
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BURWEN 1000

In order to determine the effective increase in signal-to-noise ratio that could be obtained without apparent severe degradation of music and speech, the dynamic noise filter was first fed from a high quality source of programme and the high and low frequency sensitivity controls adjusted for just perceptible degradation of the output. Pink noise was then fed to the dynamic noise filter and the difference in output noise noted in the automatic and wideband modes.

Rather alarmingly the difference was only in the order of 3 or 4 dB(A) where the subjective impression was of a 6 dB improvement which was in fact found to correspond exactly to the 'D weighted' improvement.

Even under these conditions the operation of the dynamic noise filter was clearly audible and in fact most objectionable with such musical instruments as the flute and clarinet which have large harmonic contents at high frequencies. The general effect of the dynamic noise filter was that of excessive modulation noise from tape, but to a far greater extent than I have ever heard from tape. A little thought shows that the two effects are in fact very similar because tape modulation noise is in the form of sidebands which are not musically related to the fundamental. In the dynamic noise filter, random noise is increased around the fundamental giving a similar effect. This shortcoming was quite bad enough with monophonic operation, but stereo operation where the two noise filters are ganged in function gave even more unpleasant results, particularly when the dynamic noise filter was used on a noisy stereo programme accompanied by impulsive noise.

Conclusions

Firstly, it may be wondered why I have not paid more attention to the basic input and output facilities—the simple reason is that these are virtually identical to the Burwen noise eliminator (reviewed in the February/March issue of STUDIO SOUND) and it was felt unnecessary to repeat that they are excellent.

Generally the dynamic noise filter performs to specification, provided that one takes note that some of the publicity material is obtained from normal control settings which give a deceptive view of its performance at extreme control settings.

However, it is far from easy to specify completely what one can hear, and not always easy to decide if one can hear what one measures—it is in this sphere that the dynamic noise filter comes very unstuck. From the point of view of its use for noise reduction during the recording and reproduction of high quality speech and music I found its performance most unpleasant to listen to. While it certainly can give a reasonable degree of noise reduction without degradation of the frequency spectrum, I found that the characteristic of its noise breathing effect was most objectionable. While I always find breathing of wide band noise a considerable irritation, I think that I prefer this effect to the dynamic noise filter's modulation distortion effect.

Finally it must be mentioned that the Burwen dynamic noise filter does not require the determination of a precise operating level like the Dolby system, and that material treated with the dynamic noise filter does not require to be reproduced through anything but a normal reproduction chain. It is therefore a compatible system which can be used on signals that drift in level and frequency response, such as high frequency links, without any pretreatment of the signal at the transmitting end.

In conclusion I feel that the Burwen dynamic noise filter may have some specialised uses, but, at a cost in the order of £1000 per channel and with its poor subjective performance, it does not really offer any competition to a £350 set of normal variable filters where a compatible output is required, and most certainly no competition to the Dolby system (even Dolby *B*) where a coded signal can be used.

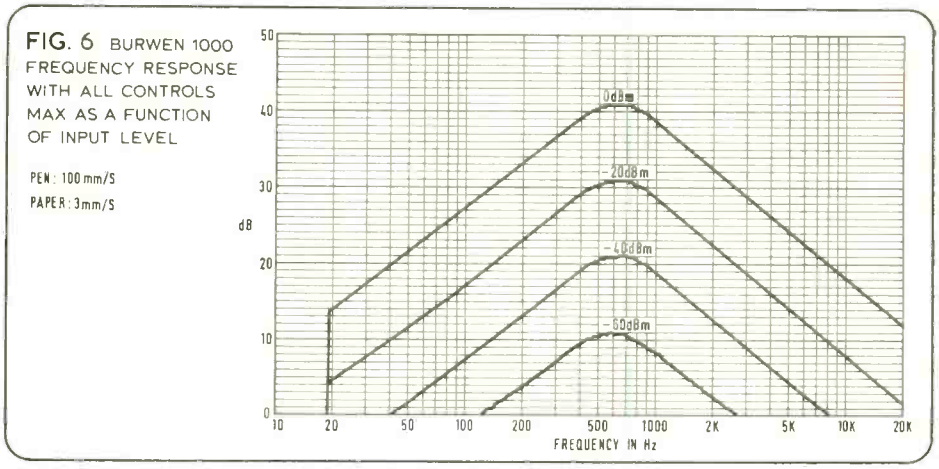

FIG. 6 BURWEN 1000 FREQUENCY RESPONSE WITH ALL CONTROLS MAX AS A FUNCTION OF INPUT LEVEL

PEN: 100 mm/S
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