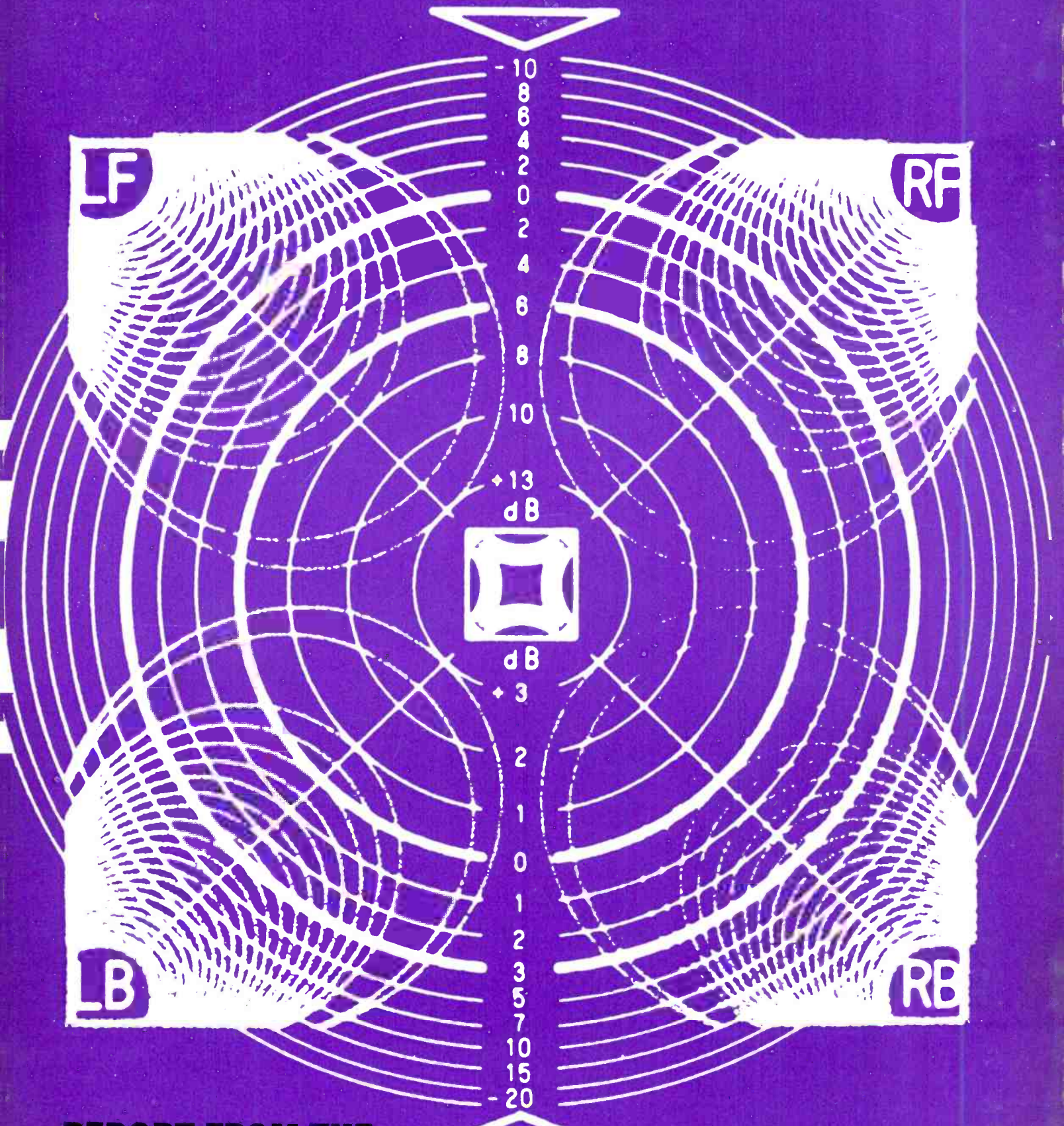
November 1973 25p

studio sound

AND BROADCAST ENGINEERING



REPORT FROM THE AES LOS ANGELES CONVENTION

EVERY PICNIC NEEDS A SYNTHI

Electronic Music Studios (London) Limited
277 Putney Bridge Rd., London SW15 2PT
Telephone 01-788 3491/2
New York 408 East 78th Street N.Y. 10021 U.S.A.

The Synthi Range by **EMS**

Another advanced Hi-Fi stereo tape recorder/amplifier from Philips.

3 heads. Solenoid-operated. Tip-touch controls. 2 x 12 watt RMS amplifier usable with the DC motors switched off. Two built-in loudspeaker enclosures.

This is the N4418, number two in the Philips range of advanced Hi-Fi stereo tape recorders. In producing this range, Philips have drawn on decades of experience in professional tape recording installations for studios, computers and airports the world over.

Each machine easily meets the DIN 45 500 standard for Hi-Fi tape recorders. Sophisticated design gives precise control, simple operation, and great reliability. Here are the main features:

4 tracks. 3 speeds – $7\frac{1}{2}$, $3\frac{3}{4}$, $1\frac{7}{8}$ ips.

Suitable for stereo and mono recording and playback, multiplay, echo during recording, A-B monitoring.

2 x 12 watt RMS Hi-Fi amplifier usable with recorder's motors and tape transport switched off.

Three motors – two DC motors for reel drive, one DC capstan motor electronically governed to keep tape speed constant.

Tape tension comparators for constant winding torque.

Three magnetic heads – one each for recording, playback and erase.

Detachable lower head cover for easy editing and cleaning.

For control of transport functions and recording mode, illuminated tip-touch controls are linked to solenoids – giving easier, quieter and more reliable operation.

Remote control unit (extra) with same tip-touch buttons as recorder.

Sliding switches for function selection–selected function illuminated.

Precise sliding faders for two microphones and another signal source.

Recording stand-by (level adjustable with tape stationary).

Two illuminated calibrated VU type meters for recording/playback.

4-digit counter, zero reset, and on/off Autostop to halt tape at pre-determined position.

Sockets for headphones and microphones easily accessible at front, concealed under sliding lid.

Built-in acoustical boxes giving 2 x 6 watts via 6″ x 4″ loudspeakers.

Reels lockable by means of metal hub locks.

Removable transparent lid.

Amplifier detachable in one unit leaving recorder functioning.

Frequency response:

40–20,000 Hz at $7\frac{1}{2}$ ips
40–16,000 Hz at $7\frac{1}{2}$ ips
with built-in stereo interference filter.
40–15,000 Hz at $3\frac{3}{4}$ ips
60– 8,000 Hz at $1\frac{7}{8}$ ips
} DIN 45 500

Wow and Flutter < 0·15 % at $7\frac{1}{2}$ ips.

See your Philips dealer for a demonstration. And for a free book on all Philips Hi-Fi stereo tape recorders, write to Philips Electrical Limited, Dept SP, Century House, Shaftesbury Avenue, London WC2H 8AS.

PHILIPS

Simply years ahead.

This is a book:
contents: approximately 100,000 words.
50 illustrations
reading time, 5-6 hours
It can be read by any literate person (2 out of 3 adults). It's probably the greatest invention since the wheel.

This is a video cassette:
contents: approximately 200,000 words, two languages. 90,000 pictures in colour
reading time: 60 minutes
It can be read by a child of 3 or an illiterate peasant. It's probably the greatest invention since the book.

...and this

is a teacher, entertainer and salesman all rolled into one — with a difference. It'll work 24 hours a day (weekends too) needs no paid holidays or Christmas bonuses and if it goes sick it is instantly replaceable. It will never replace people but it is a good understudy.

Action Video now have stocks of U-Matic video cassette recorders adapted so that you can use this exciting medium in the way that you want. Machines are available with options to fit into an existing set-up, while the U-Matic system possesses the flexibility and supporting equipment to form the basis of a new installation.

Blank cassettes cost less than £14 and give a full 60 minutes playing time and may be used time and time again. Recordings can be made from any TV camera, off the air, or from existing film material and can be played back on any monochrome or colour monitor or TV set. We are compiling a pre-recorded library too.

If you feel you could use an addition to your staff Action Video can help you (with some assistance from Sony, National Panasonic & Nivico).

Complete and return the coupon for full details of Action Video's adaptions of the U-Matic video cassette system.

Please send me details of the specially adapted U-Matic video cassette units. I am particularly interested in the following:

- ☐ Play only
- ☐ Play/Record
- ☐ NTSC colour
- ☐ PAL/SECAM colour
- ☐ NTSC/PAL/SECAM colour switchable
- ☐ Remote Control
- ☐ Pre-recorded programmes

Name_____ Position_____

Address_____

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We are manufacturers in the true sense of the word; producing Teak Cabinets, Sheet Metal Work, Tooling, Front Panel and Printed Circuit Artwork etc., our products are accurate with an attention to detail that is second nature to us.

The popular M10/2 (10in 2out) portable mixer shown is supplied as a basic unit with 10 Line inputs inc PPM, Oscillator, LF/HF Equalisers, Cue Lights, 1 Aux and PFL. You choose the number of Microphone or Gram inputs, the channels to have Presence, Switchable HF/LF Filters or Ducking. In addition a 2nd Aux channel, Talk-Back, and/or Compressors can be fitted.

Ring or write for full information, if however our standard range is unsuitable it may be possible to modify one to suit your requirements.

M10/2 Mk 2 BASIC .....£275.00+VAT
16 input version.....£415.00+VAT
12 in 4 out.....£495.00+VAT

MAGNETIC TAPES Ltd., Chilton Works, Garden Rd., Richmond, Surrey, TW9 4NS

Telephone 01-876 7957

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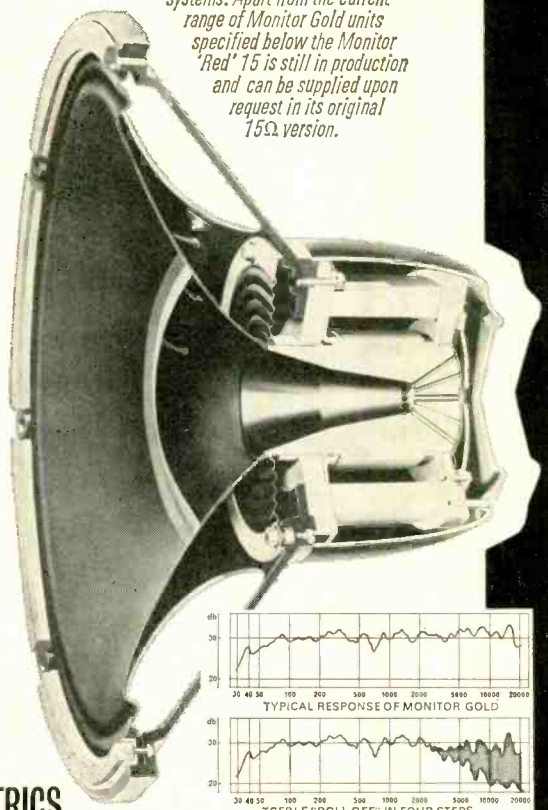
DUAL CONCENTRICS

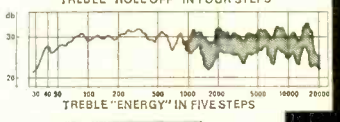
Versions of the Tannoy Dual Concentric loudspeaker have formed the basis of many of the best studio monitors for more than 25 years. The unit is incorporated in a variety of enclosures made by leading manufacturers both in the U.K. and abroad, as well as being incorporated in "package studios" produced by foremost U.K., European, U.S. and Japanese manufacturers. The unit not only has the advantages of high power handling capacity and long term consistency, but the level frequency response, good polar distribution and exceptionally low intermodulation products make it ideal for the highest quality studio monitor systems. Apart from the current range of Monitor Gold units specified below the Monitor "Red" 15 is still in production and can be supplied upon request in its original 15Ω version.



SPECIFY TANNOY DUAL CONCENTRICS FOR YOUR STUDIO MONITOR

TYPICAL RESPONSE OF MONITOR GOLD

TREBLE "ROLL OFF" IN FOUR STEPS


TREBLE "ENERGY" IN FIVE STEPS

TECHNICAL SPECIFICATIONS			
	FIFTEEN	TWELVE	III LZ
Frequency Response	23-20,000 Hz	25-20,000 Hz	27-20,000 Hz
Polar Distribution for 60° inc. Angle	–4dB at 10,000 Hz	–3dB at 10,000 Hz	–2dB at 10,000 Hz
Power Handling Capacity	50 watts*	35 watts*	25 watts*
Impedance Via Crossover Network	8 ohms (5 ohms min.)	8 ohms (5 ohms min.)	8 ohms (5 ohms min.)
Intermodulation Products	less than 2%	less than 2%	less than 2%
Bass Resonance	25 Hz	28 Hz	30 Hz
Crossover Frequency	1,000 Hz	1,000 Hz	1,200 Hz

* Depending on type of enclosure.

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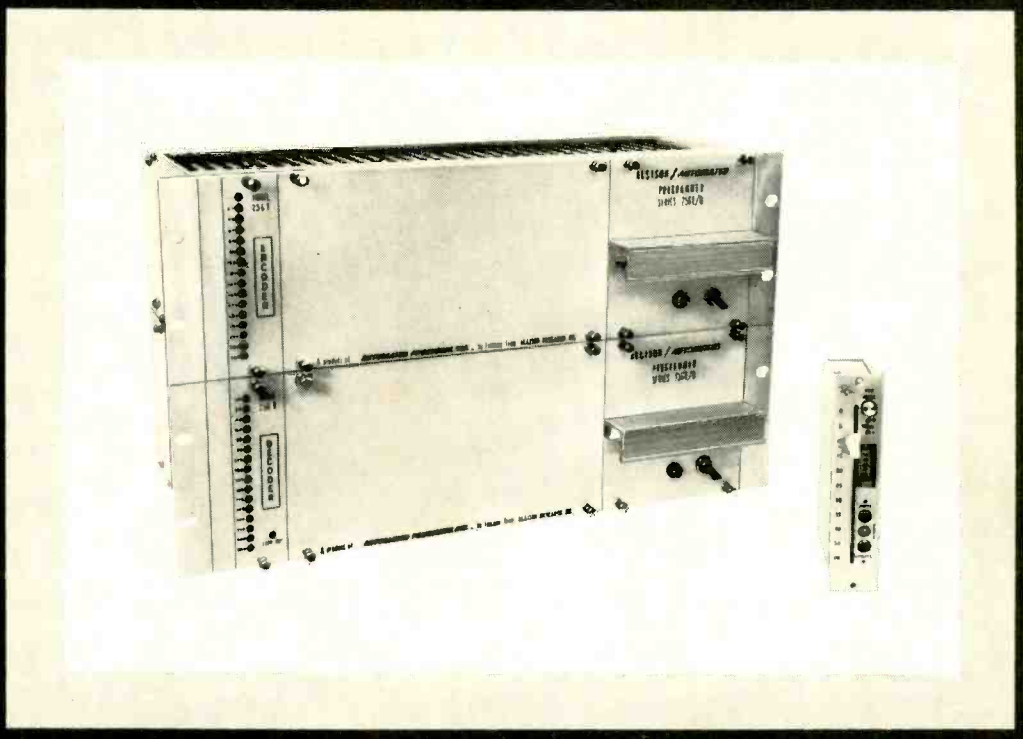
Get a lot more!



ANOTHER OPEN LETTER TO STUDIOS CONSIDERING AUTOMATION

Automation of mixing functions has progressed from a little bit to an "awe-ful" lot.

The **ALLISON RESEARCH/*AUTOMATED PROCESSES*** Programmer is, of course, at the heart of our entire system and it performs beautifully, readily accepting all the new and various inputs. Its capacity of 256 audio channels certainly is well conceived and desirable. The function utilization chart below will illustrate the arithmetic to substantiate this.

Function 1-24, individual channel gain
Function 25-48, individual channel echo send
Function 49-72, individual channel stereo panning (left/right)
Function 73-96, individual channel quad panning (front/rear)
Function 97-192, individual channel equalization (four functions per channel)
Function 193-216, master levels, echo returns, etc.
Function 217-256, future functions

It must be stressed that the 256 channels represent 256 different full range audio control functions. There is no other system on the market which can accomodate this necessary range! All of this flexibility has been accomplished with unbelievable accuracy. Hundreds of passes or revisions are possible without change or degradation of the stored data or its audio implementation.

The Model 940 Automated Fader is in production and has new remote control features for ease of operation. The other automation modules in the 900 Series are going into consoles as fast as we can produce them, and, because of their VCA technology, actually out-perform conventional audio modules in some respects.

A demonstrator unit has been completed featuring:

Automated Level Control,
Automated Echo Send and Return Level Controls,
Automated Quad Panning in each Input,
Automated Model 480 "Joystick" Quad Panner,
Automated Switching . . .
all with appropriate read, write and nulling features.

Many of these automated features were made economically feasible by a new **ALLISON RESEARCH** five output VCA!

We are building for or have delivered automation consoles ranging from level control to "the works" to such illustrious names as:

Leon Russell (Shelter Records)
Ferber Studios (France)
Music Recorders (Los Angeles)
Europa Sonor (France)
Westlake Audio (Los Angeles)
Studio "X" (France) 2 consoles

Another concurrent and equally revolutionary development adding to total automation, is our Maglink Tape Synchronizing System.

Automated Processes now really IS!

Please send for further information.

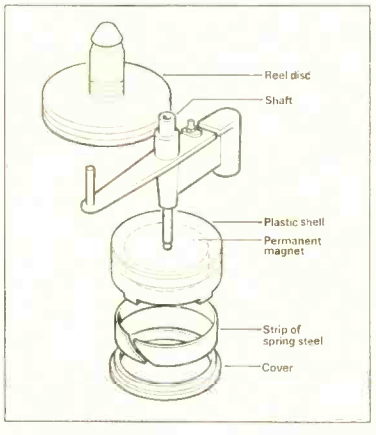
AUTOMATED PROCESSES, INC.
80 MARCUS DRIVE, MELVILLE, NEW YORK 11746 · 516-694-9212

West of Rockies: WESTLAKE AUDIO, Los Angeles, Calif.
Europe: 3M FRANCE, Paris, France
Japan: NISSHO IWAI, Tokyo, Japan

Philips invent magnetic clutch for cassette stereo -so smooth you won't hear a quaver quiver.

Just one of the advanced features of the new generation of Philips cassette stereo recorders is a new clutch that helps stabilise tape speed and give greater reliability.

Instead of a slip clutch using a felt pad compressed between two discs, which creates friction that can cause fluctuations in tape speed, we've developed an ingenious hysteresis clutch.



A circular permanent magnet on the take-up spindle is made to rotate by inducing hysteresis effects – a kind of delayed-action magnetic field that pulls the magnet round. This eliminates friction. And there's no felt to become worn or affected by changes in temperature and humidity.

That's not all

The Philips N2407, illustrated opposite, takes either standard or chromium dioxide Compact Cassettes, adopting itself automatically to the correct bias value and equalisation time constant. Most chromium dioxide cassettes have the special lugs needed to operate the recorder's sensing device.

The new improved magnetic heads pick up minimal tape dust, and gap widths are very accurately set.

To 'wipe clean' chromium dioxide tape, which is unusually deeply magnetised, the erase head has a double gap.

Dynamic Noise Limiter

We have included a DNL, with defeat switch. This increases the subjective signal-to-noise ratio, suppressing tape hiss during quiet passages without spoiling the natural brilliance of the music. It does *not* require specially treated recordings.

The 2 x 10 watt (RMS) amplifier can be used with the recorder's motor switched off, so the N2407 can form the heart of a Hi-Fi system.

Other features include monitoring through speakers or headphones; two VU-type meters; end-of-tape auto-stop with motor cut-off and flashing indicator; and 3-digit counter with zero reset button for easy pinpointing of any section of track.

Suggested selling price complete with two loudspeaker enclosures and a stereo microphone is £130*.

Ask your Philips dealer for a demonstration. And for a free Cassette System Booklet, write to Philips Electrical Limited, Dept SP, Century House, Shaftesbury Avenue, London WC2H 8AS.

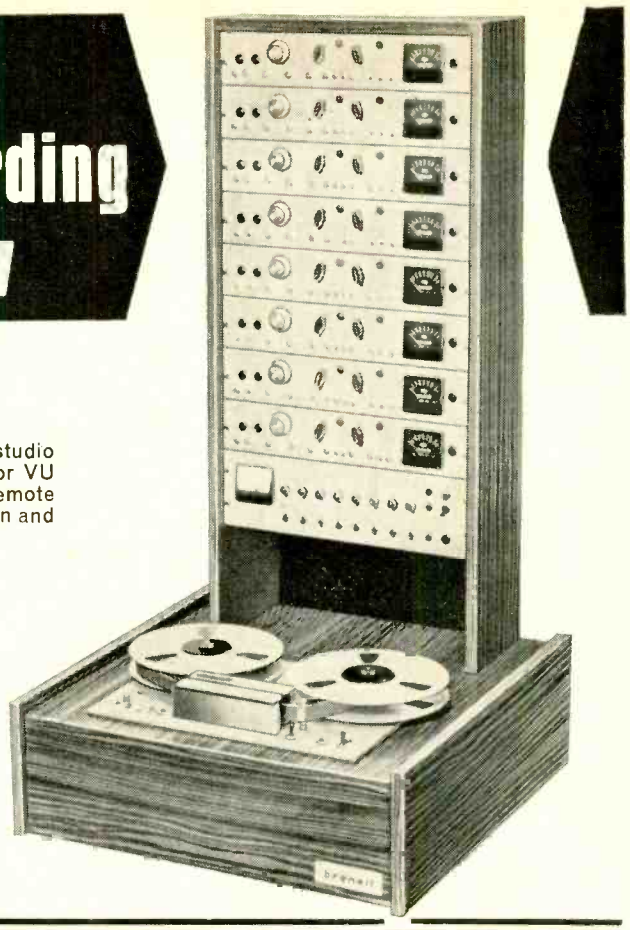
*Price subject to change without prior notice.

PHILIPS

PHILIPS

Simply years ahead.

NEW equipment for the professional sound-recording studio from brenell



DESIGNED AND MADE IN THE U.K.

MULTI-CHANNEL EQUIPMENT

We have set a new price/performance standard with our 4, 8 and 16 channel studio recorders offering full facilities for the production of master recordings. PPM or VU meters on each channel. Equalisation to CCIR, NAB and IEC characteristics. Remote control for tape transport and record functions. The equipment is in full production and studio use in both U.K. and overseas.

STUDIO RECORDERS

for 2-channel reducing, field recording and full-track mastering.

TAPE TRANSPORTS

We offer a widened range of 2 speed and 4 speed models from 15/16 to 60 IPS, ¼" to 1" tape width, with heavy duty solenoid operation and remote control facilities.

brenell

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Do you suffer from crosstalk?

For two years we have been quietly making our CNS (crosstalk and noise suppression) modules and selling them to studios and broadcasting authorities throughout the World. We have always been faced with the problem that we could never make enough, and so we instituted a programme of research, and developed an entirely new module based on integrated circuits. The result is that we can supply the new CNS Mk 2 from stock.

Whether your problem is mic-to-mic crosstalk, noisy limiters and compressors, or just plain system noise, this module can make startling improvements. (It even does wonderful things to that noisy air conditioner!)

Technically, it is a low level multi-band expander with frequency sensing circuitry. Practically, it is a multi purpose one-shot clean-up machine giving clarity that just isn't there on the original signal.

Expensive? Can you price the elimination of crosstalk and system noise at less than £100?

Give us a ring and if it is physically possible, we will arrange a demo.

Call Ted Fletcher or Jack Keene at WINDSOR 51056.

By the way . . . we also make mixers!

Alice (**STANCOIL LTD.**) ALEXANDRA ROAD, WINDSOR, BERKS. TEL. WINDSOR 51056

MACINNES moves with Amcron

We are pleased to announce that we have moved our Sales, Service and Stores into Macinnes House at Saxmundham. This will result in an even more efficient service for our customers, and we hope that we shall have the opportunity of welcoming you to our showrooms to discuss the products we market.

Amcron Amplifiers lead the world in reproduction cleanliness, rugged construction, and reliability. They are recognised in all fields of sound amplification as being the 'State of the Art' equipment, and the one by which others are judged. While others come and go, only Amcron continue to set the standard. If your needs are for an amplifier that will give the highest quality, that will stand up to being thrown into a truck each night and will be covered by a full 3-year warranty on parts and labour, then the Amcron range is for you.

The **NEW DC300A** will give up to 500 watts from one channel with distortion lower than 0.05%. Hum and noise is below 110 db below 150 watts, and the DC300A is now able to operate into loads as low as 1 ohm.

The **D150** offers up to 140 watts from each channel, or 330 watts as a mono amplifier. Again very low distortion, and rugged construction make the D150 ideal for smaller PAs and fold back systems.

The **D60** will provide up to 60 watts from each channel, and is of the same high quality as the D150. As a mono amplifier it will give over 100 watts. The D60 is only $1\frac{3}{4}$ in. thin.

MACINNES LABORATORIES LTD.

MACINNES HOUSE
Carlton Park Industrial Estate, Saxmundham
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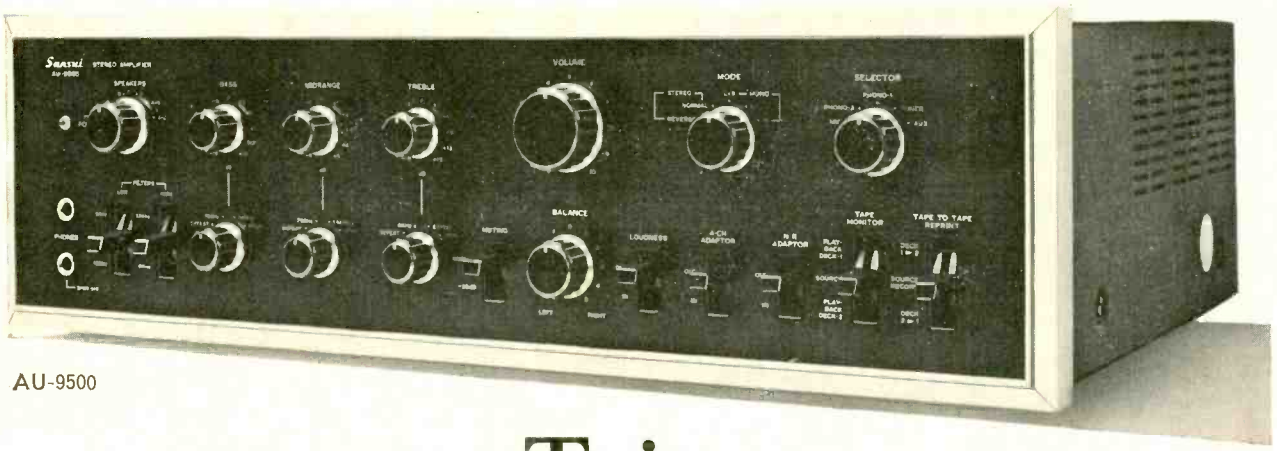
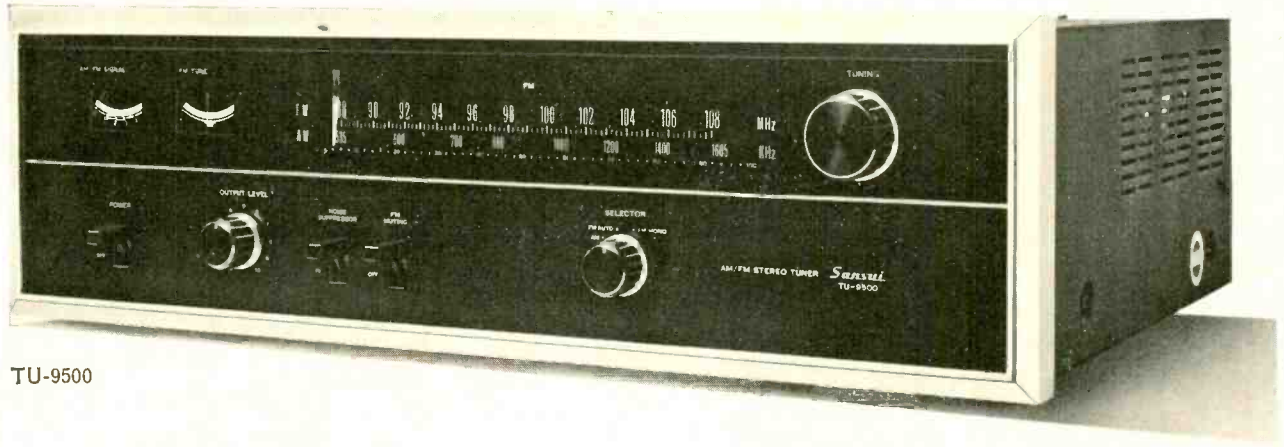
Tel. Saxmundham 2262, 2615

From Sansui a touch of genius.



AU-9500

Twice.



TU-9500

Having made a brilliantly versatile amplifier, we felt we couldn't leave it there.

So we made a brilliant tuner to match.

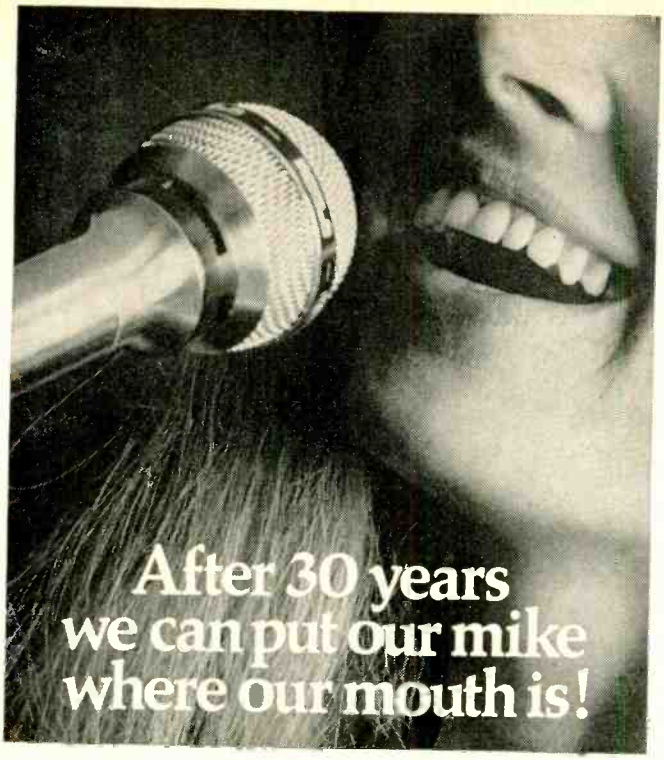
Our AU-9500 amplifier really can do an amazing number of things.
It handles three pairs of speakers with ease. Not to mention two turntables and two tape decks. It guarantees less than 0.1% harmonic distortion over the entire frequency band of 20 - 20.000 Hz, with 75 + 75 watt continuous output power into 8 ohms both channels driven.
This outstanding result is obtained by employing an all-stage direct-coupled OCL pure complementary parallel push-pull circuitry.

The TU-9500 is the other half of this talented partnership. It delivers a spectacular high input capacity of 130 dB that guarantees clean, distortion-free reception even in FM-congested urban areas. Now a whole world of outstanding FM reception can be yours.

Individually the AU-9500 and the TU-9500 are brilliant. Together they are even more. Hear them soon if you appreciate genius.

Sansui

England: VERNITRON LTD., Thornhill Southampton S09 QF - Tel.: Southampton 44811 □ SANSUI AUDIO EUROPE S.A., Diacem Bldg, Vestingstraat 53/55 - 2000 Antwerp Belgium □ SANSUI ELECTRONICS CORPORATION 55-11 Queens Boulevard, Woodside, N.Y. 11377, U.S.A. □ SANSUI ELECTRIC CO., LTD. 14-1, 2-chome, Izumi, Suginami-ku, Tokyo 168, Japan



For just over 30 years now RESLO have been making microphones of all shapes and sizes.

We believe that entitles us to a little trumpet-blowing about the quality and performance you can expect from microphones backed by that sort of experience.

There are some eleven different types of basic wired microphones covering a whole range of applications.

In addition RESLO make three superb radio microphones designed to add an extra dimension to your act by enabling movement free of trailing leads.

RESLO also make matched receiver units for the radio microphones and a wide range of accessories, stands, leads and clips for the other model types.

But after all's said and done, RESLO microphones speak for themselves, so for a start, why not send off the coupon below and we'll mail a brochure showing you our full range.

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It all sounds too good
to be true . . .

I'd like your full brochure on
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0·002% THD 100 watt per channel power amplifier

0·002% THD at all levels up to 10 watts and all audio frequencies. Less than 0·02% THD at all frequencies and all levels up to 50 watts, typically 0·004% at 1kHz and 50 watts. Intermodulation distortion is less than 0·03%.

The amplifer is unconditionally stable and does not ring even into a 2μF capacitor.

The two channels are power limited at 120 watts rms and a tracking short-circuit cut-off protects each of the four power supplies. There is also a thermal cut-out.

Both channels will deliver continuously more than 100 watts into a 4 ohm load or 70 watts into an 8 ohm load.

The frequency response is within 1dB from 10Hz to 20kHz and the noise is more than 100dB below 70 watts into an 8 ohm load.

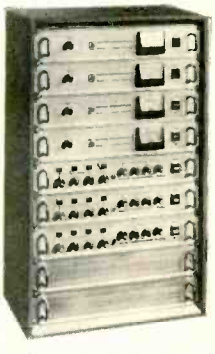
The case size is 430mm x 300mm x 76mm.

naim audio

The price of the NAP200 Amplifier is £140 + VAT.

15 CHURCHFIELDS RD·SALISBURY·WILTS·SP2 7NH·Tel:3746

"sounds perfect"



AT LAST your search is over. If second best just will not do, you should be using our range of high reliability equipment which includes power amplifiers, 100v. line transformers, microphone transformers, rack cabinets, and some superb electronic lighting control units. Delivery—usually ex-stock.

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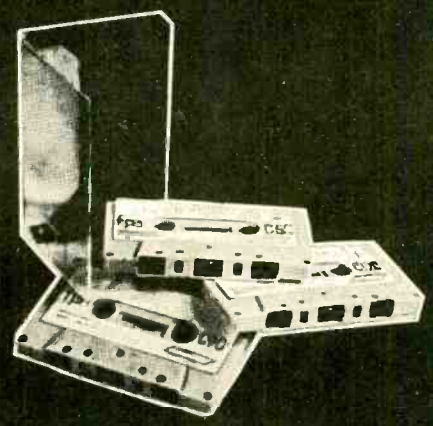

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PROFESSIONAL RECORDERS

for broadcasting and studio use

Our range includes console, transportable and rack mounting machines

Mono-stereo $\frac{1}{4}$", 4 track $\frac{1}{2}$", 4 track $\frac{1}{4}$" slow speed radio station loggers. All to IBA requirements.

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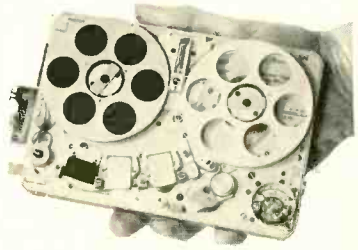
NAGRA III's ALWAYS WANTED FOR CASH



NAGRA SN MODEL AVAILABLE

50 Hz CRYSTAL £59.75 + 10% VAT PULSE GENERATOR

PANAMIC BOOM

A must for sound recordists

Detachable end mount for $\frac{5}{16}$" and $\frac{3}{8}$" thread. Anodised alloy tubes for maximum strength and minimum whip. Black finish for non-reflection. Velvetex non-slip grip. Length closed 5ft., extended 13ft. 4in. Weight 2lb. 4oz. **£65.00** + 10% VAT.

Sole distributors:

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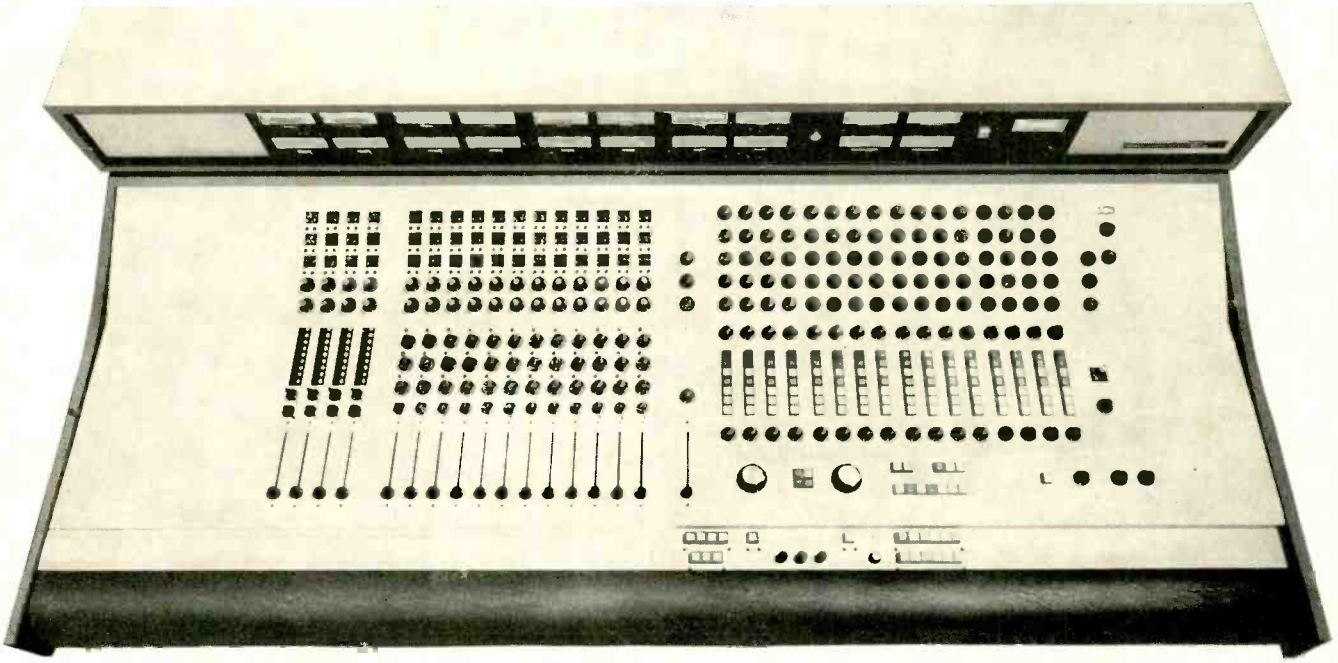
MANWOOD HOUSE, MATCHING GREEN, HARLOW, ESSEX CM17 0RS Telephone: Matching 476

Get your mind out of the clutter.



Taping a performance presents enough problems without worrying about being on the right track — that's why the Electrodyne Series 2000 was developed with you in mind.

But don't let that simplified panel layout fool you — A console doesn't have to look like a 747 instrument panel to be functional and effective.

This control board was so arranged that every operation can be reached from one sitting position (No Co-Pilots needed here!) Yet the functions are engineered to fit a man sized hand.

For example, the exclusive Electrodyne SML-20 channel assign switch module incorporates up to 24 assignment positions, 4 echo-send selections, program and echo quadraphonic pan pots and solo button, yet this compact panel is only 1½" by 9". And talk about curves! —

The Electrodyne 712 input module's 9 frequency graphic equalizer will really put your sound in shape.

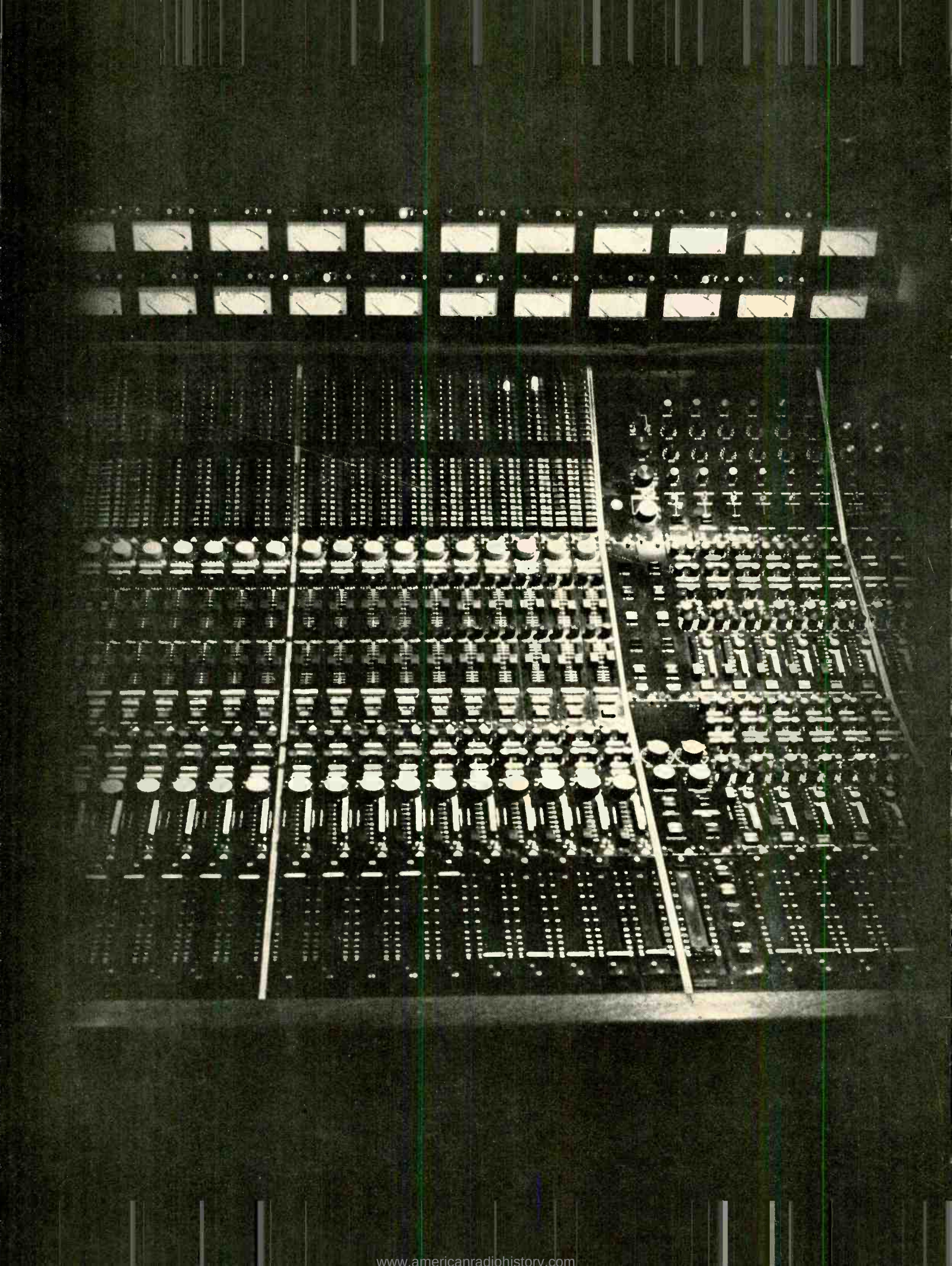
These and many other characteristics put you in command while freeing you to add the necessary creativity. After all — you're the man behind the board and you want results — not clutter.

That's why we've developed the Series 2000!

Cētec U.K.

a Division of Computer Equipment Co. Ltd.

Shaftesbury Street, High Wycombe, Bucks, England Phone: High Wycombe 37326. Telex: 837329



In the wrong hands it's wasted.

This is the Triad 'A' Series.

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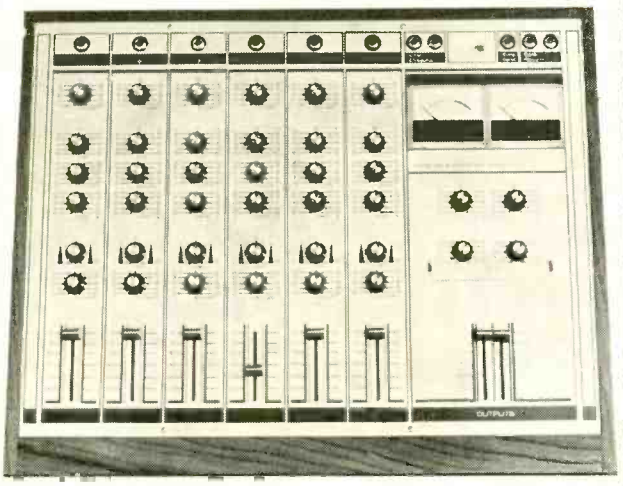

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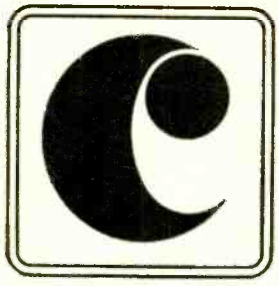

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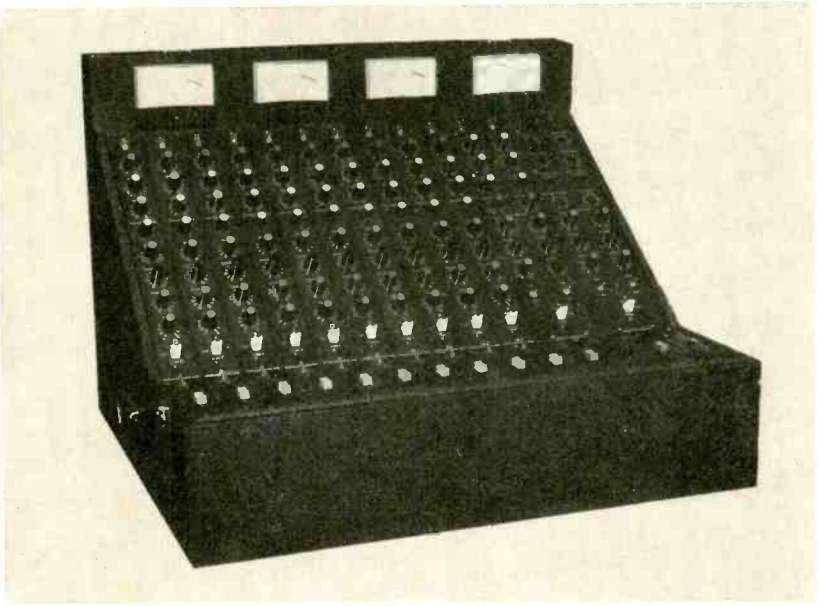

Chadacre Electronics Limited has now world wide distribution of its mixing consoles and associated products.

AGENTS

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FRANCE	**Rich Acoustics,** 25 Rue L Barthou, 64-140 PAU, FRANCE. Telephone 52328. Contact CHARLES RICH
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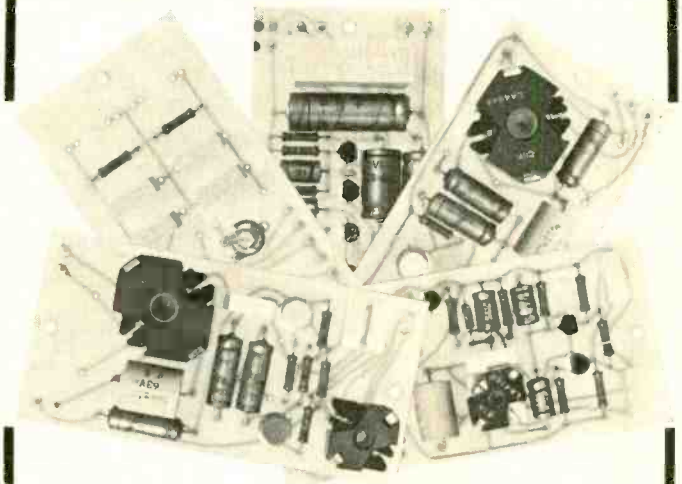

The MEG series of magnetic recording modules provide an economic means of modernising and modifying existing tape transports to multi-channel systems.
The modules are adaptable for deployment in up to 24 channels using a single Master Oscillator with separate bias and erase power amplifiers. Modules used for single channel operation do not become redundant when expanded to multi-channel applications.
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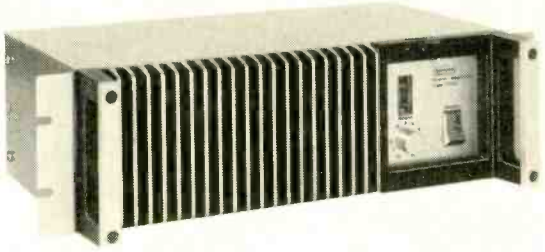

Since the company started the manufacture of the Series 7 Amplifiers, these have proved immensely successful with large Contracting and Rental Companies, and have proved so reliable in use that we now offer a 3 year warranty on these units.

Another off-shoot of the success rate of these Amplifiers is that they are now available in many variants as listed below:-

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743	Basic 50 Watt Amplifier.
7431	743 with Peak-Reading Output Meter.
7432	743 with Covered Controls and no Supply Switch.
7433	743 Studio Monitor version with Extended Frequency Range but no 100 volt Output.
744	Basic 100 watt Amplifier.
7441	744 with Peak-Reading Output Meter.
7442	744 with Covered Controls and no Supply Switch.
7443	744 Studio Monitor version with Extended Frequency Range but no 100 volt Output.
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7445	7441 with 70 volt in place of 100 volt Output.

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SS2

SNS Setting New Standards

NEWS

Capital Radio appointments

AIDAN DAY, formerly general manager of Scorpio Sound, has joined Capital Radio as music director. Mr Day joined the BBC from school initially as a filing clerk in the gramophone library, rising to the position of studio manager at 21. He later became a producer with Radio One.

Greg Grainger, a 26 year old Australian radio news reporter, was recently appointed duty editor at Capital Radio and is now working directly with news editor Ron Onions. Mr Grainger recently received an Australian award for the best news report of the year after his television coverage of the Sydney bomb explosions.

Triad win Japanese order

AGAINST THE mainstream of audio products, Triad Audio Developments recently supplied an *A Series* mixing console to the Crown Record Company in Toyko. The desk is a standard 24/16 system with additional quadraphonic facilities and was shipped from Triad's North London factory within 10 weeks of receiving the order. A further *A* console has already been ordered by Nippon Phonogram (Philips) of Tokyo for installation early in 1974.

Record pressing plant

A NEW FACTORY specialising in the manufacture of 30 cm discs has been established at High Wycombe. Managing Director is John Wooler, for many years with EMI. The premises are fitted with entirely new equipment and the company plan initially to specialise in small runs of up to 1,000. Trade orders only are being entertained. **Further data:** Sound Manufacturing (Hayes) Ltd, Temple Yard, 11a Temple End, High Wycombe, HP13 5DM, Buckinghamshire.

Chadacre appoint overseas agents

CHADACRE ELECTRONICS Ltd, manufacturers of mixers and audio effects units, have appointed agents in France, Scandinavia, Switzerland and North America. These are: Charles Rich (Rich Acoustics, 25 Rue Louis Barthou, 6400 Paux, France), Carl Nordstrand (Centroson Internationale, 14-3 Tegnerlunden, S-113 59 Stockholm, Sweden), Alfred Zemp (Emitage Delivery Zemp, Alberich-Zwyssig-strasse-49, CH-4530, Wettingen, Switzerland), and Michael Quinn (Chadacre Electronics Inc, 4 Lancaster Terrace, Worcester, Mass 01608, USA). Chadacre themselves recently moved and are now at 63 Stratford Broadway, London E15 4BQ.

North Sea communications

CONTRACTS TOTALLING £860,000 for the supply of radio and communications services to North Sea drilling rigs, production platforms and construction barges, have been won by the EAE subsidiary of Bonochord Ltd. The contracts were acquired during July and August and cover periods between two and five years. EAE now supply communication services to 54 locations in the North Sea.

Pyral prices

ALTHOUGH THE price of aluminium is expected to rise shortly, Pyral (UK) Ltd do not anticipate any increase in the prices of their lacquer discs. This statement from a Pyral spokesman was issued in reply to a rumour that their prices had risen or were about to rise. Reliable sources confirm that the rumour is baseless.

Britain's smallest outside broadcast unit, built by Dell Coachbuilders in conjunction with Ampex, for Independent Television News. A Range Rover houses two colour cameras and a vtr, crew and additional equipment travelling by separate Ford *Transit*.

Bob Auger Associates

BOB AUGER, formerly general manager of Granada Recordings' mobile recording unit, has taken over operation of the venture. The new company will be known as Bob Auger Associates and for the present continues to operate from the Granada premises at 1-3 Brixton Road, London, SW9. (Phone: 735 6675).

UK agency for DBX

SCENIC SOUNDS Equipment have been appointed North West European agents for the DBX range of noise reduction equipment, vc amplifier modules and test gear. Scenic Sounds are represented by David Hawkins and operate from 28 Bryanston Street, London W1H 7AB. Phone: 935 0141.

Scopex oscilloscopes

SURVEYING OSCILLOSCOPES in our August issue, we inadvertently omitted the fact that both Scopex instruments (the *4D10* and the *4D25*) are portable dual-trace models. The former, with a bandwidth of 10 MHz (–3 dB) offers a measuring accuracy of 5 per cent and has a 16-step calibrated sweep speed range of 1 μs/cm to 100ms/cm. It features a trace-locate facility and has internal/external triggering. Display area is 600 x 800 mm. The *4D25* is a 25 MHz bandwidth dual-trace oscilloscope with 3 per cent measuring accuracy and sweep speeds are 200 ns/cm to 200 ms/cm in 19 calibrated ranges. Full int/ext triggering and trace locate features are included.

SWAHBO go public

A SERIES OF publicity events to celebrate Hospital Radio Week were organised between September 23 and 29 by the South West Association of Hospital Broadcasting Organisations. The association now have branches in 21 towns. Details are available from Steve Coote, 35 Chesterfield Road, Portsmouth PO3 6LY, Hampshire.

Audio test unit

DESIGNED TO extend the facilities of their *ATS1* audio test set, the *ATU1* auxiliary test unit is the subject of a new folder available from Ferrograph. In addition to detailed specifications, the four page publication includes system diagrams and performance graphs. **Manufacturers:** The Ferrograph Co Ltd, 442 Bath Road, Cippenham, Slough, Buckinghamshire SL1 6BB.

Compact reverberation unit

FOUR MULTIPLES of 55 ms delay time, a signal-to-noise ratio of 60 dB, greater than 55 dB external noise immunity, and less than 0.25

per cent distortion at up to 18 dBm output are claimed for the *RV-10* reverberation unit. Manufactured by Quad-Eight (USA) and marketed by Feldon Audio, the generator accepts −20 to +4 dBm input, continuously variable, transformer isolated and floating. A three-position switch selects 100, 250 or 500 Hz bass filtration at 18 dB/octave, overall effective bandwidth being 100 Hz to 7 kHz. **Agents:** Feldon Audio Ltd, 126 Great Portland Street, London W1N 5PH.

Ic ppm

AN INTEGRATED circuit peak programme meter employing a new approach to level measurement has been developed by Key Electronics. The unit incorporates an Ernest Turner *643* movement and is designated *PPM2*. UK price is £40 in quantities of one to nine. **Manufacturers:** Key Electronics, PO Box 7, Bournemouth BH7 7BS, Hampshire.

Light chopper

A VIBRATING VANE chopper capable of modulating light or ion beams is now available from Brookdeal Electronics. Standard chopping frequency is 9.3 or 110 Hz (chosen to avoid harmonics of 50 and 60 Hz) with a corresponding 27V rms from 470 ohm reference sinewave for external synchronisation. A front panel control allows minor adjustment (typically ±2 per cent) of chopping amplitude, maximum usable aperture being 10mm². The chopper operates at up to 150°C and acoustic, magnetic and electrical emission are described as negligible. **Manufacturers:** Brookdeal Electronics Ltd, Market Street, Bracknell RG12 1JU.

Programme equaliser

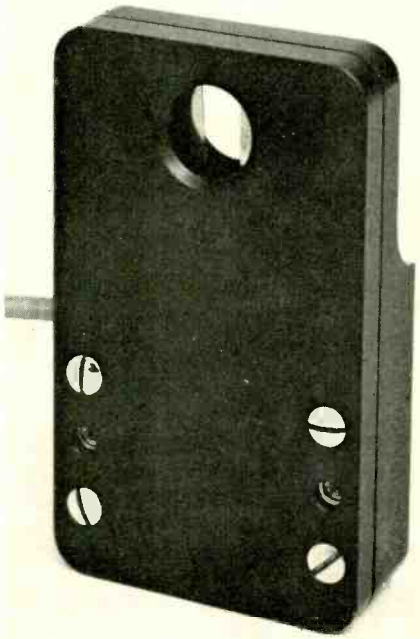
NEW FROM Auditronics, the *PEQ-82* audio equaliser provides ±12 dB adjustment at each of four frequencies simultaneously on each of two channels. A two-position switch above each level control selects the desired operating frequency: 80 or 150 Hz, 300 or 600 Hz, 1.6 or 4 kHz, and 7.5 or 12 kHz. Low and high frequency filters are also provided on each channel, with -3 dB points at 80 Hz and 10 kHz. The equaliser is warranted for one year and costs $325 (£130 nominal). **Manufacturers:** Auditronics Inc, 180-B So Cooper, Memphis, Tennessee 38104 USA.

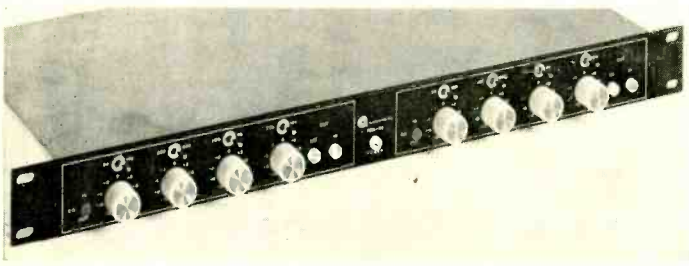
Continuity tester

PRICE £22, the Highams *HTM* provides audible or visual indication of electronic circuit continuity down to resistance as low as 0.1Ω. Sensitivity is variable from 0 to 10Ω, probe signal being 10 mV at 1 μA. The 1.5 kHz audio indication may be adjusted in volume to overcome differing ambient noise levels. Measuring 190 x 120 x 60 mm, the aluminium-cased unit operates direct from European or American standard mains. **Manufacturers:** Highams Electronic Communications Ltd, 58-60 Redchurch Street, London E2.

Audio equaliser

RECIPROCAL PEAKING at 15 frequencies in three ranges is offered by the *714* equaliser, newly introduced by Dover Systems. A five-position switch in each range (low, mid and high) selects the centre frequency while independent slide controls select up to 12 dB cut to lift. Operating frequencies are 50, 100, 250, 350 and 500 Hz (low), 700 Hz, 1.1, 1.7, 2.5 and 3.5 kHz (mid), and 2.5, 5, 7, 10 and 12 kHz (high), and over-ride switch being provided to flatten the system without involving other changes in control setting. The *714* is available self powered or to function from ±15V at 35 mA, maximum output level being +24 dBm. Panel dimensions are 178 x 42 seating 134 mm. **Manufacturers:** Dover Systems, 6232 Santa Monica Blvd., Hollywood, California.





BOOK REVIEWS

AUDIO CONTROL HANDBOOK FOR RADIO AND TELEVISION BROADCASTING by Robert S. Oringel. Fourth edition (October 1972) published by Hastings House, New York. 192 pages, hardback. Price £3.50. UK distributors: Focal Press Ltd, 31 Fitzroy Square, London W1.

IT IS A damning way to start but I cannot work up a great deal of enthusiasm for this book. Its appeal seems likely to be restricted to American readers in view of the extensive US terminology and jargon employed, together with illustrations using mainly US equipment and techniques which seem a little unfamiliar in Britain. A book that devotes 26 photographs to hand signs to be used between studio and control room and solemnly explains the meaning of 'thumbs up' does not appeal instantly to the intelligent reader and I have seen the raised clenched fist indicate something other than '15 seconds to go'. Possibly this book will have some appeal to the budding mid-Atlantic disc jockey wishing to familiarise himself with US practice.

To be fair, the book is well illustrated, well laid out, and possibly a useful study of studio practice in the USA. The author, on the staff of the US Information Agency's 'Voice of America', has had over 20 years experience of working and lecturing to courses with the VOA and this is reflected in the technique of putting questions at the end of each chapter to help readers check that they have fully absorbed all that has gone before. The book concludes with a glossary of broadcasting terminology that is not all familiar to this British reader.

I am not in a position to review this book for STUDIO SOUND's US readership, who might find it to their liking and advantage. But I must express my doubts from the British reader's point of view and suggest that anyone interested samples the contents before purchase. The Chapter on FCC (Federal Communications Commission) regulations might be of as much value as anything else to the international broadcaster who wishes to keep within the law.

J.H.F.

AN INDIVIDUAL NOTE by Daphne Oram. First edition (1972). 145 pages, softback. Price 99p. Publishers: Galliard Ltd, London W1.

IF YOU ARE a devotee of Mary Baker Eddie and enjoy the wallowing in the words with which 'Christian Science' indulges itself, you will probably also enjoy reading Daphne Oram's book very much. If on the other hand you are the kind of person who likes your science scientific and your Christianity related to Christ, you may have a little difficulty in staying the course. Which is a pity, because Miss Oram has some interesting things to say if she doesn't lose the reader first in her philosophical and metaphysical wonderings. Her descriptions and explanations are sometimes also a little imprecise, which seems to be more the fault of the language than of her knowledge. Her style is quite definitely 'individual' and much of the language invented for the purpose; frankly, I had to wade through this book.

Daphne Oram joined the BBC during the 1939 to '45 war, balancing music broadcasts, and in 1948 began experimenting with electronic music. She later helped set up, and directed, the BBC Radiophonics Workshop. Since 1959 she has been working at her studio in Kent on her own forms of electronic music production which she has named 'Oramics'. Works by Daphne Oram and by other composers using her techniques have been presented in concerts, festivals and the theatre on film, television, and radio. She has received two Gulbenkian Foundation grants for her work.

The author positively delights in words: dissecting them, inverting them, inventing them. She draws fanciful comparisons between charge in a capacitor and a composer's inspiration, carrying you away with her jargon: *elec* for the spark of composition and *cele* (the inverse) for its recreation, along with free use of symbols and symbolism. You find yourself flitting from tape to Francis Bacon and thence to howlround, from time to Robert McNamara on the human brain, to St. Augustine and Montaigne (the latter a favourite for quotes). Music, self-psychoanalysis and the use of computers whizz by.

Frankly, I felt this book would have been more informative, albeit less amusing (which Daphne Oram says she sets out to be), if she had stayed down to earth and told us more about the synthesis of music, about the development and practice of Oramics and other strains of synthesised, electronic and concrete music. Parts of chapters nine and ten, chapters 11, 12 and most of 13, would have made an excellent introduction to the subject as a magazine article and could have well been expanded. There are useful appendices on suggested listening and on Miss Oram's own works. But she does her work an injustice to cloak it in semi-mystic language. An example near the end, which really stuck with me, will give the flavour and the key to whether you would read the whole book or just the main chapters.

'I find it very exciting to think that our own personal wave-patterns may, according to their richness, energise many "vessels" when we "die". How fascinating to feel that part of oneself—perhaps just one of one's overtones—might, "in a twinkling of an eye," energise by sympathetic resonance an atom or molecule . . . of an arbutus tree . . . of an amethyst . . . of a sea anemone, of Mount Annapurna, of an antelope, of an Armenian . . . and . . . of the galaxy of Andromeda. What experience it would give "one"!

'Could individuality be viewed as the equal and opposite force which balances entropy? Just as a node balances an antinode? Could the world be a never ending pulsation of energy forming into individuality, then being disseminated by entropy, only to reform into new individuality—a basic pulsation, the very fundamental of all fundamental sinewaves?

'Do we need to wait for the death spark to feel this basic pulse? Is one not creating resonance all the time—an at *one-ness* which, alas, we seldom allow to penetrate our consciousness.'

I am still left wondering what Oramics is really all about.

J.H.F.

THE NEW WORLD OF ELECTRONIC MUSIC by Walter Sear. First edition (1972) published by Alfred Publishers, New York. 131 pages, softback. Price: $4.95. UK distributors: Music Sales Ltd, 78 Newman Street, London W1.

ACCORDING TO the cover, which is uninspiringly illustrated with a photograph of a double-ender jack lead, this is a 'practical book that gives the basic principles of sound, acoustics, electricity, magnetism recording techniques . . . necessary to understand the concepts and functions of the synthesisers and includes data on all commercially available synthesisers'.

The author sets out to explain the basic ideas and vocabulary of electronic music synthesisers. He assumes that many readers will have little or no knowledge of electronics, acoustics or the physics of musical instruments. He proceeds to put this right at great speed and, while there are simplifications and generalisations (magnetism and the microphone take up a mere third of a page), it is better than many so-called introductions to sound reproduction in the way it puts over a minimum of necessary information while keeping the subject interesting.

This introduction occupies some 60 pages, followed by a further 57 outlining simply the various aspects and functions of a synthesiser and the interconnection of synthesiser components. The remainder briefly describes the six families of synthesiser, giving the manufacturer's or distributor's addresses, and concludes with a summary and adequate index.

Walter Sear is himself a musician and an academic. He has been involved in the development of various synthesisers and his firm Sear Sound operate an extensive recording and electronic music studio in New York, as well as selling synthesisers. Mr Sear is obviously well placed to explain the basics and the philosophy of electronic music synthesising and in this, to my mind, he has succeeded.

Despite being written in the USA, the language is entirely comprehensible to the English reader—something which alas too few American semitechnical books seem to achieve. My only reservation in recommending this work as a basic introduction to sound recording and reproduction and to electronic music synthesis is its price which, even in this day and age, seems a little high for a paperback. **J.H.F.**

Would experts like John Borwick choose Philips loudspeakers in a competitive test?

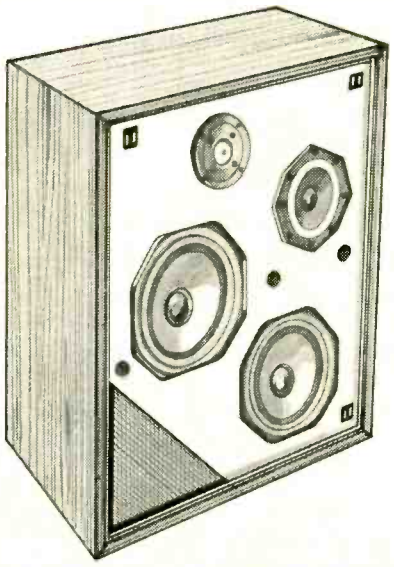
The short answer is yes. Which, if you're a Hi-Fi enthusiast, will probably surprise you almost as much as it did the Audio Editor of 'The Gramophone', John Borwick!

You see, though we've been making very good loudspeakers for years, mainly for professional use, we just haven't got around to telling you about them.

It's time the record was put straight.

You can read Mr. Borwick's report on the comparative loudspeaker test in the June '72 issue of 'The Gramophone' (pages 136-137).

On a visit to Philips at Eindhoven, he was asked to listen to several groups of loudspeakers hidden behind



an acoustically transparent screen. In each group was a prototype of the latest Philips speakers and two or three competitors' models in the same price range.

"It was agreed to use both classical and pop music in the evaluation and, without any collusion between us, we were astonished to find that I had given high marks on my score sheet to each of the Philips speakers in the various comparison groups.

These speakers scored over most of their competitors, in terms of brightness and presence, only occasionally sounding a little rough on particular records, which were perhaps worn."

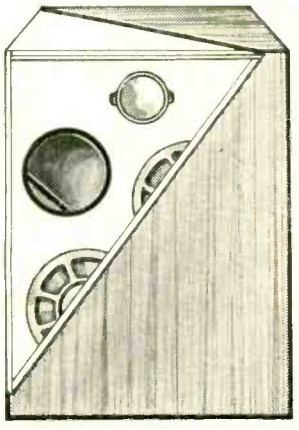
Now Mr. Borwick knows what he's talking about and what he's listening to. So we must be doing something right.

The speakers he heard were only prototypes – the final products are even better.

Our loudspeaker philosophy – no 'colour'. We believe that any 'colouring' of the loudspeaker sound can safely be left to the tone controls of an amplifier. We aim therefore to produce loudspeakers with a flat frequency response as measured via a real time analyser in ordinary living room conditions.

John Borwick's own feeling is that, "a *slightly* falling response, when measured in the Philips manner, may be best."

Other Tests. John Borwick concluded: "Philips also carry out anechoic room measurements of response, polar diagrams and distortion, using a wave analyser, multipliers and B & K pen recorders to plot 2nd and 3rd harmonic signal levels against the fundamental. This is surely the most sophisticated distortion check for speakers that I have ever seen in a manufacturer's premises."



Why don't *you* listen to Philips loudspeakers. Like John Borwick, you may be pleasantly surprised.

For a free 44-page book on Philips Audio, write now to Philips Electrical Limited, Dept. SP, Century House, Shaftesbury Avenue, London WC2H 8AS.

PHILIPS

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PATENTS

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

August 1

1329458 Licentia Patent-Ver-Waltungs-GmbH.
Broadcast receivers.
1329591 Mitsubishi Electric Corporation.
Apparatus for reproducing video information.
1329679 Motorola Inc.
Mounting arrangement for magnetic tape head.
1329698 Metson, G. H.
Microphones.
1329726 Philips Electronics & Associated Industries Ltd.
Optical scanning arrangement.
1329787 Sony Corporation.
Apparatus for magnetically recording and/or reproducing a video signal on a magnetic tape.
1329817 Nippon Gakki Seizo KK.
Soundboards for use in a piano or like stringed instruments.
1329927 Western Electric Co Inc.
Digital video receivers.
1329928 Philips Electronic & Associated Industries Ltd.
Apparatus for recording and/or playing back magnetic recordings.
1330016 Satt Elektronik AB.
Procedure for automatic impedance matching and device for implementation of the procedure
1330024 Sony Corporation.
Magnetic recording and / or reproducing apparatus.
1330026 International Business Machines Corporation.
Semiconductor switch
1330260 Siemens AG.
Electrical control of a beam of coherent light.

August 8

1330507 Wurlitzer Co.
Electronic keyboard musical instruments.
1330835 Airmed Ltd.
Microphones.
1330864 American Express Investment Management Co.
Scanned holography systems using temporal modulation.
1330880 Fuji Photo Film Co Ltd.
Method of duplicating magnetic tape.
1330923 Burroughs Corporation.
Magnetic tape recording systems.
1330926 Sony Corporation.
Fm stereophonic receiver.
1330928 Agfa-Gevaert AG.
Magnetic tape cassette.
1330968 Gendin, G. S.
Earphones.
1331031 Siemens AG.
Circuit arrangements for synchronising a plurality of variable frequency oscillators.

August 15

1331298 Olympus Optical Co. Ltd.
Apparatus for automatically operating a selected one of a plurality of tape cassettes.
1331302 Intermedcraft Corporation.
Magnetic tape apparatus.
1331369 Coulter Electronics Ltd.
Malfunction detection circuit blocking transmission of signals when the difference exceeds a predetermined value.
1331409 Parry, D. W.
Method for the display of images.
1331424 EMI Ltd.
Apparatus for producing an image of an object.
1331437 Commissariat A L'Energie Atomique and Compagnie Internationale Pour L'Informatique.
Integrated magnetic head and method of manufacture of said head.
1331480 RCA Corporation.
Photograph pickup.
1331574 Licentia Patent-Ver-Waltungs-GmbH.
Process for recording a PAL colour television signal.
1331593 Hitachi Ltd.
Noise suppression circuit.
1331594 Hadock, G. F. C.
Device for raising and lowering gramophone pickup arms.
1331755 RCA Corporation.
Liquid crystal colour display.
1331763 Eastman Kodak Co.
Ultrasonic transducer.
1331768 Philips Electronic & Associated Industries Ltd.
Automatic level control device for use in telecommunication systems.
1331841 Mitsubishi Denki KK.
Electroacoustic transducer.

August 22

1332092 Ulrich, B.
Arrangements for storing and transporting rolls of film and sound recording materials.
1332279 Philips Electronic & Associated Industries Ltd.
Circuit arrangement for compensating drop-out in the reproduction of signals recorded on a record carrier.
1332336 Dayton Wright Associates Ltd.
Audio system including electrostatic loudspeaker.
1332352 RCA Corporation.
System for recording and playing back colour encoded holograms.
1332592 Sony Corporation.
Colour television camera.
1332681 Canon KK.
Magnetic recording and reproducing apparatus.
1332729 Philips Electronic & Associated Industries Ltd.
Electro-magnetic recording.
1332742 Gould, T.
Device for testing the pitch of a musical or tone-producing instrument.
1332845 RCA Corporation.
Apparatus for handling endless tape.

August 29

Publication delayed by August Bank Holiday.

Synthesising vocal sounds

IBM in BP 1,304,929 give a helpful rundown on past progress in the art of synthesising vocal sounds. Originally the easy way out was taken and a vocabulary prerecorded on a magnetic drum. This vocabulary was spoken by professional actors and the computer extracted the necessary words at the necessary times. But the vocabulary was limited to around 200 words and increasing it presented problems, especially if the original actor had emigrated.

True synthesis in the early days involved simple juggling with phonemes. The original idea was simply to juxtapose the frequency spectra representative of the phonemes but this presented all kinds of problems such as with silent letters and because phonemes must run smoothly one into another.

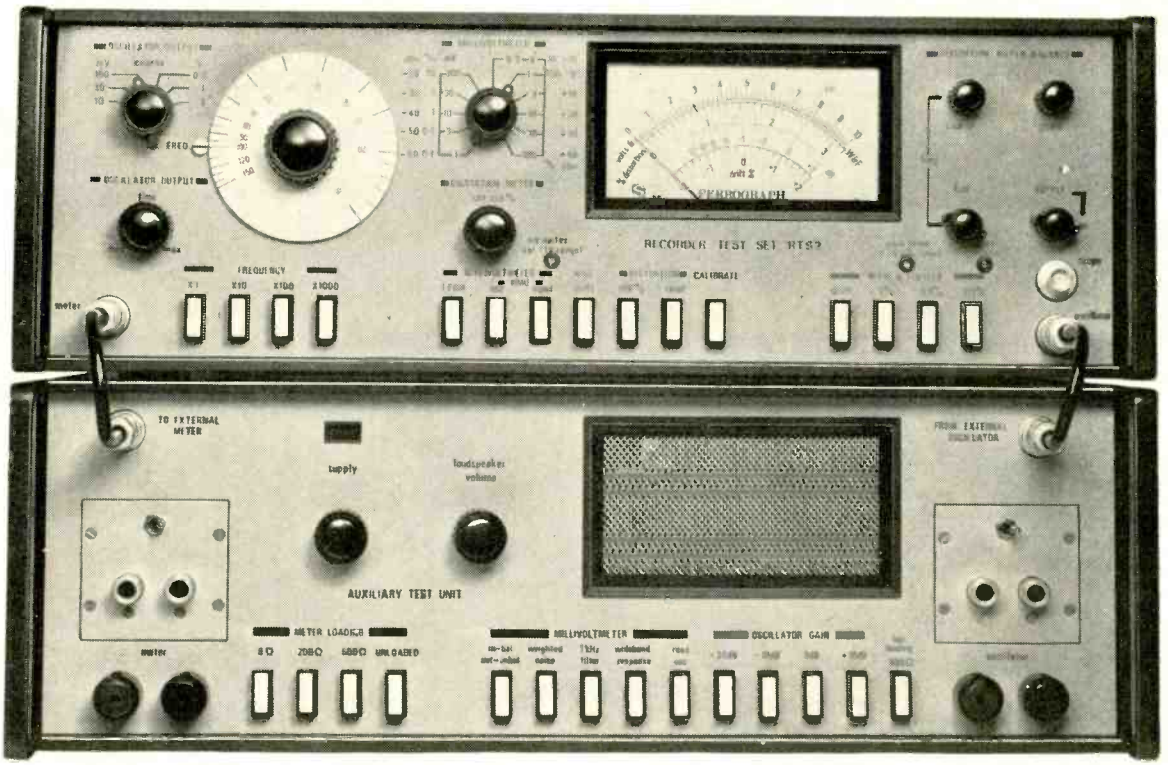
US patent 3,158,685 describes techniques for transition by distinguishing between steady phoneme states and transistory interphoneme states. But in terms of what it all sounds like, this is not altogether satisfactory. Next came a proposal that transitions be calculated by assigning a 'weight' to each phoneme with transition made in steps between the steady state of one phoneme and the steady state of the next. The problem here is that the calculations necessary involve nine parameters to define each steady phoneme state.

In the new IBM patent, a first code sequence representing a sound sequence to be synthesised is converted into a sequence of phonemes. Codes of spectral functions (defined as the coded representation of the energy level in different frequency bands) are determined according to stored rules and codes of spectrum functions corresponding to interphoneme transitions are likewise determined. The codes of spectrum functions are assembled in order and fed to a synthesiser in accordance with stored rules which govern time duration.

The patent describes how a total of 125 spectrum function codes are stored, each represented as a 15 digit number and each digit being any number from 0 to 7, so as to specify the energy density of the sound spectrum in 15 bands over a range of 0 to 35 dB by 5 dB steps. Each phoneme is allocated a duration in time units, the first of which is allotted a spectrum function representing the influence of the preceding phoneme and the last two of which are allocated spectrum functions representing the influence of the succeeding function. The remaining time units which are uninfluenced by other units are allotted spectrum functions representing the phoneme. There are also

38 ▶

Audio Test Set RTS 2



and Auxiliary Test Unit ATU1 for professional users

RTS2 Checks Amplifiers, mixers, tape-recorders

For Frequency Response · Signal/noise ratio · Distortion · Cross-talk · Wow & flutter · Drift · Erasure · Sensitivity · Output power · Gain

ATU1 Extends output level and measurement sensitivity. Provides balanced input/output facilities. Incorporates weighting filters, loading circuits. Has built-in speaker for monitoring purposes.

Send for leaflets RTS2 & ATU1

FERROGRAPH

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PATENTS

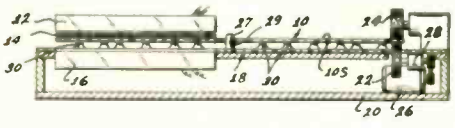
stored patterns of excitation function variation or melodic segments and selection is controlled by an operator or correlated with the phoneme.

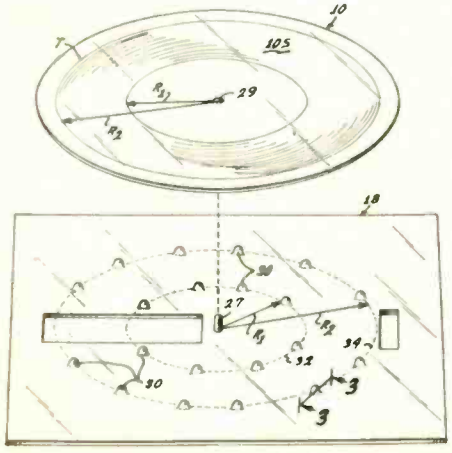
In one actual case a central processing unit feeds, for each word to be synthesised, seven bits specifying the first spectrum address, seven specifying the initial fundamental frequency value, four specifying the melodic segment, and further groups of seven and four bits specifying succeeding spectrum addresses and melodic segments for the remainder of the word. **A.H.**

Disc drive

OPTICAL DISCS are used in some types of organ to generate tones. They have also been used in speaking clock systems. Separate tracks are defined by pairs of circular opaque border lines with a transparent line of variable width track in between. This track is like the optical track of a sound film and light is shone through it to fall on photocells. But this calls for a transparent turntable which may be somewhat awkward to arrange. Mattel in BP 1,303,945 suggest using a stationary table support on which the optical disc is rotated. First impression is of all manner of problems. including static and scratching. However, Mattel suggest using a stationary support with protrusions over its surface to serve as bearing surfaces for the disc which is rotated by side wheels. These protrusions are arranged in two or three concentric circles so that an absolute minimum of disc area rubs against them. This keeps static charges down. By arranging the tracks and photocells away from these bearing circles, where scratches and dirt would inevitably build up, only the optically true parts of the disc are used.

Fig. 1 shows the disc *10* and the metal support plate *11* with an area cut out to pass the light beams through to the disc and on to photocells (not shown). Two rings of protrusions *30* with radii *R1* and *R2* carry the disc with a minimum of friction. **A.H.**

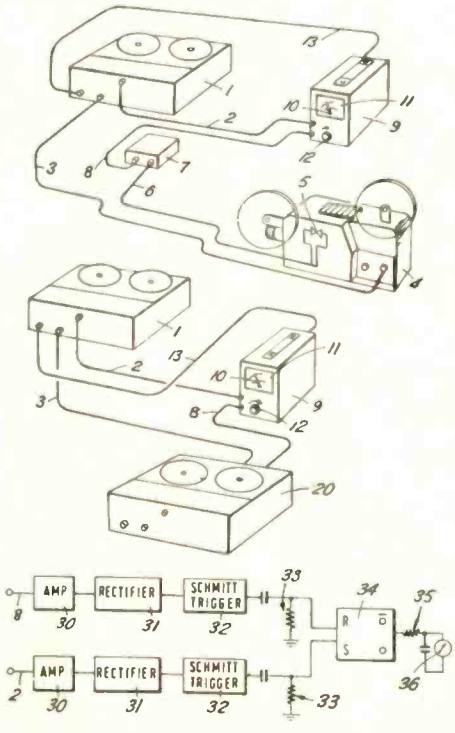




Syncing film and tape

IN THE HOME movie world, the Farnell-Tandberg system developed by Arthur Dakin is fairly well known. BP 1,304,288 explains the technique. Home movie film is exposed in a camera and audio simultaneously recorded on a tape recorder. Sync is achieved with pulses (chopped 1 kHz tone) produced by a make-and-break contact in the camera, and fed to the tape recorder. The Farnell-Tandberg system allows married transfer of the tape track either to magnetic stripe film or perforated tape so that picture and sound can be edited.

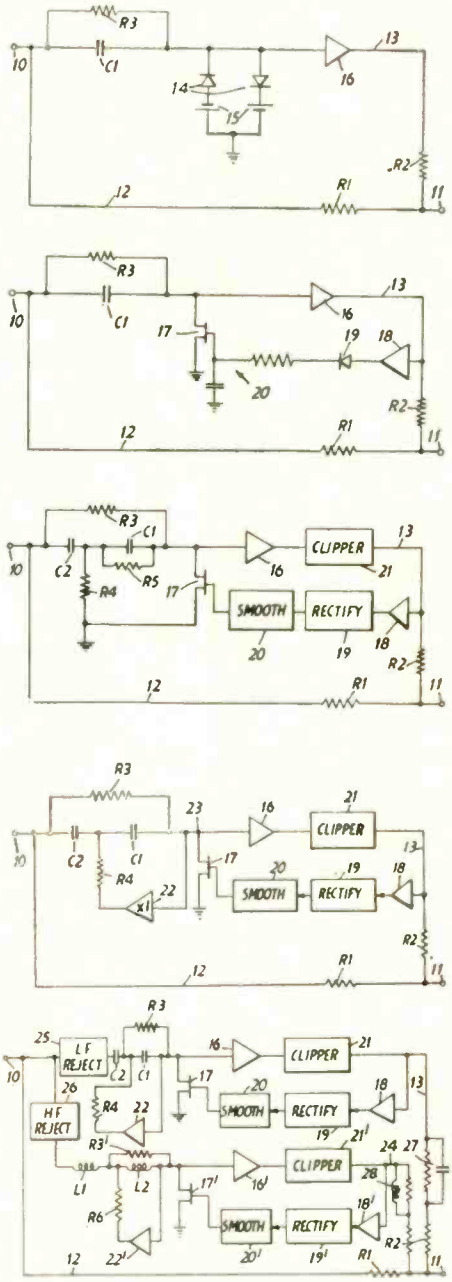
Fig. 2 shows the system for transferring tape to magnetic stripe film. The tape is reproduced on a variable speed recorder *1*, which plays both the recorded sound and the sync pulses. The latter are fed out on line *2* and the soundtrack on line *3* to stripe projector *4*. This projector has a pair of contacts *5* which close once per frame and are connected by line *6* to tone generator *7*, which provides on line *8* a chopped 1 kHz tone. Thus two separate sets of sync pulse are present—one from the original tape recording on line *2* and one from the projector on line *8*. These sets of pulse are fed to unit *9* which has a circuit as shown in fig. 3. Thus each line *2* and *8* feeds an amplifier, rectifier, Schmitt trigger and differentiating circuit *33*. The output from the two circuits *33* are fed to set and reset inputs of bistable *34* and milliammeter *36* receives the output of the bistable via smoothing circuit *35*. The meter has a centre zero and indicates the difference in phase of the two signals on lines *8* and *2*. The unit *9* has a control knob *12* which operates a potentiometer coupled via line *13* to vary the speed of the tape on recorder *1*. By adjusting 12 to bring the meter to its centre zero, the tape being played on recorder *1* and the stripe on projector *4* can be kept in sync. I gather that the system works, insomuch as it does allow sync to be achieved fairly early.



The middle chain allows transfer from tape to perforated tape with the projector *4* replaced by a recorder *20* which is capable of recording one track while replaying sync pulses. Otherwise the system is exactly comparable to the tape-to-stripe transfer. **A.H.**

Dolby C?

BP 1,305,622 CLAIMS some improvements to the basic Dolby system patents (BP 1,120,541 and 1,253,031). The patented system relies on a main straight-through signal path for high level signals in which no processing whatsoever



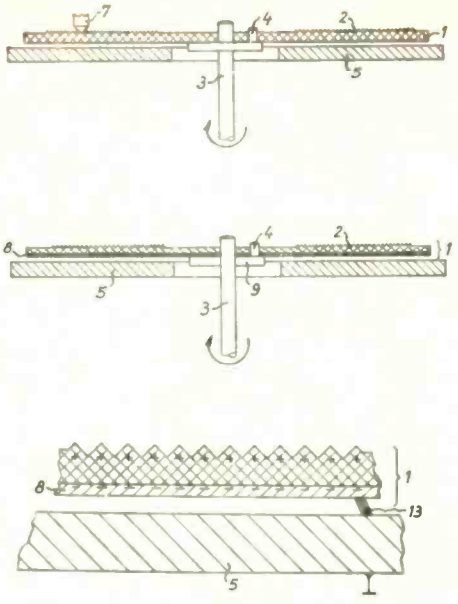
Left: Fig. 1
Near left: Figs. 2 and 3
Above, top to bottom: Figs. 4 to 8
Above right, top to bottom: Figs. 9, 10, 11

occurs. A second path treats low level signals only and, on joining it again, boosts or reduces the main signal to compress or expand as and when called for. In the *A* system, the processing path splits up its signals into various frequency bands and treats them differently. In the simpler *B* type system, a single frequency band is used but this moves up and down in frequency depending on the characteristics of the signals and their need to be treated.

The new patent protects circuits which seem essentially to be of *B* type but, especially as mention is made of their possible use for disc noise reduction, the specific circuits are worth looking at. **Fig. 4** shows a main path *12* (no treatment) and a processing path *13*. Under low level conditions, the signal is passed by resistor *R3* and amplified at *16* to boost the output of the compressor. When the signal level rises, the diodes *14* conduct and two things happen. Firstly the input, and thus output, of amplifier *16* is limited so that the output of path *13* falls in comparison to path *12*. This is what produces compression. The second effect is that a high pass *CR* filter is created by *C1* and the diodes *14*. Thus the path *13* changes from a wide band path to a high pass filter. **Fig. 5** shows a circuit in which the diodes *14* are replaced by fet *17*. Both these simple circuits in practice lack good discrimination against medium and low frequencies under high level signal conditions so noise modulation may result. The circuits of **figs 6** and **7** provide a sharper cut-off, but still with only one active element in the filter. In these circuits, however, the low and mid frequency further path limiting action is insufficient at high levels. This is mainly due to low gain of the control amplifier at low frequencies. Increasing the low frequency loop gain too far causes the hf to be affected necessarily by lf signals. An alternative approach would be to increase the low frequency path impedance driving the fet but, at high frequencies, shunting by *R3* will cause a mid frequency dip in the response. The **fig. 7** circuit avoids this quiescent condition dip and value-juggling should allow an intentional mid-frequency dip in the overall compressor output under conditions of moderate limiting. But there may be some interdependence between the low frequency and the high frequency noise reduction obtained. Again this can produce modulation effects. The **fig. 8** circuit is an answer and this is the one suggested for disc noise reduction. In this circuit the further path is made up, not of a single path, but of separate sub-path *13* and *14* which deal with high frequency plus mid band and low frequency plus mid band noise respectively. In other words, the **fig. 8** circuit seems to be something of a combination between *A* and *B* type system. Is this something that will one day be commercially available, perhaps? **A.H.**

Video discs

LICENTIA PATENTVERWALTUNGS GmbH of Frankfurt are very active in the video disc field. In BP 1,309,400 they explain how thin flexible discs floating on air (Teldec fashion) pick up electrostatic charges and thus fail to run true. The answers proposed are hardly world shattering but bear brief mention. One is to make the support *5* over which the disc *1* floats (**fig. 9**) of insulating rather than conductive material. If *5* must be made of metal, then



the disc is covered on its under surface with a coating of conducting paint or lacquer. The coating earths via the spindle drive (*3*, *9*, *4* in **fig. 10**). If the spindle drive is non-conductive, then tiny conductive brushes can be fixed on the conducting surface at the bottom side of the disc, so these rub over the metallic base plate and serve the same purpose (see brushes *13* in **fig. 11** connecting surface *8* of disc *1* to support plate *5*). **A.H.**

NEWS

Audio transformers

SPECIFICATION SHEETS relating to a new range of audio transformers are now obtainable from Marinair. Eight transformer types are described, comprising two microphone, two matching and four line-bridging. **Manufacturers:** Marinair (Radar) Ltd, South Road, Temple Fields, Harlow, Essex CM20 2AY.

Audio modules

MICROPHONE, GRAM and general-purpose pre-amplifiers, manual and voice-operated faders, monitor and power supply units are among the mixer components described in a 20 page catalogue available from Partridge Electronics. The modules are available individually or in a variety of cabinet formats and are described as equally suitable for public address, recording and broadcasting. **Manufacturers:** Partridge Electronics, 23-25 Hart Road, Benfleet, Essex, SS7 3PB.

Sibilance controller

SUPPLIED WITH three independent de-essing channels on a 45 mm rack panel, the Orban/Parasound *DSC* dynamic sibilance controller features a 1 ms attack and 50 ms release time. The unit follows the conventional pattern of a limiter with frequency-dependent feedback and incorporates an adjustable threshold control and click-free override switch. Price is £395 (£158 nominal). **Manufacturers:** Parasound Inc, 680 Beach Street, San Francisco, California 94109, USA.

Above: Described as the first audio tape machine designed with the needs of the audio engineer in mind, the Electro Sound *ES-505* was one of several new recorders introduced at the Los Angeles AES Convention. Report on page 54.

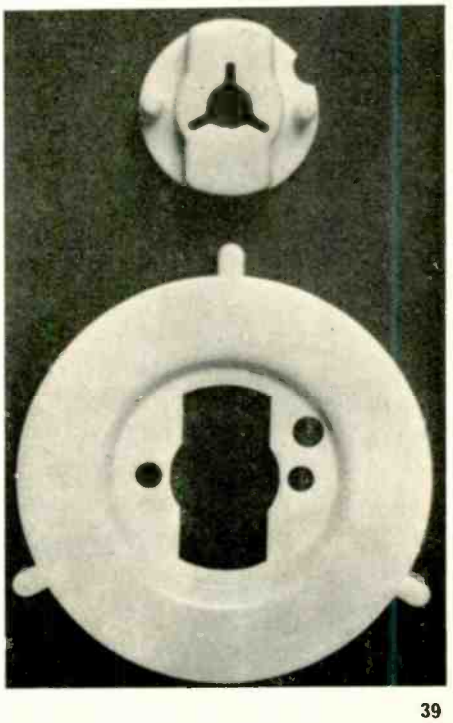
Strip indicators

RECENTLY RELEASED by Penny & Giles, a 16 page brochure describing the company's electrical and pneumatic input strip indicators. Capable of being read from up to 3m, the indicators employ sealed motor units. Also listed are *MP* motorised and *SP* servo potentiometers. **Manufacturers:** Penny & Giles Ltd, Mudeford, Christchurch, Hampshire BH23 4AT.

Headphones

STEREO AND 'quadraphonic' headphones manufactured by Clark are now being imported from the USA by Hampshire Instruments. The present range comprises six models varying in price from the 225 gm stereo *75* at £9.50 to the four-transducer *4CH-A* at £55; both prices include VAT. **Agents:** Hampshire Instruments Ltd, PO Box 28, Eastleigh, Hampshire SQ5 5XD.

Below: Can anyone identify the origin of the Cine-European-NAB adaptor shown below? Sent in by a mystified reader, they are made from white plastic and carry no trade engraving.



AROUND THE STUDIOS

ANVIL

By Ken Cameron

TWENTY-ONE YEARS ago, give or take a few weeks, the Crown Film Unit, that stalwart of the British documentary film movement, was closed down by the Government as an economy measure. Its technicians, most of them highly skilled in their individual techniques, were thrown out into an industry which was then going through a critical period (when is it not?). The studios at Beaconsfield, with two stages, plenty of cutting rooms, and a useful sized music recording and dubbing theatre, were rendered dark. It was all very sad and the Press, the Opposition, and many good friends and supporters did their best to change the official mind. But even an adjournment debate in the House of Commons at 2.30 in the morning failed. And that appeared to be that.

A good deal of outstanding work, mostly in the field of foreign version recordings, remained incomplete on the day of execution and pressure was brought to bear upon the Treasury for a minimum number of audio, projection and editing technicians to remain in the sound department for a maximum of three months. This was reluctantly granted and, while the bonfire disposing of Crown records was burning in the car park, just five members carried on. They did not particularly want to remain like ghosts amongst the ruins of Lidice but had an ulterior motive. This temporary reprieve gave a breathing space for four senior members of the old unit to try to form themselves into a company to carry on the old tradition.

They had more talent than cash. But they pawned their houses and, with the help of a kindly bank manager, raised a loan big enough to negotiate with Her Majesty's Government for a temporary use of the sound block. There was no nonsense about paying themselves salaries; the overdraft would not run to that. But they did just manage to exist. They had friends in both the documentary and feature worlds who rallied round and brought in work that might more easily have been done in the West End of London. After three months, Anvil Films Ltd were formed. Why 'Anvil'? Nobody is quite sure. A number of names were submitted to the Registrar of Public Companies and Anvil was one of the few acceptable. The fact that among their good friends were Hammer Films Ltd is claimed to have nothing to do with it.

Anvil's recording facilities were modest, even by 1950 standards, and there was little hope of up-dating them. But it was staffed by a skilled and dedicated, if scanty and impoverished crew, who knew only too well that the company had to succeed or things would become very difficult indeed. When there was work to be done they worked, frequently days and nights on end, and the corner was slowly turned. Simultaneously Anvil entered short film production. Nobody would say that Anvil's first production—*Methods of Garment Handling and Assembly Layout*—had audiences lining up in Leicester Square. But it *was* sponsored. It made money and it helped to establish a reputation for integrity, efficiency and economy which is still perhaps Anvil's greatest attribute.

Shortly before this, the Government had established an experimental feature film production unit called Group Three. It operated from Southall Studios and did good work in encouraging new talent. With Beaconsfield virtually empty, it seemed logical to move there. Group Three became Anvil's new landlords (and one of their best customers).

Before long, Group Three went the way of all flesh and Beaconsfield Films Ltd, under the banner of Peter (*Carry On*) Rogers, took over. The same amicable arrangement applied, albeit with ever increasing rents!

By this time, Anvil had become established. They survived to celebrate their tenth anniversary, in spite of Wardour Street's gloomy prophets of woe. Their reputation secured many useful contracts, largely from Government departments, while the sound recording side worked full time on major features, television serials, and documentary films. The key members, most of whom had worked together since war-time years, were still together and actually receiving a living wage. Anvil had arrived.

Independent Artists Ltd, under Julian Wintle and Leslie Parkin, were the next leaseholders of Beaconsfield and they were very happy to have the service of an efficient sound department on their doorstep. Many important features emerged at this time, and the Anvil crest even found its way on the titles—insignificantly small, perhaps, but there if you looked closely.

The days of Beaconsfield were now drawing to a close. The lease was expiring, not to be renewed by Anvil's small resources, and the end came at Christmas 1967. This occurrence may have been a blessing in disguise. The opportunity arose of taking over the main music stage and adjoining premises of the mighty Denham Studios. Despite the rather frightening prospect of these vast, expensive, open spaces, Anvil took the bit between their teeth and moved in. The garage was rebuilt as a dubbing theatre, the music stage refurnished and re-equipped, and a new control room and music mixing desk soon followed. A post-synchronising theatre was built and cutting rooms and offices sprouted all over the place. Nobody in Anvil is quite sure where the money came from. One can only assume that hard work reaps its own reward.

The geography of Anvil's premises is a little curious. Owing to a strange combination of domestic and civic regulations, Anvil are not permitted to build. Brick may not be laid upon brick—at least where anyone can see it! Therefore, Anvil have been forced to convert. Old storerooms miraculously turned into attractively designed accommodation for technicians and other staff; the post-synchronising theatre arose, Phoenix-like, from a disused control room; Denham Studios' famous long corridor proved wide enough to accommodate a reception office, a cutting room and a home for a great deal of noisy machinery. Anvil have lots of space but terribly little room to manoeuvre. Somehow it works.

The music stage is vast. Maurice Jarre's orchestra of 97 players in *Ryan's Daughter* presented no space problems but the stage also incorporates a 'dead' area where a Pop group can play under almost anechoic conditions, From the control room on the ground floor. the balance engineer, composer, and, as usually happens, the entire production unit with wives, children and dogs, can see the orchestra, the conductor, and the screen. Thank Heaven, it is fully air-conditioned.

Keyboard instruments are a permanent facility, with two Steinway grands, Hammond *A100*, celeste and Baldwin electric harpsichord. Awkward speciments, like electric pianos and synthesisers, are brought in when needed. There is a very useful vocal room (double-glazed from the main stage) where soloists or small choirs can perform in acoustic seclusion, aided by a clear view of screen. conductor and balance engineer, plus a foldback system which can muster 60 headsets.

In the control room are a 24 input Neve mixer with Studer two, four, eight and 16 track recorders. Just outside are the 35 mm one, three, four and six track recorders. And here is an interesting sidelight. All these machines, including the 25 mm and 50 mm tape recorders, together with 16 other 35 mm machines scattered throughout the building, can be interlocked with the 35 mm picture projectors. They start together, they run up together, and they remain synchronous for as long as you like. The potential of this arrangement is enormous. Overdubbing and multi-tracking in sync with the picture are no longer the problems they were. They are now a straightforward, speedy and economical exercise. The studio is, of course, fully equipped with Dolby units, together with a few little secret devices which are kept behind blank panels and closed doors!

The dimensions of the dubbing theatre are more modest, although a 6m screen can present a useful sized Cinemascope picture. The RCA desk accepts 17 inputs into triple and quadruple 35 mm recorders. Most of the reproducers are optionally 35 or 16 mm and they can all be driven at 24 or 25 f/s.

About the same size as the dubbing theatre is the theatre, specially designed for post-

synchronising dialogue and sound effects. Again a desk built by Rupert Neve is in charge and two 16 mm plus two 35 mm projectors interlock with one 16 mm recorder and two triple-track 35 mm recorders. Two Selsyn motor-generators maintain continuous projection. Under the carpeted floor are all the normal surfaces required for footstep post-synchronising. Even the basement has been pressed into service, as a very useful review theatre equipped with the magnificent Fumeo double-band 16 mm projector.

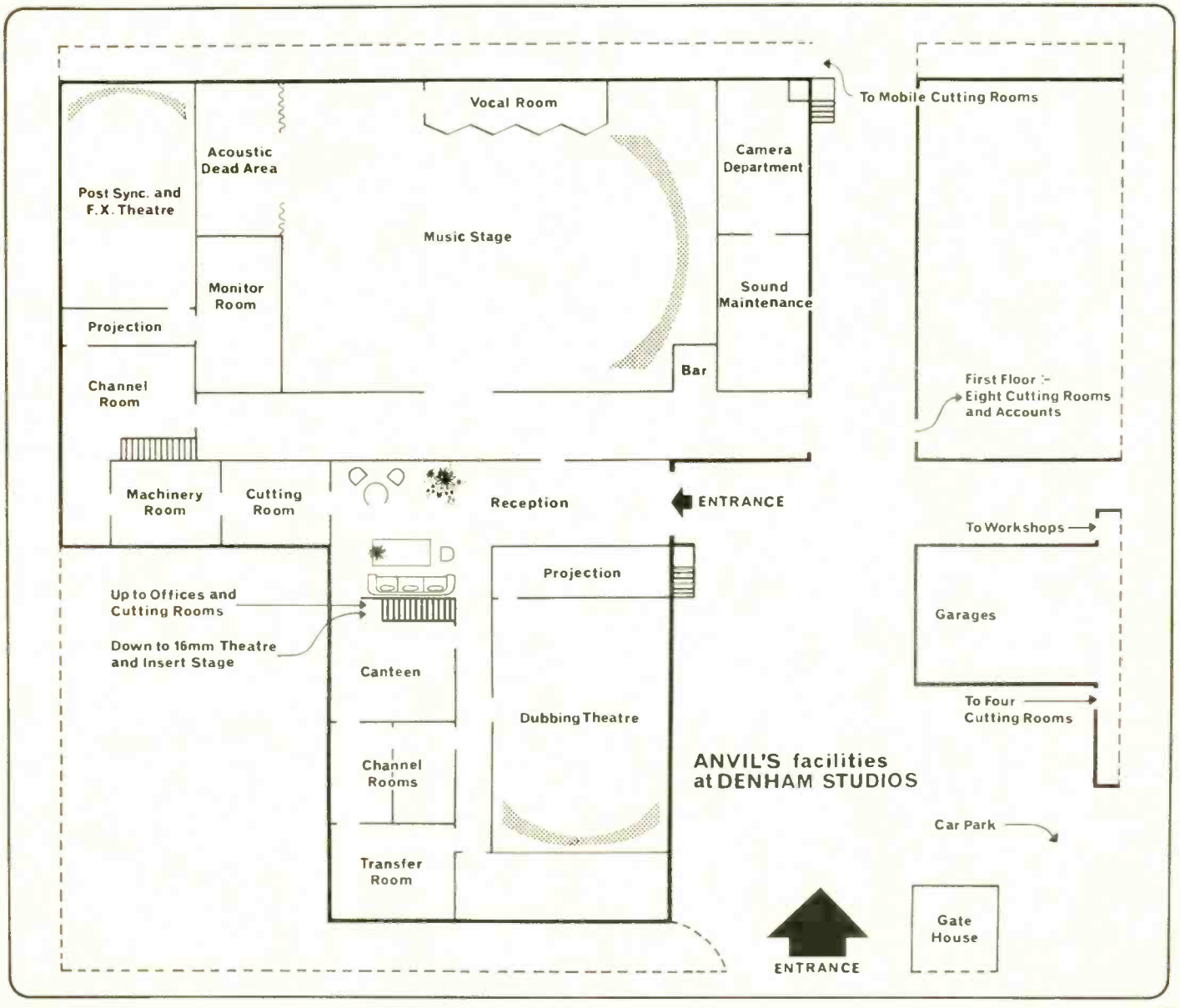
These four theatres service not only those aspects of the motion picture and record industries which need the elaborate post-production facilities necessary to produce a complete sound track; they also act as ancillaries to Anvil's increasingly complex cutting room assembly. There is a great convenience in having 15 well-equipped and smartly furnished cutting rooms, with associated production offices, literally down the corridor from one of the largest and most efficient film laboratories in the world. Many important feature films, the latest being the Cannes Festival prize-winner *The Hireling*, were serviced entirely at Anvil's assembly of studios and cutting rooms.

All three recording theatres work hard. Even with the industry in its present doldrums, there always seems to be something to do. And with music tracks like *Chitty Chitty Bang Bang*, *Ryan's Daughter*, *Fiddler on the Roof*, *Oh, What A Lovely War*, *Song of Norway*, and countless others under its belt, the sound department can look the world in the face. Anvil's production unit have visited practically every corner of the globe and have been responsible for a wide variety of films for training, education, the arts, and for industry. Two major educational series for the BBC, a long list of feature films for the Children's Film Foundation, a series of 24 teaching films on music, and eight 'potted' versions of Gilbert and Sullivan operettas, have all swelled the output of a most fruitful company.

Anvil's staff number between 40 and 50. And, particularly encouraging, most of the youngsters who were teaboys and the like early in the war are still with Anvil, now as middle-aged and highly respected members of the industry. One is inclined to doubt whether any self-generated company has such a record of long-term employment, of unselfish and devoted staff, and intimate personal friendship between everybody concerned. The company have gone through financial hazards and will probably do so again. But they are still there, still busy, and Denham Studios is no mean address for a film company; there are still people working in the industry who think nostalgically of Denham as being one of the greatest studio names in the world.

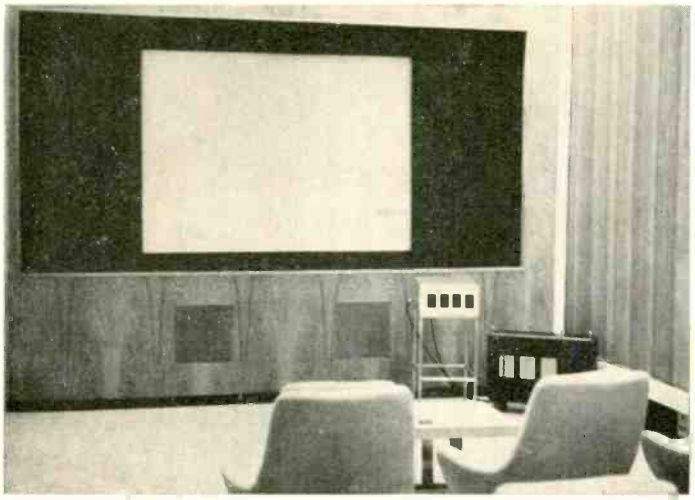
Not all of Anvil's staff are fuddy-duddies unaware of the difference between a semiquaver and a fuzz-box. During the whole of Anvil's existence, a well thought out scheme of training newcomers has been in force. In every department, young men and women are quickly taking more and more responsibility. The directors have the sense to know they will not live for ever and are taking appropriate steps to ensure the company's survival.

It is unlikely that the founder members of Anvil will see the end of the next 21 years but many of the present team are likely to add their contribution to the entertainment industry in the years to come.



DIARY

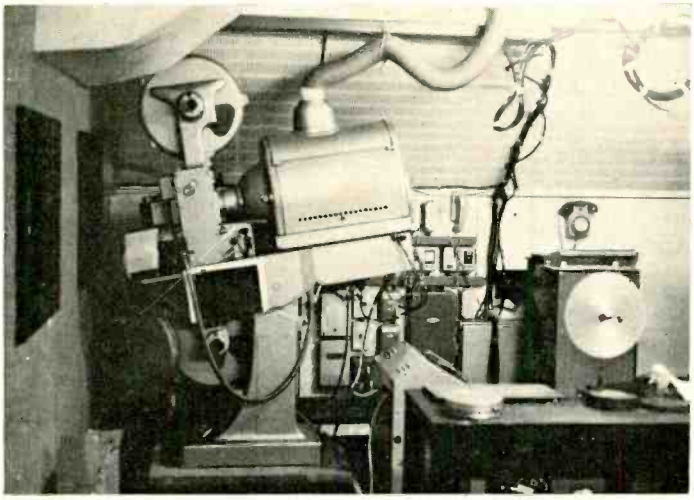
By John Dwyer



Above left: the dubbing theatre from the vocal booth.

Above right: the Advision dubbing console.

Right: one of the Advison projection rooms.



IF THE RELEASES I get from **Advision** are anything to go by, they must have one of the busiest dubbing theatres in London. Most of the work tends to be commercials and documentaries. The commercials are usually done on loops running up to about a minute but Andy Whetstone told me they can do two-minute loops, although it is much easier to run anything longer than 1½ minutes on their new 35 mm rock and roll equipment.

Andy showed me round the technical areas: the projection room the editing and dubbing room, the cutting room and the machine room, after which Bernie Seager let me watch a dubbing session for a half-minute French margarine commercial he was doing for Quartet Films.

Advision will do 35 mm recording and dubbing in three track or mono. The dubbing theatre projection room has three projectors: a 16 mm Elflite rock and roll which Andy described as very good, a 35 mm Zeiss, and a Magnatech *PR135*—all with Xenon lamps. Andy said the Magnatech was a recent buy: 'Definitely one of the best 35 mm rock and roll projectors. Very, very good indeed.'

They have nine rerecorders (these are play-in machines and not recorders as the term might imply; they are also called follower heads); five Albrecht machines which will take either 35, 17.5 or 16 mm; and three Westrex 35 mm-only recorders. The recorders include one three track Magnatech 35/16 mm; one Albrecht 35/17.5/16 mm and one 35 mm Westrex.

Advision can do magnetic transfers in any gauge, including Nagra push-pull pilot-tone. I also noticed a couple of 6.25 mm full track tape machines. 'We have full Ampex 6.25 mm tape recording facilities for wild recording and radio work.'

They also have a Westrex optical transfer machine. While we were looking at the Westrex, Andy commented: 'We have the facility for 24 or 25 frames. People still seem to fight shy of doing things at 25. As you know, television is transmitted at 25 so everything is up in pitch. If you hear the direct change from 24 to 25 immediately it's very noticeable. But by the time it gets to television you've forgotten what it sounded like in the first place.

'Of course 24 f/s has always been the standard film speed for cinema. As commentaries are always very tight on commercials, recording at 24 f/s and not 25 gives them that little bit of extra time. So they figure "well never mind about the voice going up a 25th of a second in speed".'

Later on, after the dubbing session, Bernie Seager said he did all his dubbing at Advision: 'We used to go to Andy at Bond Street. It must be about ten years ago.' Andy said the desk was about four years old. It used the same Advision modules as the desk downstairs in the music studio though obviously there were fewer of them: 12 channels, arranged with six on each side of a centre panel with four master faders for the four output channels and above this a panel with numerous buttons for rock and roll, monitor switching, cueing and so on.

For the commercial that they had just finished they had used seven channels but Andy told me the usual number was four or five. I remarked that the whole process had been more complicated than I had expected.

AW: 'Documentaries can be even worse. There could be even more tracks involved.'

BS: 'Quite often they do a premix because with a documentary you usually get a lot of atmosphere loops: wind loops or rain loops, bird loops and so on. By premixing all the effects on to one track, this saves an awful lot of bother. We even do premixes for some

44 ▶

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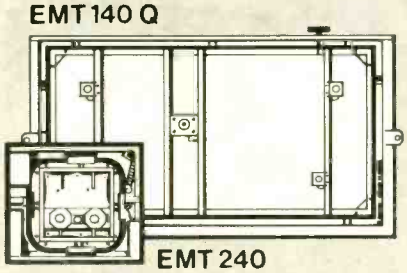

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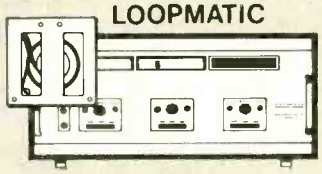
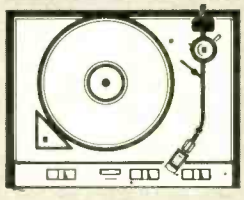


LOOPMATIC

EMT 927·928·930



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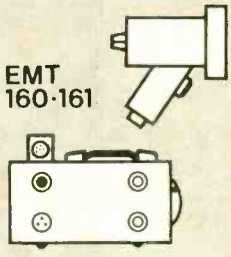

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commercials—if we've got a commercial that's got a lot of complicated effects; a lot of things you want to bring in quickly.'

AW: 'In the 30s you can sometimes get things happening so quickly it is physically impossible to cope with eight faders and it then becomes necessary either to premix or to have more hands.'

I asked if it would help to have all the faders together. Andy said it wouldn't because on a complicated dub there had to be space for a second person. 'The other thing is you can have several effects on one loop with varying levels. Not only are you chasing to get things right—fade in and out—you've got to remember, every time the 30s comes round, that that effect's got to be in that fader position, the next one's got to be there . . . and so on.'

BS: 'That's why one tries to separate the effects out and, if you can, put them on one loop so that the mixer can set a single level.'

AW: 'In general I would say commercials were more difficult than documentaries because the documentaries have just a few odd effects coming in and out, whereas in a half-minute commercial they're trying to get everything into it, particularly in animated work.'

BS: 'Yes, you can get long pieces of music and effects and you can then rock and roll. Also on a documentary you can set the level of the commentary.'

AW: 'But even with commentaries on commercials you'd be surprised. If they want certain words pushed up or down, for instance . . .'

BS: 'That is because you don't get the time between the gaps, you see. We had that trouble yesterday. A commentator babbled out an advert and almost every phrase was at a different level. We had to fight the whole time to try and even it all out.'

AW: 'It's not normally as bad, but you do get that. And even with the better commentators you still occasionally get a word that they'll push too far. Then you've got to remember, with all the other things you're doing, that every time that word comes round you've got to pull it down a bit then bring it up again for the next word.'

JD: 'It must be very skilled then.'

BS: 'They won't have it of course but I think it is. I've been working on a film for say a week and I come here knowing all about it and I give it to these guys expecting them to get it straight away. And it amazes me that we book half an hour, and within that half hour we get what we want.'

The discussions turned to the problems of making effects. Bernie told me they had been about to dub the commercial we had just seen when the agency producer said he wanted more kitchen atmospheres. They had to decide quickly what to add to it. Bernie told me the bubbling noise which emphasised the demise of the chicken was made in the commentary booth by blowing with a straw into a cup of cold coffee. A clock sound which was heard at the beginning of the ad has been made by recording Bernie's watch and slowing down the tape.

Andy elaborated on the process: 'The interesting thing is that we could put that on without stopping because we were running the three track machine. We did the dub on to the first track so we had the other two spare. We put the clock sound on one and the bubbling on the other and fed it back in again.'

I asked what he would have done if the first 15s had been all right but he had wanted to fix the rest. He explained that he could drop in. 'That's easier with documentaries because when you drop in you must be sure that all the levels are the same. If they are, you cannot detect the drop-in. It's absolutely impossible. We could have done it with that commercial by keying in again then remixing the last 15s. That is because of the Magnatech's silent drop-in. You cannot hear the drop-in; you can even drop in in the middle of a word.'

My thanks to Andy Whetstone and Bernie Seager for a very instructive afternoon.

I've paid a couple of visits to **Pop Sounds** in Wandsworth this month. They've set themselves up in a converted 240 m² taxi garage in a quiet road about 15 minutes walk from Clapham Junction. The boss man is Brian Goodman, who describes himself as 'the oldest teenager in the business'. Brian's wife, Lyn, is Pop Sounds' other director. Brian has spent some 20 years in various corners of showbusiness and, as well as being resident dj at a club called Wembley Spinners, he manages Martin Cohen, John Cleveland-Baker, Sharon Dunne, Gentle Funk, Ish, Freon and a duo called April.

Brian drummed for the Overlanders, but he had left by January '66, when they hit number one with their cover of *Michelle*. They stayed up there for three weeks until they were kicked off the top by Nancy Sinatra's *Boots*.

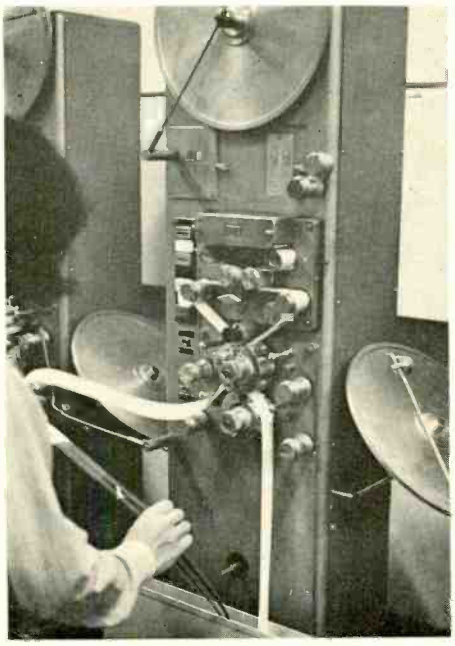
Before that he had been in the RAF, where he had drummed his way through trad, modern jazz, dance and military bands. When he left the RAF he formed his own jazz band and then in 1962 the Overlanders. When asked why he gave up drumming he gave the priceless reply that 'they wouldn't let me on London Transport buses any more'.

After the drumming he became a dj on the Rank and Mecca circuits. Eventually he joined Radio Caroline North. He also started managing a guy called Martin Cohen. Quite a career, to the description of which I should add that Brian's regular employment is as a qualified chartered accountant.

Brian is an enthusiast; he became an honorary steward at the Albert Hall so that he could hear the concerts for nothing. 'I like all sorts of music, that's why I think I could be a good producer,' he told me. 'For example, you hear an oboe and a flugel-horn together and you think "Oh that's just right there", because you picked it up at the last classical concert you were at.' Then he added: 'I don't like gimmicky line-ups—sticking something in because someone else has done it'.

Well I've described the jockey; now we'd better peek at the horse. Pop Sounds makes no pretence of being any other than a modest operation. Brian's ambition is to find and produce his own talent, and that is primarily what the studio is there for.

Brian decided early to finance the whole project himself. For all you moneyed guys I should explain that, when faced with opening a studio on limited money you have three choices: you can spend all you have on getting the best equipment you can get and ignoring the decor, in which case your prospective clients will not bother to come as far as the control room no matter how good your gear is; you can spend the loot on building an acoustically sound, comfortable working area and hoping you get enough clients to buy more versatile gear later on, or you can wait until Lew Grade walks under a falling champagne bottle and leaves Abbey Road to you in his will. All these take for granted, of course, that you aren't prepared to call on your friendly neighbourhood merchant banker. And the trouble with merchant bankers is that they're never in when you want to borrow: they're too busy being the wolf at the door of somebody who's already borrowed.



Far left: the vocal booth.
Left: lacing an MWA 35mm film machine.

46 ▶

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DIARY

Brian made choice two. In more detail the studio has 25 mic lines of which five are in the drum booth. The microphones are by AKG, Shure, STC and RCA. A piano and guitar amps are available. The studio measures 10m by 5.5m and will accommodate 25. The studio itself is well treated and very neat. Brian told me he decided to decorate in black and white and leave the rest to the lighting, a sensible idea, I think, and one that has worked very well. The acoustic treatment is first class. They had a traditional garage roof when they started but now there's so much fibreglass fluff up there they'd have to be telephoned if an H bomb dropped on Wandsworth Common. In the control room they've even mounted a suspended ceiling. Credit to Bob Davies for that.

The control room window is triple glazed. Behind it is the EMI desk that used to be at CBS in Bond Street when that studio belonged to Jacques Levy. As you might expect, it's a valve job and, as desks go, pretty old. At the moment they master on a Teac four track machine. I've heard many good comments about this machine, humble though some might consider it, but Brian says that editing on it is near impossible.

Besides the Teac they have a couple of Revox Dolby B machines. They also have a Grampian reverb unit. Monitoring is on a couple of Goodman column jobs. I think the first column speakers I've seen in a control room. The studio is open in the evenings and at weekends to begin with. When the plans are fulfilled there will be two studios and a reception area. The charges are as follows: £7 an hour for four track, £5 for stereo and mono. There are no overtime charges, although the studio is open 24 hours a day at weekends.

That's Pop Sounds; never let it be said that STUDIO SOUND ignores the little people. I think Brian and his proteges are about the pluckiest bunch I've come across in my travels so far—they're already planning to install eight track when Studio Two is finished—and for that alone they deserve to succeed. I wish them the best of luck. If you want to do live music recording and mixing, sound effects, audio commercials or radio programmes at Pop Sounds phone 01-223 2544.

I read in *Music Week* that Roger Greenaway and Roger Cook have at last bought a chunk of AIR. Ron Richards left the company recently because of ill health and they have taken over his stake, which is one-fifth of the company. The amount of money involved is undisclosed. Another AIR deal, again my source is *Music Week*, has been made with Polydor. It involves worldwide distribution, excluding North America, of George Martin's work as a producer and arranger and productions by John Burgess and Peter Sullivan.

George Martin opened his drinks cupboard this month to celebrate the fact that studio Two's 24 track gear was in and working. First session was by Larry Norman, who was making an album amid the pokings and pryings of a couple of dozen assorted engineers, journalists, photographers and their friends and relations. I asked Larry, who was busy being photographed while playing the piano for all the world like Stevie Wonder, who his musical influences were. 'None,' he said. 'I've had no influences for a long time,' at which point I left rock journalism alone and joined the others to poke and pry at the desk.

The new Neve desk, installed over the weekend of July 21, is a 32/24 job. Each channel output has two pan pots which provide quad outputs. Switches on these pots alter the outputs to give stereo when needed. As well as these, three stereo pan pots give outputs progressing from normal stereo through mid-track mono to a transposition of sound sources.

Neve say they have managed to cut setting-up time on the desk by using a switching matrix which selects the inputs and outputs of the required Dolby units. 'Thus, any tape machine selected in either the playback or record mode automatically includes the appropriate Dolby units.'

There is 24 track monitoring with individual metering and there are six speaker outputs so that four can be used for the front and two for the rear channels in quad sessions.

Tony Cornwell, a member of the Neve contingent at the proceedings, told me that, although the largest desk they had ever built was that at Twickenham Films, this was probably the most complicated. 'It has many facilities which, although we've done them before, we've never had all on one desk.' As an example he mentioned the quad panning on each channel: 'I don't think anyone else has got that in London'. He also pointed out that the desk was only slightly longer than its predecessor, in spite of all the extra facilities.

I also went to **Anvil** studios this month, and met that most agreeable of men, Ken Cameron. I hadn't realised it until I got there, but Anvil was 21 years old in July, which is old indeed in the film business. During my visit Ken promised to write an article about Anvil and you can read his brightly written piece on page 40.

Konk, London. Konk is the name that the Kinks have chosen for their studio in Hornsey. Engineer Roger Beale has written to me and I quote from his letter: 'We have room in the studio for at least 20 musicians, and there is a drive-in loading bay at the rear of the building. The studio is very comfortable and there are various fringe benefits such as a tv lounge, table tennis room etc.'

'We have a Neve console, full Dolby facilities, Ampex tape machines, including the new *MM1100* 16 and eight track machine, Cadac monitors, chamber and EMT plate echoes, and Neumann and AKG microphones.' The rates are £18 an hour for 16 track recording, £12 for eight track and £15 for fixing. There was an introductory offer until the end of August of a 15 per cent discount. I'm sorry I didn't hear about that in time to tell you about it before it expired. The studio's phone number is 340 7873.

50 ▶

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IMPRESSIONS

By John Shuttleworth

QUADRAPHONY

UNTIL RECENTLY, my only experience of quadraphonic sound had been at lectures and consumer audio exhibitions and quite frankly what I had heard had not impressed me. On many occasions the listening conditions were far from adequate and in the few demonstrations where people were not actually walking round and standing in front of the speakers, I had not been able to sit in the optimum position. The programme material offered in many of the demonstrations was of the type produced for stereo when at first appeared, railway trains and the like, and not therefore indicative of reproduction quality.

The first demonstration I heard was of a four channel 19 cm/s tape and my first impression was that four times the normal hiss level was quite intolerable. There was some orchestral music in this demonstration but it had been recorded with four omni microphones spaced 'at the four corners of an average living room' and this technique gave 'a hole-in-the-middle effect'. Since the hole in this case was the entire listening area, one had the impression of sitting in a sort of cubical vacuum in the centre of a hissy concert hall—all rather unpleasant. I can't imagine what theory encouraged the engineers to use four omni microphones as they did and it certainly didn't work on the tapes I heard.

My next experience was at a recording session where a four channel tape was being made at the same time as the stereo one. This was at one of the new unfortunately standard multimicrophone sessions and the orchestra and soloists were dotted all over the place with their own microphones and an engineer playing conductor on a large mixing desk. Two very large (and very coloured) monitor speakers were in front of the control desk, reproducing at ear shattering levels, and everything sounded on the point of cracking. From the back of the improvised control room came a rather tizzy rattle which proved to be a pair of small domestic speakers, their cabinets apparently some form of cardboard. These, I was told, were the rear channel information, picked up by a pair of microphones facing away from the orchestral and choral forces and towards the back of the hall.

I have since heard four channel reproduction via disc using the SQ system and have found the results interesting on some material but very disappointing on other items.

Having read with interest of the experiments by Granville Cooper and Michael Gerzon it seemed to me that, good as these seemed, they could not be at all conclusive as conducted. To my mind, any experiments of this type require that all the technical equipment used must be of the very highest quality and the use for instance of second or third rate microphone might immediately invalidate any results obtained. The AKG *C24* is arguably the best stereo microphone available, the two used having been selected by the late Terence Long. From my experience I find the results obtained in improvised control rooms can be very different from those obtained in properly designed ones or under domestic reproducing conditions. It was not therefore until I was able to obtain satisfactory equipment that I felt my test in quadraphony would be valid.

At the other end of the chain it is obviously important that the speakers used should have as little coloration as possibly. For practical location monitoring this narrows the field to Quad els, Rogers or Spendor Monitors.

The Quads were ruled out for the recording session on the grounds that I could not transport four of them with the other equipment also needed, and the original intention was to take four Spendor *BC1a* speakers. In the event, however, we used two Rogers *Monitors* driven by a Ravensbourne amplifier for the front speakers and a pair of Spendor *BC1a* for the rear. I found it impossible to state whether the Quad, Rogers or Spendor speakers were the best, the results with each depending on the recording technique used. If one balances on a Quad andre plays through the three systems, the Quad sounds best. If one balances on a Spendor this sounds best, and so on. I infer from this that none of the three systems is yet perfect but that they are all very good in their own way.

Settled for Teac

In between the microphones and speakers I would have preferred to use Quad *50E* amplifiers and a recorder using 25 or at the very least 12.5 mm tape, but had to settle for something rather more modest. Industrial Tape Applications market modified Teac *a3340* four channel recorders and I found that one of these using Scotch *207* 6.25 mm tape gave very good results and certainly the best four track quality I have heard.

Running at 38 cm/s, the reproduction was capable of a two track Revox *77* at its best and I felt would be good enough to make a recording of the test for later study. It was of course possible during the session to compare the a/b results and it was found that the Teac was producing sounds off tape so close to the original as to be entirely satisfactory.

It does not necessarily follow that one can extend theories about recording in stereo to quadraphony without modification, but, as I had no reason to believe that spaced microphones or multimicrophone techniques would be any more successful at recreating the correct sound picture in four channels than in two, I decided to try three coincident microphone techniques. The tests were made in Chelsea Town Hall which is very resonant and would therefore give ample opportunity to test the recording of hall acoustics. The pieces recorded were orchestral music of various types, both with and without audience, and some interesting results were obtained.

The aim was to produce a good mono-stereo-quadraphonic compatible recording. Failing this it would at least have to be possible, by suitable mixing of the channels, to obtain good stereo or mono tapes from the four channel master. With this in mind, it was decided to try using one *C24* as a normal stereo pair and the other *C24* for the reverberation channels.

The first configuration tried was four cardioids facing outwards at 90° to each other. The front *C24* gave a normal 90° cardioid stereo recording and the rear capsules a standard backward facing cardioid reverberation image. Track One was used for front left, track Two for rear left, track Three for front right and track Four for rear right. In this way, replaying the tape as a four track two channel tape gave normal stereo without the reverberation channels. Mixing tracks One and Two and tracks Three and Four could add reverberation and playing on a two track recorder would give a fixed level of reverberation as recorded at the time.

The first surprise was that, although the rear channel microphones were peaking at exactly the same levels as the front channels, no direct sound seemed to come from the rear speakers in the control room. When sitting in the quadraphonic position, one was only conscious of the rear speakers when they were switched out. The difference between stereo and quadraphony recorded in this way was not just marginal and I can well understand those who are enthusiastic over the possibilities. The main difference between the stereo and quadraphonic version was that the extra information added realism, and the sound in the control room was much closer to that in the hall.

We next tried tetrahedral ambiophony. Here the cardioid microphones face outwards at 120° to each other and towards the points of a tetrahedron: the two front corners of the hall at floor level, the centre back of the hall at floor level, and a point on the ceiling above the microphone. This method requires that speakers should occupy similar places in the listening room, which I find very inconvenient, but which in theory should give height as well as left/right and front/back information.

On the material recorded, this method did not give any improvement over the previous one and in some respects was not as good. As it was so inconvenient with regard to

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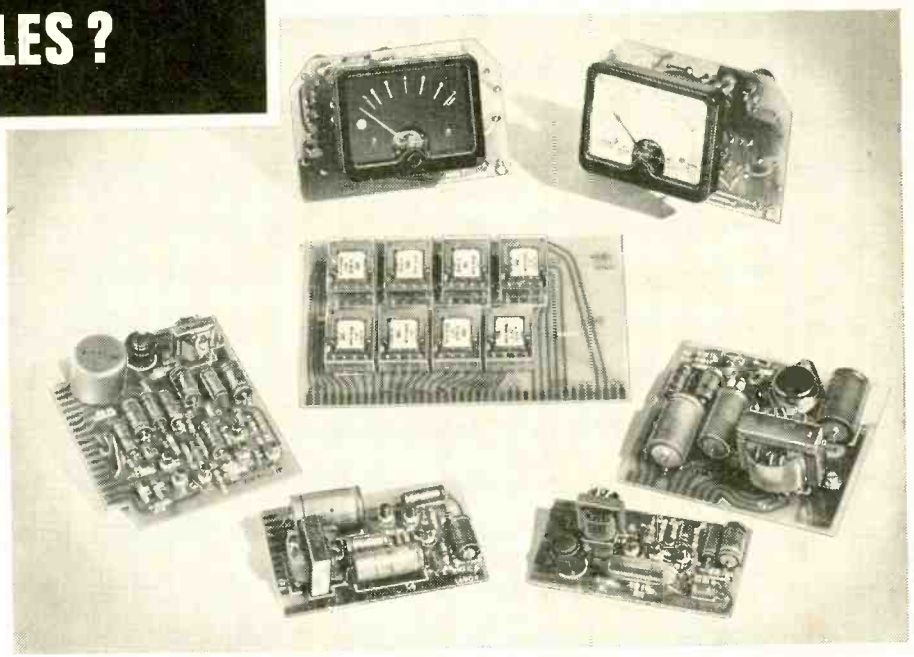

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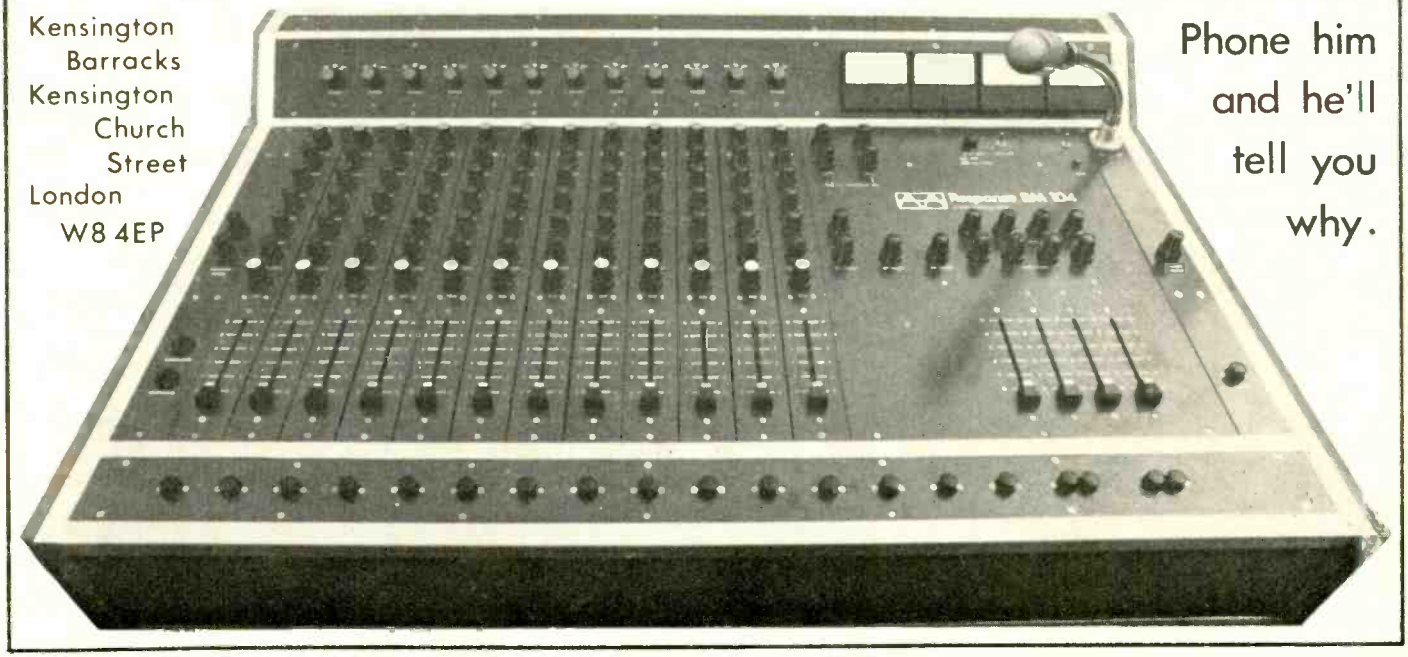

IMPRESSIONS

speaker placing and the tapes made this way were not inherently compatible, only one tape was recorded in this way.

The third trial was using the four microphones at 90° but with a 'cottage loaf' polar response instead of cardioid. This is probably my favourite polar response (apart from figure-of-eight which would not be suitable for quadraphony) and consequently the stereo recording from the two front channels would be similar to one I would normally obtain. In the control room this certainly sounded the best we had tried, so the rest of the concert was recorded in this way.

Some of the tapes recorded using the 'cottage loaf' configuration were played to a musician who had attended other concerts in Chelsea Town Hall and he was asked for his opinion without being given any information on the recording. He said he found the recording realistic but that the acoustic sounded too much like Chelsea Town Hall for his liking!

If quadraphonic tapes are recorded so that the front two channels give normal good stereo and the rear channels merely add hall reverberation, it seems that much more realism is added to the sound picture and control of the rear channels gives control over the amount of hall we wish to hear.

The Chelsea Town Hall recordings sounded much better with less rear channel information and, with the hall acoustic less obvious, were very successful.

It was obvious from this trial that, for really good quadraphony, a good hall is even more essential than in stereo as reducing hall reverberation so as to get a better sound also reduces the quadraphonic effect. The tests at Chelsea were successful enough to encourage us to try further recordings in a different acoustic.

The next trial was of an organ at Holy Trinity Church, Sloane Street. This organ is a large Romantic one in a church with a long reverberation time and Romantic music played here sounds superb. The effect of quadraphony in this sort of recording is very marked and really exciting sounds can be reproduced in the listening room. It was found here again that recordings made with the front pair of microphones in the optimum place for normal coincident microphone stereo, plus a backward facing pair for reverberation placed immediately behind them, was preferred.

Further experiments were carried out in the recital room at Eltham College in South East London. This room is lively but has a pleasant acoustic, and recordings of solo guitar, voice and general movement of sounds were made there. The difference between two and four channel was much more subtle on these recordings and, until one missed the rear speakers when they were switched off, it seemed doubtful if the extra expense of the equipment was worth the extra realism.

Finally we tried recording large choral and orchestral forces at St. John's Smith Square which has excellent acoustics. The results here were extremely good and the extra realism using quadraphony was most impressive.

We have not yet tried placing the listener in the middle of the orchestra and recording music specially arranged for four channel but using the extra two channels for reverberation to give added realism, has resulted in the following very tentative conclusion.

1. The highest quality equipment must be used in every part of the choir, and inferior microphones or speakers will not do for the rear channels. In fact coloration there seems to be more noticeable than in front.

2. The most satisfactory recordings seem to be these where the front two microphones are balanced for normal stereo working, but rather close in and with the rear microphones are close to them for reverberation pick-up.

3. Hall acoustics are even more important in four channel than in two.

4. A good four channel tape made in this way gives excellent stereo when played on a two channel machine and excellent mono when played on a full track machine.

The Teac recorder with Scotch *207* tape, the AKG *C24* microphones, and the Spendor and Rogers monitor speakers behaved so impeccably throughout the tests that it was possible to concentrate entirely on the experiment without unduly concerning ourselves with the equipment. One result not expected from the tests was the discovery that the Teac with Scotch *207* gave such good results that it could obviously be used for making good quality master tapes.

Using four channels in the way described enables a very close microphone technique to be used where necessary to give more clarity while still providing full control over reverberation.

DIARY

Roger's history is that he was at Olympic (and it seems that there aren't many good engineers who weren't), then Island and then CBS.

The Kinks were using the studio towards the end of July to do an album. They had already recorded the *Sitting in the Midday Sun* single there. 'Other sessions in recently have included groups such as Ruby, March Hare, and Kirby. Mike Berry mixed a P. J. Proby single here, and Phil Wainman, producer of The Sweet, has been in with a group called Brotherly Love. Tommy Vance has been producing a single by Jukebox.' Roger has kindly offered to show me the studio and I'll give a report in a future issue.

Majestic, London. The latest news from Majestic, which I confess is on my long list of studios-I-must-visit-but-have-never-got-round-to-it, is that they have put in a new Triad desk. The desk is a 16 track job with facilities for up to 30 microphone lines. Roger Wilkinson said that this would enable them to record sessions with up to 50 musicians compared with the previous maximum of 25. The studio is about 200 m² in area.

Roger also said in a release that charges were £25 an hour for sessions paid for within 30 days, but that the charge would be only £14.50 if clients paid at the end of the session. Alluding to the Jimmy Helms hit recorded at Majestic a few months ago, Roger said: 'We think that you will agree, an offer that nobody financing record productions can refuse'.

Speech-Plus Recordings specialise in voice recordings. The studio is 26 by 4.9 x 3.1m high. Run by Lorna Coates and John Fay, this studio is suitable, they say, for small music ensembles and solo instrumental work; commentaries; audio visual programmes, language laboratory and other teaching and training courses for which comprehensive pulsing facilities have been installed; and large-scale drama productions using several microphones, live and dead acoustics, sound effects, grams and tape replay units. The control room measures 3.7m by 4.9m, which SP say is big enough for six people besides the engineers. The width of the window is just over 2.4m. The desk is a 10/4 Lander and the tape machines are Bias and Revox with a Garrard replay machine.

Rates vary between £8 and £12 an hour depending on cost, size and facilities needed. Commentary sessions are £8, film strip commentaries with music or sound effects and pulsing are £10 an hour, full drama productions with music, sound effects, an operator and so on are £12 an hour. Quotations for tape copying are made according to individual requirements as are prices for cutting masters and so on.

There was no space for 'Diary' last month and I apologise for having to re-serve some of what should have appeared then and leaving out the rest. Blame my holiday.

Finally, STUDIO SOUND was at the Doughnut Centre, Cheltenham, in June when the National Association of Rag Merchants held their annual flower show.

This giant event gave our much-travelled salesman, Dick Resmond, a welcome change from the humid summer swelter of the Pavilion, Bournemouth. The NARM convention is the biggest C-of-E-sponsored flower show in the calendar, and millions of insects swarm over to Cheltenham to see the blooms, load up with pollen and buzz off again.

Our Dick travelled on a chartered furniture van loaded with personalities from the rag world, and had it crashed there would surely have been a crisis in the pulp business: there was Pancho Vanilla, the Cornish Ice Cream Salesman; Griselda Pugh of Hancock fame; Gerry Atrick, the grand old man of blue movies; and many others far too numerous to mention who wouldn't give our Dick the time of day, never mind their names.

'It really was a great opportunity to meet people I'd never even heard of before,' said Dick. 'It's occasions like this that make it possible for *Corn Exchange Monthly* to be where it is.'

I asked Dick who he thought the star attraction had been: 'Well, I think Norman Survis's natty line in underwear stole the show'. Our Dick must have been suffering from car sickness at the time!!!!

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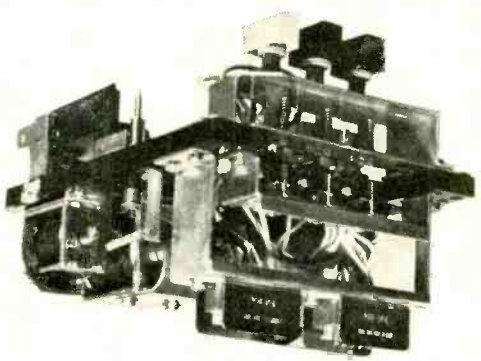

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ITA

PROFILE: JOE YOUNG

By Adrian Hope

A FLASHBACK TO THE CAMDEN THEATRE

THERE IS a well-worn story about a once well-known American Pop group who came to England five odd years ago to record a live public performance. Eight track recording was specified in the contract and the recording company had to rip out two machines they had just built into one of their new studios and borrow a third as a spare. The group were to perform on stage with the resident pit orchestra and an audience of fans were brought in for the night.

The recording went reasonably well but, as usual, the group on stage sounded nothing like the group on disc. Which was, of course, why the contract had said at least eight track or nothing. Armed with the eight track tapes, the group went back to the States and rerecorded in a studio all their vocal and instrumental tracks. Then the tracks with the British pit band were dropped (for union reasons) and an American band booked to rerecord them.

So in the final mixed stereo disc only the audience had actually been there on the night and an engineer who can do a good mix straight down on to stereo two track is pretty exceptional now. That set me thinking. Who in London still works that way? It's quite a problem, but then the answer suddenly hit me: BBC Radio.

Now, if you talk to British musicians who have done BBC jazz or late night music programmes and ask them for the name of a balancer they would like to work with, there is a good chance that the same name will crop up over and over again: Joe Young. So I went along to a BBC Jazz Club broadcast that Joe Young was mixing, the groups being the Stan Tracey Big Band and the smaller Spontaneous Music Ensemble (SME). I chose this particular night because both these bands use string bass and I have always been particularly interested in ways of getting a decent sound out of a string bass and on to tape or through the noise of a big band.

Recording was at the Camden Theatre, Camden Town, for transmission several weeks later. The programme was to be put out both in stereo and mono so the mix put down on tape had to be in mono-compatible stereo. All the preparations, rehearsal and actual red light recordings were geared to mixing direct to stereo tape (Studers running at 38 cm). The finished tape was transported bodily to Broadcasting House for eventual transmission and the mix from stereo to mono achieved by a pad in the presentation rooms at BH. The question of mono-compatibility is important and has to be in everyone's mind right from the start. For instance, if similar signals on both the stereo channels go heavily out of phase the mono signal transmitted can dip very substantially. So some of the more recent BBC control panels are of a type having four meters, one showing left signal, one right, one sum and the other channel difference. But in the tape room at the Camden Theatre there is a mixer with a simpler two-needle meter: red and green for left and right channels. There are two Studer machines in the tape room so that when the 30 odd minutes tape time on one draws near to a close, the other machine can be started up on applause. The night I was there the second band (SME) played one number that lasted over 30 minutes. But, without concern, the tape operator started up the second machine with an overlap to give himself room for an edit to finish the tape for presentation.

The mix that goes into the tape room comes from the control box where Joe Young rides a Pye 36 channel console for Jazz Club producer Ray Harvey. On the night I was there, only 13 of the 36 channels were being used but sometimes, especially when the Camden is used for light orchestral work, all 36 channels are opened out. Sometimes also an eight channel sub-mixer is used for the strings to provide an effective total of 43 channels. Ppms are used on the Pye console, one each for left and right, with VUs on the Studers for lining up. Monitoring is through two standard BBC monitor speakers with provision for muting to half volume (the normal monitoring level is high—well above the auditorium sound level) and there is also provision for listening in mono. There is no limiting because as yet ganged compressors are not available and, unless the compressors are ganged, peaking on one channel only will obviously cause that channel to be sat on and the stereo image to shift. In the control room there is another Studer, also running at 38 cms which provides a constant short delay signal feed to a pair of reveberation plates. This delay-plus-reverb are left on constantly throughout recording and add to the natural acoustics of the hall.

Camden acoustics

The Camden acoustics are certainly not ideal so close miking is virtually essential. It is an old theatre, just saved from conversion into a motorway, so the BBC have not been inclined to spend large quantities of money on trimming its honk. Hopefully they will now concentrate on doing a good job on the at least equally unsatisfactory replacement for the Camden: the Golders Green Hippodrome.

One of Joe Young's favourite studios is the Paris in Lower Regent Street. But whereas the Camden is equipped for stereo transmissions, the Paris is not. Another of those uncertain lease problems that ensnare the BBC it seems. But I believe the question of the Paris lease is now resolved so with a bit of luck it will sooner or later be fitted out for stereo and Joe Young and Jazz Club will start coming out of the Paris again, as it used to in the bad old days of mono. At the time of writing, the only way that a stereo broadcast can be weaned out of the Paris is for the BBC to treat it as an outside broadcast location and bring in an outside broadcast team.

The day really starts soon after lunch when Joe Young and his team of engineers move into the Camden and, for something like a big band, root out just about every available microphone. During the week before, he has checked with producer Ray Harvey and possibly with the bandleader himself on the musical personnel for the night and has drawn up a rough plan of their seating. He also has a very clear idea of what mics will go where and only an hour or so is spent setting them up.

'Joe tends to get the musicians to fit in with his miking and to work round him all the way' said one of the engineers. I agree, but with the rider that, as Joe seems to get the best sound out of a band, and as the musicians usually seem very happy working with him, his 'old school' way of handling things probably holds some lessons for us all.

Tracy band set-up

The set-up for the Stan Tracy big band was as follows: For the five-man sax section, there were five Beyer *M160* mics. For the three trombones there were two AKG *C12* capacitors and for the trumpets two AKG *C28*.

The piano (a Steinway with the top off) is miked with a standard figure-of-eight STC *4038* ribbon, the mic being suspended directly over the open top about 15 cm above the hole in the frame closest to the treble end. On the broadcast that I attended there were two pianos being used and Joe miked both of them in the same way. For the drummer, Joe strung an AKG *D202E* up high for cymbals and mounted an STC *4033* at floor level for the bass drum. This mic is a combination of moving coil and ribbon.

Most interesting of all is his miking of string bass. A tiny AKG *D109* is wrapped in foam and pushed in the lower scroll of one of the 'f' holes. This produces one of the best string bass sounds I've heard for a long time and I've seen all kinds of mic technique adopted for the bass with far less success.

By about 15.30 or 16.00, Joe is ready to check the mics. He moves round the stage quietly talking into each one in turn while an engineer in the box labels up instruments on the fader covers with a chinagraph pencil. Where two mics stand close together (e.g. in the sax section) Joe speaks first into one and then into the other and then into both together. This way phasing can be checked so that out of phase spill-over will not cause problems, especially when the signal gets converted to mono.

With the mics all checked—and where a mic such as the one for the bass may be moved, Joe shakes the cable during the test—the sound

stage is ready for the musicians. By now it is 16.30; time for the Stan Tracey Band rehearsal.

While we waited for this to get under way, I asked Joe Young about history. Of Bristol origin, he started with the Western Region of the BBC in 1940 and moved to London in 1946. He has been a studio manager for years and, of course, in the BBC being a studio manager does not mean being tied to any particular studio. More sensibly it means moving between studios to handle broadcasts in a particular field—in Joe's case Jazz, which is his first love.

Served time in effects

For years he served time in the sound effects department, creating the noises for programmes like *Journey into Space*, all from 78 rpm discs. He had been doing the Jazz Club mix for years now and as I said earlier is very well known amongst all musicians who do the programme. He doesn't talk much and in an article a few years ago Peter Clayton wrote about his clipped speech. All afternoon he talked to me about a missing 'trom' which was unsettling the Stan Tracey Band rehearsal and making all their new scores even more difficult to polish off than expected. Clayton suggested that by clipping words, Joe gave himself more time to say something else.

He clearly craves encouragement and appreciation, remembering occasions years back when producers have said how they liked something he was doing.

At 17.00 the Stan Tracey Band are rehearsing. No time to lose. The recording is scheduled for 20.00 and it can't be late because there will be a live audience arriving for that time. In the box, producer Ray Harvey pans the band left to right while Stan Tracey runs them through a new and particularly difficult arrangement. If the band want it, there is provision for some foldback—to reinforce the bass on stage through a couple of BBC monitors for instance. But this time no-one is using it.

Gradually a stereo image appears in the control box and Joe settles down at the console to chinagraph the names of the soloists on the channels that they will come up on. Questions like 'Will they be standing up for their solos?' and 'Who takes the first solo in this tune?' are passed around. Some questions get answered. Some don't. A list of soloists on each tune is made out, but with everyone working to a 'visual mix' it isn't too important. All in all there's a general air of controlled chaos and a feeling that it should be right on the night—an hour or so distant.

The programme isn't going out live, but remember it's going down on tape as a final stereo mix. There is no room for mistakes. Neither the audience, Humph the compere, nor the musicians will be able to stay on for a full scale retaping if it is wrong.

Eventually the Stan Tracey Band rehearsal is over; the missing trombone has slowed things up to an uncomfortable extent. The small group can now rehearse, and after checking their mic positions they have 15 minutes rehearsal time for a 30 minute spot on the show. But producer Ray Harvey has confidence in them and they have been privately rehearsing all afternoon in Studio 1A behind the control box. So they know exactly what they are going to do.

At 19.45 the audience are coming in from the rain outside and Joe Young can break for a while. He has all of 14 minutes. Then back to the control box and the red light goes on.

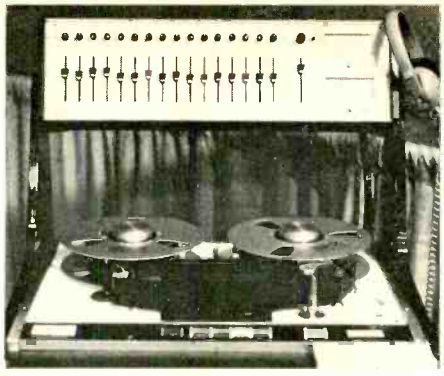
Humph thanks the audience for coming along and asks them to applaud when they want, but not to whistle. 'The people at home have spent a fortune on their stereo receivers', he explains, 'and if you whistle they will think their valves have gone'. The audience duly applaud and the Stan Tracey Big Band roars into action.

Their kind of music has a magic all its own. Controlled light and shade and dynamics generate a sort of excitement that is peculiar to big bands. A feeling of power in reverse. The sound coming over the BBC monitors is the sort that runs shivers up one's spine. After a few minutes it suddenly dawns on me. The reason why Joe Young gets what he does out of a band is quite simply that, once he has set up the mics his way, organised the musicians round his set-up and done a basic balance, he just doesn't touch anything. Apart from keeping an eagle eye on the meters in case something sticks their sax bell right up over a mic and heavily overloads it, he never alters a fader setting. In fact, the only settings that go up and down are Humph's voice mic and the audience reaction mic.

The Tracey Band finished their set and there is a short break for the SME to come on stage and play their largely unrehearsed set. As a result, the tape on the one Studer runs out and the other one is started up in overlap. By 21.15 it is all over. A total of less than eight hours and what is on tape is the equivalent of two stereo lps—one each by two widely differing groups. The next time someone like me moans about BBC balance on programmes of this type, will someone please write and remind me about all this. In what other branch of the recording industry could two different lps of mostly new material be made in the same studio, more or less simultaneously, in one eight hour working day?

AES
Los Angeles
in retrospect

STEPHEN LAMPEN



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LOS ANGELES and New York have many things in common. For one, their vast geography assails the eye with what seems to be an interminable line of office buildings, hotels and residential districts. Another is the fact that both metropolises are inhabited by three types of people: starving actors, inebriates and conventioneers. In the latter category, New York and Los Angeles share yet another similarity. They each hold a convention of the Audio Engineering Society, New York in the autumn and Los Angeles in the spring. The Los Angeles version took place this year from May 15 to 18.

The exhibits and lecture halls of the AES Convention take up the entire mezzanine of the spacious Los Angeles Hilton. A short stroll around the exhibits with my standard query of 'What's new?' produced one major impression: the audio industry in the States is, for the most part, in a period of stagnation. Whether due to the fluctuating dollar, wage-price freezes or various other causes, the professional audio industry is holding tight for the moment. Of the few concerns who are branching out or introducing new products, they are mostly small companies who have little to lose. It was surprising to hear quite a few salesmen of some of the leading companies answer my 'What's new?' with the simple 'Nothing'. Despite this, attendance to the convention broke all previous records with over 3,000 attending.

The 'big' recorder of last year, the Stephens 40-track *811D-103*, was back again. This time it was working, with a quiet admission that last year's was a mock-up and a few smiles when mentioning how many in-the-know said that Stephens would never get it working right. The machine on display had already been sold and used at Leon Russell's new studio with 'no complaints' the salesman assured. The deck, which uses 40-track heads made by Applied Magnetics, does have a 4 dB signal-to-noise loss compared with a 16-track recorder. The 40 tracks, interestingly, conform to 16 and 24 track masters which, when played on the Stephens, appear on one or more of the 40 channels. The deck uses a capstanless drive system, running at 76 and 38 cm/s and the recorder is priced at $39,500 (£15,800).

Perhaps the only recorder completely new to the convention was one introduced by Xedit. Two interesting variations were shown. One, in console, includes 16/2 mixer above the deck for straight mixing of masters (**fig. 1**). The other was the same deck in an extremely rugged military type portable case complete with optional battery pack. Electronics must be carried separately, however. Imagine, 16 tracks on a battery! Prices are $16,000 (£6,400) for 16-track and $23,000 (£9,200) for 24-track. The portable cases cost $950 (£380) extra which gives you some idea of how they are built.

MCI showed their *JH-16* recorder (**fig. 2**). This seems to have gained quite a lot of popularity since it was introduced last year. MCI have upgraded the deck with their new *JH-100* transport which features crystal-controlled tape speeds with dc servo-drive capstan motor system and an all-solid-state logic design. The 16 tracker costs $16,500 (£6,600).

3M were, of course, at the convention in force. Their 8-16-24 track versions of *Series 79* were unchanged but they have added 1-2-4 channel versions to round out the line. Specifications are identical with others in the series as the same open-loop drive system and electronics are used.

Scully/Metrotech showed some new additions to their line. They introduced the *Series 400* logging recorder which can record over 614 hours on a 27 cm reel. The recorder makes up to eight passes with automatic reversing at the end of the reel. One novel option was a matrix 24-hour time clock which can add and read the hour, second and minute on the tape. Setting any desired time with a thumb-wheel-switch, the recorder goes into fast wind and searches out the setting, where it goes into play. The *Scully 100*, 'the poor man's 16 track,' was on display with an improved pinch-roller system. A worm-gear system holds the pinch roller in place instead of the old solenoid. 'Heat of operation used to produce uneven pressure,' said the Scully man, 'but the worm-gear holds tight regardless of operating conditions'.

Custom Fidelity showed their 16 track entry, the *Pro Master 16*. Another machine to use a servo capstan system like 3M and Stephens, the *Pro Master* offers VU-calibrated peak-reading meters using leds on each channel and a digital-readout tape length counter for fixed or variable speeds. By rotating a large metal plate (on which the left-hand guide is fixed) the machine comes quickly to a stop and resumes play when you let go, making this machine

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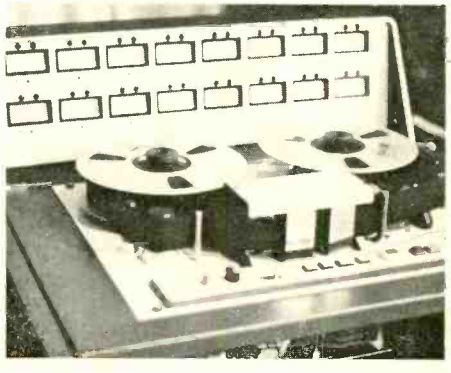


very easy to hand-cue if you are so inclined (fig. 3).

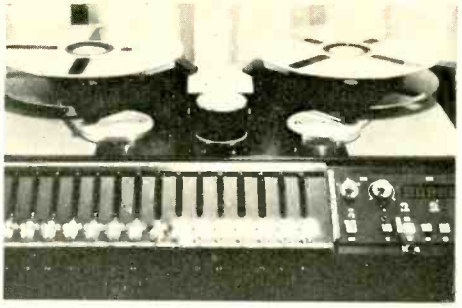
Electro Sound, long in the tape-duplication field, showed their new entry to the studio field. Similar in appearance to the Ampex *440*, the Electro Sound *ES-505* does offer some interesting refinements. The recorder includes a built-in seven-frequency audio oscillator to simplify testing and alignment. The head gate slips straight down into the deck to aid head cleaning and degaussing, and jumps back up when the play button is depressed. Motion sensing with hybrid relay-logic circuitry allows the recorder to go from fast forward to play without going through stop. As an option, the *505* offers a hook-on outboard take-up reel to simplify editing. The recorder also features a new design capstan idler wheel. Unlike most idlers, which are sand-blasted to give them a 'grip' surface, Electro Sound engineers claim to have perfected a method which puts permanent non-wearable 'teeth' on the idler. The two channel *ES-505* lists for $3,095 (£1,238) with versions from one to four channels (fig. 4).

Ampex showed their line of recorders, unchanged from last year except for some refinements in the power supply of their *1100* series. Tascam showed their latest entry into the multichannel field with an eight channel 125 mm machine for $3,900 (£1,560). The recorder displayed was their second prototype and, for such a price, it will be interesting to see how well these recorders withstand the abuse to which their more expensive brethren are subjected.

Inovonics showed their new upgrading recorder electronics. Similar to the Ampex electronics but with improved specifications and increased versatility, the electronics are available in one or two channel units, the latter listing for $1,150 (£460). Tentel showed their new *T-2* tape tension gauge which can measure tension on stopped or moving tape from 3 to 25 mm widths (fig. 5). A simple hand-held instrument, the *T-2* operates in any position (even upside down) with no adjustments. Price is $198 (£80).

3M and Automated Processes showed their audio-video, audio-audio or audio-film synchronisers. The 3M unit contains a digital read-out of hours-minutes-seconds-frames on the main control panel with an offset control and meter showing the number of frames offset either ahead or behind. Prices are not set but will be in the $12,000 (£4,800) range. The Automated Processes version, called *MagLink*, contains two digital readouts for the master recorder and slave unit. Offset positions can be introduced through a keyboard and are recorded on the master recorder. With the slave on 'auto' the relative position between the two machines remains constant. In manual, offset changes or corrections can be introduced. The unit can also preprogram the master so the slave starts and stops at predetermined points, a boon for the audio effects mixer.

The three noise reduction systems, Dolby, DBX and Burwen, were well in evidence. DBX have had considerable growth since last year and claim to be selling 400 channels of noise reduction per month, closing on Dolby in units-per-month though a good distance away on units-in-the-field. DBX showed their 119 and 216 studio systems (fig. 6), the former a record-or-play 16 channel version, the latter a record-and-play 16 channel system. A spare



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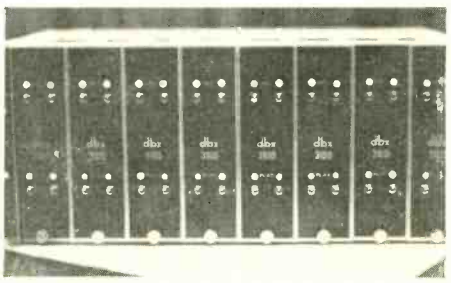

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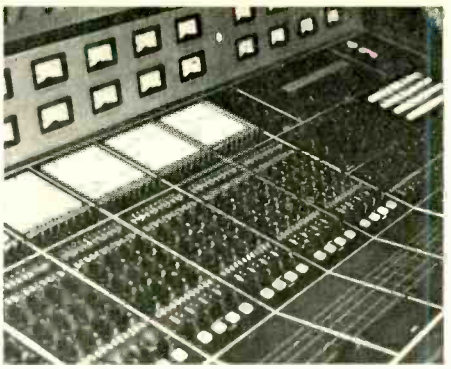

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module is included with each. DBX also showed their home noise reduction systems which are electrically identical to the other systems but are packaged as home units and use pin plug connectors.

Consoles were, as usual, the biggest thing at the convention. The trend seems to be toward stock consoles and few completely new boards were shown. Auditronics showed their 'Son of 36 Grand', a 26/24 or 26/16 desk which is claimed to be operable in ten hours after being unpacked from the shipping crate due to extensive factory testing before shipment. Spectra Sonics showed two of their custom consoles which are now all in-house built. Among their features is the smallest quad joystick panner available which fits into the standard console 37 mm width. The other console they had on display (fig. 7) was produced for Consumers Union to test consumer high fidelity equipment. Considering what some home equipment is like these days, the specifications on that console must be outstanding. Cetec, a new US conglomerate of Electrodyne, Langevin and Gauss, showed their consoles including the new Langevin *Series 10* broadcast console (fig. 8), which has quite a

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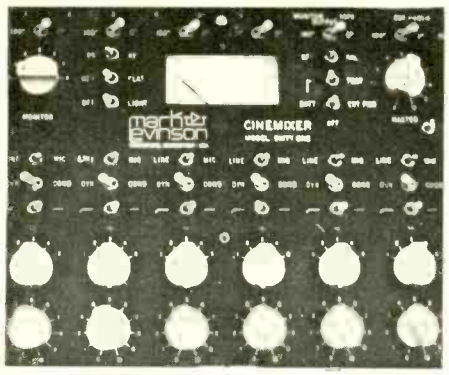

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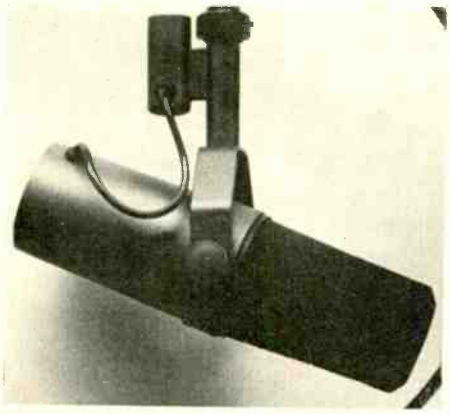

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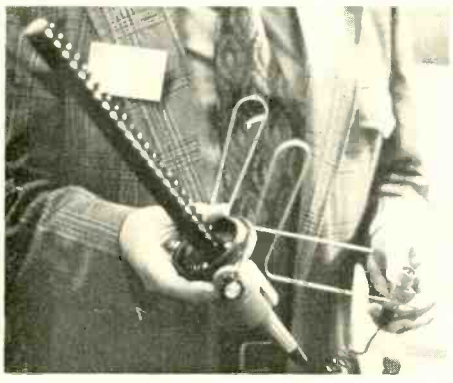

12

futuristic appearance. Cetec also showed the *Electrodyne 2000*, a large stock console with a 16/16 configuration. MCI showed their *JH-416* and *JH-416LM* stock consoles, the latter available with light meters (hence the LM designation) which can display either average or peak levels. Both models are now fitted with Penny & Giles faders and full quad panning. The *416* runs $19,950 (£7,980) for 16-channel and $24,750 (£9,900) for 24-channel with $3,000 (£1,200) extra for 24 light meters in place of normal VU meters. Tascam showed their basic consoles which can be built up to 24/4 at $450 (£180) for the basic board plus $150 (£60) per input module. The real monster boards were shown by Neve (who else?) and Audio Designs. The Audio Designs showed all output channels with pulsating lines. This is the first system I've seen where these 'lines' have been readable although it is still difficult to tell which line is with which channel.

Mixers seem to be more prominent than previous conventions due, no doubt, to the number of on-location recording and public address uses and to their cost compared with the usual large consoles. Shure showed their line including the new *SE-30* mixer which contains a gated compressor which is virtually inaudible while in operation as the gated memory reduces the 'pumping' effect normally associated with compression. Interface Electronics showed two new Stevenson mixers, the *Series 200* also has an optional compressor, track selector, high-low cut filters, solo button and other options. The 100 is available in various forms from $1,860 (£744) for an 8/4 straight mixer to $5,040 (£2,016) for their deluxe version.

Quantum Labs showed their new *QM 8* mixer, an 8/4 board. This mixer includes a headphone cue system and quad pan pots on each channel.

Mark Levinson, a new name in the audio industry, showed his *D1002* and *Model 61* mixers, listed at $7,000 (£2,800) and $2,500 (£1,000) respectively, both with five year guarantees. The *61* is a mono film sound mixer (**fig. 9**) claimed to be 'stage-of-the-art'. A battery-powered unit, it has provisions for phantom powering capacitor microphones as well as bass roll-off, phase reversal, VU meter (which reads off monitor output for setting levels and pre-auditions), led indicators and a built-in high-quality capacitor microphone to slate the tape verbally. The mixer also has provision for running all six microphone inputs through a remote cable. The VU meter reads either average or peak levels and its light can be turned off to conserve batteries. The Allen & Heath mixers were also introduced to the States at the convention and were, in general, well received.

One of the most interesting mixers wasn't exhibited on the main floor but in one of the hotel rooms. Dan Dugan, of San Francisco, was showing his prototype mixer to various manufacturers. Perhaps the 'mixer of the future', it actually performs all the time-consuming functions of the engineer. Each input has a gain control with an electronic threshold switch which turns that input on when the information on that channel exceeds a preset level. Thus, every input could be 'on' but would not pass any information until someone approaches one of the microphones and says something. Thus, the dB loss of multimike systems would not apply and maximum gain could be utilised. Mr Dugan even turned one input up until it was way into feedback. But, as he stepped away from that microphone, the feedback was shut off with that input. The secret to the system is measuring the ambient noise level in the other microphones. Since all mikes were picking up the feedback in the room, it was considered ambience while the voice, which appeared in only one mic channel, was not. Thus, in basic setups like rock bands or church sound systems, the operator would just set the levels and the threshold of ambience and that's it: the system would turn each channel on and off automatically.

Most microphone manufacturers at the convention seemed to be little changed from last year. There were a few new models, one being Shure's new *SM7* (**fig. 10**). Claimed to equal the sound of capacitor microphones, the *SM7* is Shure's answer to the Electro-Voice *RE-20*. Response is virtually flat with slight peak at 10 kHz dropping off around 15 kHz where it is 7 dB down. It has a near perfect unidirectional pattern. Burwen Laboratories have entered the microphone field with their new line of capacitor microphones (**fig. 11**). Capsules, power supply, cables and other parts are available separately and a complete omni-

58 ▶

13

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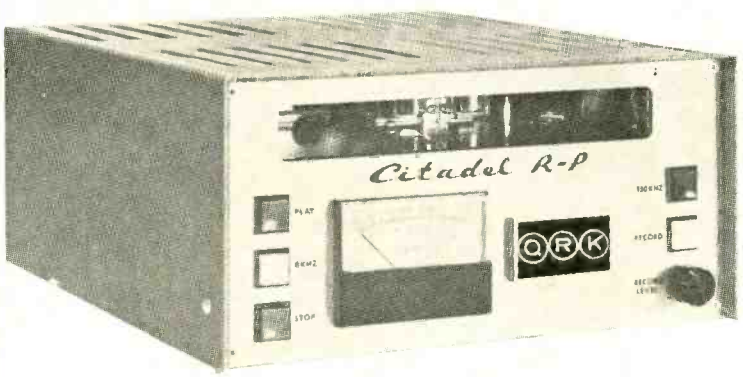

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directional mic with power supply runs just over $800 (£320) which is a great deal of money for one microphone. But the most intriguing new microphone was a new Electro-Voice entry. As yet unnamed, the microphone is about 13 mm across and virtually invisible. I was not allowed to photograph it because 'the CIA might cancel their order' said the salesman. The mic is fashioned after a tie tack with the 'tack' part, which can be pushed through a jacket or tie, actually being a miniature coax connector with the jack at the back of the garment. Response is claimed to be relatively flat from 50 to 15 kHz and the salesman to whom it was pinned had used it connected to a Nagra *SN* recorder in his pocket to make some 'very interesting' recordings—to the detriment of his victims. Electro-Voice also showed their new version of the *642* shotgun (fig. 12), which is considerably lighter than its predecessor.

Quite a few new equalisers were shown, one of the most interesting being Multi-Track's new Vari-Band Sweep Equaliser (fig. 13). This unit contains low, mid and high frequency equalisation, with a difference. The operator may choose 20 to 100 Hz or 100 to 600 Hz for low eq, 600 to 3 kHz or 3 to 6 kHz for mid eq, and 6 kHz to 20 kHz for high eq. A bandcentre control allows the user to choose the mid frequency (in any of the bands) at which peaking or dipping will be most prominent. A bandwidth control then determines the amount of peak or dip. Thus you can get a boost or dip of up to 15 dB at any setting with a bandwidth from a sharp 16 dB per octave to a wide 2 dB per octave. One section can have a wide bandwidth while the other has a narrow bandwidth and one can peak while the other dips. Cost of the units is $350 (£140), which is quite reasonable for this versatility.

UREI showed their *527A* graphic equaliser which contains 27 third octave controls from 40 Hz to 16 kHz. Controls peak or dip up to 10 dB. Shure showed their new *M610* graphic equaliser. With mic level and high level inputs and outputs, the *M610* matches their *M67* mixer in appearance and dimensions. A dip filter only, the Shure unit has eight straight-line controls from 63 Hz to 8 kHz with a maximum attenuation of 12 dB per section.

There were a few new amplifiers shown. Bose showed their *1800* series stereo power amplifier. In a rackmount chassis, the *1800* produces 400W into 4 ohms. The front panel contains a peak-reading led display for each channel. Zero Impedance Systems showed their line of amplifier cards for RIAA phono equalisation, mixing, line and mic preamplifiers and a miniature 50W card amplifier (fig. 14). Distortion is less than 0.1 per cent at full output and frequency response is ±0.1 dB from dc to 50 kHz. Output impedance is described as 'virtually zero'.

But the most interesting new amplifier was the *BGW 1500*. Called the Arc Welder's Special, an apt name, the *1500* can produce 1.5 kW into 1C! The 16 output transistors are on four-section heat sinks connected with their fins together; forced air cooling comes from fans front and back of the fins. The tremendous output, claimed to be

14

up to 100A peak, is too great to be handled by just one pair of banana jacks so *four* sets are provided to handle the current. As this is a mono amplifier, perhaps we can look forward to a stereo version. (That was a joke, but I can imagine those with 700W amplifiers will jump at the idea.) Price for the *1500* is $1,350 (£540).

Custom Fidelity showed their ic digital stopwatch. This clock, which features all ic construction and segmented readout, measured 50 x 125 mm and is about 13 mm thick.

Oberheim Electronics showed their *DS-2* and *DS-3* digital sequencer which can store and repeat up to 72 notes (16 notes for the *DS-3*) as either one 72-note run or one 48-note and one 24-note sequence or three 24-note selections. With a range of five octaves, the sequencers can adjust tempo to 16 times faster or slower than originally programmed. The *DS-2* costs $795 (£318), the *DS-3* $495 (£198). Levinson showed the Jecklin-Float electrostatic headphones. Made in Switzerland, these feature large removable electrostatic elements. Crown showed their distortion analyser. Measuring 2nd and 3rd harmonic distortion in seven ranges from 0.1 per cent to 100 per cent full-scale, the unit can read four channels simultaneously.

The matrix versus discrete battle continued as last year. Nippon Columbia introduced a combination discrete-matrix system which uses a similar system to the *CD-4* disc but with matrix signals in the baseband reducing frequency response requirements to 36 kHz (as opposed to 45 kHz for the *CD-4*). Actual discrete separation occurs only at mid-frequencies since 'sensitivity of human ears for localisation becomes poor at lower and higher frequencies' say Nippon. Well, perhaps this just confuses the issue. Of course, those who feel so inclined may take a middle-of-the-road stance. Scheiber Systems showed their new '25 dB' system which they claim produces 25 dB of separation in a matrix quad format. Peter Scheiber, the inventor and one of the pioneers of early matrix systems, said that the new system has no effect on dynamic range (greater than 60 dB) or distortion (less than 0.1 per cent harmonic, 20 Hz to 20 kHz). The system includes an oscilloscope-type polar display of quad separation. And speaking of separation displays, JVC showed their memory peak level meter (fig. 23). The meter, which uses a very eye-catching orange-line circular display system, can register peaks permanently or normal VU readings. The meter uses a 'plasma film' for the display. Among matrix systems, Sansui seem to be the leading system as all Japanese commercial broadcasters are using the *QS* system. They showed their *QSE-4*/*QSD-4* encoder/decoder system. They claim 'separation in excess of 20 dB' in quad with 'excellent mono compatibility'.

The technical sessions, which are the actual reason for the convention, were held in two large halls in the Los Angeles Hilton. The papers were divided into 13 sessions ranging from transducers to digital techniques in audio. D. B. Keele, Jr of Electro-Voice presented a paper on a new method of low frequency measurement for loudspeakers using a near-field sampling technique. Thus, using this simple low frequency approach, speaker manufacturers can no longer omit the bottom octave from their measurements because of lack of suitable equipment. All measurements can be made in a non-anechoic environment. John G. McKnight and Trevor Kendall, both of Scully/Metrotech, presented a paper on a proposed new equalisation for 38 cm/s tape mastering to take advantage of the new high-output low-noise tapes. The new standard includes no low frequency pre-emphasis and high frequency reproduction equalisation of +3 dB at 6.3 kHz (25 μs); pre-emphasis at 4 kHz is increased to +1 dB and, at 16 kHz, to +6 dB. A noise and signal reduction of 3 dB at 4 kHz and 6 dB at 16 kHz is claimed with overall response (one RC equaliser) up to 20 kHz at less than 0.5 dB ripple. D. A. Eilers of 3M proposed a new system for a compatible discrete quadraphonic eight track cartridge where the head stacks have each channel split (in a quad player) into two channels, thus both reading the same information on a standard eight track cartridge but covering separate tracks on a quadraphonic cartridge. Considering the existing alignment and noise problems in this medium, one wonders what the effect of reducing the track size would be.

A whole session was devoted to automated mixdown systems where UREI, Quad-Eight and Automated Processes spoke about their respective systems and related subjects. During the Motion Picture Sound session, Ioan Allen of Dolby Laboratories spoke on producing optical soundtracks. However, Dolby would have more effect if the cinema industry would change the well-entrenched Academy Curve by which virtually all films are made. Ronald Uhlig of Kodak spoke on producing high quality optical soundtracks where each normal channel is divided in half for stereo tracks. The convention was ended with the Recording Workshop. The third year for the workshop, Bill Robinson of Sunset Sound introduced Bill Lazerus, Brian Ingoldsby and Ron Neilson who recorded and mixed a 16-track master right in the hall. First a group named Voices played the instrumental tracks for their song *Ride a White Horse* and over-dubbed the vocals. Then came the various signal processing techniques including phasing, Kepex and ring modulation. Finally the tape was mixed through a Compumix automated mixdown system.

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VIDEO

By Roderick Snell

TEST CARDS AND SIGNALS

Part One

SOUND ENGINEERING has been developed to the point where many listeners are unable to tell the difference between a live chamber orchestra and a good tape recording if both are behind a screen. Techniques and equipment for measuring the performance differences of studio equipment are subtle and need both experience and training.

On the other hand no one could be fooled into thinking that a small flickering television screen is anything like the real thing and, although broadcast and cctv engineers may chide the public for putting up with the further degradations that take place in most domestic tv receivers, it is the viewers' lack of interest in improving the technical quality of their 'window on the world' rather than their *ability* to detect these faults which prevents their demanding better results.

Given practice, any cctv user can train himself fairly easily to assess the main aspects of tv system performance with no more than an intelligent eye and a test pattern.

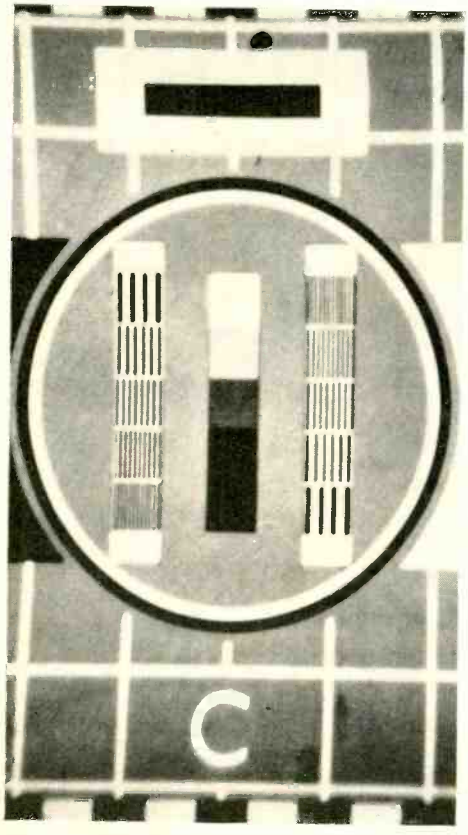
Several STUDIO SOUND readers have questioned the validity of printing test cards in the technical reviews, arguing that distortion in the printing system will mask the effect it is intended to show. In fact the photographs of testcards are chosen to show some aspect of performance which will *not* be lost in the grey-scale and resolution errors of the printing process. Grey-scale accuracy is not a significant weakness of vtrs, although such errors in a review of the Mullard silicon diode tube did obscure the results, and resolution problems can be avoided by printing the card large enough or by showing only the relevant section of the card, suitably enlarged. Ringing and noise are harder to show but there is evidence from the BBC research department that the correlation between viewers' assessments of noise off-screen and in photographs is good (ref. 1).

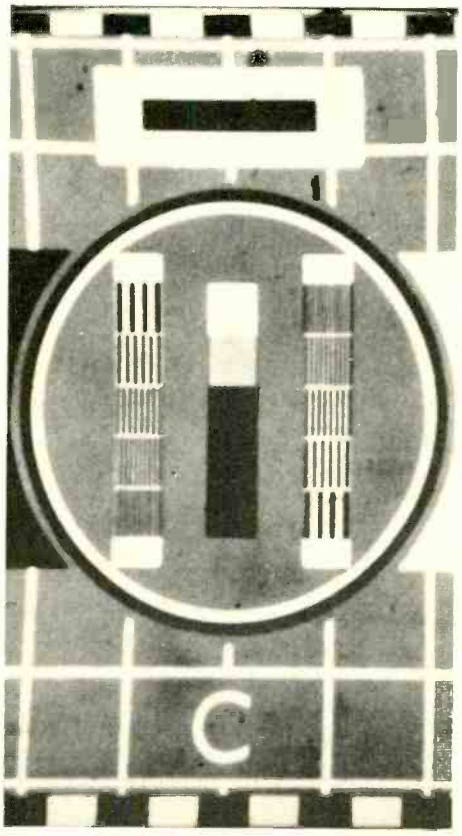
Monitor requirements

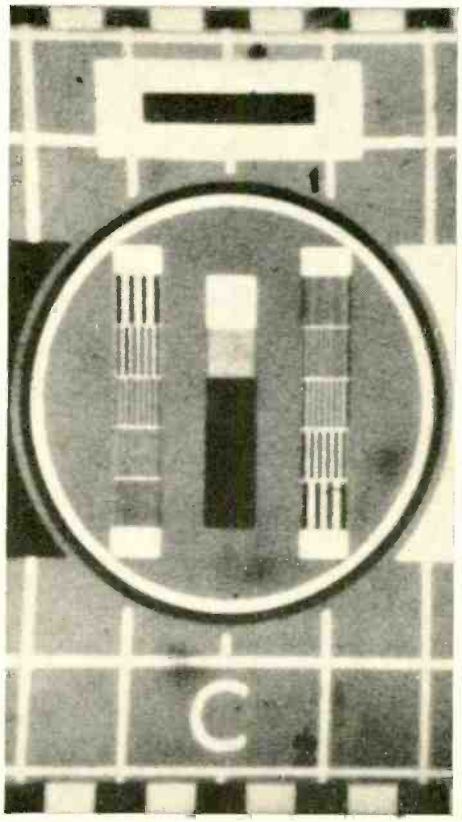
If the quality assessments are to be mainly visual, the monitor is clearly the most important instrument, and time given to ensuring that this equipment is better than the other links in the video chain is well spent. A near-perfect signal is needed to check the monitor performance, and the best source for this is an off-air test card. Allowing that the receiver is of a high quality, this is still true in the case of a broadcast camera. Broadcast test card F, for example, comes from a highly expensive monoscope system in which the test card is printed inside the camera tube, thus eliminating lighting and lenses. The signal-to-noise ratio, geometrical accuracy and resolution of test card F probably make it the best test source there is and it may well be worth spending more on the uhf aerial system plus £100 or so for a good quality front end such as the Decca *RU-4011* (which is used by many manufacturers as well as studios) for a standard signal source.

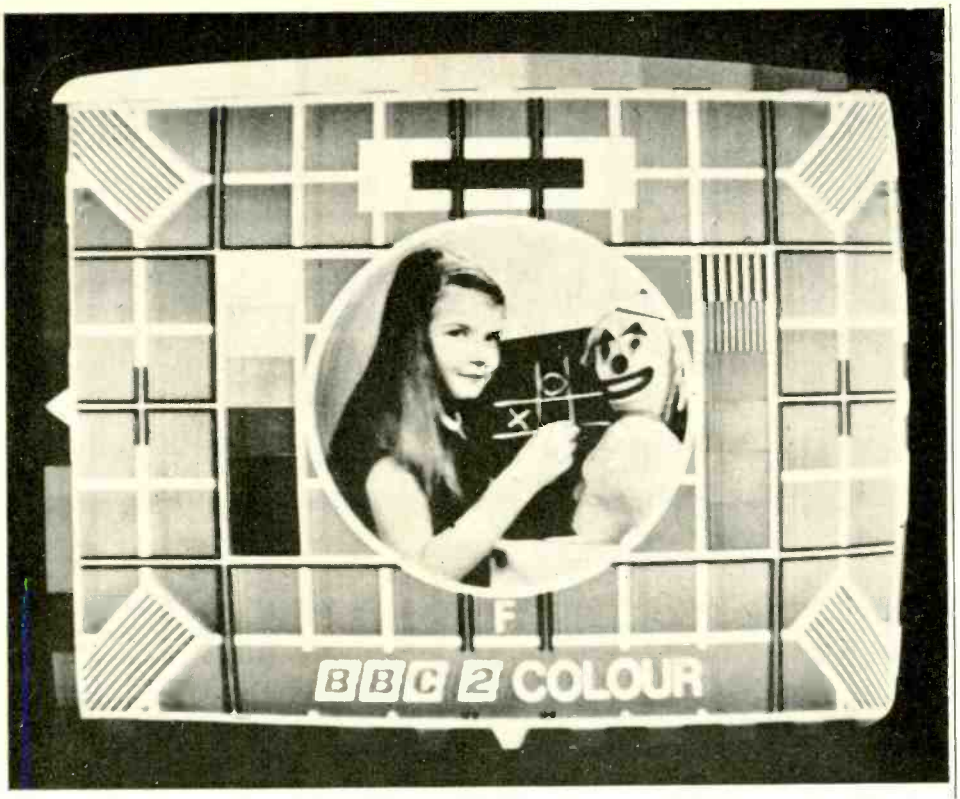
Having set up such a system, using either a specialised receiver unit or one of the better receiver/monitors, a source of test card F should be carefully tuned in and a check made for noise. The monitor contrast and brightness levels should be set so that all steps of the grey-scale are visible and the white sections of the picture are not so bright that they lose focus. This can be checked by looking closely at the line structure of the picture; if the lines thicken and merge on whites, contrast or brightness must reduced. As the brightness needed depends on the ambient light level, reducing this enables one to achieve the maximum contrast.

Noise on a good signal should be invisible at the normal monitor settings and, if it is









better than 46 dB, will only become detectable if the contrast is advanced well beyond its normal setting.

Noise on playback from a good vtr should be better than 42 dB and, if just visible, not annoying. 38 dB is visible, and quite noticeable when compared with the original off-air signal. Greater than 36 dB noise will be objectionable to many viewers, even if still usable. Fig. 1 gives an idea of the appearance of different signal to noise ratios.

The resolution can next be checked: all the frequency gratings to the right of the circle on the circle on test card F should be visible and of equal brightness. The amount of degradation that can be allowed here depends upon the vtr; the receiver and monitor resolution must exceed that of the vtr to be useful as a test. The degree of resolution of detail, like sound high frequency response, is often debated and many of those involved often have a vested interest. The argument is well put by Martin Dickstein of RCA (ref. 2) who finds that more than 610 lines cannot be seen at a viewing distance of four times the picture height. Dickstein concludes that even 400 lines will be hard to see unless contrast and other viewing conditions are carefully tailored. But this does not take into account the many specialised uses of television in, for example, engineering, medical and other scientific areas where the viewer may be close to the screen. Those who have used a high resolution 700 or 819 line system usually agree that these processes benefit from the best resolution one can get.

Above: Fig. 2, BBC Testcard *F* on monitor with poor sync separator.

Below left to right: Fig. 1a, b, c

As the cctv user needs a good monitor for his primary measuring instrument, several peculiarities of equipment originally designed for 525 line 60 Hz use are worth looking out for. Line and frame linearity is sometimes below standard, as are the sync separation circuits. Fig. 2 shows the line timing errors in a Shibaden *TU-12BL* monitor produced by the vertical castellations on test card *F*; this fault does not show on normal pictures most of the time.

Another feature worth having on a quality-checking monitor and which some argue should be fitted to all tv sets, be they monochrome or colour, is some form of black level control. If the dc component of the video signal is removed from the connection to the display tube, the *absolute* value of the video signal is lost, and only the *differences* in brightness between parts of the picture are seen. Although visually satisfactory for most of the time, fig. 3 shows the sort of test which exposes the problem. In fig. 3a, white and black sections are separated by a thin strip of mid-grey at the screen centre.

If the right-hand section is also made white (fig. 3b) both halves will now appear mid-grey and the central strip will appear black. Similarly, if both halves are made black (fig. 3c), they will now again appear mid-grey with the central strip white. This problem is not found in top-class monitors, nor in colour receivers, where the need to keep an accurate balance between the three colours has forced manufacturers to maintain true black levels.

Lastly, the monitor should be overscanned. There is no advantage to viewers in seeing the edges of the picture which may be disturbingly unstable or noisy especially in cctv signals from a vtr, so the outer 30 per cent of the transmitted picture area is not used. On the other

62 ▶

hand, a quality monitor should show these faults as they can affect the stability of the display monitors. Tracking errors in the vtr for example, which are not visible on the picture, can produce noise and dropout during or near the vertical interval period which upset the stability of the replay monitors.

Having chosen a suitable receiver and monitor system, it is worth taking a close look at the test card.

BBC Testcard F

Now used by both BBC and commercial sources, this had its origins in the early BBC test card *C* (fig. 4) which was first broadcast in 1947 when the television service restarted after the war. This card was unusual in that it was for trade use, designed after consultation with the receiver manufacturers and with the ordinary television installation and service engineer in mind. It was the care taken to make this original pattern useful to the non-broadcast engineer who was probably without test equipment that made visual checks of tv performance as penetrating as they are.

The circle is the best check of horizontal and vertical linearity and is placed near the centre of the picture because it is the most critical area. The grey and white squares over the rest of the card give a less precise indication of the picture geometry right to the edge. The black edging on some of the grey squares is for colour receiver registration checking. The grey scale left of the circle is divided into six densities to check the system transfer characteristic of brightness. Again this section has the density of each step carefully graded so that they give the *appearance* of equal density increments between steps. The actual choice of density for this was beyond calculation and was the result of empirical tests done by BBC Research Department for their test card *C*.

The choice between a frequency wedge (fig. 5) and a set of frequency bars depends upon the user's needs. The wedge is in effect a video sweep at the tv frame rate and is useful for showing the shape of the high frequency response as well as the limiting resolution of a camera or vtr. The wedge is usually marked at the side so that the figure for resolution can be read from the point where the wedge disappears into mid-grey.

The six blocks in test card *F* correspond to frequencies of 1.5, 2.5, 3.5, 4, 4.5 and 5.25 MHz, and were chosen to force the viewer into a decision about the frequency response. The designers argue that agreement can be reached, given this small number of steps, whereas with more steps or a wedge there will be differences of interpretation.

To relieve printing difficulties, as well as to give a clean appearance to these frequency bars, they are made square rather than sinusoidal, and so contain out-of-band energy. To compensate for this, their modulation amplitude is reduced to 78 per cent so that, after passing through a bandwidth limited system with a cut-off below the third harmonic of the squarewave, a sinewave with 100 per cent modulation results (fig. 6).

Incidentally, 2 and 3 MHz frequencies are left out to eliminate possible interference on receivers with intercarrier sound systems.

The picture within the circle has been care-

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Fig. 3

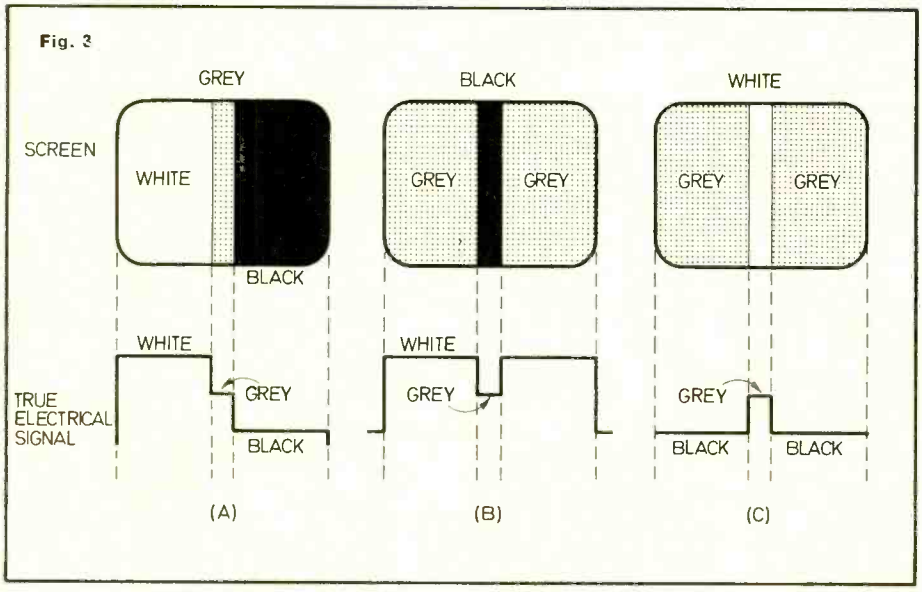


Fig. 5A

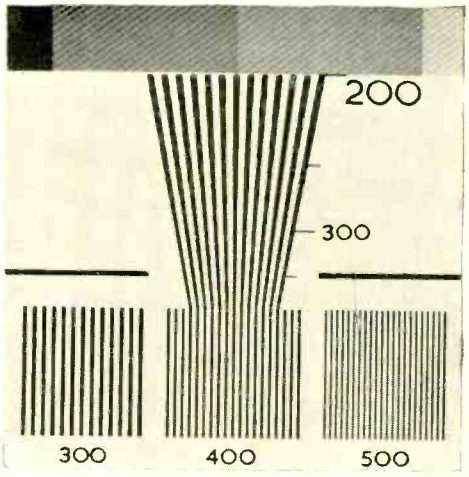
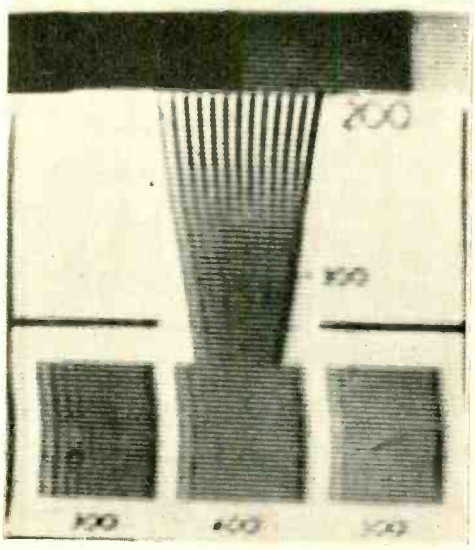


Fig. 5B



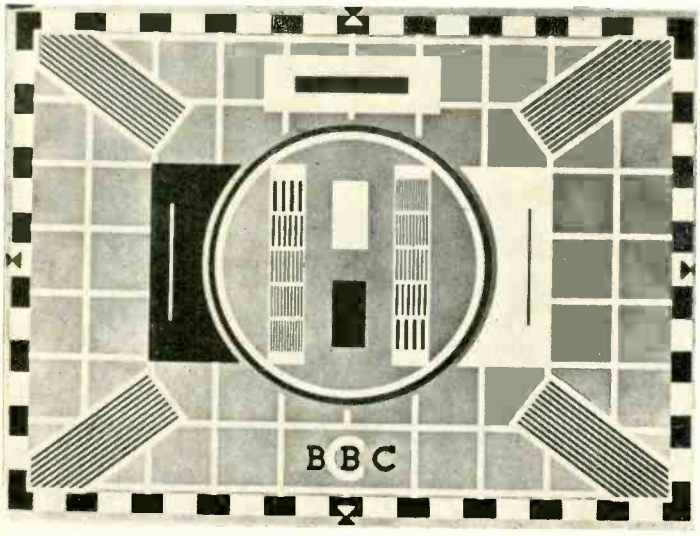


Fig. 4

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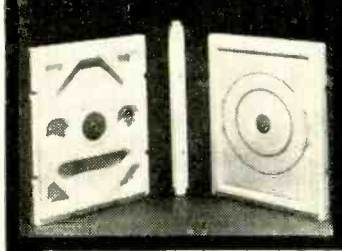

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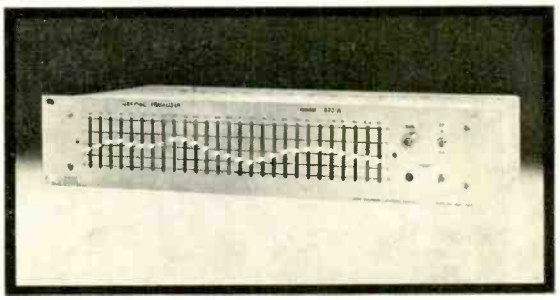

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fully chosen to be useful to non-technical viewers as well as engineers. The markings on the blackboard are for colour registration, the blouse is a saturated bright red but, if exaggerated, makes the girl's face too red. A girl was chosen because she did not need make-up, which apart from being artificial, might go out of fashion!

Test cards and vtrs

A still picture is by far the severest test for stability in a vtr or telecine so, if the salesman for some new video recorder insists on demonstrating it with fast-moving pictures only, chances are the stability is poor.

'Hop' and 'weave' are the terms used in film and telecine for the respective equivalents of vertical and horizontal jitter in vtrs. Vertical jitter usually results from the disturbances of head changeover in a two-head omega wrap vtr or the dropout period in a single-head machine such as the Ampex, Philips or IVC 25 mm models. The effect is highly monitor-dependent, its degree depending on the line flywheel time constants. However, nothing exposes the problem better than the vertical bars of the test card.

Test cards for cameras and vtrs

An off-air test card is to be preferred for vtr testing because of the very high standard obtainable but test card *F* is only transmitted at certain unspecified times. Also, broadcast signals are clearly of no use for camera testing so, after the vtr and monitor have been checked, or where no off-air facilities exist, a test card for camera use is needed.

One of the best known of these is the Marconi *1* resolution chart (**fig. 7**), which their associate company English Electric have made available to cctv users who are customers for their camera tubes. This monochrome card has frequency blocks between 100 and 800 lines and the wedges cover the range between 200 and 800 lines. The corner resolution circles and wedges are particularly useful for testing camera focus fields but the other tests still make it useful for vtr assessment, provided the camera performance is good enough.

Even illumination of the card is difficult and specular reflections have to be avoided so, where professional tests are being done, a large transparency in front of a light box with even illumination of adjustable intensity is to be preferred.

Another test chart has recently been produced by Studio 99 Video (**fig. 8**). This is similar to the BBC test card *C* but with corner resolution circles. One criticism of this card is that its frequency gratings have rather large

Fig. 6

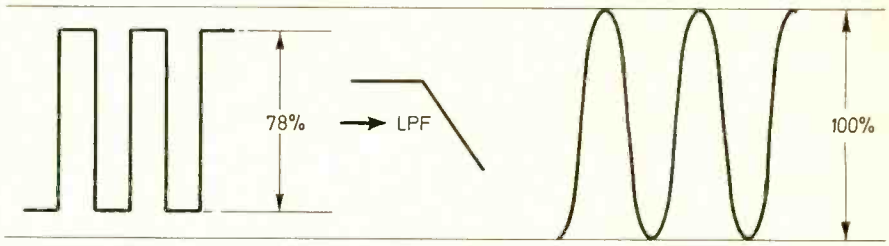
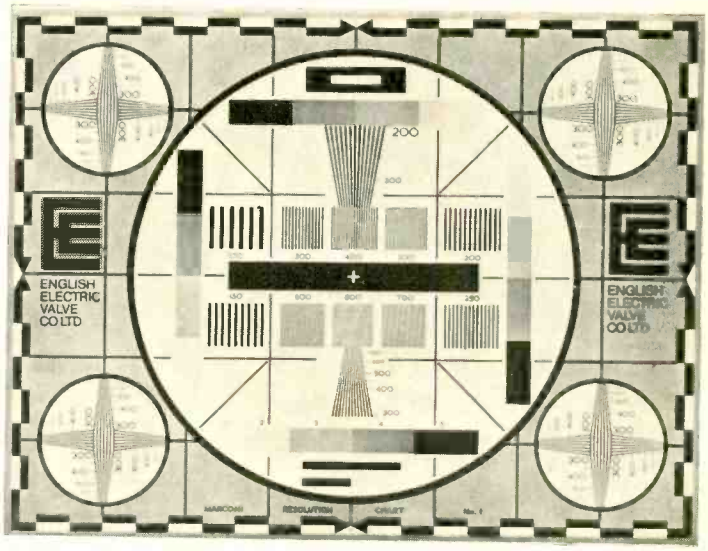


Fig. 7



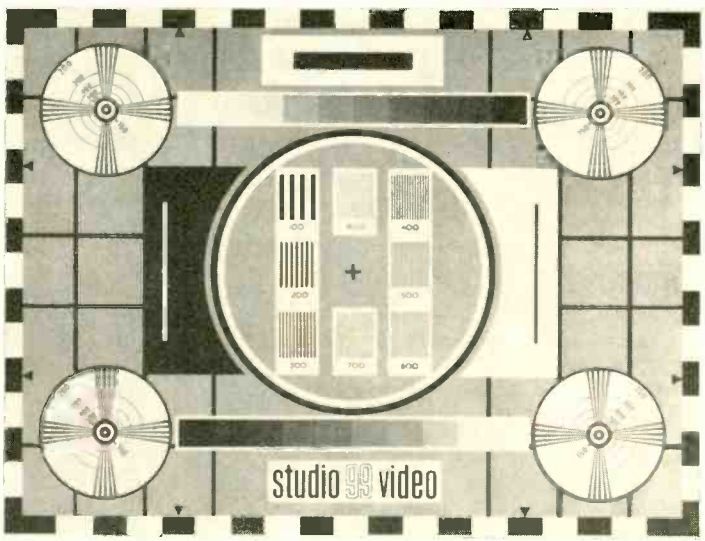
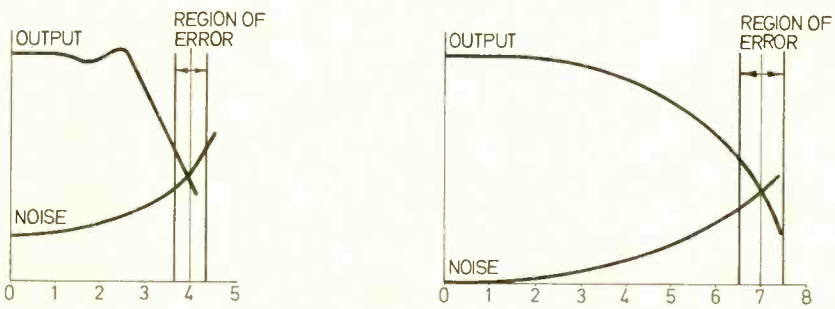


Fig. 8

Fig. 9



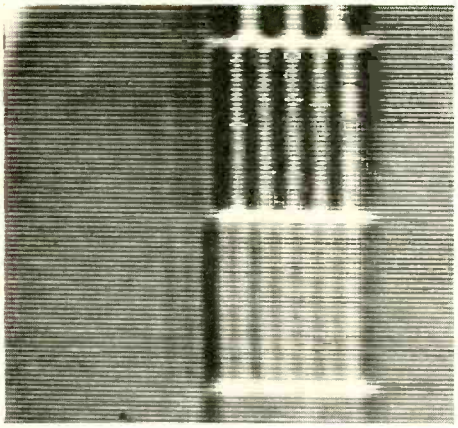


Fig. 10 Phase error

gaps and would disguise the difference between for example. a poor 12.5 mm vtr of 220 lines resolution and a much improved machine with 280 lines. Most vtrs have a very sharp high frequency cut-off (up to 50 dB per octave) and in their case it should not be too difficult to get an accurate idea of the limiting resolution as variation in monitor contrast or camera response will make no more than a few per cent difference. This is not the case with cameras, where the hf roll-off is more gradual and the exact cut-off harder to determine (**fig. 10**).

The quality of pictures cannot be related simply to the frequency range as the phase response is equally important in any tv system. A clear transition between black and white edges requires both frequency response to be wide and phase response to be constant. The sharp cut-off needed by a vtr which has had its high frequency response extended as far as the low limit of the fm carrier will often produce objectionable 'ringing' on edges. In such a case, lowering the cut-off and correcting the phase response will produce a softer but subjectively more satisfying picture. None of this information will be found in the specifications of low cost ctrs so time spent in developing the skills of visual analysis of test cards will help when choosing new equipment.

Conclusions

Visual tests of cctv performance are more important than any others and a good off-air signal coupled to a high-quality monitor is the best start. A monitor with good resolution and geometry, preferably with black level correction, adjusted to overscan the picture, can then be used in conjunction with broadcast test cards and, provided the user knows what to look for, he can achieve as useful an analysis as the trained engineer.

Part Two, next month, will discuss electronic signals and their measurements with both eye and oscilloscope. Noise tests are covered, as is the Philips electronically generated test card.

Acknowledgements to:

BBC Engineering Information, for permission to publish their test cards.
English Electric Valve Company, for permission to use their test card.
Cctv users requiring copies of this should contact Mr G. W. Garthwaite, at the Camera Tube Sales Department, EEV, Chelmsford, Essex.
Studio 99 for allowing us to print their new test card. Copies of this and Factsheet No. 2 are available from Studio 99, 81 Fairfax Road, London NW6.
Thanks also due to the Television Unit of the Brighton Polytechnic and Tim Johnson for help with the off-screen examples.

Ref 1 *The visibility of noise in television.* BBC Engineering Monograph No. 3, Oct. 1955.

Ref 2 Studio 99 Factsheet 2, January 1972.

An appendix on the relationship between frequency response and visible line resolution has for space reasons been omitted from Part One of this article and will appear with part Two. **Ed.**

The comma of Pythagoras

R. M. YOUNGSON

AS ELECTRONIC musical instruments proliferate, the need for some knowledge of the principles of tuning grows. In particular, those concerned with the servicing of keyboard electronic musical instruments must be capable of accurate retuning if the effectiveness of their work is to be apparent to the user. Even the non-technical owner, aware that only 12 adjustments need be made for the tuning of his entire instrument, is likely to be tempted to 'have a go' himself. Assuming him to be untutored in musical physics, the result will probably surprise him. The sequence goes something like this:

One or two pitches have been thought to be off-tune so the appropriate oscillators are adjusted until the notes sound right. But, when a few chords including these notes are played, the effect is distinctly off-colour. The unwary will then proceed to adjust the other notes of the chords until they sound right. The result of this is to throw further intervals out of tune and it is not until two feverish hours later that the glorious warmth and resonance of perfectly tuned chords in the key of C major is achieved. At this point the weary labourer may summon his wife to admire his skill. She may be relied upon to start playing in the key of E♭ and thereby demonstrate that some of the notes are almost a semitone out of tune. The instrument sounds wonderful in one key, dreadful in another. So the matter is not quite so simple as it seems.

A well-equipped worker can tune using a digital frequency meter, but even this is not without difficulties. It is not enough simply to set the instrument at the 1s gate time and and adjust the master oscillators until the correct frequency is displayed for each note. The one count ambiguity per second, at this setting, which is characteristic of almost all digital counters will exceed the tolerance for good tuning.

An improvement is to tune the highest full octave of the instrument, using a 10s count period. A list of values for the octave starting on C, three octaves above middle C, for a 10s count is shown in **Table 1**. This will give

TABLE 1

C	20930	F♯	29599
C♯	22175	G	31360
D	23493	G♯	33224
D♯	24890	A	35200
E	26370	A♯	37293
F	27938	B	39511

acceptable accuracy with an ambiguity of about 1/80 Hz. An alternative method is to count the cycle length in microseconds. To do this one sets the digital meter so that it measures period rather than frequency, the count gate being opened and closed by each (squared-up) double Herz of input signal while passing a 1 Mhz wave-train from the clock oscillator.

Table 2 gives a list of period lengths, in microseconds, for the octave starting on middle C. Also included in this table is a list of the frequencies of the same octave, to 11 significant figures. This is the octave normally used in tuning divided-type instruments. It is important to note that these tables are based on the standard 'equal-tempered' scale, now in universal use, in which all semitone intervals are exactly equal, permitting music to be played with equal effect in any key. The frequencies are calculated by computer on the basis of A = 440 Hz (the internationally agreed standard A) the

TABLE 2

Note	Period in μs	Frequency
C	3.8222564321	261.62556536
C♯	3.6077296627	277.18263104
D	3.4052433559	293.66476797
D♯	3.2141217322	311.12698377
E	3.0337269409	329.62755696
F	2.8634569312	349.22823147
F♯	2.702743443	369.99442273
G	2.5510501097	391.99543600
G♯	2.4078706689	415.30469759
A	2.2727272727	400.00000000
A♯	2.1451688925	466.16376151
B	2.0247698140	493.88330123

12 intervals each bearing the ratio, adjacently, of $1:\sqrt[12]{2}$. In this system all notes with the exception of the A are slightly out of tune, all semitone intervals being a little flat of tune. To those admitting some confusion as to what this means and to those not fortunate enough to possess a digital frequency meter, the following account of the physical basis of musical tuning is dedicated.

When a violinist tunes his instrument in fifths (doh to soh) he listens carefully for a rough throbbing quality in the tone, which increases in intensity as he approaches the correct tuning then slows and disappears altogether as he reaches the perfect interval. He is aiming to achieve a beat-less fifth i.e. a consonance of two notes enclosing and including eight consecutive half-notes (e.g. C, C♯, D, D♯, E, F, F♯ and G (which are unaccompanied by any audible low frequency component). At a frequency below about eight or ten Hz, separate cycles are individually audible and these can be heard when two notes are tuned almost to an exact fifth but vanish when precise tuning is achieved. How do these beats arise?

To explain this, one must mention that perfect sine waves rarely occur in nature and that almost all natural and man-made sounds of discernible pitch contain, as additional harmonics, frequencies which are integral multiples of the fundamental. So, as shown in **fig. 1**, a note of 200 Hz will have a family of harmonics respectively of 2, 3, 4, 5, 6, 7 . . . times 200 Hz. These harmonics are usually present at an amplitude which decreases steadily with the harmonic number. Now, the perfect fifth above a note of 200 Hz is a note of 300 Hz (the interval of a physically perfect fifth is a frequency ratio of 2:3, such, for instance, as 1 kHz, and 1.5 kHz, or 256 Hz and 384 Hz). So if we put the harmonic series of the tones of 200 Hz and 300 Hz together, as in **Table 3**, we find that the second harmonic of 300 Hz is the same as the third harmonic of 200 Hz and that correspondence also occurs at the fourth with the sixth and the sixth with the ninth. Of course, we could go further and find more pairs of harmonics of equal frequency but this would be a waste of time for our purposes in view of the rapidly

FIG. 1

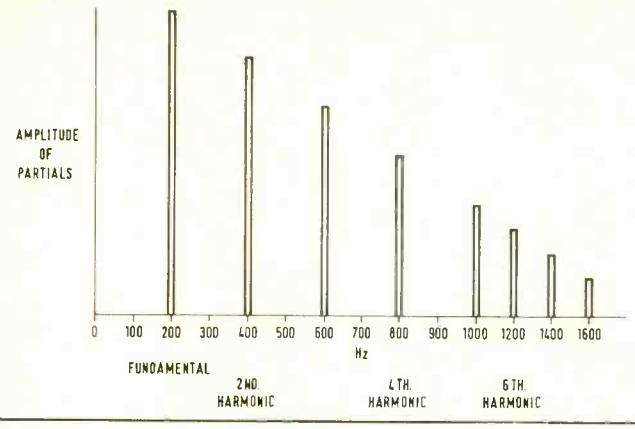


FIG. 2

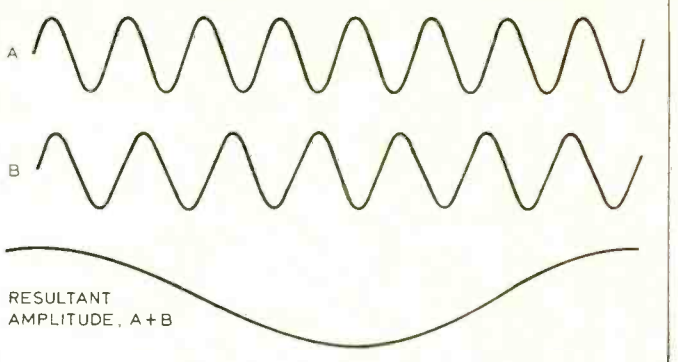
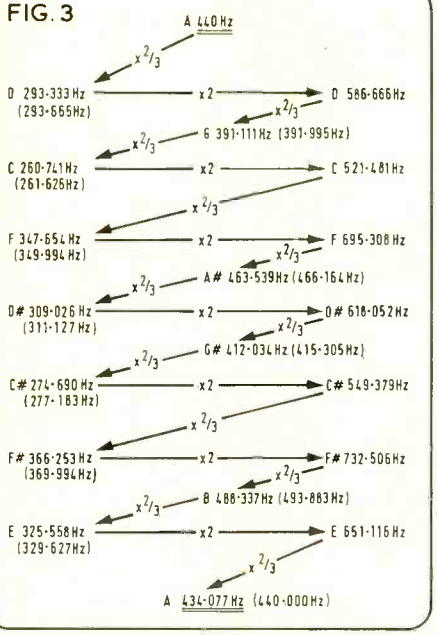


FIG. 3



diminishing amplitude of these partials.

Clearly, a slight mistuning of one of the fundamentals will lead to small differences also between the frequencies of these harmonics. In the case of the unmatched harmonics nothing much happens, as the differences are already considerable, but, in the case of the coincident pairs, a slight shift in the frequency of one will be readily apparent. Let us suppose that the 300 Hz note rises to 300.5 Hz. The second harmonic will now be 601 Hz and this will be sounding in conjunction with the third harmonic of the 200 Hz tone (i.e. exactly 600 Hz). 600 cycles of one occur in the time taken for 601 cycles of the other. This means that the phase relationship of the two waveforms changes smoothly through 360° during each second. All possible phase relationships will have occurred, from fully in-phase when the two waves potentiate each other (compress the air together) to fully out of phase, when they cancel. **Fig. 2** shows the effect graphically. You can see that we now have, added to the

TABLE 3

	Harmonics (Hz)					
Fundamental	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**
200 Hz	400	600	800	1000	1200	1400
300 Hz	600	900	1200	1500	1800	2100

TABLE 4

Interval	Frequency ratio	Notes (examples)
Octave	1:2	C to C
Fifth	2:3	C to G
Fourth	3:4	C to F
Major third	4:5	C to E
Minor third	5:6	C to E♭
Sixth	3:5	C to A

two tones, a third, swelling to a maximum once in a second and diminishing to a minimum once in the same second. This is the origin of the beats off-tuning and, if we listen carefully and count how many beats occur in a timed 10s period, we will be able to hear ten and thus verify that the difference between the two partials is 1 Hz and that the difference between the fundamentals is therefore 0.5 Hz. This is a remarkable standard of accuracy considering that no instruments are used. The beating between the fourth harmonic of one tone and the sixth of the other will be at a rate of 20 in 10s but will be less conspicuous because of the lower amplitude.

All the main musical intervals, when physically perfect, have fundamentals of simple integral frequency ratios. **Table 4** shows the main intervals with the ratios when beat-less. For the purposes of this explanation we need not concern ourselves with any intervals other than the fifth and the octave (1:2). Tuning perfect octaves is particularly easy as the beating around the octave is the most pronounced of all, since *all* harmonics of the higher note coincide with one of the lower. In electronic musical instruments, however, we very seldom have to tune octaves as this is almost always done for us, and very efficiently, by binary dividers. This convenient fact is made use of in the tuning method to be described.

Early in the history of musical theory, it was realised that by using fifths and octaves alone one could generate every pitch in the chromatic (12 semitone) octave. The idea is to proceed downwards by fifths, jumping up an octave when necessary to stay in the right part of the range. **Fig. 3** shows the scheme whereby we find, in order, the notes A, D, G, C, F, A♯, D♯, G♯, C♯, F♯, B, E and A. You can check this from the section of keyboard in **fig. 4.** It is easiest to count eight adjacent keys in a fifth, including the first and the last. Now we know that to go down a physically perfect fifth we must multiply the frequency by 2/3 and to rise an octave we must multiply by two. So, let's try. **Fig. 3** shows the results of generating a scale, using perfect beat-less fifths in a descending direction and rising repeatedly by an octave so as to keep within the desired range. The frequencies in brackets are those of the equal tempered notes as calculated by a computer on the basis of the ration $1:\sqrt[12]{2}$. An inspection will show that the natural intervals are always greater than the tempered ones and, of course, the frequency difference increases progressively throughout the series.

This surprising result is the explanation for the embarrassing fact that one can tune an instrument to a high degree of aesthetic satisfaction in one key and find it to be grossly out of tune in another. The simple and unfortunate truth is that a succession of beat-less fifths do not add up to a perfect octave. The second 'A' obtained by this process *is of slightly lower frequency* than the 'A' we started with. The difference is called the comma of Pythagoras after the discoverer of this interesting fact, who lived in Greece about 2600 years ago.

If people are singing in unison or unaccompanied harmony, the comma doesn't matter. Singers with good pitch discrimination will tend to sing in perfect intervals and will make constant slight adjustments of pitch in order to do so. To a large extent this also applies to players of the bowed string instruments and string players who use perfect intervals often sound out of tune when playing with a piano [so that's the reason—**Ed**]. But the case of keyboard instruments is a special one as there are no facilities for making minor frequency adjustments during performance. The centuries since the time of Pythagoras have seen numerous attempts to solve the problem and several distinct 'temperaments' have been adopted as compromise solutions.

The organs extant in the time of Bach were tuned so as to make most of the intervals in

68 ▶

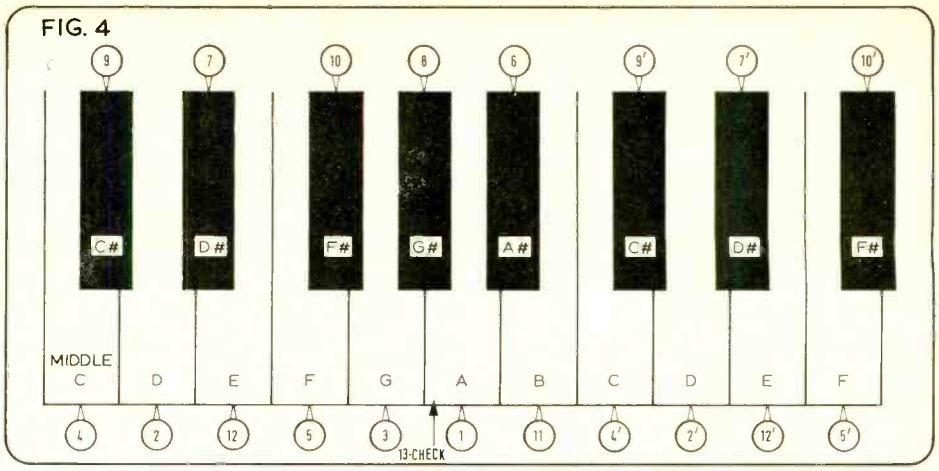
THE COMMA OF PYTHAGORAS

the commoner keys as nearly perfect as possible. This can be done so that an acceptable quality is obtained for keys up to three sharps or flats but if Bach had tried to play a piece in a remote key such as F♯ major, with six sharps, the congregation would have left in a hurry. There is a good deal of controversy about the origins of equal-temperament tuning and, probably because of the *Wöhltemperiertes Klavier*, Bach is often credited with having invented it. Certainly one can play the 48 *Preludes and Fugues* to equal effect only on an instrument tuned to equal temperament but such an obvious solution to the problem of eliminating the comma certainly preceded Bach.

It is likely that musicians preferred to limit the number of keys used rather than to accept degradation of the purity of intervals, and some of the older tunings sound glorious compared with modern equal temperament, so long as one sticks to certain keys. Helmholz, who had a very critical ear, found equal temperament almost intolerable and was very conscious of its aesthetic inadequacies. He had a harmonium tuned in perfect intervals for demonstration purposes. The fact that we now accept equal temperament uncomplainingly is a tribute to human adaptability and willingness to accept compromise. In equal temperament, *all* intervals are wrong, each being slightly adjusted so as to distribute the comma of Pythagoras throughout the octave.

Assuming that a standard A has been tuned (the method will be explained shortly) we proceed to obtain a tempered D. To do this we must compare the second harmonic of the A (880 Hz) with the third harmonic of the required tempered D. **Table 2** shows the frequency of the tempered D to be 293.6648 Hz, of which the third harmonic is 880.9944 Hz. So, when the D is correctly tuned, we will have, in each second, a beat-note of 0.9944 Hz of almost exactly 1 Hz. Counting for exactly 10s by a watch, it is easy to tune so as to achieve 10 beats in this period of time.

Having obtained a tempered D in this way, we next compare the D an octave higher (587.33 Hz) with the G a fifth below. The second harmonic of the D is 1174.6600 Hz and the third harmonic of the G is three times 391.9954 (see **Table 2**) i.e. 1175.9862 Hz. The difference is 1.327 Hz which is easily audible as a beat of just under one per second. The 10s count gives us 13 beats for correct tuning. **Table 5** lays out the process for the whole middle octave and shows how many beats must be counted in a 10s period for each successive tuning.



Now that the theory is clear, we can get down to practical details. It will be appreciated that when one presses a key near the middle of the keyboard of a divider organ and adjusts the appropriate master oscillator, one is not *directly* tuning this note. The arithmetical precision of the binary divider system ensures, however, that the effect is the same. In the uncommon case of a free-phase organ one should tune as described below and then complete the job by tuning the remainder of the notes, in octaves, to eliminate beats. In both cases it will be found that the beats are more easily heard using certain stops (such as Diapasons) than with others.

The standard A (440 Hz) can be obtained from a tuning fork or a broadcast signal. The A above Middle C should be adjusted in conjunction with this standard until the beats are first heard and then eliminated. Now go to the D a fifth below and tune this to a point obviously flat (lower pitch) of the required frequency, then raise the pitch gradually until the beats are first heard and next eliminated. Continue to adjust *in the same direction* listening carefully for the return of the beats on the sharp side of the perfect interval and adjust until exactly ten beats are heard in ten seconds. By making the D high in this way, one narrows or 'flattens' the fifth, D to A, by the amount required to consume about 1/12 of the comma.

Having fixed the D, we now take as our standard the D an octave higher, which, in a frequency-divider organ, is automatically at exactly twice the frequency, and tune down a fifth once again, this time to G. Again one must start with the pitch a little below the perfect interval and raise it through the beat-less point until one hears exactly 13 beats in 10s, thus ensuring a narrowing of the interval by just the right amount. Obviously, the beats on the wide side will sound exactly the same as those on the narrow so care is required and the method described is probably the safest. From G we proceed to middle C, then from the C an octave higher down to F and so on. **Fig. 4** shows the order in which notes are tuned and **Table 5** gives the number of beats to be counted in 10s for each interval.

Be sure to start with A above middle C. In a piano, middle C is very near the centre of the keyboard. On a standard five-octave organ keyboard, at normal (eight foot) pitch, it lies two octaves up from the bass end and three octaves below the treble end. Unfortunately, various misguided organ manufacturers have produced a range of non-standard abominations in which keyboards have a compass of three or four octaves, or something in between, and some, deplorably, even start with the note G. Since electronic organs cannot usually be mistuned by more than a semitone or two there is, however, little likelihood of confusion as to the location of middle C.

When you have returned to A after the 12 notes have been tuned, you will be able to judge how accurate you have been, the final interval E to A being a check. If all has gone well, it should be narrow of beat-less by 15 beats in 10s. On no account be tempted to touch up the A to improve the last interval. To do so is to invite disaster. The A, once zero-beated with a standard, should be looked on as the local sub-standard and never touched. If the final interval is far out, start again and proceed more carefully, remembering that errors may be additive. In particular, ensure that the beats counted are those on the narrow side of the perfect interval. Don't feel obliged to achieve exactly 15 beats in the final check. It is unlikely that you will do so and an error of four or five beats, either way, is pretty good. Remember that five beats of inaccuracy in 10s represents a frequency error of only half a Herz at the second harmonic which is a quarter of a Herz at the fundamental.

TABLE 5

Interval	2nd harmonic higher frequency	3rd harmonic lower frequency	Difference (Hz)	Beats in 10s
A to D	880.0000	880.9944	0.9944	10
D to G	1174.6592	1175.9862	1.327	13
G to C	783.9908	784.8768	0·886	9
C to F	1046.5022	1047.6846	1.182	12
F to A♯	1396.9128	1398.4194	1.506	15
A♯ to D♯	932.3276	933.3810	1.053	10
D♯ to G♯	1244.5080	1245.9141	1.406	14
G♯ to C♯	830.6094	831.5478	0·938	9
C♯ to F♯	1108.7304	1109.9832	1.252	12
F♯ to B	1479.9776	1481.6499	1.672	17
B to E	987.7666	988.8825	1.116	11
E to A	1318.5100	1320.0000	1.49	15

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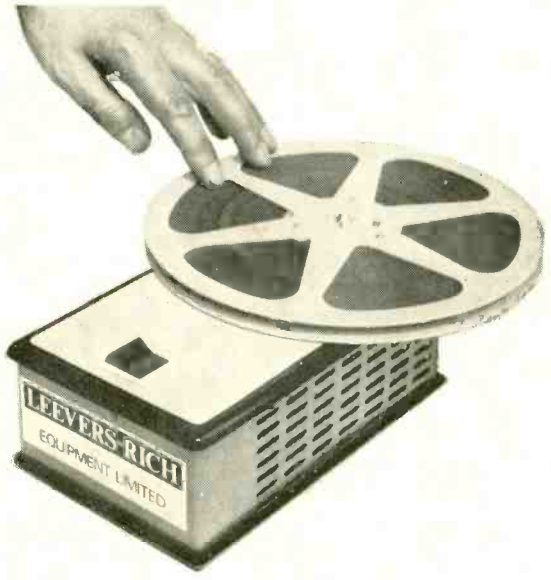

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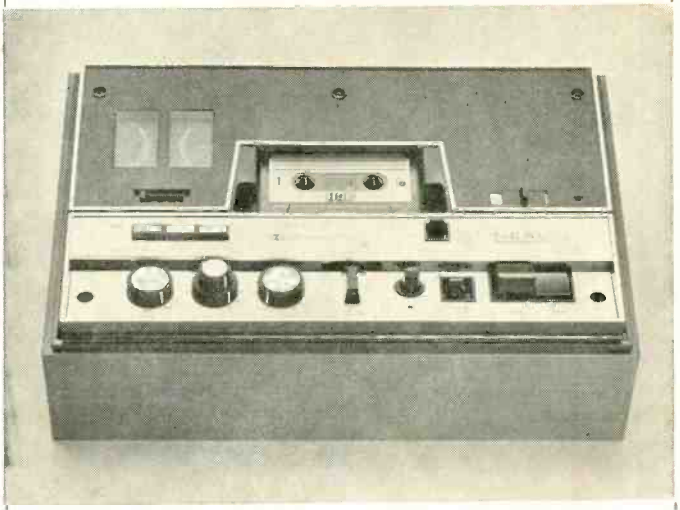

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72 ▶

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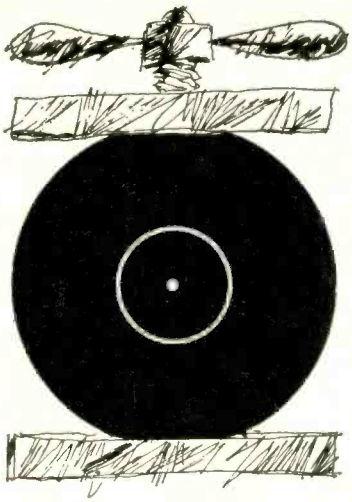

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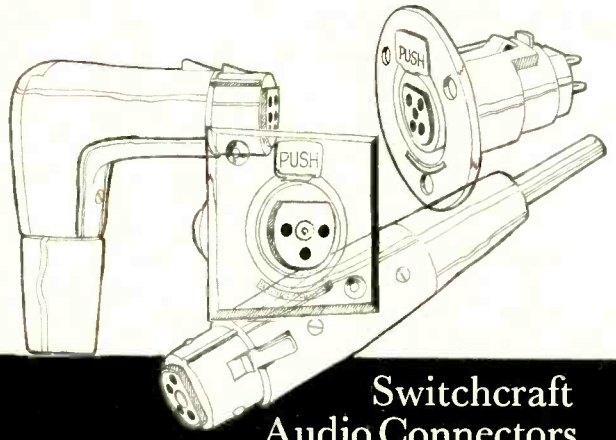

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SURVEY: AUDIO SYNTHESISERS

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Standard complement: Two af and one lf/af vc oscillators, noise generator, vc filter/oscillator, ring modulator, envelope shaper, dual-spring reverberation unit, x-y parameter joystick, and meter. Eight way Jones socket for connection to *KS*, *DKS* or *DK2* keyboard. Other connectors 6·25 mm jack.
Routing: 16^2 pin matrix or plug-in patch.
Price: £374.

Synthi AKS
Standard complement: Suitcase version of *VCS3/2* with additional 32 note touch keyboard and 256 event sequencer. Instant pitch transposition (semitone, tone, third and fifth), random note generation, and independent pitch spread.
Price: £510.

Synthi A
Standard complement: As AKS but minus keyboard and sequencer.
Price: £353.

Synthi KS
AKS keyboard panel and sequencer.
Price: £164.

Synthi Hi-Fli
Standard complement: Octave shift, phase filter, ring modulator, fuzz sustain. Designed to process external instruments.
Price: £308.

Sequencer 256
256 event six-parameter 10·75k bit digital sequencer as incorporated in *Synthi 100*. Inertia-free editing and updating.
Price: £1,645.

Sequencer 32
32 event digital sequencer as incorporated in AKS.
Price: £320.

Keyboard DK2
Three octave duotonic dynamic-sensitive keyboard with internal oscillator and vc source.
Price: £145.

Convertor P-VC
Pitch to voltage convertor as incorporated in *Synthi 100*.
Price: £187.

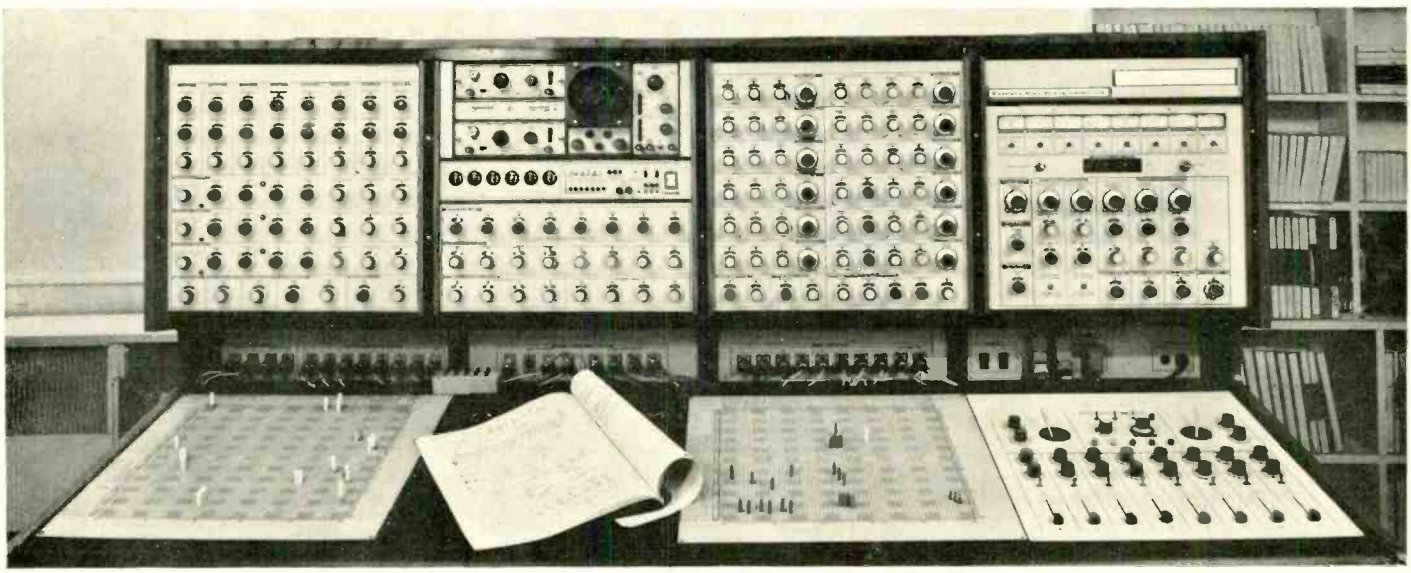
Eight octave filter
Eight octave filter bank as incorporated in *Synthi 100*.
Price: £137.

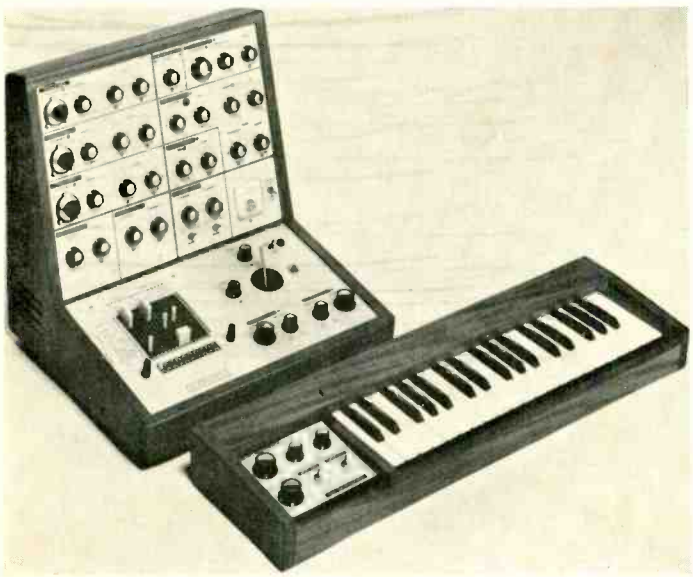
49^2 matrix
49^2 matrix board suitable for interfacing two *VCS3/2* of similar 16^2 matrix synthesisers.
Price: £583.

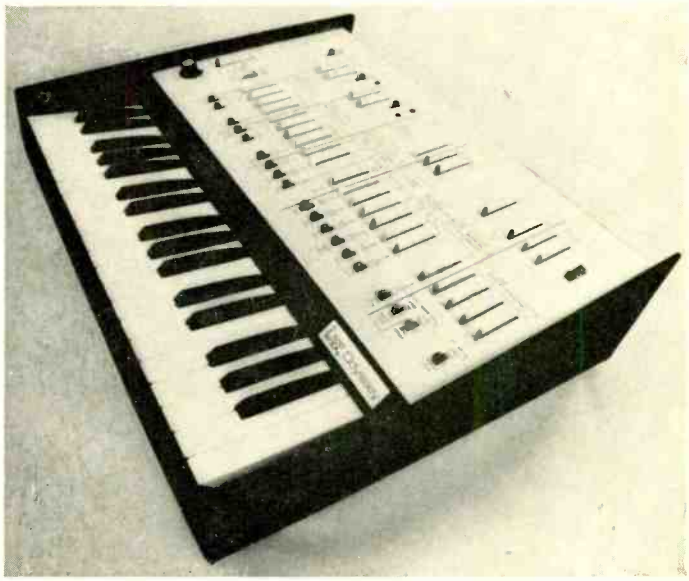
TVR generator
Two voltage random generator.
Price £125.

74 ▶

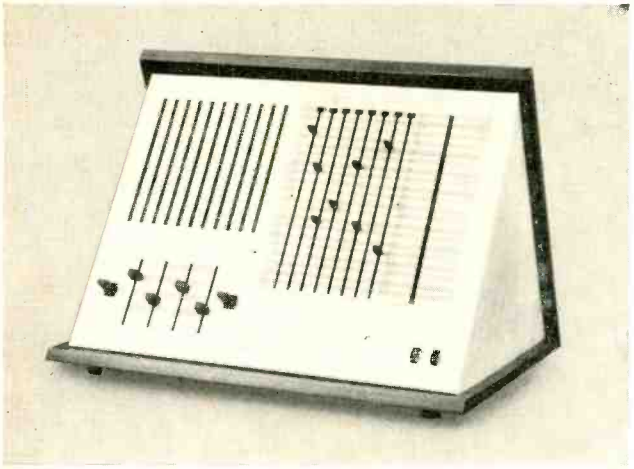
Top to bottom right:
EMS *Synthi 100* and *VCS3/2*. ARP *Odyssey*.







Triadex Inc.
MUSE music synthesiser.



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STATE-OF-THE-ART VOLTMETER WITH A DIFFERENCE

The B & K Type 2425 is a new general purpose electronic voltmeter and calibrated amplifier with exceptionally comprehensive features. This instrument will not only provide correct RMS and Average values of signals with crest factors up to 5, but it will also accurately measure positive or negative peaks. A Peak Hold facility with manual re-set enables the positive or negative peak indications to be held as required or alternatively by switching to the "Maximum Peak" mode the highest peak of the two can be held. Transient measurements thus become a simple procedure. VU and dBm measurements are also simplified by provision for two quickly interchangeable direct reading meter scales. The versatility of the new 2425 is still further increased by the choice of fast or slow meter dampings with two built in time-constants and provision for connecting an external variable time-constant. The amplifier is calibrated and adjustable in 10dB steps with an amplification of 60dB. Its input impedance is 1 megohm/47pF and 1 volt AC or DC outputs are obtainable. Frequency response is linear from 0.5Hz to 500kHz and signal to noise ratio better than 60dB from 10mV to 300V. In spite of its small size it can be mains or battery operated and the 2425 is thus *truly* "General Purpose"

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Ditton 66 Studio Monitor

1.) Celestion's new super tweeter. 2.) New design 'pressure' mid-range unit. 3.) Ultra Linear 12" Bass drive unit. 4.) A.B.R. ensures controlled bass down to 16Hz.
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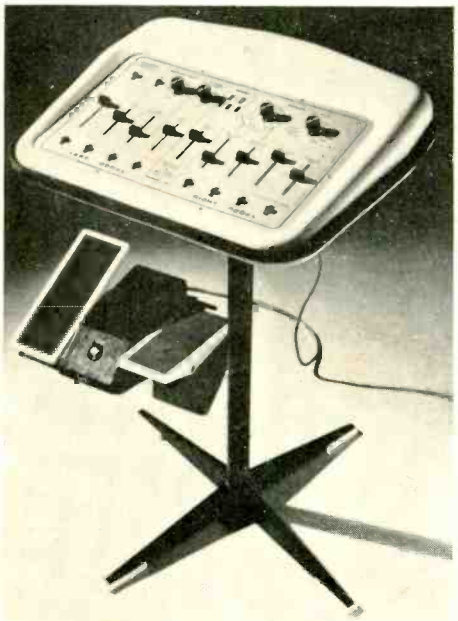


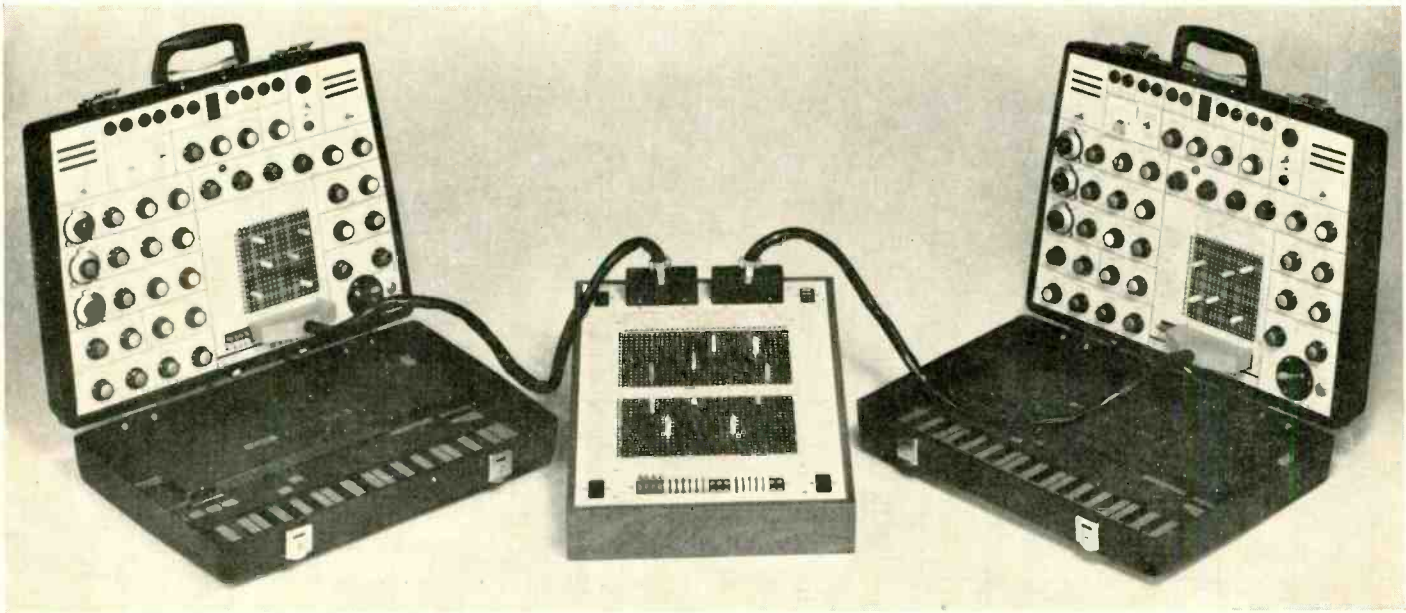
Above: EMS *256* Sequencer.

Right: Moog *12*.

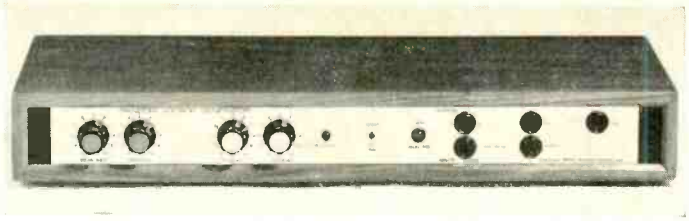
Left: EMS *Synthi Hi-Fli*.

Mid right: Moog *Mini*.

Below: EMS Synthi *AKS* units coupled by interface unit.



Moog *Sonic Six*



EMS random voltage generator

MOOG

Manufacturers: Moog Music Inc, Academy Street (PO Box 131), Williamsville, New York 14221).
Phone: 716 633 2280.
Agents: Dallas Arbiter Ltd, Dallas House, Clifton Street, London EC2P 2JR.
Phone: 247 9981.

3C

Standard complement: Ten vc oscillators, three oscillator controllers, three vc amplifiers, one random signal generator, one vc lowpass and one vc highpass filter, filter coupler, reverberation unit, three envelope generators, one dual trigger delay, envelope follower, extended range fixed filter bank, keyboard controller, ribbon controller, four channel mixer, attenuator panel, trigger/envelope panel, and power supply. Additionally, four console panels each with four input mixer, two trunklines, control voltage switches and attenuator; one console panel including lowpass and highpass filters, jack multiples and three control voltage and trigger outputs.
Routing: 6·25mm jacks.
Shipping weight: 80 kg.
Price: On application

3P

Transportable version of model 3C.
Shipping weight: 79 kg.
Price: On application

12

Standard complement: One random signal generator, fixed filter bank, lowpass vc filter, envelope generator, oscillator driver, two lf oscillators, one vc oscillator, vc amplifier, envelope generator, four input mixer, jack multiples, reversible attenuator, two control voltage and trigger outputs, two trunlines, duophonic keyboard controller and power supply.
Routing: 6·25 mm jacks.
Shipping weight: 36 kg.
Price: On application

Mini

Standard complement: Three vc oscillators, noise source, external source preamp, five input mixer, lowpass vc filter, envelope generator, 440 Hz (A) reference oscillator, 3½ octave keyboard, pitch bender, overall tuner, glide control three control inputs and external trigger input.
Weight: 13 kg.
Routing: Prewired.
Price: £675.

Sonic Six

Standard complement: Two vc oscillators, 440 Hz (A) reference, ring modulator, noise generator, contour generator, lowpass vc filter, four octave keyboard, glide rate, master loudness and pitch bend controls, monitor amplifier and loudspeaker, external source input.
Routing: Prewired.
Price: £595.

Survey: Industrial tape recorders (addenda)

AMCRON (USA)

Agents: Macinnes Laboratories, Macinnes House, Carlton Park Industrial Estate, Saxmundham, Suffolk IP17 2NL.
Phone: Saxmundham 2262 or 2615.

800 series and 700 series

Amcron machines are available with one of two tape transports, four sets of electronics, one or two channels, and one, two or four tracks. Standard speeds are 19 and 9.5 cm/s. Speeds of 19 and 38 can be ordered if required. The *700 series* has standard speeds of 19 and 9.5 but there is an extra charge if 19 and 38 cm/s speeds are specified. CX machines have three speed electronics normally 38, 19 and 9.5 cm/s. There is also an SX mono and an SP play only set of electronics.
Price: on application.

AMITY

Manufacturers: Amity Tape Developments, 3 New Compton Street, London WC2.

Phone: 836 7811.

Studio tape machines available in 25 or 500 mm formats and operating 76 and 38 cm/s. 27 cm NAG spool capacity.
Prices: £3,990 (eight track), £6,490 (16 track), and £7,990 (24 track). Prices for stereo and mono models to be announced.

BRENELL

Manufacturers: Brenell Engineering, 231-5 Liverpool Road N1 1LY.

Phone: 607 8271.

Master recorders

Series A (full track on 6.25 mm), *Series B* (half track on 6.25 mm), *Series C* (four tracks on 12.5 mm), *Series D* (four tracks on 25 mm), and *Series E* (eight tracks on 25 mm tape). All the units are for 483 mm rack mounting.
Tape speeds: 19 and 38 cm/s, 38 and 76 cm/s.
Prices: *Series A* from £450 for 9.5 and 19 cm/s version; *Series B* from £735 as above; *Series C* from £1,520 as above; *Series D* from £1,710 as above; *Series E* from £2,600 as above.

IC2000

Tape speeds: 4.75, 9.5, 1.9 and 38 cm/s. A two channel tape recorder with space for up to four heads, and separate record/replay electronics. It will take 27 cm spools and is available in quarter 2/4 and half 2/2 track forms.
Price: on application.

Type 19

Solenoid-operated tape transport available in either a two or four speed version and in 6.25, 12.5 or 25 mm tape widths.

Mk 6

Tape speeds: 4.75, 9.5, 19 and 38 cm/s.
Tracks: twin 2/2 or quarter 2/4.
Reel sizes: up to 21 cm (27 cm to order). Available as a stereo or full track mono model.

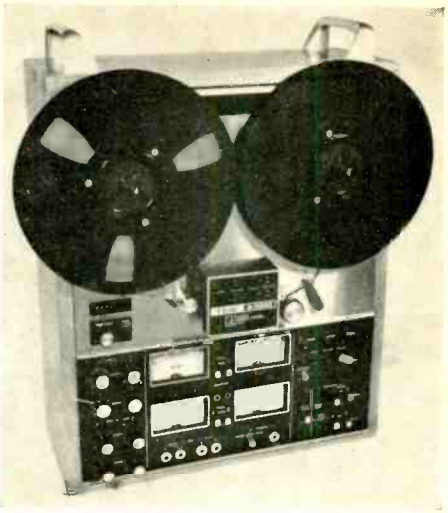
3M (USA)

Agents: 3M (UK) Ltd, 3M House, Wigmore Street, London W1A 1ET.

Phone: 01 486 5522.

Series 79

Speeds: 19 and 38 or 38 and 76 cm/s. DC servo capstan permits continuous variation between 13 and 114 cm/s.
Formats: Single channel 6.25 mm to 24 channel 50 mm.



Teac *A3340*

TEAC (Japan)

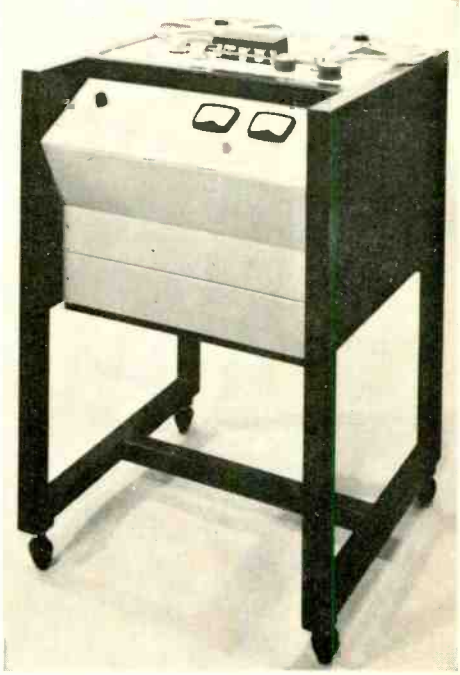
Agents: Industrial Tape Applications, 105 High Street, Eton, Berkshire.

Phone: 95 52663.

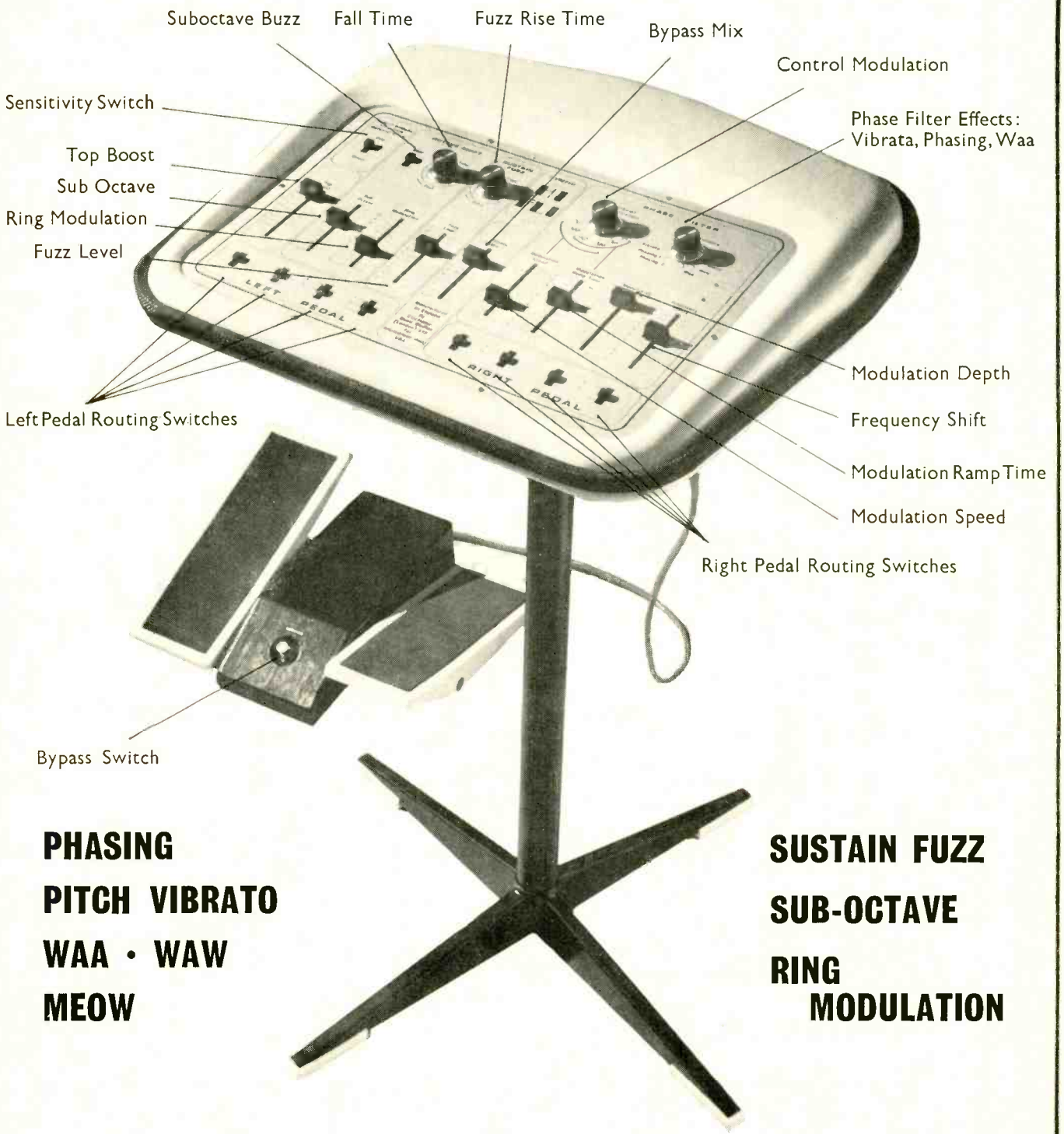
A3340

Tape widths: 6.25 mm.
Reel sizes: 27 cm.
Speeds: 19 and 38 cm/s standard.

Bias *BE1000* incorrectly labelled last month.



EVERY GROUP NEEDS A HI-FLI –EVEN THE PINK FLOYD



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BRUEL AND KJAER
2425

MANUFACTURERS' SPECIFICATION

AMPLIFIER RESPONSE

Measuring Range: 1 mV to 300V rms for fsd on meter display.

Frequency Range:

Meter damping slow: 0.5 Hz to 500 kHz ±0.5 dB, 2 Hz to 200 kHz ±0.2 dB.

Meter damping fast: 10 Hz to 500 kHz ±0.5 dB, 20 Hz to 200 kHz ±0.2 dB.

Phase deviation: ±5° between two instruments in the 1 Hz to 50 kHz range with meter damping set to slow.

Total amplification: 60 dB.

INPUT

Impedance: 1 MΩ in parallel with 47 pF.

Maximum input voltage for V ranges: 250V dc, 380V rms, 600V peak. For mV ranges: 250V dc, 80V rms.

ATTENUATOR RANGE

Range selector One: 0 and −60 dB corresponding to mV and V range respectively.

Range selector Two: 0 to −50 dB in 10 dB steps corresponding to 1 to 300 mV or 1 to 300V with range selector One set to mV or V respectively.

Total attenuation: 110 dB for gain of 60 dB.

RECTIFIER CHARACTERISTICS RMS

Dynamic range: 40 dB.

Crest factor capability: 5 (14 dB) ±5 dB at 1 dB below full scale deflection on meter.

Accuracy: ±0.5 dB from 10 dB above to 20 dB below fsd.

Averaging times: Approximately 270 ms and 3s respectively for fast and slow meter damping. With an external capacitor, the averaging time may be increased by 1s for every 2.5 µF added.

PEAK

Indication: +peak, −peak, max peak and peak hold.

Dynamic range: 40 dB.

Accuracy: ±0.5 dB for 10 dB above to 20 dB below fsd, ±1 dB from 20 to 30 dB below fsd.

Rise time: 50 µs with fast meter damping, 500 µs with slow meter damping

Decay time: 2.7s with fast meter damping, 30s with slow meter damping. With external capacitor the decay time may be increased by approximately 10s for every 2.5 µF added.

Peak hold decay: 0.05 dB/s with fast meter damping, 0.005 dB/s with slow meter damping.

AVERAGE

Indication: Average with fast and slow meter damping, average fast mode in accordance with ANSI Standard *C16.5-1961* for VU measurements.

Dynamic range: 40 dB.

Accuracy: ±0.5 dB from 10 dB above to 20 dB below fsd, ±1 dB from 20 to 30 dB below fsd.

OUTPUTS

AC

Output voltage: 1V rms ±2% corresponding to fsd.

Maximum output: 4.46V peak into 2 kΩ/200 pF.

Output impedance: 100 Ω approximately.

DC

Output voltage: 1V ±2% corresponding to fsd into 2 kΩ.

Maximum output: 3.16V.

Output impedance: 10 Ω approximately.

SIGNAL TO NOISE RATIO

10 mv to 300V: 60 dB.

3 mV: 50 dB.

1 mV: 40 dB.

STABILITY: 0.2% for ±10% change in supply voltage.

Warm-up time: 20s

Mains supply: 100, 115, 127, 150, 220 or 240V ±10%, 50 to 400 Hz.

Consumption: 9W.

External battery: Two 22 to 35V.

Dimensions: 142 x 140 x 225 hwd.

Weight: 2.1 kg.

Manufacturers: Bruel & Kjaer, DK-2850 Naerum, Denmark.

Distributor: B & K Laboratories Ltd, Cross Lances Road, Hounslow, Middlesex.

Price: £204.

JUST THE length of the specification for the B & K *2425* electronic voltmeter shows that it is no run of the mill instrument and much more information about its performance is given in the 63 page instruction book which accompanies it.

The mechanical size of the instrument is not much greater than a 14 cm tube, and almost half the area of the front panel is occupied by the clearly calibrated meter which has interchangeable meter scales. The scale as supplied as standard has two voltage calibrations in a √3:1 ratio and a dBV calibration but the two optional scales or dBm or VU measurements may be inserted by removing the top cover of the instrument, which is secured by one screw, then removing two knurled nuts. The remainder of the front panel is occupied by: pushbotton power on/off switch; two small slide switches (which control the meter time constants); six interlocking pushbutton switches for meter range in the ratio 300, 100, 30, 10, 3, 1 to one; four further pushbutton switches which control the rectifier characteristics; and a BNC input socket.

All these front panel controls are sensibly arranged so that it is extremely easy to see the precise function of the instrument at a glance, and to take accurate readings from the mirrored and illuminated scale.

The rear of the instruments is occupied by the mains input socket and voltage selector, a BNC output socket for connecting the ac output from the instrument's amplifier to other equipment, and a seven pin DIN socket which provides facilities for powering the instrument from dc, feeding the dc output from the instrument's rectifiers to other equipment, altering the metering time constant by adding external capacitors, or resetting the meter from an external switch.

So much for the layout of the instrument from the user's point of view. The interior of the case is mainly occupied by the meter movement and the mains transformer, the whole of the circuitry being mounted on a single fibreglass printed board at the bottom of the case. As might be expected of an instrument of this calibre, only high quality components are used and the circuitry involves a large number of transistors and integrated circuits.

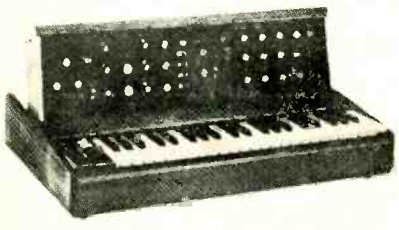
At a cost of over £200, one is right to expect something rather special about an electronic voltmeter and in several respects the *2425* is a very special instrument. The first point of considerable interest is the variety of rectifier characteristics; unlike the most electronic voltmeters which employ an average rectifier characteristic calibrated in terms of rms, with consequent errors in measurement of complex waveforms, the *2425* has not only the facility of a true rms rectifier characteristic but an average rectifier characteristic and comprehensive facilities for peak measurement. It is possibly the latter which will be of particular interest, for one can measure the positive peak, negative peak or maximum peak value of waveforms with an associated meter time constant of only 50 *microseconds*. Furthermore the meter will hold the value of such a single peak, decaying from the peak value at a rate of only 0.05 dB/s, with the facility of manual meter reset.

Such a facility is extremely useful for evaluating the performance of clippers and limiters, among many other applications, because the meter rise time and readability are so much better than the conventional ppm.

Another facility not incorporated in cheaper electronic voltmeters is the provision of IEC standard meter ballistics normally known as fast and slow in the field of noise measurements. With the rectifier system set to average and the meter time constant set to fast, the *2425* has the precise characteristics of a standard VU meter to American standard *C16.5-1962*.

It is perhaps unfortunate that the characteristics cannot be set to the standard BBC ppm but the inbuilt peak facility is much faster and possibly more useful. 80 ▶

AN ADVENTURE IN SOUND BY EUROPE'S LARGEST MUSICAL INSTRUMENT DISTRIBUTOR - DALLAS



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The top groups do. They pick Moog for the same reasons you'd be happier with the original instead of a copy. Moog quality and engineering. Performance features that come directly from daily contact with the world's leading contemporary musicians. Only the MiniMoog brings you the famous sound and versatility of a Moog studio synthesizer. Only the self-contained Sonic Six brings you Moog sound plus carry-along convenience.

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The first sound in synthesizers

B & K 2425 REVIEW

A further unusual facility is the provision of a DC output from a low impedance source, the output being proportional to the meter reading and therefore useful for making a graphic record with a linear pen recorder.

So much for the 'extras'—what does it lack from an audio engineers' point of view? Firstly, while the specified bandwidth extends to 500 kHz, there is no facility for restricting the bandwidth. Secondly there is no provision for an A weighting network which is virtually essential for noise measurements on equipment. However, the voltmeter could be preceded by an 'A' weighting box for many applications. A further possible limitation is the maximum sensitivity giving 1 mV fsd but it is possible to read down to 100 μV with acceptable accuracy.

While it is possible to battery power the instrument, it requires two separate batteries at a rather awkward voltage (22 to 35V each), and also takes a specified 45 mA per battery which is too high for the majority of common dry cells.

The performance

It was initially noted that the mechanical zero of the meter was not absolutely identical to the electrical zero: for all the following measurements the meter was adjusted to its electrical zero as precisely as possible.

The first investigations were directed towards the input impedance and measuring accuracy with a 1 kHz sinewave. The precise input impedance was measured as 992 kΩ in parallel with 48.6 pF which is extremely close to the nominal value and was found to be virtually independent of the attenuator settings. Meter accuracy at full scale was within +0.26 per cent to 0.44 per cent, falling to +0.93 per cent to 0.83 per cent at one third full scale deflection in the worst cases. Having regard to the fact that these errors include attenuator error, rectifier error, meter error and errors in reading the meter this accuracy is most excellent. Furthermore, the accuracy of the 60 dB attenuator which is inserted when changing from millivolt ranges to volt ranges was better than 0.1 dB. The residual meter deflection due to internal noise on the 1 MV range was found to be 20 μV when employing the rms or the average rectifier characteristics and 90 μV when employing any of the three peak rectifier functions; these figures are certainly no cause for complaint.

Within the audio range the frequency response was within about +0.1 dB and remained within +0 −0.5 dB to well above 500 kHz, falling to −1.5 dB at 1 MHz and then rapidly to −13 dB at 2 MHz. With the meter time constant set to the fast mode, the low frequency capability is controlled by meter damping which starts to introduce error greater than 0.5 dB below 10 Hz. However, in the 'slow' time constant mode steady readings are obtained well below 1 Hz where the metering error was found to be only −0.25 dB and evaluation testgear of sufficient accuracy was not to hand.

While there is little difficulty in obtaining a reasonably accurate rectifier with an 'average' characteristic, it is no easy matter to design a good rms rectifier which is accurate with high crest factor (ratio of peak to rms voltage of a waveform) waveforms such as random noise. The specified accuracy of the B & K instrument is ±0.5 dB for crest factors up to five and, tested with regularly spaced single cycles of sinewave, the accuracy was measured as within +0.3 dB −0 dB at various sinewave frequencies.

Peak reading facility

Probably the most interesting aspect of the rectifier system is the peak reading facility which has a specified time constant of only 50 μs with fast meter damping. Unfortunately the specification is not clear about the true response time of the peak rectifier to single pulses and also, because the instrument's amplifiers are ac coupled, the peak rectifier system can do very misleading things if the instrument is fed with highly asymmetrical waveforms.

Investigations using single cycles of sinewave at very long intervals so that the meter could be manually reset between cycles showed that, if the period of the sinewave was equal to the specified rise time of the rectifier, the meter under-read by about 3 dB. This means there is a 3 dB error in metering the value of a single cycle (or half cycle) of a 20 kHz sinewave under the fastest metering conditions—not bad going!

If the period of the sinewave was increased to twice the specified time constant for the rectifier the under-reading was only in the order of 0.5 dB and then proceeded to decrease even further as the length of the input burst was increased.

Investigations into the scale linearity over the upper 10 dB section of the scale gave virtually identical results with all three rectifier characteristics, and showed that the calibration was within 0.3 dB. The accuracy at lower indications was not investigated, for one would normally change range if the indication was below −10 dB.

Ballistics

The next matter of interest was the metering ballistics which should comply with IEC standard *179 (Precision Sound Level Meters)* and British Standard *4197:1967* which are identical for these purposes. It was found that in both the fast and slow modes there was very little overshoot when a continuous tone was applied and that in both cases the meter was just on the lower limit of reading when tone bursts were applied. While the B & K meter is within specification by a very small margin, the overall meter damping is a little excessive. On the other hand, when the meter is set to the fast time constant and the average rectifier characteristic it is claimed to have the ballistics of the standard VU meter to American Standard *C16-5-1961* and there were no complaints in this direction.

The outputs

The output most likely to be used in audio applications is the ac as the voltmeter may then be used as a wideband amplifier with up to 60 dB gain. The nominal output voltage is 1V rms ±2 per cent for full scale deflection, and was (no doubt largely by coincidence) measured as 1.003V rms! Loading of the output, which had a measured impedance of 98.8Ω was not found to have any significant effect upon the meter reading provided that ridiculously small loads were not applied; the maximum output voltage into an open circuit before amplifier clipping was over 8V rms.

Attempts to measure harmonic distortion in the output waveform with the input voltage set for full scale deflection of the meter did not give very precise results as a result of noise and testgear distortion but it can be safely stated that the 1 kHz distortion is less than 0.006 per cent which is certainly more than adequate.

Measurements of noise at the output created general confusion when comparing the measured results with the printed specification and it was not until the manufacturers in Copenhagen were telephoned by B & K Laboratories in Hounslow that it was discovered the printed specification referred noise to the crest factor capability and not to full scale meter deflection. The following results refer noise to fsd, which is probably of more interest, but 10 dB may be added to the following figures when it is convenient to overdrive the meter by 10 dB.

METER RANGE	WIDE BAND NOISE (2 Hz-200 kHz)	AUDIO BAND NOISE (20 Hz-20 kHz)
Above 10V	over 80 dB	over 80 dB
10V	74 dB	over 80 dB
3V	63.7 dB	68.5 dB
1V	53.0 dB	58.5 dB
300 mV	75.0 dB	82.7 dB
100 mV	73.7 dB	81.3 dB
30 mV	68.0 dB	74.3 dB
10 mV	57.7 dB	64.3 dB
3 mV	48.5 dB	54.0 dB
1 mV	38.5 dB	43.5 dB

The remaining facility is the dc output, which gives a dc proportional to the deflection of the meter and was found to provide precisely 1V at full scale deflection. The dynamic range of this output is somewhat limited by the dc offset under no-input signal conditions which was measured as 8.5 mV and meant that the accuracy of the dc output was within about two per cent levels above −30 dB below fsd of the meter, but became progressively worse as the output level fell.

Summary

The Bruel & Kjaer *2425* electronic voltmeter has a number of features which are somewhat uncommon among available instruments and are of great potential use to the audio engineer. On the other hand, it lacks any form of bandwidth restriction or noise weighting network. Sensitivity is adequate, but no more, for low level measurements but the accuracy of calibration is absolutely first class as is the performance of the three rectifier characteristics. While the specification provided is extremely comprehensive, and is met by the instrument in all respects, the interpretation of some parts of the specification is not clear.

Overall, this is a delightful little instrument but, in common with all testgear of this precision, it is expensive. **H. D. Ford**

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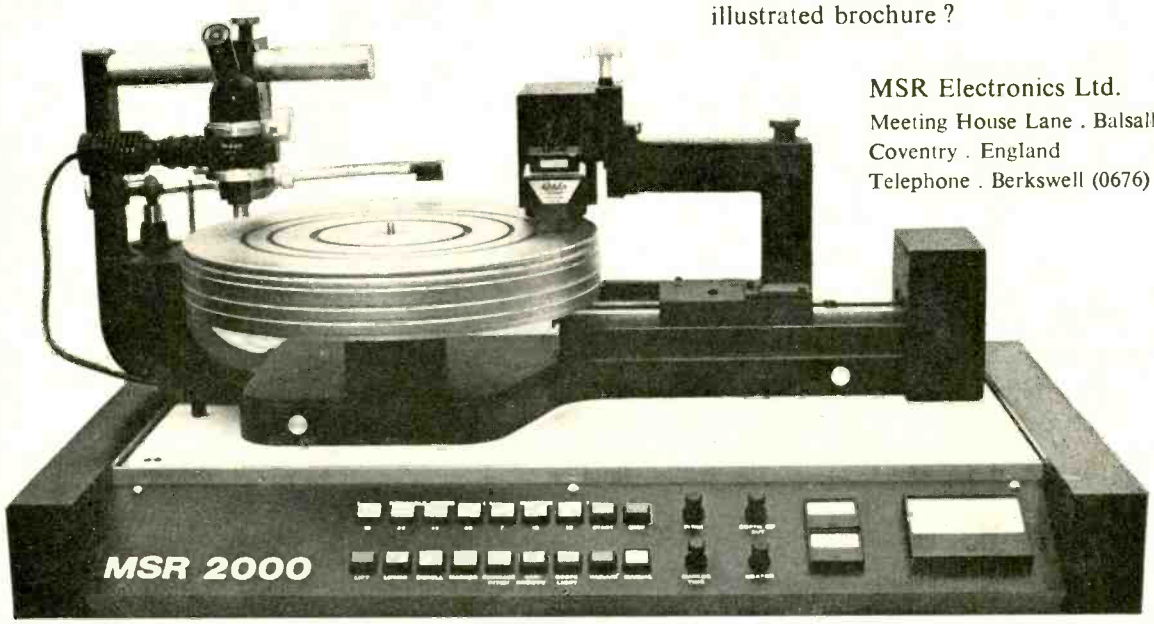

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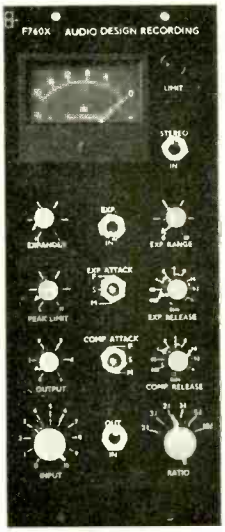

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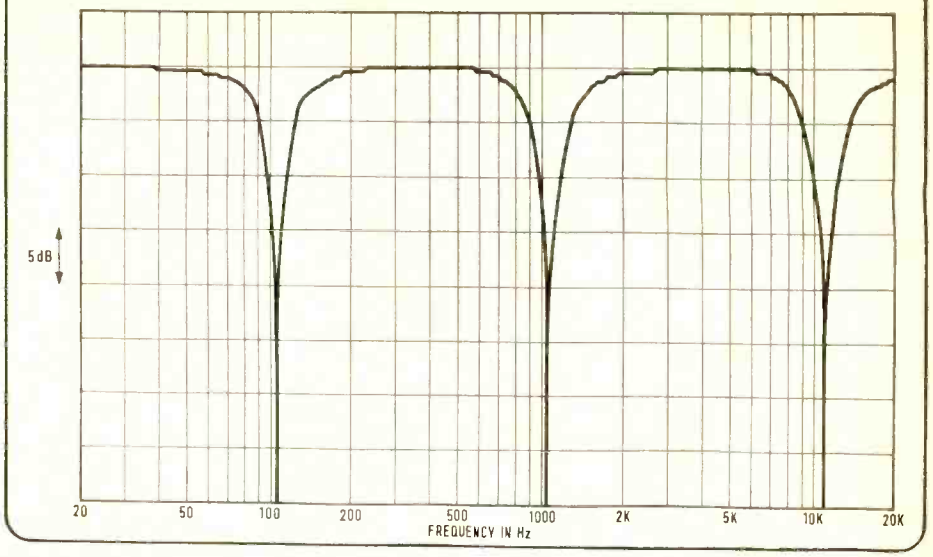
By Hugh Ford

MANUFACTURERS' SPECIFICATION

Frequency range: 20 Hz to 20 kHz in six bands.
Sensitivity: 300 mV to 10V.
Input impedance: 100k ohms and 20 pF.
Distortion factor: 7 ranges from 100% to 0.1% fsd in 10-3-1 sequence.
Accuracy: The mean value of residual components or of noise are measured within 3% fsd.
Rejection filter: At fundamental frequency: 80 dB: at second harmonic: not more than 0.5 dB for fundamental up to 2 kHz; 1 dB for fundamental between 2 and 6 kHz. 2 dB for fundamental greater than 6 kHz.
Inherent noise: Less than 0.01%.
Low frequency filter: When measuring fundamental of 1 kHz and higher, a high pass filter can be switched in giving a low noise frequency cut of 3 dB at 400 Hz and 20 dB at 50 Hz.
Output: 500 mV from an impedance of 600 ohms when the meter has full scale deflection.
Voltmeter range: 7 ranges from 10V fsd to 10 mV fsd in 10-3-1 sequences.
Accuracy bandwidth: 3% between 100 Hz and 30 kHz, 30 Hz to 100 kHz (—0.5 dB).
Power supplies: Mains or 24V nominal Nickel Cadmium rechargeable battery of 400 mAh capacity giving a typical operating time of 20 hours between recharging. Batteries are recharged, in situ, by means of an internal charging circuit, in 14 hours from a fully discharged condition (22V).
Meter: 125 mm movement with mirror backed scale calibrated 0 to 10, 0 to 3, and a dB scale of —12 to +2 dB for relative measurements. A 'check' battery pushbutton connects meter across battery to read voltage directly.
Whd dimensions: 421 x 165 x 200 mm.
Weight: 6.3 kg.
Price: £195.

MANUFACTURERS: Dymar Electronics Ltd, Colonial Way, Radlett Road, Watford, Hertfordshire, WD2 4LA.

FIG. 1 DYMAR 765A DISTORTION FACTOR METER REJECTION CHARACTERISTICS



THE DYMAR *765* Distortion Factor Meter is one of a series of instruments manufactured by Dymar Electronics with maintenance work on radiotelephone equipment in mind, for Dymar are well known manufacturers of radiotelephones for land-based and marine use.

Dymar's products include millivoltmeters, wave analysers and counters covering both af and hf applications, and many of the instruments are built on a modular basis so that a single metering section can be connected to a number of different ancillaries.

The distortion factor meter is no exception, in that the metering section is common with other instruments, and the distortion factor bridge plugs into the main chassis with a McMurdo red-range plug and socket. The chassis comprises a substantial metal case with a carrying handle and a hinged foot which gives a good viewing angle when the unit is used on a bench. However, there is no protection for the front panel controls when the instrument is carried around, and its weight is such that considerable damage could result from inadvertently hitting anything.

The left-hand section of the instrument is occupied by the mains on/off toggle switch and the 127 mm meter which is mirror backed and extremely clearly calibrated on the two scales 0 to 10 and 0 to 3. There is also a dB scale calibrated from −12 to +2 dB, the actual decibel values being completely arbitrary. It is 'pure coincidence' that the zero dB mark coincides with the 0.775 mark on the 0 to 10 scale!

On the right-hand section of the instrument (which is the plug-in unit) is a calibrated frequency dial with two sets of calibrations from 20 to 64, and from 64 to 200, which are read in conjunction with the six-position frequency range switch. This covers the frequency ranges 20 to 64 Hz, 64 to 200 Hz, 200 to 640 Hz, 640 Hz to 2 kHz, 2 to 6.4 kHz and 6.4 to 20 kHz without any overlap. The 20 to 64 ranges are identified in black on the range switch and the calibrated dial, the 64 to 200 ranges in blue. However, the contrast between the blue and black is so poor that this colour coding is of little use.

Underneath the frequency range switch is a second rotary switch with a 'set reference' position and seven distortion ranges from 100 per cent to 0.1 per cent fsd in a 1:3 sequence. The 'set reference' position is used to set the input signal level in conjunction with the 'set reference' input attenuator. The switch is then set to read distortion and the instrument balanced for maximum fundamental rejection by means of a fine frequency balance control, and two concentric controls which effect coarse and fine phase balance. The remaining control on the front panel is a slide switch inserting a high pass filter for reducing the effect of mains hum on distortion measurements.

Signal input

The signal input to the distortion meter is by means of two standard 3 mm banana sockets/terminals which are mounted on standard 19 mm centres. The residual harmonics are available at the output of the distortion meter, which is in the form of two 3 mm banana sockets that for some reason are not the same as the input sockets so that it is impossible to use screened adaptors on the output.

At the rear of the instrument are the single mains fuse and the mains input lead (which is permanently attached). The rear of the instrument has two lugs round which the mains lead is intended to be wound during transport. This practice of providing lugs for stowing mains leads is all very well when the mains plug is not fitted but a 13A plug is quite impossible to stow with this arrangement and is a lethal weapon in transport. Generally, plug-in mains leads are more satisfactory, and cannot really increase cost by more than a few pence.

Finally, well buried at the rear of the distortion meter section so that you have to remove the chassis to gain access, is a slide switch for disconnecting the meter rectifiers. This is necessary, if the distortion factor meter is to be used as an amplifier, because the rectifiers introduce considerable crossover distortion at the output.

Inputs and outputs

The maximum input which can be accommodated by the set reference control was measured at 16.75V, and the minimum input required to use the most sensitive distortion range was 321 mV, the latter being 12 mV outside the published specification. In practice the maximum sensitivity is quite adequate as, by setting the reference on the 30 per cent distortion range, one can read at least down to 0.1 per cent distortion with a 107 mV input signal. It would, however, have been better if the instrument accepted a higher input level as it is a quite common requirement to measure distortion in 8 ohm loads dissipating in excess of 35W or 15 ohm loads dissipating over 18.7W; in these circumstances it would be essential to use an external attenuator to reduce the input voltage to the distortion meter.

Measurement of the input impedance showed a remarkable constant resistive component of 113.5k ±1k ohms but the effective shunt capacitive component varied from 21.5 pF at minimum input gain to 43.5 pF at maximum input gain. These results are, however, satisfactory for most applications.

With the meter set to full scale deflection, the output voltage was 562 mV. The output

83▶

amplifier did not clip until the output reached 4.53V, the output impedance being 370 ohms at 1,592 Hz in contrast with the specified figure of 600 ohms which the circuit confirms to be incorrect.

When the meter rectifiers were in circuit, the output showed very serious crossover distortion which might cause confusion if the rejection output is subjected to frequency analysis: this distortion completely disappeared when the meter rectifiers were switched out of circuit by means of the slide switch at the back of the distortion meter plug-in chassis.

Meter and attenuator

The accuracy (linearity) of the meter was investigated at intervals between an indication of 10 fsd and 3, which is the limit where one switches to the next most sensitive range, with the following results:

Meter indication	Input voltage	% error
10	0.991	0
7	0.690	−0.5%
5	0.497	+0.3%
3	0.302	+1.6%

Next the accuracy of the distortion range attenuator was measured with equipment having an accuracy of 0.02 dB and found to be within +0.17 dB with respect to the 100 per cent distortion setting. These accuracies are to a very high standard and beyond criticism in even the most expensive instruments.

In the most expensive instruments, the meter rectification is true rms but the Dymar instrument uses average rectification in common with the vast majority of distortion factor meters. However, unlike so many, Dymar give a very clear warning in their instruction book about the errors likely to be introduced by average rectification and also suggest necessary corrections to the indicated distortion.

Perhaps an unfortunate omission from the instrument is that it cannot be used as a voltmeter because there is no inbuilt voltage reference or fixed attenuator position. This really does seem to be cheese-paring for the sake of at most a few pounds on the user cost.

The rejection bridge

The instrument employs the common active Wien bridge circuitry for rejection of the fundamental frequency and has the usual four controls for adjusting the bridge for maximum rejection.

Accuracy of the frequency calibrated control is not specified by the manufacturer but this was measured and found to be generally within ±3 per cent of the actual input frequency with the exception of the 6.4 kHz calibration on the 2 kHz to 6.4 kHz range, where the error was +5.18 per cent.

It was very easy to achieve the null condition of the bridge, the coarse and fine nulling controls having well chosen ratios for easy nulling. Difficulty was experienced in setting the reference level with the input set reference control—one of those horrible 'rubber' controls which move when the knob is released.

The following table shows the maximum obtainable fundamental rejection, together with a stable rejection; that is the fundamental rejection which will remain stable for a reasonable time without manipulating the bridge balance controls during a measurement:

Fundamental Frequency	Maximum rejection distortion		Stable rejection distortion	
100 Hz	86 dB	0.005%	60 dB	0.1%
1 kHz	91 dB	0.0028%	80 dB	0.01%
10 kHz	88 dB	0.004%	80 dB	0.01%

Residual system noise gave a meter indication of 0.01 per cent equivalent distortion, so the maximum obtainable fundamental rejection is in fact better than 6 dB below system noise. This performance is certainly very good, and far better than many distortion meters. Furthermore, the stability of the bridge null was really excellent at the higher fundamental frequencies.

Fig. 2 shows the rejection characteristics of the instrument at approximately 100 Hz, 1 kHz and 10 kHz, together with the instrument's frequency response without the rejection bridge in circuit. The precise attenuation of the second harmonics were found to be 0.5 dB with 100 Hz fundamental, 0.6 dB with 1 kHz fundamental, and 1.4 dB with the 10 kHz fundamental. These results are well within specification and are to a generally good standard.

Other aspects

Fig. 1 demonstrates the effects of the switched high pass filter which is included for reducing the effect of mains hum and its harmonics on measurements. This curve is very close to the specified characteristics of −3 dB at 400 Hz and −20 dB at 50 Hz, both of which are sensible attenuations, however the filter does show an attenuation of −1 dB at 1 kHz which is undesirable and means that the reference level should be set with the high pass filter out of circuit when measuring with fundamental frequencies of 1 kHz. A further slight snag to the filter is that the filter switch is very prone to hum pickup from nearby mains cables. It would be better if the switch had been a metal toggle switch instead of the existing plastic (unscreened) slide switch.

It has already been mentioned that the meter rectifiers introduce severe crossover distortion when the instrument is used as an amplifier (if the meter rectifiers are not switched out of circuit). This distortion may be eliminated by switching out the meter rectifiers but it is a shame that this switch can only be reached by completely removing the distortion meter chassis from the instrument's case.

The review sample of the instrument was the original valve version and it is understood that it will in due course be replaced by a transistorised instrument with the same performance. I do not, however, consider valves to be any deterrent.

The standard of assembly was good and high quality components were used throughout, with neat wiring and sound soldered joints.

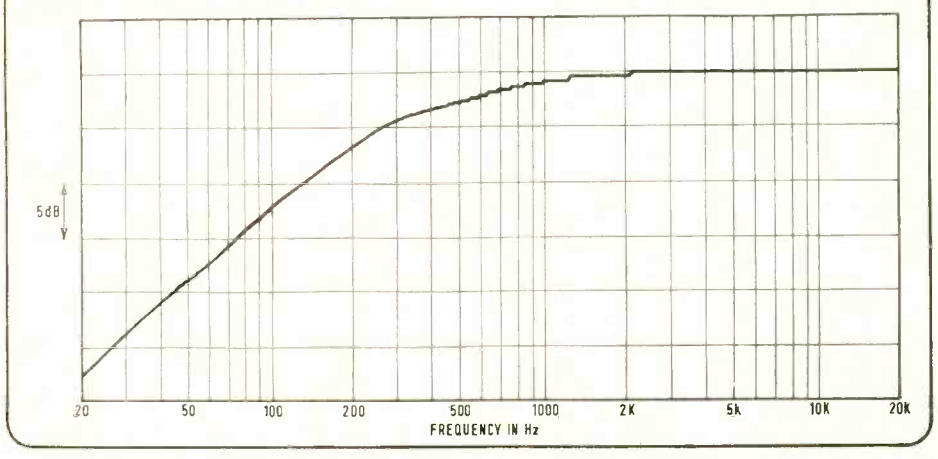
Summary

For an instrument costing £195, the accuracy and overall performance of the Dymar *765* is impressive. It is a pleasant instrument to handle and quick and simple to use. It is, however, felt that it should have facilities for using it as a voltmeter, which would cost very little extra.

Various minor shortcomings exist but none of them is serious and, provided that the recommended precautions in the instruction book are observed, the Dymar will give accurate results.

Overall this distortion factor meter is to be recommended as good value for money.

FIG. 2 DYMAR 765A DISTORTION FACTOR METER CHARACTERISTIC OF HIGH PASS FILTER



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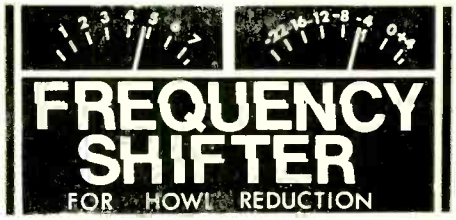

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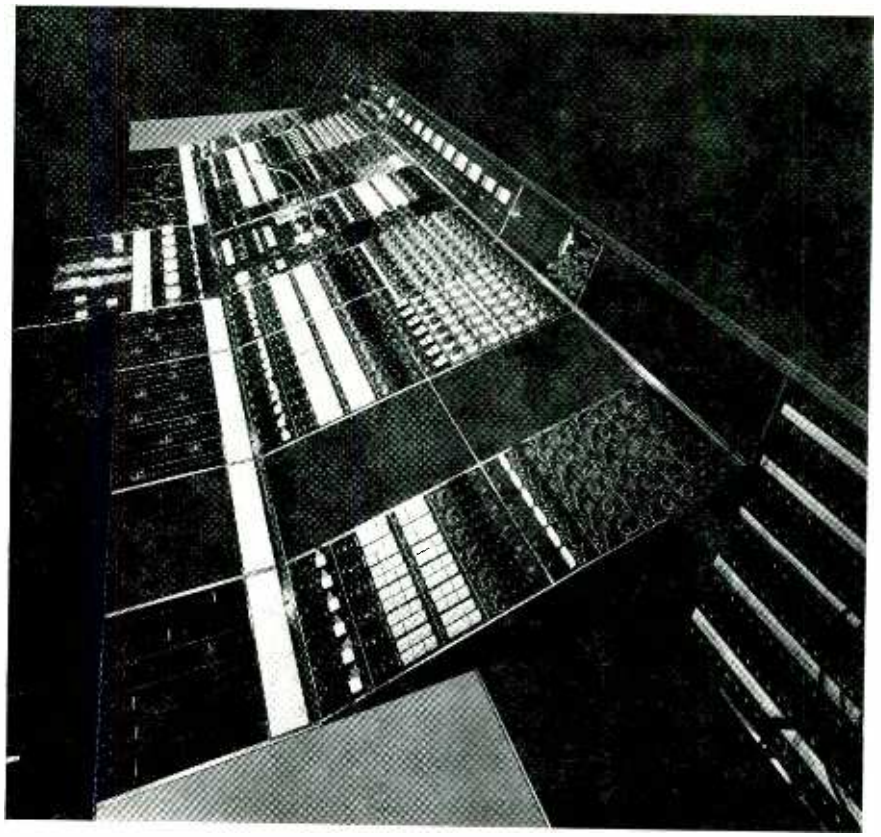

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