FEBRUARY 1971

15p (3s)

STUDIO SOUND

Survey of video tape recorders

WHY MULTITRACK ? WHY SO MANY TAPE RECORDING STANDARDS ?

JOHN SHUTTLEWORTH
VISITS THE BBC'S MAIDA VALE STUDIOS

DOLBY AND MULTITRACK IN LONDON

With the increasing sophistication of **pop and** rock recording, quality conscious London studios are finding the DOLBY SYSTEM essential in preventing the noise problems which are otherwise inherent in multitrack recording. In London's rapidly expanding network of 16-track studios, 19 of the 20 recorders currently in use are fully equipped with Dolby noise reduction units.

Robin Cable at Trident Studios
23 Dolby A301 units,
including 16 on two 16-track recorders

Mike Claydon at I.B.C. Recording Studios
fully Dolby equipped 16-track installation

Frank Owen at Island Studios
30 Dolby A301 units,
including 24 on three 16-track recorders

top right:
One of the Dolby installations at Olympic Studios
London's first multi-track studio to use
noise reduction throughout

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For the highest quality equipment

The AKG K180 headphones
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Price: £29.00.

CMS Microphone C:451
Modular capacitor microphone with wide range of polar responses. Employs field effect transistors in head amplifier.
Frequency range: 20 Hz-20 KHz.
Sensitivity -60.5 db referred to IV/dyne/cm²
Price from: £48.00.

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AKG's top studio dynamic microphone employs two-way cardioid principle.
Frequency range: 20 Hz-20 KHz ± 2 db.
Sensitivity -78 db referred to IV/dyne/cm²
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D 190E
D 202E
D 224
D 707E
D 1000
C 451E

HEADPHONES
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K 180

STANDS
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ST 201
ST 102A

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- **A. Revolutionary Phono Preamp.** New concept originated by Crown for purer disc-to-tape recording than ever before possible, with greatly improved S/N, almost unmeasurable distortion and precision calibrated equalization for flattest frequency and phase response.
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2. WORLD'S FIRST IC PREAMP. High-quality integrated circuits for greatly simplified circuitry.

3. LOWEST DISTORTION. New industry records for both IM and harmonic.

4. HIGH OUTPUT LEVEL WITH LOW IMPEDANCE Will deliver a perfect signal to any amplifier it's teamed with . . . even the demanding DC300.

5. WIDE RANGE TONE AND LOUDNESS CONTROLS. With pushbutton cancel for true flat.

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7. CONTINUOUSLY VARIABLE INPUT CONTROL With calibrated tracking.

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★ OPTIMUM BALANCE OF ESSENTIAL FEATURES

The features you need most, plus sensible functional design for exceptional operating ease.

— SPECIFICATIONS —

Frequency Response. Hi-level: ±0.6db 3Hz-100KHz with high impedance load, ±0.1db 10Hz:20KHz with IHF load; Phono: ±0.5db of RIAA, calibrated.
Phase Response. High-level: typically +1° to -12° 20Hz-20KHz with IHF load; Phono typically ±5° 20Hz-20KHz additional phase shift.
Hum and Noise. 20Hz-20KHz inputs shorted; High-level: 90db below rated output (typically 100db with IHF "A" weighted measurement; Phono: 80db below 10 V input) typically 0.5 V input noise.
Distortion THD: essentially unmeasurable; IM: less than 0.01% at rated output with IHF measurement (typically under 0.002%).
INPUTS. Five high-level inputs (1 tuner, 2 auxiliary, 2 tape), two equalised phonos.
Input Gain and Impedance. High-level 20.8db ±0.2db, 100Kohms; Phono: 50-70db (adjustable), 47K ohms.
Phono Input Capability. 33-330mV at 1KHz, depending on gain (100mV when set to 60db total preamp gain).
Output. 10v maximum before overload, 2.5 rated, 600 ohms output impedance.
Phono Output and Impedance. (at tape out.) 600 ohms with typical maximum output of 9V RMS at 1KHz into high-impedance load.
Volume Control. Over 60db dynamic range with calibrated tracking.
Loudness Compensation. New wide-range design for excellent simulation of Fletcher-Munson curves down to 60 phons; co-ordinated with volume control.
Panorama Control. Unique continuously variable control for infinite adjustment from stereo to mono to stereo reverse, replaces confusing conventional stereo mode switches and blend controls with the first intuitive control of stereo spatial dimension.
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Filters. Rumble: -3db at 50Hz with 6db-per-octave cut-off; Scratch: -3db at 5KHz with 12db-per-octave cut-off.
AC Outlets. Four switched with 25A switch, one unswitched.
Power requirements. About 2 watts at 120V or 240V 50-400Hz AC.
Semiconductor Complement. 2 integrated circuits (equivalent to 22 transistors and 14 diodes), 12 bipolar transistors, 1 FET, 2 zeners and 7 diodes.
Dimensions. 5¼" high x 17" wide, 8⅞" behind panel.
Weight. 10lb., with walnut cabinet 16lb.

CARSTON ELECTRONICS LTD., Shirley House, 27 Camden Road, London NW1 9LN Telephone 01-267 2748

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AUDIO DEVELOPMENTS now have in stock twenty varieties of ARGO aluminium control knobs, nine types of linear and log law slide faders, and also miniature locking dials. For further details contact:

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automatic

continuous INVERT-O-MATIC reverse

Another revolutionary recorder has been developed by AKAI. It's the world's first stereo cassette recorder capable of automatic continuous reverse recording/playback! This *CS-50 Stereo Cassette Recorder* incorporates AKAI's unique "INVERT-O-MATIC" mechanism which makes this possible. Almost unbelievable in the cassette field. Yet, it's true. Of course, manual reverse is also possible. Up to two full hours of hi-fi stereo recordings can be made. Sound quality is superb. Frequency response of 30 to 16,000Hz at 1⅞ips is almost equal to open-reel performance. Wow/flutter is within 0.16 to 0.2%. This top-grade cassette recorder also boasts automatic stop and automatic shut-off. *The CS-50D Stereo Cassette Tape Deck*, perfectly matched with the *SW-30 Hi-Fi Stereo Speaker System*, is also available.

Audio & Video

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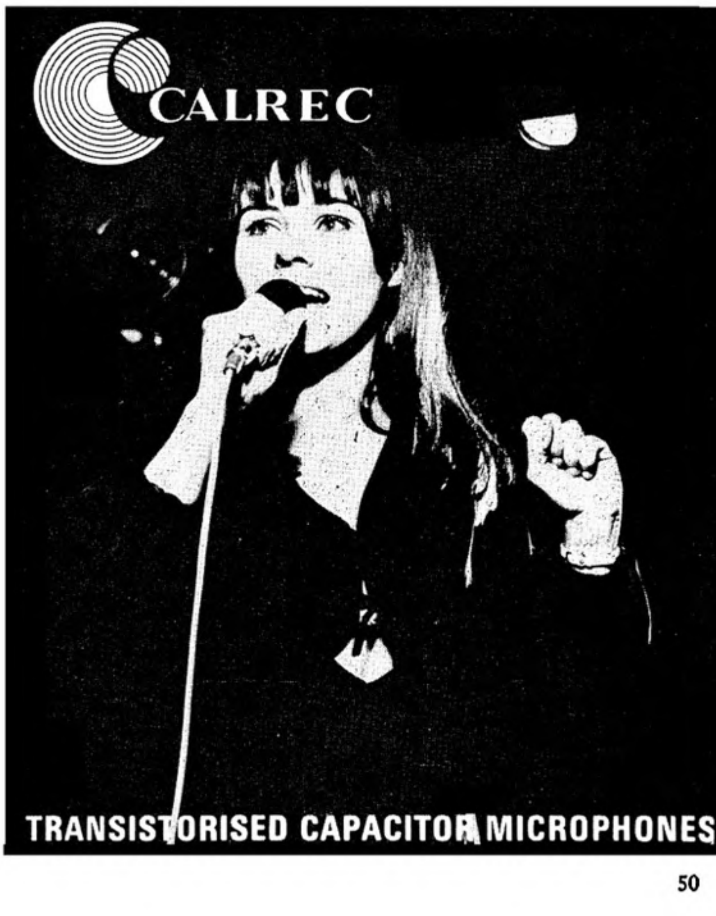
AKAI ELECTRIC CO., LTD.
Ohta-ku, Tokyo, Japan

Rank Aldis-Audio Products, Rank Audio Visual Ltd.: P.O. Box 70, Great West Road, Brentford, Middlesex Tel: 01 568-9222



CALREC
TRANSISTORISED CAPACITOR MICROPHONES

1720L offers durable part-by-part stereo mastery

Model 1720L

The 1720L is the kind of stereo tape recorder you can feel completely confident about. What's wrong with other company's tape recorders? It's not what's wrong with other tape recorders. What matters is that there is so very much more that is right with all AKAI instruments, including the compact, leather cabinet, durably constructed 1720L. This 4-track stereo/monaural recording and play-back system with 3 speeds (1⅞, 3¾, 7½ ips — 15 ips optional) is minute-by-minute, hour-by-hour, year-by-year dependable. That's why you can be supremely confident with this and all AKAI models.

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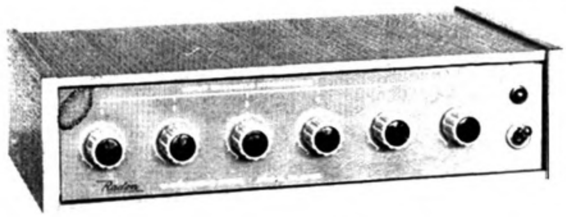

RADON'S DL6CM MIXER

Designed for Professionals at unprofessional Prices

Nine transistors plus diode bridge rectifier are employed in this compact mains powered unit with the following features:

Lightweight and pleasing appearance, all controls numbered at the front to correspond with inputs at the rear, no ventilation ducting as there is no heat to dissipate, no waiting for warm-up on switching on, has high impedance output facility as well as low, with gains of x2 or x5 available at the flick of a switch, reliable standard jack sockets and a low noise level with absence of hum. The front panel is permanently engraved on grey laminate. The unit is housed in a satin polished wood cabinet.

Lo or Hi-K Standard Model	**£49.19.8** rec. retail
200 ohm Balanced Line Model	**£72.10.0** rec. retail

Frequency Response	10 c/s (Hz) to 35 Kc/s (kHz) Level 30 c/s (Hz) to 25 Kc/s (kHz)
Output	@6K ohms position 2.5v. max. @68 ohms position 0.025v. max.
Gain	x2 and greater than 5
Input Impedances	35 to 100 ohms (or Hi-K if required)
Hum and Noise	Better than 40 dB down
Power Supply	220 to 240 volts 50 c/s or 110 to 120 volts 50-60 c s Please state voltage required
Size	Inches: 13 x 7 x 3½ Centimetres: 32.5 wide, 17.5 deep, 10.5 high
Weight	6lb. 8oz. 3¼ kilos.

Also Available

Special "Audio Blocks". These are inexpensive all transistor line-matching units, to solve all those 'High and Low' problems. They are small, battery-operated units, in all-metal cases, that can take the 'treatment' and give the results you want.

Model MLA/L1 — Low to High impedance
Input 5 ohms to 1K
Output 10K to 50K Typical gain 2000—according to impedance used **£11.0.0** rec. retail

Model MLA/H2— High to Low impedance
Input 50K to 100K
Output 600 ohms Gain 20 dB @ 600 ohms 50 mV in for 1v. @ 100K out. **£11.10.0** rec. retail

Available from Dealers, or in case of difficulty, write to: **Radon Industrial Electronics Co Ltd**
Brooklands Trading Estate, Orme Rd, Worthing, Sussex Tel. Worthing 34904

ALICE BUILDS QUIET MIXERS—

Our new professional modular system will not improve our noise figures—but it will provide a desk that an engineer can operate more quickly and efficiently than ever before.
The illuminated routing matrix and linear controls give constant visual mode reference.
Write for details of the BD range.

Of course we still make a remarkably compact 6- or 8-channel stereo desk if you wish to make masters on a mixer 27 inches long!

ALICE (STANCOIL LTD.) **15 SHEET STREET**
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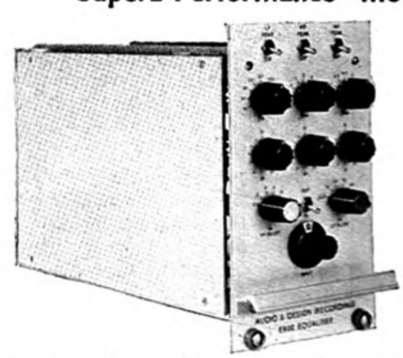
LEVEL CONTROL EQUIPMENT

Superb Performance—moderate cost



E800
Line/Channel
Equaliser

A versatile equaliser divided into three independently operating ranges. Each range has nine frequencies, any one of which may be selected to PEAK or DIP up to 20dB. The range covering the Mid-frequencies overlaps the ranges either side providing optional broad or sharp peaking. 12dB/octave LF filter and 6dB/octave HF Boost is also included. Noise—85dBm. Normal operating level—10 to+10dBm.

also available

F600 & F700 Compressor/Limiters.

Audio & Design (Recording) Ltd.

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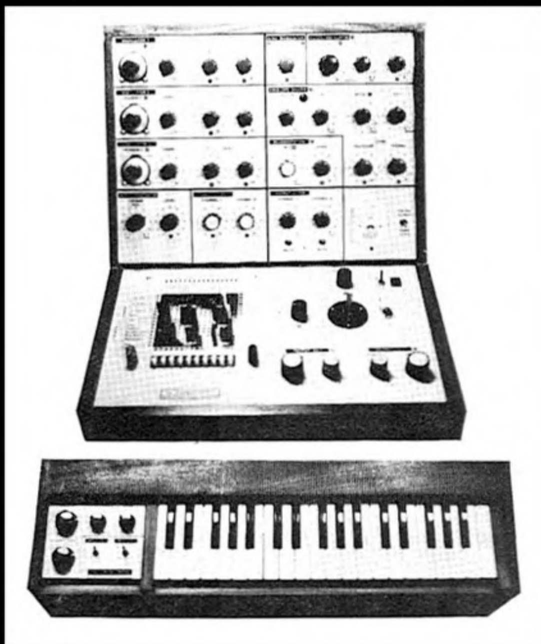
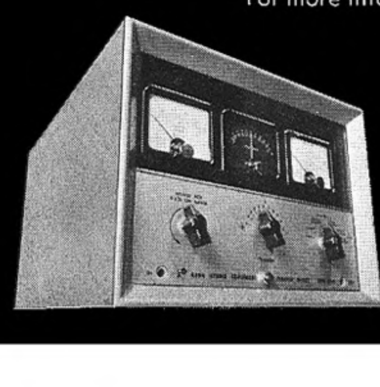
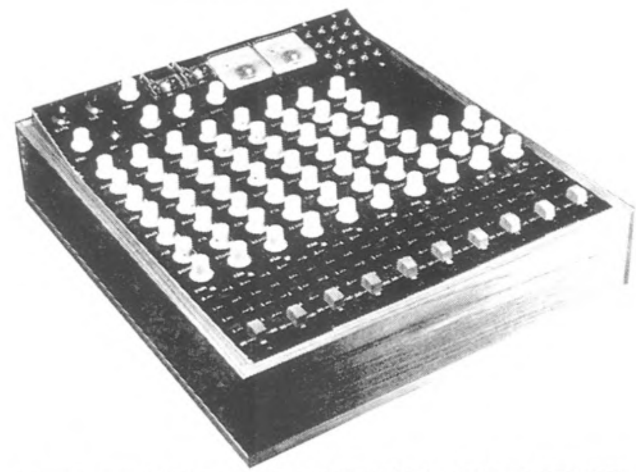




A new range of sound mixing consoles



FROM ONLY £292

Built on a modular system that allows each mixer to be assembled to customers' individual requirements, Allen & Heath sound mixing consoles have been designed to give compactness, versatility and quality at reasonable cost.

There are two standard units, the smaller accommodates up to 20 modules (10 large and 10 small) and the larger up to 40 (20 large and 20 small).

In either case the basis of the customised unit incorporates the following equipment:

* Jackfield, employing two-way jacking system
* Twin metering module
* Oscillator or talkback module
* Metered echo and foldback send modules
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* Monitor control module
* Two output modules incorporating echo return and equalisation

Modules available for inclusion in the mixers are:

MIC/LINE INPUT MODULE
EFFECTS EQUALISER
LIMITER
STEREO HEADPHONE AMPLIFIER

Units are supplied in attractive teakwood cabinets or portable vinyl cases with GPO Jack sockets on rear, or, if required, in chassis form with tag strip connectors.

Write or phone for full details

ALLEN & HEATH LIMITED

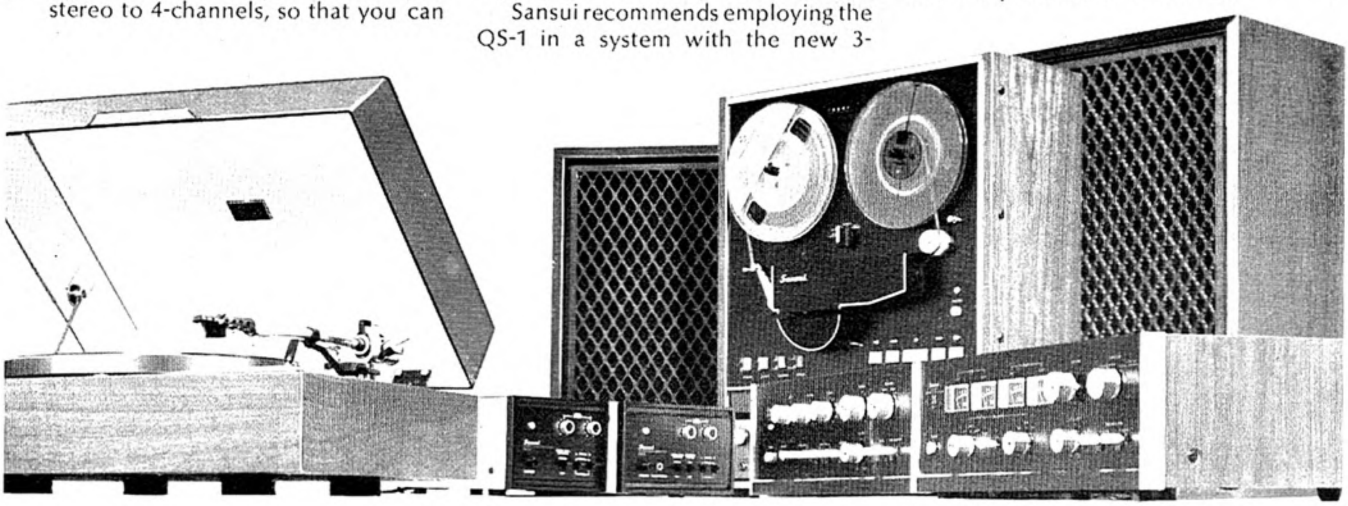
Drummond House, 203-209 North Gower Street, London N.W.1.
Telephone 01-387-9611

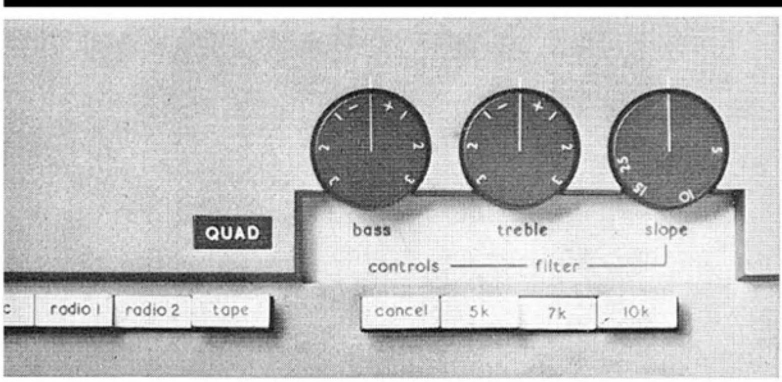
AKG D202

The popular D202 used on radio, T.V., sound recording studios, schools and by many amateur sound recordists, incorporating two dynamic moving coil systems in a single housing, one for high and one for low frequencies, giving smooth frequency response similar to a condenser microphone.
Electric Bass attenuation 0 to —20 Db Hz Frequency range 20/18,000 Hz.

Retail Prices from £35.10.0.

For more information on this and other AKG Microphones please contact **AKG** Equipment Ltd., Eardley House, 182/4 Campden Hill Road, London, W.8.





Even with a perfect pickup, the distortion from a gramophone record for sounds of equal level increases very rapidly at high frequencies, eventually doubling for every major third increase in pitch.

There comes a point when, to musical ears, the distortion is increasing faster than the musical quality. The QUAD filter system is designed to enable those with ears to hear to obtain more of the music and less of the distortion.

QUAD

for the closest approach to the original sound

Send postcard for illustrated leaflet to Dept. S.S.T.R.
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Studio Sound

FEBRUARY 1971 VOLUME 13 NUMBER 2

AND TAPE RECORDER

INCORPORATING
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COVER PICTURE

Alice Electronics make mixers and, to be as conversant as possible with their customers' needs, run their own recording studio in Windsor.

SUBSCRIPTION RATES

Annual UK subscription rate for *Studio Sound* is £1.80 (overseas £2.10, $5 or equivalent). Our associate publication *Hi-Fi News* costs £2.82 (overseas £2.65, $6.30 or equivalent). Six-month home subscriptions are 90p *(Studio Sound)* and £1.41 *(Hi-Fi News).*

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

IT IS COMMON practice among newspaper and magazine journalists to predict, now and then, events which they know to be inevitable. A word in or out of confidence, from a man of politics or commerce, can be used to enhance a prophet's reputation. So here we go.

There is a need, widely acknowledged in the recording industry, for a modestly priced tape machine to replace the Revox and Ampex/EMI equipment being used by small studios. Such a machine is in fact currently being developed by a reputable British company though the only certain information so far announced refers to a 27 cm spool capacity and an electrical tape tension sensor. The rest of the design is still in flux so now seems the time to air our views on what the average small studio requires.

The Telefunken *M28* serves as a good model on which to base our concept of the ideal. It has a solenoid control system which is ergonomically perfect—very light push-buttons with white / red / green illumination (respectively wind/record/play). The system would be the better for a logic lock of the late Unitrack kind, delaying the selection of a control mode until both spools are motionless.

Ferrite record and play heads are in our opinion essential to modern studio machines and the only excuse for omitting them is the claim that they are virtually unobtainable in other than two channel form. The narrowest practical guard band will maintain a respectable signal-to-noise ratio in studios unlikely to possess Dolby A.

Our ideal machine would operate at 38 cm/s only. The extra mechanical and electronic complexities introduced by adding a second speed, invariably 19 cm/s, outweigh the one advantage of a domestic speed—the ability to supply demo tapes for replay on a customer's Grundig. Regardless of the freedom from mains voltage and frequency variations offered by tachometer capstan control devices, we would still opt for a plain hysteresis synchronous tape drive motor. The Philips *Pro 20*, properly adjusted, showed the extremely low wow and flutter obtainable from a Papst direct drive system. No electronic components to drift, nor transistors to fail.

Traditionally the most reliable form of tape tension control has been a brake band around the supply spool, progressively slackened by the inward movement of a sensing arm in contact with the tape coating. A similar arm, on the *Pro 20* and *M28*, controls the takeup tension. The company to which we refer has its own ideas on this subject which may result in something closer to the elegant electrical tension control on the Studer *C37*.

At least one low price professional recorder lacks any form of adjustable replay equalisation—a curious omission in a machine with a non-ferrite play head. It is to be hoped that designers of new studio machines will both allow for long-term variations in head characteristics and provide a wide enough degree of record and replay curve adjustment (and reserve bias) to suit the eventual introduction of chrome dioxide professional audio tape. We may be sticking our neck out in forecasting this application, when the tape's only immediate advantages are for low speed operation, but we nevertheless suspect the change will come. The fact that normal 38 cm/s quality is inadequate for modern studios is proved by the success of Dolby A.

The question of meters is most easily solved by either fitting none and leaving the job to an external mixer or by incorporating PPMs or VUs to customers' order. A similar marketing attitude should be extended to input/output facilities; not all studios wish to pay for low level microphone inputs, for example.

Which leaves the small matter of price. The Telefunken *M28* costs £495 in its simplest form. If a British company could undercut this with a comparable design, dealers in third-hand Ampexes would face strong competition.

FEATURE ARTICLES

REGULAR COLUMNS

EQUIPMENT REVIEWS

studio diary

ARGO APPOINT AGENT

ARGO ELECTRONIC Components Ltd of Garston, Hertfordshire, have appointed Audio Developments of Walsall Wood, Staffordshire, as their UK distributors. From this month, Audio Developments will stock 20 varieties of Argo aluminium control knobs, nine types of linear and log slide faders and a range of miniature locking dials.

SOUTH COAST MULTITRACK

DETAILS OF their four-channel mastering facilities have been sent to us by Hayling Recording Studio, 26 Elm Grove, Hayling Island, Hampshire. Established in 1970, their present premises comprise a 7 x 4 m studio separated from the control room by sound-proofed wall and 12.5 mm plate glass double glazing. Equipment comprises 12.5 mm four channel Ampex *AG440*, a two channel 6.25 mm TRD *622/S/15*, 11 channel Audio Developments mixing desk, Grampian *636* spring reverb, Audio & Design compressors, and Quad amplification. Lockwood Major, Bowers & Wilkins and Wharfedale speakers are currently being used. Hayling anticipate moving to larger premises shortly, offering overnight board to customers. Proprietors are N. D. Ruffell and A. B. Edwards.

NOISE MEASUREMENT TECHNIQUES

A SECOND EDITION of their successful booklet *Noise Measurement Techniques* has been issued by Dawe Instruments Ltd. This is an enlarged version of the first edition, 15 000 of which have been issued since 1958. It has been updated and expanded to 20 pages by its author, W. V. Richings, the company's technical director. Copies are available free from Dawe Instruments Ltd, Concord Road, Western Avenue, London W.3.

ZONAL BOOKLET

ZONAL FILM LTD have published a booklet which describes the company and its products. The booklet is illustrated in colour and covers the Ilford Zonal range of computer and instrumentation tapes, audio and video tape and film. 'The Zonal Booklet' can be obtained from Zonal Film (Magnetic Coatings) Ltd, Holmthorpe Avenue, Redhill, Surrey.

RCA WIN £3 000 000 STUDIO ORDER

A CONTRACT FOR the supply of a complete colour television studio has been received by RCA from Oesterreischischer Rundfunk GmbH (ORF). Worth nearly £3 000 000, this is one of the largest equipment orders ever made in the broadcasting industry. It covers the construction and installation of colour cameras, VTRs, telecine and TV production equipment. Facilities will be provided for the simultaneous production of several programmes from live, tape and cine sources. The studio will be situated in Vienna.

COMPONENTS CATALOGUE

THE FIFTH EDITION of 'Hi-Fidelity, Electronic Components & Equipment Catalogue' has been published by Smith (Radio). Price 37½p, the 250 page well-illustrated catalogue covers a wide field of basic accessories from Aerials through Croc clips and neon lamps to Zener diodes. G. W. Smith & Co. (Radio) Ltd, 147 Church Street, London W.2.

CALREC SOUTHERN DISTRIBUTION

BEYER Dynamic (GB) Ltd, 1 Clair Road, Haywards Heath, Sussex, has been appointed southern distributor for Calrec capacitor microphones. These are manufactured in Hebden Bridge, Yorkshire.

PYE SUPPLY MUZAK DUPLICATION EQUIPMENT

AN ORDER worth £16 500 for the supply and installation of tape duplication equipment has been placed by Planned Music Ltd (Muzak) with Pye TVT, Cambridge. The system will comprise two master reproducers and six slave duplicators from the Philips ETD range.

EIGHT-TRACK BACKING

LEEVERS-RICH eight-track recording equipment has been installed in the Bristol studios of Harlech TV to permit the production of multitrack recordings for the accompaniment of pop singers appearing live. In the past, accompaniment has usually been recorded on mono or two-track equipment but the greater versatility of the eight-track machine permits of the production of a backing comparable to that on original discs.

CARTRIDGES AT US TRADE CENTRE

CARTRIDGE RECORDING equipment was displayed and demonstrated in London recently at the US Trade Centre. The equipment included the Spotmaster 'Ten/70' series of record/playback units. This system accepts NAB standard cartridges, permitting fast-forward wind. Long tape life is claimed.

EUROPEAN AES CONVENTION

FOLLOWING THE establishment of a UK branch of the US Audio Engineering Society, similar national sections have been formed in several European countries. These are now in the process of merging into an AES Central Europe Section run by a committee of national representatives. Peter Burkowitz (DGG, Hanover) has been appointed chairman, with K. O. Bäder (EMT) as secretary. Professor H. Wilms (National Radio and Film Institute, Brussels) represents the Benelux area (Belgium, the Netherlands and Luxembourg), B. Weingartner (AKG) representing Austria.

The first AES Central Europe Convention will be held from March 16 to 18 in the Esso Motor Hotel, Cologne. This will include an exhibition of professional audio equipment and a presentation of technical papers. Dr Ray Dolby will talk on the Dolby B system and Teldec video discs will be demonstrated. AES members and non-members in the UK who wish to attend should contact John Borwick, 47 Wattendon Road, Kenley, Surrey, before the end of January.

NEXT MONTH

THE PRACTICAL results of tests on chromium dioxide tape will be given by Angus McKenzie. John Fisher describes his construction of a stereo capacitor microphone while Ivor Dykes outlines the development of a theatresound installation for the Lancaster University Nuffield Theatre.

John Shuttleworth visits the BBC's Maida Vale Studios

inside Maida Vale

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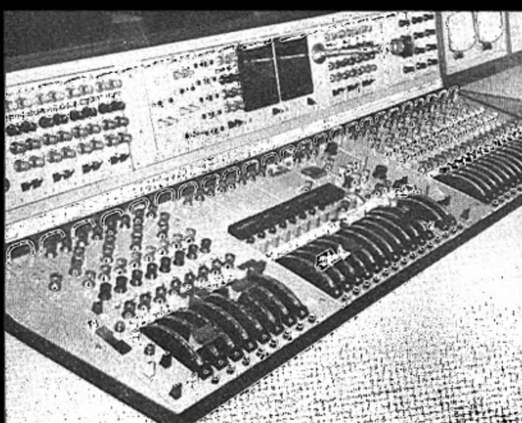

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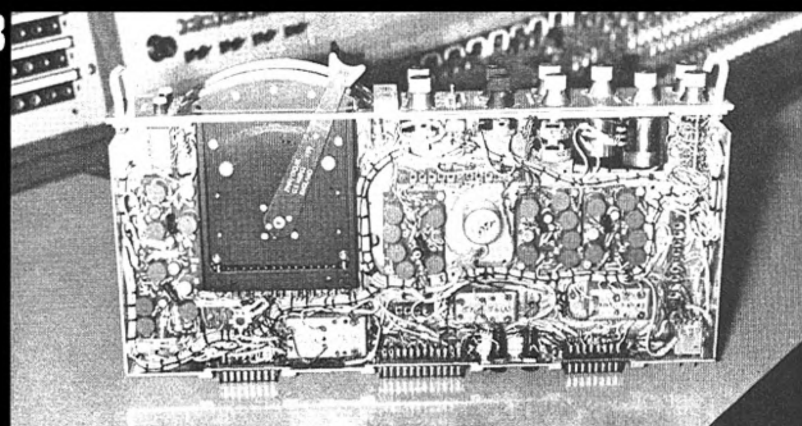

I CORRESPOND fairly regularly with recording engineers in America and on the Continent, and one thing on which they are agreed is that the BBC leads the world both in the standard of programme content and technical quality. My correspondents seem to find it difficult to understand why I sometimes complain about the Corporation, even though my chief complaints relate to the lack of decent stereo and the excessive use of discs for music reproduction.

I also know a number of BBC engineers and studio managers. While I don't necessarily agree with all they do, I know them to be painstaking and sincere. In the light of this, I was delighted by the opportunity of visiting Studio One at Maida Vale to discuss balance and other topics related to broadcasting. My visit started rather disastrously as, on my way to Broadcasting House, my car had a difference of opinion with a Belgian coach. The coach won.

The studios at Maida Vale are built inside what used to be an ice rink. Each studio has its own walls and roof built inside the original building. This has great advantages in acoustic insulation but means that the studios are smaller than they might otherwise have been. Owing to local building restrictions, it is not possible to raise the roofs of the studios, so Studio One is really too small and too low for satisfactory orchestral climaxes. There is a dead spot in the studio where the woodwind normally sit and, unless the orchestra is arranged with the woodwind on the conductor's right and all the strings on his left, it is difficult to achieve a satisfactory balance.

There is an additional complication in Studio One that, if the microphones are raised too high, their bass response deteriorates. Studio One is 33 m long, 22 m wide and 9 m high. Mid-frequency reverberation time is 1.8 seconds. The studio manager has to remember that the vast majority of listeners listen in mono, many using small transistor radios. Any stereo balance must also be compatible for mono and this necessitates some compromise.

For stereo reproduction, a crossed stereo pair of microphones with figure-of-eight characteristics might give ideal results. When mixed for mono, however, the out-of-phase components from the side quadrants cancel, giving too little reverberation. This can be cured to some extent by reducing the rear lobes and using the crossed pair in 'cottage loaf'. BBC engineers seem to favour an additional pair of backward facing cardioids for reverberation as this gives control over the amount they can add. They can then get the best balance for both the mono and stereo signals.

Another example of this compromise is the relative level of music and speech when announcing symphonic concerts. A level of speech sounding right when reproduced with high quality equipment would be almost inaudible on a car radio.

At the time of my visit, Promenade concerts were being rehearsed in Studio One. The main microphones used in Studio 1 are AKG *C24* stereo capacitors, *C12A*, *C28* and STC *4038*.

One *C24* was set up as a crossed stereo pair in 'cottage loaf' characteristic, and another as a sideways facing back-to-back cardioid. Two AKG *C12A* microphones were also set up as a backward facing cardioid pair to pick up studio reverberation if required. As in any commercial studio, there are junction boxes in convenient positions. Microphones connected to these receive the correct power supply and feed their outputs to the mixing desk in a separate control room. Setting up the four microphones we were to use was a simple and speedy operation.

The control desk is the first of the BBC

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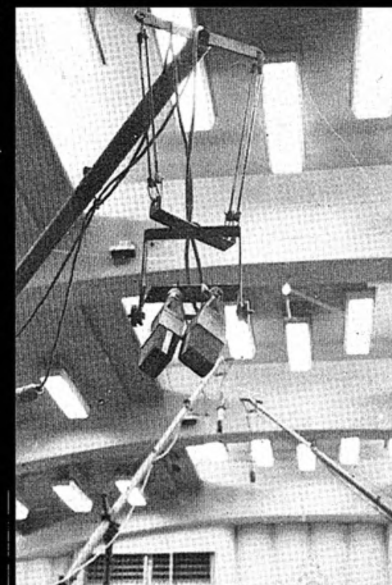


1 Two **C37** Studers
2 Type D mixing desk
3 Channel module from the Type D desk
4 Richard Gundry (back to camera) and author in Studio One
5 Foreground: Two back-facing **C12A.** Two **C24** can be seen in the background

Type D transistor stereo desks.

Getting a sufficiently wide dynamic range from a control desk while keeping noise to a reasonable level is not easy. If the faders are ahead of the amplifiers this avoids the danger of overloading but introduces noise problems. If they are placed after the amplifiers, the noise problem is considerably eased but there is no way of preventing the amplifier from cracking if it gets an unusually high signal. The *Type D* incorporates an elegant solution to this problem, having ganged preset controls, one before the amplifier and one after the first stage of amplification.

The desk has four stereo and 16 mono channels via three group faders to a master fader. Two independent channels are available for announcers. As a programme may be going out over different networks at the same time, it is sometimes necessary to feed out the same music with different announcements.

Each channel accepts plug-in frequency selection amps and can be connected to Hammond spring or EMT plate reverberation, or delayed tape loop echo. There are also facilities for complete remote control of the *C37* Studers in the recording booth next door. Any channel may be routed for studio monitoring. The meters are PPM, these being exclusively used by the BBC except for lining up where VUs are adequate. Separate PPM pointers read left and right levels, sum and difference. They are respectively red, green, white and yellow.

Also in the control room was a central microphone power supply unit and a pair of RML experimental BBC monitor speakers which have been found to give most satisfactory results in this particular control room. One side of this control room is largely window, with a sloping roof at one end, which qualifies as a 'difficult condition'.

We returned to the central room to experiment with microphone balance while Jascha Horenstein rehearsed a Mahler symphony with the LSO, we listened to the single *C24* used as a crossed stereo pair in 'cottage loaf'. This gave a very pleasing sound in stereo though it was a little too close for my taste. Richard Gundry, my host on this occasion, claimed that if the microphone was moved further back the balance would be wrong. When mixed to mono the reproduction was rather dry and certainly would have been improved with more reverberation from the studio.

We listened next to the back-to-back cardioid *C24* and, while the sound in mono had improved, I felt that the stereo was less realistic.

The final trial was a return to the 'cottage loaf' *C24*, adding a controlled amount of reverberation with the backward facing *C12As*. Although in the past I have disliked this method of balance, I must admit it gave the most satisfactory compromise for both mono and stereo.

I was thankful that our listening tests were not carried out at the painfully high sound level one finds in most control rooms. The signal was beautifully clean and clear, very close to the original sound being produced in the adjacent studio.

It became increasingly obvious during my visit that a lot of thought and care is taken over every aspect of sound reproduction connected with this studio, and it was a pleasure to see top grade equipment being expertly used and maintained.

I am grateful to the BBC for allowing me this glimpse behind the scenes, to Brigadier Tucker (Engineering Information) for authorising the visit, and to Mr R. S. C. Gundry for giving up so much of his time to show me round.

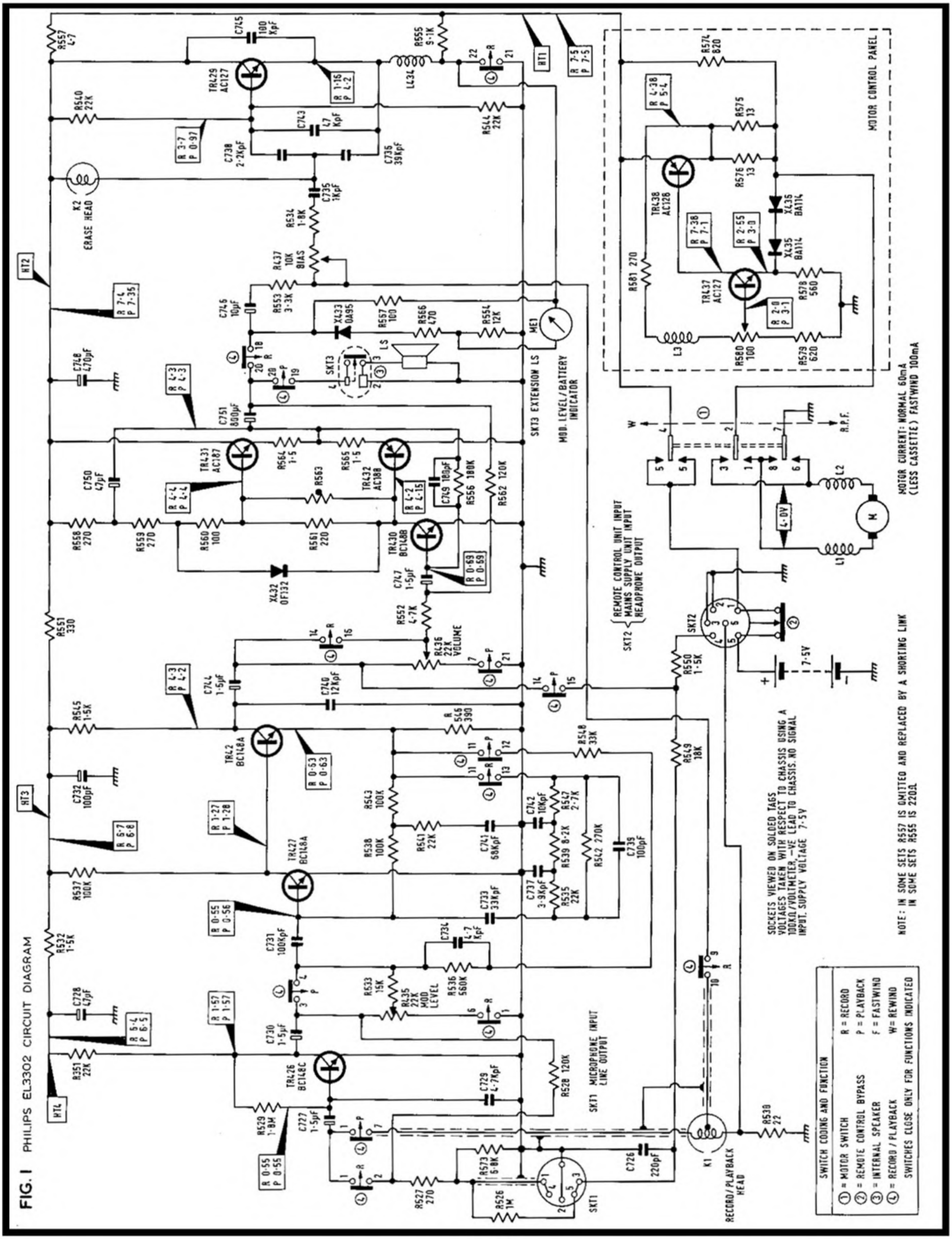


FIG. 1 PHILIPS EL3302 CIRCUIT DIAGRAM

PHILIPS EL3302

BY H. W. HELLYER

BEFORE we are accused of hogging the limelight with Philips, we must conclude this section of servicing articles with a look at some of the mechanical features of cassette mechanisms—both the original Philips design and some of the derivations.

The principal feature in which these derivations differ from the earlier Philips design is in their use of key or push-button control instead of a single-knob device operating a long, angled lever. Some of the methods of key control, without the complications of latching, are blessed by simplicity, and the charge of unnecessary complexity has been levelled at Philips by many a service engineer, struggling with tiny plastic washers. Repair is much easier when we understand what each part is intended to do.

In the original Philips design, drive is via a single belt from the motor pulley to the flywheel. The belt contacts a grooved plastic wheel, mounted on a pivoted bracket which has a hairpin tensioning spring. The spindle on which this bracket is mounted has been known to work loose. This and other mounting pieces of the deck are 'nail-head' fixings. The 'head' is punched so that it spreads and grips the deck metal. But the area of grip is small and it takes very little to dislodge such a fixing. Once loosened, the nail-head pins and pillars seldom answer to makeshift fitting. Where there is only a small degree of movement, a renewed punch mark at the head (while the deck and pin are individually supported) can be made to clinch. The pin holding the take-up wheel bracket can be so treated. The bracket is held on to the pin by a plastic washer. Take care when removing—after the first couple of times, these washers are useless.

The wheel is clutched by a brass disc and felt ring, and beneath its well (deck inverted) there is a compression spring. The spindle of this assembly carries a bushing which bears against the take-up spool. Most frequent fault here is the rubber tyre, not the drive mechanism. Changing these small turntables has become second nature to us. They are secured by a push-on cap and beneath them is another plastic washer. Again, the pin on which each turntable is mounted can too easily be bent: great care has to be taken.

Many times in this series of articles I have plugged the point of cleaning. It is essential that dirt particles are removed from these running parts. When the drive is as precarious as it can be with some versions of the cassette mechanism, notably those with 6 V drive and no margin, every drag-adding cause must be checked. Many a motor has been changed because the combination of worn belt and rough or dirty surfaces has caused slow operation.

Another of those pins

Another of those problem-giving pins is the one on which the pressure roller bracket is pivoted. Here we do have a fair amount of pressure but not a lot of movement. The bracket is forced inwards by a torsion spring whose lower end (deck now the right way up) sits in one of four holes in an arc around the base of the spring mounting. The nearer the edge, the greater the force helping to keep the roller in place against the capstan spindle. Inward movement of the bracket when the deck is neutralised is limited by a tongue on the travelling plate on which heads, record interlock spring, and pressure roller bracket are mounted. With the roller engaged, there should be a couple of millimetres clearance between the bracket and this tongue. Worn rollers have not been too great a problem with this deck, curiously, but watch for those tell-tale black specks around the flywheel's upper bearing.

Another item

The flywheel is another vulnerable item. Once more, the spindle is the problem: it is too easily bent, and the result is wow. Fortunately, replacement is not too difficult: the lower bearing is a nylon pad held on a bent bracket which is secured by three very obvious screws. On models that have a motor control panel, this will have to be swung out of the way and there is a catch here. In addition to the two screws that hold the panel to the bracket, we have to swing the bracket itself out of the way so that the flywheel can be slipped towards the front of the machine to clear the nylon pulley. Temptation is to try and fiddle it. You may get the old one out; you are almost sure to do some damage trying to get the new one in. Don't be tempted—turn over and look for the screw that holds the spring support for the recording level meter. This screws through to the motor control board support bracket.

The nylon pulley bracket may have to be removed but, before you do so, take particular note of the way that hairpin spring lies. It hooks over a small spigot more easily identified from the top of the chassis, passes around the support spindle and strains against the outer wall of the deck to give the necessary inward force. Are you with me? Good! Then you will not be insulted by my reminder that you now have a mess of knobs (including the control knobs and, in some machines, compression springs around the control knob spindles), buttons, brackets and tiny 3, 5 and 6 mm screws rolling around the kitchen table. Watch that speaker magnet!

When re-assembling, hold the motor control board a little above its fitted position, slip the screws through its holes so that their heads are supported by the board and then, using a correctly sized screwdriver blade (best quality Woolworth's, believe it or not), gently locate the screws and tighten them. This apparently elementary advice is heartfelt. Having spent more time than a pilgrim to Mecca on my hands and knees under the bench, I deplore lost screws. My practice for years has been to use a Philips bench mat, hard rubber squares into which anything that falls is trapped. Working on these cassette mechanisms has more than a few times given me cause to bless it.

Still on the flywheel, allow me to remind you that there is a deliberate adjustment of this bottom bearing—or rather, of the siting of the bracket. When the three screws are refitted, note that a wedge shaped aperture in the middle reveals the edges of a gap in the deck wall. The idea is to insert a screwdriver blade when refitting the bracket, before the three screws are fully tightened. A slight twisting action sets the height. Ensure that the deck is horizontal. Failure to do this will result in a spilled belt, or at least irregular running.

Driven from the flywheel, we find another nylon pulley, this time a stepped one, with a rubber tyre. This fellow is coupled with a small belt to an alloy pulley on another sprung bracket. The pulley has a common spindle with a roller that engages one or other turntable for fast winding. Rewind is effected by reversing the polarity of the applied voltage.

The hairpin spring in this case sits in a fork. When play is selected, the spring is as far into the fork as it can go. Although the lower nylon pulley is then clear of the flywheel, the roller is allowed to engage the feed spool turntable very lightly. This applies a small braking action and helps keep the tape at the right tension. Possible fault is wear of the nylon mounting so that the common spindle is slightly retarded. This is seldom enough to affect fast winding, but can give a halting action to the feed spool braking and cause wow—or, at least, accentuate wow when other causes are also present.

More than one cause

When dealing with decks, it is always wise to remember that faults may have more than one root cause. In this case, neglect can have resulted in a gritted flywheel upper bearing, a dried lower one, a relaxed belt, a tired motor and the pulley assembly we have just been discussing tending to seize. Overall outcome—wow and slow running. Solution, a general clean-up and relubrication.

As we have observed before, the best method of checking torques on these battery-operated

(continued overleaf)

tape recorders, where drive is direct, is to take current readings of the demand at the motor. If we know what the normal consumption is, and then apply a touch of retardation here and there, we can judge by the difference where our area of fault may be. In the case of the clutch friction of these cassette models, holding the left turntable while a cassette is being played will show a marked increase in current. About 10 mA should be expected if all is well. If it is below 7 or above 14 mA it may indicate either retardation of the take-up clutch mechanism or wrong adjustment of the winding clutch mechanism, causing this to engage the flywheel all the time.

Cassette mechanisms, because they employ no frantically spinning spools and massive torques, need no elaborate braking systems. Some designs are so rudimentary that one has to look twice to see whether any brakes exist. Like the cords of the old Elizabethan *LZ30*, the brakes of cassette mechanisms may be more of a token than a tug.

In the case of the Philips mechanism, the brakes are plastic pads on 'bent-up' angle pieces of a transverse bar, which contact the rubber tyres of the turntables. The setting is not at all critical. But the engagement of the pin on the main actuating lever (a substantial item this time) with the rear edge of a slot in the brake bracket for 'off' and a spring piece for 'on', is very important. The adjustment for correct action is not obvious: if you study the brake action, you will see that the bracket is centrally sprung, very lightly, and the anchoring of this spring is to a central tag.

One of the worst troubles I have had with these decks has been crosstracking and occasional seizing of tape transport caused by misalignment of the record/play head. Easy, you say, but that does not reckon with the practical problem of a 2 mm screw with an unco-operative thread at its engaging end. When the head is misaligned, the thread grips well, but as it comes into alignment it fails to keep a strong grip and allows the head to slip upwards at its outer edge each time the shock of a new play engagement is made. The only possible answer is a new screw and, regrettably, a new threaded hole into which that screw must seat. Any attempt to fiddle it can lead to disappointment—sorry, Joe, but you will have to order a plate, possibly mount the various pins and things on it if CES are not kind to you, and start all over again.

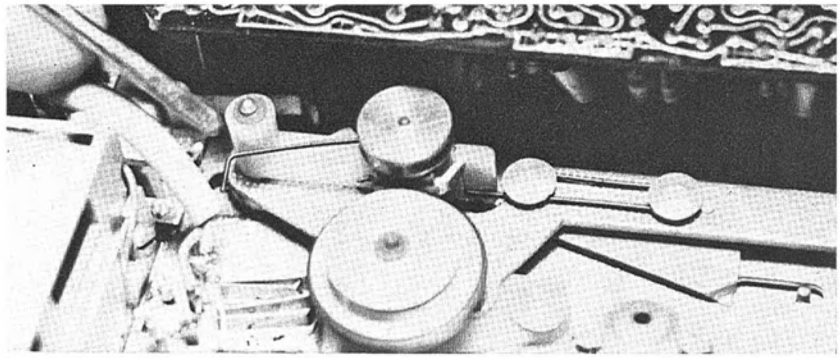
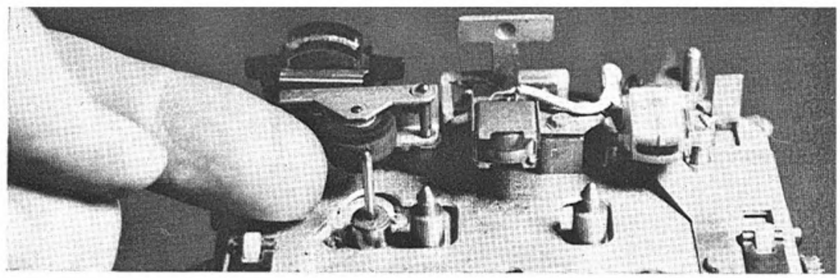


Fig. – The main function knob controls all switch actions and drive engagement, including this clutch pivot. The flywheel has been removed to show the hairpin spring on the main function lever.

Fig. 2 Upper deck, with flywheel spindle indicated.



In extremis, you could retap the hole and fit a different screw. When the plate is so thin that even a 3 mm thread gives little grip, the repair is not likely to be effective.

In the later *3302* models, I note, a more sensible approach has been made. Now we have a pin with a slotted castle nut to make the final azimuth adjustment. The solid, unequivocal erase head mounting has been retained. There is some sense about this, for it provides a datum for alignment of the other adjustable items.

There seems to be much more that could be written about the Philips design: The nylon rollers of the side-spring pieces, with their possible seizure and failure to make an exact location in the cutout. The loss of one of the four small ball-bearings that sit beneath the moving plate. The jamming of the strong spring that supports the record knob as the main plate moves forward . . . and so on. All manner of minor faults have cropped up, and readers will have to forage for themselves if the foregoing notes have not covered the principal ailments we are likely to experience. No more space can be spent on the subject here, I regret to say, but any correspondence on the specific points that have been raised I shall be happy to deal with.

impressions

BY JOHN SHUTTLEWORTH

SETTING UP

I DECIDED a while ago to take up photography and, realising that I would become dissatisfied if I bought an inferior camera, I decided to save myself money and buy the best straight away.

I spent some time asking friends, and several different dealers, about the relative merits of different cameras. Two things emerged. First that the same manufacturer's name appeared in the various lists of 'best' cameras and secondly that one of his products was extensively used by professionals.

The professional photographer, like the professional recording engineer, cannot afford a failure. I can't afford a failure either—I haven't the service facilities for repairing my own camera or the cash to pay someone else to do it for me, so I bought myself the 'professional' camera. It is beautifully engineered, large and heavy by amateur standards, but gives every indication of outliving me if treated with reasonable care.

I hold the same attitude towards tape recorders and, for studio machines, suggest the following basic requirements are basic in order of importance.

1. Complete reliability even with prolonged use.

2. Ease of servicing and aligning.

3. Very low wow and flutter.

4. Good electronic performance, particularly with regard to noise.

As with my camera, I don't see how one can satisfy these requirements unless one accepts a large heavy and expensive machine, and the classic example of one that gets pretty close to my ideal is the EMI *BTR 2*.

What makes a good tape recorder? Some readers may prefer to re-word the question as *Who* makes a good tape recorder? The answer to that is very few manufacturers indeed.

Ideas as to what is needed in a good recorder vary considerably. No doubt, however, we would all agree that high reliability is essential. The main factors affecting reliability are good design, size and weight. I am often asked if I can recommend a good recorder in the under £100 category that is reliable, easy to use, light to carry, and makes good quality recordings. Regrettably, I know of no such recorder.

I remember visiting a BBC Studio in London seven or eight years ago and seeing an enviable array of *BTR2* EMIs (then £1 000 each) and being told by the engineer that they were being given cheaper recorders which, he claimed, would be less reliable and more difficult to maintain.

The *BTR 2* is very large, heavy, and was very expensive. It is also completely reliable and, despite a specification that alongside that of a modest Japanese domestic looks laughable, makes superb recordings and will continue to do so for many years yet.

I use one of the Philips machines the engineer was so concerned about, and I can surely see why.

It is a superb recorder and handles tape gently and makes tapes of the highest professional quality. Yet, because of its size, servicing is much more difficult.

My second requirement—ease of servicing and aligning—is also very important. No self respecting engineer will start a session without first checking his recorder so it is essential that all the controls for this purpose are easily accessible.

The procedure I use requires the following equipment: Defluxer, clean cloth with tape head cleaning fluid (or spit), test tape, Low distortion audio sine generator, valve millivoltmeter and distortion measuring unit.

The first task is to clean and deflux the tape heads and tape transport. Apart from the effect on future recordings, I can't afford to risk damaging a valuable test tape by running it on a badly adjusted deck or past magnetised heads.

The test tape should never be fast wound in either direction, or stopped in the middle of one of the test tries, and should always be treated with the greatest care.

Next line up the replay side of recorder. There are two things to check here, head alignment, and amplifier and head frequency response.

If tapes are to be replayed on different recorders without loss of quality, it is essential that the head gap on each machine should be aligned exactly vertical.

After prolonged (and sometimes not so prolonged) use, the heads can go out of azimuth, shifting from vertical. I don't know how this can happen in properly designed recorders with suitable locking devices after the head has been adjusted, but it sometimes does, and therefore should frequently be checked.

Chinagraph

I dislike the idea of marking tape with a chinagraph pencil while it is still in contact with the replay head, since it can contribute to head movement.

A better arrangement involves a post on the deck, the same distance from the replay head gap as the mark on a built in editing block is from the cutting slot.

After removing the head cover and demagnetising the screwdriver or key needed to adjust the replay head azimuth, connect the valve millivoltmeter to the amp-out socket of the recorder together with the correct load (600 ohms in my case) and load the test tape.

Replay the 15 kHz test (10 kHz at 19 cm/s) tape and adjust the head azimuth for maximum output registered on the meter. Adjust the replay tone to give about 500 mV output on the meter.

Repeat the process on the lower track and then the output from the upper track once more.

Unless both the upper and lower head gaps are perfectly in line (and this is rarely achieved by the manufacturer) adjusting the lower track will upset the alignment of the upper track, and it will be necessary to find a position where the two are as nearly vertical as possible. I therefore make adjustments to the head azimuth, reading the output from the upper and lower track alternatively, until output is as high as possible while being the same from each. The replay head is now adjusted for azimuth and locked in position. Double-check that the act of locking has not shifted the setting.

The next thing to be checked is the replay response of the recorder. Since the replay side is used to line up the record amplifiers, it is important that it should be well within the tolerances allowed. The minimum requirement is that a treble equaliser should be easily accessible for each replay channel, though some of the better machines have adjustments for treble, middle and bass.

Assuming only a treble replay equaliser, replay the 1 kHz test tone and adjust the output to record 500 mV on the voltmeter. Then replay the 15 kHz tone (for 38 cm/s) and, leaving the same setting on the replay gain, adjust the equaliser control to give 500 mV reading on the voltmeter once more.

When this has been repeated for the lower track, it only remains to measure the output from all the frequencies on the test tape. With a suitably designed recorder this should be within 0.5 dB from 30 Hz to 15 kHz (10 kHz at 19 cm/s) on both channels. I certainly would not be happy with a wider deviation than this.

I prefer a fairly rapid fall off in response above these frequencies, as most of the signal at the top end is 'dirt' and highly undesirable if we want clean reproduction. We can only stretch the frequency response beyond 15 kHz at the expense of distortion and s/n ratio. A recorder with a response within 0.5 dB from 30 Hz to 15 kHz then falling away, makes vastly superior recordings to one having a response ± 3 dB (meaning within 6 dB?) from 20 Hz to 18 kHz, the latter being a typical specification of many foreign domestic recorders in the higher price range.

Having checked the replay side of the recorder, it is now necessary to adjust the record channels. It is essential that this should be done with the type of tape to be used. There are substantial variations in the characteristics of modern tapes, even in different types from the same manufacturer, and for optimum performance the recorder should be adjusted for each different type used.

Some tapes require as much as double the bias others need (this is not a fault, merely a

(continued overleaf)

different characteristic) and if used with the wrong bias produce hissy and otherwise nasty recordings.

To adjust the bias I feed a 1 kHz tone and adjust the signal to give full modulation on the meter. With the valve voltmeter still connected to the output, switch to record, reduce the bias, then increase the bias slowly until a maximum 1 kHz output is reached, then continue to increase until the output has dropped 2 dB below maximum. This gives the optimum bias for low distortion, high s/n ratio and good frequency response. The next task is to adjust the azimuth of the record head, and I now change the 1 kHz tone to 15 kHz and, using the azimuth adjusting screw, set the record head to give maximum output on the meter. As with the replay head, it may be necessary to find a mean position where the upper and lower track heads are as near vertical as possible.

It is now necessary to ensure that the frequency response of the recording amplifiers and record head are properly adjusted so I now inject a 1 kHz tone and adjust the record level for maximum modulation and then reduce the input to −20 dB. This is necessary to avoid overloading the record amplifiers with the pre-emphasised top frequencies. I then adjust the record amplifier equalisers to give the same output from the tape when tones of 1 kHz and then 15 kHz are recorded. The last adjustment to make is to ensure that, using the recorder's meter for level, tapes are fully modulated. We can either adjust for a standard level of magnetisation (the usual method adopted, for obvious reasons) or we can adjust for a given distortion level. I usually adjust for a standard magnetisation by injecting a 1 kHz tone at 1.95 V into 600 ohm line input and then adjust the record level so that the recorder's meter reads 0 on line out.

As the replay volumes have already been adjusted to give correct output from the test tape, the tape now being recorded will be modulated to the same extent. I now switch the meter to read 'line in', leaving all other controls as set, and then adjust the meter to read '0' once more. I now know that '0' on the meter indicates a magnetisation of my tape identical with that on the test tape. The procedure is, of course, repeated on all channels. A frequency check on record-replay and recording tones from 30 Hz to 15 kHz at −20 dB should produce a response on replay within 0.5 dB throughout the range, again with a rapid fall-off at the top end.

To adjust for a given distortion level, it is necessary to connect a distortion measuring unit between the tape recorder output and the valve voltmeter. The unit consists essentially of a filter that cuts out a spot frequency completely. This particular frequency (usually 1 kHz) is recorded on the tape and the replay output of the recorder measured without the filter. The filter is then switched into circuit between recorder and meter and the new output reading taken. The signal now shown on the meter is the distorted waveform only and can be measured as a percentage of the unfiltered signal. I like to measure distortion at several frequencies, for I have found that some rather nasty amplifiers measured quite well at 1 kHz but were poor at high frequencies. One I measured gave 1% distortion at 1 kHz and 25% at 10 kHz! This accounted for its very nasty sound, despite its respectable specification. To measure distortion at different frequencies requires a tunable distortion measuring unit. My own recorder, set up as outlined above, gives a distortion reading of about 1.5% at all frequencies from 30 Hz to 15 kHz (the usual 'professional' figure given for studio recorders is 2%). I could, of course, increase the modulation and arrange for the zero on the meter to give 2% distortion. This would improve the s/n ratio but my tapes already overload the input stages of some modern transistorised recorders and my present s/n ratio at 1 kHz of a genuine 60 dB unweighted is quite adequate. Setting the recorder up in this way I obtain the following performance figures at 19 cm/s:

Total RMS wow and flutter: 0.08%

S/n ratio at 1 kHz unweighted: 60 dB

Record replay frequency response: 40 Hz to 10 kHz ±0.5 dB

Distortion at 1 kHz and 10 kHz: <1½%

I find that with this spec the recorder makes its 'cleanest' recordings. Test equipment is expensive and, being hard up, I have had to find the most economical way of getting it together. I use a WHM Fluttermeter, Heathkit *AG 9U* signal generator (the lowest-distortion model in their range, Heathkit *AV3U* valve millivoltmeter, and J. E. Sugden *Si452* distortion measuring unit.

Headphones

TONY WALDRON CONSIDERS THE THEORY AND PRACTICE OF HEADPHONE MONITORING

WHEN the loudspeaker was introduced to the audio world in the 1920's, many people thought that headphones had been banished to the world of amateur radio and telecomms. However, the last few years has seen a great revival in the popularity of headphones. Admittedly, the latest models are a far cry from the squeaking relics of the twenties.

There are two main advantages with headphones. They are far cheaper than a pair of loudspeakers of comparable quality and they provide the listener with an island of sound in a sea of noise.

A simplified diagram of the most common type of headphone available can be seen right. It is basically a miniature moving-coil loudspeaker, mounted in a plastic cup. The coil is suspended in a magnetic field set up by the permanent magnet. When an AC electrical signal is fed into the coil, the coil moves in sympathy. The diaphragm, or cone, being mechanically connected to the coil, sets up vibrations in the surrounding air, converting the electrical impulses in the coil into sound.

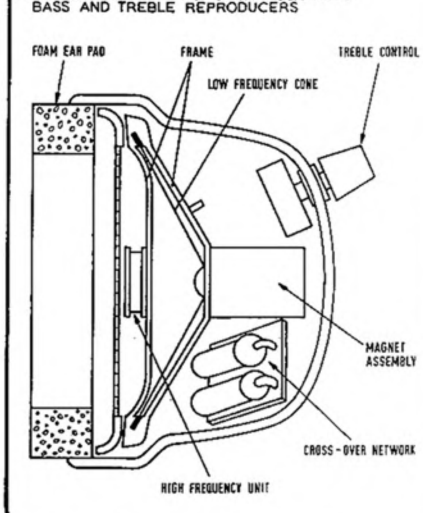
When you look at the size of this type of reproducer, you may well wonder how such a small cone can produce a decent bass response. The answer is quite simple. Unlike a loudspeaker, which (in the average living-room) has several cubic metres of air to set in motion, the headphone, being mounted right up against the ear, has only a few cubic millimetres of air to deal with. The result is that a very small diaphragm can reproduce all audio frequencies fairly evenly, without too much trouble.

The quest for flatter frequency response brings us to the second type of headphone. Again a moving-coil system, but this time with separate units handling low/mid frequencies and HF. Some prove the point by including a treble control but I advise against these for monitoring as the control confuses the ear.

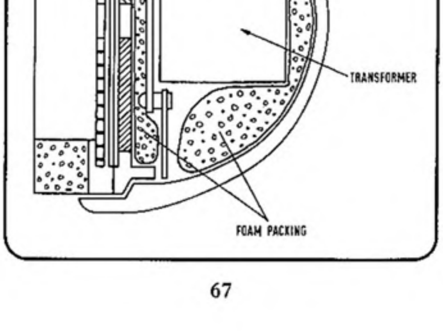
The third type of headphone in use for high quality audio applications is shown below. Electrostatic headphones are relatively new and very expensive but the frequency response of such devices is very smooth indeed. Instead of having a magnetic field, set up by an associated permanent magnet, we have an electric field, set up between two metal plates, by a DC polarizing voltage. The two plates act like a capacitor. A piece of metal foil is suspended between the plates, and the electrostatic repulsion between the plates varies with the electrical impulses from the amplifier, so that the foil diaphragm is set in motion. The diaphragm causes the surrounding air to vibrate, and hence produce audio representations of the applied electrical signal. Because the diaphragm is thin and light, it responds quickly and faithfully to the changes in the signal. Also, the driving force is applied evenly over its entire surface, so that it will not buckle during its rapid oscillations when reproducing the applied signal. Very low distortion figures are claimed for this type of unit, and this is the reason.

Most headphones made today are fitted with a cushion for each ear-piece, to achieve an air-seal between the ear and the headphones. Foam is used in many designs but liquid-filled rubber is more effective.

MOVING COIL EARPHONE WITH SEPARATE BASS AND TREBLE REPRODUCERS



ELECTROSTATIC EARPHONE



Interest in the use of headphones stems largely from the stereophonic sound reproduction. In controlled acoustic conditions, say in a recording studio or studio control room, stereo reproduction can be achieved extremely well, but still only one or two persons (usually the engineer and producer) can hear the true stereo effect, due to the precise placing of the listener required for this type of reproduction. However, with headphones, the placing of the listener does not matter. He has the sound all around him. Indeed, the sound seems to come from inside the head.

The headphones should exclude all outside sounds. This is most important when monitoring near, or in the same room as, the subject. It must be remembered that stereo headphones, like loudspeakers, have their own individual tone coloration. Some have a very crisp and brilliant sound, while others sound more mellow and velvety. It is very important to get to know the deficiencies of your 'phones, otherwise you may put too much or too little top into a recording.

Almost as important as sound quality is comfort. It should be possible to wear a pair of headphones as easily as a comfortable hat. Weight is, of course, important and many models on the market are extremely light. More important than weight, though, is a proper fit. Even the heavier models are quite acceptable if they fit comfortably—and that means holding themselves on when you angle your head forward. The head-band is rarely a problem, because it is either flexible or adjustable. The ear-pieces, however, have fixed dimensions, so it is best to make sure that they don't squeeze or pinch your ears. They should fit around the ears and not ride over the top of them. If the latter happens, you get a loose fit and poor bass response. Most modern makes rely on a foam surround to provide the user with a firm air seal.

Fortunately one of the best moving-coil headphones is far from being the most expensive: the AKG *K60*. This is possibly the most comfortable design going, though I know one user who complained they gave him damp ears. Solution: buy a handkerchief. The Sharpe *HA10* is rather dearer, some £23 compared with £18, imported by Carston, but is exceptionally efficient in attenuating ambient noise. The difference in sound quality is not substantial, but the all-important aspect of headphone monitoring is to choose a decent headset, learn to live with it, and then keep to it.

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PART FOURTEEN

MONITOR LOUDSPEAKERS

BY ANGUS McKENZIE

(Roundabout Records)

POSSIBLY one of the most controversial items of equipment used by the recording engineer, as far as choice is concerned, is his monitor loudspeaker. Loudspeakers are undoubtedly the weakest link in the whole of the recording and playback chain, and many people, because of this, think it pointless working to close frequency response tolerances in equipment, when virtually all loudspeakers ever produced have severe peaks or valleys somewhere in the audio range. The performance of loudspeakers is not measured in frequency response alone, since coloration is generally regarded as even more important. There are quite a few examples of loudspeakers with a very variable response, particularly at the high frequency end, with very low coloration in the middle. These tend to sound better than speakers with a much flatter frequency response, but which are highly coloured.

A monitor loudspeaker must give out sufficient audio power without distortion and without burning out or otherwise suffering. It must faithfully reproduce the musical balance of the programme being monitored and must also show up any electronic faults developing in the system. It is essential for speakers to be standardised in any particular organisation so that the same judgement may be applied to tapes in different control, dubbing and editing rooms. Speakers used on the studio floor itself must be capable of giving out high power levels, and in control rooms almost as high a power level is required. To my dismay, one frequently finds the control room power level so high that any type of music is increased to an earsplitting din.

In general, the higher the efficiency of the loudspeaker, the greater the coloration in the region 250 Hz to 2 kHz. Some of the most natural reproduction of the human voice and of violin tone that I have ever heard has come from speakers such as the Quad *ESL*, Spendor *BC1A* and even Goodmans *Maxim*; all these three types have a relatively low efficiency. At the other end of the scale, speakers such as the Leak *Sandwich*, the Tannoy *Monitor Gold* and Lowther *Acousta* would appear to have more coloration but are all capable of considerably higher output power.

Up to a few years ago I standardised on Tannoy 38 cm dual concentric speakers in large cabinets made by A. Davies of Belsize Park to a modified BBC *LSU 10* pattern. Although considerably more coloration was present on these speakers than on Quad *ESL*, they were so widely used in other studios, reliable and efficient over a wide frequency range, that comparatively little trouble was ever experienced in their use. The old 15 ohm version having a fixed crossover was more efficient than the new 8 ohm *Monitor Gold* version with variable crossover controls. At no time did I ever hear of a 38 cm 15 ohm version having to go back to the manufacturers because of burning out but, soon after changing mine, I found to my cost that the new version did not have the same handling capacity. A bass guitar completely wrecked the speaker, a disaster which would certainly not have happened with the original unit. The coloration produced by the Tannoy speakers however is now not acceptable to many discriminating engineers, and the problem therefore becomes one of finding a loudspeaker that has as high as possible an audio output and yet low coloration and wide response. If the Quad ESL could produce 6 dB more output they would be almost ideal. but alas such an improvement would appear to be impossible. I was very pleased indeed that the late Terence Long demonstrated to me an early pair of Spendor *BC1A* speakers which sounded surprisingly like the Quads and yet had an audible output of about 3 dB more power when driven from a Quad *303*. This I consider as almost ideal both for domestic and quality-monitoring purposes. The Spendor has recently been improved in that its efficiency has been increased by generally lowering the impedances, the subjective improvement when driven from a *303* being of the order of 3 dB. When used with its own internal 20 W amplifier the improvement becomes approximately 4 dB over the earlier model, thus giving enough volume for monitoring classical music although naturally the 5.4 litre cabinet will not successfully reproduce frequencies below 60 Hz. An 8 litre version of the Spendor is being developed, provided with a built in 50 W amplifier, and should provide the volume necessary for first class monitoring. I was also impressed with the KEF monitor speaker though unfortunately have not had the chance to test this thoroughly.

Recently I had the opportunity of trying J. B. Lancing speakers loaned by Feldon Recordings. I found them distinctly better than Tannoy speakers, for both response and lack of coloration, but oddly their control room monitor is better than their far more expensive and larger studio monitor. The control room monitor is fitted with controls (on the front panel—a pity since it invites interference) for both the middle and treble range units. After a number of listening tests with different types of material, including speed and white noise, I found that the best sound was achieved with practically almost no middle at all, although this sounded incorrect with white noise. I had the impression of considerable coloration at lower middle frequencies although the speaker never sounded unpleasant. I preferred the Spendor *BC 1A* for monitoring classical music but in control rooms the JBL monitor would be preferable for its high efficiency and good low frequency power handling capacity. The larger JBL studio monitor gave an exceedingly fine performance under very loud listening conditions, although there was considerably more coloration than with the smaller unit. I would therefore consider the larger unit an excellent one for use in large studios when playback is required to be given in the studio itself at high volume.

The reader will probably realise by now that, for programme-quality monitoring, the type of loudspeaker best suited may be completely different from the type preferable in the control room. I would think it wise for studios to have available speakers such as Quad *ESL* or, better still, Spendor *BC1A* for use when playing tapes in relaxed conditions when they wish to hear accurately what the recorded sound is really like reproduced at domestic levels. It would be nice to standardise everywhere on a particular type of speaker for such work, although I don't suppose any standardisation will be achieved. It is most interesting how one violin concerto recording made recently by CBS sounds very boxy on Tannoy speakers, and yet very smooth and sweet on Spendors or Quads. This can be a revelation to an engineer who will often be happier hearing his sound balance reproduced later on less coloured speakers.

In the control room, the engineer wants to hear what is on the tape, not the reverberation of the listening room. The control room should therefore be as dead as is reasonably possible. I recommend that ceilings be fitted with acoustic tiles at least 25 mm thick. Any windows, apart from double-glazing to the studio itself, should have heavy curtains. At least one side wall and one end wall should be acoustically treated if possible, preferably at least half the floor being carpeted.

The main difficulty in most rooms is at the bass end which will appear to have cancellations at some positions in the room and maximums in other positions. This trouble can only be eliminated by providing bass absorption which is both costly and very awkward to situate.

VIDEO TAPE RECORDERS SURVEYED

THE FOLLOWING is a basic guide to helical and quadruplex video recorders and players currently available in the UK. With the exception of quadruplex models, it may be assumed that VTRs produced by one manufacturer will not be compatible with those produced by another. Similarly, prospective buyers should not assume that one manufacturer's helical VTRs are compatible with others in that company's range.

AKAI

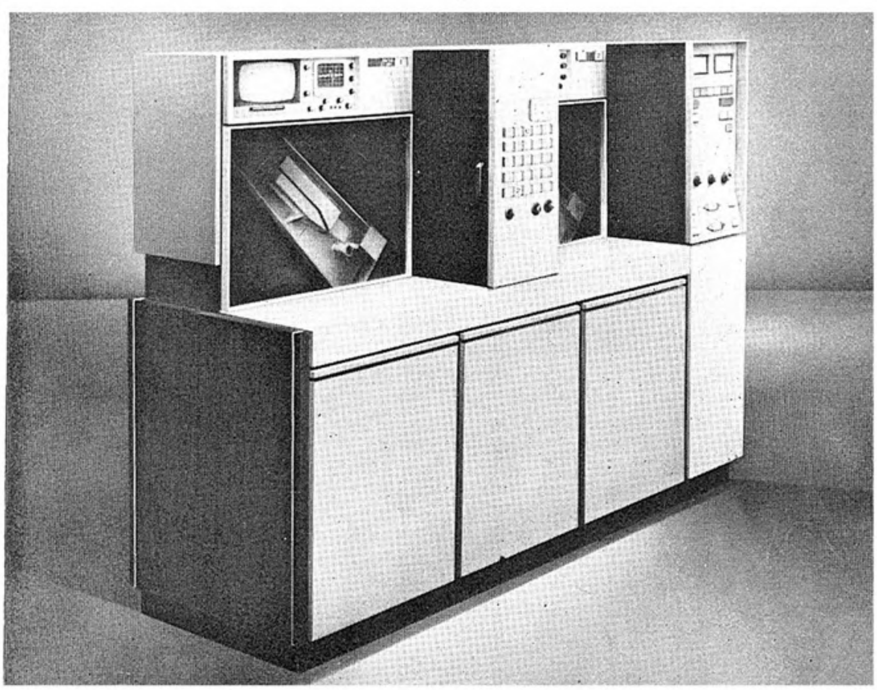
Model: VT-100 (Battery)
Power Requirement: Two 6V accumulators (12 V DC)
Dimensions: 255 wide x 112 high x 263 mm (plus 98 x 112 x 263 mm monitor)
Weight: 4.6 kg (plus 1.69 kg monitor)
Tape speed: 27.3 cm/s
Tape width: 6.25 mm
Tape scan: Two-head helical
Video input: 1.4 V p-p
Video output: 1.4 V p-p
Video bandwidth: 200 lines horizontal resolution
Video s/n ratio: 40 dB
Video standards: 625 lines, 50 fields
Audio input: -65 dBm (microphone)
Audio bandwidth: 100 Hz to 10 kHz
Basic price: £595 including camera, monitor and power unit
UK agent: Rank Aldis-Audio Products, PO Box 70, Great West Road, Brentford, Middlesex.

AMPEX

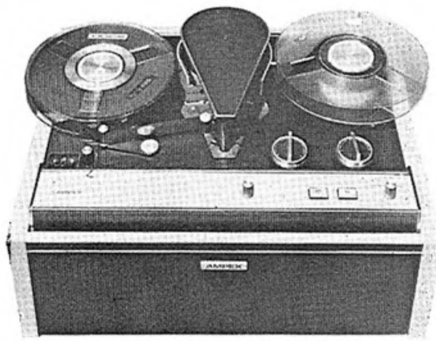
Model: ACR-25
Automatic quadruplex cassette recorder. Six/twelve minutes capacity per cassette. Total playing time 150 minutes back-to-back, 25 cassettes. Details on request.
Basic price: £83 000
UK agent: Ampex Great Britain Ltd., 72 Berkeley Avenue, Reading, RG1 6HZ

Model: ADR-150
High speed magnetic contact duplicator for quadruplex video tapes. Copies 60 minute programme in six minutes, rewinds in three minutes. Colour/monochrome, 525/625 line standards. Re-useable high-coercivity master tape.
Basic price: £40 000

Model: AVR-1 (Colour)
Power Requirement: 50 Hz mains
Tape speeds: 39.7 and 19.85 cm/s
Tape width: 50 mm
Tape scan: Quadruplex
Wow and flutter: 0.1% RMS (0.15% RMS at 19.85 cm/s)
Video input: 700 mV to 1.8 V p-p, 75 ohms
Video output: 1 V p-p
Video bandwidth: 5.5 MHz (-3 dB at 6 MHz)
Video s/n ratio: 44 dB (p-p video to RMS noise)
Video standards: 625 lines, 50 fields
Sync input: 1 to 8 V, 75 ohms
Audio input: –24 to +16 dBm at 15 K balanced or unbalanced (programme and cue channels)
Audio output: +8 dBm at less than 30 ohms (programme and cue channels)



Ampex ACR-25



Ampex VP-4900 Player

Audio bandwidth: 50 Hz to 15 kHz ±2 dB (50 Hz to 10 kHz at 19.85 cm/s)
Audio s/n ratio: 55 dB at peak record level
Basic price: £59 000 (£51 000 monochrome)

Model: VP-4900 Playback Unit
Power requirement: 50 Hz mains
Dimensions: 588 x 460 x 320 mm
Weight: 28 kg
Tape speed: 24 cm/s
Tape width: 25 mm
Tape scan: Single-head helical
Wow and flutter: 0.3% total, 0.04% RMS 0.5 to 6 Hz
Video output: 75 ohms, 800 mV to 1.5 V p-p
Video bandwidth: 30 Hz to 3 MHz +2 –6 dB
Video s/n ratio: 42 dB (p-p signal to RMS noise)
Video standards: 625 lines, 50 fields
Audio output: 10 K unbalanced line, 1 V; 2 W at 8 ohms monitor
Audio bandwidth: 90 Hz to 9 kHz ±4 dB
Audio s/n ratio: 39 dB at peak record level
Basic price: £690

Model: VR-1100
Power Requirement: 50 Hz mains
Dimensions: 1 520 high x 1 062 wide x 600 mm*
Weight: 363 kg* (*without monitor bridge)
Tape speeds: 39.7 and 19.85 cm/s
Tape width: 50 mm
Tape scan: Quadruplex
Wow and flutter: 0.1%, 0.15% RMS
Video input: 500 mV to 2 V p-p
Video bandwidth: ±2 dB, 20 Hz to 5 MHz
Video s/n ratio: 40 dB
Video standards: 625 line monochrome
Sync input: 4 V p-p at 75 ohms or high impedance
Audio input: –10 dBm at 15 K, programme and cue lines
Audio bandwidth: ±2 dB, 50 Hz to 10 kHz (38 cm/s)
Audio s/n ratio: 45 dB ref +14 dBM peak level
Basic price: £13 000

Model: VR-2000B (Colour)
Power Requirement: 50 Hz mains
Dimensions: 1 600 high x 1 650 wide x 787 mm
Weight: 590 kg
Tape speeds: 39.7 and 19.85 cm/s
Tape width: 50 mm
Tape scan: Quadruplex

VIDEO TAPE RECORDERS SURVEYED

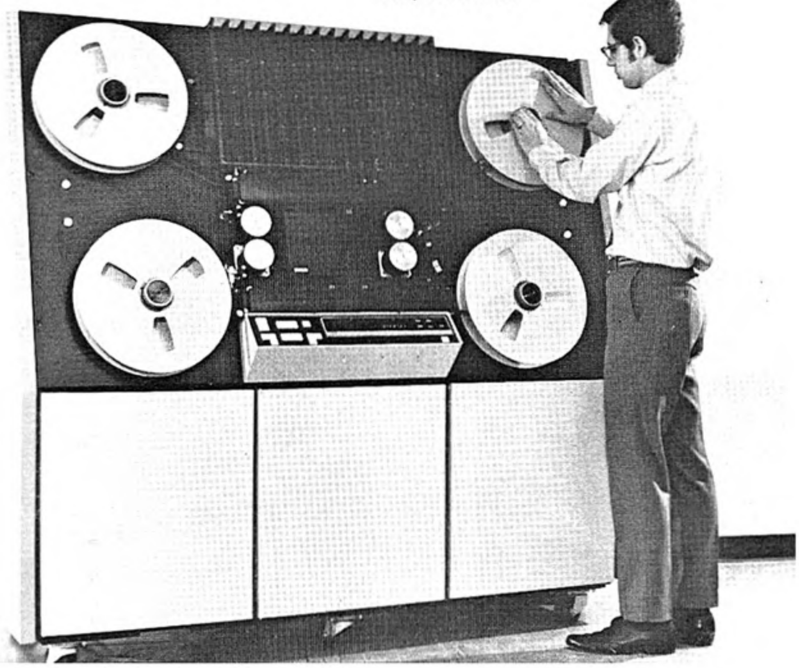
Wow and flutter: 0.1% and 0.15% RMS
Video input: 500 mV to 1.5 V p-p, sync negative
Video bandwidth: 5.5 MHz (-3 dB at 6 MHz) ±0.5 dB
Video s/n ratio: 43 dB p-p video to RMS noise (colour and monochrome)
Video standards: 625 lines, 50 fields
Sync input: 2 to 8 V p-p at 75 ohms
Audio input: +8 dBm at 15 K, programme and cue channels
Audio output: +8 dBm at 600 ohms
Audio bandwidth: 50 Hz to 15 kHz ±2 dB
Audio s/n ratio: 55 dB (ref 3% distortion at 1 kHz)
Basic price: £37 000

Model: 5100 E
Power Requirement: 50 Hz mains
Dimensions: 320 x 464 x 606 mm
Weight: 28 kg
Tape speed: 24 cm/s
Tape width: 25 mm
Tape scan: Single-head helical
Wow and flutter: 0.3% total, 0.04% RMS 0.5 to 6 Hz
Video input: 800 mV to 1.3 V p-p at 75 ohms
Video output: 800 mV to 1.3 V p-p at 75 ohms
Video bandwidth: 30 Hz to 3 MHz +2 -6 dB
Video s/n ratio: 42 dB p-p signal to RMS noise
Video standards: 50 fields, 625 lines
Audio input: 200 µV ±20% at 200 K (microphone); 100 mV ±20% at 100 K
Audio output: 1 V at 10 K; 3 W monitor (line and remote)
Audio bandwidth: 90 Hz to 9 kHz ±4 dB
Audio s/n ratio: 39 dB
Basic price: £1 386

Model: VR-5103
Power Requirements: 50 Hz mains
Dimensions: 608 x 460 x 320 mm
Weight: 28 kg
Tape speed: 24 cm/s
Tape width: 25 mm
Tape scan: Single-head alpha wrap
Wow and flutter: .04% 0.5 to 6 Hz, .3% 0.5 to 250 Hz
Video input: 75 ohms unbalanced
Video output: 800 mV to 1.3 V p-p, 75 ohms unbalanced
Video bandwidth: 30 Hz to 3 MHz +2 -6 dB
Video s/n ratio: 42 dB p-p signal to RMS noise
Video standards: 625 lines, 50 fields
Audio input: 1.8 mV at 80 K (microphone); 96 mV at 47 K (line and remote)
Audio output: 1 V at 10 K unbalanced
Audio bandwidth: 90 Hz to 9 kHz ± 4dB
Audio s/n ratio: 39 dB ref peak record level
Basic price: £810

Ampex VR-7003

Ampex ADR-150



Model: VR-7003
Power requirements: 50 Hz mains
Dimensions: 420 wide x 350 high x 740 mm
Weight: 45 kg
Tape speed: 24 cm/s. Optional slow motion
Tape width: 25 mm
Tape scan: Single-head helical
Video input: 500 mV to 2 V p-p at 75 ohms
Video output: 1 V ±10% p-p with 75 ohm termination
Video bandwidth: 25 Hz to 3.5 MHz +1 -3 dB
Video s/n ratio: 40 dB p-p video to RMS noise (100 kHz to 3.5 MHz)
Video standards: 625 lines, 50 fields
Audio input: -10 dBm balanced or unbalanced (line); 500 mV at 200 ohms (microphone)
Audio output: 600 ohm line and 8 ohm loudspeaker
Audio bandwidth: 50 Hz to 12 kHz ±4 dB (measured at -10 VU)
Audio s/n ratio: 45 dB (-3 dB weighting at 50 Hz and 12 kHz)
Basic price: £1 958

Model: VR 7400
Surveillance recorder. Basic specification as Model VR-7003. Price on application.

Model: VR-7800 (Colour)
Power Requirement: 50 Hz mains
Dimensions: 380 high x 460 m wide x 860 mm
Weight: 60 kg
Tape speed: 24 cm/s
Tape width: 25 mm
Tape scan: Single-head helical
Video input: 500 mV to 2 V p-p at 75 ohms
Video output: 1 V p-p into 75 ohms
Video bandwidth: 20 Hz to 4.2 MHz +1 -3 dB
Video s/n ratio: 42 dB (p-p video to RMS noise)
Video standards: 625 lines, 50 fields
Sync input: 75 ohms
Sync output: 4 V/p-p at 75 ohms
Audio input: +8 dBm at 100 K (two channels)
Audio output: +8 dBm at 600 ohms (two channels)
Audio bandwidth: 50 Hz to 15 kHz ±2 dB (programme); 50 Hz to 7 kHz
Audio s/n ratio: 50 dB (programme); 40 dB (cue) ±3 cB (cue)
Basic price: £4 850

IVC

Model: 600
Power Requirement: 50 Hz mains
Dimensions: 254 x 355 x 636 mm
Weight: 22 kg
Tape speed: 17 cm/s
Tape width: 25 mm
Tape scan: Single-head alpha-wrap helical
Wow and flutter: 0.25% RMS
Video input: 500 mV to 2 V p-p. 1 V p-p nominal
Video output: 1 V p-p into 75 ohms
Video bandwidth: 30 Hz to 5 MHz +1 dB -4 dB
Video s/n ratio: 41 dB p-p signal to RMS noise
Video standards: SECAM colour and CCIR monochrome or PAL colour and CCIR monochrome
Audio bandwidth: Channel 1: 75 Hz to 10 kHz ±4 dB. Channel 2: 250 Hz to 7.5 kHz ±4 dB
Audio output: +4 dBm
Audio input: 400 mV at 200 ohms (microphone); -20 to +16 dBm line, balanced or unbalanced
Audio s/n ratio: 40 dB, ref 3% THD at 400 Hz

(continued overleaf)

VIDEO TAPE RECORDERS SURVEYED

Basic price: £1 045
UK agent: International Video Corporation, Liverpool Victoria House, Cheapside, Reading RG1 7AG.

Model: 800 (Monochrome and PAL/SECAM colour)
Power Requirement: 50 Hz mains
Dimensions: 610 x 305 x 330 mm
Weight: 35 kg

Tape speeds: 17 cm/s
Tape width: 25 mm. Spool capacity: 20 cm NAB
Tape scan: Single-head alpha-wrap helical
Wow and flutter: 0.25% RMS
Video input: 500 mV to 2 V p-p
Video output: 1 V positive-going, into 75 ohms
Video bandwidth: 30 Hz to 5 MHz +1 -3 dB (PAL)
Video s/n ratio: 41 dB p-p signal to RMS noise
Video standards: Any standard 50 field monochrome or PAL/SECAM colour
Audio bandwidth: Channel 1: 75 Hz to 10 kHz ±4 dB. Channel 2: 75 Hz to 7.5 kHz ±4 dB
Audio output: +4 dBm
Audio input: 200 mV at 200 ohms (microphone): -20 dBm to +16 dBm line, 600 ohms bal/unbal
Audio s/n ratio: 40 dB, ref 3% distortion at 400 Hz
Basic price: £2 200 (or £3 600 with insert and assemble editing)

NATIONAL

Model: NV-204 EM
Power Requirement: 50 Hz mains
Dimensions: 620 x 428 x 305 mm
Weight: 47 kg
Tape speed: 20 cm/s
Tape width: 25 mm
Tape scan: Two-head helical
Video input: 500 mV at 75 ohms
Video output: 2 V p-p
Video bandwidth: 10 Hz to 3 MHz ± 2 dB
Video s/n ratio: 43 dB
Video standards: 625 lines, 50 fields
Audio input: -65 dBm (microphone); -10 dBm (aux)
Audio output: 0 dBm balanced
Audio bandwidth: 80 Hz to 8 kHz ±2 dB
Audio s/n ratio: 46 dB
Basic price: £2 189
UK agent: Photo-Scan (London) Ltd, Upper Halliford Road, Shepperton, Middlesex.

Model: NV-1020E
Power Requirement: 50 or 60 Hz mains
Dimensions: 540 x 535 x 270 mm
Weight: 24 kg
Tape speed: 25 cm/s
Tape width: 12.7 mm
Tape scan: Two-head helical
Video input: 500 mV to 1.5 V p-p, 75 ohms unbalanced
Video output: 1 V p-p, 75 ohms unbalanced
Video bandwidth: 2 MHz
Video s/n ratio: 40 dB
Video standards: 625 lines, 50 fields
Audio input: 1 mV at 20 K (microphone); 100 mV at 1 M (aux.)
Audio output: 100 mV, 600 ohms unbalanced
Audio bandwidth: 80 Hz to 10 kHz
Audio s/n ratio: 40 dB
Basic price: £398

NIVICO

Model: KV800
Power Requirement: 50 Hz mains
Dimensions: 290 x 520 x 440 mm
Weight: 30 kg

Nivico KV810

Tape speed: 24.5 cm/s
Tape width: 12.5 mm
Tape scan: Two-head helical
Wow and flutter: 0.3%
Video input: 500 mV to 2 V at 75 ohms
Video output: 1 V at 75 ohms
Video bandwidth: 220 lines horizontal definition 625-line CCIR
Video s/n ratio: 40 dB
Video standards: 405/625 lines, 50 fields
Audio input: -60 dBm (microphone) and -10 dBm (aux)
Audio output: 0 dB at 2 K
Basic price: £385
UK agent: Top Rank Television, PO Box 70, Great West Road, Brentford, Middlesex.

Model: KV-810
Power Requirement: 50 Hz mains
Weight: 28 kg
Tape speed: 23.5 cm/s
Tape width: 12.5 mm
Tape scan: Two-head helical
Wow and flutter: 0.2% RMS
Video input: 500 mV to 1.5 V p-p, 75 ohms
Video bandwidth: 220 lines, horizontal definition
Video s/n ratio: 40 dB
Video standards: 625 lines, 50 fields
Audio input: -60 dB at 10 K (microphone); -10 dB at 30 K (line)
Audio output: 0 dB at 2 K
Audio s/n ratio: 40 dB
Basic price: £510

Model: KV 820
Power requirement: 50 Hz mains
Weight: 28 kg
Tape speed: 23.5 cm/s
Tape width: 12.5 mm
Tape scan: Two-head helical
Wow and flutter: 0.2% RMS
Video input: 500 mV to 1.5 V p-p, 75 ohms
Video bandwidth: 220 lines horizontal definition
Video s/n ratio: 40 dB
Video standard: 625 lines, 50 fields
Audio input: -60 dB at 10 K (microphone); -10 dB at 30 K (line)
Audio output: 0 dB at 2 K
Audio s/n ratio: 40 dB
Basic price: £385

PHILIPS

Model: LDL 1002
Power Requirement: 50 Hz mains
Dimensions: 420 x 340 x 195 mm
Weight: 12 kg
Tape speed: 16.8 cm/s
Tape width: 12.5 mm (VPL61C or VPL51C chromium dioxide)
Tape scan: Two-head helical
Video input: 1.4 V p-p at 75 ohms
Video output: 1.4 V p-p at 75 ohms
Video bandwidth: 2.2 MHz

Video s/n ratio: 40 dB (RMS noise to video p-p)
Video standard: 50 fields, 625 lines
Audio input: 0 dBm
Audio output: 0 dBm
Audio bandwidth: 120 Hz to 10 kHz ±6 dB
Audio s/n radio: 40 dB
Basic price: £275
UK agent: Pye Business Communications Ltd, Orchard Road, Royston.

RCA TR70

RCA

Model: TR-60
Power Requirement: 50 Hz mains
Dimensions: 1680 mm high x 840 mm wide x 610 mm
Weight: 524 kg
Tape speeds: 39.7 and 19.85 cm/s
Tape width: 50.8 mm (RCA 7200 or equivalent)
Tape scan: Quadruplex
Wow and flutter: 0.15%, 0.2%
Video input: 500 mV to 1.4 V p-p, 75 ohms terminated
Video output: 500 mV to 1 V p-p
Video bandwidth: 50 Hz to 5.5 MHz ±0.75 dB
Video s/n ratio: 43 dB
Video standards: 625 line PAL/525 line NTSC.
Sync input: Negative-going, 3 to 5 V p-p
Sync output: 200 to 400 mV p-p
Audio input: +4 to +36 dBm, line and cue channels
Audio output: +18 dBm into 150 or 600 ohms balanced or unbalanced, line and cue channels. Monitor channel +37 dBm into 8 ohms
Audio bandwidth: 50 Hz to 15 kHz (10 kHz at 19.8 cm/s) ±2 dB.
Audio s/n ratio: 50 dB (ref 3% THD)
Basic price: £30 000
UK agent: RCA Ltd, Sunbury-on-Thames, Middlesex.

Model: TR-70B
Power Requirement: 50 Hz mains (3.2 kW)
Tape speeds: 39.7 and 19.85 cm/s
Tape width: 50 mm
Tape scan: Quadruplex
Wow and flutter: 0.1% RMS
Video input: 500 mV to 1.4 V p-p at 75 ohms
Video output: 500 mV to 1 V p-p
Video standards: 50 fields, 625/525/405 lines
Sync input: 3 to 5 V at 75 ohms
Sync output: 200 to 400 mV p-p
Audio input: +4 to +36 dBm, line and cue channels
Audio output: +18 dBm at 150/600 ohms, balanced or unbalanced
Audio bandwidth: 50 Hz to 15 kHz ±2 dB
Audio s/n ratio: 55 dB (programme); 40 dB (cue)
Basic price: £40 000

Model: TCR-100
Power Requirement: 50 Hz mains
Dimensions: 1 694 high x 1 372 wide x 724 mm
Weight: 850 kg
Tape speed: 39.7 cm/s
Tape width: 50.8 mm in cartridges. Cartridge capacity: 2 to 180 seconds programme
Tape scan: Quadruplex
Wow and flutter: 0.1%
Video input: 500 mV to 1.5 V p-p across 75 ohms
Video output: 500 mV to 1 V p-p
Video standards: 625/525 line PAL/NTSC
Audio input: +4 to +36 dBm bridging 600 ohms
Audio output: +18 dBm into 150 or 600 ohms balanced or unbalanced
Audio bandwidth: 50 Hz to 15 kHz ±2 dB
Audio s/n ratio: 55 dB
Basic price: £42 000

SANYO

Model: VTR-1000SL
Power Requirement: 50 Hz mains
Dimensions: 470 x 430 x 260 mm
Weight: 23 kg
Tape speeds: 19 cm/s and slow motion
Tape width: 12.5 mm
Tape scan: Four-head helical
Video input: 500 mV to 2 V p-p, 75 ohms
Video output: 1 V p-p at 75 ohms
Video bandwidth: 20 Hz to 2.5 MHz
Video s/n ratio: 40 dB
Video standards:
Audio bandwidth: 80 Hz to 10 kHz
Basic price: £538
UK agent: Teletape (Video) Ltd, 80 Shaftesbury Avenue, London W.1.

SHIBADEN

Model: SC-727E
Power Requirement: 50 Hz mains
Dimensions: 550 x 550 x 340 mm
Weight: 60 kg
Tape speed: 20 cm/s
Tape width: 25 mm
Tape scan: Two-head helical
Wow and flutter: 0.15%
Video input: 1 V p-p at 75 ohms
Video output: 1 V p-p
Video bandwidth: 360 lines horizontal resolution
Video s/n ratio: 40 dB
Video standards: 50 fields, 625 lines
Audio input: –70 dBm (microphone); +4 dBm (line), balanced
Audio output: +4 dBm line, balanced
Audio bandwidth: 50 Hz to 10 kHz ±3 dB
Audio s/n ratio: 46 dB
Basic price: £2 200 (25 mm PAL colour VTR £2 700)
UK agent: General Video Systems Ltd, 61/63 Watford Way, Hendon, London NW4.

Model: SV 800E
Power Requirement: 50 Hz mains
Dimensions: 250 x 215 x 235 mm
Weight: 60 kg
Tape speeds: 17 cm/s
Tape width: 12.5 mm
Tape scan: Two-head helical
Video input: 1 V p-p sync negative at 75 ohms
Video output: 1 V p-p
Video bandwidth: 3 MHz
Video s/n ratio: 38 dB
Video standards: 625 lines, 50 fields
Audio input: –60 dB at 10 K (microphone); –14 dB at 10 K (line)
Audio output: –15 dB into 600 ohms. 300 mW monitor
Audio bandwidth: 50 Hz to 10 kHz
Audio s/n ratio: 40 dB
Basic price: £500

SONY

Model: CV 2100 CE
Power Requirement: 50 Hz mains
Dimensions: 470 x 400 x 280
Weight: 25 kg
Tape speed: 29.5 cm/s
Tape width: 12.5 mm
Tape scan: Two-head helical
Video input: 1 to 3 V p-p at 75 ohms
Video output: 1.4 V p-p at 75 ohms
Video s/n ratio: 40 dB
Video standards: 405/625 lines, 50 fields
Audio input: –65 dBm (microphone); –20 dBm (line)
Audio output: 0 dBm
Audio s/n ratio: 40 dB
Basic price: £385
UK agent: Sony (UK) Ltd., VTR Division, Ascot Road, Feltham, Middlesex.

Model: DVK 2400 B
Power Requirement: Rechargeable accumulators
Dimensions: 288 x 285 x 124 mm
Weight: 5 kg
Tape speed: 19 cm/s
Tape width: 12.5 mm
Tape scan: Twin-head helical (skip field)
Video input: 1 V p-p sync negative at 50 ohms
Video output: No replay facility. Complements CV 2000 B
Video bandwidth: 220 lines horizontal resolution
Video s/n ratio: 40 dB
Video standards: 405 lines, 50 fields (625 lines 29.5 cm/s version to suit CV 2100 CE available; details on request)
Audio input: –65 dBm (microphone)
Audio bandwidth: 100 Hz to 8 kHz
Audio s/n ratio: 40 dB
Basic price: £287 (including charger)

Model: EV 310CE (colour)
Power Requirement: 50 Hz mains
Dimensions: 478 wide x 283 high x 487 mm
Weight: 40.5 kg
Tape speeds: 17.88 cm/s
Tape width: 25 mm
Tape scan: Two-head helical
Wow and flutter: 0.25% RMS
Video input: 500 mV to 2 V p-p at 75 ohms, sync negative
Video output: 1 V p-p at 75 ohms
Video bandwidth: 250 lines horizontal resolution (colour), 330 lines (monochrome)
Video s/n ratio: 40 dB (43 dB monochrome)
Video standards: Any composite 50 field signal, including random interlace
Audio input: –70 dBm (microphone) balanced, +4 dB at 10 K (line) balanced
Audio output: +4 dBm balanced; +4 dB at 10 K balanced monitor
Audio bandwidth: 100 Hz to 5 kHz ±1 dB
Audio s/n ratio: 40 dB
Basic price: £1 250

Video Delay Modules

BY VINCENT EMMERSON

(*Matthey Printed Products*)

COMPACT video delay modules, believed to be the first of their kind in the world, attracted wide interest at IBC 70 in September. Produced for colour TV broadcasting studios by Matthey Printed Products, they are already in use by both BBC and ITV. They are not intended for TV receivers.

In a broadcasting station, pictures from different sources are combined in a mixer to form one signal train. Added to this signal train at each source is a periodic master pulse which accompanies the picture signals through to the domestic receiver for synchronisation purposes. These different pictures are displayed on monitors at the mixer and the programme controller can then switch in any one of them as required. **Fig. 1** shows a typical studio layout of several cameras and a video tape recorder all being co-ordinated at the mixer before the mixed signal train is passed through for transmission. In this typical situation a commentator could be presenting a football match from a telecine recording. A flashback may be inserted which will be played from video tape in a room far away from the studio, and other cameras may be focused on a panel discussing the game as it progresses.

If the cables connecting the picture sources to the mixer were all the same length, the synchronised pulses from each source would be in phase during the switching process in the mixer. However, in practice the routes are of different lengths. If no delays are introduced, the pulse from each picture source will arrive at the mixer out of phase and cause synchronisation problems during switching. The result would be that the viewer would see the picture resolve for a short period until the electronic locking mechanism in the receiver synchronises with the master pulse. Thus it becomes necessary to correct for these time delay errors. This is currently achieved by using 75 ohm delay cable.

It is a constant problem, and a time consuming one, to use 75 ohm cable for balancing the delays between routes. To start with, cable has to be cut to length based on 200 metres per 1 μS. Then an equaliser circuit has to be built to correct the insertion loss characteristic of the cable. After checks to ensure correct quality and operation, the cable has to be stowed away, often in a cupboard or under the floor. Some idea of the magnitude of this problem is shown in the fact that 1 μS of delay cable weighs 20 kg (see **fig. 2**). It is not uncommon to encounter delays of 3 and 4 μS and the storage problem therefore becomes immense. We should also not lose sight of the fact that a significant part of the total cost of cable delay installation is the pay of skilled men. Therefore, the lower installation costs of modules obviously become more and more desirable as wage rates continue to rise.

The 'Silver Star' delay modules are a series of fixed delay plug-in units with delay times of 200, 500 nS and 1 μS. Equaliser circuits are built inside the finished modules to achieve an overall insertion loss flat to within 0.1 dB. No further adjustment is needed by the user. The modules can be cascaded to form any combination of delays between 200 nS and 4 μS, without significantly degrading the performance. The performance is, of course, matched carefully for 625 and 525 line colour working.

As studio or equivalent delays seldom work out to the fixed values described, a fourth module (*M200/47001*) can produce delays from 5 to 155 nS in 5 nS steps so the total delay required can be easily selected. A further refinement is a 'Silver Star' switching unit *UN14/511* which covers the range 10 to 165 nS with an infinite variety of delay available with fine adjustment.

Another important feature is the lower degree of amplification required by signals which emanate from the video delay modules compared with the signals from cable. Lower amplification usually means lower cost and the relationship is shown by the insertion loss of 4 to 5 dB from 1 μS of delay cable compared with 2.6 dB from a 1 μS delay module.

Fig. 3 shows the portion of 2 T luminance and 10 T chrominance pulses where distortion, if it exists, can be readily seen. The fact that so little difference can be seen between the *in* and *out* pulses handled by the Silver Star module is an indication of their quality.

FIG. 1

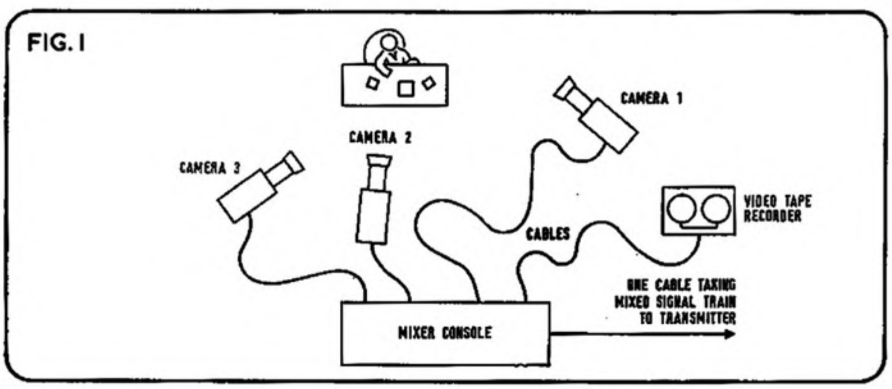


FIG. 3 Input (left) and output chrominance pulses.

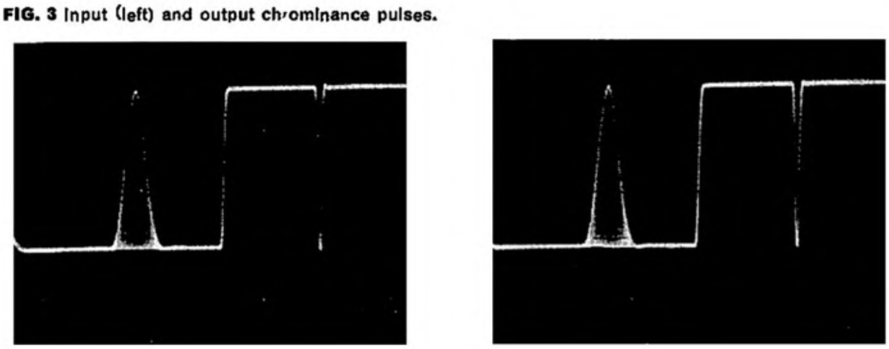
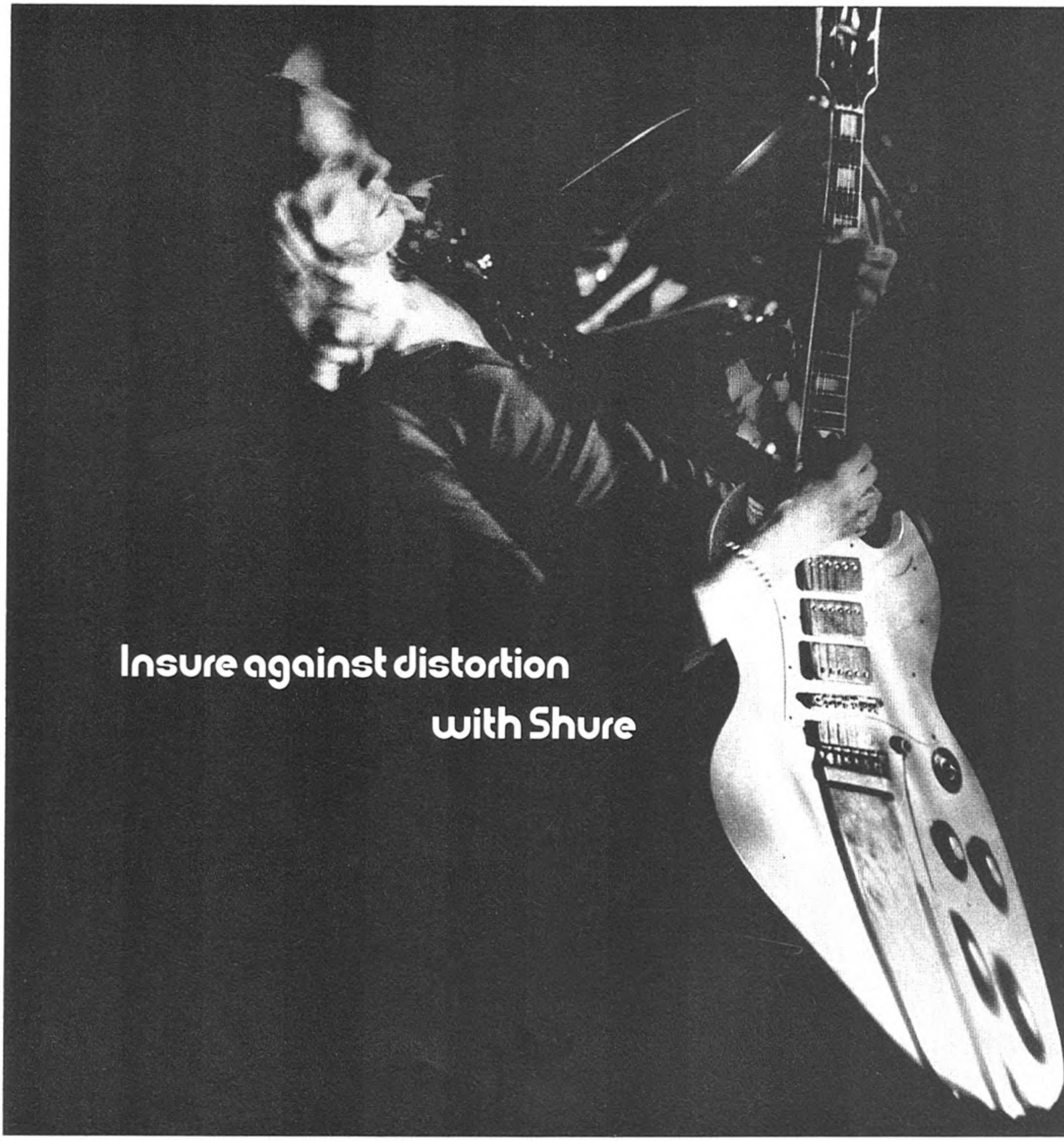


FIG. 2



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A HIGH QUALITY MIXER

David Robinson

PART NINE
FILTERS AND EQUALISERS

THE two main criticisms I have received concerning the prototype 1964 mixer were that the filtering circuits were not sufficiently complex to cover many studio needs and that there was no mention of compressors or limiters. The reasons for the first were that at the time my own experiences were limited for what was required, and that to cover all possible applications would bias the whole series out of proportion to the requirements for the basic modular design. Compressors and limiters really need a full series in their own right, since there are many varied types each with a particular application to different programme material.

Taking advantage of new circuit techniques means that the necessary circuits can now be made smaller and simpler so, to continue with this new mixer design, I will describe firstly some filter circuits which, while being by no means comprehensive, should cover the majority of applications.

Tone controls

The basic treble and bass control circuit has already been described, the circuit diagram being fig. 24, Part 3. This provides roughly ±15 dB of control at 60 Hz and 10 kHz, which is adequate. Some modern mixers have variable turnover points but, if the simple circuit is used in conjunction with the low and high pass filters to be described, it is an unnecessary extra complication.

High pass filters

These fall into two types: those of low frequency fixed cut-off, mainly used to remove rumble from turntables, and those which are variable and can cover wider ranges. Examples are hum removal filters and signal modifiers such as telephone line simulators.

Fig. 51 shows a switchable 12 dB/octave filter. A few years ago this circuit would have used inductors and capacitors to produce the required characteristics, but the disadvantage of this approach is that for low frequencies the component values are large, which in turn means physically large inductors. These are expensive to buy and difficult to make. However, as the circuit shows, a single stage of unity gain and no phase shift can be used to form the basis of an active filter which is an exact analogue of the inductor/capacitor filter. The circuit is shown arranged for three switched turnover frequencies and a flat position (which is –0.2 dB at 20 Hz and 50 kHz). Different turnover frequencies can be arranged by changing the value of resistors in the switched arrangement. Note that the resistor in the first pole of the filter is half the value of the corresponding resistor in the second pole; e.g. R27 is half R22. Starting with R22 at the design value of 50 K, for 45 Hz, other frequencies can be derived by straight division or multiplication. The input impedance of the circuit must be considered and, if the circuit driving this stage is not a low output impedance type, then a value of 3.5 K for R25 is the lowest that should be used. At that point C16 and C17 can be lowered in value for higher turnover frequencies.

The circuit can be adapted for a variable turnover frequency by replacing R22 and R27 with a ganged potentiometer of 25 K+50 K logarithmic (which may be difficult to obtain) for the appropriate arms of the network; add a series resistor of 5.6 K with the section replacing R22 and 3.3 K in series with the other section to fix the minimum resistance of the arms.

Occasionally a 12 dB/octave filter is inadequate, for example if large amounts of spurious signal have to be removed. **Fig. 52** shows the active filter concept extended to a three-pole section which gives 18 dB/octave, and arranged for a 3 dB point at 100 Hz (–18 dB at 50 Hz, –36 dB at 25 Hz). The circuit is similar to the previous two-pole design but without switching (which becomes cumbersome with a three-pole filter) it can be simplified slightly. Again, resistor and capacitor values can be scaled to change the turnover frequency.

Low pass filters

A similar technique can be used to produce a low pass filter as shown in **fig. 53.** The circuit has obvious similarities to fig. 51, with basically the resistors and capacitors interchanged. Three turnover frequencies are shown, but these can be increased in either direction by suitable adjustment of the capacitor values, subject only to physical size and stray capacities. Results obtained with the 3 kHz version were –3 dB at 3.5 kHz, –12 dB at 6.5 Hz, and –24 dB at 13 kHz, which agrees with the theoretical value of 7.3 K for R20 and R21. Use this latter value for any frequency scaling and round off to the nearest preferred value.

A single printed circuit card has been designed which can be built either as a high or low pass filter as desired. The noise output of the stage is better than –95 dB (limit of measurement), and the gain is within 0.5 dB of unity,

(*continued on page 79*)

FIG. 51 12dB / OCTAVE HIGH PASS FILTER

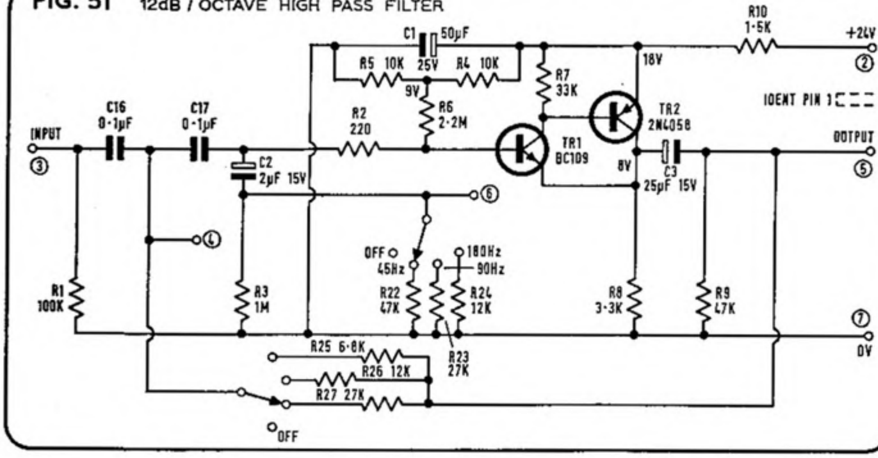
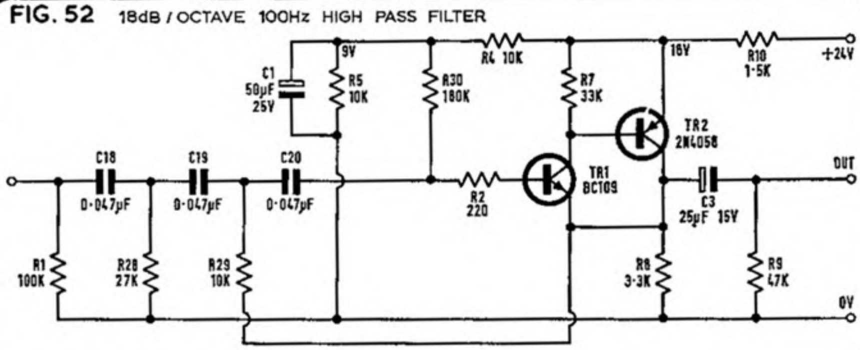


FIG. 52 18dB / OCTAVE 100Hz HIGH PASS FILTER



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Reel capacity 7 in. (18 cm) or smaller.
Frequency response 20 – 25,000 Hz at $7\frac{1}{2}$ ips; 30 – 20,000 Hz $\pm$ 3 dB at $7\frac{1}{2}$ ips; 30 – 17,000 Hz at $3\frac{3}{4}$ ips; 30 – 9,000 Hz at $1\frac{7}{8}$ ips.
Signal-to-noise ratio Better than 52 dB (normal), 55 dB (SLH).
Wow and flutter Less than 0·09% at $7\frac{1}{2}$ ips; less than 0·17% at $3\frac{3}{4}$ ips.
Harmonic distortion Less than 1·2% at normal recording level.
Level indication Two VU meters.
Fast forward and rewind time Within 1 min, 40 sec (1,200 ft. tape).
Inputs Microphone input, sensitivity -72 dB (0·19 mV), impedance 600 ohms, auxiliary input, sensitivity -22 bB (0·06 V), impedance approx. 100k ohms.
Outputs Line output, output level (0·775 V), impedance 100k ohms, headphone impedance 8 ohms.
Dimensions $16\frac{7}{16}$ in. (w) x $8\frac{5}{16}$ in. (h) x $14\frac{13}{16}$ in. (d).
Weight 22 lb. 8 oz.
Accessories Empty reel R-7A, connecting cord RK-74 (2), head cleaning ribbon, reel caps, dust protector, non-skid pad (1 set), motor pulley, "SLH" sample tape.
Recommended optional accessories Telephone pick-up TP-4S, microphone ECM-21, F98 or equivalent (600 ohms), stereo headphone DR-4A, DR-5A, microphone mixer MX-6S, rec/PB connector cable RC-2, magnetic connecting cord RK-66.

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so that the card may be inserted anywhere in the block diagram where the signal level is higher than –25 and still preserve a 70 dB s/n ratio. Reference to fig. 35 shows that this means anywhere after the front panel plug-in amplifiers. The circuit card is built to the same size as the internal plug-in cards so that it can be added to the output channels after the mixer amp but before the main gain control. Leads to the switches must be kept short, so that the best place for this card is in the fader rack with the controls in the centre section. Alternatively, to provide a filter for each channel, it can be added after the channel fader with the controls behind each fader on the rack extension (fig. 14).

An alternative arrangement is to have an add-on filter box (as in some BBC mixers) which has a number of channels each containing a tone control module, filters, and any other channel processing circuits, and can be plugged into any of the mixer channels via the breakjack supplied (fig. 3). The power supply will cope with the extra current of the filter circuits (4 mA per printed circuit card). In this case all the cards for one channel can be mounted in a framework similar to that used for the front panel plug-in units but with about twice the front panel length to allow for the extra controls necessary.

All of the filter circuits described so far have been Butterworth-type, which are characterised by having maximum flatness in the pass-band. Similar techniques can be applied to Chebyshev or Bessel filters (for maximum cut-off rate or minimum phase distortion, respectively). Interested readers are referred to 'Electronics', Aug. 18, 1969 (Vol. 42, No. 17).

Special filter circuits

This section is limited since filters can be designed to any reasonable specification. The first example (**fig. 54**) is of a filter which was designed for the film industry recording on to optical soundtracks. Response is limited so that filtering is used on replay (and recording) to reduce the noise levels. The circuit includes low cut-off frequencies of 70 and 100 Hz, and

(continued on page 81)

FIG. 53 12dB / OCTAVE LOW PASS FILTER

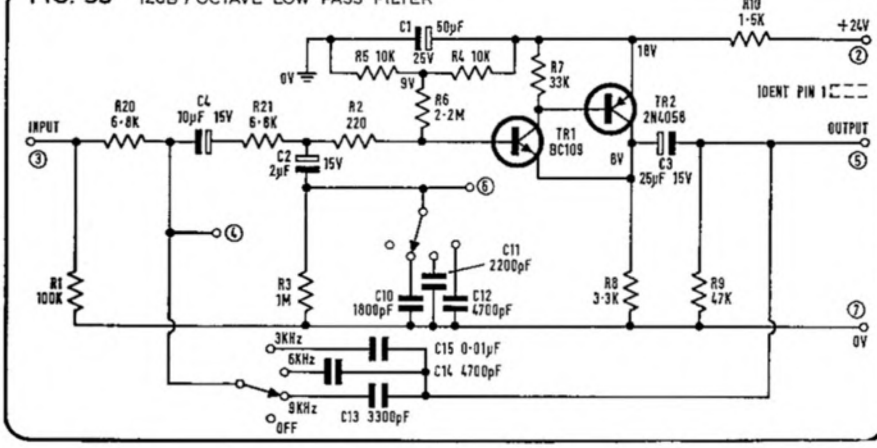


FIG. 54 FILM INDUSTRY FILTER

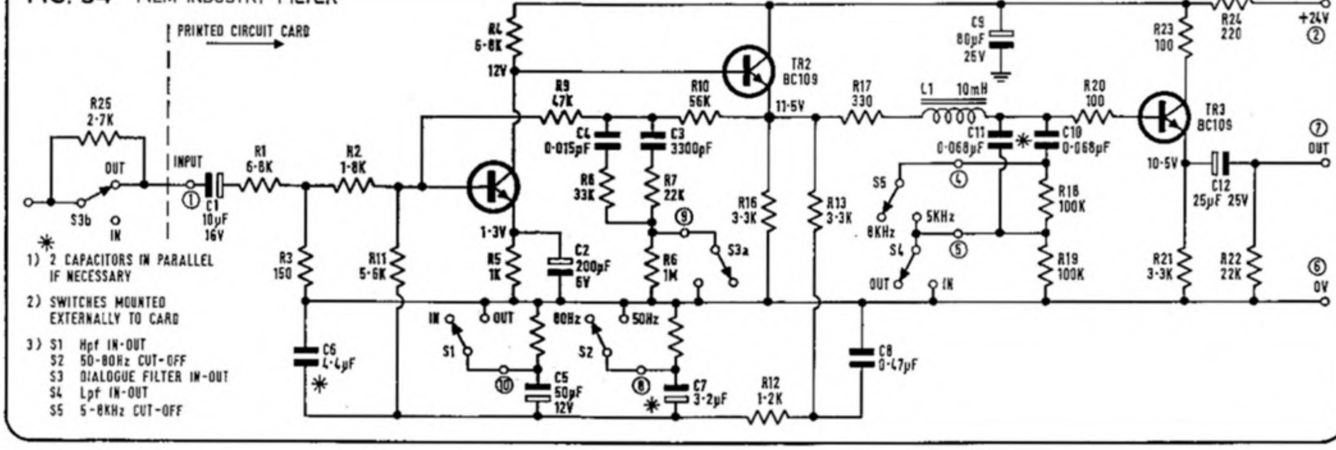


FIG. 55 FILM INDUSTRY FILTER RESPONSE

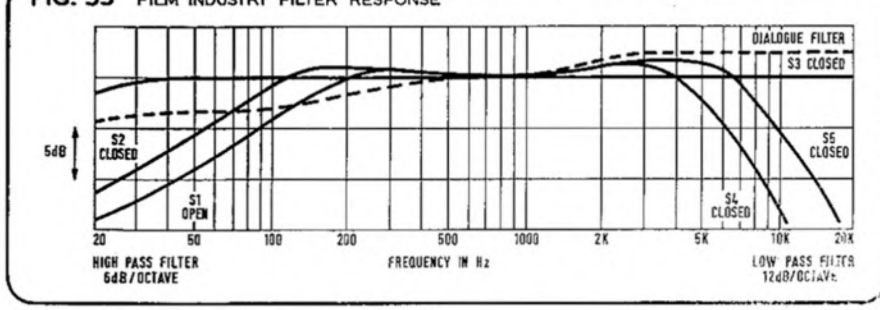
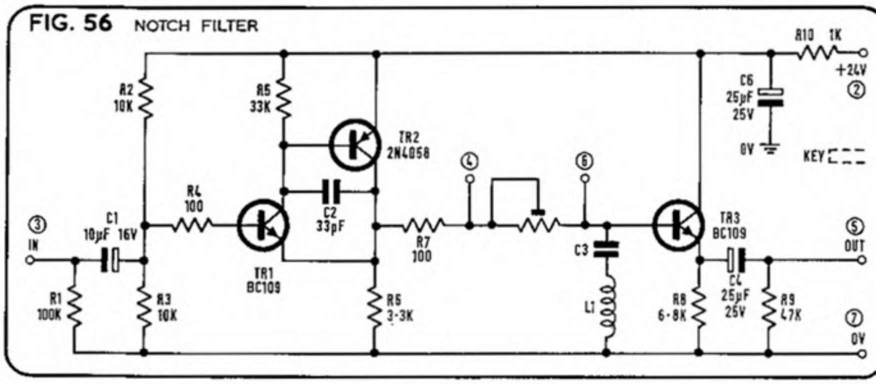


FIG. 56 NOTCH FILTER



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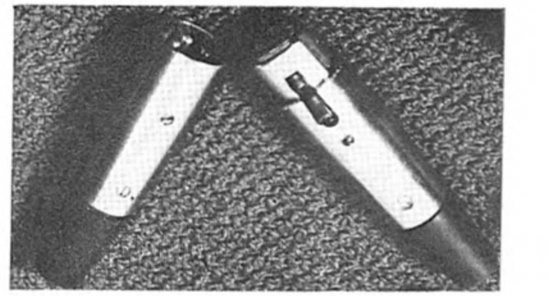

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high cut-offs of 5 and 8 kHz. This latter uses an inductor and immediately becomes more difficult for the average constructor to build.

The interest in this circuit is the dialogue filter, which is a two-shelf design which raises the voice centre frequencies relative to low frequencies, and emphasises the sibilants even more. This aids clarity and intelligibility in speech, and may be of use to any film studios building the mixer. **Fig. 55** shows the response.

A printed card was designed for this circuit but, since it was not originally built for use with the mixer, its dimensions of 120 by 75 mm means it has to be fixed in the body or else in an outboard section, such as was outlined earlier in this article.

Band rejection filters

It is my opinion that presence filters should be boost only, and so the earlier circuit (fig. 24) is very suitable. Anti-presence circuits, or band rejection filters, are not often used to modify music but more usually to remove an unwanted single interfering frequency—such as 100 Hz hum or 9 kHz whistles. Fig. 56 shows a suitable circuit for experimentation. The frequency of the notch is determined by the formula $f=\frac{1}{2}\pi\sqrt{LC}$. To achieve best results C3 should not be greater than 5 kpF. The Q of the circuit, which controls the depth of the notch, is determined by the setting of RV1. To give an idea of the performance, a 9 kHz filter (C3=3.9 kpF, L1=76 mH) gave the following results:

RV1	*notch depth*	*3 dB points*
100	12 dB	8.9, 9.1 kHz
1 k	30 dB	8.0, 10.0 kHz
10 k	47 dB	3.5, 20 kHz

There is a printed card for this circuit; its position in the mixer is the same as the previous filter card. The coil is the same type (Mullard *LA2500*) as that used in the tone control circuit, fig. 24, but wound to suit the particular inductance.

Graphic equalisers

The one remaining type of frequency control is the graphic equaliser, which is a set of filters giving both boost and cut over the whole audio range, with each filter covering a small segment of this band. **Fig. 57** shows the available responses from a commercially produced unit.

FIG. 57 GRAPHIC EQUALISER

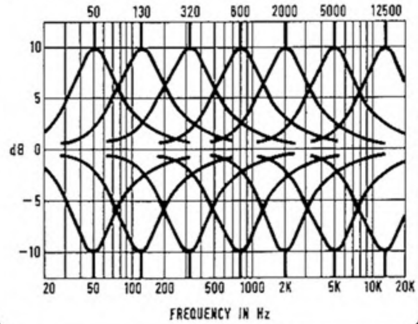


FIG. 58 GRAPHIC EQUALISER

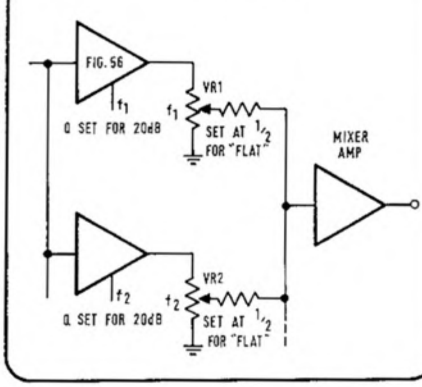


FIG. 59 OPERATIONAL AMPLIFIER GRAPHIC EQUALISER

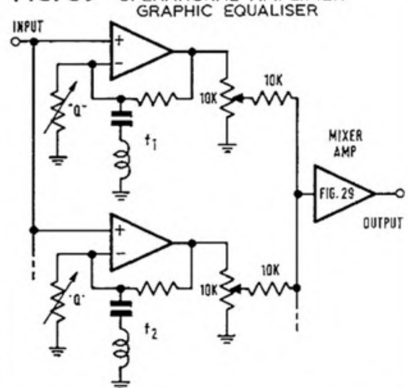
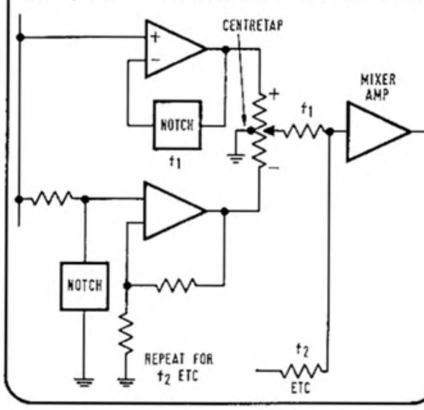


FIG. 60 SYMMETRICAL GRAPHIC EQUALISER



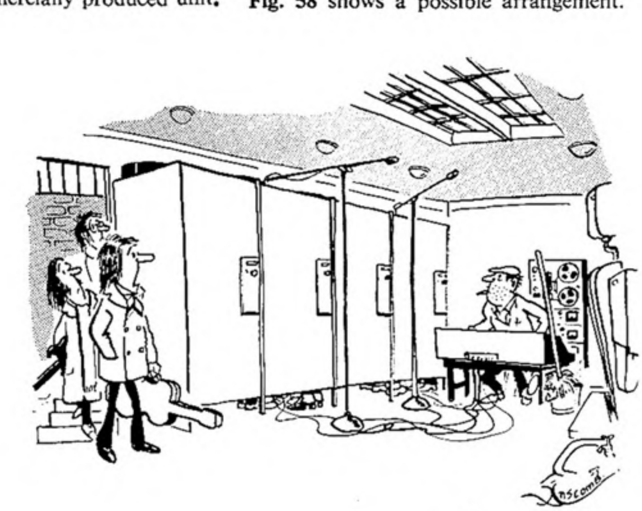
There are two methods of producing the response, and I will describe these so that experimenters can try out the idea—but I stress they are experimental and I cannot undertake to answer any queries on the circuits. No printed circuits have been produced for this reason.

The first method is to use many filter networks similar to **fig. 56.** The Q control is set to produce a 20 dB notch and the output of each is taken via a pot set to half reading; all filter outputs are then summed together. Frequencies are chosen so that the addition produces a flat response; then increasing the potentiometer raises that frequency by 10 dB. Reducing the pot to zero gives a 10 dB notch. **Fig. 58** shows a possible arrangement. The same idea can be extended using one of the many operational amplifiers, either of the integrated circuit or encapsulated component variety. **Fig. 59** shows this circuit. One of the *709* ICs would be suitable.

This method has a small disadvantage in that the shape of the dip is not a mirror image of the peak, as those curves in **fig. 58.** Nevertheless it produces very acceptable results. However, to avoid this phenomenon, the filter network must be switched (as the control passes through the flat position) from the feedback path of an amplifier to the input circuit. This is obviously more complex to arrange—but, for those interested, **fig. 60** shows how.

So much for filters; next month limiters and compressors will be discussed. The plans for the remaining articles are to follow this with a synthesis of the more common queries produced by readers (together with answers!) and finally, to complete the series, photographs and descriptions of mixers built to this and the 1964 design. I would welcome photographs of readers' mixers with notes of any special features for this concluding article—but I shall have to receive them by 15 January 1971 for inclusion.

'Talk about quick conversions'



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why so many tape recording characteristics?

by Eric Robjohns

ONE of the greatest problems facing both the sound recording engineer and the designers of sound recording equipment is the fact that with recording systems now in use it is not practicable to use a flat 'frequency-amplitude characteristic'. Take disc recording, for example. In this process, low frequencies have to be attenuated before they are recorded on to the disc because if this were not done the very large sound power levels at these frequencies would cause the overlapping of adjacent grooves. On the other hand, high-frequencies must be boosted on recording because the sound power-levels at these frequencies are very small. Any resultant modulation of the disc surface would otherwise be so slight that they would largely be marred by the inherent background noise of the disc surface on reproduction.

Ideally, for disc recording it is best if *all* frequencies are recorded at a constant degree of modulation. The standard amplitude/frequency characteristic adopted in 1955 by the majority of commercial recording companies conforms fairly closely to this ideal, although at mid-frequencies it 'flattens' slightly as mid-frequencies do not require any appreciable degree of boost or cut. The standard characteristic adopted was, of course, the so-called RIAA (Recordings Institute Association of America) or BSI 1925/1955 (British Sound Institution).

Before 1955, every major recording company used its own 'characteristic'. In general American companies preferred a curve approximating to the present standard one, although using perhaps slightly more bass cut and treble lift than today's standard. Most British and European companies preferred a characteristic much more nearly approaching 'flat' with comparatively little bass cut and treble lift. In fact, for some time after 1955, some European concerns such as DGG still continued to use their 'constant-velocity' characteristics, with only a small bass attenuation and no treble lift at all. The result was that most domestic audio amplifiers control-units were provided with a switch by which one could select a particular reproducing characteristic according to the make of record which was going to be played: European LP, International LP (the present standard), RCA OrthoPhonic, American Columbia, *FFRR* 78, etc. However, since the advent of stereo, *all* recording companies are using the RIAA/BSI disc standard, and the above facility has been dropped from nearly all modern audio amplifiers.

At the present time another confusing regime exists—this time with the tape recording medium. Even at the time of writing it is only just beginning to sort itself out. As in the case of disc, it is not possible to record on to magnetic tape and reproduce the same tape recording thus made with a flat frequency characteristic. The main difficulty here occurs mostly in the reproduction process.

A magnetic tape recording requires a bass boost on playback, but none on recording. This is fundamental to the magnetic recording/reproducing process, and is caused by the fact that the amplitude of the signal delivered from a magnetic tape playback head is more or less in direct proportion to the flux frequency on the tape, until the recorded wavelengths on the tape become so short that they begin to cancel each other; the output then begins to fall with increasing frequency. Clearly this means that, quite apart from other considerations, a 'mirror image' reproducing characteristic of this tape characteristic must be provided in the tape reproducing equipment.

Because the recorded wavelengths of a given frequency become shorter in direct proportion to the tape speed, it follows that the 'cancelling' effect will begin to take place at a much lower frequency at low tape speeds than it does at higher tape speeds. At 19 cm/s the effect will take place about an octave lower than at 38.

At the time of writing, a certain amount of confusion reigns about exactly how much bass lift is required for playback of a magnetic tape. Provided recording and reproducing tape-heads are well designed, only the treble response is governed by the width of the 'gap' between the pole-pieces. The narrower the gap is, the higher the HF response of a head at a given tape speed. HF response is, of course, also governed by other factors, such as the magnetic retentivity of the tape being used and the bias level. The main factors governing bass response, apart from bass equalisation, are head-amplifier coupling and matching. This brings us neatly to the main subject of this article; the degree of bass equalisation, whether treble equalisation is desirable, and, most important of all, why there are so many disagreements as to what degree of equalisation shall be used.

Until comparatively recently, only two types of equalisation were used: the so-called CCIR curve, and the NAB curve—the former being used in Europe and most other countries in the eastern hemisphere, and the latter in the USA, Canada, and most other countries in the western hemisphere. The main difference between these two curves was, and still is, the degree of bass lift and treble cut provided in the playback amplifier. The CCIR curve is that which is provided by an equalisation network having a 'time-constant' of 100 μS for playback at 19 cm/s, whereas the NAB curve for the same speed has a time-constant of 50 microseconds. This means in effect that the degree of bass lift is greater in the case of NAB equalisation. In addition, whereas the CCIR curve only provides bass correction and has no treble lift or cut, the NAB curve has, in addition, a time-constant of 3 180 μS providing a treble 'roll-off', thus reducing tape-hiss and other HF noise on playback. Another fundamental difference between the two is that, when a recording is made with equalisation so as to provide a substantially 'flat' response-curve when the tape is reproduced with the NAB curve, the 'saturation' point of the tape is reached equally at all frequencies. In other words, all frequencies are recorded at approximately equal amplitude. There is, of course, a rough analogy here with the standard RIAA characteristic used in disc recording. The CCIR curve, on the other hand, does not fully utilise the dynamic range of modern tapes equally at all frequencies.

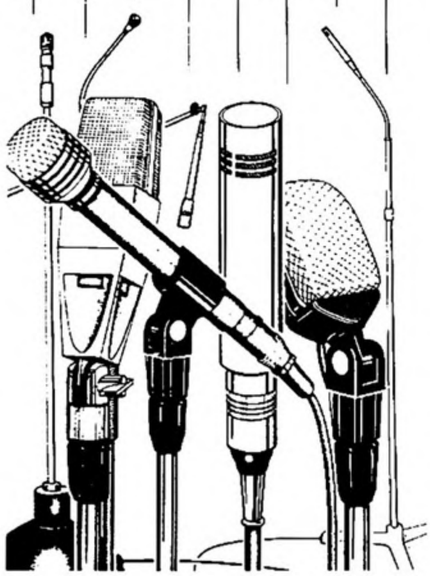
Because the amplitude of HF signals is so small when compared to the much larger LF amplitude, it follows that the tape will saturate more quickly at low than at high frequencies when recording for CCIR playback.

Because the full dynamic range of the tape is only utilised at lower frequencies, and because no treble cut is used on playback, a tape recorded and played with CCIR equalisation will sound more hissy, other factors being equal, than a tape recorded with NAB equalisation. The NAB curve is really more 'ideal' for the magnetic recording process, and at the moment it does appear that this may become the final agreed standard for magnetic recording.

An important third standard which is being put into practice by European manufacturers in particular, this being a kind of compromise

(continued on page 86)

Why multitrack?



by Bob Auger

THE interview with American engineer Jerry Bruck (published in the December 1970 *Studio Sound*), wherein he outlined his theories for using only one microphone per track in quadraphonic recording, prompts me to offer the other side of the picture, so to speak, and state why I always try to avail myself of the latest technical developments when making master tapes of symphonic music.

Basically, when one considers the financial aspects of recording orchestral music today in this country, and even more so in the USA, one must ensure that the tapes produced will have the maximum possible life-span and will not sound too antiquated in say 10 years time. This much the engineer owes to his producer, and indeed to the record company for which he is working. It is the engineer's responsibility to explain the latest available facilities to the department financing the operation and to suggest a recording method which will allow some form of insurance for the future. There are several ways in which tapes can be recorded with this point in mind, and the following serve as examples:

(a) The use of the Dolby system ensures that the tapes will have maximum signal-to-noise ratio possible at the time of writing. I cannot understand any major company recording classical music today without the use of this or some similar system.

(b) Obtaining maximum clarity in the initial recording, which may involve multitrack techniques, so that the original tape can be taken out of the vault and redubbed later in an attempt to copy the sound fashion of the time, thus giving the tape renewed appeal and a further chance to recapture some of the original financial investment.

It should be remembered that one can always 'cloud-over' the sound, or subtract 'presence' during dubbing, but it is very hard to conjure-puinformation not there in the first place.

Fine influence

In my mono recording days I had the good fortune to come under the influence of certainly one of the most individual American recording engineers, Bob Fine, who readers may recall was responsible for Mercury Records' sensational *Pictures from an Exhibition* (Chicago Symphony Orchestra/Kubelik), *The Rite of Spring* (Minneapolis Symphony Orchestra/Dorati), and of course the original, incredible *1812* with cannon and bells (for which he has a lot to answer!). His philosophy was that all mono recording should be carried out with one microphone, which was placed very carefully to achieve a very precise balance between the instruments of the orchestra, which brought out a lot of detail hitherto obscured. The type of microphone used, and a lot of understanding and encouragement given to the performers by the engineer, produced some very exciting results. Many of the early Pye recordings were made in this manner, some by Fine himself and some in imitation, with varying degrees of success, by his very green understudy. Two successful ventures which I wouldn't dare to attempt again today were an LP of harmonica pieces accompanied by full symphony orchestra, featuring Larry Adler, and the complete recording of *A Child of Our Time*, by Tippett, which featured soloists and the Royal Liverpool Philharmonic Chorus and Orchestra, under John Pritchard. This latter recording was taken on completely single-handed in 1957, which feat involved the unpacking of brand-new equipment delivered straight to Liverpool from the USA. Slung microphones and the complete recording apparatus were installed overnight before the sessions. My only companion during this episode was a lone security man, who interrupted the proceedings from time to time with the necessary refreshments.

I continued with the single mike technique for mono recording until mid-1958, when I considered Pye's technical policy for the future should be to record in stereo only, using the stereo master tapes to produce mono discs.

I tried out several different mike systems during the period 1956 to 59 before deciding that a form of multimike technique offered the most flexibility and got the sessions 'off the ground' more rapidly in all locations. This is particularly necessary at the present time now that concerts and recording sessions are arranged as a block within a few days of each other. This means that the engineer is faced with an orchestra and conductor fully rehearsed and impatient to go. A shattering example of how one can be swept along on this kind of tide was during the CBS recording of Scriabin's *Second Symphony* where the first playback took place within 15 minutes of the commencement of the session. It's a brave engineer indeed who dares to suggest microphone changes 45 minutes into this kind of session!

For some time I experimented with only two microphones for stereo recording and, whilst inclined to the co-incident pair (usually made up of two mono capacitor mikes strapped together, one upside-down above the other), I found that this system often produced a somewhat thin string sound, with too much prominence given to the front desk players. No doubt this problem could have been relieved by setting the microphone further back from the orchestra, but by doing this I found that I was losing presence and clarity of the orchestra to which I had become accustomed when working in mono. There are other limitations with this system, particularly with music of a concerted nature. It is difficult to see how, for instance, a guitar or harpsichord concerto can be satisfactorily recorded with only a stereo 'pair' and no reinforcing microphone for the solo instrument, the sound of which is often lost in these ensembles in the flesh. A multi-microphone system was found to produce a much better spread of strings and, by 'panning' the microphones precisely between the two stereo tracks, the correct location of instruments could be simulated.

It is unfortunate that, as the years have progressed, I notice that the majority of American producers still prefer to produce recordings with a pronounced stereo image, with all the high strings on the left, winds and percussion in the centre and low strings and brass on the right. They still seem to want to prove that the record is in stereo and not confuse the listener with a realistic spread of sound between the two loudspeakers. My experience in working with American producers generally leads me to say that they usually want to hear everything which is in the printed score, even if this is not normally audible as a separate sound in performance. This is in marked contrast to many British producers, who are quite satisfied with a fair representation of the music, and vulgarities such as timpani and other percussion are kept to the absolute minimum. In fact, one often wonders why the cost of the session is not reduced by leaving out some of the orchestral parts altogether.

Taking the Mahler *Third Symphony* sessions specifically into account, the combined use of multi-microphone and multitrack recording techniques allowed a simultaneous stereo and quadraphonic recording to take place with a minimum of technical fuss, and also Mahler's chamber music style of writing to be made as clear as possible. I think an extraordinarily Viennese style of recording has emerged in this instance. If one takes the trouble to listen back to Bruno Walter's recordings of *Das Lied von der Erde* and the *Ninth Symphony*, made in the mid-30s, one will find a similarity in the presence of the wind and evenness of balance between the solo instruments and string sections of the orchestra. I have always noticed in both these recordings, and in the same conductor's New York recording of the *Fourth Symphony*, that a whole string section was never allowed to have more prominence than a solo wind instrument. I found it most interesting that Mr Horenstein produces very much the same kind of balance.

Jerry Bruck's comment that the multimike engineer sits at his console and plays God, and that the result 'has nothing to do with reality', brings us to the old controversy as to whether the finished record should sound as much like the real thing as possible or whether it should sound 'different'. My belief is that it should sound *better* since we are engaged in manufac-

(*continued overleaf*)

turing recordings for playback in the home, and are not in the concert promotion business.

If you want the real thing insofar as traditional symphonic music is concerned there is no substitute for going to a concert. What I try to do is to present a recording which is exciting in its own right and is a small extra contribution to the aims of the composer and his interpreters. In other words, an extension of the art-form.

A point I never tire of making is that so-called life-size sculpture of the human body is invariably over-scaled, as actual life-size has long been found to appear puny. So, as sculptors have had to increase overall size, and often proportions, to overcome lack of presence and movement, the sound engineer has come to point out and clarify details of the score in an attempt to compensate for the lack of 'total fidelity' (What a title for a record label!), i.e. three-dimensional sound and vision in his sphere of operation.

We are in the very early stages of quadraphonic recording and, up to now, no standard loudspeaker arrangement has been laid down by the recording industry. Once a recommended standard has been published, the recording engineers will know precisely how to set out their ambience microphones in the studio. A few words of caution here, though:

Since nearly 99% of American record sales are pop-orientated and I believe that the most exciting and flexible use of four loudspeakers for pop-music calls for one speaker in each corner of the room, this arrangement is most likely to become the standard.

It is unlikely that several different types of recording will compete on the commercial market, as this would face the listener at home with the problem of having to place his speakers differently according to which make of record he is going to play.

It would appear most likely that a speaker in each corner will become the normal arrangement and this is why the major companies involved in quadraphonic recording at this time record in the manner adopted at the Mahler sessions. I must say in passing that I find it incredible that a major company should undertake a project like the recording of *Grande Messe des Morts* by Berlioz in Westminster Cathedral in 1969, utilising only two-track equipment without the Dolby system. I know that it is often alleged that automobile manufacturers incorporate built-in obsolescence, but this is ridiculous!

Within a decade or two no doubt most serious music may be composed for recording (as the pop side is already), making full use of the recording techniques available at the time. From then on we shall venture out to the concert hall only to hear a replica—and a poor one, at that—of what the composer intended us to hear in the privacy of our own homes. This will be the time, no doubt, when the 'old' music, such as Beethoven, will be recorded with the different sections of the orchestra coming from different sides of the room, ceiling and floor. Although I like to think that some of the tapes we are making today may still be of use at this time, I hope that I am not around to be any part of it.

between the NAB and CCIR standards, is called the DIN/IEC (or sometimes 'new CCIR') characteristic. However, more about this later, for first it is necessary to introduce a factor which tends to make matters run against the adoption of the NAB characteristic.

This is the question of saturation distortion, the harmonic distortion introduced when a tape recording is accidentally overmodulated. It follows from what has been said that a tape recorded to CCIR recommendations will carry a greater amount of bass distortion than at other frequencies, when the saturation point is passed, whereas a tape recorded to the NAB characteristic will saturate equally at all frequencies. From the subjective viewpoint, this means that the distortion occurring from an overloaded tape recorded to NAB standards will be more noticeable, even for a given amount (or percentage) of distortion. Secondly, even from the objective viewpoint, it follows that for a given amount of overloading beyond the saturation point (at least within the first few dB) the amount by which any accidental overload occurs will usually be not more than 5 dB and usually only 2 to 3 dB.

To sum up, all this means that a greater signal-to-noise ratio can be obtained when using the NAB characteristic but much greater care has to be taken to avoid possible overmodulation. It is largely in this connection that a 'compromise' characteristic is now being used by some manufacturers.

Just to add to the confusion, there are two other characteristics which are competing with the main three contenders, although so far they have not been generally adopted. These are the 'Ampex' characteristic, which is slightly more severe than the NAB curve, and a characteristic which, until now, has been used in France and (as far as the writer knows) nowhere else. The latter is basically similar to the CCIR curve up to 1 kHz, but thereafter follows the NAB practice of boosting the treble on recording and reducing it on playback. When overmodulated, a tape recorded to this latter curve would distort at high and low frequencies before it did so at middle frequencies. Although the percentage distortion increase taken over the entire frequency range would be higher in the treble than in the bass, approximating to the figures given for the NAB curve, the 'subjective' distortion would be slightly less than with the other standards so far mentioned. This characteristic, however, can really be dismissed, as there is little if any likelihood of it being adopted as a world standard. Even in France the DIN standard is now being rapidly adopted by the ORTF and commercial recording companies.

The whole question of equalisation characteristics may be revised within the next year or two, if and when chrome dioxide tape is brought into use for audio. Changes from present standards will be essential to take full advantage of this tape. Is it too much to expect the various committees to agree with each other, as and when these changes come?

equipment reviews

WEIRCLIFFE MODEL 8 BULK ERASER

MANUFACTURER'S SPECIFICATION. Bulk magnetic tape eraser. **Spool capacity:** 37 cm, 50 mm audio or video tape. **Handling:** 100 to 400 reels per hour. **Dimensions:** 520 x 520 x 265 mm. **Weight:** 42 kg. **Price:** £90. **Manufacturer:** Amos of Exeter Ltd, Weircliffe Court, Exwick, Exeter. **Distributor: Rank Audio Visual Ltd, PO Box 70, Great West Road, Brentford, Middlesex.**

ALTHOUGH magnetic recorders should be capable of erasing even the most heavily modulated passages of a tape, all too often a portion of the original programme may be just audible in a quiet passage of a new recording. For this reason any tapes should be bulk wiped with a really effective bulk eraser.

The Weircliffe Bulk Eraser measures approximately 52 cm x 52 cm x 27 cm high, excluding the extra height of the vertical push tab. It is fitted with feet and carrying handles. The consumption is approximately 13 A but this varies slightly from one machine to another.

The device works basically on a letter box principle. After pushing down the vertical tab to open the horizontal slot, the spool of tape should be pushed through the slot until it reaches a spring loaded buffer. The tape should be further pushed through until the near end of the spool just passes a white line showing that the entire spool has been erased. The buffer should then be allowed to push the spool out again, and the spool is then withdrawn gently still holding down the push tab.

A series of three bulbs light up for 27, 30 and 35.5 cm spools, reminding the operator that the spool has been pushed in sufficiently. An erasure light is provided to remind the user that the instrument is working when the push tab is down, which can be easily seen by anyone nearby.

One might imagine that the entire system is almost foolproof. I tried erasing many different types of tape and in particular performed some prolonged erasing tests on some Agfa *PER 555* containing a full track saturation signal of approximately 12 dB above 32 mM/mm at 1 kHz. This tape was chosen because of its extremely high saturation point and also because it is slightly more difficult to erase than most tapes. After bulk erasing, the tone was almost completely inaudible when listened to on unweighted playback. Using a third octave filter, the tone was never louder than 83 dB below the original recorded level, thus showing the Weircliffe to be better than its specified 80 dB in this respect. However, this is not the entire story since the very action of bulk erasing can put a cyclic bonk on the tape unless the operator finds the knack of avoiding this. It is still a mystery to me why, for some reason, I could not produce any serious bonking and yet a colleague for the first few operations did produce an audible thump on the tape which showed up when the spool was wound through at high speed. The measured level of this thumping was approximately 60 dB below 32 mM/mm. The lowest level of bonking occurred when the tape spool was fully withdrawn with a steady continuous movement. Occasionally, by intentionally withdrawing the tape carelessly, it was possible to introduce a severe cracking once or even twice per revolution rather than the bonk or thump previously referred to, and it is therefore obvious that engineers should familiarise themselves with this eraser thoroughly before using it operationally.

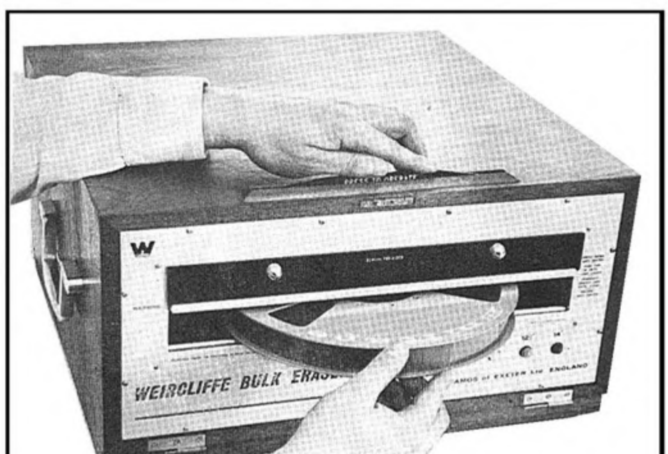
When using metal NAB spools, the device is quite noisy in operation and the operator's hand is considerably shaken by the spool vibration. All who have used this equipment have regarded this as initially unnerving but one easily gets used to it. Metal spools became quite warm with the exceptionally strong alternating magnetic field, which is hardly surprising since in use the equipment is taking in excess of 2.5 kW. The intense magnetic field is generated by coils under the shelf on which the tape spool slides, and behind these coils are a series of capacitors to suppress the different switches operating the signal lights. No fuse is provided on any accessible part of the instrument, and it is therefore considered imperative that the unit should be used with a fused mains plug. Taps are however provided for 220 and 240 V AC working. The mains cable provided is of a very heavy duty variety and should prove to have as long a life as the instrument. Since the manufacturer did not disclose the weight, which appeared to be rather high, the bathroom scales were brought to the eraser. These showed the weight to be approximately 42 kg.

I checked the external field by its effect on a 13 cm reel containing a low speed stereo recording. The tape was placed on the top of the eraser near the push tab whilst the tab was depressed energising the instrument. When the tape was replayed, there was no measurable or audible decrease in the level of the tone on either track, and no cyclic thump despite the fact that the tab was released whilst the tape remained on top. The field actually inside the eraser is incredibly high and yet no magnetic screening is provided inside the top of the instrument which is made entirely of wood.

To prevent misuse the eraser is provided with a lockable front cover. A removable section at the top of the slot allows erasure of up to 50 mm video tapes on 35.5 cm spools. All spools, particularly these, should be treated on both sides to ensure adequate erasure. A special clip-on adapter is available as an accessory to assist in the loading and unloading of quadruplex video tapes, which are relatively heavy. Smaller spools can also be easily erased, although with very small spools it will not be found necessary to push against the buffer. The unit can be used for continuous operation, provided it is not energised for more than 50% of the operating time, i.e. 12 seconds in every 24.

The price of this eraser is very high, but so is its standard of manufacture. It is considered easy to maintain, but I feel it is very unlikely that anything would in fact need maintenance. With the proviso that the operators are careful not to introduce a cyclic thump, I strongly recommend it for use in studios.

Angus McKenzie



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	Length	ea.	3 for		Length	ea.	3 for		Length	ea.	3 for		
3"	150'	2/-	5/9	3"	220'	2/6	7/-	3"	400'	4/6	13/-	3"	7d.
4"	300'	4/-	10/-	4"	450'	5/-	14/-	4"	600'	6/9	19/6	4"	1/8
5"	600'	6/-	17/6	5"	900'	8/-	23/6	5"	1200'	12/6	37/-	5"	1/9
5¾"	900'	7/-	20/6	5¾"	1200'	10/6	30/6	5¾"	1800'	17/-	50/-	5¾"	1/9
7"	1200'	9/-	25/6	7"	1800'	13/-	38/6	7"	2400'	21/-	61/-	7"	2/-

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STARMAN TAPES, 421 Staines Road, Bedfont, Middlesex

AMPLIVOX ASTROLITE HEADSET

MANUFACTURER'S SPECIFICATION. Moving-coil headset with moving-coil boom microphone. Frequency response: 100 Hz to 20 kHz ±3 dB (microphone), 100 Hz to 10 kHz ±5 dB (headphone). **Impedances:** 400 ohms (microphone), 200 ohms (headphone). **Microphone sensitivity:** 2 mV on close speech. **Headphone sensitivity:** 100 μW produces 90 dB above threshold in ear. **Price:** £12.25 (with microphone); £8.25 (without). **Manufacturer: Amplivox Ltd, Industrial Division, Beresford Avenue, Wembley, Middlesex.**

THE headset submitted for test is one of a series produced for language laboratories, domestic stereo, audio visual applications, and programme monitoring. It is a development of an air crew headset which was designed for use in high ambient noise conditions so that efficient noise exclusion is still one of its most useful features. The relatively large volume of the ear enveloping cushion presents many problems in properly coupling the moving coil transducer to the ear. Both subjective listening tests and measurements on an artificial ear indicate that these problems have not yet been solved.

My first listening test using full range white noise showed a preponderance of heavy low frequency noise with practically no 'hiss' or extreme high frequencies. Speech sounded 'tubby' and although the sibilants could be heard they were obviously well down compared with the bass components. (Speech from the attached moving coil boom microphone sounded less heavy but this proved to be due to a bass cut in the microphone response.)

The response of the microphone was first checked in a monitored sound field using narrow bands of filtered white noise and this is shown in **fig. 1.** The response did not alter with distance from the sound source, indicating that the microphone has a pure pressure response. There are noise reduction properties due to pressure gradient effects. The bass cut below 250 Hz explains the better speech balance when listening to the microphone-headset combination.

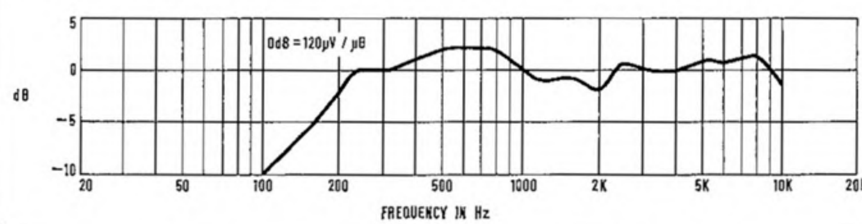


FIG. 1 AMPLIVOX ASTROLITE BOOM MICROPHONE FREQUENCY RESPONSE

The artificial ear used for the headphone measurements is a B & K *4152* unit which conforms to the American National Bureau of Standards *9A* coupler specification. A 6 cm^3 cylindrical cavity couples the headset under test to a pressure calibrated capacitor microphone. As the oval shape of the ear cushion prevented an air-tight seal to the 'ear' cavity, a small baffle was used as shown by the sketch above **fig. 2.** It will be seen that the 'ear' projects into the cushion cavity in similar fashion to a real ear. The resultant response shows a series of peaks and dips due to longitudinal and transverse cavity resonances but the mean curve shows a trend towards a 6 dB per octave fall at high frequencies as estimated by the listening tests.

Constant power, constant voltage or constant current fed to the earphone gave almost identical responses as the moving coil is almost purely resistive.

This response was very different to the published response of **fig. 3,** which contained the following caption: 'earphone measured in shell on flat plate coupler, with 12 mm diameter microphone with diaphragm at surface of plate'.

A 20 mm capacitor microphone was available with a calibrated pressure response, so this was fitted flush to a wooden baffle as shown by the sketch above **fig. 3.** and the Amplivox headphone tested again. The response is shown by the solid curve of **fig. 3.** Once again we find the steady fall of 6 to 8 dB per octave with superimposed peaks and dips

(continued overleaf)

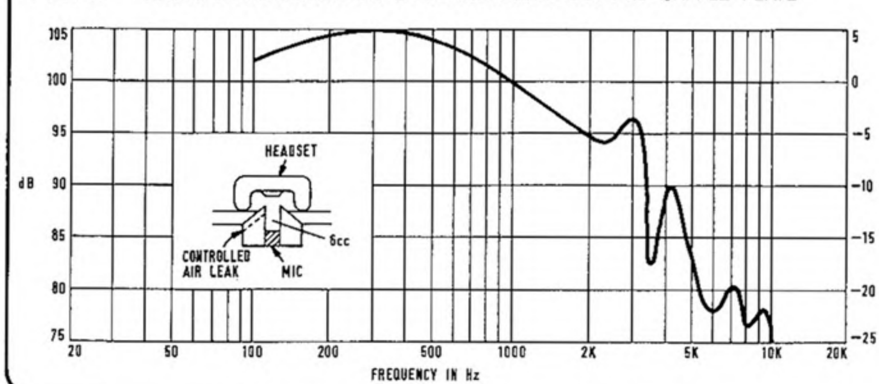


FIG. 2 AMPLIVOX ASTROLITE ON B+K ARTIFICIAL EAR AND BAFFLE PLATE

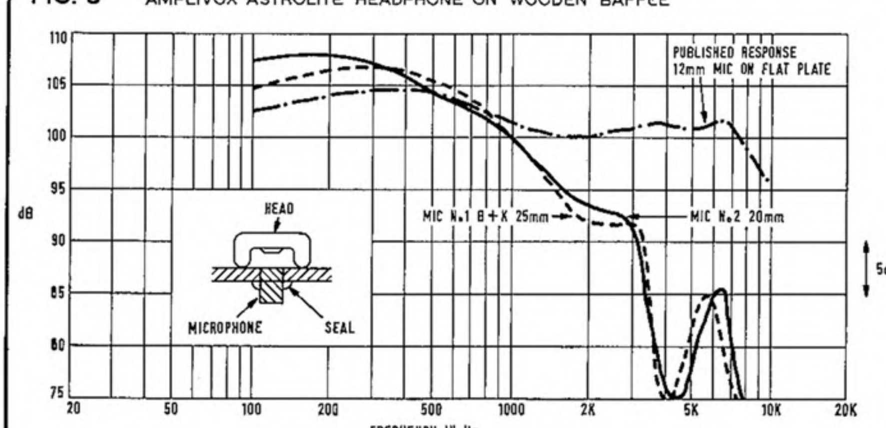


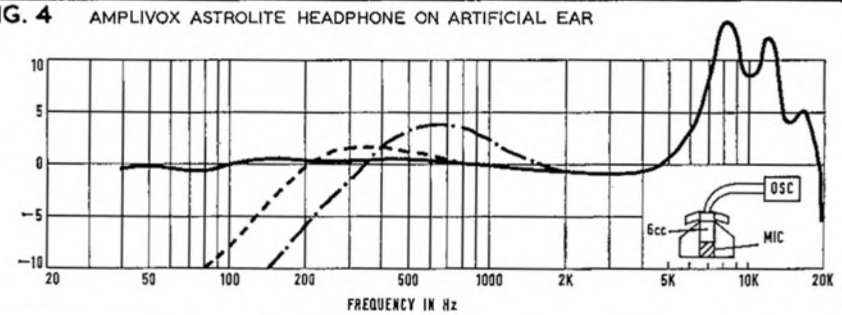
FIG. 3 AMPLIVOX ASTROLITE HEADPHONE ON WOODEN BAFFLE

rather larger and lower in frequency due to the unobstructed cushion cavity. The B & K 25 mm diameter microphone was tested under similar conditions to give the lower dotted curve of **fig. 3.**

Finally the 20 mm microphone capsule was mounted directly on the artificial ear and used as a sound transducer of high acoustic impedance to measure the resonances of the 6 cc cavity and the effect of various degrees of leakage on the low frequency response.

To return now to the response of **fig. 2,** I feel satisfied that this at least shows the trend of the response of this particular moving coil headphone. I would hazard a guess that the moving coil diaphragm is mass controlled, so that the *velocity* is constant over most of the frequency range. This means that the *amplitude* is falling 6 dB per octave to give the response shown. The peaks and dips may not occur at exactly the frequencies shown, on a flesh and blood ear, but careful listening tests near hearing threshold have convinced me that they do exist.

FIG. 4 AMPLIVOX ASTROLITE HEADPHONE ON ARTIFICIAL EAR



Comment

This is a mechanically robust headset with good sound-excluding properties which can be useful for language laboratory use if the frequency response is tipped by 6dB per octave to give a more balanced response. For programme monitoring it would be a dangerous tool which could result in the 'customer' getting a thin emasculated signal which would only sound right on this headset. **A. Tutchings.**

FIELD TRIAL: CALREC 1050 CAPACITOR MICROPHONE

ONE MIGHT BE forgiven for thinking that several companies have manufactured low-price capacitor microphones in the last few years: Hammond, Fi-Cord, Orange and Calrec. In fact both Fi-Cord and Orange models can be traced back to Calrec's factory and in turn, over several years of evolution, to the original Robinson, Stebbings & Whatsit articles in *Hi-Fi News*. Since Angus McKenzie finally bought the *1050* pair he reviewed in August 1969, a further pair was submitted for field test.

The *1050* is a cardioid capacitor intended for studio hand or stand use. Its price is remarkably low compared with other capacitors of similar specification and I know for certain that the unsophisticated price tag dissuaded at least one studio from purchasing it.

A substantial presentation case is supplied with the microphone. For optimum signal-to-noise ratio the Calrec, like any electrostatic microphone, should be stored in a heated cupboard; this minimises the accumulation of condensation on the diaphragm. The *1050* is well finished, with a rigid endshield and chrome-plated body terminating in a Cannon *XLR* three-pin socket. The two-core cable connects to a mains power unit (battery versions are available) and thence, via a short lead, to the mixer or recorder. Although the power unit output is balanced, the signal from the microphone itself is not. The three conductors are employed as audio, DC and common earth respectively. This should not be confused with true phantom techniques which normally allow balanced working by using the two audio conductors as one side of the DC circuit.

The two samples were tested as a stereo pair on live piano material and later on drums, Hammond organ, electric guitars and flute pop group. The microphones behaved well despite sound levels approaching the threshold of pain. HF quality was noticeably superior to the majority of dynamics and the stereo separation was more precise than with figure-of-eight ribbons. On this occasion a female singer was being panned from a separate dynamic mike through a Soundex mixer, a technique I cannot recommend unless you (a) put the singer through a reverb unit or (b) turn the performers' amplifiers down to a uniformly low level. It was a rotten tape, thanks to the recording technique, but the Calrecs worked beautifully.

The output level is quite sufficient for the medium impedance microphone inputs of the Revox *77* and Ferrograph *7* though careful attention must be given to balancing. The usual method of unbalancing a balanced line (earthing the 'black' lead) upsets the Calrec power supply. Acceptable results were obtained working into the 50 ohm balanced input of an *RE301* but the Soundex, switched to 200 ohm inputs, avoided the theoretical bass loss arising from feeding into too low an impedance. Calrec can supply an adapter for 30 ohm operation.

Angus complained in his review of audible 100 Hz hum from a Calrec power supply, eliminated on a second sample. Although I gather this has been overcome on the production line, the power supply sent to me produced slight audible hum on one of its two channels. With the one reservation that you check this point before purchasing a *1050*, I can strongly recommend the microphone and would prefer it to a moving-coil in any application. **David Kirk**

MANUFACTURER'S SPECIFICATION.

Calrec 1050: Studio cardioid capacitor microphone. **Frequency response:** 30 Hz to 20 kHz ±4 dB. **Front-to-back ratio:** 20 dB. **Source impedance:** 50 ohms maximum. **Load impedance:** 200 ohms (or 30 ohms with *CL 1081* matching lead). **Equivalent self-noise:** 20 phons. **Maximum SPL for 0.5% total harmonic distortion:** 400 μB (125 dB). **Operating voltage:** 45 to 50 V. **Current consumption:** 400 μA. **Battery life:** 400 hours. **Length:** 136 mm. **Diameter:** 22 mm. **Weight:** 113 gm. **Price: £48.80.** (Omni 1000 available at **£44.30.**)

Mains Power Units: Eleven versions, for one, two, four or six microphones, from **£8.20** to **£59.50.** Complementary cables, attenuators, windshield and stand adapters available.

by Peter Bastin

ONE GETS a little tired of the smug television or film story where everything goes right. The chap gets straight out of bed in the morning, dresses, goes to his car, rushes through the town and parks outside wherever he's going. The normal bloke gets out of bed, hares for the loo, washes, shaves, eats (perhaps) and blunders out to his garage. His car may not start, or he may have forgotten his jam sandwiches. The lights are against him all the way, and when he gets to where he is going, he can't park at all. That's life. I realise all the sordid details of daily living would make for a very dull story, but I do get fed up with people in films getting up from the table in the middle of an expensive meal, leaving two-thirds of a glass of beer, leaving Bentleys unlocked, walking out of rooms and leaving lights on and, above all, being called urgently to Vladivostok. This latter caper consists of a mad rush round the flat (apartment?) throwing bits of clothing willy-nilly into a suitcase. The milk isn't stopped, the gas, light and water aren't turned off, the papers aren't stopped. And to crown it all, the Vladivostok-bound rushes out of the door madly swinging a patently empty suitcase. I don't hanker for swishing water closets or Brigit Bardot cleaning out her ears, but I *would* like to see something put in those disgustingly-empty suitcases.

I HAVE ALWAYS been a little surprised how few 'hi-fi' (wretched word) domestic tape recorders boast a speed of 38 cm/s. It seems to me that manufacturers regard anyone who wants to record at this speed as a nut. They will, apparently under duress, produce a variant with an undecipherable code number, which records at this speed. Now anyone who does any serious recording needs this speed, and I shouldn't have thought it either uneconomical or, in fact, particularly silly, to market all machines coming within the loose specification of 'semi-professional' with a 38 cm/s tape speed. I do not know, personally, what this may involve in terms of mechanics. It must involve something, but nothing, I am sure, to warrant the extra cost applied by such people as Ferrograph. Some time ago, I did a cursory survey through a long list of all foreign and home-produced recorders. I found that it was impossible to get a machine running at 19 cm/s under about £80. Why? There are literally dozens of recorders on the market with two speeds—9.5 and 4.75 cm/s. If a machine can be satisfactorily rigged to give two low speeds, albeit practically useless, why can't it be similarly rigged to give two *high* speeds? 4.75 cm/s is a nonsense speed for anyone. It's all right for speech and it's all right for 'hi-fi' (that word again) cassette recorders, but such a speed on a machine costing £100 or so is almost impudent. Why not use the labour and mechanics to provide a decent top speed?

PETER CLAYTON, reviewing cassette records in the *Sunday Telegraph*, was unable to praise or criticise some of the offerings because the leader splices broke on rewind. Never had that trouble with my phonograph cylinders. Ever tried repairing a cassette? First thing you find is that the two halves are welded together and that nothing short of a pickaxe will force them apart. Judging from this month's *Tape Recorder Service*, similar design logic seems to have been used on the recorders. Washers useless after a couple of removals and the need to change an entire plate because of one bad screw. What are the decks made of—cardboard?

REMEMBER THE days when tape manufacturers were proud enough of their products to print their name all the way down the backing? The loo paper at Abbey Road takes this idea a step farther: each sheet carries the letters EMI.

EVER HEARD of the Footstep Girls? Not a chorus line at all, but seven young ladies who spend their time crushing skulls, cutting off heads, thumping people, breaking bones, squirting blood and other ghastly things. Lynda Lee-Potter in the *Daily Mail* explains it all. These ladies produce dubbing-on noises for almost every British film you've ever seen. There are only seven of them in the British industry and, from all accounts, they are kept pretty busy mangling up people. They have performed their various (and usually grisly) effects in such films as The Virgin Soldiers, Soldier Blue, Dracula, The Creatures the World Forgot, The Avengers series and many, many more. For those do-it-yourself enthusiasts, here are a few recipes: *Fist-blows:* hit yourself or thump a bolster. *Crushing a skull:* twist a knife in a potato and, at the same time, slice through a cabbage. *Bones breaking:* cut through celery. *Blood spurting:* squelch your hands in an orange (a blood orange?). *Squeaks and creaks:* two pieces of wood which screw into each other. *Bushes rustling in the wind:* a long shredded palm leaf. And so it goes on. So arm yourself with a greengrocer's stock, a knife and a bolster or two, and you can eliminate the whole neighbourhood in a matter of minutes.

ANGUS MCKENZIE reports a disgusting situation. Desmond, a sound editor, is hard at work in the Editing Room, chopping away and listening carefully to his monitor speaker. Suddenly, a discourteous belch from the speaker. Desmond is puzzled, but presses on. Another disgusting noise a few seconds later; and another, and another. Careful Desmond rewinds his tape and plays back. Not a thing; not a belch in earshot. Desmond is puzzled. He finishes his editing and takes his tape to George in the next room. There sits George behind a pile of onion sandwiches, a talkback microphone beaming over the whole scene. Suspicious Desmond turns detective and finds that the microphone is connected through the amps to his monitor speaker. Much angered mangling of onion sandwiches and George.

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WHARFEDALE 100.1 ...	£131 5 0	£105 0 0
TELETON CR55 ...	£120 0 0	£95 0 0

Starred items above take ceramic cartridges only. All others take both ceramic and magnetic cartridges. Except for Armstrong (where decoder is extra) all the above Tuner Amplifiers are complete with MPX Stereo Decoder.

SPEAKERS

	Rec. Retail Price	Comet Price
ARENA HT 16	£13 0 0	£10 19 0
B & W Model 70	£139 10 0	£115 0 0
B & W DM3	£63 0 0	£52 19 6
B & W DM1	£32 0 0	£25 10 0
CELESTION Ditton 120 ...	£24 0 0	£18 0 0
CELESTION Ditton 15 ...	£32 0 0	£24 0 0
CELESTION Ditton 25 ...	£65 0 0	£49 0 0
GOODMANS Minister ...	£22 9 0	£18 19 6
GOODMANS Majesta ...	£57 0 0	£44 19 6
GOODMANS Maxim ...	£20 7 9	£16 15 0
GOODMANS Mezzo 3 ...	£30 18 0	£22 19 6
GOODMANS Magnum K2	£40 2 0	£28 19 6
GOODMANS 3005 (pair)	£25 0 0	£18 19 6
KEF Celeste	£29 0 0	£21 10 0
KEF Concord	£43 10 0	£32 19 6
KEF Concerto	£53 10 0	£41 19 6
KEF Cresta...	£22 3 4	£17 19 6
KELETRON KN 654/3 3 speaker system (pair) ...	£19 0 0	£14 19 6
KELETRON KN 824/3 3 speaker system (pair) ...	£23 0 0	£18 19 6
KELETRON KN 104/3 3 speaker system	£16 15 0	£12 19 6
KELETRON KN 123/3 3 speaker system	£18 15 0	£15 19 6
KELETRON KN 120/4 4 speaker system	£24 10 0	£18 19 6
LEAK 300	£29 10 0	£20 19 6
LEAK 200	£23 0 0	£17 19 6
LEAK 600	£45 0 0	£32 19 6
LOWTHER Acousta (with PM6)	£45 10 0	£38 7 6
LOWTHER Acousta (with PM7)	£53 0 0	£45 19 6
LOWTHER Ideal Baffle ...	£35 10 0	£29 17 6
PHILIPS RH481	£11 0 0	£9 2 6
PHILIPS RH482	£18 0 0	£14 19 6
SINCLAIR Q16	£8 19 6	£7 19 6
STE-MA 275 3 speaker system	£23 2 0	£15 0 0
WHARFEDALE Speakers		
Airedale	£69 10 0	£55 19 6
Denton	£19 0 0	£14 19 6
Super Linton	£22 10 0	£18 10 0
Melton	£29 10 0	£22 19 6
Dovedale 3	£39 10 0	£29 19 6
Rosedale	£59 10 0	£46 19 6
TRITON (pair)	£55 0 0	£42 19 6
Unit 3 Speaker Kit ...	£11 19 6	£9 10 0
Unit 4 Speaker Kit ...	£16 0 0	£12 10 0
Unit 5 Speaker Kit ...	£23 10 0	£17 19 6

TURNTABLES

GARRARD SP25, fully wired with Goldring G800 Magnetic Cartridge. Complete with base, plinth and cover. Special price £20 19 6.

	Rec. Retail Price	Comet Price
ARENA SP25, with base and cover	£22 1 0	£17 19 6
DUAL 1219 transcription...	£60 8 0	£49 19 6
DUAL 1209 transcription...	£42 12 4	£34 19 6
GARRARD SP25, Mk. II ...	£15 11 4	£10 10 0
GARRARD AP75 ...	£23 16 0	£17 10 0
GARRARD SL65 B ...	£19 6 5	£14 19 6
GARRARD SL75 B ...	£35 12 4	£27 10 0
GARRARD SL95 B ...	£45 9 1	£36 10 0
GARRARD 401	£31 14 2	£25 19 6
GARRARD SL72 B ...	£30 2 0	£24 19 6
GARRARD 3500, with GKS Cartridge	£15 15 0	£11 19 6
Base and Cover to fit GARRARD SP25, SL55, SL65B and 3500	Special price	£3 19 6
GARRARD 40B	£12 11 3	£9 19 6
GOLDRING 705/P ...	£26 0 0	£21 19 6
GOLDRING GL69 Mk. II ...	£26 12 6	£21 10 0
GOLDRING GL69 P Mk. II	£35 5 9	£27 19 6
GOLDRING GL75 ...	£39 0 0	£32 19 6
GOLDRING GL75 P ...	£47 13 4	£39 19 6
GOLDRING Covers for 69P and 75P	£4 6 7	£3 10 6
GOLDRING GL 75 complete with plinth, cover and G800 E Cartridge ...	£67 19 0	£53 19 6
GOODMANS 3025 ...	£37 14 9	£25 19 6
McDONALD MP 60 ...	£15 0 0	£10 19 6
McDONALD 610 ...	£18 19 6	£13 19 6
Base to fit McDONALD turntable	£3 13 0	£3 2 6
Cover to fit McDONALD turntable	£2 12 0	£2 2 6
PHILIPS 228	£19 19 6	£16 19 6
PHILIPS GA146	£31 10 0	£24 19 6
PHILIPS 217	£33 0 0	£27 4 0
PHILIPS 202 Electronic ...	£69 0 0	£54 0 0
PIONEER PL11	£50 17 11	£39 0 0
THORENS TX 25 cover ...	£8 4 5	£6 10 6
THORENS TD125... ...	£75 17 8	£61 19 0
THORENS TD 150A Mk. II	£43 12 7	£35 10 0
THORENS TD 125AB ...	£120 2 11	£99 19 6
THORENS TD 150AB Mk. II	£47 8 7	£39 5 0
THORENS TD TX11 Cover	£4 2 3	£3 13 6

PICKUP ARMS

	Rec. Retail Price	Comet Price
GOLDRING Lenco L75 ...	£12 6 6	£10 10 0
GOLDRING Lenco L69 ...	£9 5 9	£7 0 0
SME 3009 with S2 shell ...	£34 9 5	£27 19 6
SME 3012 with S2 shell ...	£36 14 3	£29 19 6

HI-FI STEREO TAPE DECKS AND TAPE RECORDERS

	Rec. Retail Price	Comet Price
AKAI X200D	£190 0 0	£159 19 6
AKAI 1800SD	£199 8 4	£167 0 0
AKAI 4000 4-track Stereo	£124 18 0	£99 19 6
AKAI 4000 D 4-track Stereo deck	£89 19 1	£69 19 6
AKAI 1710L 4-track Stereo	£89 17 0	£69 19 6
FERGUSON 3246 4-track...	£43 0 0	£33 19 6
FERROGRAPH 722 ...	£242 10 9	£202 0 0
FERROGRAPH 724 ...	£242 10 9	£202 0 0
GRUNDIG TK 121 (Twin-track)	£54 15 7	£43 19 6
GRUNDIG TK 149 4-track	£57 12 8	£47 19 6
PHILIPS 4500 4-Track Stereo Tape Deck	£126 0 0	£98 19 6
PHILIPS 4408 4-Track Stereo	£139 0 0	£109 0 0
TOSHIBA GT 840 S ...	£110 0 0	£79 19 6
TOSHIBA GT 601v Twin Track	£45 3 0	£29 19 0
TOSHIBA 850 SA	£94 0 0	£59 19 6

COMET Hi-Fi DISCOUNT WAREHOUSES

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or Dept.SS 68A Armley Rd. (Artist St.) Leeds LS12 2EF. Tel. 32055 (5 lines) *(Service Dept., New Road Side, Horsforth, Leeds)*

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