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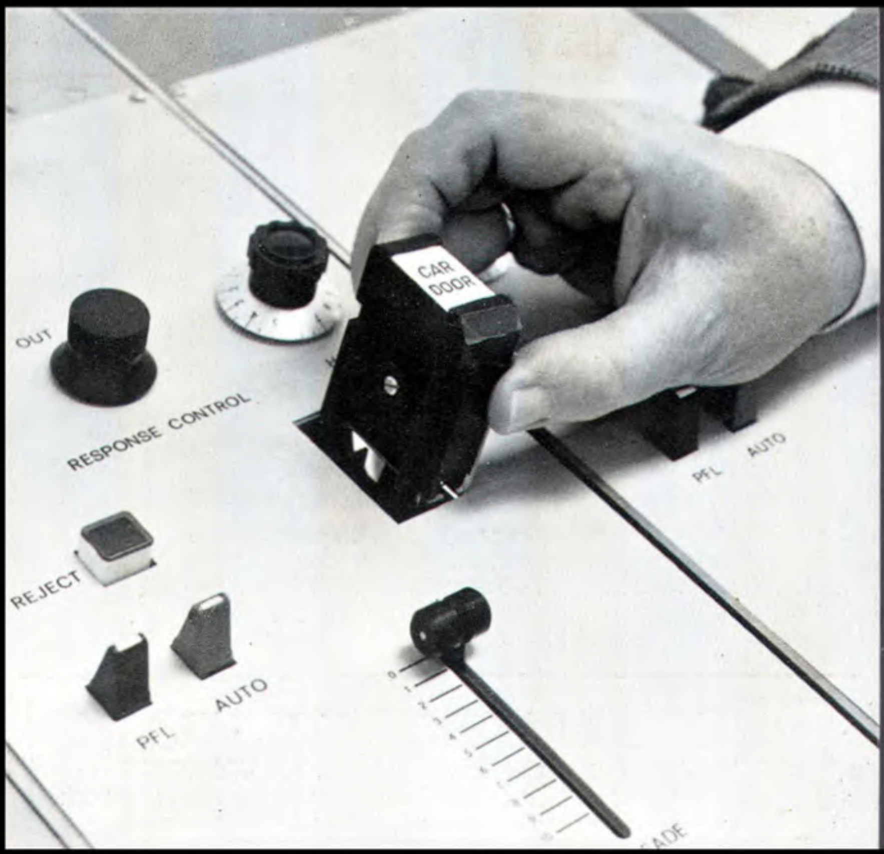

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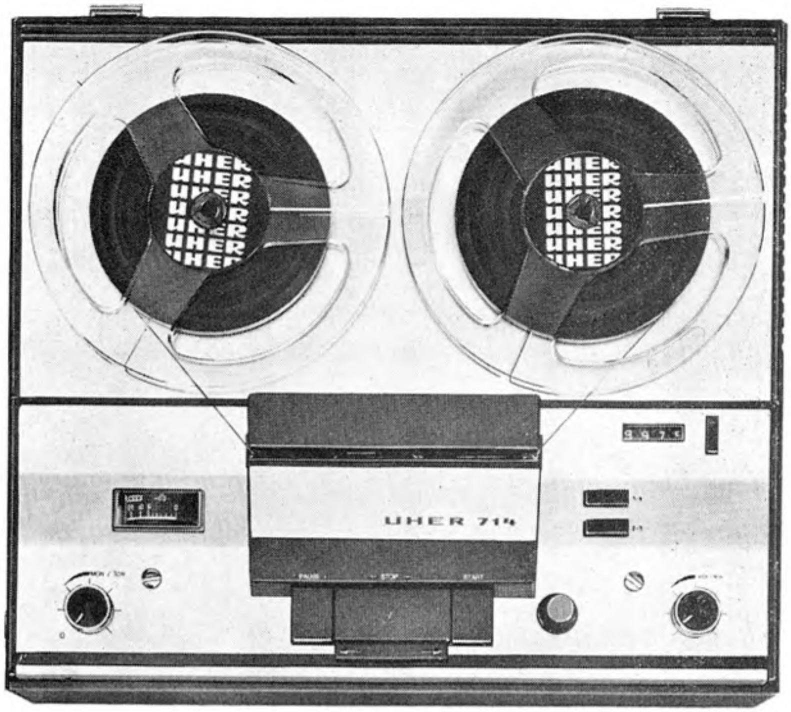

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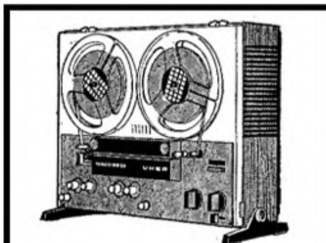

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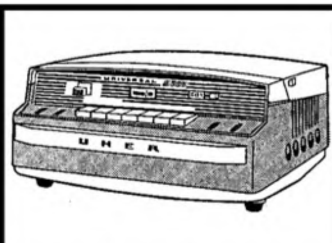

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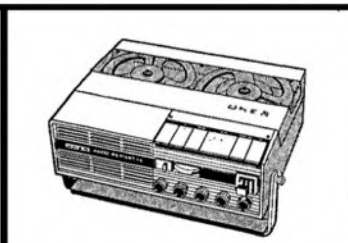

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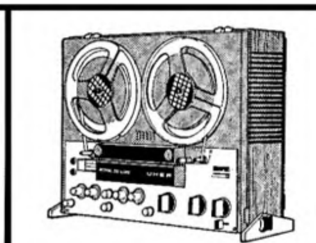

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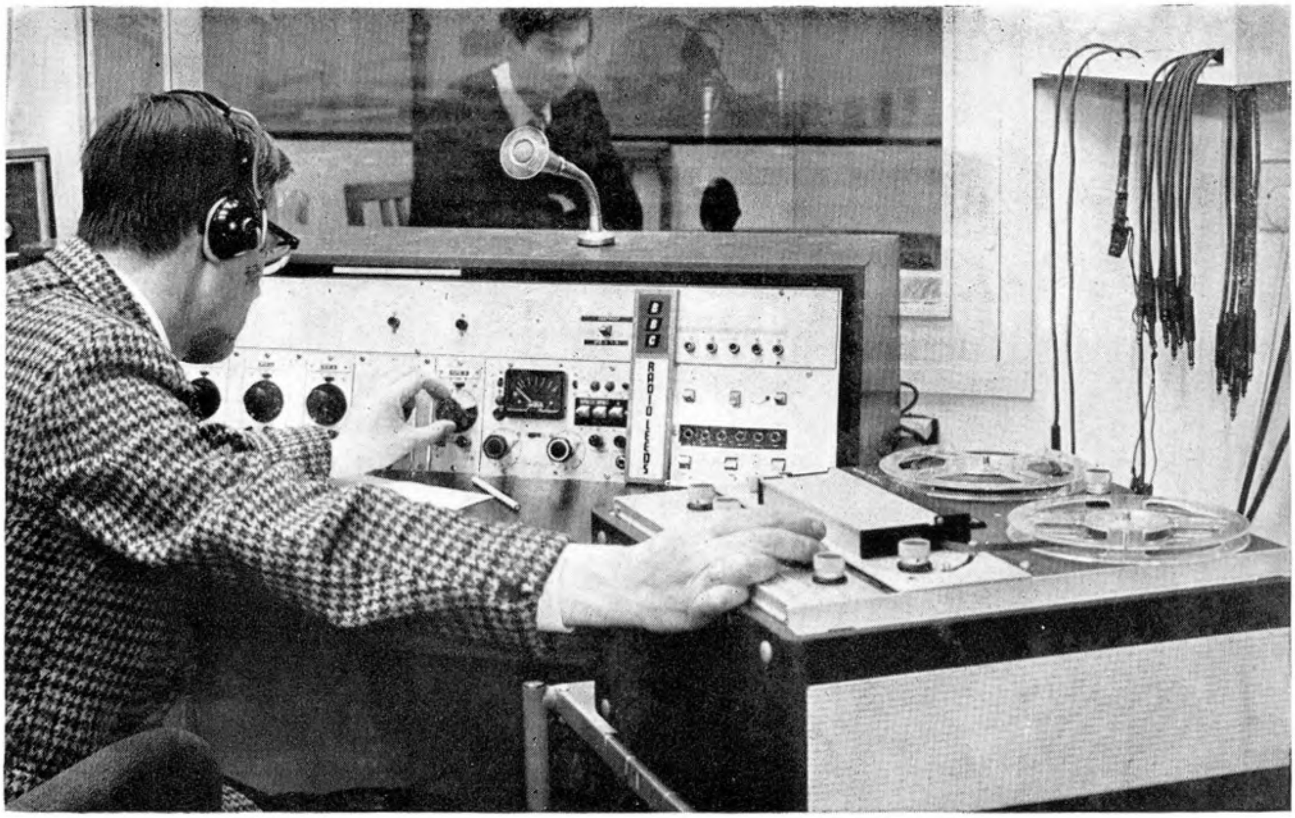

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Studio Sound
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APRIL 1970 VOLUME 12 NUMBER 4

INCORPORATING
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Telephone: 01-686 2599

COVER PICTURE

Part of the Mellotronics Programme Effects Generator described by Keith Wicks on page 140. One example of automated tape handling.

SUBSCRIPTION RATES

Annual subscription rates to *Studio Sound* and its associated journal *Hi-Fi News* are 30s. ($4.30 or equivalent, overseas) and 44s. ($5.60) respectively. Six-month home subscriptions are 15s. *(Studio Sound)* and 22s. *(Hi-Fi News)*, from Link House Publications Ltd., Dingwall Avenue, Croydon CR9 2TA

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

THE INCREASING complexity of multichannel mixers provoked a comment, during the recent BKSTS Mixer Symposium reported in this issue, on the need for some form of computer assistance in sound balancing. The 16-channel *Sound Techniques* mixer on last month's cover is typical of the elaborate systems now being installed in London's multitrack studios. This unit, built for Trident, contains in the region of five hundred controls, every one of which has to be adjusted whenever the mixer is used to its maximum channel capability. The number of control-position permutations is beyond human imagination.

While the fascination of artificially-generated effects continues to dominate pop circles, there is unlikely to be a return to simpler recording systems. Four-channel (quadr*a*phonic, quadr*i*phonic or quadr*o*phonic—the industry has yet to solve that one) reproduction can only increase mixer complexity. It has already done so at Olympic Studios, where an American engineer, Michael Shields, has learnt to drive a 'vector pan pot'. This is a 360° version of the familiar left-to-right stereo pan and can be used either to shift a sound image or to rotate it endlessly round the room.

The four-channel (from an 8-track master) Royal Albert Hall recordings of Verdi's *Requiem* will be three weeks into history by the time this issue appears. This venture marks the entry of CBS into the four-channel market (theirs is *Quadraphony*). Philips have also entered the field, in the USA, and are trying to sell *Quadrophony*.

Two significant developments have occurred since Alec Nisbett's survey of four-channel techniques (March issue) was written. On this side of the Atlantic, Michael Gerzon has proposed a method of broadcasting three-channel audio from an FM multiplex transmitter. The subject of a patent application, his QUART (QUadratic Ambience with Reference Tone) system is described as being compatible with mono and two-channel reception. Audio quality would 'not be greatly inferior to the quality of a conventional (Zenith-GE) stereo broadcast'. Interested members of the industry are invited to contact him for details*.

In the US, Peter Scheiber is attempting to patent a four-into-two (and back again) coding system which might conceivably delay the demise of the gramophone record. One report (not attributable to Larry Klein, page 139) suggests that Scheiber takes advantage of hitherto ignored human hearing characteristics, rather as Dr Dolby has successfully done. It agrees with Klein's comments on the low crosstalk level *when one channel is operative*, but predicts a more obscure sound image when all four channels are pumping out simultaneously. This is only surmise, however. We shall have to wait and see.

Change of subject: It seems only a few months ago that we were asking readers to pay sixpence more than the two-shillings *Tape Recorder* had previously cost. Looking back we find that it was actually two years ago. Faced with continuing inflation in printing and paper costs, we are now forced up in price (from next month) by a further sixpence. We can only hope that readers will continue to bear with us and that the inflationary spiral will level off in the course of the *next* two years.

**M. A. Gerzon, Mathematical Institute, 24-29 St. Giles, Oxford, OX1 3LB.*

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Model TC-630, recommended retail price £199:15:0

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Recording system 4-track stereo/mono recording and playback.
Power requirements AC 100, 110, 117, 125, 220 or 240V, 50/60 Hz.
Power consumption 40 watts.
Tape speed $7\frac{1}{2}$ ips (19 cm/s), $3\frac{3}{4}$ ips (9·5 cm/s) $1\frac{7}{8}$ ips (4·8 cm/s).
Reel capacity 7 in. (18 cm) or smaller.
Frequency response 30 Hz–22 kHz at $7\frac{1}{2}$ ips; 30 Hz–13 kHz at $3\frac{3}{4}$ ips; 30 Hz–10kHz at $1\frac{7}{8}$ips.
Bias frequency 160k Hz.
Wow and flutter 0·09% ot $7\frac{1}{2}$ ips; 0·12% at $3\frac{3}{4}$ ips; 0·16% at $1\frac{7}{8}$ ips.
Power output 15 watts per channel.
Signal-to-noise ratio 50 dB.
Harmonic distortion 1·2% at rated output (overall); 0.5% at rated output (amplifier).
Level indication Two VU meters.
Inputs Microphone: sensitivity –72 dB (0·2 mV), impedance 250 ohms.
Tuner: sensitivity –22 dB (0·06V), impedance 100k ohms.
Auxiliary: sensitivity –22 dB (0·06V), impedance 560k ohms,
Phono input (MM or MC cartridge): sensitivity –53 dB (2 mV), impedance 14k ohms.
Outputs Line: output level 0 dB (0·775V), impedance 100k ohms.
Headphone: output level –28 dB (30 mV), impedance 8 ohms.
External speaker: impedance 8 ohms.
Lid speaker: impedance 8 ohms.
Rec/PB connector Input: sensitivity –40 dB (7·75 mV), impedance 10k ohms.
Output: output level 0 dB (0·775V) impedance 100k ohms.
Dimensions $17\frac{7}{8}$ in. (w) x 20 in. (h) x $11\frac{5}{8}$ in. (d).
Weight 46 lb. 3 oz.
Supplied accessories Microphone (F-45) (x2), Sony pre-recorded 5 in. tape, Sony empty reel (R-7A), connection cord (RK-74), head cleaning ribbon, reel cap (x2).
Optional accessories Speaker system (SS-3000), telephone pick-up (TP-4), stereo headset (DR-5A) (8 ohms), microphone mixer (MX-6S).

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studio diary

FOUR-CHANNEL DISCS

WRITING IN the December 1969 *AES Journal*, Peter Scheiber of Bloomington, Indiana, claims to have developed a basically simple method of encoding four-channel audio information into the two channels of a conventional stereo tape or disc recording system, decoding to four channels in the playback channel. The claim is backed by the Audiodata Company of Rochester, New York, and a demonstration of the equipment is reported by Larry Klein in a recent issue of the American *Stereo Review*. Mr Scheiber's system is described in his AES letter as the product of a 'powerful design method of particular value in dealing with atypical or complex design goals'. It yields 'four full-bandwidth output channels without adding distortion'. 'The encoded signals may be recorded on tape or disc, or broadcast by conventional FM multiplex methods.' The solution to the problem 'was not found in bizarre or exotic circuitry unavailable to the average engineer'. The components of the decoder need be no more expensive than the extra pair of tape replay preamps needed to reproduce a 4-track stereo Vanguard tape. Encoded four-channel material may be reproduced without a decoder in two-channel stereo, the system therefore being potentially compatible.

AMPEX 'TIME MACHINE' ON BBC 2

AN AMPEX HS-100 video disc system was shown before BBC 2 cameras during the Christmas period at the Royal Institution, London. The equipment featured in the last of six Christmas lectures for young people, this being devoted to the subject of 'time machines'. Wilson Scullion, Professional Video Sales Manager of Ampex GB, demonstrated the system's 'action replay' facility as an example of man's ability to 'control time'.

COMPONENTS FOR THE ATTEWELL MICROPHONE

READERS APPEAR to be experiencing difficulty in obtaining small pieces of gauze for the hypercardioid capacitor microphone described for constructors in the January, February and March issues. The author has therefore made arrangements with Bedford Steer End & Co. Ltd., who will supply a piece of 10 mesh x 24 SWG brass gauze, size 6 x 12 inches (enough for three attempts) at 15s post-paid, cash with order. Rather expensive but better than the minimum charge of £5 quoted by other firms. Full address is: Bedford Steer End & Co. Ltd., 74-84 Long Lane, London SE1.

The high-value resistors can be obtained from Welwyn Electric Ltd., Bedlington, Northumberland (Tel. Bedlington 2181). Welwyn's agent in North-West London is The Radio Resistor Co. Ltd., Palmerston Road, Harrow, Middlesex.

TONMEISTER COURSE

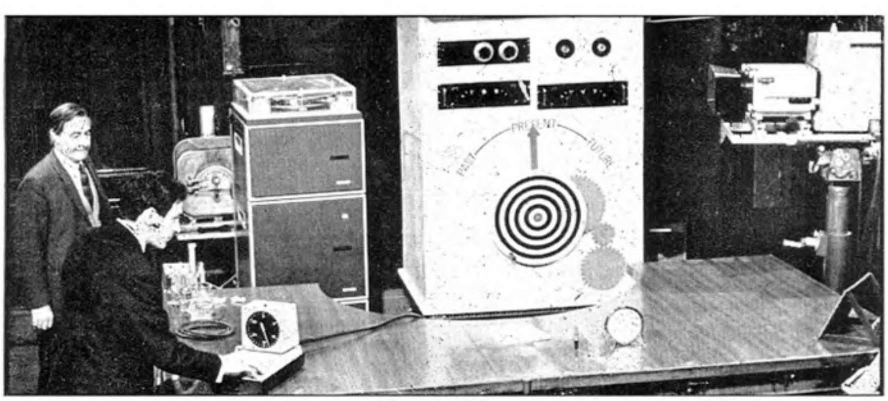
A COURSE COMBINING 50% music and 50% sound recording is to be started this autumn at the University of Surrey, Guildford. It is believed to be the first to offer formal training in studio sound techniques and adopts the *Tonmeister* title.

MOOG FOR HIRE

A TYPE THREE Moog Electronic Music Synthesizer is now available for short-term hire at Advision Studios, 126 Great Portland Street, W1. The unit's owner, Mike Vickers, may also be hired to instruct users in its operation. Charges have not been decided at the time of writing.

DOLBY USED IN FILM PRODUCTION

MUSIC TRACKS recorded by Bob Auger (Granada) for the film 'Battle of Neretva' recently were produced with the aid of a Dolby *A301* noise reduction system. The sessions were taped on 3-track 12.5 mm equipment and transferred to 3-track 35 mm magnetic film which will be used in compiling the final sound track. Artists involved were the London Philharmonic under Bernard Hermann. There are signs that the Dolby system will be used to its full advantage by incorporating a playback processor in the sound reproduction system of individual cinemas.



CBS INSTAL 16-CHANNEL DESK

A 16-CHANNEL mixing desk, the first of several systems ordered from Rupert Neve, has been installed at the Theobalds Road, WC1, head office of CBS Records. An unusual feature is its light-beam level meter, manufactured in Switzerland. The desk was hauled into the studio through a fourth-floor window and one of its first tasks was the mixing and reduction of Debussy's *Pelleas et Melisande*, a Royal Opera House production conducted by Pierre Boulez.

BKSTS SYMPOSIUM ON SOUND CONTROL CONSOLES

STUDIO MIXERS, faders and their ancillaries were the subject of a BKSTS symposium held during the afternoon and evening of January 28 at the ITA Conference Suite, Brompton Road, London, SW3, attended by nearly 100 members and visitors.

In the afternoon, under the chairmanship of A. W. Lumkin (Head of Engineering, Associated British Picture Corp.) general design principles were covered by A. R. Neve and G. Watts of Rupert Neve & Co. Ltd. Mr Neve began by outlining the conflicting requirements demanded by modern studio working and referred to the simpler desks of a decade ago, when the number of channels was relatively low, passive networks and balanced lines were used, and valves were the only choice for really high quality systems. Turning to the present day, he said that transistors now allow a system performance that would have been unobtainable with conventional valves, because of noise and hum problems, although even now it was necessary to exercise extreme care in design, due to the number of stages of control now required and the number of channels which could be grouped and mixed. Specifications were often very tight, with distortion figures usually the most difficult to meet, and circuit simplicity was usually an advantage if the optimum path between noise and overload levels was to be maintained.

On faders, Mr Neve demonstrated that even high quality stepped models gave audible discontinuities when varying the level of test tones. Continuously variable types were therefore normally preferred. He then went on to discuss the broad requirements for the amplification, tonal control and matrixing of signals, with examples of reduction from eight channels to stereo or mono. He was emphatic that only the highest quality moni-

(*continued on page 159*)

NEXT MONTH

THE APRIL **STUDIO SOUND** will carry reviews of the Philips Pro 12 (by Terence Long) and Ferrograph Seven (by Stanley Kelly). Keith Wicks visits the new Advision studios while David Kirk turns the tables on interviewer Arthur Garratt. Tony Waldron describes a remote control unit for the Revox 77. Professional tape recorders will be surveyed.

PEG from the BBC

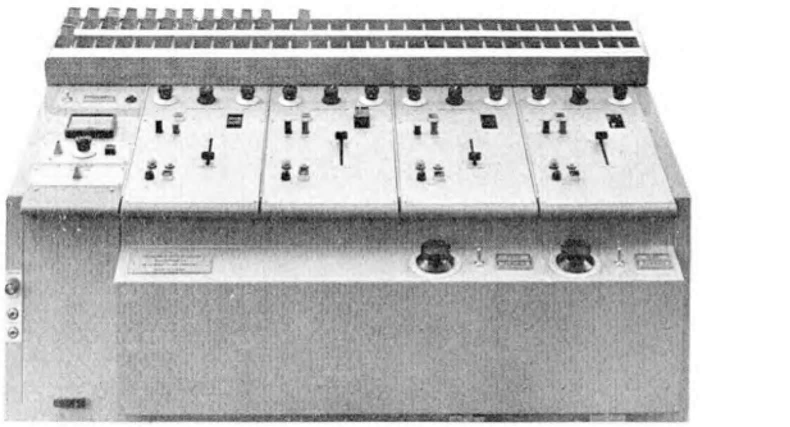
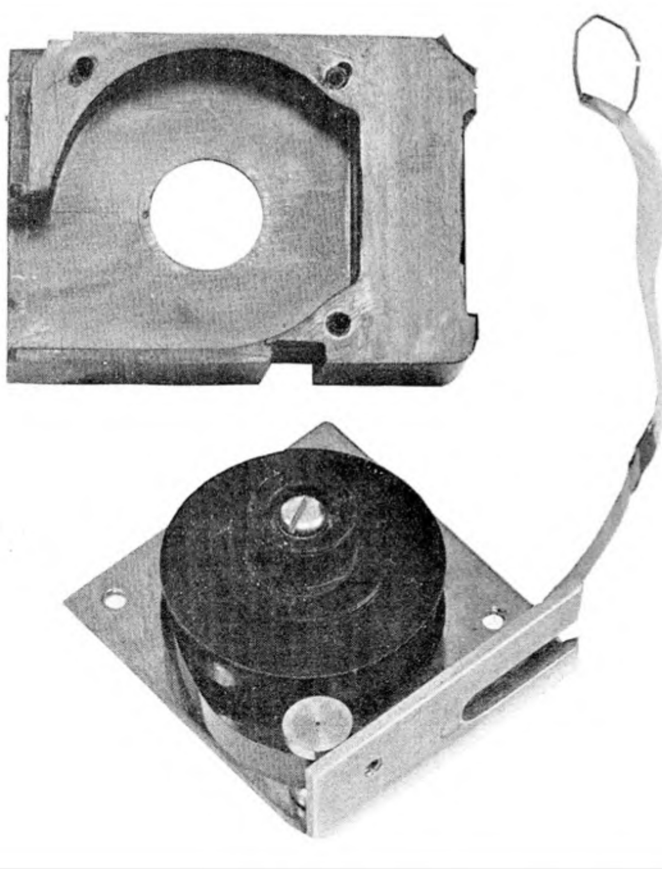


FIG. 1 PEG control panel and storage tray.

FIG. 2 Internal assembly of a PEG cassette.



'SEE what you think of Peg, and get some pictures.' It sounded to me like a pretty good assignment but, alas, Peg was not the 36 x 24 x 36 I had hoped for; more like 38 x 22 x 20 or, if we *must* use metric these days, 960 x 545 x 510 mm. Unusual proportions you may think, until you realise that Peg is in fact PEG or, to be more precise, the BBC's Programme Effects Generator.

My visit took me not to the BBC but to the premises of Mellotronics Limited, well known for their Mellotron sound-effects console which was described by David Kirk in the February 1966 issue. Under licence from the BBC, Mellotronics are now producing PEG which is illustrated in **fig. 1.** It is a four-channel tape cassette machine designed primarily as a source of sound effects, and intended to replace the bank of turntables and associated equipment normally used to provide effects in BBC studios.

Let us first consider the disc system and some of its inherent disadvantages. It involves fine-groove discs played on Garrard turntables fitted with BBC-designed fast-start mechanisms. Just above each turntable is an aluminium plate which carries the disc. By lowering the plate on to the turntable, which is left running, the disc can be brought up to speed within about a quarter of a second, which is quite satisfactory. The problem is that the gram operator has first to listen to the disc on 'prefade', find the start of the effect, stop the disc, then manually move it back a fraction of a turn. The pickup is left in contact with the disc, so the effect should then be almost immediately obtainable by relowering the plate and fading up the channel. The procedure uses up time, which is an important factor because of the large number of effects used in some programmes, and may necessitate the assistance of a second operator. A disadvantage of standard turntables is that the available speed variation is fairly low (about $\pm5\%$) whereas, for versatility, it is desirable to be able to vary the speed over a much greater range. The BBC therefore decided to design new equipment specifically for the purpose of providing effects in a more convenient way.

Many possible systems have been considered and tried with some degree of success. These all involve the use of tape, as it is generally more convenient than disc in that the quality of the recording is less likely to deteriorate. Also, since the system is to be time saving, some degree of automation is necessary. Tape is much more suitable than disc in this respect.

One way to simplify operations during a programme involving a large number of effects would be first to record them in sequence on a standard tape machine. Unfortunately, this would be time consuming, and often a single tape cannot cope with the situation. For example, a spot effect such as a car

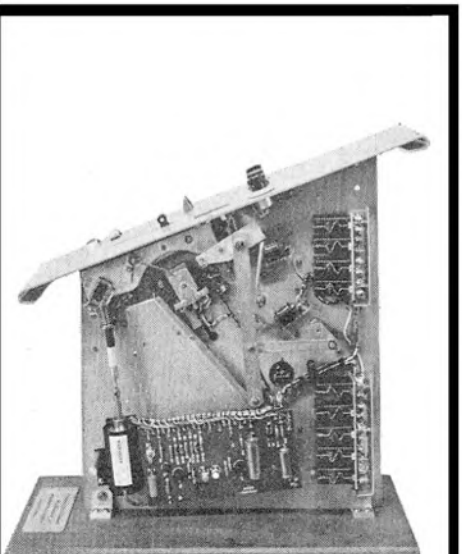
keith wicks describes the mellotronics programme effects generator

crashing may be required at one particular point in the dialogue, in addition to a continuous background atmosphere effect. A tape containing the background atmosphere and, at some point, a car crash effect, would not be very suitable from an operational point of view. It would clearly be undesirable to have to time the dialogue to fit the prepared effects tape in order for the crash to occur at the right time in relation to the speech. Any error in timing could lead to embarrassing discrepancies between the effects and the dialogue. 'Look out, they're going to crash!' loses most of its dramatic effect if the listener has just heard the crash take place.

I am told that in the early days of tape, similar disasters did occur but for different reasons. The problem of print-through used to be quite bad and occasionally, in recorded drama, printed gunshots would forewarn the listener of the violence to come.

Clearly then, not only must an effect occur precisely when required; in addition there must be no noticeable unwanted noise of any kind introduced by the insertion of the effect. A problem of discs used by the BBC is that one can often hear severe surface noise just before and during the effect. Of course the situation could be improved by careful handling of the discs and their more frequent replacement. However, to avoid the problem altogether is better, and the use of taped effects does just this.

FIG. 3 Tape storage reservoir.



Besides using a number of effects recorded in sequence, there are many other possibilities. For a series of programmes, many of them requiring the same sounds, a tape can be compiled containing the effects, the start of each one being marked by pulses on a second track. The location of any effect could then be automated, selection being effected either by coded buttons or by dialling. The main trouble here is the sometimes lengthy spooling time required between items, and this limitation points to the desirability of having a number of separate taped effects available for immediate use. Besides overcoming the difficulties of an 'in-line' tape system, this would be more versatile and allow the mixing of effects during the programme. A number of standard tape machines is of little use for this kind of work because the time required to load and unload each tape would be prohibitive.

There are two possible solutions. One is to avoid loading and unloading by using an instrument such as the Mellotron, mentioned earlier. Briefly, this looks rather like an electronic organ, each key operating a pre-recorded tape. Certain adjustments allow several effects to be available at each key and a total of 1 260 can be stored in the instrument. The start is virtually instantaneous and, on releasing the key, the tape is automatically reset at high speed, ready to be replayed once more. This is a most useful facility, and means that individual sounds such as gunshots can be synchronised with the action of a play very easily, as the rewind time for such an effect would be a fraction of a second. A whole battle could be created by using a number of different gunshot recordings. Elaborate operations of this kind require a special skill on the part of the operator—the digital dexterity of a pianist. The main disadvantage of the Mellotron as far as broadcasting is concerned is that the maximum duration of each recording is only eight seconds. Also, it is not very easy to change the stored material.

Instead of a highly complicated machine of this kind, a system using individual effects contained in cassettes was considered much more suitable, and PEG was at last conceived.

When PEG was developed, there were several different types of cassette available which might have been used in the system, but none were ideal for the purpose. It was considered essential to provide the quick return facility of the Mellotron and this ruled out endless loop cartridges as they do not take kindly to winding at high speeds. Other existing cassettes employed two small reels and the minimum rewind time was still too long, so a new cassette had to be designed for the purpose. A single spool design was arrived at, and the inside of this is shown in **fig. 2.** The free end of the tape has a metal loop attached to it which is engaged by the lacing mechanism in the reproducer on insertion of the cassette. When the tape is played it is allowed to drop into a triangular shaped reservoir compartment, which can be seen just above the printed circuit board in **fig. 3.** Rewind time is greatly reduced, as only one spool has to be turned; it is small and light, and there is little opposing friction.

The small spool size, which does of course limit the maximum duration of the recording, was the result of a design compromise. A speed of 19 cm/s and standard 6.25 mm tape were chosen. The possibility of employing the 3.8 mm tape used in Philips cassettes was considered, as was the use of LP tape, but for highest reliability Standard Play tape was chosen as this would best stand up to the inevitable occasional high tensions caused by the use of a fast rewind system. A maximum running time of 30 seconds was settled on because this would be sufficient in nine cases out of ten. Obviously a line had to be drawn somewhere and this duration permitted the spool dimensions to be kept down and the total rewind time short. The spool diameter is 320 mm and the cassette itself measures about 60 x 40 x 20 mm. Rewind time is approximately one tenth of the playing time so that the whole spool is rewound in about three seconds and short effects such as gunshots almost instantaneously.

The standard PEG has four channels, which should be adequate for most productions. Although more gram units than this are usually considered necessary, the PEG system is much quicker to set up and, as we shall see, more versatile in operation, so less channels are required. (When additional facilities *are* needed, a two-channel auxiliary unit can be used in conjunction with the standard unit.) Construction is on a modular basis and, if a fault occurs on one channel, the module can be quickly removed and a spare inserted without affecting the other channels.

To play a cassette, it is first pushed into a slot in the module, where it latches in place. When this has been done, a lacing mechanism engages the wire loop attached to the end of the tape, and drags it over the replay head and transport system. Within two seconds of inserting the cassette, the tape is thus brought to the STANDBY position and a green RUN button illuminates, indicating that the channel is ready for operation. The tape starts immediately the button is pressed and the reproduced level is controlled by means of a quadrant fader. Visual monitoring of the PEG output is effected by a PPM or a VU meter mounted on the left of the console. A small loudspeaker is provided for aural monitoring although headphones would normally be used. Aural prefade facilities are

(continued on page 143)

PEG from the BBC

provided on all channels. Bass and treble controls with associated in/out switches enable the output of each module to be modified when necessary. As soon as a RUN button is released, its light goes out and, as with the Mellotron, automatic rewind takes place, this condition being shown by the illumination of a rewind indicator. When the tape is back in the STANDBY position, the RUN button illuminates once again.

For effects lasting more than a few seconds, it is inconvenient to have to hold down a button and to get over this a switch marked AUTO is provided on each module. In the 'down' position this causes the tape to continue playing after momentary operation of the RUN button. To stop the tape, the AUTO button is returned to its normal position, which again causes automatic rewinding to take place. If a cassette is left running, a lamp operated by a timing circuit will start to flash about five seconds before the end of the tape as a warning to the operator. For very long effects, it is necessary to cross fade from one cassette to another. As the tape itself is not visible, an end-warning device of this kind is essential. When the end of a tape is reached, this is detected by a photo-electric system (the end of the tape is transparent), and automatic rewind takes place. Whenever the tape is being rewound, the channel output is muted in order to prevent unwanted noise at the output of the console. After rewinding, the cassette may be rejected or left ready to run again.

On the standard console, variable speed facilities are available for the right-hand module. The drive motor may be switched either to the mains supply or to the output of a VFO which is mounted on the bottom of the trolley. More than one module position can be adapted for variable speed working if required, by the installation of extra oscillators and controls. Normally one is sufficient.

The use of tape instead of discs makes the system versatile in a way not yet discussed. PEG relies mainly on the existence of a library of prerecorded cassettes but, when necessary, new effects may be manufactured using the record facility provided on Chanel One. When the button situated just below the meter is pressed, it illuminates to show that Channel One is in the record mode. A recording can be made by pressing the RUN button, provided that the cassette used has been fitted with a special screw-on stud. This acts as a safety device and operates a microswitch in the module, allowing the record circuitry to be energised. Subsequent removal of the stud prevents any operational error from erasing a wanted tape. A safety device such as this is very important, and I'm sure that most of us, even if we would not admit to doing it ourselves, have at least *heard* cases of recordings being accidentally spoiled during attempted copying.

An input selector switch near the RECORD button allows a choice of source. In the EXTERNAL position, the record amplifier input is switched to a Cannon connector to which a high level source may be plugged. (Input impedance above 50 K, balanced.) When switched to INTERNAL, a recording can be made of any or all of the other channel outputs. The input signal can be adjusted by the record level control and monitored on the panel meter.

To simplify operations during a programme, several short effects required consecutively can be copied on to one cassette. During my visit to Mellotronics, Peter Nichols (services manager) and Michael Tippett (general manager) put PEG through her paces, and I was most impressed by the performance. One demonstration was the recording in sequence of: approaching footsteps, car door opening, and car driving off. This would presumably be a fairly common series but, rather than keep a large number of combinations involving different types of footsteps and car noises, and various durations thereof, it is more convenient to make up a tape to one's exact requirements prior to the programme. Such sequences can be assembled very quickly once the component tapes have been chosen, and the more use that is made of this facility, the smaller the risk of errors occurring during programmes.

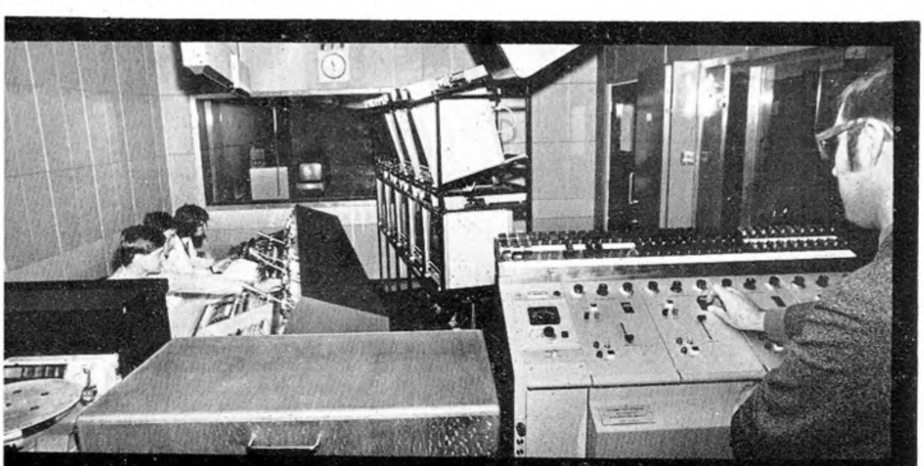
Use of the record mode is sometimes essential because of the machine's inability to start playing part of the way through an effect. If a particular section of the tape is required, it is no use playing it up to that point and then stopping it, for the rewind mechanism will automatically come into action. Sometimes it would be possible to time the effect and, with the fader out, start the tape the appropriate number of seconds early. This is often referred to as a prefade start, and the material can be monitored on prefade before the required part of the effect is eventually inserted into the programme by advancement of the channel fader. There are obvious difficulties with such a method, and these can be overcome by using the recording facility. Before the programme, the original cassette is played, and Channel One started in the record mode at the appropriate point in the effect. The new tape thus starts at this point, and so can be handled in the conventional way. This part-copying process is essential when timing accuracy is critical.

The main disadvantage of PEG is to my mind the short duration of the tapes. Although as I have explained, most effects are less than 30 seconds long, occasionally such things as 'outdoor atmosphere' or 'factory noises' are required for several minutes at a time. To improve matters in this respect, Mellotronics have introduced cassettes with DP tape to give a maximum duration of one minute. The tape used does apparently stand up to the tension caused by PEG's fast rewind system. If a one-minute cassette is used, strictly speaking, a modification is required to the module because the end-warning is needed after 55 seconds instead of 25 seconds. When very long duration effects are required, two cassettes are needed so that the operator can cross-fade from one to the other. Trouble arises when there is a noticeable rhythm in the sound—for instance footsteps—and the operator may need a few rehearsals to ensure that the pedestrian does not appear to hop or speed up during the change over from one cassette to another. Most operators would be able to cope with this problem. A sound-effects man I met recently told me that he found it most annoying to have to keep performing changeovers in this way, and considered it best to use a disc to provide long duration FX. Since grams are always available, this seems a reasonable thing to do, but it does mean that both cassettes and discs would have to be produced. Another point that he had to make was that he liked to glance at a disc during use in order to estimate the remaining playing time, whereas with PEG you cannot see the tape. Personally, I don't think this matters much as the five-second warning given before the end of the tape should be good enough for most purposes. Apart from these two points he was very much in favour of PEG.

A disadvantage of the cassettes themselves is the fact that, although small, they are still a bulky way of storing 30 or 60 seconds of material. As they are simple and robust, their life should be longer than the life of discs,

(continued on page 145)

Fig. 4 Four-channel PEG at Television Centre



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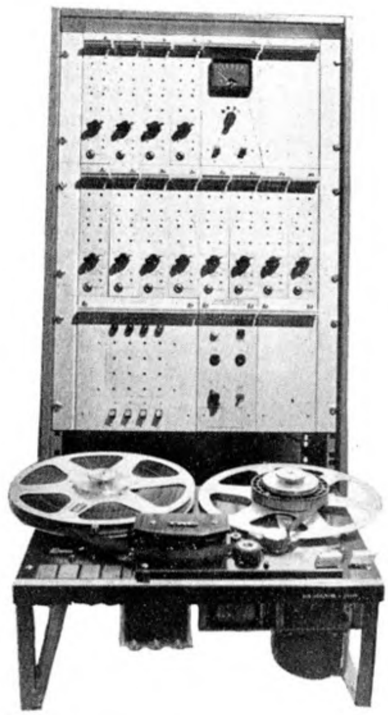

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OUR READERS *write*

. . . about 50p capstans

From: Terence Long, West Lodge, Totteridge Lane, London N20

Dear Sir: With reference to your interview with John Alcock, I have always been under the impression that centreless ground steel capstans, having a series of flat sides like the present 50p piece, are only reserved for cheap and nasty domestic recorders. As for finish-turned capstans, there are no such things these days.

The finest capstans are made from steel or bronze, turned and ground between centres, finally plated with hard chrome, re-ground and super-finished.

Nothing less than the best should be used on Unitrack equipment. *Yours faithfully*

John Alcock comments :

Terence Long is quite correct, strictly speaking, though we have been able to maintain relatively tight tolerances by careful selection from production batches of centreless ground capstans. We have in fact gone over to grinding between centres on our wide-tape multitrack models.

Nothing less than the best is *used on Unitrack equipment* !

. . . about a Messiah videotape

From: Howard M. Dell, 20 Vyners Way, Ickenham, Uxbridge, Middlesex.

Dear Sir: We engineers who work at the BBC TV Centre are becoming increasing'y irritated by the continuing perpetration of the myth that the videotape of the *Messiah* was wiped whilst preparing it for Christmas transmission ('Studio Diary', February 1970).

Will you please make the point clear to your readers that the story was the admitted fabrication of a columnist on one of the national dailies. In fact, the tape had been deliberately erased earlier in the year upon executive's instructions, in accordance with normal tape library clearance procedure.

Yours faithfully

'Admitted fabrication' is unnecessarily strong language but Mr Dell and his colleagues have every right to be irritated. The videotape in question **was** *accidentally erased though the fault was not theirs as most reports implied. An administrative accident resulted in the 'Messiah' being consigned for erasure when in fact it was required for later broadcasting. A newspaperman's assumption that everyone in the BBC is an engineer seems to have done the rest.*—**Ed.**

. . . about early stereo

From: Bob Auger, Halfacre, Bix, Henley-on-Thames, Oxfordshire

Dear Sir: I am rather interested by Angus McKenzie's remarks in his first article on recording studio techniques in regard to some of the early Pye stereo LP's and, in particular, to his quite truthful comment that Larry Adler's harmonica appeared to be three metres wide. It occurs to me that some of your readers may be interested to know how this phenomenon came about.

All the early Pye stereo recordings were made using two microphones only, with the capsules arranged exactly as per the photograph on the front cover of your January issue. As the soloist was only standing a third of a meter or so away from the microphones (the orchestra being picked up in stereo over his shoulder, so to speak) it is easy to see that a slight movement of his head causes the tiny solo instrument to move from the axis of one microphone over to the other.

It is principally because of this kind of problem that Pye, and all other companies, eventually got round to the practice of providing the soloist with a separate microphone which was injected into the stereo system so as to appear to come from between the two loudspeakers. One of the great advantages of this system is that since the location of the soloist is done by electronic means, a soloist is now able to stand to one side of the conductor as in a concert, allowing the engineer to obtain much more separation between the soloist and the orchestra. *Yours faithfully*

. . . about the M28C review

From: D. Gosselk, AEG (Great Britain) Ltd., Lonsdale Chambers, 27 Chancery Lane, London WC2

Dear Sir: With regard to your recent review of the Telefunken *M28C*, a new series will be available in June with the following modifications:

The capstan motor will be replaced by a Papst motor. The present series is fitted with Engel motors.

An azimuth adjustment will be provided on the replay head.

All plug-in amplifier units will be on epoxy-resin bonded paper cards. *Yours faithfully*

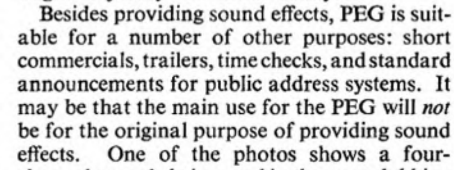
. . . about inputs

From: C. D. Brown (Express Technical Translations), Quinta Terceira, Kiln Lane, Cores End, Bourne End, Buckinghamshire.

Dear Sir: The February *Talkback* column concluded by drawing attention to a photo showing part of a patch board labelled 'Track Equaliser Imputs'. I would suspect a foreign firm or engineer being involved since some English grammars for foreigners state that there is a rule in English which makes N into M before B and P. Possibly Philips, Telefunken or a Japanese source.

Yours faithfully

Possibly. The installation lives in London. —**Ed.**



PEG FROM THE BBC CONTINUED

but they are more expensive to produce than discs, and the cost per minute of playing time is very high in comparison. The BBC did envisage keeping just one recording of each effect, and installing a two-channel console in the library. This would, in their own words, 'provide a uniquely quick and simple way of obtaining copies', but I cannot really see this working. The operation of a recording machine by a librarian would probably be regarded as a threat to the security of recording engineers (there was enough fuss when studio managers were allowed to handle tape machines), so an engineer would probably have to be employed for this job. According to the Corporation, it is not unusual for a hundred inserts to be used in a half-hour programme, so the recording of these would take some time. The extra man-hours thus required to produce the effects for one programme would therefore tend to offset the labour-saving operational advantages of PEG. For this reason it would seem preferable to keep several copies of each effect in stock.

Besides the basic PEG, larger or smaller consoles can be made to order. There are several accessories available, and some of these are illustrated here. There is a bulk eraser which for safety will affect only cassettes which have the screw-in stud fitted. The tape is slid into the eraser and the stud operates a switch at the end of the unit, causing erasure to take place when the cassette is removed. Also available are remote control units, cassette racks, extra VFO's and spare modules. The cheapest single-module PEG costs a little over £1 400 (without VFO) while the standard four-module unit (with VFO) is £3 300, which may seem expensive. However, the man-hours saved ought to justify the initial outlay.

Besides providing sound effects, PEG is suitable for a number of other purposes: short commercials, trailers, time checks, and standard announcements for public address systems. It may be that the main use for the PEG will *not* be for the original purpose of providing sound effects. One of the photos shows a four-channel console being used in the news dubbing suite at Television Centre, but PEG has not yet become widely used in the Corporation; discs are still the main source of sound effects. Engineering Information explained the reason for this: with some half million effects on disc, changing to a new system would be a monumental task.

My opinion of PEG is that for most purposes the advantages outweigh the disadvantages; it is a useful, reliable and easy to operate device.

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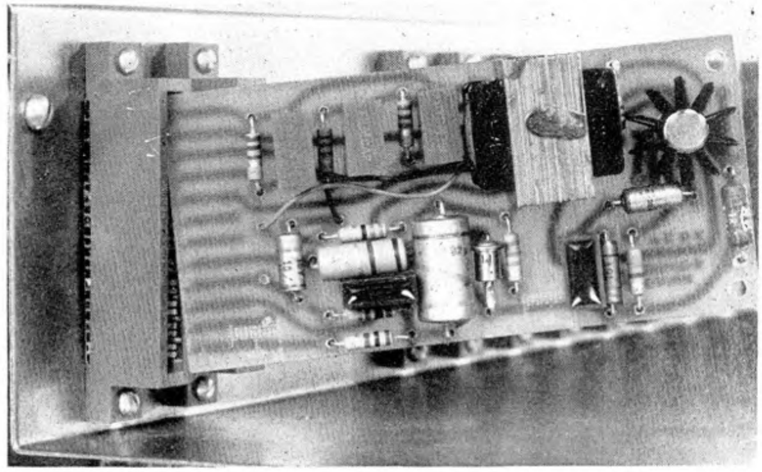

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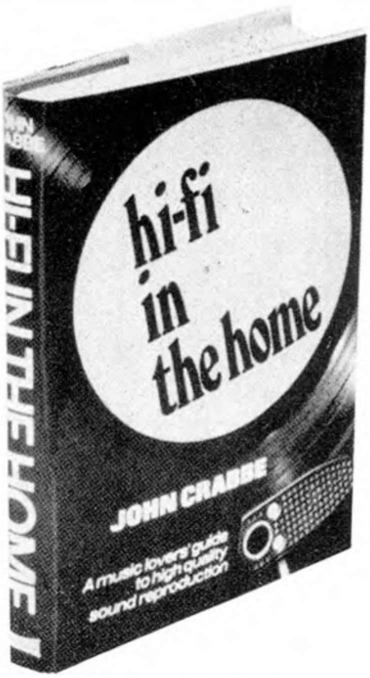

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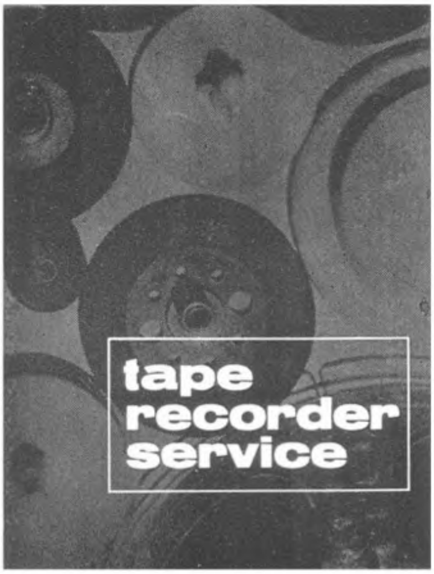


FERROGRAPH SERIES 4

BY H. W. HELLYER

'BUILT like a battleship', the saying goes. And not only on account of the naval grey paint. Ferrograph tape recorders are built to last, with no truck to the 'let's save a penny' school of design. Before the regrettable tendency to compete with imported domestic tape recorders came about, the dreadnought look was something of a British speciality. For years after everyone else (except perhaps Brenell, who are a special case), Ferrograph maintained the solid respectability that had gained them a deserved reputation for constant and predictable performance. Since the curtains were drawn back on the *Series 7*, Ferrograph have shown that it is possible to be both competitive and trustworthy.

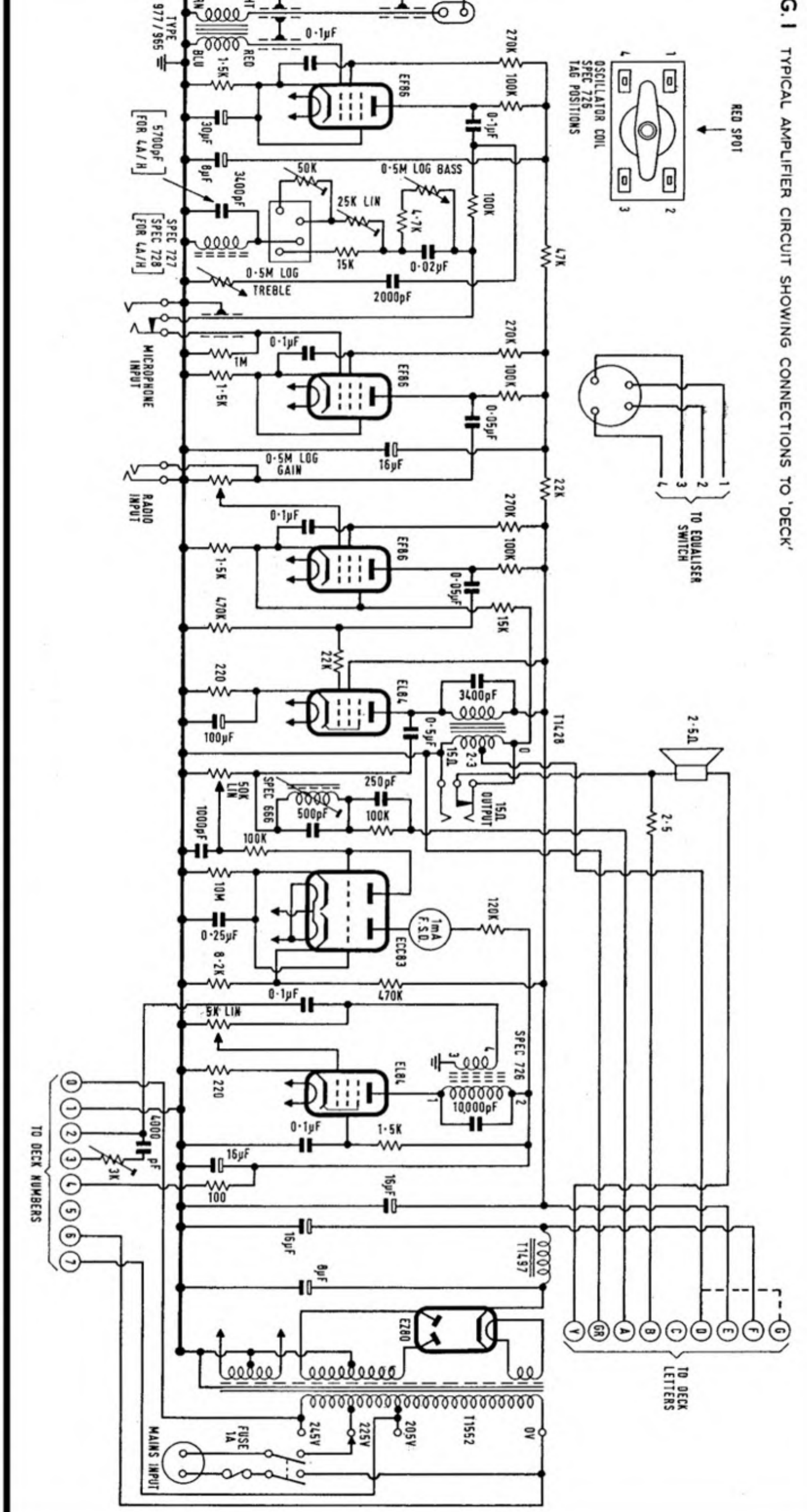
Our postbag demonstrates quite clearly that Ferrograph models are expected to go on for ever. The treatment meted to some of them which have been brought to my workshop 'just for a bit of an overhaul, old chap. It's not going as well as it did' reveal that the non-professional (I hesitate to say 'unprofessional') user expects a little too much.

The unsinkable quality of these tape recorders depends, as does the dependability of a veteran car or an old steam engine, on regular maintenance and loving care. You do not find the professional blowing cigarette ash into the head channel, or cleaning the heads with any handy bit of rag, nor lending his oilcan to the neighbours. To him, a breakdown means loss of earnings and a below-spec performance means lost goodwill.

After which paean, I can go on to talk with a little more confidence about some of the troubles which have beset Ferrograph

(*continued on page 149*)

FIG. I TYPICAL AMPLIFIER CIRCUIT SHOWING CONNECTIONS TO 'DECK'



owners. This is a firm which comes down heavily on the unfortunate technical journalist who calls the product into disrepute. I must make it clear that in starting this servicing look at the older machines, I am only attempting to aid those readers fortunate enough to pick up one of the battleships secondhand but not yet ready for mothballs. The regular Ferrograph owners will read me only to gloat over the points I may miss.

There may be a few such, for this machine has been the subject of numerous small changes. Its deceptively simple design tempts embellishment. I have found all manner of strange additions to circuitry, some of them quite drastically reducing performance for reasons which may emerge. **Fig. 1** gives the basic circuit of the *Series 4A* (and the high-speed *4AH* version) but with the styling suggested in the original Wright & Weaire blueprints. Careful comparison with later Ferrograph models reveals that there are several minor alterations, such as the detail of the meter circuit and the equaliser network between first and second stages. **Fig. 2** goes on to show the deck wiring, including the switching which has given some people an awful lot of bother when they have had to rewire a broken switch.

Because it has to put up with a lot of rough treatment, the selector switch is one part of the Ferrograph that may be vulnerable. On the models with the inserted red record button, especially, I have found a curious trick of some users has been to force the large knob round, jamming the button and its small spring. Stiffness of the main function control should lead one to check this small point before the formidable task of dismantling the spindle and cam assembly. We shall return to this later.

For the present, let's stick to circuitry and especially the head characteris ics, which have aroused the curiosity of a number of readers. Most people will be well aware that this company make their own heads, and as might be expected, match them with religious exactitude to the circuitry. Even to the extent of ensuring a make-before break contact on the oscillator section of the switch. I am quite well aware that the 'Important Notice' in the front of the *Series 4* handbook tells the user to switch s-l-o-w-l-y from record to windback to allow oscillations to die away. As our old friend Joad used to say, it depends what you mean by slowly. In my definition 'slowly' means the speed it is not possible to operate a Ferrograph switch faster than ! But I always did suffer with a weak left wrist.

Enough of this levity : the standard head on *Series 4* models is the *FR7A*, now considered obsolete. It is a $\frac{1}{2}$-track record play head with a plug-in four-pin base, which suits an octal valveholder. It has a separate bias winding (shades of crossfield argument !) a 3.75 μm gap and a 120 mH inductance (signal winding). Recording signal, with a 1 kHz tone to give 3% maximum distortion on replay, is 150 μA and this depends on a 68 kHz oscillator with a bias current of 2.5 mA. No use arguing that the oscillator of your machine is 56 kHz—I know, but this is one of the Ferrograph tricks, and it is impossible to be precise when the maker changes his mind before the ink on the blueprint is dry.

The *FR7* head is the recording companion of the *FR7A*, with a wider gap, and therefore a less wide frequency response, so don't let anyone fob you off, even if it has similar basic characteristics.

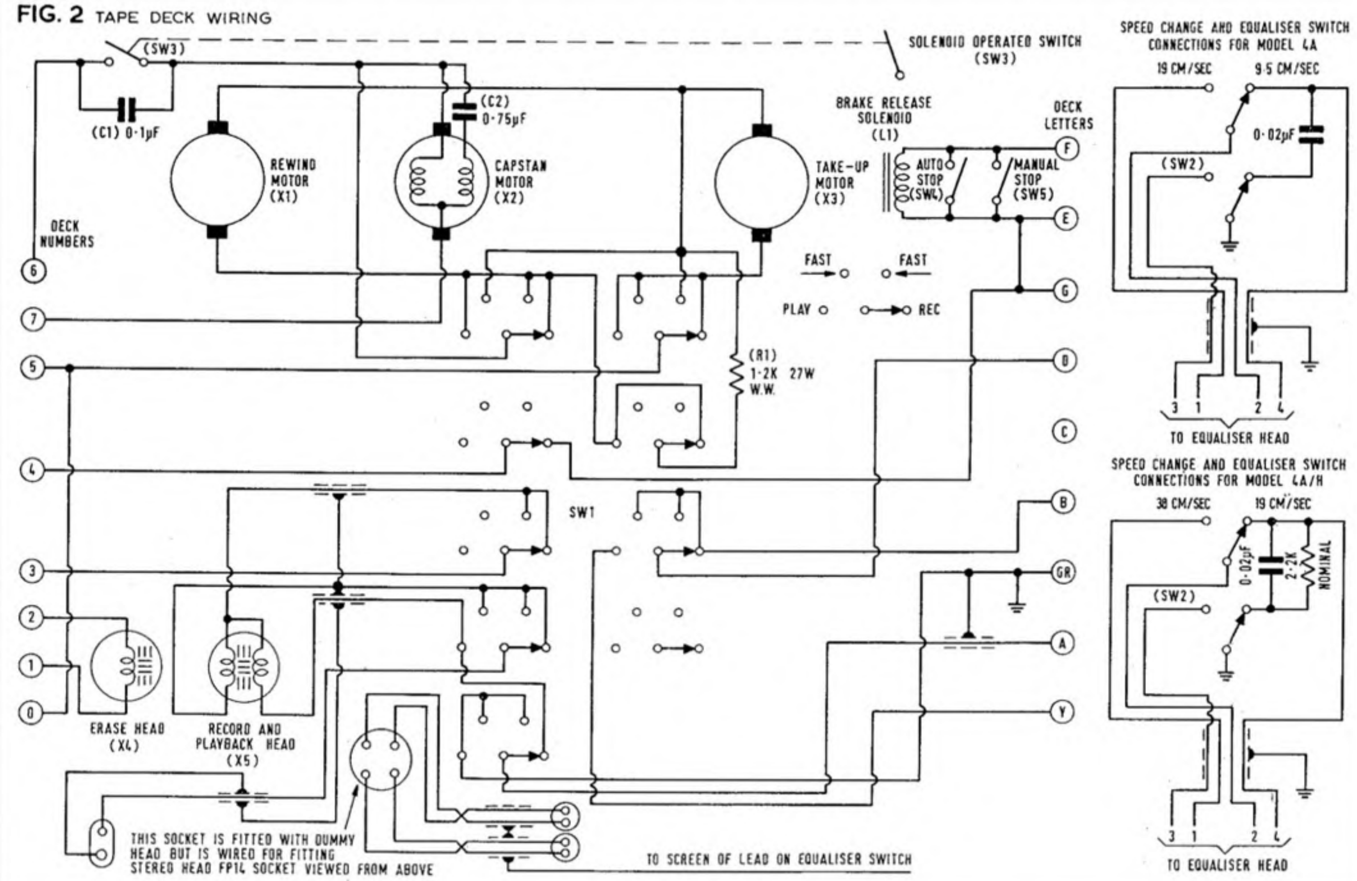
The other head about which people enquire is the *FP16*, the $\frac{1}{2}$-track stereo version, as used in the *4S* for example. I suspect that some questions are inspired by a desire to supplant the standard Ferrograph heads with others of less celebrated make, but must not question motives when providing information, so here goes. *FP16* : Play version, 3 μm gap, inductance 28 mH, per winding, output 0.16 mV and crosstalk better than 50 dB.

The $\frac{1}{4}$-track stereo version, which is roughly equivalent, is the *FP28*. It has an even lower inductance (16 mH) and, as may be expected, a lower output (12 mV).

Matching these heads to the circuit for playback has occupied Ferrograph engineers' attention closely and a range of suitable transformers has been produced. Nowadays, we get so much of the 'hook-it-up-and-hope' attitude, and by quite well-known manufacturers, too, that we tend to kowtow deeply when we see how much trouble some designers will take to ensure that the circuit is as noise-free as they can make it. A replay head can

(continued overleaf)

FIG. 2 TAPE DECK WIRING



be considered as an inductive generator with some series resistance, across which thermal noise develops. The ohmic resistances of the heads we have been discussing for example are: *FR7A*, 40 ohms; *FP16*, 11 ohms and *FP28*, 9 ohms. There are two approaches to head design and matching. Making a head of medium to high impedance increases the noise problem but, for a simple circuit, can give sufficiently high output level for some of this deficiency to be masked. This is with high impedance valved inputs. On the other hand, a low impedance replay head can be matched very nicely by a transistor amplifier, and this is the modern technique. I confess, I have not had to do any matching jobs on older Ferrographs. There is a reluctance of owners to debase them with transistors. But the alternative approach, a low impedance head and a transformer matching, is favoured by the lads from South Shields, and practice has borne out their theories.

The ratios of matching transformers, Ferrograph design, are important, and some special figures can be quoted. The mono transformer, which matches the *FR7* heads, is numbered *977* (taking the place of the earlier *965* and the *913*, and has a 1:5 ratio). Its primary inductance is 880 mH and secondary inductance *22H*. The *973a* transformer which matches the two and four-track stereo heads, is now superseded by the *973B*, with a 1:12 ratio, primary 135 mH and secondary 18 H. Colour coding of the cables for the head matching transformers is as follows: Primary, white and green; Secondary, red and blue. The green and blue connections are the earthy end of each winding.

It is interesting to note that the same heads are used in the *Series 7* machines (*FR/P 28z*), with direct transistor matching and an above-average noise-free performance.

It should be remembered that the circuit of **fig. 1** is only the recommended design, and that eventual Ferrograph circuits differed in detail, if not in essentials. An example is the oscillator. Using a *726* oscillator coil and the *EL84* valve shown, between 25 and 35 V can be obtained across the erase head. Bias voltage is lower, derived from a tapping on the coil. The method that Ferrograph use, of a separate winding for bias, allows them a greater freedom of matching for the recording signal, which has a series resistor feed in the valved circuits (a constant current source being more easily arranged with transistors). The ratio of bias winding to main winding is 1:5.2 in the original version so that the shunting effect of the bias winding, when fed from more than a 1 K resistance, will be negligible at the higher frequencies. The production models differed only in that a thermistor was made the grid load, with the bias potentiometer dropped, and a fixed resistor of 6.8 K fitted.

One of the problems some Ferrograph owners have encountered has been oscillator checking. 'How do I know I have the right frequency?' they ask. It is no use merely adjusting for a maximum bias figure, or a calculated depression of the bias curve. The circuit has a variable bias feed resistor, but no real adjustment for oscillator tuning. If it is going to give you ulcers, worrying over the exact oscillator frequency, then you will find the easiest way of checking is with oscilloscope and signal generator, beating the tape recorder oscillator with the external oscillator to produce a Lissajous figure. Normal way of doing this is with the Y plates tapped to the oscillator grid, the X plates, with timebase switched off, to the external source, which is somewhere near the calculated sub-multiple of the tape recorder oscillator frequency. Then the external generator is varied and the rings can be counted to give an indication of exact frequency. Alternatively, the Z-axis input of some 'scopes can be employed, with the easier process of 'counting the dots', but my own rough check is always to set the Y timebase correctly, and then settle the trace and count the number of complete cycles I can get when a known timed sweep is selected.

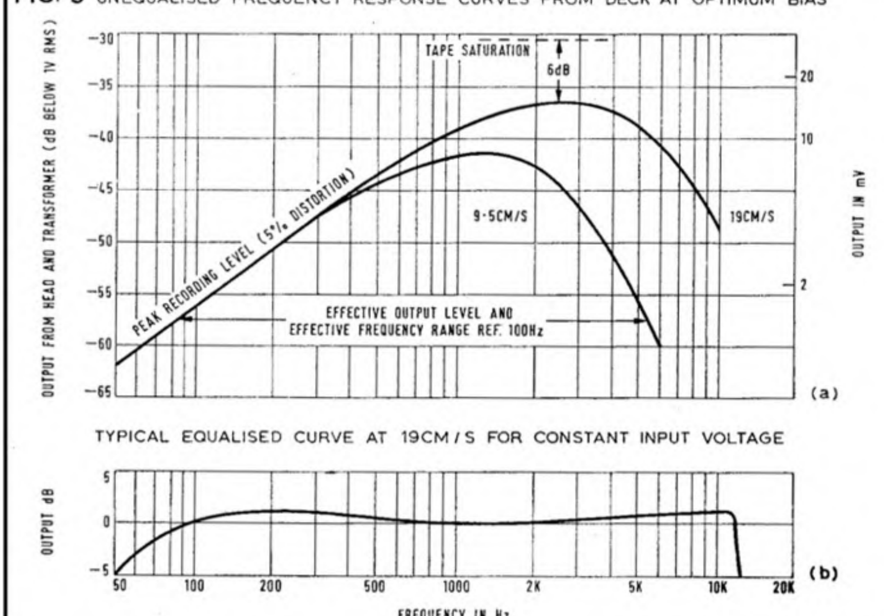
When making this test, one should always check the oscillator drive, for any change here, or in the loading, tends to pull the frequency away from resonance. This needs a VVM at the grid of the *EL84* while the trace is still being viewed. Alteration of grid drive (especially where this is adjustable, as on the old type), will distort the trace. It needs careful surveillance and the first hint is a slight thickening toward the lower part of the trace just before turnover. Grid drive of the early design was between 9 and 10 V RMS, when the grid displayed about 1 K of resistance. With the thermistor fitted, the drive will not be as much as that, and you will be lucky to get as much as 9 V before the trace begins to distort. It is always necessary to keep the oscilloscope in place when making these tests. A good waveform is as vital as the correct bias and erase voltage.

Where the minimum of instruments is available, and bias setting has to be made, the recommended method is to record a 200 Hz signal to give a reading of '3' on the level meter, with various bias settings. Log the position of the potentiometer knob, or, if a VVM is to hand, measure the bias voltage in steps of 2 V from 6 V to 14 V. Make the measurement at the head side of the bias feed, i.e. between tags 1 and 3 of **fig. 1**. Then replay the recorded tape, having identified each section (voice over tone or by index). Note the way the replayed output rises through a peak and reset the bias potentiometer to the position which gave the next step beyond the maximum. To quote one of my apprentices: '... that should get you over the hump.'

A lot of newcomers to this machine get caught by the trap coil. This tunable inductor, which is in series with the head feed during recording (going to terminal A of the connector to the deck from the amplifier), is mounted on the amplifier sub-chassis. With its adjustable iron-dust core, it proves a temptation to the itchy screwdriver finger and, when offsetting appears to have no effect, the maladjusted coil is left. Later, complaints of noisy recording arise. This is because bias is breaking through. So, when setting the oscillator, take a little time out to make sure of the bias trap of this inductor and its parallel capacitor, shown as 500 pF on **fig. 1** but more likely to be 460 pF in practice—I'll bet you have not got one of those in your spares box. Check that the trap is tuned to the same frequency as the oscillator. Again the 'scope is a useful asset.

Another warning point: ensure that the input level is kept down on these recording tests. Anywhere approaching tape saturation is dangerous, because false maxima can be obtained. This is common to all types of bias testing and is the reason for that '20 dB down' stricture so many makers give.

FIG. 3 UNEQUALISED FREQUENCY RESPONSE CURVES FROM DECK AT OPTIMUM BIAS



(continued on page 152)

the synthesis of musical instrument tone

Part Seven
By Robert M. Youngson

FIG. 76 SPRING ENERGY TRANSFER REVERBERATION UNIT
THIS IS AN ELECTRO-MAGNETIC VERSION USING SUSPENDED CERAMIC MAGNET RODS

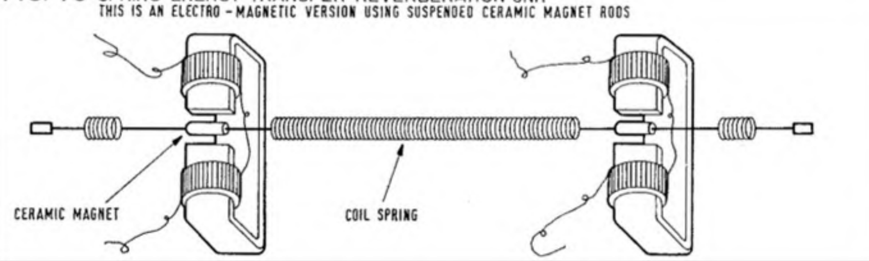


FIG. 77 SUGGESTED OMNI-DIRECTIONAL ENCLOSURE PLANNED ON ECONOMIC RATHER THAN ACOUSTIC GROUNDS

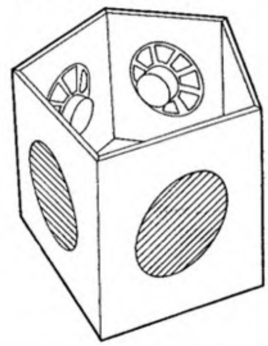
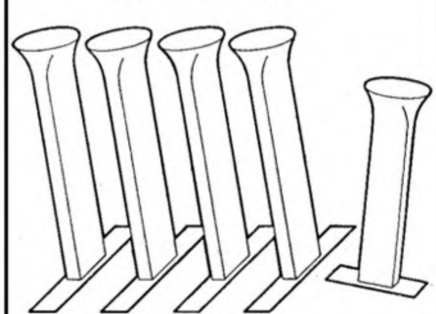


FIG. 78 FINGER-OPERATED CONTROL LEVERS. THESE MAY BE COUPLED TO CONVENTIONAL POTENTIOMETERS OR MAY OPERATE PHOTO-ELECTRIC CONTROLS USING LIGHT-DEPENDENT RESISTORS.



I HOPE I have sufficiently emphasised that aesthetic criteria should always command the technological, rather than vice versa. In considering the effect of environmental factors on tone synthesis, one is concerned very largely with aesthetic factors. Indeed one is in much the same situation, here, as the player of a conventional musical instrument. Some attention has been given, by designers of electronic musical instruments, to the compensation for acoustic deficiencies in the (usually domestic) environment in which these instruments are played. In practice, these boil down to the provision of tone controls to compensate for differential frequency absorption, and artificial reverberation to compensate for dimensional and surface-reflective inadequacies.

Whether or not one should resort to synthesis, in this context, is a matter for the artistic conscience but it must be borne in mind that even the finest conventional or analogue instrument cannot be expected to give of its best in an unsuitable environment. However skilfully one may have managed the synthesis, the dampening effect of a small room full of absorptive material such as carpets, curtains, stuffed armchairs and cushions will at once remove most of the brilliance, sparkle and life.

It follows that, if the playing location is necessarily restricted to one such as this, and if domestic circumstances preclude acoustic amendment, one may have no alternative but to turn to the judicious application of a little artificial reverberation and tone control. Such addenda should, of course, be under 'preset' control and must be capable of being turned off entirely, at will.

The subjective effect of any musical performance varies considerably with differences between the relative phase and amplitude of frequencies reaching the ear directly and those reflected from room surfaces. These differences are determined by room size and shape, by the absorption coefficients and relative quantity of absorptive material, by the direction in which the sound is projected, and by the relative position of the sound source and the listener. Detailed analysis is very difficult because of the complexity of the situation and one must usually fall back on empirical trials. A measure of reverberation is essential if music is not to sound lifeless, but if the reverberation time becomes excessive, intelligibility is rapidly reduced.

It will be clear that, if the output of the instrument can be divided into a large and a small component, and if the appearance of the latter can be delayed briefly so that a complete facsimile of the full output is available at reduced amplitude and with a phase difference from the main output, an effect can be produced which is identical to the effect of performance in a musically more 'live' environment.

Various methods have been used to achieve the necessary time delay. An obvious approach is the use of two transducers, such as a loudspeaker and a microphone, coupled by an air column which is significantly longer than the distance between the main sound source and the listener. One can, for instance feed sound from a small loudspeaker into one end of a long coiled Polythene hosepipe with a microphone fitted to the other end. The microphone output is then amplified (the gain control of this amplifier acting as the reverberation amplitude control) and applied to a supplementary open loudspeaker. This loudspeaker

(continued overleaf)

may be sited near the main output speaker or remote from it, whichever produces the better effect.

In large fixed installation, the reverb channel may consist of a small room whose surfaces are of high acoustic reflectivity (such as a spare bathroom!) in which a high quality loudspeaker system and a carefully-placed microphone are installed. Such an arrangement can give excellent results but is hardly practicable for our purpose.

A popular and compact system makes use of the mechanical inertia of one or more closely coiled long metal springs coupling two transducers. A simple arrangement such as that shown in **fig. 76** can be surprisingly effective. Care must be taken to insulate the spring unit adequately from ambient mechanical vibration.

The position of the sound source may have a bearing on the quality and some empirical trials may be worthwhile. It is, however, desirable to avoid dissociating the player from the loudspeaker as this introduces a new parameter never found with conventional solo instruments.

Acoustic output

In view of the small acoustic output of solo musical instruments, no great demands are made on the loudspeaker system and any small reasonably high quality item will suffice. Again, because low bass frequencies will, in most cases, not be produced, the loudspeaker enclosure can be of the simplest kind and need not be large. There may, however, be some merit in adopting a small multi-speaker system arranged to have an omnidirectional characteristic, as shown in **fig. 77.** With such a system, even very cheap and (individually) nasty speakers can give a good account of themselves and the final cost may be less than that of a single high-grade loudspeaker. It is best to use units of dissimilar pattern and the box may be lagged or not, depending on whether or not this improves the audible results. If a transformerless power amplifier is used, five or six 3-ohm impedance speakers may conveniently be joined in series, but they should all move in phase. To this end, the connections should be checked by the brief application of a small dry cell to the connecting tags. Note which orientation of the cell causes the cone to move out and mark the tag then connected to the top of the cell.

I would emphasise that this suggested arrangement is put forward expressly for use with monophonic musical instrument analogues. In such an application, the non-linearities may be turned to positive advantage, simulating as they may the imperfection of natural instruments. The loudspeakers work well within their power-handling capacity and resonant frequency range. If the system is found wanting in the upper audio frequencies, a tweeter can be added.

If such a system is adopted and the loudspeakers mounted in an enclosure other than that containing the controls, it should be located near the control box.

It is now possible to summarise the nature and degree of controls necessary for effective synthesis. This is most readily shown in tabular form, and you will see (**Table 5**) that controls are divided into classes depending on whether the effect is under full manipulative influence, or under partial influence, or whether control occurs automatically or is preset. Parameters which vary randomly can scarcely be described as 'controls' but they are included for completeness.

If you are embarking on a practical project, you may wish to limit your ambition initially by restricting the range of controls. Some are, however, mandatory, if the instrument is to have any serious pretensions to reality and these are marked with an asterisk. In the end, you are not likely to be satisfied with less than the full range of control.

on the other hand, can be sited along the upper edge of the control panel above the note buttons, as these will rarely, if ever, be operated while the instrument is actually being played.

Because of the limitation in the number of anatomical extremities available for control manipulation, ingenuity must be exercised to obtain the greatest possible range of influence in a small compass. One interesting possibility is the use of a number of lever controls, mounted together, after the manner of aircraft throttle controls, which can be operated simultaneously, but differentially, by one hand. Four such controls can readily be managed by the four fingers of the left hand, especially if the knobs are hollowed on top to give purchase to the finger-tips. It is not excessively difficult simultaneously to operate a fifth lever control, with the thumb, if it is arranged to move in a plane at right angles to the plane of movement of the other levers (see **fig. 78**). No difficulty need arise in getting the levers close enough together, as they may be connected to their respective potentiometers (which can be placed alternatively in front of and behind the point of articulation) by mechanical links of suitable length in the way already shown.

Control by lever movement is inherently so much more satisfactory than control by knob rotation that it is now almost standard technique in professional audio circles. Lever-operated potentiometers are now readily available commercially and may be obtained as single or multiple units.

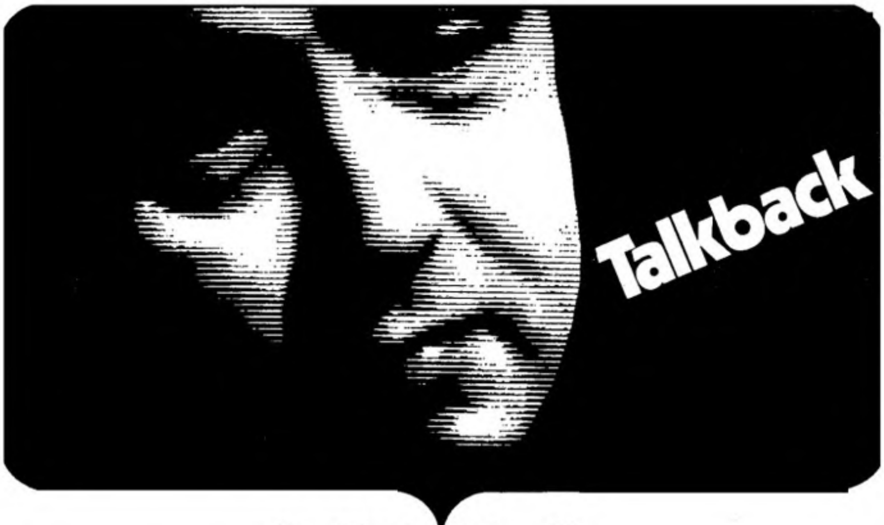
TABLE 5 OPTIMUM CONTROL REQUIREMENTS

Parameters and Facilities Under Direct Control	*Pre-Set Parameters*	*Parameters Varying Automatically*	*Parameters Varying Randomly*
Pitch Intonation Vibrato Temperament Note Duration Loudness Attack Harmonic Development Transient Noise Muting Wind Noise Decay Change of Timbre of fixed pitch with change of string	Choice of Instrument Tone Balance Reverberation Percussion Sustain Pizzicato Strumming 'Artificial Harmonics'	(a) *With Loudness* Harmonic Content Noise (b) *With Pitch* Harmonic Content Attack (c) *With Attack Rate* Harmonic Content Noise	Pitch Loudness

Much thought must be given to the best practical layout of the controls in the final design. Many factors are pertinent. It is desirable, for instance, to ensure that the area most accessible to the player's right hand is devoted mainly or exclusively to pitch controls. Most of the other controls should be designed to be operated by the left hand. At the same time, it is desirable that the left hand should be able, from time to time, to assist in note selection, and the left-hand controls must be such that they remain at a given setting when released. The main controls should be so sited that neither they nor the hand operating them offer any obstruction to the playing hand. This will, in general, mean that they will be fitted well to the left of the 'keyboard'. Pre-set controls

One of the reasons may be made more clear with reference to **fig. 3** where the effective output levels of recordings made at two speeds and a dotted saturation level mark at -30 dB (**a**) are depicted. The reference to 100 Hz and the 6 dB below saturation are figures with which some modern users will argue, especially now that we have some excellent low-coercivity tapes available. The curve **b**, also, with its steep cut above 12 kHz, depends on careful adjustment of the equalisation, and this will be referred to in later discussions. The *Series Six* can be used as a better example.

Deck details will be discussed as we come to the later models. There have been minor changes, and these can be listed with reference to later marques rather than added piecemeal. Despite the 'sameness' of the Ferrograph models, that grey-faced exterior has hidden quite a lot of differences, and we shall attempt to list and detail these for the benefit of anyone fortunate enough to pick up one of the trusty warriors second-hand, with nothing but its appearance to identify it. You should be so lucky . . .



Talkback

by Peter Bastin

AMERICAN Patent 3 435 153, held by Carl D'Amato of New York, covers what is described as an 'electronic sound producing walking cane'. The enlarged handle end of the cane contains a small cone speaker, a solid-state amplifier and a battery. A cylindrical roller attached to the bottom end carries a turntable for interchangeable gramophone records rotating in a vertical plane when the roller is pushed or pulled. The pickup arm is supported in the cover of the roller. Another version carries a magnetically-coated cylinder with recording and replay heads. Absolutely astonishing. I suppose a gadget like this must have some sort of use, but I can't think of one at the moment.

I DIDN'T KNOW until recently that the doggy-staring-into-the-gramophone picture does not exclusively refer to HMV records. Apparently, RCA has been using this device for over ten years without any connection with HMV. So, it seems, have French, German and Italian companies.

'WORLD OF SOUND' (South Africa) quotes a Mr A. Jonker of Kimberley who runs a flourishing record business in the town. He is, apparently, so tired of answering silly questions about hi-fi that he keeps the door of his shop locked until the potential customer can convince him that (a) he knows what he's talking about and (b) he genuinely wants to buy something. Mr. Jonker considers himself lucky if he sells two good systems a week.

GRAMOPHONE FOR October lists one or two records which may be of interest to recordists. For example: *Bird Sounds in Close-up* (Marble Arch), *Railway Record* a record of ex-GWR locomotives at work (Argo), Electronic Music —all sorts, Swedish, odd and classical (Swedish HMV, Philips and Turnabout), *Modern History on Record* (Longmans) and Stories on Record—stories by Stan Barstow, Sid Chaplin and Alan Silitoe (Longmans). The latter two records would have specialised interest but I should warn readers that the prices are sometimes a bit steep, due to the discs being 'special issues'. For example, a *Modern History on Record* single costs 15s. 1d.

A RECENT edition of *Wireless World* contains the only comprehensive advertisement for Ampex video machines I have ever seen. With prices. For those of you who are well-breeched and raring to go, you can get the *VR 7003* for £1 440, the *VR 5103* for the bargain price of £856 or the *VR 7803* for the price of a house—£4 650. Tape prices are not given, although the recommended tape is 25 mm polyester-base. 3 000 feet (914 metres) is necessary for one hour's recording and a 243 mm reel is needed. Also in this edition, is a brief review of a voice-operated typewriter developed by Standard Telecommunication Laboratories. The sounds 'di' and 'dah' are used, representing the dot and dash of Morse, and these are processed by the machine accordingly. It is claimed that a trained operator can produce 20 words a minute with this machine.

HURRAY for the Federation of British Recordists and Clubs whose Contest trophy is a very nice little rose-bowl, suitably and tastefully engraved *and which can be kept*.

WHATEVER HAPPENED to the British Tape Recording Club? This was founded in January 1959 and operated from somewhere deep in Cheshire. It published the now-defunct *Amateur Tape Recording*. This was a bright little magazine, aimed at the amateur and beginner, and was first published in August 1959. (An irritable Deputy-Editor has just thrown something hard at me which hurts: it seems that *Tape Recorder* was born seven months previously.) It is interesting to look back at these first veteran issues to see what was happening in the world of tape. Recorders in vogue and scarcely heard of these days were the Winston, Veritone Venus (with reverberation!), Kurland, Walter, Clarion, Reflectograph, Verdik, Sound, Saba, Simon, Harting, a peculiarity called the Gramdeck, and so on. Ferrograph, Philips and Grundig, and many of today's big names were all there. A Ferrograph *3AN* cost 79 guineas, a Brenell *Mk.5* 64 guineas, and a Vortexion *WVB* £110. Oddly, there were very few inexpensive recorders and, by the same token, very few recorders costing over £100. The cheapest were Phonotrix and Sound Belle at 26 guineas and the average price for a reasonable recorder was £60. Tape recorder personalities of the time were Rene Cutforth, I.W. Jarman, and John Borwick (still going) who with Marguerite Cutforth was jointly responsible for the first BBC 'Sound' programme broadcast on 5 January 1959. F. C. Judd was somewhere round and eventually ended up in the hot seat of *Amateur Tape Recording* until the magazine disappeared.

DURING THE course of each year, clubs who know no better ask me to talk to them and play some of my tapes. This I thoroughly enjoy, for everyone likes shooting their mouth off without interruption. Most of my recent talks have been, oddly enough, to cine clubs. This venturing into the Opposition is a very pleasant and stimulating experience. The first time I was asked to talk to movie men, I felt that it would hardly be worthwhile. They would all be stuffy types in corduroy jackets with light meters hanging round their necks. They would look at me down their noses and greet everything I said with chilling silence. How wrong you can be. Admittedly, there was a sort of chilling silence at the beginning, but this is common to any type of audience faced with a weird-looking bloke hovering behind a tape-recorder. It is when it comes to Questions that the difference is felt. The cine men have a tremendous interest in sound and are constantly in search of knowledge on types of machine, microphones, tape and technique. They are comparative strangers to sound techniques and, whereas your tape-club audience will ask what *means* you used, the cine men will ask *why* you used a certain technique. In other words, the tape types know, naturally enough, most of the answers and the cine men know virtually none of the answers. So, if you are ever asked to address a cine club, accept. It is, of course, helpful to know the difference between a slide projector and a zoom lens.

FOR THOSE readers who are ever tempted to buy one of these inexpensive Japanese battery-portable jobs, *please* take the thing home and try it first. As an experiment, I borrowed one to try out. In the dealer's shop, the supplied demonstration tape sounded first class. It sounded fine at home, but when I put another tape on it and made a recording, the background hiss was like a high storm in winter. Terrible. Is is clear that sales depend on these professionally-recorded tapes and I think that these sort of things are very near to being False Pretences. Anyway, don't be caught.

SOUND balancing

PART ONE.
MIXING
BY BOB AUGER

Bob Auger and Brian Snelling check a detail of balance during the tabe dubbing session.

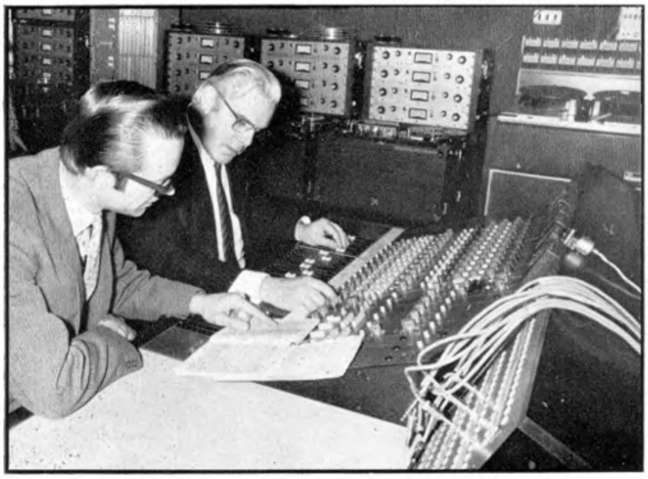


FIG. 1 TYPICAL LAYOUT OF A SYMPHONY ORCHESTRA (LARGE REVERBERANT ROOM)

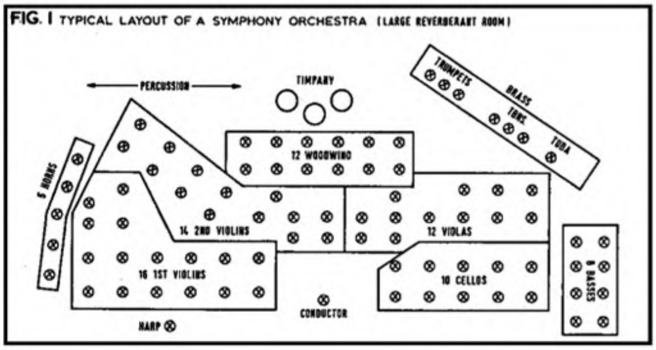
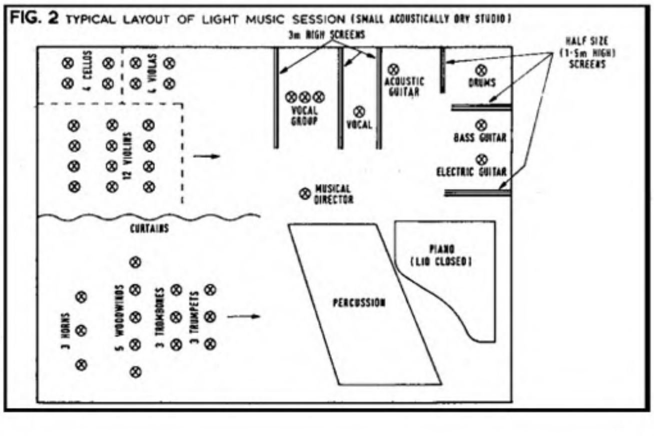


FIG. 2 TYPICAL LAYOUT OF LIGHT MUSIC SESSION (SMALL ACOUSTICALLY DRY STUDIO)



THE purpose of this series of articles is to provide a general guide to professional recording techniques both in the permanently equipped studio and when recording music on location with mobile equipment.

The principal difficulty in attempting to instruct newcomers to the professional recording business is that the whole operation of the balance engineer is judged purely subjectively and is one of entirely personal taste.

I suppose the most successful balance engineers are those fortunate people who manage to please most of the people most of the time. When one takes into account that the final sound produced by the engineer has to be acceptable to the musicians and musical director in the studio, to the producer and solo artiste in the control room, and finally and most important of all, the customer, it can be seen that the engineer has to be some kind of technical diplomat.

A simple example of differing points of view regarding balance in the classical field is found when playing back tapes of the recording of a piano concerto to the pianist and conductor. The conductor will be more interested in orchestral details than in the soloist's performance but at the same time the soloist will not wish to hear any of his intricate work obscured by the orchestra. The advent of multitrack recording at least made the engineer's problems somewhat smaller at the time of the session since he is now able to adjust the balance on the monitor loudspeakers during tape playback. (The next time a concerto recording is played back to a conductor with the solo instrument turned right down will not be the first!)

Of course, the engineer is only at this time postponing the evil when he finally has to mix all the tracks together and then has to arrive at a compromise between the soloist and the orchestra. At least the pressure of the recording session itself will be off him by then and the finished sound can be achieved in the relative calmness of the dubbing room.

I mention all this as an introduction merely to point out that the balance engineer works on a razor's edge of other people's opinion at all times, and he is a tough cookie indeed if he

SOUND balancing

PART ONE.
MIXING

BY BOB AUGER

is not disturbed by strongly worded criticism of his work in one of the well respected gramophone periodicals. Because each balance engineer works to his own particular style, it is very difficult to lay down hard-and-fast rules regarding types of microphones, placement, etc., but I will during the course of these articles mention techniques which I have found from experience to give good results. I must stress that the ideas introduced are entirely my own and will, no doubt, be the subject of controversy amongst my professional colleagues.

Oddly enough, there is a kind of 'national' style in the recording and reproduction of sound, and the following four examples will give some idea of the sort of sound I would expect to hear from records produced in the countries mentioned.

USA

Generally speaking light music and pop music recordings from the States seem to suffer from poor separation in the studio, and one often hears what seems to me a sloppy percussion sound produced by the drums spilling over into microphones intended to pick up other instruments. The recent introduction of 8- and 16-track recorders with the ability to track on instruments after the initial session has not, it appears, produced any great improvement.

In the realms of recording classical music, the American trend is generally to have the symphony orchestra split quite clearly into three sections: namely left, centre and right. This is, no doubt, a hangover from the early days of stereo when it was necessary to demonstrate these effects to the public. Also since the majority of American companies record their classical sessions with 3- or 4-track facilities, no doubt the producers like to keep the sections of the orchestra separate for subsequent re-mixing at the dubbing session.

Germany

German pop records always seem to me to have the voice much too far forward and this is strange since the language is so clear. Most German singers have such good voice projection that there would never be any difficulty in hearing the words even if the voice was reduced by as much as 4 to 6 dB in the final mix. The same fault is often in evidence in German opera recordings, coupled with the strange practice of having the singers very close to the microphones. All German recordings seem to have extended treble and bass response with some kind of trough in the frequency response around the middle frequencies.

Italy

There is no doubt that Italian pop records are very well produced indeed and, although some of the engineering seems haphazard by our standards, the emotional content of the music is always allowed to come through. It is a strange thing that, for all their musicality, the Italians have never produced a good series of classical orchestral recordings, which is a pity when taking into account the excellent sound studio centre which RCA operates in Rome.

United Kingdom

It is difficult to say much about recording conditions here since we are so close.

A good general stereo spread is usually evident in classical recording, though I do wish we would adopt the American practice of reducing the playing time on our discs to around 20 minutes per side. The advantages gained in being able to cut disc grooves at maximum level with reasonable land between each groove far outweighs the financial gain of having an LP which plays for 60 minutes or more.

The first thing a balance engineer must do when planning a forthcoming recording session is to make up his mind quite firmly which overall technique he is going to adopt. At the present time the basic philosophy regarding the recording of classical versus pop music differs so much that, once embarked on a session using one system, it is virtually impossible, because of the time factor, to change over to the other system later on in the session.

Basically the differences are these:

Classical recordings (Symphonic Orchestra)

The orchestra is seated approximately in its normal concert arrangement as shown in **fig. 1.** Only a limited number of microphones are used and these are suspended above the orchestra on high booms. Since the internal balancing of the various sections of the orchestra has been attended to in advance by the composer, assisted by the conductor, all the engineer has to do is to re-present the sound in the studio on tape, taking into account the limitations of the medium.

Popular and light music

The musical arrangements written for pop music sessions take into account the engineer's ability to superimpose one section of the orchestra over another. For instance, a very loud rhythm section comprising drums, extra percussion, electric guitar(s), piano, etc., may also have an important part for acoustic guitar which is of course one of the quietest instruments on the concert stage. However, by giving each instrument its own microphone and setting the performers in such a way that the sounds from one instrument do not intrude on the microphones placed near the others, it is possible for the engineer to achieve a balance where the acoustic guitar is predominant.

For this reason the musical director in the session is entirely in the hands of the engineer, and it is important that a rapport is developed between them so that a feeling of mutual trust is engendered.

A typical studio layout of a solo vocal session featuring a medium sized 'concert orchestra' is shown in **fig. 2.**

It can be seen that, if an engineer has started a session with a classical layout and then finds that the composer has written something which could not balance itself in the concert hall, he has a serious problem in that the layout of the orchestra does not allow him much opportunity to pick up the quieter instruments with additional microphones because the rest of the orchestra would intrude. Another point to be kept in mind is that it is customary to record symphonic music in a large reverberant room, whereas popular music is recorded in much smaller studios having a substantially dry 'open-air' acoustically. The reason for this of course is to help the engineer with his separation problem, in that the sounds from the instruments do not ricochet from the walls into the microphones.

The one occasion where a mixture of both techniques seems to work is in the recording of large music scores for films. It has become customary in Hollywood over the last 30 years to use the large symphonic sound for the title music of motion pictures, adding extra microphones to bring solo instruments to the foreground during music which is incidental to the dialogue.

The second decision the engineer has to make before the recording session itself is how many tape tracks he is going to use for the session and, if multitrack recording is decided upon, how the music is going to be spread across the tracks to give the maximum flexibility at the later dubbing session. In this country, classical music is still often recorded in straight stereo, that is to say, the sound which is to appear on the finished record is achieved on the session. This means recording on 6.25 mm tape using two tracks only, the only process the tape has to go through before the disc is cut being that of editing for musical reasons. As mentioned before, the majority of American companies use 3-track or 4-track recording for classical work; three of the tracks being used for the main body of the orchestra (left, centre and right) and the fourth track carrying some important detail of the orchestration (for instance, the Harp or Celeste) which can be blended in later, or if a concerto is being recorded for the solo instrument. It is not usual at this moment for classical music to be recorded using multitrack facilities although this is on the way and will, no doubt, become standard practice within the next few years.

During the planning of the session, the producer will usually suggest the number of tracks to be used, and their allocation with the engineer, at the same time. In the case of pop music the producer decides whether all the music is to be recorded simultaneously, or some of the instruments tracked on subsequently. Very often the rhythm and wind instruments are recorded first, allowing the conductor to concentrate on details in their performance. The string instruments being tracked on at a later date since their contribution is usually of

(continued on page 159)

Model MR-929

All transistor stereo/monaural tape recorder.

4-track Monaural Recording and Playback, choice of $7\frac{1}{2}$ in/sec. and $3\frac{3}{4}$ in/sec. speeds. Sound-with-sound System. 2-channel 4 track full-frequency recording and playback with true-to-life stereo sound effect. All-transistor OTL Circuitry. Professional Type VU Meter for each of the 2 channels, indicates best sound input. Built-in tape counter facilitates spotting of recorded contents by eliminating guess work. Vertical or horizontal operation.

SPECIFICATIONS

Recording System: AC bias
Erasing System: AC erase
Reel Size: 7″ dia.
Speeds:
$7\frac{1}{2}$ in/sec (19 cm/sec),
$3\frac{3}{4}$ in/sec (9.5 cm/sec)
Playing Time:
stereo
30 min. x 2 at $7\frac{1}{2}$ in/sec with 7″ (18 cm), 1,200 ft. (360m) tape
1 hour x 2 at $3\frac{3}{4}$ in/sec with 7″ (18 cm), 1,200 ft. (360 m) tape
monaural
30 min. x 4 at $7\frac{1}{2}$ in/sec with 7″ (18 cm), 1,200 ft. (360 m) tape
1 hour x 4 at $3\frac{3}{4}$ in/sec with 7″ (18 cm), 1,200 ft. (360 m) tape
Rewind Time: 3 min. with 7″ (18 cm)
Frequency Response:
20-19,000 c/s at $7\frac{1}{2}$ in/sec (19 cm/sec)
(30-15,000 c/s $\pm$ 3db)
30-12,000 c/s at $3\frac{3}{4}$ in/sec (9.5 cm/sec.)
Recording Level Indicator:
VU meter
Power Output:
Maximum 4W (each channel)
Music 6.5 W (each channel)
Speakers:
Two 4″ free-edge permanent speaker boxes.
Voice coil impedance 10K ohms.
Line Outputs:
IK ohms
Power Source:
AC 100V, 117V, 125V, 220V, 240V
Dimensions:
$14\frac{1}{4}$″ wide x $12\frac{3}{4}$″ deep x 11″ high
(350mm x 330mm x 280mm)
Weight:
28.6 lbs. (13 kg)

The MR-929 is available from the Sanyo dealer in your area, specially selected for first-class before-and-after-sales service. Or you can write for illustrated leaflet to:

Sanyo Marubeni (U.K.) Ltd.,
Bushey Mill Lane, Watford, Herts.
Telephone: 92 25355.

SANYO

People the world over agree there's something about a Sanyo

RECORDING STUDIO TECHNIQUES

I AM very often asked to explain the differences between tapes and to recommend one brand against another. Although the former is easy to answer, the latter is very difficult indeed, especially since new tapes are continually being developed by one company after another. Although one manufacturer's tape may be best one year, another's may show a distinct improvement in the next. I will deal only lightly with tapes for domestic machines, and for this reason shall be talking mainly about Standard Play tape.

Professionals mainly purchase tape on NAB spools having a large hole in the centre and an external diameter of 27 cm. These spools contain 732 m (2 400 feet) of tape, thus having a playing time of 32 minutes at 38 cm/s, the speed normally used by professionals. It is important in the studio that high speed spooling should be neat and not full of ruffles or pack slips. Many studios therefore prefer matt-surfaced tapes. These, however, usually cause more head wear than tapes with a shiny back and polished oxide coating. In general, matt tape can only be made in Standard Play form, or thicker. It tends to be stiffer and the wrap round the recording and replay heads is not quite so good as with thinner tapes though print-through, the tendency for one piece of tape to copy itself on adjacent windings, is comparatively low.

For 20 years there has been a most useful reference of tape magnetisation intensity. This reference corresponds to a replay flux of mM/mm (milliMaxwells per mm width of track). Nearly all full-track test tapes produced in Europe for 19 and 38 cm/s have a tone at the beginning corresponding in peak level to this reference standard which used to represent a 2% distortion figure on tapes made many years ago. On present-day tapes, however, this distortion figure usually occurs at a much higher level—as much as 8 dB. The studio engineer has the choice of using either normal tape, which has slightly improved over the years, or tape having lower inherent tape hiss, known as 'low noise' tape. Such tapes, although they give a much improved signal-to-noise ratio, are almost all prone to higher print-through which can be particularly disastrous with speech recordings. Yet another alternative is a tape which will accept a higher recording level for the same distortion, and thus play back at a higher level. Known as 'high output' tape, its virtues can be combined in a tape having the characteristics of low noise *and* high output. It is important to remember that many professional machines designed some years ago do not have sufficient current output available from the recording amplifier to drive the latest high output tapes fully. Many high output tapes will only give their best performance when using record heads with a gap in the region of 18 μm. This wide gap is necessary in order to allow the magnetic flux to penetrate fully the somewhat thicker oxide coating of high output tapes. Such wide gaps will not give a satisfactory performance at slow speeds and a number of professional machines made to work at three speeds, with optimum performance at 38 cm/s from wide gaps, will frequently not record more than 10 kHz at 9.5 cm/s. A similar position occurs with replay heads; a very fine gap on a replay head will tend to wear very much faster than a wider one made of the same material, and a wider gap will tend to replay high output tapes recorded deeply into the oxide more satisfactorily. The best compromise, therefore, with machines recording at 9.5, 19 and 38 cm/s, would appear to be 12 μm record and 4 μm replay. Such an arrangement can give a response extending to 14 kHz at 9.5 cm/s. I have also found that high output tapes such as BASF *LR56* can often sound bubbly when used with fine gaps since, because the surface is not smooth, the recorded flux only penetrates the external layers of oxide. It will therefore be seen that any variation in thickness can give rise to such effects, and also to dropouts.

When testing tapes, several other factors have to be taken into consideration. These include modulation noise which can clearly be heard as a 'shush' when a high frequency is recorded at a fairly high level. As referred to in last month's article, a new bias setting can reduce this but some tapes will be found much better than others. Distortion also varies from one brand of tape to another and I remember many years ago comparing a reel of British manufactured tape with that of a Continental manufacturer and remarking that the British reel behaved like a pentode valve whereas the Continental tape behaved like a triode valve. In other words the British tape gave a rapid increase of distortion above a particular recording level, while the Continental one had a far more gradual increase giving audibly better transients, although the 2% limits on both tapes were the same.

I have just completed some tests on recently manufactured tapes, both Standard Play and LP. It is interesting that, although the figures confirm the noted audible differences, the measured differences were relatively small. For these noise measurements, a bass roll-off of 6 dB per octave was introduced below 250 Hz, plus a similar roll-off above 15 kHz. The basic noise of the machine, referred to 32 mM output at 1 kHz, was −70 dB. The lowest audible hiss was obtained from Agfa *PER555*, followed closely by BASF *LP35LH* (the *L* stands for low noise and the *H* for high output), and Agfa *PE35*. The next lowest was a sample of the new EMI *815* professional tape, at the moment undergoing tests, then EMI *Afonic* LP tape, followed by BASF *LR56*. The *LR56* in fact only had a measured hiss level 2 dB worse than Agfa *PER555* but the audible difference seemed higher. On the same scale ordinary BASF *LP35* had a noise level 1 dB worse than *LR56* and ordinary Agfa *PE31* was 3 dB worse still. It will be seen therefore that the hiss levels of the tape samples measured varied within only 5 dB and yet, audibly comparing Agfa *PE31* with the same manufacturer's *PE36*, the difference was incredibly marked. The same noise tests were also measured through an NAB dBA weighting curve with almost identical results to check whether the latter curve, which is considered fairly close to the human ear's susceptibility to noise at different frequencies, would give different results. The overload factors of several tapes were then examined and the overload points at 1 kHz and 10 kHz checked by determining the point at which the increase of input signal ceased to correspond linearly with the signal output. The best tapes at 1 kHz were BASF *LR56* and Agfa *PER555*, these giving a measured distortion of only 3% with an output of some 9.5 dB above 32 mM/mm. This is not the whole story however, since at 10 kHz both these tapes started compressing at 2.5 dB above 32 mM/mm. Thus, for some types of music with large amounts of modulation at high frequencies, a recording level of 5 dB above 32 mM/mm should certainly not be exceeded.

A very interesting new tape has been developed by EMI which will be released shortly, having the type number *815*. It has the somewhat phenomenal property of almost the same overload point at 10 kHz as at 1 kHz and is therefore safe for recording any type of music, no matter how 'toppy', and also high quality speech recording, no matter how sibilant. Users of the Dolby system should be particularly interested since a recording level of 32 mM/mm is normally used to obtain lower distortion. It seems, however, that EMI *815* tape, which has a lower basic noise level than *LR56*, may be equally or more suitable for the Dolby system, which incidentally is being tested by the writer on an extensive field trial, the results of which will be given in a forthcoming article.

When using *LR56*, on some types of music I have noticed very little audible sign of distortion when instantaneous peaks of up to 11 dB above 32 mM/mm have been played back. The print-through at this high level can reach alarming proportions, however, and only certain types of music can be recorded, even when the tapes are stored in closely controlled conditions of humidity and temperature. It is not so many years ago that classical master tapes were recorded to a peak level of only 32 mM/mm.

Assuming the recording amplifier is capable of the very high current requirement for high

(continued on page 159)

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Philips 4307 ...	£35	0	6	£30	0	0
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Sansui AU222 ...	£62	17	7	£55	0	0
Sansui AU555 ...	£80	8	7	£70	8	6
Sansui AU777 ...	£115	15	3	£101	6	0
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Sansui 400	£109	10	0
Sansui 2000	£145	17	0
Sansui 5000	£186	16	6
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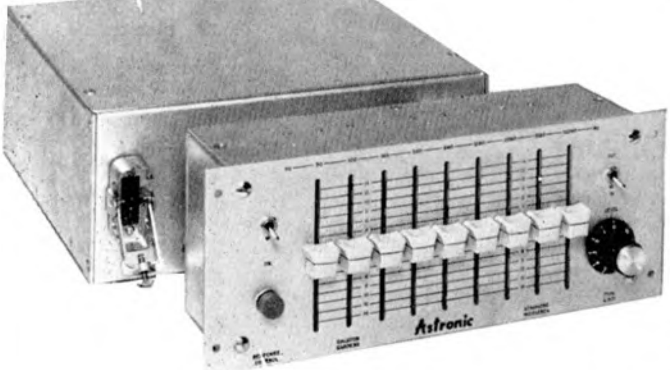

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RECORDING STUDIO TECHNIQUES CONTINUED

output tapes, most studios prefer to peak 6 dB above 32 mM/mm since only rarely will the high frequencies present in music reach a peak in excess of 4 dB below the peaks at 1 kHz, and such peaks are usually of so transient a nature that the instantaneous distortion produced would not be objectionable. Tape hiss is noticeable on wide range equipment when recording at this level, though it is certainly not too marked. When a copy has to be made from the master, the hiss begins to build up and it is largely for this reason that the Dolby system (described by Keith Wicks in February and March *Studio Sound*) has been designed, giving a 10-15 dB improvement in signal-to-noise ratio without any noticeable degradation of quality. The use of the Dolby at the peak recommended level of 32 mM/mm allows you to record with a distortion of less than 1.5% in the audible range, in addition to approximately 6 dB lower noise than using the same tape without the Dolby system at the higher level and with greater distortion. In this connection, however, the distortion of the tape at 32 mM/mm is what matters, not the distortion at the normal rating given by the manufacturer. It is probable that tapes with even lower distortion factors than *LR56* will emerge, but will not necessarily be high output ones.

It will therefore be seen that almost every different tape has its merits for one application or another and, briefly, the parameters that should be measured to evaluate any tape should be as follows: weighted recorded hiss level (as previously explained), maximum level for 1% and 3% distortion at 1 kHz and the 10 kHz bias requirement, recorded drive requirement to give these levels, the amount of treble boost required to give the correct playback characteristic, the amount of modulation noise, the print-through factor, the ease of spooling and editing, the effect of humidity and temperature in storage, the susceptibility to dropouts, and, of course, the price with relation to the performance.

To sum up then, I would recommend very strongly that low noise high output tapes such as BASF *LP35LH*, Agfa *PE36* and to a slightly lesser degree EMI *Afonic*, give a far better performance in general than ordinary tape, the retail price usually being only 15% higher or so (in the case of EMI the same price). They will often give a performance little inferior at 9.5 cm/s to standard LP tape at 19 cm/s on a good domestic machine, and therefore work out cheaper in the long run. I do not think it will be long before virtually all tape sold will be low noise but few domestic tape recorders have sufficient current output in hand at the recording amplifier to drive the high output ones fully.

Studio engineers should test many brands of tape before deciding which gives the best results on their equipment. The playback characteristic in use in the studio should also be borne in mind when choosing a tape. The American NAB playback curve, having time-constants of 50 μS with a 3 180 μS, bass roll-off, requires approximately 3 dB less treble pre-emphasis at 10 kHz than the British 35 μS playback curve. As already explained, many high output tapes will not accept much HF pre-emphasis but, using the NAB curve, can have a higher recording level on them. For this reason, such tape as EMI *815*, BASF *LGR30* and Agfa *525* may well be less suitable. Conversely the British standard curve of 70 μS is far more suitable for 19 cm/s when high output tapes are used since the identical 38 cm/s NAB curve requires too much treble pre-emphasis (approximately 3 dB boost) for the high output tapes. It is therefore suggested that professionals keep to 70 μS for 19 cm/s in order to allow a higher peak recording level with tape saturation at high frequencies.

STUDIO DIARY CONTINUED

toring loudspeakers should be used if both effective and consistent programme control was to be maintained.

Mr Watts dealt with some of the more detailed aspects of design, starting with subjective considerations and then going on to the problems associated with matching, wide frequency response, high dynamic range and minimal amplitude distortion. Despite the additional difficulties introduced by the incorporation of comprehensive signal processing facilities, the frequency response of the transistorised systems is held at 20 Hz to 20 kHz ± 1 dB, with residual noise only about 3 dB above the theoretical minimum. Distortion was kept well below 0.1% total; Mr Watts remarked that only a little over 0.1% distortion of the type associated with Class-B working is detectable on a sine-wave tone.

He thought the performance of integrated circuits was now almost acceptable for mixer applications but the reduction in circuit volume was not a great attraction, since functional controls and indicators presented the limiting factor as regards space reduction.

The evening sessions started with an illustrated discussion on the development of sound control desks at Thames Television over the last 12 years. J. Tasker, P. Sampson and G. Karn of TT gave a running commentary on the colour slides, with observations and criticisms from the film and research industries by L. Abbott of ABPC and L. Giddens of EMI Research. The series showed how the equipment had evolved from a few channels and controls up to a sophisticated system of 48 channels, distributed between three desks, capable of being used separately or in conjunction. However, as pointed out in the discussion afterwards, no provision had been made for supporting the script board; in the pictures it was seen resting over some of the channel controls! This seems to be a common problem and representatives of the film side indicated how it was being solved in their layouts. It also turned out that there does not yet appear to be an agreed convention regarding the direction of operation of quadrant faders. Demonstrations on typical programme material were given of the wide extent of the desk control facilities and a further example of the superiority of continuous versus stud faders for smoothness of control.

Next, Mr M. Batchelor of EMI Research Laboratories outlined the design principles behind the latest EMI studio desks. These are built up from modules; each has two signal channels and is entirely self-contained as regards power supplies, the circuits operating at minimum power dissipation levels to ensure reliability and low noise performance. Among the special features of the desks is a 'correlator' meter, showing the 'vertical' component of the stereo signal over a wide range of levels, its purpose being to detect the presence of undue out-of-phase signals, which can cause embarrassment when cutting discs or mixing down to mono.

The final lecturer was Mr R. W. Swettenham of Helios Electronics Ltd, who started by drawing out a block diagram of a modern multi-channel desk, with its many channels, groups, groups of groups, provision for fold back, and so on, and then suggested that such complexity was often unnecessary or inefficiently utilised. He then dealt with the problems associated with monitoring an extensive number of channels, involving the most efficient layout of meters and the distribution of monitor loudspeakers; even for eight channels, four loudspeakers were considered a maximum. On programme level indicators, he thought research was urgently needed and suggested that the most effective medium might be a cathode ray tube display, which could provide a compact and easily viewed system with 'memory' for eight and even more channels. Mr Swettenham concluded with the observation that programme control was now so complicated that he seriously thought some form of computer assistance might be worthwhile.

SOUND BALANCING CONTINUED

a more romantic nature with less detail in the playing.

The foregoing gives some idea of the background of the balance engineer and also something of the problems which will be going around in his head before he even walks into the recording studio to mix a session. Although some of the more experienced engineers may tend to make their job seem easy, this should not delude a casual visitor to the recording studio. He is never blasé, will have left nothing to chance, and certainly knows exactly what he can get away with if a tricky situation should develop, as it is a case for instance when additional instruments are added to the session at short notice.

A very good friend of mine (and a competitor I may say) once said: 'You can tell a good engineer by the way he *uses* bad separation'. He was perfectly right. But my advice to the young engineer is take no chances and build your future reputation on a foundation of painstaking work. Don't let a studio full of musicians harass you and, if you have difficulty with a particular section of a piece of music, listen to it over and over again until you have got it right. However, remember that the musicians are only human; do not ask the whole orchestra to play merely in order to check something on one microphone, for instance.

A BUDGET MIXER

THIS article is aimed at the would-be constructor, its purpose being to describe a transistor mixing unit suitable for small studios. Various circuits are described, all of which have been tried and tested and are being used in professional studios at the time of writing. The reason for a collection of separate circuits is to permit conversion of existing equipment if this should be considered economic.

If one is building from scratch, the *n-p-n* negative-earth circuits are recommended as the latest transistors are employed which give lower distortion and noise figures.

Fig. 1 illustrates one channel of a monophonic mixer and a stage-by-stage analysis will show its full operational facilities. The microphone amplifier is needed to boost the low level mike signal to match the later stages with a minimum of distortion and noise. The microphone impedance determines the type of transformer required.

Other important parameters are screening (if one is to avoid a 'noise-to-signal' ratio), the frequency response of the transformer, and the cable capacitance. Both the latter factors may limit the HF response and in so doing affect the transients. All the amplifiers described here are capable of a frequency response better than 20 Hz to 20 kHz ±1 dB.

As well as handling microphone levels, this amplifier may also need to pass line level. Suitable switching arrangements to disconnect the transformer should be made for this mode.

It may be required to include a high-pass filter to reduce traffic noise, etc., when recording under bad conditions. This may be achieved by inserting a high-pass filter unit or just switching the input capacitor so that its reactance in combination with the input impedance will attenuate the lower frequencies. An auxiliary mixing bus for foldback headphones or loudspeakers may be taken from point X. **Figs. 2, 3** and **4** show further microphone amplifiers. **Fig. 2** is a simple yet very efficient positive earth circuit with switched gain, 120 K input impedance and approximately 15 K output impedance. **Fig. 3** is a variable-gain transformerless circuit, the input impedance of which is determined by R1 and R2. **Fig. 4,** a Mullard design, has voltage gain adjustable between 13 and 40 dB. At 13 dB gain, impedances are 145 K (input) and 47 ohms (output), respective figures for 40 dB being 120 K and 120 ohms.

The next device in the chain is a tone correction unit usually termed an equaliser. It has a number of uses from compensating for studio acoustics to the creation of special effects. **Fig. 5** is a simple 60 Hz lift/cut and 10 kHz lift/cut circuit using the Baxandall principle and designed to work from the **fig. 2** microphone amplifier.

Fig. 6 depicts a similar equaliser using a negative earth configuration. Both **figs. 5** and **6** have a flat response at 1 kHz relative to any setting of the controls. A similar concept is used in **fig. 7** though only one frequency is available. It may be selected at will (e.g. presence lift 3 to 4 kHz) by using

FIG. 1

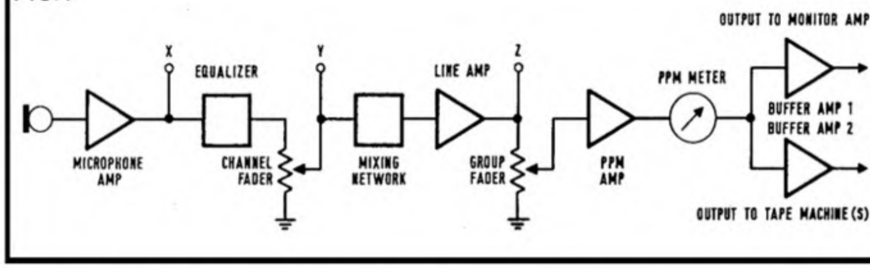


FIG. 2 POSITIVE EARTH MICROPHONE AMP

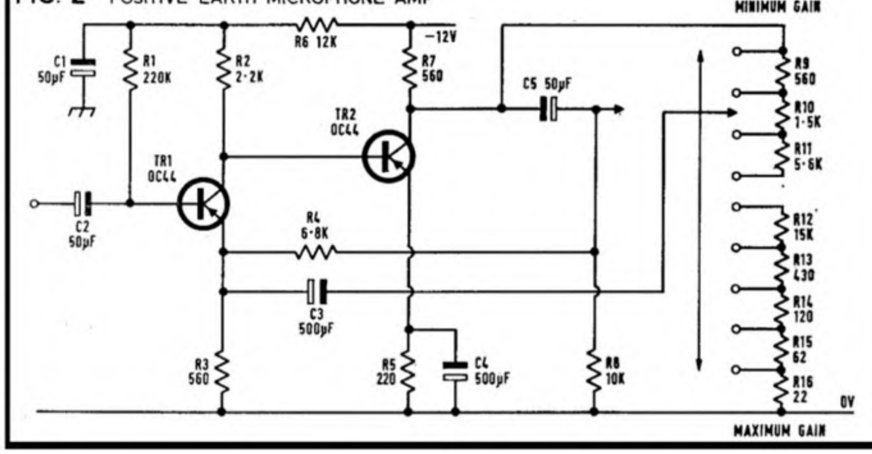


FIG. 3 TRANSFORMERLESS MICROPHONE PREAMP

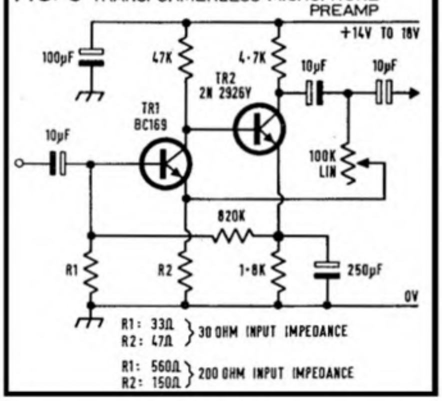
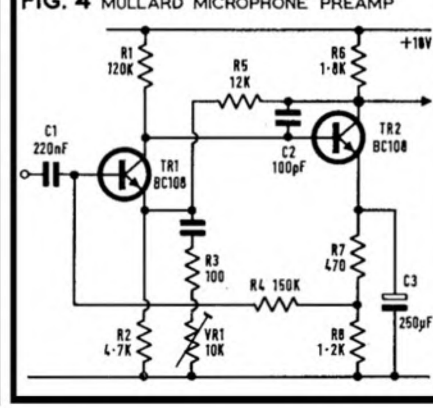


FIG. 4 MULLARD MICROPHONE PREAMP



by Gerald Chevin

FIG. 5 EQUALIZER (POSITIVE EARTH)

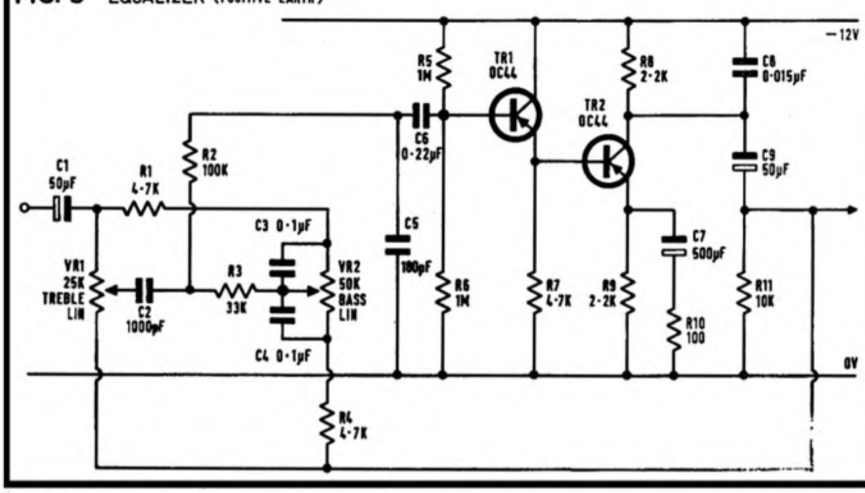


FIG. 6 EQUALIZER (NEGATIVE EARTH)

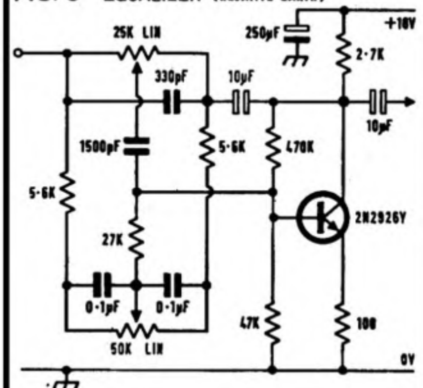
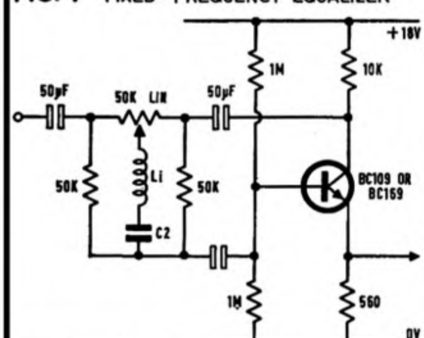
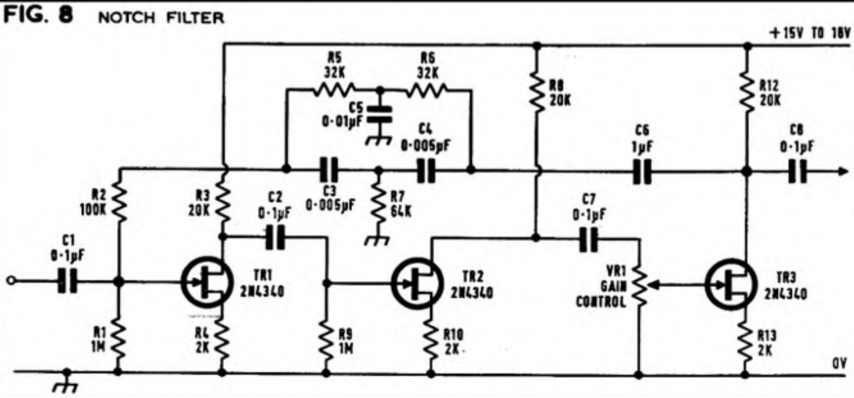


FIG. 7 FIXED-FREQUENCY EQUALIZER



WHEN L1 300mH
C2 IS 0·001µF FREQUENCY IS APPROX 3KHz

FIG. 8 NOTCH FILTER



the following expression :

$$f = \frac{1}{2\pi\sqrt{LC}}$$

where f=frequency of resonance in Hz
L=inductance in Henrys
C=capacitance in Farads

If f is to be expressed in kHz, L is in µH and C in µF.

$$f = \frac{159}{\sqrt{LC}}$$

Alternatively, f metres (wavelength) $= 1885\sqrt{LC}$

Using this circuit with a tapped coil and suitable capacitors, various spot frequencies may be selected whose Q factor depends on the following formulae:

$$Q = \frac{X_L}{R} = \frac{X_C}{R} \text{ at resonance.}$$

The circuit described in **fig. 8** is interesting because it utilises field effect transistors. It is only intended for experienced constructors and can be patched into any channel. The action of the circuit is to pick out a selected frequency sharply and amplify it 42 dB. The tuning is accomplished with a parallel-T network (C3, 4, 5 and R5, 6, 7). This is a null network (notch filter) and is connected in the feedback loop between output transistor Tr3 and input Tr1. The values given are for tuning 1 kHz peak. Parallel-T networks may be set up for other desired frequencies provided that the following relationships are maintained (all 1% resistors) :

$$C3 = C4 = \frac{C5}{2}$$

$$R5 = R6 = 2R7$$

The band pass frequency is then

$$f = \frac{1}{2\pi CR}$$

where f is in Hz, C is C3 in Farads and R is R5 in ohms.

It is hardly necessary to stress that FETs are extremely sensitive and even combing your hair in front of one is liable to kill it.

The signal has now been suitably amplified and if necessary corrected (the equaliser may incorporate an in/out switch if desired). A logarithmic slider of about 10 K may then be used to feed the mixing network which for this purpose will be passive. There are two schools of thought about mixing networks and it is certainly true that an active mix is preferable but the expense is rather high so resistive mixing only is described. **Fig. 9** shows a simple system of connecting all the channel outputs to a common bus.

The value of Rx is something of a com-

(continued overleaf)

promise between minimum signal attenuation and channel interaction, which may be described as the effect one channel fader has on a steady tone through another, as well as breakthrough when all channel faders are closed.

Using this method and depending on the number of channels, attenuation of the signal will occur and the signal must be boosted to its original level. In doing this, of course, the signal-to-noise ratio will suffer but when using low-noise transistors in the line amplifier and preceding stages, this method is still the preferred system from an economic viewpoint.

As described above, a line amplifier is the next step and the circuit in **fig. 10** is a *p-n-p* line amplifier with a 30 dB maximum ain by varying the negative feedback voltage. Input impedance is high and output impedance low and the circuit may be used in conjunction with the other positive-earth circuits described.

Fig. 11 is a line amplifier suitable for use with negative earth circuitry, careful attention in construction layout is required if instability is to be avoided. Constructors may prefer to build the Mullard line amplifier by utilising the microphone amplifier instead of **fig. 11.**

Point Z on the **fig. 1** block diagram allowed for a limiter/compressor to be patched or built into the mixer. A suitable unit was described by the author in the July and August issues of *Tape Recorder* and a future article describing an improved device using an FET is in preparation. (The July/August design is for negative earth only.)

Some form of signal level indicator is required and most people prefer peak programme meters. A suitable design appeared in this journal in October 1968. **Fig. 12** shows a further circuit which, for all intents and purposes, indicates a peak reading when used with an Ernest Turner *Type 702* 1.52 mA right-hand mechanical zero meter.

It is important to use heat sinks for Tr4 and Tr5. The amplifier drifts slightly and initial setting up should only be undertaken after an hour or so of operation.

The PPM amplifier is preceded by another slider control acting as a main gain for a mono mixer or group return for a multitrack mixer.

The final output stage requires two buffer amplifiers, one to drive the monitor amplifier and the other to feed the recorder. **Fig. 13** is simply the line amplifier with the voltage negative feedback removed giving a 12 dB gain. **Fig. 14** is based on a Mullard design, has a very high input impedance (145 K) and low output impedance (63 ohms) with a fixed gain of 10 dB.

It is necessary to bear in mind that a stabilised power supply with a low output impedance will minimize distortion on transients and reduce crosstalk.

When built, the PPM amplifier should be adjusted so that O dBm at the mixer output (measured on high impedance VVM) gives a meter reading of '4'. This can be achieved using the sensitivity control VR7.

Extra items that may be constructed are a simple keyed 1 kHz oscillator for zero level line-up purposes, a talkback unit which partially mutes the monitor when keyed and perhaps an auxiliary mix from point X (**fig. 1** again) for echo send which will need to be amplified, equalised and fed back through an echo return slide potentiometer into the group mix.

It is a good idea to terminate all inter-unit connections at jack sockets on the rear panel (not break jack) for either testing or connecting external equipment.

FIG. 9 PASSIVE MIXING BUS

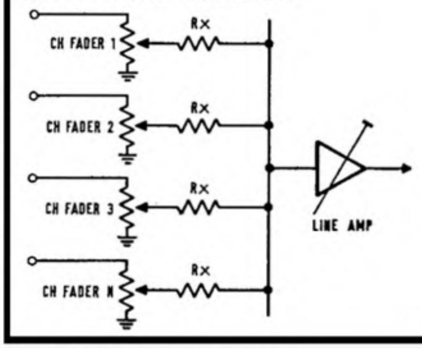


FIG. 10 30dB LINE AMP (POSITIVE EARTH)

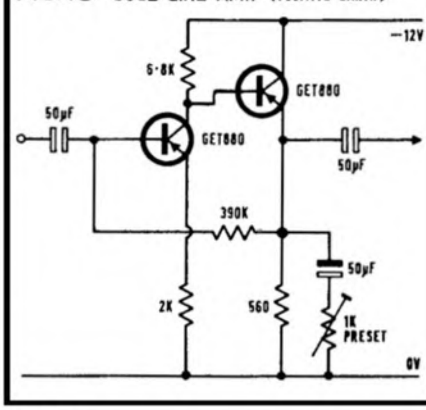


FIG. 11 HIGH GAIN LINE AMP (+8dBm OBTAINABLE)

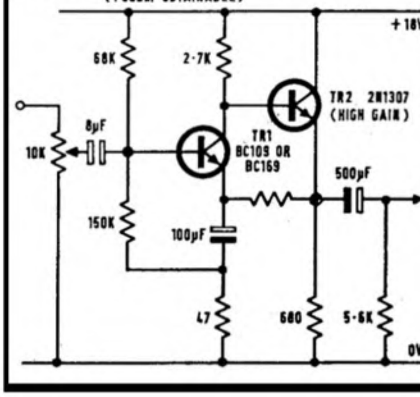
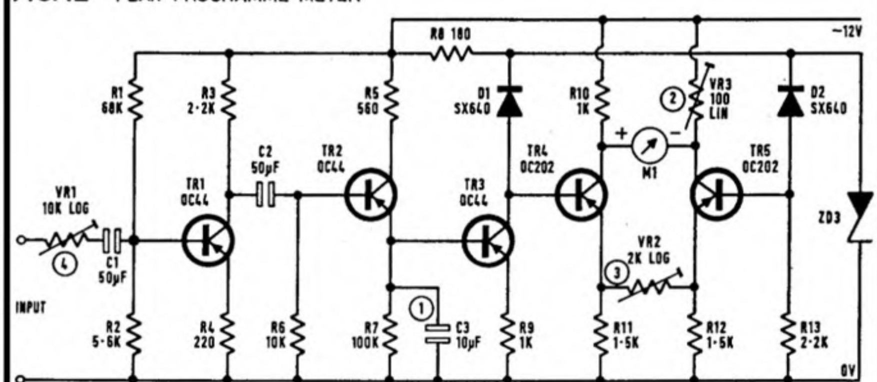


FIG. 12 PEAK PROGRAMME METER



1.....DECAY TIME
2.....ZERO (ELECTRIC)
3.....D.C. GAIN (FOR A DIFFERENCE OF 20dB BETWEEN '1 AND 6')
4.....SENSITIVITY

FIG. 13 BUFFER AMP

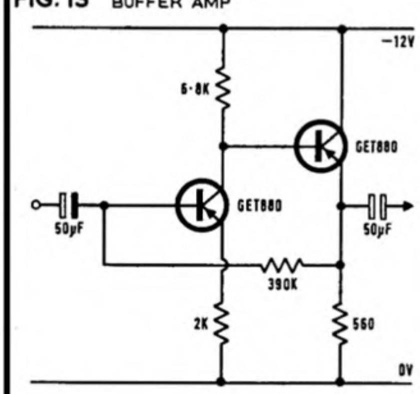
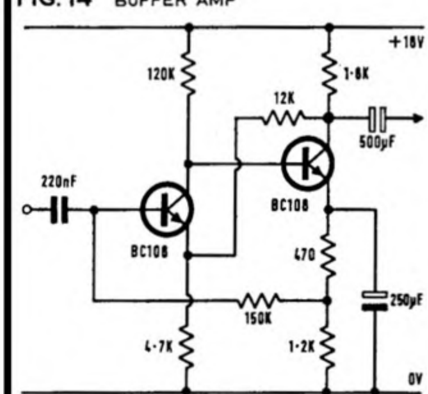


FIG. 14 BUFFER AMP



VTR CIRCUITRY PART 6

BY HENRY MAXWELL

SOME of the circuitry involved in the playback chain of the video tape recorder has already been discussed. This is not to say that, as so often found in cheap sound recorders, the circuits can be used to 'share' a function, but rather that the same signal path is followed by the replayed signal after initial processing, through limiter circuits to the video amplifier and output stages.

Where multiple head systems are used, the usual procedure is to couple each replay head to its own preamplifier, the matched output from these circuits being mixed and amplified into a complete carrier.

Fig. 1 shows a skeleton circuit of the two replay preamps of the Sony *CV2000B*, a six-transistor section sufficing to shape and prepare the FM signal for application to the limiter block that we discussed when we considered monitoring.

Tr1 and Tr2 are common-emitter stages, although the circuitry including these *p-n-p* devices makes them appear 'upside-down'. A second stage, a low-noise, medium gain silicon *n-p-n* transistor in the emitter-follower mode, lifts the signal level to a value suitable for mixing. The two emitters are coupled by a 500-ohm preset resistor which is adjusted to give a symmetrical output at the point marked TP9, after the two-stage playback amplifier.

Note at this point that there is no striving for more gain, or adjustment for maximum level. The important point is symmetry. It should be remembered that the machine we are discussing has a two-head system with one of the heads offset at a slight angle and mounted a little higher than the other. By this means, and by exact timing, the same line of recorded information on the tape is scanned by each head as they revolve on their common spindle.

In fact, a signal level discrepancy of as much as 6 dB can be tolerated, but should be taken as the utmost limit. The signal level of the smaller of the two successive lines in the pairing should not be less than 0.4 V.

From the playback heads, the signal is coupled via the take-off rotor and brushes to input transformers. Across the secondary winding of each is a fixed and a variable capacitor. The two preset capacitors are employed to achieve resonance, giving some boost at the higher frequencies, where tape head losses are most apparent. **Fig. 2**, a rough graph of the relevant losses, reveals why it is not possible to use the same circuits for both functions—at least, without involved correction switching which would defeat the object.

In the machine being dealt with, the tuning of the head take-off circuits is nominally at 2.5 MHz. In practice, after initial tuning for maximum, using signal generator, a sinewave input, and an unloaded head, the presets are 'tickled up' on final setting of gain and balance.

At TP9 there will be a combined signal, a positive and negative waveform, with the outputs from the two heads showing as successive envelopes. The oscilloscope needs to have a 3 mS/cm horizontal setting with 10 mV/cm vertical gain for an adequate registration of the 40 mV p-p signal.

It may seem that a lot of fuss is being made to get this balancing of the signals right. After all, it could be argued, what discrepancies occur on one line will be compensated more or less by those on another. But the argument is fallacious. Just as the butter side of the dropped toast always falls to the floor, so do noise signals (and that is all that these discrepancies are) always seem to be cumulative. So the signals are trimmed and tailored as early as possible and fed from another potentiometer, which is used to reduce the risk of saturation, to the limiter stages.

The limiter section of this machine has five stages in cascade, all common-emitters, with base voltages stabilised by parallel reversed diodes providing the limiting action. **Fig. 3** shows a pair of these stages, with the coupling between them intended as our focal point. Base bias is set by a potential divider, and working bias determined by the emitter resistor. From the collector of the foremost stage, a relatively large coupling capacitor takes the 1.7 MHz signal to the pair of diodes and, from the swinging waveform, a clipped output is derived.

The action of such a pair of reversed diodes is as shown in **fig. 4**. On the axes of our graph, the crossover point denotes zero voltage applied and zero current obtained and the diode characteristics—these are silicon devices—are as shown by the curves A and B. After a fairly small forward bias is applied, current conduction rises and this, of course, shunts the signal. This is forward bias current and there will always be a small value, so the applied voltage is allowed to reach a level determined by the diode characteristics and the circuit time constants. There will be a region of 'neutral'

(continued overleaf)

FIG. 1

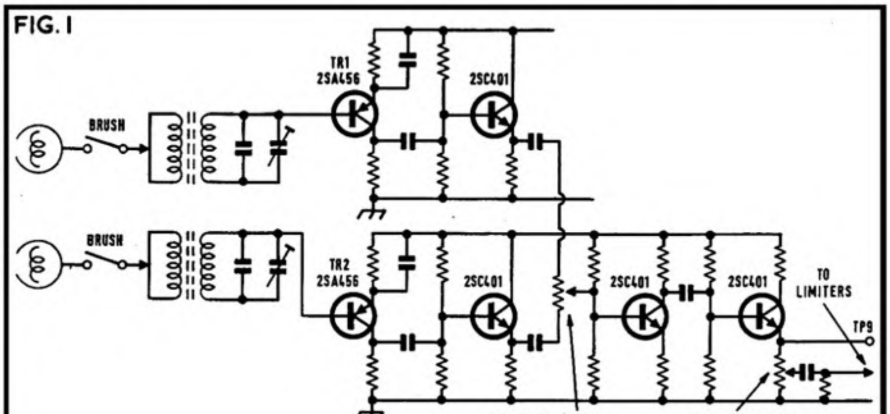
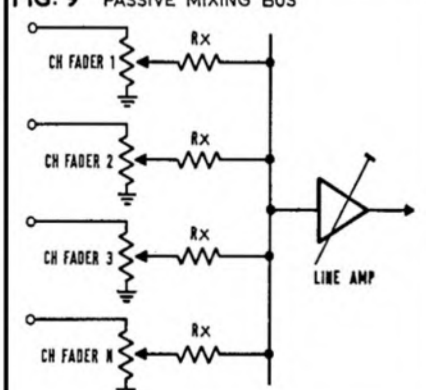


FIG. 9 PASSIVE MIXING BUS



positive and negative voltage when two diodes are connected as shown, with the small leakage currents present. Any input that swings beyond the limits determined by the diodes will be clipped and, providing the diodes are a matched pair, the clipping will be symmetrical. The trouble begins when they are not—or if circuit characteristics cause an effective change. Immediately, signal-to-noise ratio is impaired. In our case, a 1.8 V p-p waveform is obtained, as shown, and a final adjustment for symmetry is given with the method of returning the diodes to the emitter (via chassis) by a preset resistor. This is in the final stage of the limiter section.

This fanatical attention toward balancing and symmetry can be seen also in the Ampex method, where, in their earlier models such as the *VR6000*, they had four stages of limiting preceding the detector but also employed a signal level sensor which tapped off part of the RF signal in the second/third limiter stages and applied it, via a video switch circuit, to the penultimate video amplifier. The video stages were clamped in this design to a normal mid-grey, and the additional sensing controlled the clamp to allow for small differences in level that were unavoidable, caused by the fluctuations in tape-to-head contact.

Reverting to our Sony friends, who still provide the best example as well as—dare I say it?—results as good as anyone else's at a comparable price: We come to the detector and video amplifier circuitry, a skeleton breakdown of which is shown in **fig. 5.** From the limiter section, the signal is applied to the differential transformer. Each end of the secondary winding, whose centre-tap is taken to chassis, feeds a 'spike' of opposite polarity to the diode, acting as a push-pull circuit, so that the diodes are really pulse-detectors. Each time the waveform crosses the zero reference, a pulse is obtained. The combined pulse output is at twice RF (3.4 MHz) and this is picked off across another balance control and applied to the base of a matching transistor.

The purpose of this emitter follower is simply to couple the signal into the low-pass filter which follows. High frequencies are limited, the dangerous twice-carrier frequency is blocked and, by a process of integration, we obtain the necessary video signal.

There follow no less than five video stages, with de-emphasis provided in the second stage, where there is also a control of signal level. From the third video amplifier stage, a portion of the signal is tapped off, fed to a noise cancelling circuit and used as a control for the video output stage. This is the noise cancelling circuit we spoke about earlier.

The HF content of the signal is picked off and applied to the base of an amplifier which is amplitude limited by a pair of diodes in a similar way to the process we noted in the limiter section. But while the initial take-off from the third video stage is to the base of this noise canceller, and there is thus one inversion before application of the corrector signal to the base of the fifth stage, the primary video signal has gone through *two* inversions and will be in opposition when presented to the output stage.

As we noted, only the HF content concerns us. Noise is present as spikes on the top of the envelope—indeed, maladjustment reveals as 'grass' on the outer line of the waveform. It is this noise content, trimmed and presented in exact opposition to the original, which is applied to the base of the video output stage, cancelling itself out by the time the signal gets through this amplifier. Adjustment of the settings of these stages, and particularly the noise canceller, can be quite ticklish, but a little extra care pays off in improved results.

One more section needs to be considered: to keep the sync tip of the waveform at proper DC level, which is vital for insertion of the synchronising pulse, a clamper and mixer circuit has to be added. From the third video amplifier stage after de-emphasis, a diode and network of components clamp the signal and apply it through an emitter-follower to the mixer stage, which is gated by the 50 Hz vertical pulse. The mixer circuit clamps the input to the video amplifier, preventing noise triggering of the sync which could result from the method of two-head coupling, with noise in the vertical blanking.

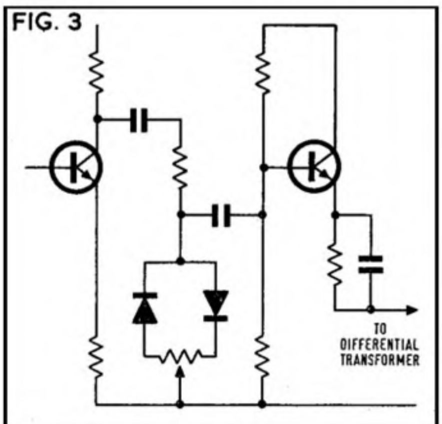
FIG. 3


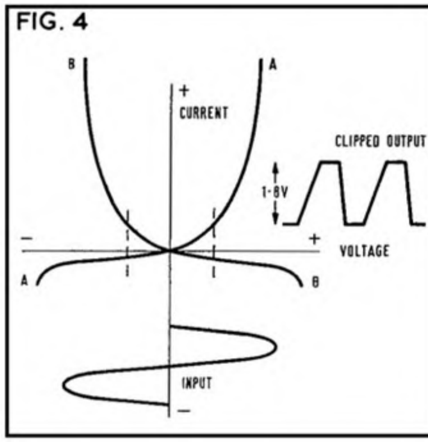
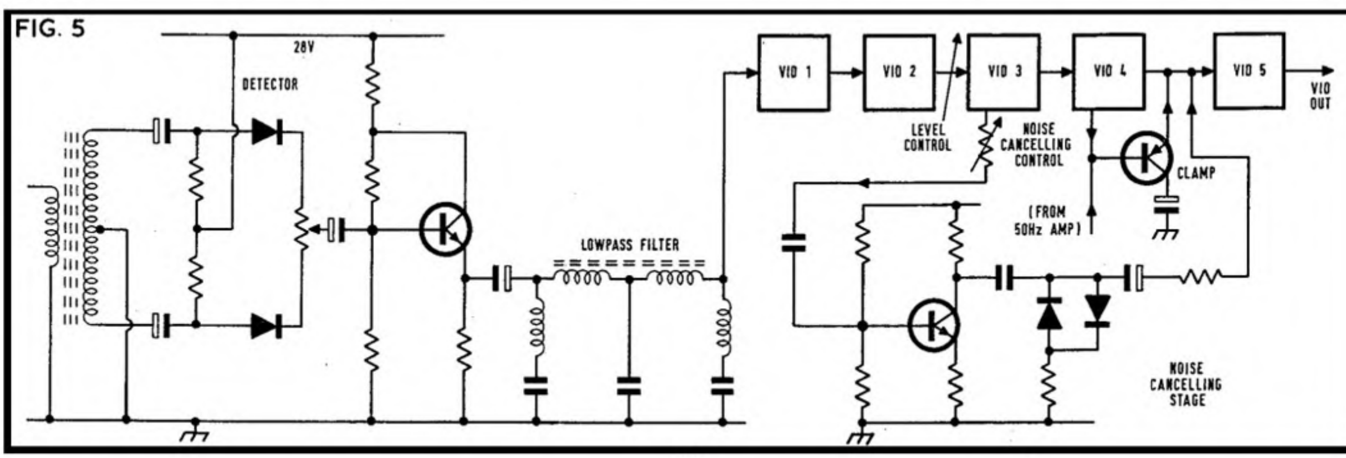
FIG. 4


FIG. 5


CASSETTE DUPLICATORS

THE INFONICS range of high-speed Compact Cassette duplicators is now available in the UK. A Teac transport carries 19 and 9.5 cm/s reel-to-reel masters at eight times their nominal speed, feeding a bank of four 38 cm/s cassette recorders. Model *SRC2* accepts 2-track masters and dubs both tracks simultaneously. The *SRC4* copies four tracks simultaneously, each cassette recorder incorporating an in-line 4-track head; it is also 2-track compatible. Claimed cassette frequency response at 4.75 cm/s is 20 Hz to 10 kHz ±3 dB for 45 dB signal-to-noise ratio. Wow and flutter total 0.3% RMS. Synchronous motors drive each cassette capstan, a two-speed hysteresis-synchronous motor plus separate torque motors being employed on the 18 cm capacity master deck. Individual gain controls and VU-meters govern each track. Record bias frequency is 500 kHz. Price of the *SRC2* is £1 600, the *SRC4* being £2 600. Additional slave units are available, extending the dubbing facility by eight or more cassettes.

Distributor: Fraser-Peacock Associates Ltd., 94 High Street, Wimbledon Village, London SW19 (Tel. 947-1743/2233)

44-PATTERN CAPACITOR MICROPHONE

LATEST PEARL capacitor microphone to be imported from Sweden by Jagor is the *DC 63* offering 44 different directivity patterns through continuously-variable controls. A twin-sided capsule is incorporated plus an FET head amplifier operating from a 67.5 V battery. The 0.5 to 0.7 mA power supply is fed along the microphone signal cable. Claimed sensitivity at 1 dyne/cm² is between —56 and —60 dB, depending on pickup pattern, dynamic range being 130 dB. Case dimensions are 150 x 31 mm and the weight is 175 gm.

NEW equipment

Also available from Jagor is the Pearl *5310* FM radio microphone system. This is designed around the *EC-71T* (cardioid) and ***EK-71T*** (omni) lavalier capacitor microphones. The transmitter unit is contained in a 105 x 75 x 30 mm Polythene case weighing 210 gm including 9 V battery and two 15 V microphone batteries. The *M33* receiver supplies 10 mW into a 200 ohm or high-impedance load and measures 150 x 120 x 40 mm.

GARDNERS EXTEND TRANSFORMER RANGE

FULL SPECIFICATIONS of new transformers being introduced by Gardners will be published by the company in July, entitled 'A Manual of Audio Frequency Line-Matching Transformers'. The new models are aimed at more specialised applications than the existing range and include transformers suitable for mounting in microphone sticks (left of photo), or on printed circuit boards. New materials are being exploited, typically the use of a closed-cell epoxide resin foam compound to provide a higher degree of acoustic damping than normal oil or air filling. Data sheets *AT15*, *AT16* and *AT17* are available on request.

Manufacturer: Gardners Transformers Ltd., Christchurch, Hampshire BH23 2PN (Tel. 0201-5-2284)

MICROPHONE BOOM AND FLOOR STANDS

A NEW 915 mm chrome-plated brass telescopic microphone boom, extending to 2 m, has been introduced by Reslo. The *MS 180* dispenses with bulky counterweights and may be paralleled with the vertical floor-stand tube if desired, providing normal floor-stand mounting. Price is £8 retail.

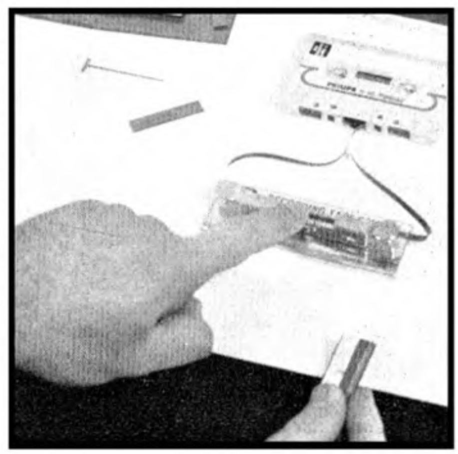
Model *MS 1108* is a grey hammertone enamel heavy-weight base with chromed outer and inner vertical tubes. The *MS 70* comprises three 380 mm anodised aluminium legs stemming from a solid metal boss at the foot of an 840 mm chromed-brass outer stem. The inner tube telescopes to 1.42 m from the ground. A single hand-locking screw holds the three legs. Both stands retail at £10.

Manufacturer: Reslo Microphones, Romford, Essex

REVERBERATION UNIT

A REVERBERATION unit employing two time delay systems in a manner claimed to eliminate peaks in frequency response is announced by Pioneer. Eleven transistors and two diodes are incorporated in the 300 x 115 x 200 mm unit which sells for £45 9s. 11d.

Distributor: Electronics Division, Shriro (UK) Ltd., Lynwood House, 24/32 Kilburn High Road, London NW6 (Tel. 01-624-9102)



CASSETTE EDITOR

PATIENT READERS who object to dubbing a cassette on to faster 6.25 mm tape before editing will welcome the *Bib Cassette Editing and Joining Kit* now being produced by Multicore. A scaled-down version of the company's 6.25 mm editor, it is supplied complete with razor cutters, splicing tape, cassette labels and a piercing tool. Price is 29s.

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Ferguson 3232 4 Tr. Stereo
Ferguson 3247 4 Tr. Mono
Ferguson 3248 2 sp. 4 Tr. Mono
*Ferrograph 713
*Ferrograph 702/4
*Ferrograph 722/4
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Fidelity 'Braemar' 2 or 4 Tr. Mono
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Grundig 144 4 Tr. Mono
Grundig 149 4 Tr. Mono Auto
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Philips EL3302 Cassette
Stella 9112AT Batt./Mains Cassette
Pye Cassette
Sharp 505 2 Tr./2 sp./BM
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UHER 4200

MANUFACTURER'S SPECIFICATION (19 cm/s). Half-track stereo battery tape recorder. Wow and flutter: ±0.2%. Frequency response: 40 Hz to 20 kHz to DIN 45 511 standard. **Dynamic range:** 53 dB. **Microphone input:** 0.1 to 25 mV at 2 K for full load (1 kHz). **Radio input:** 2 to 500 mV at 47 K for full load (1 kHz). **Phono input:** 30 mV to 7.5 V at 1 M for full load (1 kHz). **Radio output:** 1 V at 15 K. **Speaker output:** 2 V at 4 ohms (1 W single-ended push-pull output stage). **Power supply:** Five 1.5 V or 'dryfit' storage battery. Car battery adapter available. Power consumption: 3 W. **Level indicators:** Two meters. Remote stop/start facility. **Spool capacity:** 13 cm. **Dimensions:** 106 x 33 x 82 mm. **Weight:** 4 kg with battery. **Price:** £130 10s 2d plus £32 4s 10d. **Manufacturer:** Uher Werke Munchen, 8 Munchen 47, Barmseestr. 11, West Germany. **Distributor: Bosch Ltd., Rhodes Way, Radlett Road, Watford. (Tel. 92 44233).**

IT is strange that in these days of stereo there are relatively few transistor stereo tape recorders driven off accumulator or batteries. The one under review is the latest model of probably the most popular make available for some years. The *4200 Report* accepts spools up to 13 cm diameter and will record mono or stereo at 19, 9.5, 4.75 and 2.375 cm/s. It records to the NAB characteristics at all speeds, i.e. 50/3180 µS at 19 cm/s, 90/3180 µS for 9.5 cm/s, etc. The machine includes a monitor speaker working on the top track and has two loudspeaker monitor amplifiers to drive external headphones or loudspeakers, preferably of between 4 and 8 ohms impedance. The Uher can be operated either off five *HP2* batteries or a special 6 V lead-acid (or better still nickel cadmium) accumulator, both being rechargeable using an external charger unit. Separate units are available for the two types of accumulator. The machine will also wind forward a 13 cm LP reel, or rewind, in just over three minutes, although taking a considerable amount of power to do so. Two five-pin locking DIN sockets on the front panel are the medium impedance mike inputs and also contain a remote-control stop/start for the tape if the machine has been switched to the record mode. Also on the front panel are the recording level controls, stereo monitor gain, speed equalisation switch, recording track pushbuttons, level meters, turns counter and its reset button, and the grille covering the mono loudspeaker. The right-hand side of the machine carries a five-pin DIN countersunk socket for a sensitive high impedance input and also a 1 V high level input at high impedance, which on playback becomes an output taken before the stereo monitor gain control on the front panel. Two DIN loudspeaker sockets, one on each end of the machine, supply approximately 500 mW to external loudspeakers and are suitable for driving medium-impedance headphones. They are not recommended for use with low-impedance headphones without built-in attenuators since the monitoring volume control would have to be reduced too far to give the correct volume in the headphones, and a fairly loud hiss would be audible. The charger unit, which can also be used to run the machine directly, off mains, plugs into a socket on the right hand side.

I found the Uher extremely easy to use and very light in weight (about 4 Kg). Provided the nickel-cadmium cells were always charged the night prior to use, I always had a full day's use, although I kept spooling to a minimum. The piano keyboard type record replay and spooling controls are very neat and reliable and do not give any trouble on the latest machine, although slight trouble was experienced with keys on a model bought five years ago. The Uher is very easy to thread, and the spool spindles contain simple but effective spring locks to hold down the spool in use, allowing the recorder to be operated in any position, including upside down!

The recording amplifier is so good that 19 cm/s recordings made off batteries give virtually studio quality when played back on a professional machine later, although the replay amplifier in the machine itself is not quite as good, particularly at bass frequencies. The monitor amplifiers have rather a high distortion level, and in the instrument under review do not give the output stated by the manufacturer. Considering it is working off accumulators, the wow and flutter figures are good, allowing the recording of music at 19 cm/s to a very reasonable degree of fidelity. I regard it as important to use low noise tape to get the optimum performance and it is unfortunate that the machine is not capable of running at 38 cm/s, for which reason I do not recommend the *PES40* tape recommended by the manufacturer, which is not particularly low noise and incidentally is half way between standard and LP in thickness. For all the tests I used BASF *LP35LH* tape and recorded at a peak level giving 4 dB above 32 mM/mm. Although the instrument measured satisfactorily as delivered I decided to set it up very carefully to see how good it could be.

The recording level meters were set such that the needle corresponded at 2 dB below 32 mM/mm on a 1 kHz tone when at the meeting point of the black and red scales, providing under-reading of music and sound effects. The motor speed can be varied electronically and was set such that, after 25% of battery capacity had been used, the recorder played back a very accurate 1 kHz test tape exactly at this frequency.

The bias controls were set up for an NAB response at 19 cm/s, and this bias figure proved extremely close to the recommended setting for the tape in use. It was found necessary to adjust the bias and symmetry controls on the loudspeaker amplifiers for minimum distortion as the manufacturer's settings were considered quite a long way out. At no position was it found possible to obtain more output, but the final position chosen reduced the distortion considerably at lower outputs. It was noticed that no other combination of positions clipped either the top or bottom or both ends of a sine wave, and the bias figures chosen agreed with the correct operating characteristics of the transistors.

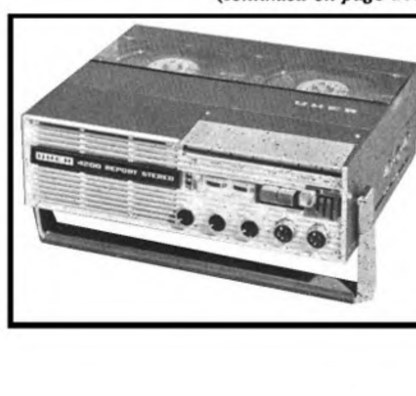
The nickel-cadmium life was checked by replaying a 1 kHz test tape of approximately 180 m. After each play from end to end, the tape was rewound on the machine by the battery. The speed maintained an accuracy of ±0.3% for the major life of the accumulator, the major part of this life giving a speed accuracy from end to end of ±0.15%. After setting the 19 cm/s carefully, the other three speeds were found to be extremely accurate, all within ± 1%. The speed began to drop during the ninth replay rewind cycle, taking approximately 30% longer. The tenth play showed a decrease in speed towards the end of the reel of 5% which, although not tolerable for music, might be accepted for sound effects.

To judge the machine in use, every Thursday evening for several weeks it has been used for recording the audio lectures at the Northern Polytechnic, consisting of two hours non-stop running in the recording mode. The machine performed satisfactorily, the battery always having a considerable amount of life in hand. Provided that the *4200* is not used for rewinding at all, and each reel is used from end to end, it should be possible to record at least six hours of material from one charged accumulator, and possibly very much more.

The RMS wow and flutter figures were measured on a WHM meter and checked with the latest Miniflux meter, under both mains and battery conditions. The battery figures were never more than 10% worse than the figures given for mains operation, which measure as follows:

19 cm/s	0.11%
9.5 cm/s	0.13%
4.75 cm/s	0.2%
2.375 cm/s	0.31%

(continued on page 169)



These figures are considerably better than many domestic machines and no audible wow was noticed when recording orchestral music at 19 cm/s. The wow figures are weighted to the latest DIN specifications.

Frequency response. The replay response of the two tracks at 19 cm/s are found in the accompanying table together with a record response calculated from the overall response. It will be seen that both are extremely good, in fact up to professional specifications, with the exception of bass loss on replay which is insignificant when replaying tape in the field on small loudspeakers.

The record response with a slight adjustment of bias could have been made ±1 dB from 40 Hz to 18 kHz, which is incredibly good for a machine of this price. The response was measured at other speeds and found to be up to specification but figures are not given since these speeds are not recommended for high-quality recording.

The signal-to-noise ratio was measured by recording a 1 kHz tone at 4 dB above 32 mM/mm on both channels, rewinding and erasing the recording, rewinding again and measuring the noise level on the tape. The measurement was taken unweighted and was –57 dB on the left and –59 dB on the right, relative to the level of the original recording. Again I regard these figures as very good and fully up to professional specifications. The replay noise without the tape running measured unweighted at 19 cm/s was –62dB left and –66 dB right, below the peak recording level of 4 dB above 32 mM/mm. These replay noise figures equal the figures of professional machines costing up to ten times the price.

As previously explained, the loudspeaker monitor amplifiers did not give their full rated output, even after a considerable time had been taken using an oscilloscope and other test instruments to adjust them. The best figures obtainable for 2.5% distortion were 400 mW into 4 ohms and 4.5% distortion at 500 mW. Less output power was available at the same distortion into high impedance loads. A 1 kHz tone recorded at 32 mM on a test tape gave just over 1 V on the DIN output socket and all frequency response and s/n measurements were taken at this point. The microphone input sensitivity and impedance were measured and I made the input impedance considerably higher than the manufacturer's spec, namely 5 K from 40 Hz to 15 kHz. For recording extremely quiet sounds, it might be possible to use a step-up transformer for low impedance mikes, though little if anything would be gained with mikes of 300 or 600 ohms impedance. It was found that 0.5 mV was required at the microphone input socket in order to give a recording level of 4 dB above 32 mM/mm, which is less sensitive than specification. The manufacturer's specification, however, is for a recording level of 32 mM/mm and this is still not achievable. The amount of gain should be sufficient for all normal requirements, including speech. The mike amplifiers could also accept very high input levels, requiring the recording level controls to be taken very far down, without audible overload distortion.

The response of the internal monitor loudspeaker was measured using an AKG *451E* capacitor mike and the speaker was found to be reasonably flat from 200 Hz to 3 kHz, the speaker being effective from 150 Hz to 8 kHz. For this reason, stereo headphones are advised for serious work in the field rather than the use of the internal speaker.

The crosstalk was measured by recording a high level 1 kHz tone on each channel in turn and comparing the outputs of the two replay channels. The crosstalk at 1 kHz averaged –52 dB and was considered good.

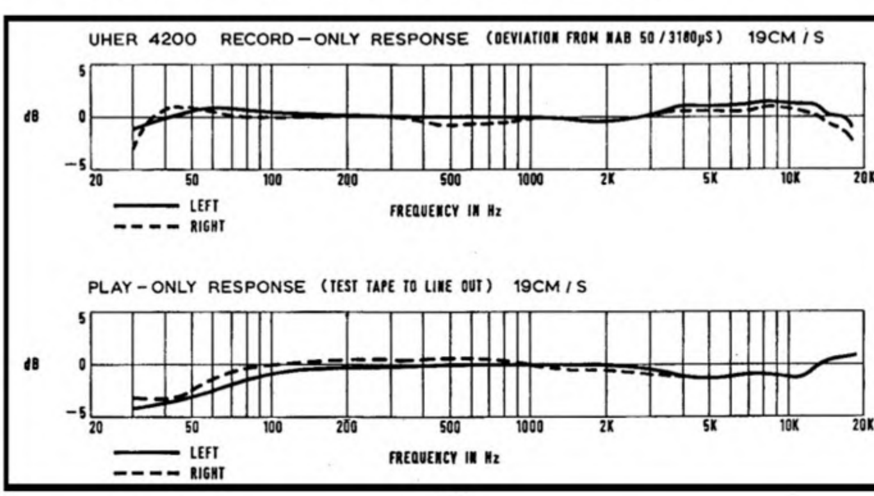
The battery indicator, worked by pulling out one of the recording level controls, was found to be accurate. When the speed began to run down, the needle of the indicator was exactly on the meeting point of the black and red portions of the scale. The recording level meters are illuminated by pulling out the other recording level control, a very useful facility if the machine is used in the dark.

On the latest models the speed and equalisation switch can be locked off by rotating the end of the lever through 90°. This prevents the machine being accidentally left on when not in use. My previous Uher did not have this facility and on two occasions I ruined lead acid accumulators when on holiday since my error was not noticed for several days. It is important to mention here that the lead-acid. accumulator must never be left discharged, although the nickel-cadmium one can be left for long periods in this state without damage. The lead-acid cell also will not last more than about 100 charges even when used carefully, but the nickel-cadmium lasts many times longer, and is therefore strongly recommended although it is much more expensive. There is, unfortunately, no way of telling when the accumulators are recharged, although on the earlier models a small red button popped out. It was found that approximately 16 hours of charging was necessary to recharge a completely discharged accumulator, although overnight charging was found to be more than sufficient for an average day's recording.

To sum up, I consider this Uher tape recorder to be exceptionally good value for the high price asked, and can recommend it highly for the uses for which it was designed. Readers will be interested to know that a recent Marble Arch stereo disc of steam locomotive sounds was made entirely on one of these machines, and intending purchasers would find the recording very interesting. Performance in general is excellent and should prove satisfactory even for professional use. In the home it proves to be a good tape recorder although the somewhat limited playing time at 19 cm/s may be considered a disadvantage. The use of triple play tape, although not really recommended, would give a playing time of 48 minutes at this speed. I understand that BASF will shortly be bringing out a low noise tape of this kind.

The recorder is sold with a carrying handle but the accumulator and charging unit are extras. As previously mentioned, these are not necessary if the machine is used with *HP2* batteries. A carrying case is also available and the machine should work satisfactorily with any low or medium impedance microphone. For normal-quality work I recommend the AKG *D19* mikes with windshields. For highest quality work, two AKG *C451E* cardioid capacitor mikes with battery power supply can be used straight into the mike input or low level input if the sound intensities are very high, allowing the recording level controls to be in a reasonable position. AKG *K60* headphones of 600 ohms impedance worked exceptionally well with very low hiss, and without any external attenuation.

Angus McKenzie



impressions

BY JOHN SHUTTLEWORTH

HOW HIGH THE MICROPHONE?

WHO wants a full symphony orchestra in his living room? I think this question was asked by Flanders and Swan in their Hi-Fi song, and I for one don't.

I do, however, like to be transported in imagination to the concert hall and unfortunately, with modern recording techniques and fashions, this seldom occurs.

The chromium plated reproduction from some modern discs made with close multi-microphone techniques, even if one can ignore the snap, crackle and pop, bears little relation to the sound actually heard in the concert hall.

I am prepared to admit that the sound of a good clean brand new disc played on first-class equipment can be satisfying, exciting and occasionally thrilling, but, far too often nowadays, it is an example more of the recording engineer's art than the musician's.

It seems to me that many record companies have their recording philosophy wrong. In some spheres, I admit, it is desirable, even essential, that the recording engineer should 'improve' on the original sound. Who would listen to most of the 'pop' if it was reproduced exactly as originally taped and played? In the case of a guitar concerto, careful microphone placing can improve the balance between the solo instruments and the orchestra but I consider that, in most cases, the job of the recording engineer is to reproduce the original sound as closely as possible.

A recording made from several microphones dotted round different parts of the orchestra, fed through a mixer controlled by an engineer who increases the volume on soft passages and reduces it on loud passages, may sound good when reproduced but will bear little relation to the intentions of the conductor or the performance of the musicians and my ears tell me that many of the discs I hear nowadays are recorded in this way.

If we are to get back to reproducing the original as closely as possible we must first examine our methods of reproduction.

To me 'hi-fi' (means 'faithful reproduction'), the hi'er the fi, the nearer the sound to the original, and this rules out mono straight away.

We can think of our sound as being reproduced in 0, 1, 2 or 3 dimensions. Zero dimensional sound is sound from a point source and mono reproduction from a good speaker approximates to this. Using two speakers in 'double mono' does not strictly add a dimension, it merely shifts the point from the speaker enclosure to somewhere in between the two speakers.

One-dimensional sound is produced when the sound is from a line between the two speakers but there is no depth or height to the sound picture. This is the sort of sound usually produced by the multi-microphone knob twiddling brigade, and far too much of this lands up on discs in our shops.

Two-dimensional sound has a left to right and a front to back and is beginning to aproach the original. It can be readily recorded with a pair of microphones spaced about 23 cm apart and properly angled. Recordings made in this way make sense when replayed through properly balanced stereo equipment and can give a reasonable degree of realism, and go a long way to fulfilling my requirement to be transported to the concert hall in imagination.

Three-dimensional sound would have a left to right, front to back, and also an up and down sound picture. I don't know how this can be reproduced by two speakers under domestic conditions, and it would seem to be theoretically impossible, but I have heard it and must believe my ears.

Ralph West has made a superb recording in stereo of a dawn chorus, and one can hear quite distinctly on this, which birds were in the trees and which on the ground. Listeners to many of my own recordings have been able to describe exactly the relative positions of the instruments, even being able to tell which were up on the stage and which were on the floor.

If we look at the human head we see that the two ears are set about 23 cm apart, facing outwards at about 90° to each other.

Information from the two ears is 'processed' in the brain to decide on the direction, distance and height of the sound source from the listener.

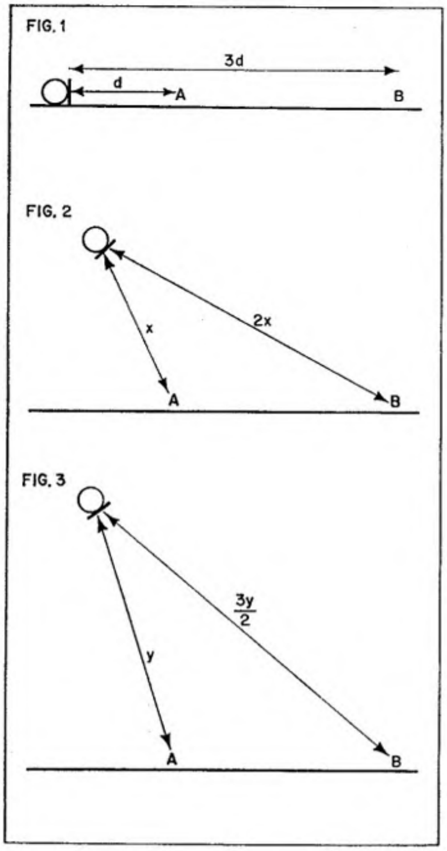
If we are to reproduce this sound faithfully, we must somehow transmit exactly the same information to the ears so that the brain will give the same answers as before.

As an attempt to do this, it seems reasonable to place two omni-directional microphones in a dummy head to make the recording, and to replay through headphones. This was the method originally tried, it works reasonably well, and hearing recordings made in this way can be a thrilling experience.

The main disadvantage of this method arises from the use of headphones. Few people listen through headphones for, even though the reproduction through some of the good modern phones puts many a loudspeaker to shame, we seem reluctant to return to the situation of the old 'crystal set' days when people sat in groups wearing headsets.

We have to settle, therefore, for the transmission of sound to the ears via loudspeakers, and it happens that all we have to do to allow for this is to place directional microphones in the position the ears would have taken. The ideal microphones for this arrangement would be figure-of-eight microphones placed at the same distance and angle to each other as human ears.

I have used a pair of Reslo ribbon microphones in this way with remarkably realistic results, and also the AKG *C24*. This latter is an excellent capacitor microphone but has to my mind the small disadvantage that the capsules are mounted on top of each other: a



most curious position for ears. The *C24* has so many other advantages, however, that I now use it for all important recordings and, again, can get recordings of very high quality which are very close to the original.

When placing microphones in the manner suggested, we have to remember that most of us use our eyes as well as our ears when listening in a concert hall. If we see a choir behind the orchestra and wish to hear what they are singing, we can use our powers of aural and visual selection to concentrate on the choir and ignore, in part, the orchestra.

The microphones cannot do this and record what they hear without any selective process, so we have to help by adjusting microphone positions to allow for this. If we double the distance between the microphone and the sound source, we divide the sound intensity at the microphone by 4. We can make use of this fact to obtain a correct balance between different groups of musicians and between direct and reflected sound.

In a 'lively' hall, or one with some echo, the microphones should be moved nearer the performers so that the sounds reflected and distorted by the hall are less intense than sound direct from the source.

In a 'dead' hall, it would help to move the microphones farther from the performers so as to get a greater proportion of reflected sound.

If the microphones are placed too low, the performers at the back are so far from the microphones relative to those in front that they will hardly be heard.

In the **fig. 1** arrangement, if A and B play equally loudly, the sound intensity at the microphone is nine times as great from A as from B (3^2).

If we raise the microphone so that the distance of B from the microphone is only twice the distance of A then the sound intensity from A is now only 4 times the sound intensity from B (2^2), **fig. 2.**

If we raise the microphone still higher, B is now only 1.5 times the distance of A and sound intensity from A is now only 2.25 times as great (1.5^2), **fig. 3.**

We can see then that raising the microphone has the effect of reducing the depth of the sound picture, and if carried to excess results in 2-dimensional sound again, i.e. a sound picture with left and right but no back to front.

I have found in general a good balance can be obtained with microphones just high enough to be looking over the heads of the performers in front, to see those right at the back.

Many experienced recordists would not agree with me, but I have yet to hear a recording made in any other way that is equally realistic or makes as much 'sense' when I listen to it. I am trying to keep an open mind on this subject, but until I have demonstrated to me a method of microphone placing that gives more satisfactory results, I am sticking to my stereo pair on the same stand.

It is some consolation to the amateur that this method is not only in my view the best, it is also the cheapest, as no expensive mixers are required.

'Still it's better than using the lounge'

column speaker

A CONCLUDING COMMENTARY

BY DROPOUT

TAPE RECORDER as its devoted readers know, has changed its nature somewhat in the direction of professional aspects of the recording art. Poor old Dropout, of course, is about as amateur as a man can be, and would be hardly recognisable in a professional studio. With the change in direction of *Tape Recorder*, therefore, Dropout drops out and switches off. And if your response to that shattering piece of news is to mutter 'About time too', you may be interested to know that Dropout agrees with you.

When this column was started, I thought—and the Editor agreed with me—that it was a good idea. It was to be the section of the magazine in which the amateur had his say; in which he made known to manufacturers his comments on their wares and his needs for new production; in which he passed on hints to others; in which recording clubs let everybody know of their fun and their achievements. I saw myself—no false modesty about Dropout—as the Victor Blackman of the recording world, with the significant difference that he is very much a professional photographer, whereas, as I was saying . . .

What happened? Precisely nothing—or so nearly nothing as to make no difference. The only time there was any real response was when I voiced my own need for an easy means of disconnecting the earth lead to one recorder when it was to be connected to another which was also earthed (those loops, you know). Then indeed boffins from the four quarters wrote in to enlighten my darkness. One of them even sent me a gadget to do the job (and it does: I've used it ever since). I tried everything from provocation to near-insult to raise a fury; but not so much as the faintest breeze. At one point I revealed my identity—as though anybody cared—to a club I was visiting, and offered space for anything they thought ought to be said. Not a squeak.

I find it all very sad. My experience goes back to the earliest days, when recording clubs were nearly all on a national basis (we were even expected to regard ourselves as 'tape stations' and repeat a call-sign at the beginning and end of every tape we sent out; and I actually did it once). Then followed a great upsurge of local clubs, the proceedings of which were regularly reported in the journals—*Tape Recorder* amongst them. They seemed a pretty lively crowd; and I helped to start one in my own district. It still exists; but only as a wraith.

What has gone wrong? Photography is generations older than tape-recording, yet the movement is stronger and more active than it has ever been; and members of camera-clubs actually take photographs and spend hours and hours in the dark, brooding over prints and negatives. Many have even tackled the really tricky business of home-processing colour film; and the best of British to them—I'll get round to it myself one of these days. Yet recording clubs languish and die, and the movement can no longer hold its principal journal to its old allegiance.

The truth, as I see it, is that recording as a hobby is one of the greatest flops of all time, for the simple reason that most of those who own them have absolutely no use for them once they have been acquired. If one were to judge by the adverts, one has only to acquire a machine, and the whole world of music is there beneath one's fingers. What they do not tell you is where you get that music from: it is as simple as that. You can, of course, buy recorded tapes, at a vast price and of a quality inferior to that of good disc records. You can record broadcasts if local FM quality satisfies you and you are lucky enough to be on hand when the work and the performance you want are being transmitted. (You are breaking the law by doing it; but nobody will know.) You can borrow gramophone records and dub them—that's illegal, too, and the tape will probably cost you as much as buying the record itself. But none of that is what I mean by recording.

RECORDING BEGINS WITH A MICROPHONE

Recording begins, oddly enough, with a microphone; and what your amateur recordist lacks is access to signals which are worth recording, if his interest be confined to music. Oh, *something* can be done along those lines; but how many tapes have you made which you can replay with the kind of musical satisfaction you get from your chosen repertory of discs? I'll bet it's very few; I know it is with me. But then, I long ago abandoned that fantasy, and began to derive my reproduced music from the radio and the gramophone. I use my recorders—three mains' machines and a battery-portable—for other things; and when I say use, I mean use.

But, with reluctance, I have come to the conclusion that most amateur recordists have no interests with which tape can help them or—which is more likely—they have not the imagination to see what those interests might be. And so, while machines will continue to sell in thousands to people who think it would be nice to have one, those machines will give great fun for a few weeks, and then gradually disappear into the oblivion which is clearly the fate of most of the others. We shall continue to have the boffins whose joy it is to knock point nought-nought-something off the signal-to-noise ratio and extend the flat frequency-response another couple of kilo-Hertz. God bless them. I envy their knowledge and skill, and am humbly grateful for the generosity with which they let me take advantage of it. But the means is not the end.

It is strange to me that most of the people I know who actually use the machines they have brought would never refer to themselves as recordists at all. Many of them are blind, old or otherwise handicapped, and they use their machines to break out of what would otherwise be a very restricted world. Others are naturalists, who use their recorders as they use their cameras: to record rather than to kill. Others are musicians, who use their machines to improve and criticise their performances. A few—pathetically few—use them to help others. And there, as I see it, is the true world of the amateur and the general-purpose machine: the hobby has broken down because it has never been presented as what alone it can be. Anyone who has ever looked inside a professional studio knows that the facilities, experience and skill deployed there, to say nothing of the vastly expensive equipment, are beyond the reach of anyone less wealthy than a Beatle. [*At least one EMI disc was recorded on a Revox—see October 1968 issue*—**Ed.**]

PHOTOGRAPHIC RIG

With some hard saving and/or a bit of HP, your amateur can acquire a photographic rig to rival that of the professional—indeed both often tote the same gear. Given the zeal, he can scoop the professional when his local students start one of their radical reforms by smashing everything in sight. The film, chemicals, paper, lenses and what-not he uses will be seen in the bowels of newspaper buildings as well as in his own bath-room. The matter is vastly different in that world—and many recordists have a foot in both. But when a friend of mine asked permission from Fernando Germani to record an organ recital he was to give in a local hall, the reply, with genuine regret, was that he was under contract to a certain recording company and must refuse.

And so *Tape Recorder* sensibly accepts the facts, and sets out to cater for those who have need of it—including those amateurs who can usefully absorb it. The rest of us—survivors of the brave new world of twenty years or so ago—will continue as we have always done: having our fun and doing our thing. That select band contains some of the nicest people I know. To them I send my greetings, and wish them continued good hunting. I've enjoyed my taping, and hope to go on doing so. If some of my hopes and expectations were impossible, I am left with much. That is part of my life, and I name it for a blessing. Column Speaker recedes into the silence; but what it hoped to sound forth goes on still. He that readeth, let him understand.

CLASSIFIED ADVERTISEMENTS

Advertisements for this section must be pre-paid. The rate is 6d. per word (private), minimum 7s. 6d. Box Nos. 1s. 6d. extra. Trade rates 9d. per word, minimum 12s., Box Nos. 2s. extra. Copy and remittance for advertisements in MAY 1970 issue must reach these offices by 20th MARCH 1970 addressed to: The Advertisement Manager, Studio Sound, Link House, Dingwall Avenue, Croydon, CR9 2TA.
NOTE: Advertisement copy must be clearly printed in block capitals or typewritten.

SITUATIONS VACANT

Tape Recorder Engineer required, experienced most makes. Telesonic, 92 Tottenham Court Road, London, W.1. 01-387-7467.

Young man interested in tape recorders wanted to assist in running hire service. Magnegraph, 1 Hanway Place, London, W.1.

FOR SALE—PRIVATE

EMI L2B professional portable recorder, immaculate condition, with canvas case and instruction manual. Offers? Box No. 571 (Middlesex).

Tandberg 64 (Multiplex Filters) just overhauled by Farnell-Tandberg and now offered for sale in perfect condition. £75 delivered. Box No. 570 (Yorks.).

MSS PMR 1. ½-track. Professional quality, in excellent condition. £25. 01-703-4567.

Goodman's Ten Ten Speaker, teak cabinet. Eagle Reverberation Unit, S.T.C. 4021 Microphone 20 ohms with Transformer to 100K. All good condition. £24. Phone 01-954-5126.

Vortexion WVA in good condition £45. Tel. 01-857-1455 (Eltham) after 6 p.m.

Exclusive Sanyo MR915 Stereo Tape Recorder with Akai Headphones, miscellaneous tapes and equipment. Specifications on enquiry. £105. Box No. 572 (Hants.).

Nagra 3 Recorder, Pilotone model, leather case instructions. Perfect working order £375. Hemel Hempstead 52848.

E.M.I. Guides, six recorded talks on recording techniques, effects. Unused. 42s. 6d. Will separate, 5s. 11d. each. Marlow, 168 Psalter Lane, Sheffield S11 8UR.

FOR SALE—TRADE

60% OFF EMI and Zonatape 5″ L.P. Polyester tapes (boxed with leaders). These tapes have been partially used by the professional recording industry, electronically cleaned, and are 100% perfect. Satisfaction or refund. 10/- each, post 9d per tape. 5 tapes 50/- post free. 10 tapes 95/- post free. Avon Enterprises (Dept. TRA), Fladbury, Pershore, Worcs.

Pre-recorded American Stereo Tapes. 7½ ips. Cheap as records. Bernsteins, Mahler, Maazels, Sibelius, Karajan, Beethoven Symphonies. £15 per set of 5 tapes incl. PT and duty (any duty or purchase tax charged by the postman will be refunded—see instruction slip in tape box). £3 cheaper than records. P.O. 5/- for complete catalogue. Postereo Tapes, 9 Darley Street, Harold's Cross, Dublin 6, Eire.

Substantial Discounts on top quality microphones and recording equipment. Reslo, A.K.G., Grampian, etc. All accessories and P.A. equipment. Harrower West, Microphone Specialists, 6 Wolfe Road, Falkirk, Scotland. Tel. Falkirk 22239.

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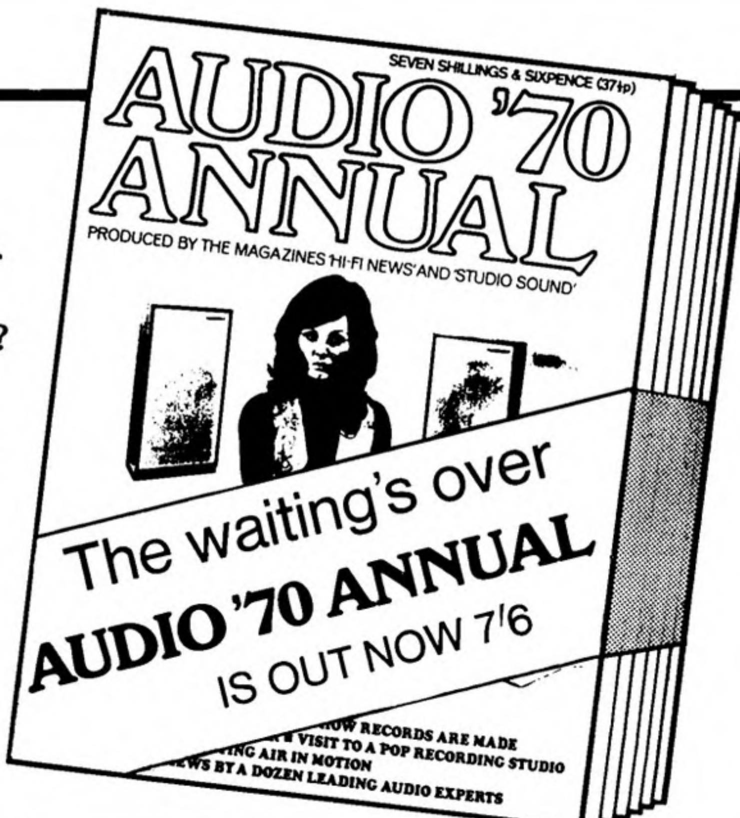

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