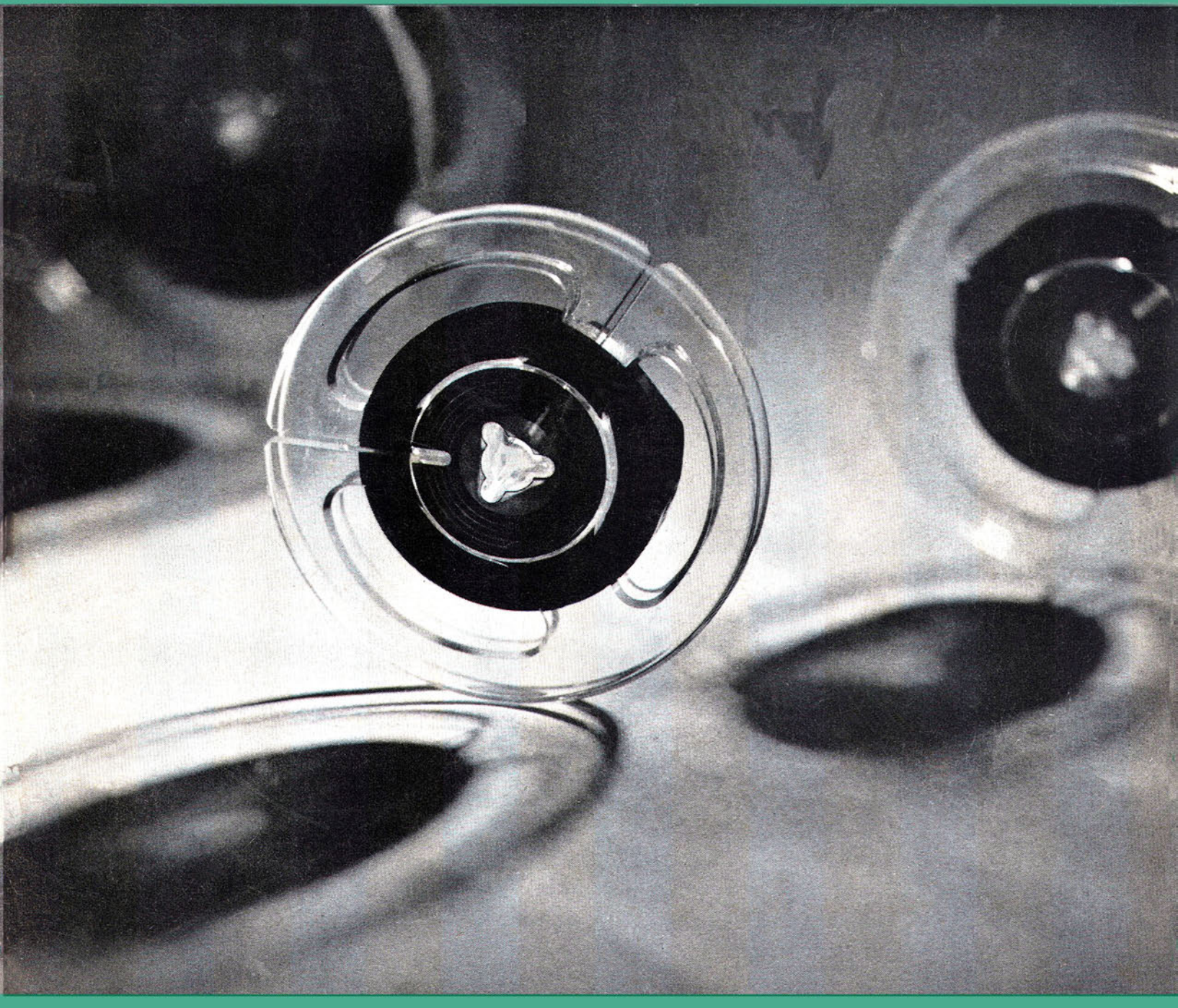
APRIL 1966 TWO SHILLINGS

tape recorder



SOUND AND CINE – SERVICING THE VERDIK S.1 – HEATHKIT TM-1 REVIEW
VOICE ANALYSIS – OPTACORD 408 FIELD TRIAL – SUCCESSFUL HOME RECORDING

Meet the Akai Crossfield Head . . . .

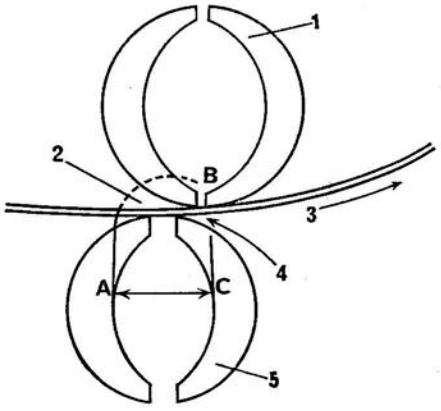
AKAI X355	**239 gns**	
AKAI M8	**136 gns**	
AKAI X4	**99 gns**	(A.C. Adapter £20)

AKAI ST1	**94 gns**
AKAI 44S	**82 gns**
AKAI 910	**62 gns**

Shown above Akai X355

See the Akai Demonstration. Room 213 at the Audio Fair

.... the best head for sound in the business



This is the Crossfield Head—only Akai has it.
1 signal head. 2 bias field. 3 direction of tape travel. 4 signal field. 5 bias head. 6 bias head retracts automatically on playback.

On conventional heads the high frequency components of the signal recorded tend to be attenuated or erased by the effect of bias fields. On the exclusive Akai Crossfield Head the signal head and the bias head are mounted in opposition with their centres slightly off. The tape is pre-magnetized between points A and C and recorded with the signal at point B. The recorded signal is completely free from the effect of prevailing bias fields and can be retained on the tape without loss.
It will be seen from the construction of the Akai Crossfield Head assembly that, as the signal head is arranged obliquely apart from the bias head, across the tape, the amount of bias may be selected without regard to the functioning of the signal head. This means that the tape can be modulated over the entire frequency spectrum with maximum fidelity since the recorded signal is entirely unaffected by the bias field.
The maximum audio frequency that can be recorded on tape is usually around 790 c/s, at a tape speed of 1 centimetre per second, rising to about 2,000 c/s. at 1 inch per second. For Standard tape speeds: 9.5 cm/s. ($3\frac{3}{4}$ i.p.s.) —7,500 c/s. and for 19 cm/s. ($7\frac{1}{2}$ i.p.s.) —15,000 c/s.
The Akai Crossfield head makes possible the recording of a signal frequency of up to 2,750 c/s. at a tape speed of 1 cm/sec. or 7,000 c/s. per inch. In other words, the Akai Crossfield head—makes it possible to record 18,000 c/s. at a speed of $3\frac{3}{4}$ i.p.s. or 21,000 c/s. at $7\frac{1}{2}$ i.p.s. With the low speed of $1\frac{7}{8}$ i.p.s. (4.75 cm/sec.) now available on the M8 and X4 models, it is practicable to record up to 11,000 c/s.
Employing this Akai technique, it is now possible to record four continuous hours on a standard 1,200 ft. tape without the need for professional $10\frac{1}{2}$ in. reels.

3 heads plus X-field; 3 motors; computer-type solid state circuitry with removable modules; push button solenoid controls, echo effect, remote control play optional, $10\frac{1}{2}$" reel adaptable, Sound-on-Sound, Sound-over-Sound, Sound-with-Sound, channel transfer sound, hysteresis synchronous capstan drive, electrical speed change, 4-digit push button index counter. This instrument features 2 types of Automatic Reverse Play actuation—timed adjustable indexer, and precise tape foil sensor method. 68 stereo watts output.

TR.2

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UHER

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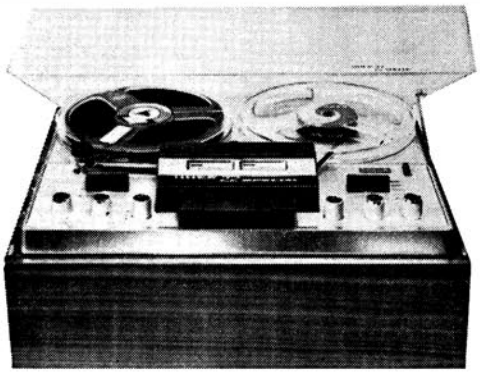
4000 REPORT L

A battery portable that offers you virtually every facility of a mains-operated recorder—with many exceptional new features. Four tape speeds provide an infinite variety of recordings. Price (incl. microphone and tape) 103 GNS.



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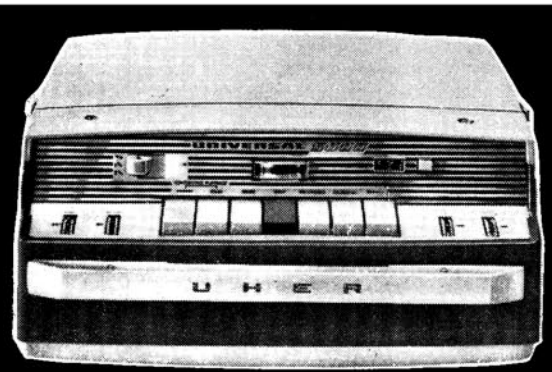
724 L STEREO

A new, four track, all mains recorder priced at only 75 gns—and specially designed to meet the demand for an instrument particularly easy to understand and to operate.



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An ideal dictation machine and recorder ensemble for professional and business use. Three tape speeds, exceptional handling comfort and high tonal quality. Price: 95 GNS.

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During the period of the AUDIO FAIR at HOTEL RUSSELL – April 14th and 15th we shall be featuring a special display of UHER TAPE RECORDERS, to which you are cordially invited. Our showrooms are easily reached — just one minute from Gt. Portland Street Underground station (Circle and Metropolitan lines).

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TAPE DECKS
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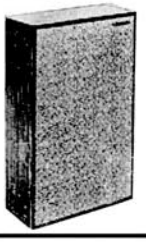

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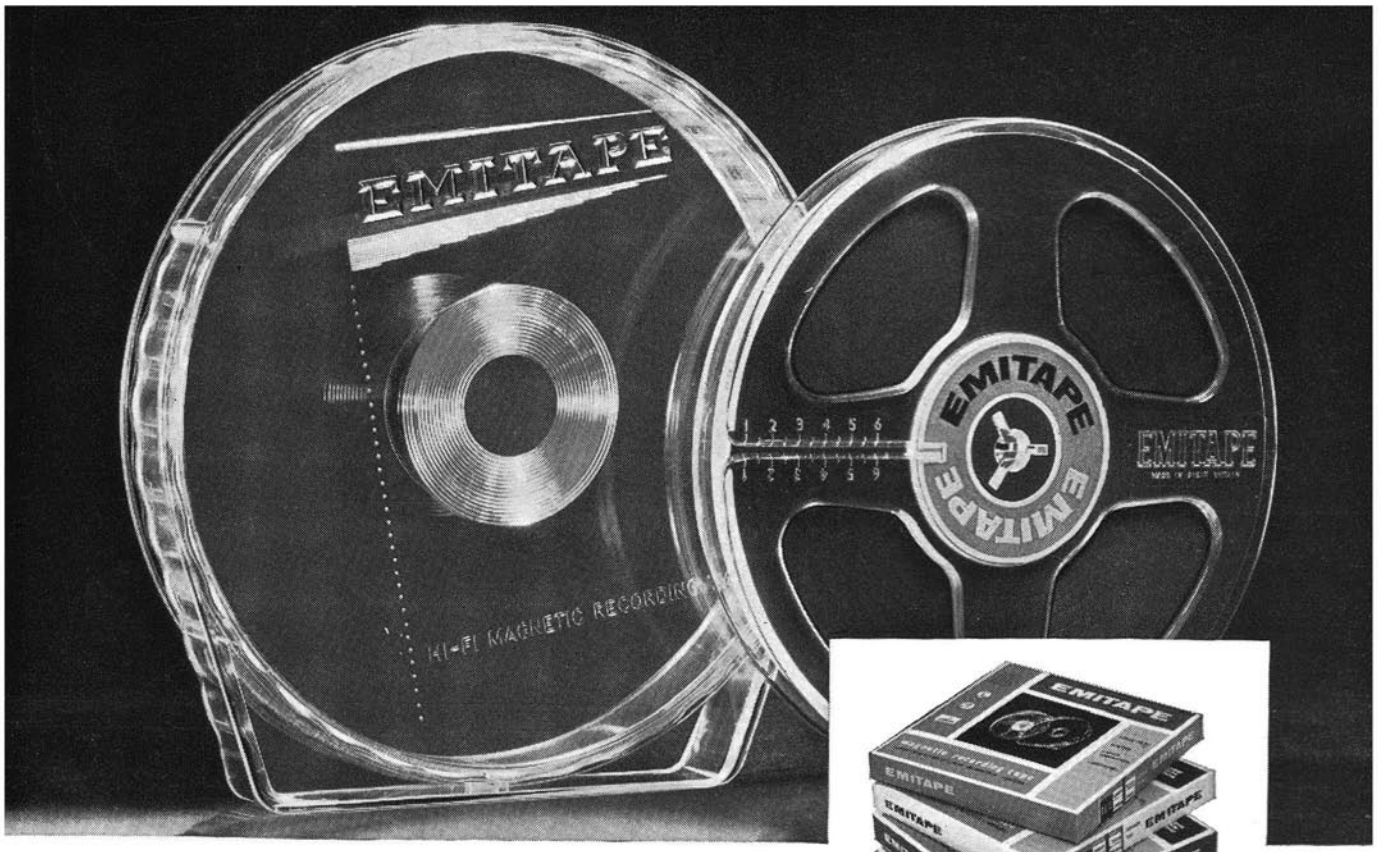

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editorial

THE NEWS PAGES of all electronics and audio publications continue to be interspersed with reports of developments on the television recording scene. From the United States, Europe and Japan, the leakage of rumours and facts gains momentum with each passing week. *Akai* are applying cross-field bias techniques to television tape recorders ; *Sony* have overcome the problem of matching the world's multitudinous video standards by making the receiver an integral part of the recording machine ; *Ampex* are introducing an electron-beam recorder, while another American company claims improved head-to-tape contact—sadly missing from the low-price linear transports currently in existence—with a new rotating-belt pressure system.

Much talk continues to come from across the Atlantic of successful experiments in recording video on ¼ in. tape at 15 i/s, though the complete absence of details suggests that these follow the pattern of *Phonovid*—employing a short-term memory to build up and store single frames, these being changed or repeated eight or ten times each minute.

Of all the inventions and new techniques that have appeared in the last ten years, helical scanning is undoubtedly the most promising for low-price video recording. Though far from being the ultimate in tape scanning systems, it enabled the price barrier to be broken, bringing costs down from tens of thousands to only a few hundred pounds. Apart from its mechanical simplicity, the 'helical head' (a doubtful term, since the *tape* generally forms the helix) reduces the need for high speed stability, simplifies the problem of head-to-tape contact, and also simplifies the recording and reproducing switching circuits.

Although development is currently taking place of new tape coatings capable of storing information at a higher density than has previously been possible, we are doubtful of the future of linear video recording, even allowing for a new approach to the task of manufacturing micro-gap heads. It seems likely that the recording world will suffer not one but two revolutions in the coming decade. It is almost inevitable that the domestic market will be flooded with helical recorders employing 1 in. tape, followed later, perhaps, by similar devices using ½ in. and even ¼ in. tape. Helical techniques are by no means ruled out for conventional ¼ in. tape, though alignment and switching become considerably more of a problem, with the fascinating facility of stop and slow-motion probably being rendered impossible.

So much for the first revolution—which may even poke its nose into audio, with combined audio-video and high-quality audio recorders, the rotating head being switched to a lower speed or discarded for a conventional audio head, when vision recording facilities are not required. The second upheaval—and one which, in our opinion, may have a promising future—will be in the field of electron-beam recording. Forgetting the aforementioned Ampex development (which is designed for high frequency digital recording) this system involves the use of an electron 'gun' (of the type used in an ordinary television display tube) to burn a series of pictures in plastic tape. By guiding the beam across the tape width, it is possible to melt thousands of tiny indentations in the tape, building up a series of miniature pictures very similar to those in an 8mm. cine film ; the pictures are indeed visible to the naked eye. Reproduction is a simple matter, using optical principles. The beauty of this system is that the bandwidth obtainable from a given area of plastic tape is far greater than that offered by a similar area of magnetic tape—disregarding the problem of scanning in the latter case. Further, electron-beam recordings may be erased by the simple process of passing the tape over a hot bar. We may yet see Mr. Hellyer warning us "not to touch the erase head".

If this system is so wonderful, why has it not been adopted? The simple fact is that electrons can travel at usable velocities only in a vacuum—they do not pass the glass face of a conventional television tube, but merely plunge into a phosphor coating, converting their energy into light. Creating a vacuum between an open-ended miniature television tube and the tape is practicable, and has indeed been done ; but it is costly and complex. There have been reports, however, that a closed electron-beam recording tube may be introduced. We await the component with interest, for when it arrives it will mark yet another step on the road first trekked by Valdemar Poulsen and signposted by A.E.G. (Telefunken.)

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COVER PICTURE

What can one say about this abstract photograph, other than that it goes better with green than with red? Imaginative readers might care to concoct captions of their own: A fleet of moon-crawling machines, perhaps? The remnants of a reel following an attack by tape-weevils and dropouts? No prizes, since even we do not know what it is meant to be!

SUBSCRIPTION RATES

Annual subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 30s. and 38s. respectively, Overseas subscriptions are 32s. 6d. (USA $4.50) for *Tape Recorder* and 38s. 6d. (USA $5.40) for *Hi-Fi News*, from Link House Publications Ltd., Dingwall Avenue, Croydon, Surrey. *Tape Recorder* is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.

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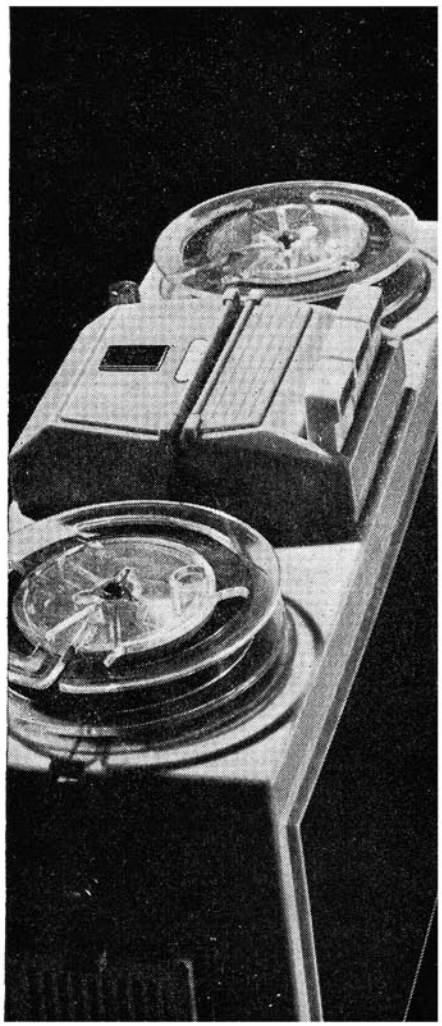

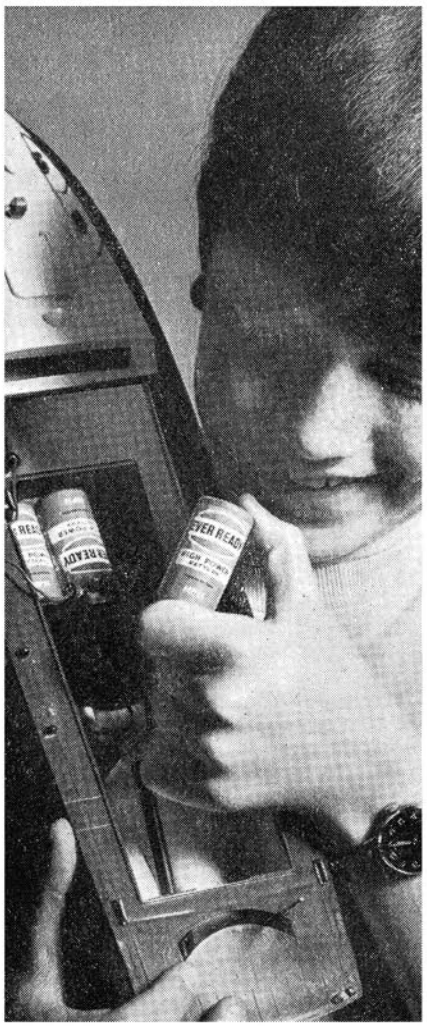

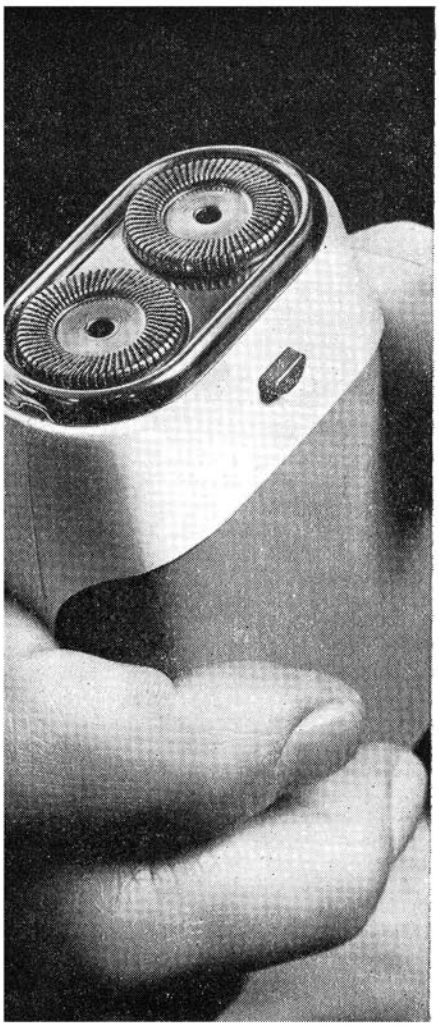

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world of tape

TRUVOX DEMONSTRATE SPEAKING SCRUBBER

IT is not widely known that *Truvox*, in addition to their audio interests, manufacture industrial cleaning equipment. One result of their two activities was displayed at the *Industry '65* exhibition when a *Concord Single Brush Polisher/Scrubber* announced its virtues from a 'mouth' somewhere inside its black drums. Two *Rola Celestion Ditton* speakers within the drums were fed with a recorded commentary from an endless loop cassette played on a *Truvox R102*. A *TSA 100* amplifier between recorder and speakers completed the audio chain, while a visual display was provided by a slide projector synchronised to the recorder.

AUDIO ANNUAL TO BE PUBLISHED IN APRIL

APRIL 14th—opening date of the *Audio Fair*—is also publication date of the *Audio Annual*. Ten contributors to *Tape Recorder* and *Hi-Fi News* have combined to produce what amounts to a souvenir edition of the two magazines. The intricacies and pitfalls of reviewing are examined by Alec Tutchings in *Comparing and Measuring Tape Recorder Performance* while H. W. Hellyer's *Approach to Tape Recorder Servicing* describes the techniques of coaxing new life out of elderly tape decks. Graham Balmain examines the past and future of magnetic recording machines, while David Kirk considers those who use them. For the constructor, David Robinson has prepared a *Transistorised Sine-Square-Wave Generator*, while, for the hi-fi man, George Tillet, B. J. Webb, John Crabbe, Rex Baldock and Ralph West provide specialist insight into many aspects of the audio field. *What Matters in Amplifiers? Aural Visual Discord. Whither Stereo? The Loudspeaker Story*, these are some of the features in the first edition of what may well prove a very popular annual.

A large section of the Annual will be devoted to reprints of reviews of the more important equipment that has been tested during 1965. Tape recording equipment, amplifiers, tuners, tuner-amplifiers, turntables, loudspeakers, pickups and cartridges will appear in an array of tests that (we hope !) would put even *Which?* to shame. This feature is intended for those who have been disappointed in their attempts to purchase back numbers and, since much of the equipment will be on display at the Audio Fair, will provide a factual guide for those who take their ears to the Hotel Russell.

BRENELL EQUIPMENT CHOSEN BY TAPE LIBRARY

FIVE years' experience of various designs of tape recorders has resulted in the *British Library of Tape Recordings for Hospital Patients* selecting *Brenell* equipment with which to copy their tapes. Eight modified decks and one player are employed to permit speed-to-speed copying of up to four tracks simultaneously.

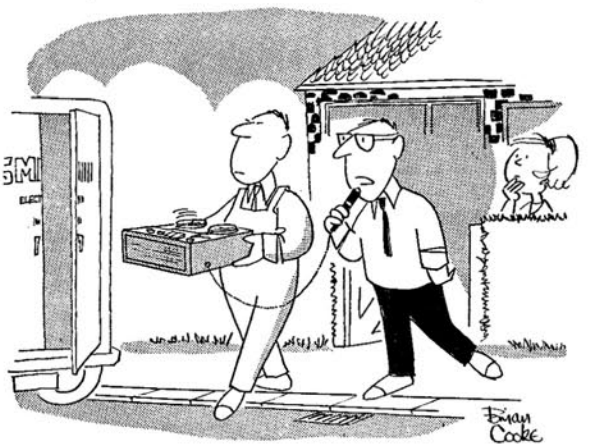
MORRISON ON HELICAL SCAN

WEDNESDAY, 2nd February, at the Central Office of Information saw a lecture to the BKSTS by Mr. Frazer Morrison of *Ampex* on the subject of helical-scan video tape recorders. Mr. Morrison covered the elements of magnetic recording techniques and then discussed the advantages and limitations of high speed tape transports and rotating head systems. With a head gap of 0.1 mil (one ten-thousandth of an inch), the smallest commercially obtainable, it was explained that conventional stationary-head recorders (of the type used in audio) would need to operate at tape speeds of 23 mph to give a 4 Mc/s frequency response. It had been found very difficult to achieve good head-to-tape contact at such velocities.

Transverse-scan recording (the system currently used for television broadcasting) also had its drawbacks and it was overcoming these that resulted in the very high cost of such equipment. One advantage of helical-scan, apart from cost, was that variable frame speed and even stop-motion were possible, since a complete rotation of the scanning drum gave, in effect, a complete single frame. In designing transverse and helical-scan recorders, a compromise was necessary between tape width and linear transport speed. The economy of a recording system was determined, not by the *speed*, but by the *area* of tape used. Several factors made it impossible to record efficiently on the tape edges and only 83% of the width of 2in. tape was usable for video. As the tape width was reduced, it was necessary to increase linear tape speed to retain a good signal-to-noise ratio, the latter being determined by the width and separation of the tracks. Despite the increased speed, only 64% of the width of 1in. tape would accept a video recording, though this presented no problem, since whatever the tape width, the outer edges always contained linear audio and control tracks, the latter track being employed to stabilise the tape speed through a servo mechanism. Although the most economical form of video recording employed 4in. tape, the linear speed needed to be only 2 i/s and at this speed the conventionally-recorded audio quality became very low indeed. Tape speed and width were inversely related, 2in. tape requiring a nominal speed of 4 i/s and 1in. tape needing 8 i/s, servo-control becoming more efficient at the higher speeds. Although early experimental helical recorders employed 4in. tape, this was now practically obsolete.

While professional helical recorders needed two heads spaced on a rotating drum, much cheaper recorders could be produced when only one head was employed. The most satisfactory of several methods of wrapping tape round the head-drum left a finite gap in what theoretically needed to be a complete circle of tape. Each rotation of a single-head drum would, therefore, be accompanied by a momentary break in recording. By employing spaced heads, this regular 'dropout' could be eliminated, though compensation for differing head characteristics, switching and limiting, caused a considerable rise in complexity, and hence in cost. Although unsuitable for broadcasting purposes, domestic and industrial single-head helical recorders could be made at down-to-earth prices, the regular break in recording being arranged to occur at the beginning and end of each frame, thus affecting only the top and bottom few lines. This had no distressing effect on the picture. After hinting that Ampex would shortly be marketing a domestic helical-scan recorder for under £300, Mr. Morrison ended his lecture with a demonstration of a twin-head model costing some £4,000.

Details of future BKSTS talks and membership fees may be obtained from the Secretary, **British Kinematograph, Sound and Television Society, 164 Shaftesbury Avenue, London, W.C.2.**



"One miserable payment in arrears, and you send your lackey to snatch it back, you tight-fisted old . . ."

(By courtesy of *Electrical and Radio Trading*.

BRITISH AMATEUR TAPE RECORDING CONTEST

AGFA, *BASF, EMI, Grundig, Ilford, Kodak, Mastertape, Philips* and *3M* are sponsors of the 1966 *British Amateur Tape Recording Contest*, closing date for entries being 30th July. Following the style set last year, entries will be categorised into *Novice* and *Amateur*, the former section catering for those having owned tape recorders for less than a year or who have not previously entered a recording contest. No material may be taken from radio or television broadcasts, or from commercial recordings unless prior authorisation has been obtained in writing from the copyright controller. Recordings must occupy only one track and commence at the beginning of the tape, to which leader should be fitted. Speeds may be 15, $7\frac{1}{2}$, $3\frac{3}{4}$ or $1\frac{7}{8}$ i/s mono or stereo on $\frac{1}{4}$in. tape and recording time not more than four minutes (Novice) or eight minutes (Amateur). Further details and an entry form may be obtained from : **British Amateur Tape Recording Contest, 7 Tudor Street, London, E.C.4.** (*continued overleaf*)

SOUND GUIDES ACROSS SPAIN AND ITALY

WHEN faced with the task of recording material for gramophone 'Sound Guides' of Spain and Italy, Mr. Harry Traynor of *Traynor, Kester* chose an *Akai X4* battery portable. With this machine, 130 hours of music, singing, sound-effects and interviews were taped, from which were produced master programmes, linked by a commentary, conveying the atmosphere of the two countries for potential visitors. Quality of the recordings, which were made at $7\frac{1}{2}$ and $3\frac{3}{4}$ i/s, was found to be well up to the standard required by the disc manufacturer—*Qualiton Records*.

AUDIO FAIR TICKETS

DETAILS of the 1966 Audio Fair were released recently by the organiser, and include plans for expansion to the fifth floor of the Hotel Russell. We shall ourselves be exhibiting, with our sister publication *Hi-Fi News*, at Booth 55 on the ground floor and in Room 155 on the first floor. The Audio Fair will begin with a Trade Opening on Thursday 14th April, public admission being from 4 p.m. on that date until Sunday 17th inclusive. Admission is by ticket only, being obtainable from most local audio dealers or, in cases of difficulty, from this magazine. Requests for tickets (stating number required) must be accompanied by a stamped-addressed envelope and must include no reference to Editorial, Advertising or Subscription matters. Letters should be addressed to : **Tape Recorder (Audio Fair Tickets), Link House, Dingwall Avenue, Croydon, Surrey.**

SUCCESS FOR GRUNDIG SCHOOLS COMPETITION

SCHOOL choirs and bands, playlets, debates, documentaries, poetry and essays composed and read by pupils—these were among the 139 entries submitted to the *Grundig* Schools' Tape Recording Competition. Open to schools in Britain and British Service areas, the contest attracted 65 tapes from Junior, 53 from Senior and 21 from Infant schools, including two from Aden and one from Germany and Cyprus. Considerable imagination and care were given to the majority of entries, though sound-effects were noticeably lacking and, where attempted, in most cases not entirely successful. Judging has not taken place at the time of writing, but names of winning schools—each being presented with a *TK 18L* recorder—will appear in *Competitors' Journal*.

FRENCH CLASSICAL TAPES

UNTIL a few months ago, classical music was not available to tape record purchasers in France. This gap has now been filled, however, by *Diffusion Magnetique Sonore*, a company previously specialising in providing background music for retail establishments. The tapes, which are recorded from *Philips* masters, cost almost twice the price of equivalent discs but are claimed to be of higher quality.

NEXT MONTH

THE MAY ISSUE of *Tape Recorder*, to be published on Thursday, 14th April, will contain a detailed preview of the 1966 Audio Fair, seen from the tape enthusiast's angle. William Henry will describe the intricacies of *Lubrication* in recording mechanisms while David Haines contributes *A Fair Trial*, another in his series of play scripts. For those visiting the Capital during Audio Fair Weekend, *Anscombe* suggests ways and means of capturing *London on a Three-Inch Reel*.

A MARRIAGE OF DECKS

PROMISING SUGGESTIONS BY MARTIN YORK

A SOLDIER was once suspected by the Orderly Officer of smoking on sentry duty. He produced his pipe which, being cold, exonerated him. After the officer had departed, the soldier commented, "Now I know why they say that a good soldier should have two of everything."

While this would not be a safe generalisation to apply to life, I believe that a case can be made out for having two tape recorders. I sincerely hope so, for some slight dissension has arisen in the York household over this very point.

"But . . . why ?", asks the Little Woman, her eyes wide.

A valid question. With rates, taxes and the cost of keeping young (two of 'em), the domestic owner could perhaps be forgiven for clinging to his ancient, single-speed, ¼-track machine. After all, it will record material from any source and will play it back, after a fashion, so where is the need for extra expense ? Let me give you an example from the files :

York Junior, during Papa's absence, had taped an hour-long television programme. Unable to fathom the mass of wiring in the vicinity, he had hopefully shoved a microphone alongside the speaker and let the machinery rip. The result may be imagined but, right in the middle, there occurred one of these freaks of luck which should happen more often. With practically no faults there rang out Liszt's *La Campanella*, clear as a bell (if you will forgive the pun). So Papa now has twelve hundred feet of tape with a four-minute gem right in the middle. Let us store it with the remaining miles of tape in the same condition until Adam Bryant happens to drop in with his machine. In the meantime, depart for the tape shop, and buy a few more miles, to be treated the same way.

Another point : it would be a brave 'three-and-three-quarters' man who dared to put on a 900ft. reel to record a 45 minute programme, so what does he do ?

"Easy—record it on 1200ft.", says your ½-track man. "You can whittle it down to size afterwards and splice the odd bit on to your 'gash' reel." Fair enough for him, but what about the poverty-stricken ¼-track brigade ? What about *Mrs. Dale's Diary* for 1965 on the other three tracks ?

The answer seems to be either to hope that one day you will find a piece of music exactly 16 minutes long, or to get hold of another machine and transfer the recording at your leisure to a space which will fit its length. This is where a second machine would pay dividends. Let us suppose that this machine, equipped with an enormous reel of very long-playing tape, were used as the prime recorder. It would then be a simple matter to transfer the wanted material to suitable spaces on storage tapes, omitting anything not required, and leaving the monster master-tape quickly available for further use. There would be a need for accurate timing and indexing, and for an accurate footage indicator, but I have already said my piece on those subjects.

So, here is a way in which a second tape recorder can serve mankind —but need it be a complete recorder ? Surely a deck and preamplifier would suffice. And it is at this point that we throw out another suggestion to the mysterious 'they'. Why can they not make a double-decker machine ? I am well aware that the hi-fi brigade have their own answer : the cost would be as high, if not higher than two domestic machines. I am not knocking the purists, bless them. They have the clever ideas which help to make the domestic machine cheap and reliable, and they are entitled to their purity of reproduction.

The domestic man, however, often does not have the resources to enjoy hi-fi, stereo and what-not, nor the peace and quiet so essential to that enjoyment. His listening must be done in competition with the rattle of the fire-irons, the Little Woman's conversation and the imprecations of Junior, mending his cycle in the hall.

Go on, somebody ! Offer him a twin-deck machine, with $1\frac{7}{8}$, $3\frac{3}{4}$ (for recording) and $7\frac{1}{2}$ (for rapid copying) on both decks, or perhaps provide a multi-pin socket to carry *all* services to a second 'deck and pre-amp' which could be marketed as an 'add-on' unit. Please, however, make them simple. There must be many good men in the Operator class who would not know a *Megohm* from a *Therm*.

And while you are about it, here's another feature you can stick on your machines :

A simple socket into which one can plug either a track-selector switch or a blanking plug, coupled with sockets for interchangeable half and ¼-track heads. Then everybody would have two sets of heads and 'they'—the manufacturers—would make lots of nice money. What are they waiting for ?

BY H W. HELLYER

where no harm can come

EVERY so often a letter comes to the Editor saying something like : "What would be the effect if I reduced the input load when using a crystal microphone ?" or "Can I use a 15-ohm loudspeaker with the *Blank* recorder ?".

It says much for that sorely-tried gentleman's tact that he desists from replying "Suck it and see", and suggests instead that experiment may be profitable. Indeed, in the replies to readers' letters he may even prevail upon one of his string of tame experts to provide a suitable circuit. And if the one minion cannot help, he will cast his benign eye around till it lights upon another source of information. All in the cause of goodwill.

This sometimes explains why it takes so long for those anxious queries to get an answer.

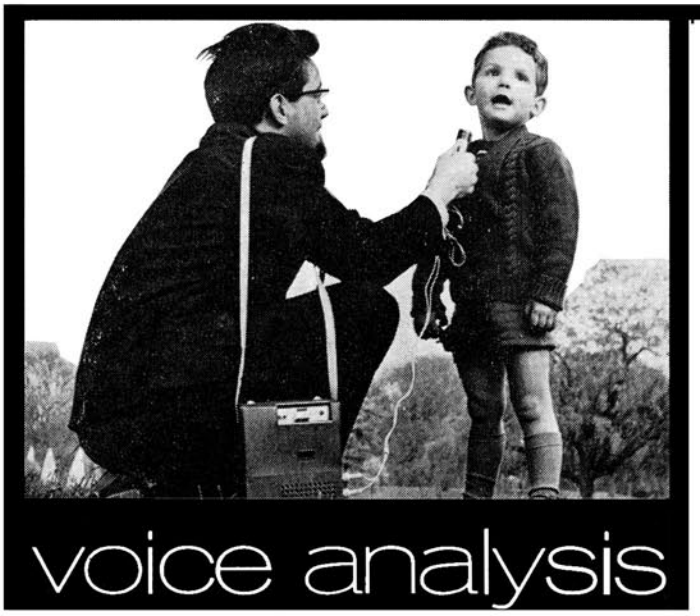
But really, what happens while 'Perplexed' is waiting for the oracle to speak ? Does he twiddle his thumbs, putting up with his boomy microphone response, or listen to the rattling output from his outworn portable while the cabinetted twelve-inch languishes in the corner? Or does he tentatively twist the wires together, shield his eyes, cover his ears and switch on, waiting for the bang ?

Cynics among my readers, including the professional gentleman who decried the servicing articles in this magazine on the grounds that they "encouraged the dabbler", will interpret these remarks as an invitation to disaster. But the logic of the situation is this : if you know nothing at all about the subject, then read it up and learn before making any experiments ; if you know a little and would know more, then experiment where you are sure no harm can come ; if you experiment successfully and feel you know a bit more, then write to the Editor and share your success.

Where *no harm can come*—this is the crux. It would be foolish to tamper with power supplies, to leave output stages unloaded, to apply voltages to transducers whose capabilities are unknown. Yet what is to prevent our altering attenuator values to obtain the matching we require ? Nothing, you say. Nevertheless, about a dozen letters a month ask for guidance on this subject, and some of the writers are obviously afraid to attempt the hook-up.

That's all very fine for the professional, says our cynic. He has plenty of spare parts with which to experiment. We have to humble ourselves at the counters of disdainful local dealers who regard a request for a 560K resistor in the way a Saville-Row tailor would sneer at an order for a button. To which I can only reply that experiments should begin with study, be continued with calculation and only then carried out with the tools. For the study we need look little farther than these pages and those of our sister magazine *Hi-Fi News*. A flip through the back numbers reveals a wide coverage of the subject. The calculation needs little more than a knowledge of basic formulae. The parts we purchase will be those that can always be used later : it is a poor enthusiast who is satisfied with one twitch only.

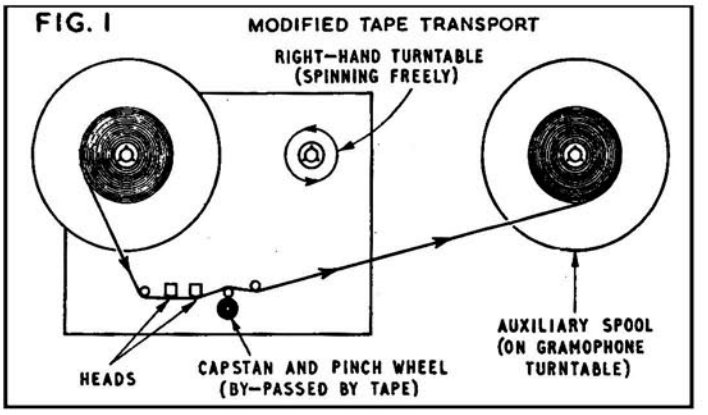
Tape recording is an active field. The fact that you are thumbing through these pages is enough indication that your interest lies deeper than listening to your own shocking accent, or storing the budgie's first chirps. When the tape recorder owner makes his first editing cut, or solders his first trembling joint, he has entered the creative world of his hobby and much enjoyment lies ahead. From that moment, his letters to the Editor become more difficult to answer, maybe impossible to satisfy, but certainly more and more welcome.



voice analysis

BRIAN FORD DESCRIBES
SOME UNUSUAL EXPERIMENTS WITH
A TAPE RECORDER

FIG. 1 MODIFIED TAPE TRANSPORT



THE human voice is, as anyone who has seen oscilloscope displays of speech will readily agree, a more complicated phenomenon than it seems at first. It is always tempting to assume that speech is simply the net result of interlacing sine-wave vibrations of varying wavelength and magnitude—but it is not quite as simple as this. By modifying a conventional tape-recorder it is possible to obtain instructive recordings of human speech which are greatly slowed down —time-magnified—and some startling findings can be derived.

First let us lock at the actual method of obtaining the recorded sounds. To hear a greatly slowed version of a recording, it is obviously necessary to make the recording initially at a very high tape speed. In this way, when the tape is played back at conventional speeds a great reduction can be realised. Human speech is best studied for these purposes when slowed down scme 25 times, and it is obviously feasible to make recordings at 30 i/s (a standard speed, as the professional knows, for high-quality music recordings) and then replay these at the conventional 'domestic' speeds such as $1\frac{7}{8}$ i/s. But this method, as well as being inflexible, does rely on the use of slow replay speeds (which are not always as good as higher-momentum replay speeds in the conventional machine) ; also, the 30 i/s recording speed cannot be varied to obtain best results, while amateur machines are rarely ever capable of this speed.

However, it is possible to obtain high-speed recordings with the conventional machine if some means of externally boosting the rate of tape-pass can be used. This is an easy matter. An extra turntable device is built on to the take-up side of the machine, so that an empty spool placed on it can spin around freely. It is then possible either to give the extra spool some momentum (by fitting it with a flywheel) or to provide it with an electric motor by which its rate of spin can be controlled—and, as important, varied at will. The spinning take-up spool provided in this way acts as the means of drawing the tape across the recording head at high speeds.

Of course, if the tape were simply laced-up in this way—by-passing the normal drive mechanism—it would not move at constant speed. The increase in diameter of the effective take-up mass of tape (which is growing, of course, as tape is wound on to the outside of the spool core) would lead to irregularities in take-up speed.

But, as a spool becomes increasingly filled with tape, the diameter of the tape reel increases more and more slowly (as all tape-recorder users know). In this way, a full spool, spinning at a fairly constant rate, gives a reasonably constant means of controlling the speed of tape that is being wound on to it. What happens in practice is that the machine is laced up so that the tape passes normally through the recorder's head mechanism, but not through the capstan drive (see fig. 1). The tape instead passes to one side of the drive mechanism, and straight on to the full (or nearly full) spool that has been put alongside. The take-up spool is now spun fairly fast, either by rotating it with one finger near the centre (which works surprisingly well, I have found, for amateur use) or by switching on the electric drive if one has been fitted. If the tape recorder is now switched to record, then any sound that is transferred in the form of electromagnetic impulses to the tape surface is recorded with the tape moving far faster than normal, and by playing back at a conventional speed the slowed-down, drawn-out recording can be heard.

This speeding-up method seems very liable to errors, and it is very difficult to gain any accurate idea of the tape speed during the recording. But this can be done with great accuracy, if the actual length of the recording is timed with a stop-watch, and divided into the time taken for the same recording when played back at normal speeds. If the phrase recorded lasted for four seconds in life, and the recording played back at (say) $3\frac{3}{4}$ i/s lasts 40 seconds, then clearly the time-magnification equals ten. And, though quite obviously the tape speed is not constant for a great length of time, it *is* relatively constant for the length of a four second recording.

There is a drawback to this mode of time-magnification : it is, simply, that the bias-frequency is reduced to audible limits and is present as a distracting whine on the recordings. This is not a serious drawback in many instances, but it is possible to eliminate much of the noise by superimposing a band of recording over the slowed track, without a microphone in the input socket. This 'over-recorded silence' has in some machines the effect of wiping all—or most, at least—of the whine that would otherwise be present.

In practice, after obtaining a recording and hearing it to be satisfactory, one rewinds to the beginning of the track and switches to superimpose ; the microphone is removed and the recorder is switched to play until the end of the track is reached. On playback the whine is often so greatly reduced as to be negligible. It may be that the recording is not of a suitable speed, in which case it can be heard at $1\frac{7}{8}$ i/s, $3\frac{3}{4}$ i/s and $7\frac{1}{2}$ i/s successively ; if none of these gives a coherent result, then a re-recording can be made with the tape travelling at different speeds : arbitrary as the speeds may be, remember, a timing will give a readily available, highly accurate index of the exact amount of slowing that has occurred.

This is where the interesting conclusions really begin to occur. One can immediately distinguish between vowel and consonant sounds : the consonants are rumbling hisses, clicks, or a kind of roaring, whereas the vowels sound like a series of regularly-spaced sharp, grunting peaks of sound. They are quite unmistakable. Perhaps if you say 'duh-duh-duh . . .' rapidly in a sinister intonation you may mimic the sound of a 'magnified' vowel very well indeed. This type of drawn-out linear configuration is an ideal means of hearing clearly the movements of the vocal chords of the pharynx : these movements are heard to be, not really a 'vibrationary' movement at all, but a series of outward 'explosions' of compressed air released in regularly spaced 'puffs'. This concept is borne out by visual observations, by high-speed cinemicrography, that have been made of the vocal processes.

We can hear, too, exactly what the consonants are. The letter 't', for instance, can be resolved into its physical components with great

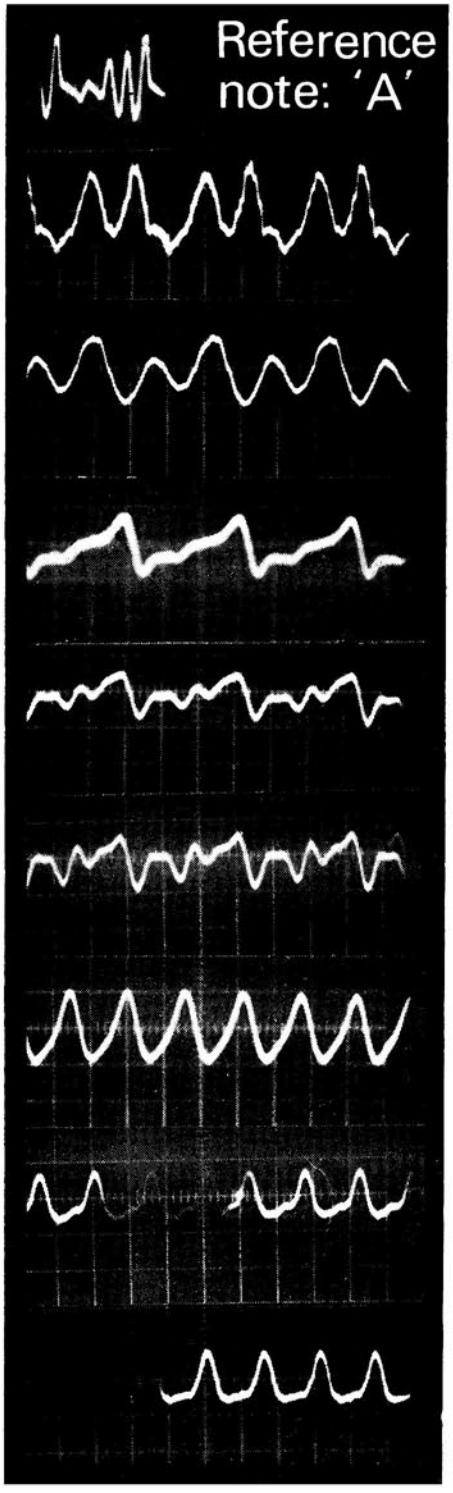
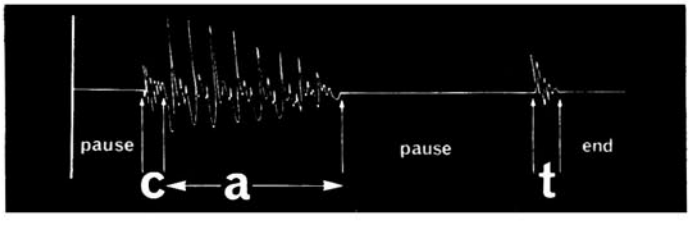


Fig. 3: (left) Oscilloscope traces of human voice producing an 'ah' sound.

Fig. 2: (below) Graphical diagram, from linear traces and oscilloscope photographs, of the word 'cat'. Note pauses for accumulation of breath before consonant sounds.



clarity. The tongue, bent upwards to touch the roof of the mouth and block the exit passage of exhaled air, acts as a dam behind which the expired air builds up. Eventually the pressure reaches a point where the tongue is withdrawn from the roof of the mouth and a short jet of the accumulated air is expressed.

This build-up of pressure takes time : in the word 'cat', for instance, the silent pause between the 'a' and 't' whilst the pressure increases is as long as the rest of the word. The sound pattern of this word is shown in **fig. 2.**

A splendid word to analyse by this technique is 'textbock', as the accumulation-pauses, as we may call them, are here very marked. The slowed record shows first the sharp, muffled explosion of the 't', followed by the staccato sound peaks of the vowel 'e', then a pause approximately equal in length to the vowel as pressure builds up for the 'c' sound at the beginning of the letter 'x'. There is a short gap, then the hiss of the 's' sound. Another long pause follows before the 't', and before the sharp 'b' too ; then comes the 'oo' sound in the form of typical vowel peaks and a final pause as the 'k' is formed. The total amount of silence during this word exceeds the sound output by a considerable margin !

In fact, by timing sentences, it has been possible to observe that a large amount of speech is actually silence. In round figures it seems that at least one-third of a sentence is complete silence, and since much of the sound output of the vowel is silence too, it is possible that a person speaking for five minutes will make noise, as such, for only two minutes of that time. Perhaps more interesting is the fact that words containing accumulation-pauses frequently have more silence from this source than there is separating individual words : "That animal" is spoken, in practice, "Tha tanimal" and the gap between 'a' and 't' is at least as great as the length of the entire 'tha' sound.

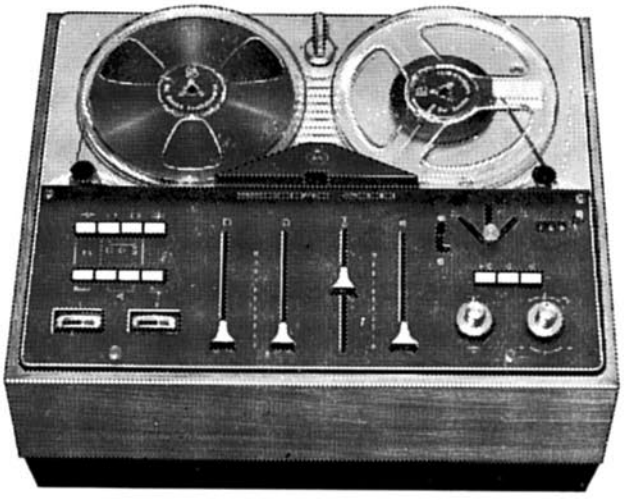
Clearly, sound patterns are more complex than are often assumed. Indeed, though many workers in the past have produced graphical representations of vowel wave-forms and stated that a given pattern is characteristic of a certain vowel sound, we have found by a separate series of oscilloscope recordings (some of which are shown) that there is a great deal of variation between given sounds when said even by the same individual. It is true to say that there appears to be a greater difference between the pattern produced by one person at different times than between different vowel sounds—and if this is as widespread as it seems, then the use of patterns as 'voiceprints' to identify criminals —as has been tried in the USA—would seem to be a risky business. (See the section of Speech Formants in *Musical Instruments and Audio* by G. A. Briggs for a more detailed discussion.)

Quite obviously there is a great field here for interesting experiment. And as this work has shown, though evolving the technique takes a little time and equipment, a good imitation of the results can be obtained by very simple means. The results should be, to say the least, intriguing.

Bang and Olufsen

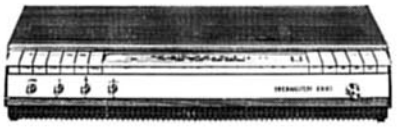
for those who value design and quality above price

Enthusiasts demand the best—they choose the Bang and Olufsen Beocord 2000K tape recorder



Modern design distinguishes the Beocord 2000K from conventional tape recorders. It has been designed by top Danish engineers to give you the following features: Built-in 3-channel mixer section which gives an amazing variety of recording effects such as 'sound-on-sound', the synchronizing of two recordings on separate tracks, echos on both stereo and monaural recordings.
Power output is 2 x 8 watts, distortion at 5 watts, less than 1%. FREQUENCY RESPONSE: 7½ in./sec.: 30-20,000 c/s (±2 dB: 40-16,000 c/s); 3¾ in./sec.: 1⅞ in./sec.: 50-8,000 c/s (±2 dB: 50-6000 c/s). Price 119 Gns.
Also available to the same specification is Model 2000T which has two speakers built into the lid of the portable carrying case.
Price: 123 Gns.

BEOGRAM 1000 V. A four speed stereo record player featuring the famous B & O pick-up cartridge with Diamond stylus. Suitable for use with the Beomaster 1000 and B & O pressure chamber speakers. 34 Gns. Complete with cover.



BEOMASTER 1000. Hi Fi enthusiasts will acclaim this outstanding compact all-transistor Hi Fi Stereo amplifier FM Radio combination. 2 x 15 watts output. Long, low cabinet, suitable for bookcase installation. Price: 79 Gns.

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THE Optacord 408 belongs to that relatively limited breed of recorders—the mains/battery portable. Unlike its predecessors, however, the 408 is neither heavy nor expensive, despite its thick metal cabinet. Apart from a visually rather 'loud' chrome grille, the 408 is unpretenticus and simple to operate.

Mechanical controls take the form of four plastic press-tabs, these selecting, from left to right, fast rewind, stop, play and fast-forward. A small red button positioned over the rewind tab interlocks with the play control to give the recording mode. A single rotary control governs record and replay gain, there being no facilities for monitoring or tone control. A small meter is located near the gain control on the same plane as the tape deck, and this serves as a modulation indicator when the red record button is pressed, with or without the play switch engaged. It is thus possible to set recording level without putting the tape in motion. Although having no effect on tape transport, the button powers both amplifier and motor.

All input and output connections are through DIN sockets, facilities also being provided for car-battery operation. Moving-coil microphone and DIN connecting lead are supplied.

Spools of up to 4½in. diameter may be located on the plastic turntables which protrude through the metal deck. The deck, too, is finished in grey-striped chrome. It was found difficult to remove certain manufacturers' spools from the hubs, and several spools were in fact cracked over a period of several months. To be fair, the spools supplied by *Loewe Opta* fitted well, the split turntable spindles operating efficiently to prevent the spools rising from the deck. The spindles were rather less effective, however, in their rotational grip. The hub-locking system adopted on the *Grundig TK6* and *EMI L4* might be employed to advantage on the 408—though the lid might require redesigning to provide the increased clearance that would be needed above the spools.

The lid deserves special mention : it is detachable and on several occasions detached itself without warning when being carried outdoors. Small metal clips engage against studs on the cabinet but are, perhaps, a little too flexible for their task, in view of their habit of giving in to pressure from the stud. They are, however, easily bent back into shape. General finish of the lid was thought to be rather below what one expects from contemporary Continental equipment, and it would not be difficult to cut one's flesh on its rather rough edges—but perhaps I am being too fussy.

Entry to the battery compartment was by way of a removable metal base, this being held in position by a wide chrome screw. A single anti-clockwise twist—using a coin as a screwdriver—disengaged two teeth in the screw from slots in a plastic-reinforced cardboard sheet, the latter sheet affording further protection to the amplifier and mechanism. Four large torch cells were accommodated in a strong plastic cradle. Cells were fairly easy to insert and remove—an important point when one remembers thumb-trapping acquaintances of the past. Close to the battery cradle was a stowage slot for the mains flex, the two-pin plug itself being located in a small socket. Removing the plug automatically disconnected the batteries and—with the flex connected (via the two-pin plug, or a suitable adaptor) to the mains permits economical operation from the home power supply. Battery consumption was quite low, bearing in mind that only four cells are used, and this is not a portable for which rechargeable batteries are financially essential, though they are available for the 408 if required.

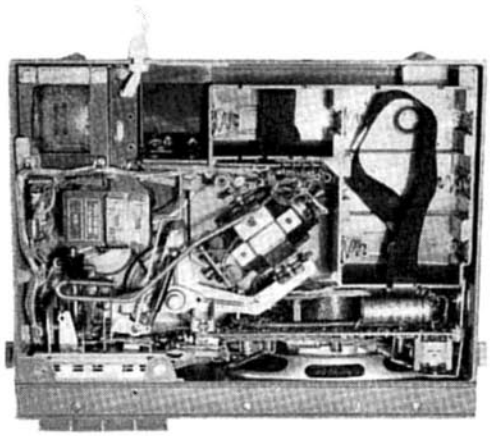
Performance on speech was well up to the standard expected of a £40 battery machine, the recorder functioning quite happily in a vertical position. The only drawback to the 408 when used 'in the field' was the difficulty of checking recording level without pulling the recorder into a horizontal position. One way round this was to hold the 408 in the right hand, with the meter facing inwards, whereupon modulation level could be checked rather more easily by pulling the recorder upwards, more or less level with the waist. Controlling gain from this position was found to be a somewhat difficult contortion, however, and operation of the press-tabs required the recorder to be swung meter-outwards again. Despite the excellent stability of the tape transport under normal conditions, the movement involved in such rapid changes of position could hardly fail to cause wow.

Recordings made through the high-level socket suggested that the 408 was less suited to music than speech, the recording channel being singularly poor in this respect. But whereas recorded material was noticeably distorted at all settings of the gain control and with input material of various levels, the quality of playback was good. Pre-recorded music was reproduced well, despite the rather fatiguing nature of the monitor loudspeaker. Strangely, this speaker was less suited to speech than to musical material.

The 408 is at its best when feeding an external amplifier and speaker. In this condition it fulfils all the requirements of the outdoor recording enthusiast, while lending itself to replay of pre-recorded music.

Mechanical construction of the recorder is somewhat intricate when compared with other domestic designs, and the 408 is no machine for the home serviceman. Thus, when the first model submitted for test developed a loud 'click' in the take-up turntable drive, a quick home repair seemed out of the question ; the machine was returned for a new model. The fault did not occur again.

In concluding this short field test, I find that the only real virtue of the 408 is the economy of batteries made possible by its mains power facilities. Beyond this, and beyond remarking that replay quality is up to the standard of most similarly-priced battery portables, I can find little to recommend this machine.



The 408 with rear covers removed. Mains transformer is visible at top right and motor in centre.

FIELD TRIALS OF BATTERY PORTABLES

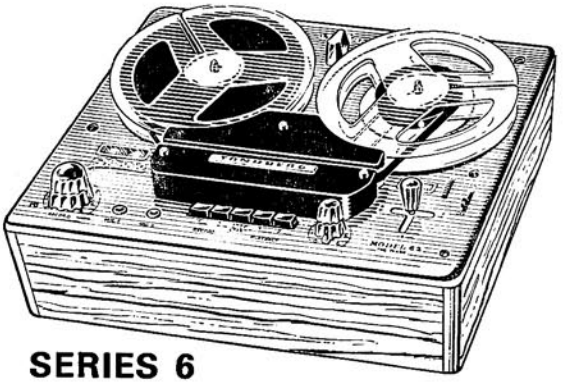
No 13

LOEWE OPTA OPTACORD 408

BY DAVID KIRK

MANUFACTURER'S SPECIFICATION. Half-track transistor mains/battery recorder. **Tape Speed:** 3¾ i/s. **Wow and flutter:** 0.3%. **Frequency Range:** 90 c/s—10 Kc/s. **Output Power:** 800 mW. **Spool Capacity:** 4½in. **Level Indicator:** Meter. **Power Supply:** Four torch cells, car battery or 110/240V 50/60 c/s mains. **Dimensions:** 9½ x 7½ x 3⅝in. **Weight:** 6½lb. **Price** £40 19s. **Distributor: Highgate Acoustics, 71-73 Great Portland Street, London, W.1.**

Are you at sixes and sevens with Tandberg ?



SERIES 6

SERIES 7

Q. Tandberg stereo tape recorders have been highly recommended. Which shall I buy Series 6 or Series 7?

A. For playback purposes Series 6 requires additional power amplifiers and loudspeakers. If the tape recorder is not to be used as part of a Hi-Fi installation then Series 7 is the one for you.

Q. The Tandberg Series 7 is a complete Stereo Record and Playback system, incorporating power amplifiers and loudspeakers. If I should decide to buy Hi-Fi equipment later can I use a Series 7 with it?

A. YES Series 7 has high impedance outlets designed to feed Hi-Fi pre-amplifiers.

Q. If that is so why should a Hi-Fi owner consider Series 6?

A. Because Series 6 has separate Record and Playback Heads, two recording amplifiers and two playback pre-amplifiers. These special features permit instant playback monitoring off the tape at the time of recording. "Sound-on-Sound" is also possible.

Q. Does this mean that Series 6 recordings will be superior to those of Series 7?

A. Not necessarily! The expensive "Off-the-tape monitoring", as used in professional recording studios, is well worth while, but with only a little care and experience tapes can be made on Series 7 audibly indistinguishable from those of a Series 6.

Q. "Sound-on-Sound" has been mentioned. I am very interested in photography and would like to synchronise Sound with my pictures. Is "Sound-on-Sound" similar to "Superimposition"?

A. Quite definitely No! Superimposition consists of partially erasing the first recording with consequent degrading of sound quality. With "Sound-on-Sound" a master recording, on one track, is transferred and mixed in perfect synchronisation with a second recording on the other track. Multiple recordings are possible without loss of quality.

Q. Is "Sound-on-Sound" possible with Series 7?

A. No. Not to the same extent. It is possible with Series 7 to playback track one and record track two in synchronisation with it. Afterwards both tracks can be played back, and mixed as required, either through stereo speakers or combined through the centre channel outlet.

Q. I suppose if I require the very best reproduction, and signal to noise ratio, I must buy a two track Tandberg?

A. Tandberg made the 15 i.p.s. speed, with its large reels, obsolete by low speed performances never previously thought possible. Tandberg engineers pioneered, and later perfected, four track tape recording techniques. We challenge you to detect audible difference between two and four track Tandberg recordings.

Q. Then which shall I choose four track or two track?

A. If you tend to be rather conservative. If you do not expect to purchase pre-recorded stereo tapes, which are all 4-track nowadays, and if tape economy is not a consideration then a 2-track 6 or 7 may be the one for you. Please note, however, that 4-track Tandbergs outsell 2-track by five to one.

Q. In conclusion will you please run through the complete technical specifications for me?

A. Unfortunately we have no more space, but we shall be pleased to send you illustrated literature, describing the complete Tandberg range, Mono or Stereo, upon request.

Visit us at Booth 17, Dem. Room 222, at the International Audio Festival, at the Hotel Russell, Russell Square, London W.C.1, on April 14th to 17th.

For further information and specifications please write to: Dept. TR

Tandberg

ELSTONE ELECTRONICS LIMITED, 81 Kirkstall Road, Leeds 3. Leeds 3-5111 (7 lines).

OUR READERS WRITE . . .

. . . about the February Editorial

From: A. Adcock, Davy Hall, Oaklands Road, Salford 7, Lancashire.

DEAR SIR, I read with interest your Editorial in the February issue, but failed to see the point of the article. Is the implication that the Essex dealer exchanges the tape on the cheap American and good quality spools, and if so to what profit?

I am particularly interested in this matter, since a friend has recently purchased a number of unboxed plain spools for 10s. each, each containing 1,200ft. of *Agfa* tape.

I have spent hours arguing that one cannot get something for nothing, and that there must be something wrong with the tape; but nevertheless I am still left wondering.

I would be pleased if you could throw a little light on the matter.

Yours faithfully

The implication is indeed that the dealer exchanges tapes from spool to spool—this being implied by the dealer himself. An inexperienced fuel merchant might store all grades of coal, anthracite and coke in a single container . . . they look much the same and combustive qualities are, after all, a subtle irrelevance! **Ed.**

. . . about a competitive design

From: K. C. Smith, Truvox Ltd., Neasden Lane, London, N.W.10.

DEAR SIR, I was very surprised to read Mr. Bolt's remarks about competitive designs (*Readers' Letters*, February issue), and indeed I have written to him asking the pertinent question: "Have you not heard of the Truvox?".

A Truvox Series 100 stereo tape unit has the following features: (1) It is fully transistorised, (2) has preamplifiers only, (3) has three good ½-track or ¼-track heads, (4) has three tape speeds, (5) takes 7in. spools, (6) will operate vertically, and (7) has styling and a colour scheme equal, we consider, to the best from Japan or America.

The only controversial point is the case for one motor as against three.

Perhaps this letter will help to save a proportion of that import tax which concerns Mr. Bolt so much. *Yours faithfully*

. . . about quality and cost

From: John Bradley, 8 Canning Road, Croydon, Surrey.

DEAR SIR, Under the title 'BBC Cover the Contest' in the January *World of Tape* column, reference was made to the high quality of amateur tapes played in the *Soundhunters* programme (Home Service, 3rd November, 1965). Kind reference was made, in the same news item, to an extract from my own recording—'The Real Thing'.

Many amateurs may feel that to attain quality acceptable for transmission by the BBC needs high quality and very expensive tape recorders and microphones plus the higher tape speeds of 7½ and 15 i/s. Perhaps a description of the equipment used for 'The Real Thing' will be a reassurance that this is not necessarily so.

The original outdoor material (a rag-and-bone man with his pony cart) was recorded on a *Philips EL3585* battery portable with the supplied microphone. This machine was bought new in 1962 for £25 4s. Since the recording was at 1⅞ i/s, cutting and editing would have been a little tricky, so it was dubbed to a 3¾ i/s Philips *AG8109* (bought second-hand for £10). This recorder was originally on the market in 1958. In addition, an inexpensive Japanese transistor mixer was used, and this can be bought for about £2 17s. 6d.

As an entry in the Actuality class of the International Contest, the original tape, together with all the other entries, was dubbed to a master at 15 i/s by the Federation of British Tape Recording Clubs and the extracts needed for the programme were copied by the BBC yet again at 15 i/s.

Out of interest, the programme was recorded on the AG8109 at 3¾ i/s from an *Armstrong* tuner and the ultimate dubbing, four copies plus a transmission away from the original material, is quite comparable in quality, although some slight losses are detectable.

The old AG8109 is still to be found, from time to time, at the £10 to £12 mark, and the portable EL3585 can be purchased on the market for some £14 second-hand.

The message here, I feel, is that good work of excellent technical quality can be done on quite low-priced equipment. First, let the enthusiast master his technical and creative approach on simple tools. Then, if he feels the need, he can branch out to higher priced equipment. There is a point to watch here, though. Taking the modestly priced and adequate mains recorder in the £30 class, the next jump is inevitably to the £90-£130 category. The middle price range (£40 to £60) seem generally to be only the same quality as £30 models, but with a lot more gadgetry.

Although I have at my disposal a number of recorders, including the *Fi-Cord 1a* and *202*, *Uher 730* and *Revox 736*, the early Philips machines are still in almost daily use and are highly appreciated members of my stable. *Yours faithfully*

. . . about azimuth misalignment

From: A. L. Oliver, 45 Durham Avenue, Gorleston-on-Sea, Great Yarmouth, Norfolk.

DEAR SIR, I am a student apprentice in electronics and a keen amateur tape recordist. I started with a small 20 gn. model and have now graduated to a *Truvox R102* (congratulations to Truvox on all-transistorisation) with which I am very pleased. I find, however, one fault cropping up time and time again—azimuth alignment. Being in the electronics field I am able to carry out small repairs to machines and have done several for friends, but head alignment is not *easily* dealt with.

On several occasions I have loaned tapes, only to be told that they lacked bass or treble response, and on looking at the machine discovered that the alignment of their playback head was out of true (no it wasn't mine, that has been checked!). I then aligned the heads using a pre-recorded tape which I find quite suitable for the job. Only the other day I dubbed an educational tape for a teacher at a local school; on playing back the tape all the voices were 'out of focus' and on adjusting the playback head to suit the recording became clearer; this was evidently due to misalignment of the machine which had made the recording.

Apart from the tinker who likes fiddling with his machine and misaligns them himself, there are the innocent non-technically-minded ones who have their machines shop or factory aligned and on exchanging tapes with others are unable to obtain the quality which is nevertheless there on the tape. I therefore call on manufacturers and dealers (not all, however, some are quite conscientious) to be a little more precise with head alignment so we may all interchange tapes without loss of quality. *Yours faithfully*

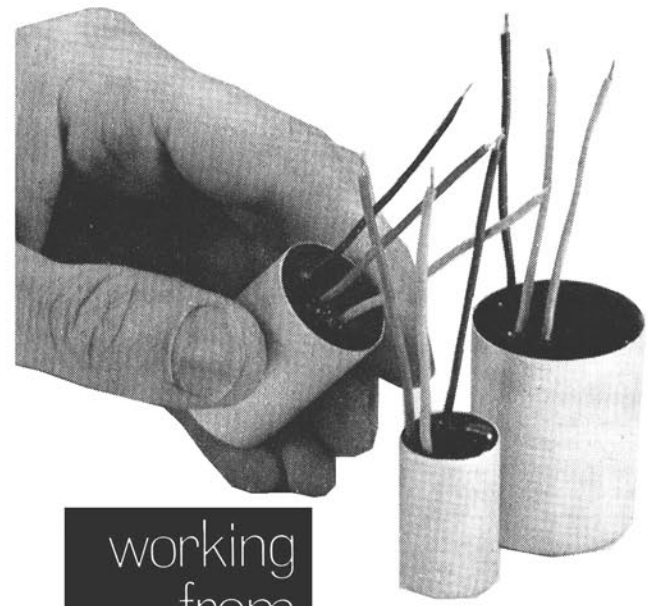
. . . about Victorian concepts

From: Colin Braddock, The Tape Recorder Centre, 266 Waterloo Road, Blackpool, Lancs.

DEAR SIR, I would agree with Mr. D. J. Bolt (February *Readers' Letters*) that manufacturers in the U.K. are more than conservative, they are in the main Victorian in their concept of the tape recorder, with the exception of one or two who are beginning to wake up. As a dealer stocking the best equipment, I stock only one machine made in the U.K., and this I name as the *Brenell*, still antiquated in design, but for a British made product (using, I might add) German motors and other non U.K. components, fine value for money. I would add to this, however, my utter contempt for single-motor and belt-drive transport systems: three motors are essential. Mention of transistors is merely heaping coals on the fire.

The economists should wake up to the fact that by protecting British goods with restrictions on the free import of the best of European equipment, they are allowing British workmen and manufacturers alike to live in a cocoon. Import tariffs are only a temporary relief from the shock that will come when imported goods are placed on an equal footing with our own, for even with such tariffs, the best of Continental audio products are comparable in price to British equipment. *Yours faithfully*

battery powered tape recorders



working from the mains

NUMBER 5 BY MICHAEL GORDON

LAST month we concluded contemplation of the zener diode as a device for assisting with the battery powering of tape recorders. We saw that the zener has the ability of stabilising an output voltage over a range of output currents and input voltages. This it achieves by the reverse current through the diode increasing rapidly when the reverse voltage exceeds a somewhat critical value, called the *zener voltage*. Up to the zener voltage, the diode behaves in the same way as any other solid-state diode in that a very small reverse current flows, which is the 'leakage current' composed of minority carriers.

Although all solid-state diodes tend suddenly to pass a very high current when the reverse voltage exceeds the 'breakdown voltage' (the same as the zener voltage when the device is a true zener diode), not all diodes of this kind are suitable for voltage regulation or control. This is because the high current beyond the breakdown point incites a high power dissipation in the diode, and ordinary (non-zener) diodes are not usually designed for a continuously high breakdown (or zener) current.

However, most zener diodes can be used as ordinary diodes provided the reverse voltage to which they are subjected does not exceed the zener voltage. Solid-state diodes have a maximum *peak inverse voltage* rating. This really corresponds to the voltage that the diode can accept in a reverse direction before the zener effect occurs. Clearly, the efficiency of a rectifier circuit would be considerably impaired if the diode conducted heavily on the tips of the waveform of the AC supply corresponding to the direction of non-conduction.

Practical zener diodes (or *voltage regulator diodes*, as they are sometimes called) are classified both in terms of nominal zener voltage and maximum power dissipation, usually at a specified temperature. The latter is because the maximum dissipation is related to the junction temperature, the dissipation being reduced with increase in temperature.

To keep the temperature down as much as possible, some zener diodes are designed for use on a 'heat sink', which is a solid piece of metal into which the heat of the diode is 'drained'. Indeed, the nominal power rating of most zener diodes can be increased by mounting on a heat sink.

At this stage it is not intended to explore the circuits of battery-powered tape recorders to discover the internal application of zener diodes. This will come later. Right now we shall investigate an external application of the device and see how we can use it to our advantage.

Let us suppose that we have a battery-powered tape recorder and wish to economise on batteries during the winter months when portable, 'sound hunting' activities are out of mode. The logical thing to do is to run the machine from the mains supply. This is possible to some extent with machines that employ, say, nickel-cadmium or some other kind of rechargeable battery system. All that is necessary is to plug the battery into a charger overnight, thereby drawing on the mains supply to operate the machine during the day.

The problem arises when the machine is designed for the use of a battery made of dry-cells, such as *U11's* or *U2's*. Some batteries have rechargeable equivalents (such as nickel-cadmium cells), making it possible to exploit the mains supply through the medium of an external charger. News has recently reached us of a range of charging modules' from *Kynmore Engineering Ltd.* (19 Buckingham Street, London, W.C.2) probably suitable for this purpose. The illustrated modules are encapsulated in *Araldite* and are designed to be permanently connected across the battery of rechargeable cells and can be built into the equipment if required. There are six different sizes, ranging from 2 to 45mA. The author is hoping to have the opportunity to test these devices and to make a report on them in this series at a later date, along with other suggestions for battery charging schemes. To some extent, it is also possible to 'charge' (or extend the life of) ordinary all-dry cells, and details of this technique will also be given.

To revert to the main theme, an alternative to battery charging is to run the battery-powered tape recorder from the mains supply. The question is, how can this be done without harming the equipment? It must be said straight away that under no circumstances should a battery-powered recorder be connected *direct* to the mains supply. Such a connection would result in immediate blow-out, coupled possibly with explosion and fire.

Neither is it possible to couple battery equipment to the mains via a step-down transformer. This is because a transformer delivers an AC supply, and even if the mains voltage is dropped to match that supplied by the recorder's battery, AC would cause considerable trouble. The transistors in the recorder would almost certainly blow, as also would polarised components, such as electrolytic capacitors. The DC drive motor would also be highly embarrassed by an AC supply, and may or may not work, depending on its nature.

What is required is a unit that, when connected to the mains supply, delivers a DC output voltage to match that of the battery supply and a current to match the demands of the recorder at 'all systems go'. For instance, with the amplifier at full output of playback and with the motor running.

Moreover, and this is where the zener voltage regulator comes in, the voltage supplied to the recorder must remain substantially constant on all functions which call for different currents. On 'record', for example, the current demands are probably less than on full-output playback, while with the amplifiers on and the motor off, the current taken from the supply is less than with the motor running, of course. The unit must, therefore, supply a constant voltage, irrespective of the current consumed. Were this condition not satisfied, the higher voltage developed across the battery input of the recorder on 'record', or on 'playback' without the motor running, would probably damage the amplifier, its transistors and components.

Conversely, if the supply were designed to give the correct voltage on the load of the amplifier alone, a substantial drop in voltage may well occur when the motor is switched on, which would starve both the motor and the amplifier and result in poor motor control (emphasising wow and flutter) and audio distortion.

There is another angle, though probably not so important, and that is the playback output stages of many transistor tape recorders are arranged in the class-B mode. This means that the supply current increases with increase in audio output, and good supply voltage regulation is desirable to prevent the voltage from dancing about too much under playback conditions, towards full power.

The reason why a battery of dry cells holds a constant voltage under the varying current conditions is that the battery has a relatively high capacity and low internal resistance (see Part 1 of this series). The low internal resistance ensures that very little voltage is developed

across it when it is supplying its nominal design current. Thus, in spite of the changing current, the resulting voltage changes across the internal or source resistance are likewise very small, meaning that the voltage across the supply terminals of the recorder holds substantially constant.

As a battery ages, however, its internal resistance rises, and this is why the terminal voltage falls much more sharply as the current demands on the battery are increased. The idea, then, is always to maintain a low internal or source resistance of the power supply. The largish capacity of the battery ensures that sufficient current is available and that the internal resistance of the battery as a whole is decreased.

In a like manner, the zener diode represents a very low resistance source at the zener voltage, due to the relatively high zener current. From the equipment's point of view, the high zener current implies a very low source resistance.

Now the stage has been set, we can consider a mains supply unit for a battery recorder. It must have a transformer to step-down the mains voltage to a value required by the recorder; it must have a rectifier to translate the AC output from the transformer to DC; it must have a filter to smooth the DC supply, that is, to eliminate the mains ripple that is present on all rectified AC supplies; and it must have a voltage regulator, preferably in the form of a zener diode, to endow the output with a low resistance.

The basis of such an arrangement is shown in **fig. 1.** Here we have the mains transformer T1, stepping down the 220/240 mains voltage to approach that required by the recorder, the rectifier, MR1, comprising a bridge of four half-wave rectifiers, the reservoir capacitor C1 (first aid to smoothing), the series resistor for the zener diode R1 and the final smoothing capacitor C2.

Now let us see how the various components would be calculated. Let us suppose that the tape recorder requires a DC supply of 9V at a maximum current of 270mA, made up of, say, 250mA for the drive motor and 20mA maximum for the amplifier. The mains transformer, then, would have to deliver an AC voltage (root-mean square—RMS) of about three times the required DC voltage. A suitable transformer would be one with a secondary winding delivering about 30V and capable of supplying a little under twice the maximum current requirements—say, 500mA (that is, half an ampere). The primary winding, of course, must suit the local mains supply voltage (usually 240V).

The zener diode would have to be one rated close to a nominal 9V. To calculate the value of R1 we shall have to know the DC output from the bridge rectifier. That is, the DC voltage across C1. This we can take to be *approximately* equal to the RMS value of the voltage across the mains transformer's secondary.

Thus, under conditions of *minimum* load current (20mA) the series resistor carries 20mA plus the zener current. The zener current must be something above the maximum load current; let us say, 300mA. This means, then, that R1 carries 20 plus 300mA, or 320mA. The difference between the supply DC and the load DC is 21V (i.e., 30—9V). From this we can find the value for R1 which, by Ohm's law, is equal to the voltage divided by the current in amperes, or, $\frac{21}{0.32}$ ohms. This works out to a little over 65 ohms.

When the current is minimum (20mA) the 300mA zener current at 9V gives a zener dissipation of (9 x 0.3) watts, or 2.7W. The zener diode should be rated somewhat above this value to provide a safety margin. A suitable diode would be the *Mullard OAZ227*, which has a maximum dissipation of 7W at 45°C and a nominal zener voltage of 9.1V.

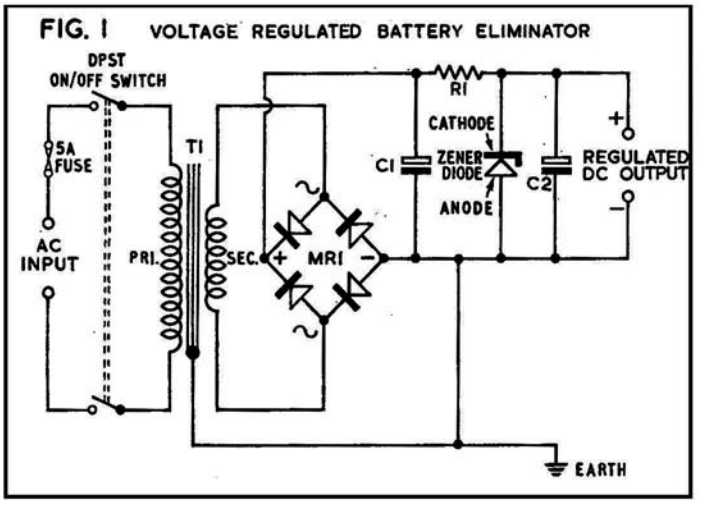
This diode is constructed as shown in **fig. 2,** the design being for clamping to a metal chassis acting as a heat sink, as already discussed. The eyelet connection of this device is the 'anode' which has to connect to the negative of the supply. Thus, if the supply unit is built upon a metal chassis, the chassis potential will either have to be *positive* or negative by employing a metal heat sink adequately insulated electrically (though probably not thermally) from the chassis proper. This is because the metal stud of the diode housing is connected to the 'cathode', which is the positive side and has to be connected to supply positive for *reverse* conduction. It is most important that these points are borne in mind.

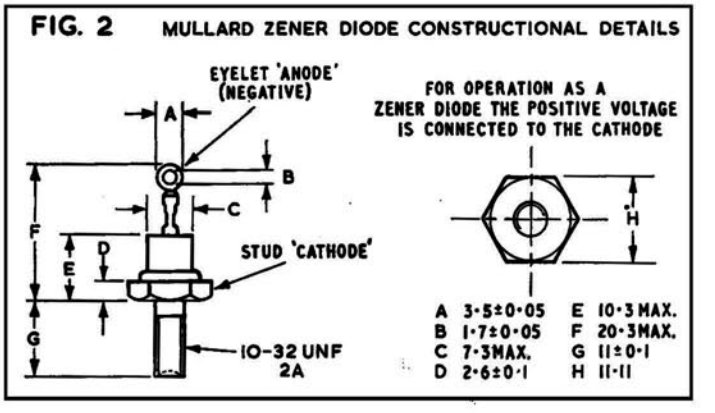
Indeed, some tape recorders call for a negative supply, relative to chassis. To secure this condition in the power supply unit it is only necessary to change the connections relative to positive at the rectifier, zener diode and electrolytics as shown in **fig. 3.**

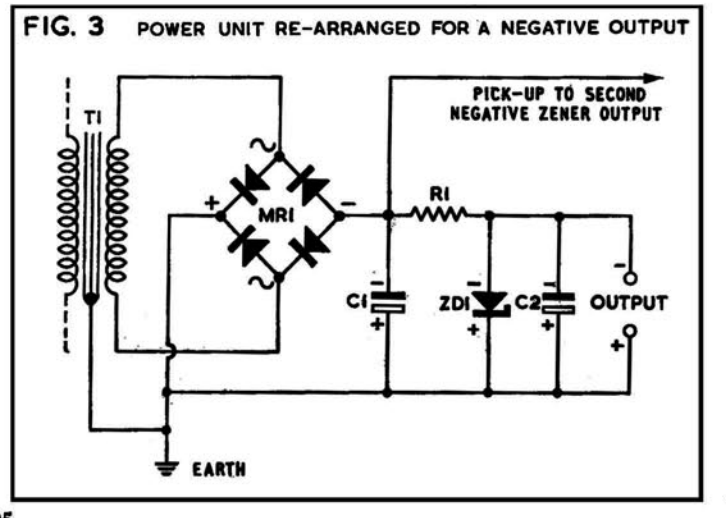
In operation, therefore, the zener diode circuit will pass 300mA when the recorder is consuming 20mA and only 50mA when the recorder (with motor running) is consuming a total of 270mA. In that way, then, the current through R1 remains constant, as does the voltage dropped across it and hence the supply voltage to the recorder under all conditions of operation.

The wattage rating of R1 can be computed by multiplying the voltage across it with the current in amperes through it. Under all conditions, this is 21 x 0.32, which works out to 6.72W. In practice, a good quality wire-wound 10W resistor would be used.

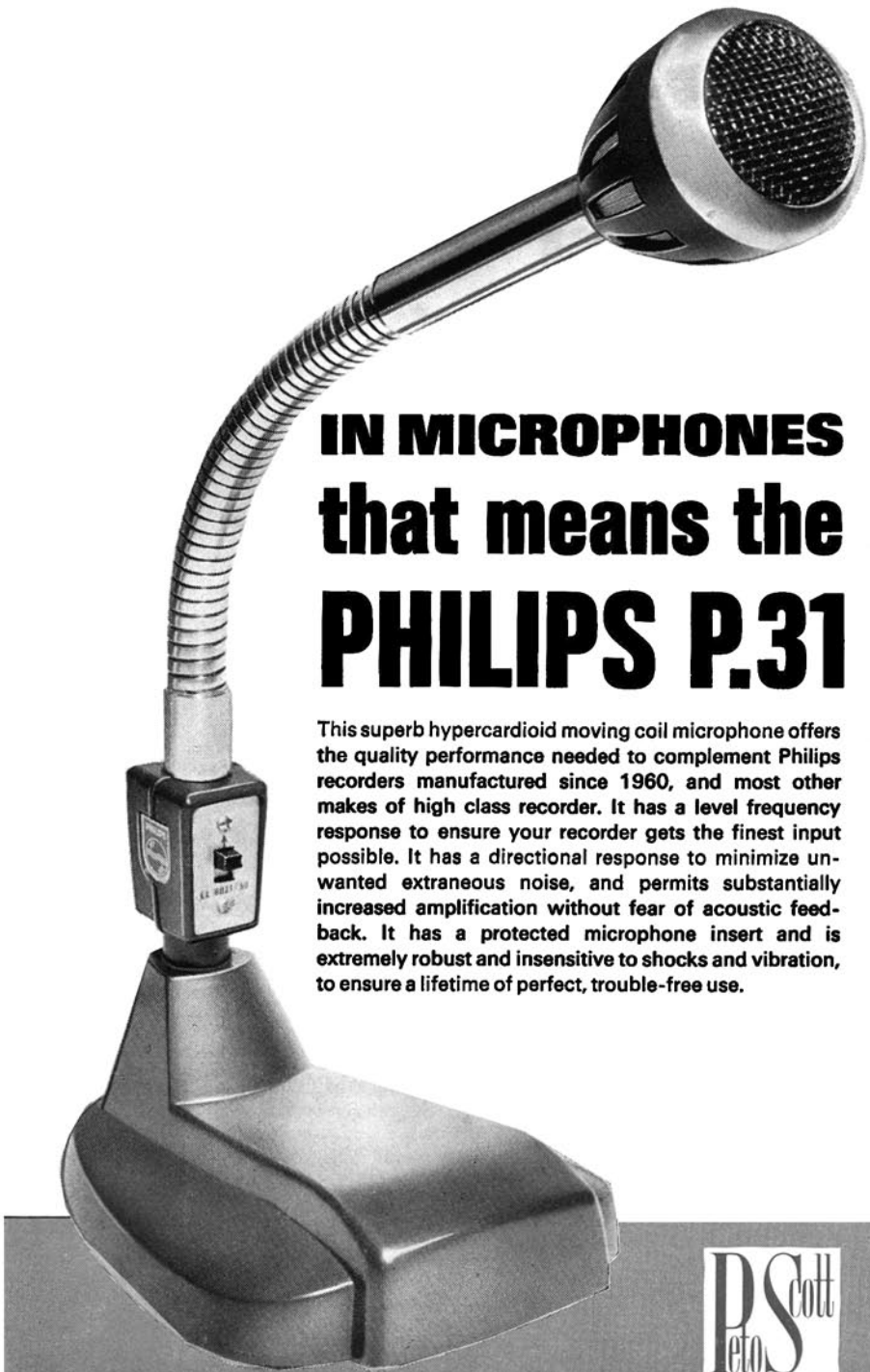
Next month more information on this type of supply unit will be given, and a way will be shown to secure two DC outputs, as some recorders require for the amplifiers and the motor.







YOUR TAPE RECORDER DESERVES THE BEST...



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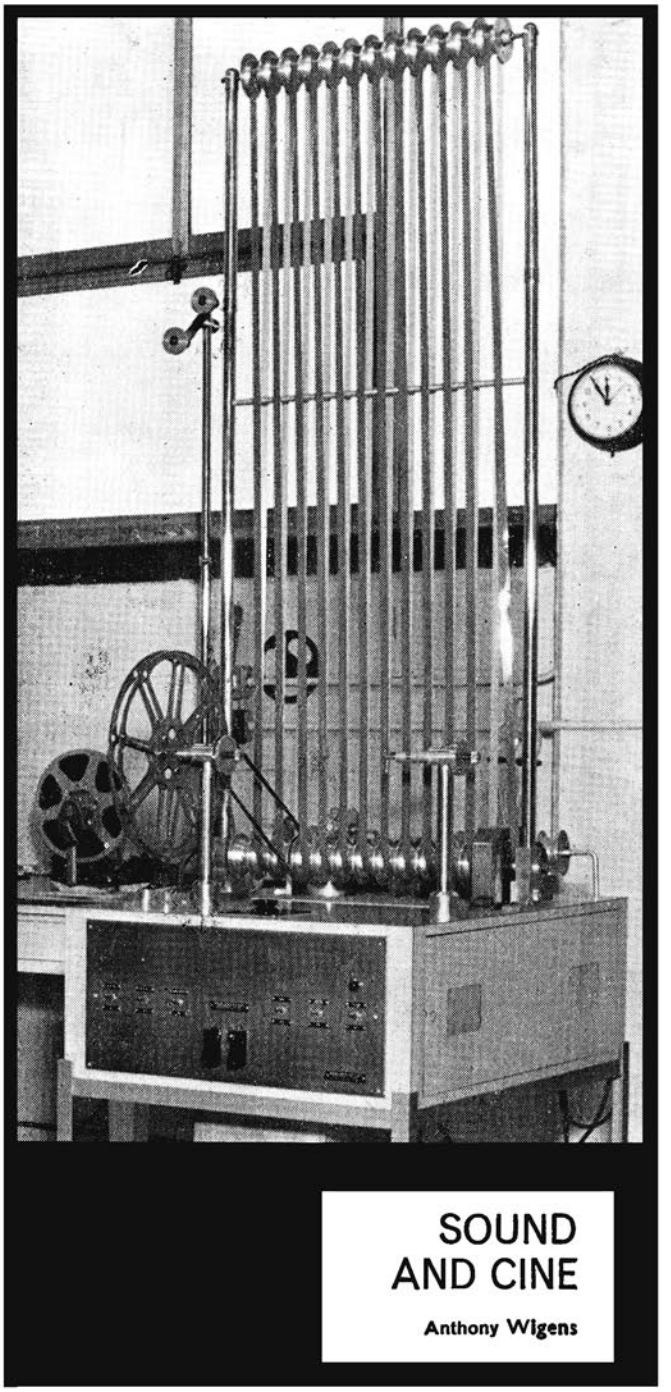


Left: An imposing array of film undergoing striping at the *Zonal* factory

SOUND AND CINE

Anthony Wigens

a visit to zonal

BACK in December in an article called *Stripe Gets into its Stride* I covered briefly the how, what and where of magnetic stripe sound tracks, with a reference to do-it-yourself striping. Since then I have paid a visit to *Zonal's* Acton factory* to find out precisely what happens to film sent there for striping.

To many film-makers, parting with their film is a traumatic experience. To have had it back safely from the laboratory, possibly spent hours editing and titling it, and then to have to send it off again into the unknown for striping is almost too much. So I will try to make the unknown a little less so.

Zonal do not add a laminate stripe. Theirs is a paste or extruded stripe, a band of ferric oxide applied as a liquid and dried on. It is a method used for professional films of all gauges—by no means an amateur-film-only technique.

Unless customers specifically state "striping only", Zonal give all film their Permafilm treatment first. This replaces part of the moisture content of film with organic chemicals which make the emulsion tough and pliable, and resistant to both static and colour fading. The price is 12s. 6d. per 1,000ft., with a minimum of 5s. So for anything up to 400ft. of film, striping costs 2d. a foot plus 5s.

Zonal do not recess their stripe, so there is a build-up on the reel. Do not send more than 380ft. on a 400ft. reel.

All splices are covered with a temporary green tape patch for safety's sake while the film undergoes treatment, joined top and tail with other customers' films. A break in your film could mean that someone else's would suffer.

The best kind of splice is a well-made cement splice, in the opinion of technical manager Tommy Martin. He recommends the *Premier* splicer with scraping block, frame line version, which is $\frac{1}{16}$in. In practice, however, a $\frac{3}{32}$ splice may be better since this can be used for both 8mm. and 16mm. film. Both versions are suitable and cost about £8. If you use tape splices, they still tape over the top of them (it peels off afterwards leaving the original patch undisturbed). The heat drying treatment at Zonal does not do a tape patch any good, but if you stick to tape use the *Quiksplice* cutaway patches (*T816M*) or the *Ferrania* splicer which trims patches from $\frac{1}{2}$in. tape rolls and leaves the stripe area free.

Do not use the standard *Sellotape* supplied with this model. It yellows and dries out, becoming brittle with age. Buy polyester tape. Sellotape have discontinued their excellent polyester splicing tape, but you can buy 36-yard rolls for 6s. from *Photographic Electrical* † as used by professionals.

If you send copies of films, which have been contact duplicated, the stripe will be applied to the emulsion side instead of to the base. A different lacquer is used, but recording characteristics remain the same. A special lacquer is also required for polyester film, but it is available. Zonal can therefore stripe on to the Japanese Single 8 in the future if necessary, and they have already received the applicator required for striping on to Super 8.

In the past two years the overall volume of 8mm. striping business (from amateurs, and from professionals for 'suitcase cinema' 8mm. sound projectors) has doubled.

A distressing situation recently has been the frequent request for a salvage treatment for owner-striped film. I imagined that the problem would be wavy application of the laminate stripe on one of the do-it-yourself machines, but I learnt at Zonal that the problem is cement application. Sometimes it is too little and the stripe peels off in places; sometimes it is too much and the film buckles as a result. Either way, there is nothing Zonal or anyone else can do about it, except commiserate.

The answer is clear enough. If you stripe your own film, practise hard on waste to check your expertise before subjecting precious irreplaceable film to the hazards of home-striping.

In France, Ferrania 8mm. film is available pre-striped with a balance stripe (not normally provided for 8mm.). The claimed response, incidentally, at 16f.p.s., is 60c/s—4 Kc/s ±1 dB; sensitivity 50 dB; total harmonic distortion 1.8%. In time it will probably appear over here too.

Pre-striped film is really meant for single system sound cameras where the sound is recorded as the picture is exposed, in the camera. The *Fairchild* sound camera is the only one that could use this Ferrania film that way, and this camera is not available over here. But film that is pre-striped does not have to be sent away after it comes back from processing. The only trouble is that the stripe is cut during editing.

Like most people, I have my stripe applied after editing; but I have just made a series of tape and cement joins in a length of striped film to judge the effect. The break in the stripe at a cement join tends to widen with wear and gives a distinct drop-out on playback. The butt-join of a tape splice on the other hand is more protected (though it may stretch open in time) and the break in my experiment was virtually inaudible. Maybe buying pre-striped film and editing it with polyester patches will not be such a bad idea after all—one day.

* *Zonal Film Facilities Limited, Zonal House, Heron Trading Estate, Westfields Road, London, W.3.*

† *Photographic Electrical Co. Limited, 71 Dean Street, London, W.1.*

SUCCESSFUL HOME RECORDING

MICROPHONE TECHNIQUE AND A STEREO MIXER

BY JOHN LAW

THE spread of the guitar, pop singer and group cult during the past few years has given many young people the opportunity to develop their latent musical talent. One result of this is that nearly every locality has its quota of amateur musicians in the form of folk singer with guitar, guitar group, or jazz ensemble. By no means all are good in the professional sense, but they enjoy playing and, perhaps more important, they give enjoyment to many other people at parties, dances and other social functions. At small family parties held in the home, however, the volume of sound generated by a group can be overpowering. One possible alternative is a tape recording where the volume is under control.

A recording of family talent, be it 'junior' reciting his first party piece, or members of the family playing solo or in concert, is a never failing source of entertainment. Whilst the production of a recording of professional quality demands studio equipment and facilities, a surprisingly good record can be obtained using a domestic tape recorder under controlled conditions. Such recordings can be made in a reasonably sized room of, say, 18 x 9ft. dimensions. The higher the ceiling the better.

Generally speaking, the more expensive the recorder the more likely it is to produce good results. The microphone is the weakest link in many domestic audio chains, and a better model will considerably improve the quality of the recordings. Microphones are available in three main types—crystal (the cheapest), ribbon and moving-coil. Ribbon microphones have the advantage of being directional, and therefore more versatile, and are not too expensive. The *Reslo* range of ribbon microphones cost around £11 each. Moving-coil microphones can give excellent quality and are used by many singers. The *Grampian DP/4*, for example, is very good value for just over £8. Many moving-coil microphones are designed to be held in the hand for intimate work as well as for stand mounting.

It may be possible to borrow good quality microphones from a local group, complete with adjustable stands. Whilst one microphone can give excellent results, there are advantages in employing two or more, especially for group recordings. A simple domestic recorder will only accommodate one microphone ; a stereo machine two. The use of a mixer enables a number of microphones to be fed into any recorder. Separate control of each is made possible, allowing emphasis of any particular instrument or artist. Comprehensive mixing units are expensive, but an easily constructed and inexpensive mixer will now be described. It was designed to supply the need for a good quality stereo mixer of reasonable dimensions and conveniently placed controls for group recordings. It will take up to four microphones.

The mixer is of simple design and can be constructed in a few hours. Physical layout is left to the constructor and will depend on how permanent the unit is intended to be, whether a lash-up for a few recordings or a permanent piece of workshop equipment. Tag boards or *Veroboard* form a convenient base for mounting the components. Design of the cabinet will be a matter of personal preference and may vary between a simple wooden box and a professional instrument case. A point worth noting is that the control knobs should be at least an inch in diameter and spaced some nine to ten inches apart for comfortable control during a recording. Dual concentric knobs are very suitable.

The circuit of the mixer is shown in **fig. 1.** It will be seen that two transistors are used in each channel in a well tried circuit. Great amplification is not required. In the original model standard jack plugs and sockets were used, since space was not limited and these seldom give trouble. There is, however, no reason why miniature jacks or co-ax plugs and sockets should not be used, or the Continental DIN plugs and sockets.

Each channel is self-contained with its own battery. A pilot lamp may be advisable to show when the unit is switched on. This could be a 3.5V 0.1A bulb with its own battery and switch. The mixer current is only a milliamp or so and *PP6* batteries are adequate. For the pilot lamp, a 4.5V lamp battery would suffice.

The impedance of a microphone must be considered when used with tape recorders. Crystal types of high impedance are normally supplied with domestic machines. Ribbon and moving-coil microphones are of low impedance, but some are supplied with a matching transformer to raise the impedance. This makes them suitable for use with mixers or recorders having a high input impedance. The input of the mixer outlined above is high, but the additional amplification which it provides in front of the recorder offsets, to some extent, the loss resulting from the mismatch of a low impedance microphone. If, however, a matching transformer is available it should be used.

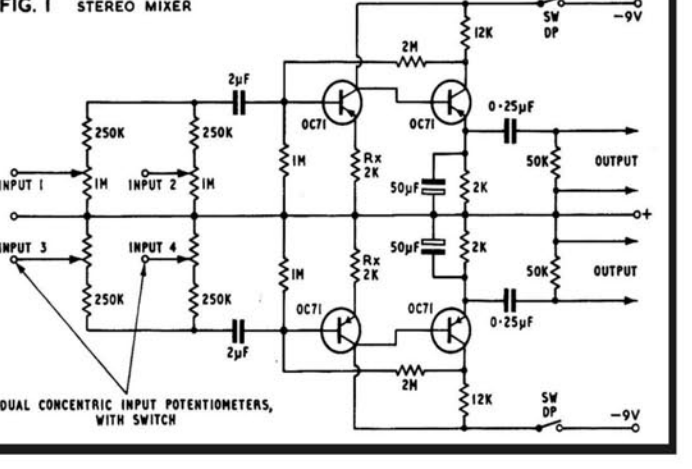
An alternative to a transformer is a transistorised matching stage. **Fig. 2** shows the circuit. A transistor in the earthed-emitter mode has a low input impedance and a relatively high output impedance. In this respect it resembles the matching transformer. The microphone is fed between base and emitter and the output is taken between collector and emitter. Very few components are used and one or more of these stages could be added to the mixer as required.

Room acoustics can make or mar a recording. A great deal of money is spent on professional studios to obtain the best reverberation period. This condition is determined by the amount of padding or absorbent material in the studio. For home recordings, assuming a spare room can be used, curtains, carpets, couches and chairs will be the padding. Remember to remove the clock ! Increasing or decreasing the amount of this damping and moving the furniture around will alter the reverberation characteristics. There is obviously much scope for experimenting to obtain a suitable degree of reverberation. Too little padding will give the recording a hollow sound ; too much can absorb the higher musical notes and so destroy the brilliance of the recording.

Human bodies are excellent sound absorbers and the more players there are in the room the greater the damping. Thus it might be found that the couch and chairs could be removed for a group recording but

(*continued on page* 111)

FIG. 1 STEREO MIXER



WHO SAID BEAUTY AND BRAINS DON'T GO TOGETHER?

This great new tape recorder is best in its price range for performance and looks!

Philips 'High Performance' Tape Recorder with Furniture Look Model EL3556 62 gns.

Whoever said beauty and brains don't go together was wrong! For Philips brilliant new High Performance tape recorder is more than a leader in its price range for performance, reliability and technical excellence. It also has Philips breakaway Furniture Look—it's a handsome, contemporary piece of furniture that's *designed to look right in your home.* Judge for yourself. Its technical features include four tracks, four speeds, separate treble and bass controls, powerful four-watt output through the 7″ x 5″ loudspeaker, a frequency response of 60–18,000 c/s at 7½ips, a signal to noise ratio that's better than 47dB and Duoplay, Multiplay and Stereo playback facilities. In styling, too, it's way ahead. Rich teak veneer combines with dark grey polystyrene to form the sleek cabinet. All controls are sensibly grouped, clearly marked for easy operation. Supplied complete with moving coil microphone, L.P. tape, empty spool, and direct recording/playback lead.

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Rich teak veneer cabinet. Automatic recording control regulates recording level — manual control provided. Four tracks, two speeds. Mixing, monitoring and parallel track replay. Supplied with moving coil microphone, LP tape, empty spool and direct recording/playback lead.

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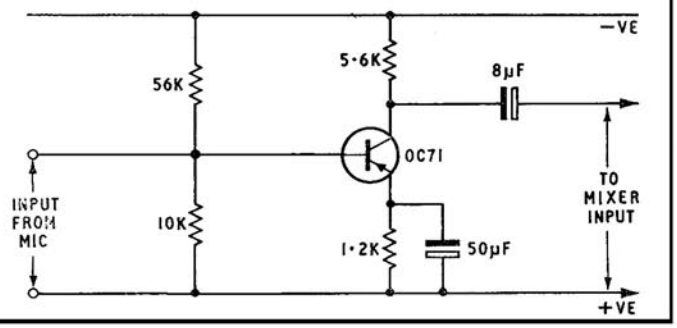
are necessary for taping a solo singer. Recording studios make use of various materials mounted in vertical panels. These are used to break up sound paths, to reflect or absorb middle and higher frequencies. There are many professional types and sizes, but an old folding draught screen can be modified for amateur use. One side should be covered with hardboard, shiny side out, the other with carpet felt or other absorbent material. Placing the screen with the hard side cut between a singer and accompanying group will soften the music and emphasise the voice. Where difficult reflections are heard, one or more screens

FIG. 2 LOW—NOISE MATCHING STAGE (ALTERNATIVE TO MATCHING TRANSFORMER)



can be used to break up the sound paths. Again there is scope for experiment.

For a simple recording, consider a girl folk-singer with guitar. The singer will normally be seated with the guitar on her knee. A position about one third the length of the room and about two feet from the wall as in **fig. 3** (left) would be a good starting point. Apart from the acoustic problem which positioning will solve, there is the question of microphone balance between guitar and voice. Raising the microphone level above the guitar strings towards the singer's mouth will clearly bring out the voice in relation to the music, but it is worth spending some time on this in order to obtain the pleasantest combination. Normally the microphone would be about 18in. from the singer's mouth, with height adjusted as needed for a standing singer (right, **fig. 3**).

To record a singing group—a mixed quartet for example—a position close to one corner will often give good results if the voices are directed towards the far corner. The singers should be in a crescent formation, with the microphone front and at mouth level. The girls should be in the centre. Should the bass singer's voice seem too powerful on the trial recording it will help if he turns slightly away from the microphone or stands a few inches behind the crescent. The use of a screen behind the singers, with the soft side towards them, will give a mellow quality to the recording.

A violin solo is best recorded with a microphone suspended above the player some two feet to the right and in front of the instrument. A hard screen behind will help. Moving the violin while playing must be avoided as this might give unwanted changes of level and timbre through the microphone.

A piano is generally regarded as a difficult instrument to record because of the wide range of frequencies covered, the relatively large area of the sounding board, and the power output. To record an upright piano, place it a few inches from a wall. Open the top an inch or so. Start with the microphone level with the top and some four feet to the right as in **fig. 4.** With a ribbon mike make use of the directional properties to obtain the best balance between treble and bass.

Recording a singer with piano accompaniment is also difficult, but rewarding when successful. Try the above set-up and place the singer to the right of the piano microphone with her own intimate microphone. This can be done with either a mixer or a stereo recorder. The latter will give the piano on one track and the voice on another. The two can then be combined in the best ratio on to a second recorder. (A more natural sounding balance and presentation of the surrounding acoustics may be achieved in stereo using a single 'crossed pair' microphone.) Should the singer be using a ribbon directional microphone it must be fixed in a stand, otherwise the movements of the singer will cause variations in the piano level.

For group recording, a four-track stereo machine is most suitable. Using the mixer and four microphones, very close balance can be obtained. Two microphones can be fed on to one track and two to the other. The final result can be kept on two channels or fed eventually on to one track to give a conventional mono recording. The advantage of this type of recording is that it allows scope after the recording session is over, for balancing the tracks independently to obtain the best sound.

Fig. 5 shows a suggested layout for recording a guitar group. One microphone is placed on either side of the players, one close to the drums and one out in front for the soloist. With the mixer, separate control of the sound level from each microphone can be obtained, although there will be some interplay through each. Endeavour to persuade the group to use acoustic guitars rather than electric ones through amplifiers ; many of the amplifiers are not capable of good quality output. Alternatively, the guitar output may be passed via a separate pre-amplifier to the recorder, employing the guitar amplifier as a monitor at low level. Keep the microphones down of about 4ft. except for the solo microphone, which should be level with the singer's mouth unless a hand microphone is being used. Again, where a hand model is used the singer must stand in one position. Should the group seem too loud for the singer's voice, a screen can be used between singer and instrumentalists. The drum volume can be reduced if necessary by covering the skin with a soft cloth.

Because of the high power output of a jazz group, a really large room

(*continued on page* 127)

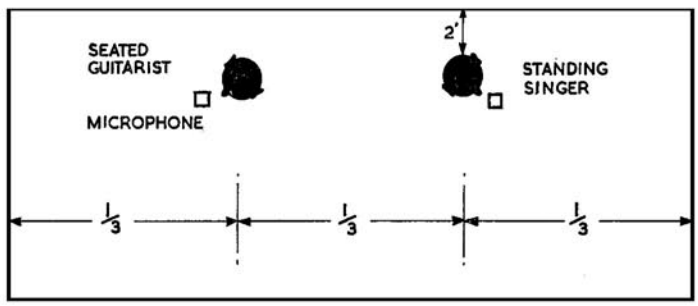


Fig. 3: Folk singer shown self-accompanied on left. With separate accompaniment, twin microphones are employed.

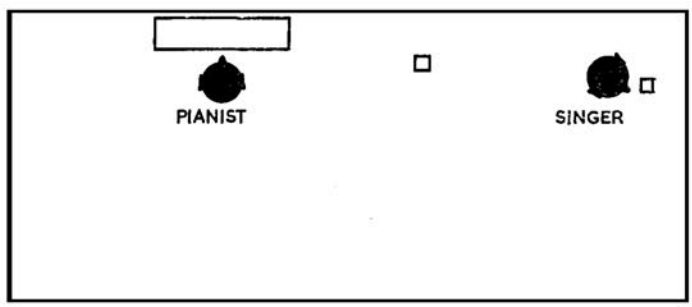


Fig. 4: Singer with piano accompaniment.

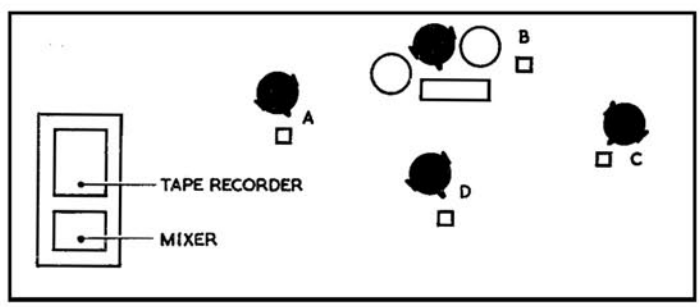


Fig. 5: Arrangement for group recording. Lead guitarist shown at **A**, percussion to rear at **B**, with accompanying guitarist at **C**. Solo singer occupies position **D**.

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Specifications

Power requirement	100, 110, 117, 125, 220 or 240 V, 40 watts, 50/60 cps.
Tape speed	Instantaneous selection, 7½ and 3¾ ips, (19 and 9.5 cm/s.)
Frequency response	30-18,000 cps at 7½ ips, ±3 db 50-15,000 cps at 7½ ips 30-13,000 cps at 3¾ ips
Signal-to-noise ratio	Better than 50 db
Flutter and wow	Less than 0.19% at 19 cm/s Less than 0.25% at 9.5 cm/s
Harmonic distortion	1% at 0 db line output
Erase head	In-line (stacked) quarter track, EF17-2902H
Record/Playback head	In-line (stacked) quarter track, PP30-4202
Bias frequency	Approx. 55Kc
Level indication	Two VU meters (calibrated to 0 VU at 12 db below saturation of tape)
Input	Low impedance microphone inputs – Transistorised (will accommodate any Microphone from 250 ohm-1 K ohm impedance) Sensitivity – 72 db (0.2 mv) High impedance auxiliary inputs Sensitivity – 12 db (0.2 v)
Output	Low impedance line outputs Auxiliary Record/Playback connector
Transistors	2SD64 (x6), 2SB382 (x2), 2SB383 (x2)
Weight	Approx. 16.9 lbs.
Dimensions	14.2 (W) x 6.3 (H) x 11.4 in (D) (360 x 158 x 287 mm)
Accessories	Connecting leads Head cleaning ribbon 60 c/s pinch wheel capstan

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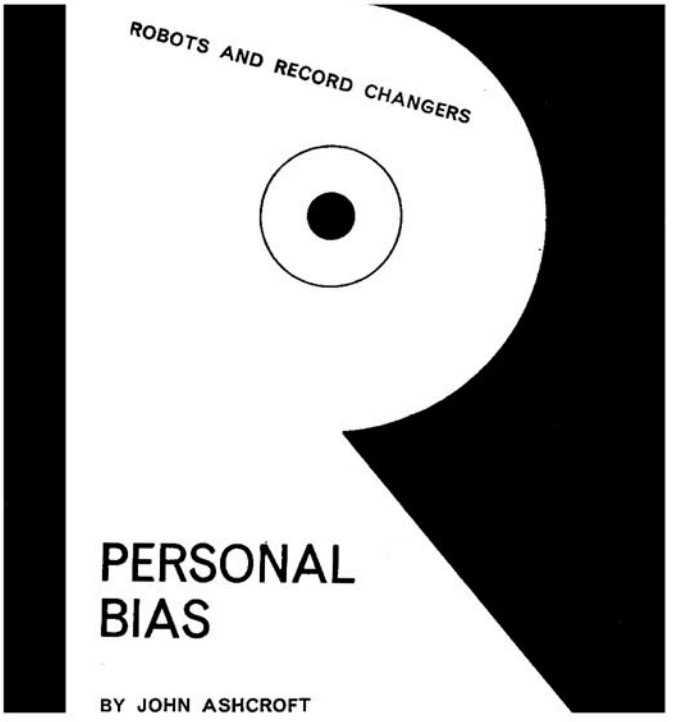


IT began, perhaps, with record-changers. Some early models casually dropped 78 r.p.m. discs into a grinding slithering black heap, or blithely trundled them into a bin beside the turntable. Their descendants are more refained, of course, and I've seen one that held an audience's fascinated attention for thirty minutes without even being connected to an amplifier ; but I retain a deep-rooted and probably incurable mistrust of all such contraptions.

Ignoring minor problems of rumble, pickup weight, stylus angles, disc damage and similar irrelevancies, I'm scared most by unpredictability. I've seen 'foolproof' record-changers do quite remarkable things . . . usually with my discs, in the days when I innocently took treasured LPs anywhere without first checking on the equipment. I'm cautious now ; but in the middle fifties (the century's, not mine) I let several devices have a go at my discs.

And some really did have a go. Wilfred Pickles would have been reet proud of 'em, and Barney would have disbursed the loot without being asked. They refused to play certain discs at all ; or dropped six LPs at once and lowered the stylus on to the heap while the turntable was still jogging from the shock, with excruciating results ; 45 r.p.m. discs frequently failed to revolve ; occasionally the stylus descended with a shattering *gggrrrooonnnkkk* in the opening chorus, or missed a 10in. LP entirely and bounced along playing the Rubber Turntable Mat Concerto, which from my viewpoint was preferable, although perhaps I was prejudiced.

And now the robots are seeking new fields to conquer.

Consider this campaign to convince us that tape-threading is too tedious or too difficult for humans and requires a special device. This is lurching at the pace of the slowest, or indulging in gadgets for gadgetry's sake. Any normal person can hook tape into a spool-slot —or use the method which I and most of my taping acquaintances prefer. That is, press the leader to the hub-face, take two quick turns of the spool, and—lo and behold !—it grips by friction alone, and terminates that progressive chewing up of leader-tape until the stuff resembles frayed binder-twine.

The trend towards automatic loading and cassettes is ominous : I'm sure there's a conspiracy to remove tape from human hands. Mind you, having seen some allegedly human hands at grips with LP tape, sometimes it is a good idea. Nevertheless, I have grave doubts.

But it is automatic gain control that terrifies me. I can speak with considerable confidence and impartiality on this topic, never having used a machine incorporating that facility : my prejudices are utterly uninfluenced by facts—I'm open minded. And I'm worried.

Granted, AGC is ideal for recording discussions, the recorder adapting itself to drastic volume fluctuations where everyone argues or laughs at once. What scares me is the knowledge that the system makes nonsense of musical dynamic range, the prospect of manual over-ride being omitted, and the fear that the Great Brainwashed Public might actually welcome this. After all, it will save people from thinking and making decisions, and who cares about dynamic range ?

Already, much pop-music is apparently ironed out into a uniform yammering blather ; with the range contained in a symphony, drastic levelling is often essential even on the finest recording or transmitting equipment—and, while engineers strive to overcome the problem, mass opinion (or lack of it) might drag us all downwards. And those robots are subtly helping the trend.

One day we will slump in mobile chairs, folding our atrophied limbs, blinking our listless eyes at ubiquitous mechanisms that do everything for us. Then there'll be a powercut. And, having studied great literature in my schooldays, I remember with unpleasant clarity what happened to the Mekon, when Dan Dare shot the flying throne from under his little green backside

Bring back the Luddites—stop the robots while there's time ! But don't smash that gadget in the fridge, or my beer will get warm. Wait a minute now . . . automation has its uses. Let's keep it doing the dull, routine yet essential jobs, and prise its metal claws from the necks of our hobbies. Then we will have the best of both worlds . . . cool beer, *and* the pleasure of tape recording.

Speaking of gadgets reminds me . . . Ebenezer and I were discussing domestic videotape. He'd already adapted his £20 machine to record TV with satisfying fidelity, using four tracks simultaneously—Track I for the sound, Track II for the light, Track III for the shade, and Track IV to collect all the distortion filtered from the other three channels which was then diverted and transmitted, vastly amplified, on the wavelength of a pirate radio ship to which the hulk next door had his receiver permanently tuned.

Then Ebenezer perfected an instant off-the-tape replay facility that put the pictures back on to the screen with the originals but displaced two inches to the left, and set up a working model in his shop window to amuse passers-by. (Tape is his hobby ; by trade he is an optician.)

As we sipped Drambuie bought from the profits of a baffling but welcome boom in spectacle sales, I mentioned the problem of editing out the commercials.

"Aha !" cried Ebenezer. "Don't tape the commercials, then !"

"Dodgy," I protested, "watching the screen and locking down the pause control every quarter hour. Sometimes puts a blip and a flicker on the recording, too."

"Don't worry, John," he said. "I'm having an inspiration."

From habit, I warned his family, who moved up to a caravan in the Pennines ; they usually do this, during his inspirations.

For three months Ebenezer did research into vocal inflexions, incorporating his findings into a mass of apparatus. Vocal insincerity, he found, was always detectable as a subtle overtone in the 38 Kc/s range. His device detected it, using a tape speed of only sixteen feet a second ; at the first split-second of such insincerity, or of overloud music, his videotape recorder went on pause control, backtracked neatly to the last desired sound, and continued without even a pop at the resumption of the programme.

He soon found a customer, but he made a mistake—to ensure satisfaction, he tuned the equipment too sensitively before selling it. Next day the purchaser was back, raving, with the equipment and several three-foot spools in a wheelbarrow. "I've got problems," he snarled. "Then I've just the thing here," said Ebenezer, with his most placating smile. "New line from Japan. Fully transistorised contact lenses, with . . ."

"It's not my eyesight !" howled the customer. "It's this thrice-accursed de-commercialiser; it cuts nearly everything off every channel ! During amateur talent shows it rejects the compere's introductions ; it whips half the music from any American crime series ; during give-away quiz shows it accepts the nervous comments of the twits who participate but lops out whatever the compere says to them ; unless the acting's brilliant, every play gets condensed into three lines of dialogue ; it cuts the applause from *every* American comedy programme ; it refuses to record *any* party political broadcast ; it clips off . . ." "Let's simplify matters," said Ebenezer patiently. "What *will* it record ?"

"Religious broadcasts," said the customer ; "and it has its doubts about most of them too. Oh, and the weather forecast—but only if the announcer looks happy when he predicts a dirty big deluge or blizzard in my district. *This* for your invention !"

So, if any reader would like a unique videotape machine, in wonderful condition except for the Ebenezer's-head-shaped hole in the screen . . .

TAPE RECORDER SERVICE NUMBER FIFTY-TWO

VERDIK S.1

BY H. W. HELLYER

"DON'T forget you are writing for the owner-driver, not for the professional mechanic." So went the Editor's admonition, after last month's contribution.

Suitably chastened, but secretly glad to be able to use a more personal approach, I submit the following notes on a machine which very many owners have driven for well over five years ; which makes it something of a vintage model in tape recording circles. This column is not concerned to sponsor old crocks, but despite the many glistening offerings in the shops, many of the old favourites are still with us, and their rugged construction has ensured that they still work. Thus, they circulate constantly on the second-hand market and we are asked for information about them : information which is simply not available. In many cases, it has never been published. Hence the occasional excursion by your scribe into the musty sheaves of workshop notes that fall behind the drawers of the filing cabinet.

As can be seen from the circuit diagram, the principal virtue of this machine is its use of separate Record and Playback amplifiers. The modern trend in cheaper machines toward combination circuits, with the output valve doubling as oscillator, and switched equalisation circuits, and using a single head for both record and replay, is something to be deprecated. When the practice is met also on machines that are by no means in the 'Utility' bracket, we think the British talent for compromise has been rather overdone. The Verdik made no such concessions. It was a two-track, two-speed machine ($7\frac{1}{2}$ and $3\frac{3}{4}$ i/s), with a no-nonsense three-motor deck, separate record, replay and erase heads, a very simple ram slide arrangement for pinch-wheel and pressure-pad engagement, a sprung tape tension arm and solenoid-operated servo-type brakes. Perhaps not the quietest of machines, not by any means the least weighty, but a solid and dependable model.

The amplifier and deck were constructed as a single unit, with the power pack mounted in the cabinet separately, and connected by a cable harness. Earlier models had direct connections and some care was needed when dismantling to avoid straining the cable, but the makers later fitted a 12-pin plug and socket. (The socket, would-be constructors should note, is on the power unit end. This should be general practice, and can save a few burnt fingers.)

Dismantling the deck and amplifier involved first taking off the spools to obtain access to fixing screws. There are three of these countersunk screws, one under each spool and one at the centre of the front. This releases the deck cover, once the control knobs are removed and the front head cover also taken off—its 4BA hexagonal bolts go through the dress cover to the deck-plate. The deck is held by four PK screws to the cabinet mounting, and it can be lifted, with a slight backward movement and tilt, to clear obstructions, then rested on the cabinet for immediate servicing.

The power unit and loudspeaker are left in the cabinet, and can be removed by releasing 4BA nuts and washers, The amplifier is secured by 4BA screws to the deck, via mounting pillars, but its separation requires disconnection of several leads. The heater wires, the loudspeaker feedback wire, the blue and white leads from the on/off switch and the output transformer cables all have to be temporarily disconnected.

It will be necessary to make a diagram of the transformer connections, to prevent phase reversal of the feedback loop when re-connecting, and it is advisable also to make a drawing of the three-way tag panel with the HT leads on it, and the head connections, which can be mixed up quite easily.

This business of making 'envelope-flap' diagrams of transformer tag panels, etc., has caused a little levity in the editorial office ; but, speaking as a practising engineer who may have to tackle twenty other jobs between the time the wires are removed and the new part fitted, or the equipment re-assembled, let me assure you that this is scribbling time well spent. I wonder if Mr. Ashcroft will have a few personally biased remarks to make about the crazy ways of service engineers?

Continuing with the 'hardware', let us take a look at the brake solenoid adjustment. As can be seen from the circuit, the solenoid is powered, in the record, replay, and fast-wind positions by HT from the main line, via a 2.7K resistor. This is a 7W component, and it is essential that it is mounted in a position where air circulation can keep its temperature down as much as possible. It is passing current all the time the machine is in operation, and can grow quite hot. When replacing it, always use a good-quality wirewound component. (N.B. The solenoid releases to apply the brakes, not vice-versa, which means the spools are locked automatically when the power is off—a small point, but a useful one.)

The solenoid throw is adjusted by two 4BA self-locking units on a rod, and the plunger should be adjusted in the off position to sit just within the solenoid tube. Adjust first with the rear self-locking unit by holding this and turning the plunger gently. There should be a clearance of $\frac{1}{16}$in. between the front self-locking unit and the brake arm under these conditions. The brakes themselves can be given individual adjustment by two locked 6BA screws which go through the main panel supports at the rear of the deck. If the spring anchor of each brake is set in line with the brake band, and the brake bands are clean and not too smooth, a very direct and easy action should be obtained. The 6BA screws permit quite a fine adjustment to suit your own ends, i.e., precedence to the feed spool to prevent spillage, etc.

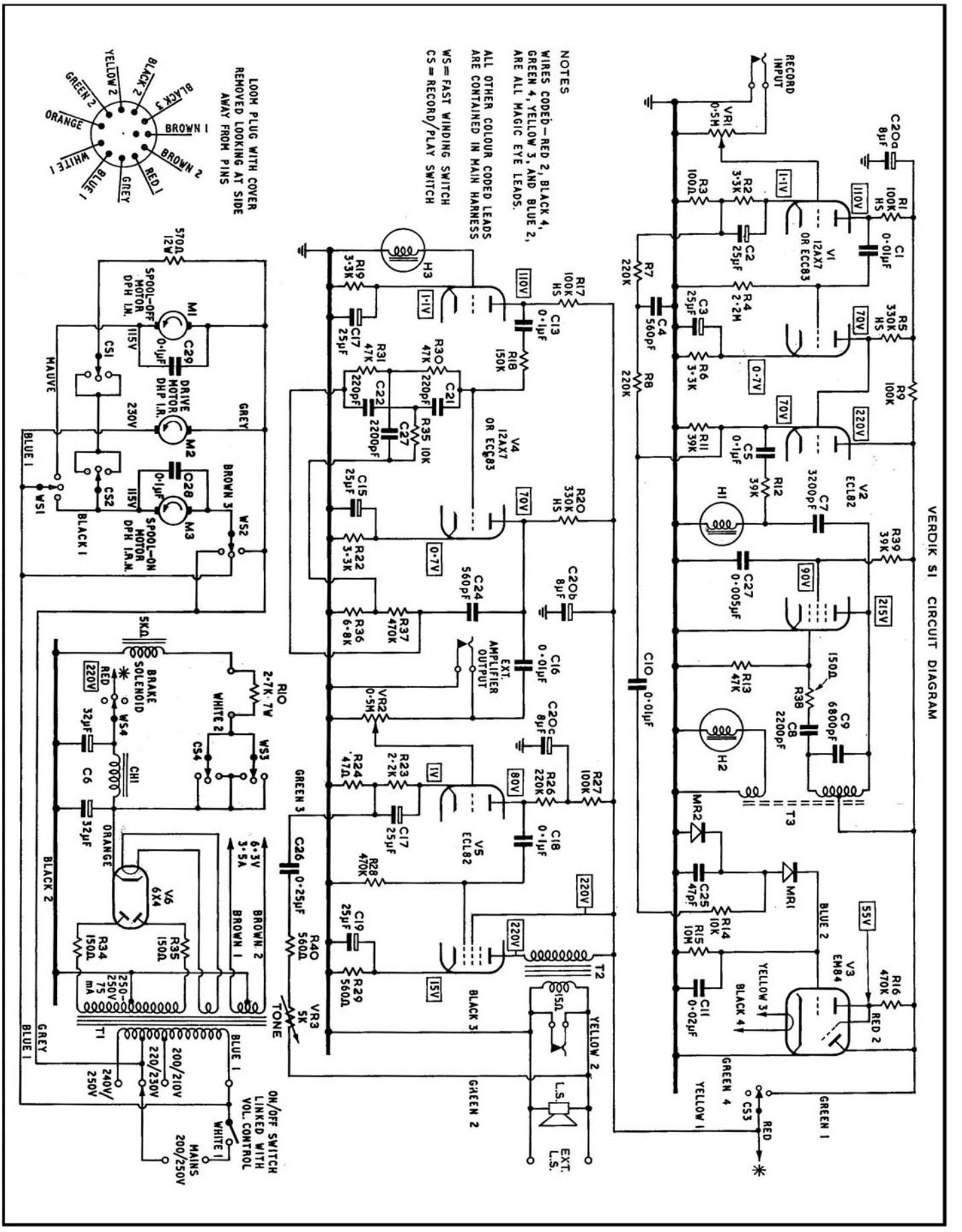
Remember that the tape tensioning arm is bearing, via a felt pad at its inner end, on the brake drum, and excessive wear here can cause some disconcerting effects. This provides back torque as necessary for record/replay action, the feed motor being energised only during fast rewind. We can see why exact brake adjustment is needed on machines of this nature to prevent tape spillage.

The other two motors (and all three, by the way are *Garrard* types), are switched in the usual manner, with the drive motor receiving full power, and the spooling motor in series with a 570-ohm, 12W resistor for reduced torque take-up action. The combination of pinch pressure, back torque and reduced forward torque is enough to maintain tape tautness. But although this version has a 220V AC line to the motor supply from the mains transformer primary, it is worth noting that later versions used 120V switching instead of the limiting resistor. A personal view is that an adjustable resistor in this position is more useful for fine setting of the take-up torque, especially when using some of the gossamer tapes that the chill winds of economy have driven us to employ.

The pinch-wheel pressure adjustment is another point that needs airing with this machine—if only because some owners seem unaware that it was provided ! It is necessary to remove the pinch-wheel to get at the lock-nutted screw in the arm. The neoprene wheel is held by a

(*continued on page* 127)

VERDIK S1 CIRCUIT



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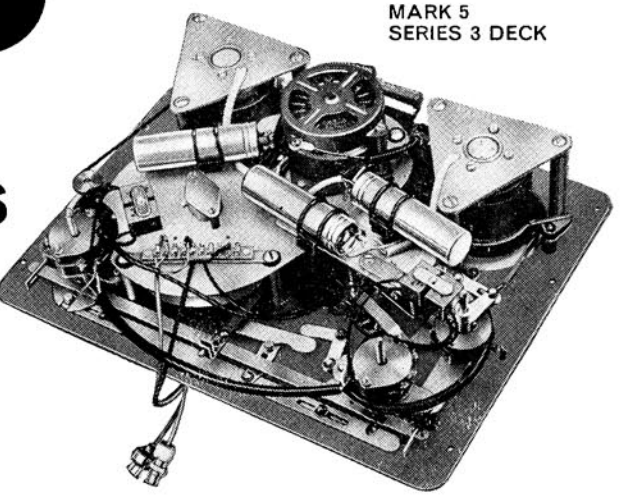
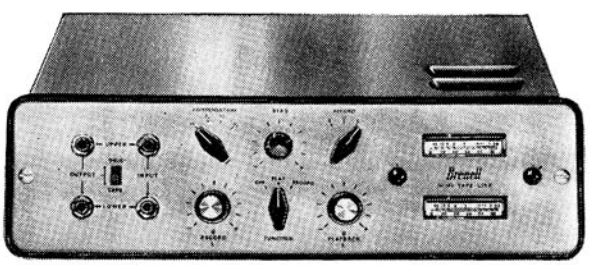


MARK 5
SERIES 3 DECK

MONO/STEREO
HI-FI TAPE LINK



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☐ STEREO TAPE RECORDERS ☐ TAPE LINK

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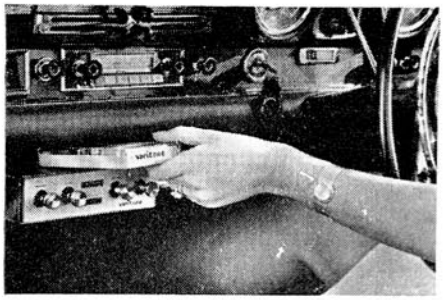


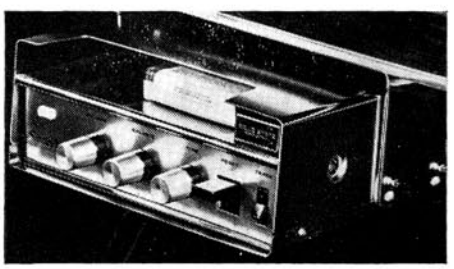
VERITONE STEREO TAPE PLAYER

ONE of two car tape players to appear in recent months, the *Veritone Automatic Stereo* is described as equally suitable for installation in a motor car, coach, caravan or yacht. The unit is slightly smaller than a car radio and is mounted beneath the dashboard. Pre-recorded endless-loop cassettes are employed these being available through direct purchase or on hire from the *Wilson Stereo Library, 463 Streatham High Road, London, S.W.16.* Manufactured in Japan, the unit operates at 3¾ i/s from a 12V supply and has 0.25% RMS wow and flutter and a frequency range of 50 c/s to 12 Kc/s. Signal-to-noise ratio is 46dB and output power to each of two 7 x 4in. 8-ohm speakers is 4W. A twin or four-speaker network is available as an accessory, nominal price of the player being £45 3s. (We are assured by Anscomb that speakers mounted to the rear provide a realistic impression of an orchestra in tow).

Distributor: Veritone Ltd., Eden Grove, Holloway, London, N.7.

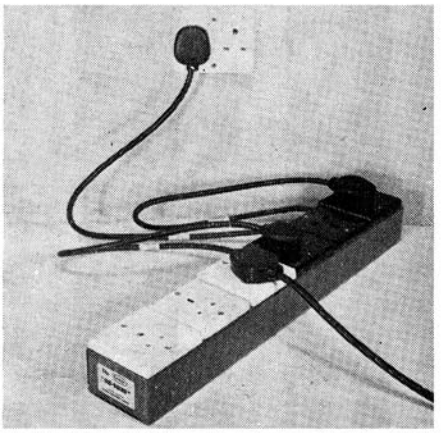
CAR STEREO TAPE PLAYER

ANOTHER tape player is also available for installation in motor vehicles. Imported from Japan, the *Craig Car Stereo* uses endless cassettes of ¼in. tape, relaying pre-recorded music through twin speakers fitted elsewhere in the vehicle. Selling for £48 6s. including speakers, the unit has a tape speed of 3¾ i/s with 0.3% RMS wow and flutter. Frequency response is 100 c/s—6 Kc/s +3dB, with 40dB signal-to-noise ratio and 35dB channel separation. Output power is 4W per channel and dimensions are 3½ x 9½ x 9½in. A wide selection of commercially-recorded ¼-track stereo tapes is available for the player.



These are supplied in two sizes, the smaller having a 30 minute playing cycle and costing £2 while the latter repeats every hour and sells for £3 9s. 6d.

Distributor : Hasmick Promotions Ltd., 13 Elvaston Place, London, S.W.7.



LEXOR POWER DISTRIBUTOR

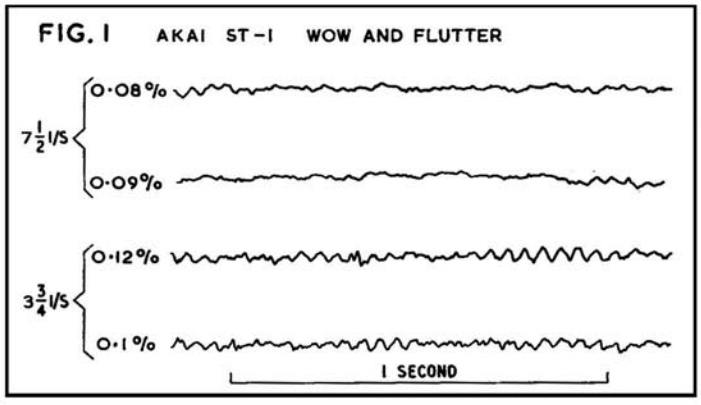
SIX mains sockets from a single power point are provided neatly and safely by the *Lexor Universal Distributor*, price £5 16s. The unit is housed in a metal cabinet and accepts two plugs of three-pin 5, 13 and 15A types. Five-amp fuse protection is incorporated.

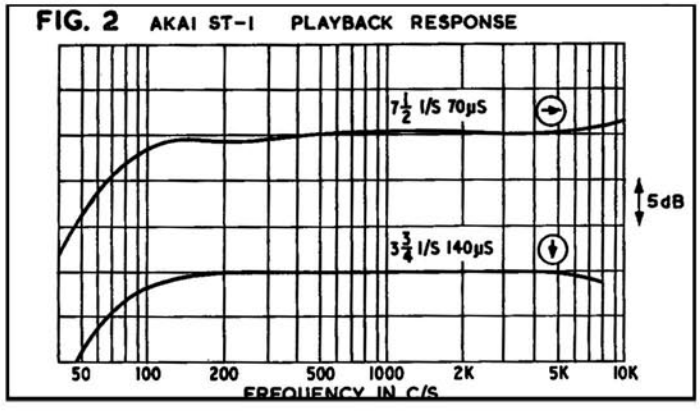
Manufacturer: Lexor Dis-boards Ltd., 25/31 Allesley Old Road, Coventry, Warwickshire.

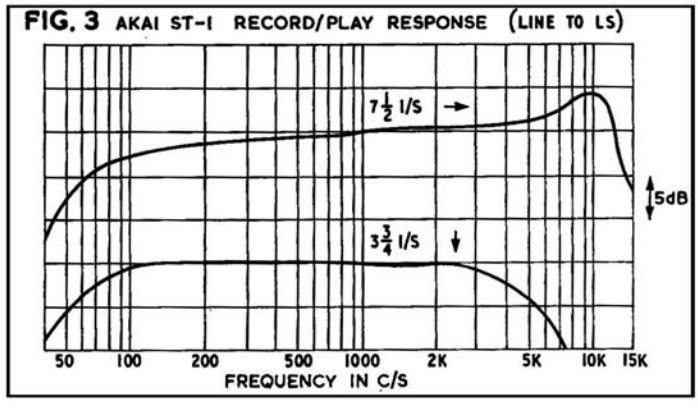
SANYO BATTERY PORTABLES

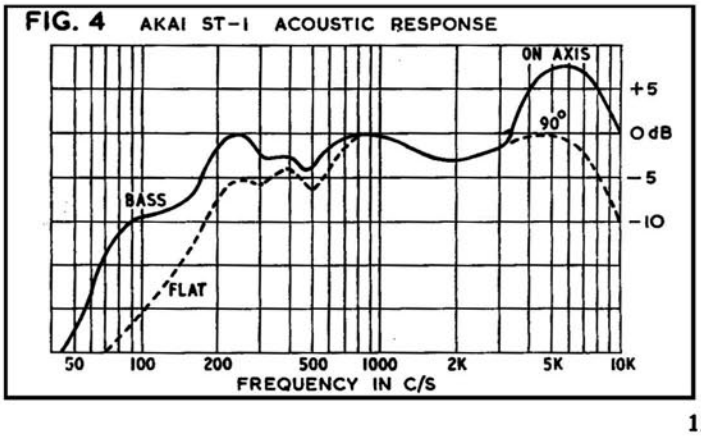
TWO new battery tape recorders—models *MR101* and *MR212*—have been introduced by *Sanyo*. Both machines have speeds of 3¾ and 1⅞ i/s, obtained with a removable capstan sleeve, and both operate on two tracks with maximum amplifier outputs of 650mW. Frequency range of the MR101 at its fastest speed is claimed to be 100 c/s to 5 Kc/s, while the 212 covers 150 c/s to 5 Kc/s. Signal-to-noise ratios are quoted as 40dB and 30dB respectively. Automatic gain control is featured on the 212, which sells for £22 1s. and mode selection is by three-way joystick. Model 101 costs £29 8s. and has press-tab mechanical controls with a motor-supply switch on the microphone. Separate sockets for microphone, gram and headphones are provided, microphone and leather shoulder-case being supplied.

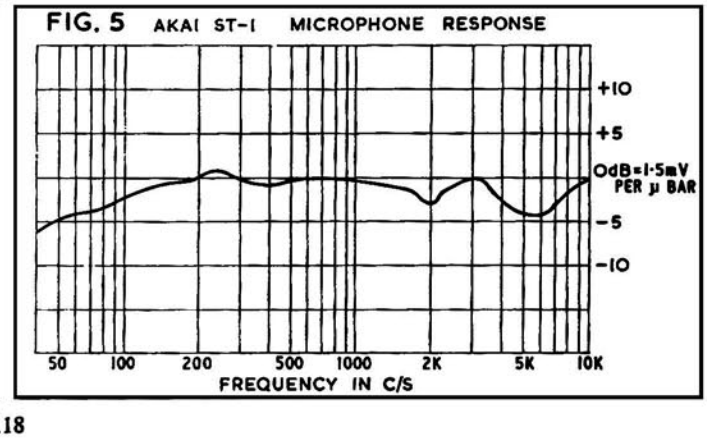
Distributor : Sanyo Sales and Service, 23 Savage Gardens, London E.C.3.











AKAI ST-1 STEREO

MANUFACTURER'S SPECIFICATION. Quarter-track transistor/valve stereo tape recorder with twin power amplifiers and speakers. **Tape Speeds:** 7½ and 3¾ i/s by removable capstan. **Frequency Response:** 40 c/s-15 Kc/s at 7½ i/s, 40 c/s-9 Kc/s at 3¾ i/s, both ±3dB. **Wow and flutter:** 0.17% and 0.28% respectively. **Spool Capacity:** 7in. **Output Power:** 3W per channel. **Fast Wind:** 2½ minutes for 1,200ft. **Weight:** 42lb. **Dimensions:** 13½ x 21 x 9in. **Price:** £98 14s. **Distributor: Pullin Photographic Ltd., 11 Aintree Road, Perivale, Greenford, Middlesex.**

THIS is a recorder which grows on you. First impressions are that the styling is crude and perhaps a little cheap. This is partly due to the relatively enormous lettering against the deck controls. My first guess was that they were at least half an inch high, but careful measurement showed them to be only a fraction above one quarter of an inch. Nevertheless, I was left with a mental picture of a myopic Japanese gentleman peering through thick lensed spectacles trying to decide which knob to turn. How he managed the small print on the meters and electronic controls I cannot imagine!

As soon as the controls are handled and the sound quality savoured the impression of cheapness quickly recedes and, as one proceeds to mono and stereo recording, track-to-track transfer, and so on, the logical layout of the controls and input/output terminations begins to break down your resistance until, eventually, you realise that it has nearly all the features of its bigger brothers at a highly competitive price.

Part of the cheapening process has been achieved by using hybrid transistor-valve circuits with *n-p-n* transistors in the preamplifier stages and triode-pentode valves in the output stages. The bias-erase oscillator is also a valve.

The deck design remains unchanged, but it is powered from a single speed four-pole hysteresis-synchroncus motor. Speed change is effected by fitting a sleeve to the capstan for the higher speed.

The relatively expensive cross-field biasing system has been replaced by an orthodox, but well designed, erase and micro-gap record/play head.

The 5 x 7in. speakers make the best possible use of the 2-3W output stages, and the upright cabinet styling has the right dimensions to load these units effectively. A switched bass rise is provided to compensate the inevitable low-note loss of the small cabinet.

The fluttergrams of **fig. 1** show that there is no wow at either speed but that there is a slight flutter at motor rotation frequency (25 c/s) at 3¾ i/s. The combined wow and flutter readings of 0.08% to 0.09% RMS at 7½ i/s and 0.1% to 0.12% at 3¾ i/s are excellent on this particular machine.

The replay time-constant is continuously variable and can be used as a tone control. The arrows on **fig. 2** show the settings of the tone controls for level responses from 70μS and 140μS test-tapes at 7½ and

3¾ i/s respectively. The low frequency response falls sharply below 100 c/s at either speed, but treble response is well maintained to the highest frequencies on the test-tapes.

System noise with the bass switch on 'flat' was 32dB below test-tape level at both speeds.

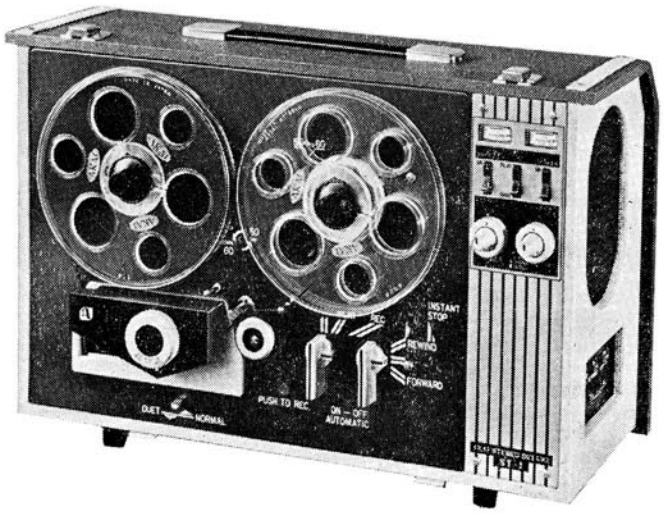
The overall record-play responses from line input to line output (loudspeaker jack) are shown in **fig. 3** with the tone controls set as in **fig. 2.** A small anti-clockwise rotation of the tone control brought the response at 7½ i/s nearly level from 100 c/s to 10 Kc/s, but the tone control was nearly full on at 3¾ i/s and the response could only be improved by 1dB at 5 Kc/s. The recorded response at 7½ i/s is therefore near the standard 70μS characteristic, but more high frequency recording pre-emphasis is required at the lower speed of 3¾ i/s.

Overload tests at 500 c/s showed that peak recording level (12dB above test-tape) could be recorded at either speed without visible waveform distortion of the reproduced signal. At this recording level the needles were well off the VU-meter scales and 0dB corresponded to a recorded level 6dB above test-tape. CRO checks with normal programme signal showed that the dynamic range of the tape was fully used if the needles were allowed to move into the grey sector of the meter scales only on loud peaks.

Erase and bias noise was at a very low level and the ratio between peak recording level and wide band noise and hum was 42dB. Weighting the background noise to correspond to the ear's response at low levels improved the ratio to nearly 50dB.

The electro-acoustic response was measured by recording 25 one-third-octave bands of filtered white noise and measuring the sound output of the speakers with a calibrated microphone. Responses were taken on the axis of the speaker and at the normal listening position in front of the cabinet, and with the bass switch on and off. The curves of **fig. 4** show that the high note peak of the speaker is well placed to hold up the 'round the corner' response. The exact high note response depends on the quality of the reflecting surfaces near the speakers and placement near the corner of a room seems to improve both high and low frequency response. The bass lift is well chosen to hold up the response to 100 c/s without causing boom due to mid-low frequency peaking.

The response of one microphone was taken by setting the sound level on each noise band to a constant reference and measuring the open-circuit response of the microphone under test with a sensitive



valve voltmeter. The response is smooth and within limits of ±3dB over the full measured range from 40 c/s to 10 Kc/s. The microphones are of the non-directional type so that stereo recording will have to be done using the spaced microphone technique which is well suited to domestic recording of small groups, or voice and backing, as the microphones can be placed near the sound-sources for intimate crisp sound pickup. The theoretically more perfect crossed directional microphones can only be used in a large room or hall with good recording acoustics.

COMMENT

I think my opening paragraph may have revealed my own opinion of this machine: I like it for its sound quality—it is one of the best completely self-contained stereo reproducers I have met. Obviously it could be improved by plugging in wide-range widely spaced speakers, but there must be many people who would like to enjoy the spacious sound and added listening pleasure that stereo can give without a room full of complicated equipment. This is for them. **A. Tutchings.**

BEYER M55 DYNAMIC MICROPHONE

MANUFACTURER'S SPECIFICATION: Medium price dynamic microphone. **Polar Pattern:** omnidirectional. **Frequency response:** 70 c/s-16 Kc/s ±3dB. **Output Level** (at 1Kc/s): **0.12mV per μBar** (—78dB ref 1V). At 80K: 2mV per μBar (—54dB ref 1V) at **200 ohms. Cable:** 6ft. terminated in 3-pin DIN plug. **Price:** £6 17s. **Distributor: Fi-Cord International, Charlwoods Road, East Grinstead, Sussex.**

THE frequency response of this microphone was measured in a white noise sound field to give the curves shown in **fig. 1.** The sound quality was smooth and clean as would be expected from such a response. The slight bass roll-off below 200 c/s was an aid to clean speech reproduction and helpful to reduce the effects of low frequency room resonances which can be very obvious on a non-directional microphone of this type.

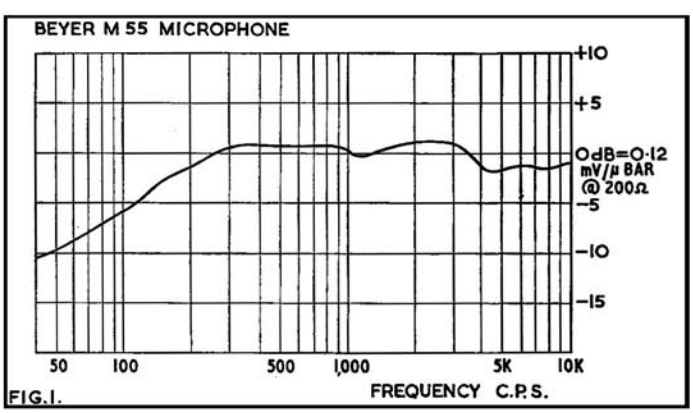


FIG. 1.

An impedance measurement confirmed the low impedance as 200 ohms and there was some evidence that some of the bass cut was due to low inductance in the internal transformer as the impedance fell slightly at low frequencies. A very small bump in the impedance curve also disclosed the diaphragm resonance at 2.5 Kc/s.

To obtain sufficient sensitivity in a microphone of this type the natural diaphragm resonance must be placed somewhere near the centre of the frequency range and sufficient acoustic resistance applied to damp the peak critically to a very broad hump. The high note response can be brought level by dimensioning the diaphragm so that pressure-doubling, due to complete reflection of high frequency sound from the face of the diaphragm, fills in the high note response. Occasionally, cavity resonances, either under or outside the diaphragm, are used to give a high note peak, but such resonances must be carefully controlled if they are not to colour the high frequency response.

The mid-low-frequency response can be lifted by coupling the acoustic compliance of the case cavity to the diaphragm through a carefully controlled acoustic resistance. Finally, the very low note response can be boosted by allowing a little low frequency sound into the microphone case at the end remote from the diaphragm so that it arrives at the rear of the diaphragm, out-of-phase with the sound pressure on the front of the diaphragm so that the velocity is roughly doubled at the frequency where the phase change is exactly 180°.

Like any other electro-acoustic device, the microphone is a subtle blend of 'tricks of the trade', each of which takes care of a different part of the sound spectrum. It is a tribute to the M55 that the final response is so good, being level within ±2dB over the range 150 c/s to above 10 Kc/s, which was the limit of my test gear.

The 2mV sensitivity on the high impedance output compares favourably with that of most crystal microphones, and if the recorder has a response to do it justice the M55 should prove a worthwhile investment. **A. Tutchings.**

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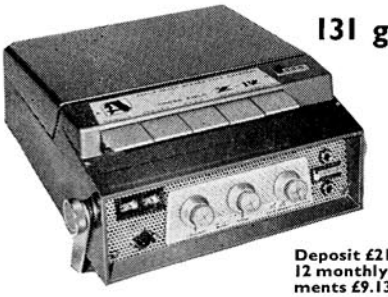

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1966 AUDIO ANNUAL

This new publication is concerned with high fidelity sound reproduction and tape recording and is produced by Britain's leading magazines in the audio field—'HI-FI NEWS' and 'TAPE RECORDER'.

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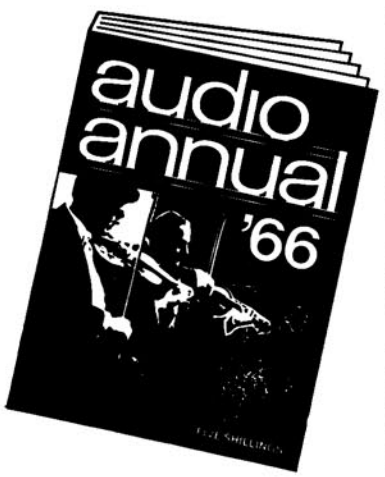

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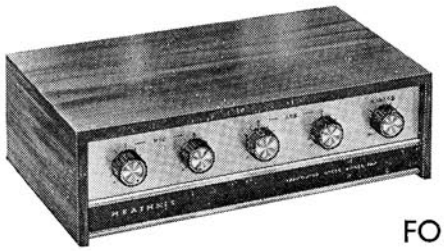


HEATHKIT TM-1 FOUR-CHANNEL MIXER

MANUFACTURER'S SPECIFICATION. Transistorised four-channel mixer. **Microphone Inputs:** Both 1.5mV at 1M, *Channel* 1 being switchable to 4.5mV at 2.5M. **High-level Inputs:** Both 180mV at 250K. **Output:** 200mV at 600-ohms. **Power Requirement:** 9V battery or eliminator. **Bass cut:** -3dB at 150 c/s (switchable). **Frequency Response:** 15c/s—30 Kc/s ±3dB. **Distortion:** 0.2% maximum. **Dimensions:** 11⅞ x 3¾ x 7⅛in. **Price** £11 16s. 6d. (kit) or £16 17s. 6d. (assembled). **Manufacturer: Daystrom Ltd., Gloucester.**

CONSTRUCTION

OVER the years, *Daystrom* have made a reputation for themselves as manufacturers of the finest electronic kits on the market. They have few competitors, none of whom have managed to equal the *Heathkit* range in terms of easy construction, reliability, after-sales service and value for money. This may seem a little overstated, but a description of the construction and operation of the *TM-1* four-channel transistorised mixer may convince unbelievers that buying and building a Heathkit is no mere money-saving gamble.

The writer has never had cause for pride in his soldering. Graduating to the art of electronic construction by way of 'hotted-up' crystal-sets and simple transistor radios, he moved on to slightly more complex oscillators and amplifiers only to meet with absolute failure. This failure had three causes: frequently over-heated transistors and resistors finally gave way, poor connections via many inches of tangled wire refused to conduct, and the habit of placing solder on joints *via* and not *with* the hot tip of a soldering iron.

Such was the situation when the writer was confronted with the *TM-1* kit. Somewhat better facilities were available for the construction task than before, however, comprising an *Antex* miniature soldering iron, long and short-nose pliers, wire-cutters and a small pair of scissors. Previously it had been a far-from-miniature (and very slow-heating) iron, plus scissors. All can be purchased for a little over £2.

The kit was unpacked carefully and spread across a bench so that each component might be checked against the parts list. Polythene bags were opened one by one and their contents—resistors in one, capacitors in another, more resistors, the five potentiometers—were all ticked against a list on the last page of the instruction manual. Nothing was missing, from chassis plates to solder—though Daystrom did supply a slight excess of nuts, bolts and washers ! A semi-flexible red plastic rod was supplied and at first sight it seemed that this had been included in error. Far from it: the rod turned out to be a "4BA/6BA nut starter" and simplified the often tricky task of supporting nuts as the chassis was assembled; a conventional spanner would have been almost useless in certain cases. With all components checked, the various bits and pieces were returned to their bags in preparation for construction the following day. The rest of that first evening was spent in reading the instruction manual from cover to cover. Two amendments to the Parts List (alterations to code numbers), which had been stapled to the manual, were made, and when the time came to begin construction the writer felt fully acquainted with the path that lay ahead.

"Refer to Pictorial 1 for the following steps:

( ) Select the front panel and lay it face down on your workspace in the position shown. Use a soft cloth on your workspace to prevent damage to the panel."

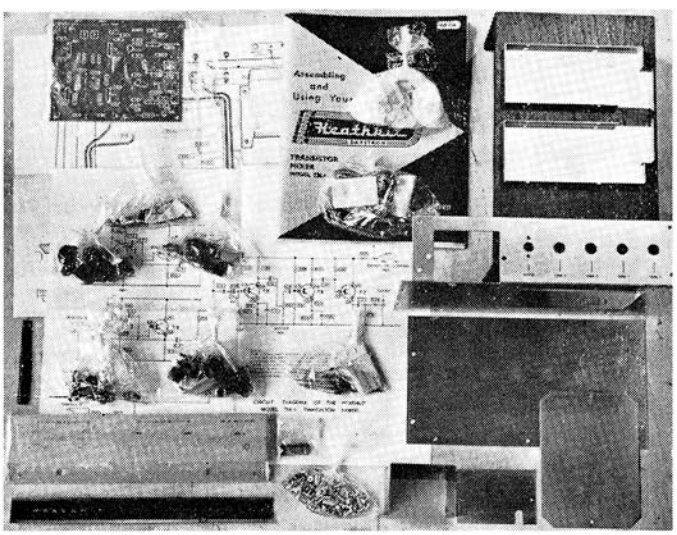
The panel is selected and positioned as instructed; a tick in the left-hand margin bracket, and on to the next step.

"( )Mount a one-way tagstrip at TB by sliding a 4BA T-bolt into the lower slot on the rear of the front panel. Position as shown and secure with a 4BA nut and lockwasher."

And so it goes on. Seventeen more such steps and the front panel sub-assembly is complete, the five potentiometers mounted and connected by a few short wires and resistors. And it was in this initial soldering that the seeds of success were sown. Those of us inclined to use five inches of connecting wire where two or three would suffice were prevented from doing so by the Heathkit foresight of taking apparently simple matters right out of the constructor's hands. No-one disobeys an instruction like "Connect a 4in. length of wire between. . ." by cutting a 5in. length of wire.

Following the instructions given at the beginning of the manual under the title *Proper Soldering Procedure*, each wire and component is connected to the potentiometer or tag mechanically, employing the invaluable pliers to bend the leads until they hold themselves in place. This mechanical pre-connection is the secret of good soldering, since it eliminates the need for three hands, and allows the soldering iron, in one hand, to be brought against the connection, remaining there for a moment until the local temperature has risen by a reasonable amount, when the solder can be applied by the opposite hand. A spot of solder flows, iron and solder-reel are removed, and the connection is made. If, for some reason (such as movement of the component before the solder solidified) the joint was unsatisfactory, another quick application of the hot iron bit will re-melt the solder and complete the connection.

With the front panel sub-assembly completed, a respite from soldering comes with the construction of the main chassis. Thanks to the aforementioned plastic nut-starter, this presented no difficulty whatsoever. Fifteen steps later, page 12 of the instruction manual is reached, on which is printed a life-size illustration of the printed circuit board that forms the heart of the mixer. Twenty-seven 'boxes', each containing the description of a component, are located around this illustration, and each refers with an arrow to the relevant part of the board. The board (which measures 4⅞ x 4in.) is shown, of course, printed-circuit-downwards, and is over-printed with a silhouette of each component, marking the various mounting positions. Resistors are given with their colour codes to eliminate a possible source of error and at three points in the list of steps the constructor is asked to check components for correcting positioning and then to solder them to the printed circuit below. Wiring and soldering printed circuits (this applies also to *Veroboard*) is incredibly simple. The subject is well covered in the Heathkit manual and really only amounts to bending component leads through a right-angle (again, with pliers), so that the two vertical leads pass straight through the relevant holes in the printed board. Turning the board up-side-down, the leads are then bent flat against the conductive coating, locking the component



temporarily in position while the waste leads are snipped off and solder is applied to the joints. It is particularly important, when soldering such short component leads as are employed with printed circuits, to avoid overheating transistors, capacitors and resistors. Transistors can so easily be destroyed by heat that pliers should *always* be clamped between iron and component to conduct the heat away. Resistors are, of the three, the most tolerant of high temperature, though once they begin to 'sweat', the iron should be removed and a heat shunt brought into action. A fair amount of such 'sweating' occurred during construction of the *TM-1*, though it says much for the component quality that none of the resistors were damaged. (*continued on page* 123)

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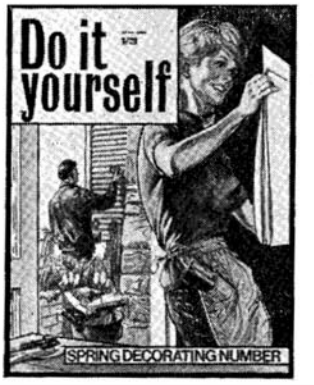

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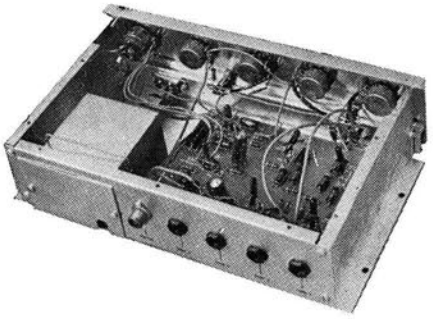
Following the 27th connection, attention is turned to the facing drawing—page 13—which details 33 more such joints. Sixty pairs of solder joints may sound like a lot of work, but were accomplished unhurriedly, and with an interval for lunch, in little more than two hours. When one considers that this really is the backbone of the construction task, two hours is not so very long.

Printed circuit wiring is completed with the connection of seven OC44 transistors, via mounting spills. Heat shunting presented no problem, since soldering the transistor leads to the spills eliminated that need for a third hand to hold the shunting pliers, which might have been required if the transistors had been mounted in the usual way.

Final steps in the TM-1 construction were the assembly of the printed circuit to the chassis—by means of four corner screws and bushes acting as 'legs', and soldering of the dozen-or-so leads which sprouted from the board to potentiometers, tags and sockets.

With the unit more-or-less completed, the constructor feels a moral responsibility to go back and check the wiring from the beginning, though there is nothing in the Heathkit manual to suggest that this should be done. For the writer, however, the temptation to see whether the mixer worked or not was much too great and it was decided to plough ahead and connect the 9V battery and commence a test. All inputs to the TM-1 are via GPO jack sockets, while the output is of the coaxial type. The four input channels are controlled by separate potentiometers, all passing through a master fader. A hinged door running the length of the facia conceals two switches, one controlling input impedance on Channel 1 and the other a Speech/Music switch, giving a specified 3dB drop at 150 c/s in the Speech position (Channels 1 and 2), to prevent bass booming prevalent with certain types of ribbon microphone. Channels 1 and 2 will accept medium impedance microphones and, in the former case, high output crystal microphones, switching being from "High Z" to "Xtal". Both feature two-transistor preamplifier stages, while Channels 3 and 4 are resistive networks catering for high level radio or gramophone sources. All four channels feed into a three-transistor stage from where they may be passed to the high-level input of a tape recorder or amplifier.



Mixer chassis with upper plate and cabinet removed. Printed circuit board is visible, with battery compartment to left.

Apart from a little trouble with a coaxial connecting plug which shorted itself, the unit worked perfectly the moment it was switched on. Two *Akai* dynamic microphones showed Channels 1 and 2, and the output stage, to be operating happily, while subsequent mixing of microphones, second tape machine and radio, gave the constructor a feeling of achievement that he could never have enjoyed had the mixer been purchased ready-built—as it can for an extra £5.

Perfection is an impossibility, however, and I strived hard from my notes in the margin of the instruction manual to find points worthy of criticism. I could find only one: the five knobs which fit on to the potentiometer spindles are extremely difficult to remove once they have been pushed home. The conventional system of retracting tight controls by threading a handkerchief round the spindle behind the knob and then pulling hard just did not work. The knob controlling Channel 1, despite the great care in aligning its pointer with the facia graduations, did not point exactly to zero when turned fully anti-clockwise. Since the potentiometer mounting nut was out of reach behind the knob, great difficulty was experienced in turning the component to its correct angle, though this was achieved in the end by applying force to the component body. If any manufacturer has yet produced a screw-on knob that does not continually work loose, might I plea for its incorporation on the TM-1 ?

My closing comment is simple: I am converted to Heathkit.

David Kirk

PERFORMANCE

AS usual with any piece of equipment sent in for review, the mixer was used in the normal way by plugging in a variety of microphones and auxiliary inputs and connecting the output to a wide-range recorder so that the subjective effect of operating the controls and switches could be judged by careful listening tests.

My first impressions were good: noise and distortion were low at all settings of the main panel controls, interaction between controls was not audible on normal programme content, and frequency response sounded adequate.

Further tests showed that neither microphone input could be completely faded out—a very faint signal was still audible with the controls fully anti-clockwise. Also, the controls were slightly cramped at the full-on setting (i.e. most of the gain variation occurred within the first few scale divisions). The master gain control was OK in this respect: control was smooth and well spread over the scale.

I next opened the flap below the main control panel to try the effect of the 'Hi.Z—Xtal' microphone input impedance switch and the 'speech-music' switch. The microphone switch dropped the gain by about two to one, but brought up noise by an estimated five or ten to one. The bass cut switch had no effect at all on the low gain channels, and only acted on the microphone channels when the gain controls were fully advanced. At lower microphone gain settings the effect of the switch was negligible.

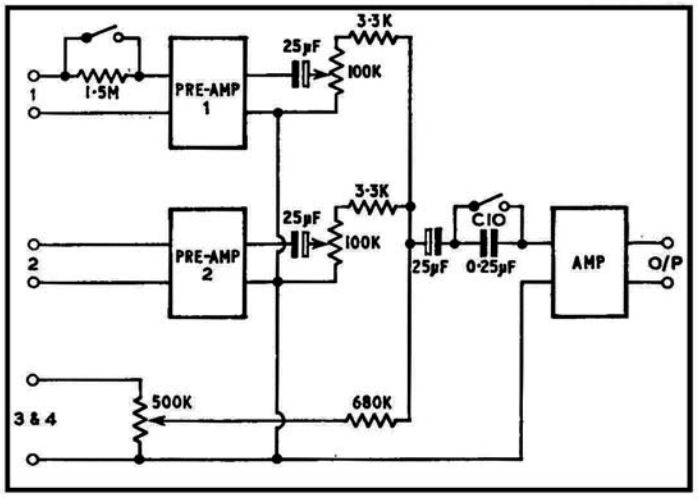
Actual measurements were next made and gave the following information:

(1) Output overload occurred at an open-circuit output of 1.5V RMS.

(2) Input overload of the microphone channels occurred at 30mV RMS, and at 60mV on No. 1 channel when the microphone impedance switch was set to 'Xtal'.

(3) Frequency response was level to 20Kc/s within 1dB on all channels and -3dB at 100c/s on the two low-gain channels.

(4) Bass response was very variable on the microphone channels being -2dB at 100c/s with the controls set to the mid position, and,



-7dB with either control fully advanced. The bass-cut switch introduced a further loss of 10dB at 100c/s with the control full on, but had practically no effect with the controls in the half way position. The bass-cut switch had no measurable effect at all on either of the low-gain channels at any setting of the controls.

(5) Noise and hum on either microphone channel, with a screened open-circuit jack-plug inserted in the input socket and all controls at maximum, was 12-15 mV at the output socket.

(6) With a screened 0.001μF capacitor plugged into channel No.1 to simulate a crystal microphone, operation of the 'Hi-Z—Xtal' switch dropped the gain by 6dB and put up the noise by 6 to 8dB, giving a total signal/noise ratio deterioration of 12 to 14dB.

(7) The attenuation law of the microphone gain controls was measured to give these figures: 1st division from maximum -10dB,

(continued on page 125)

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(8) Main gain control showed 6dB attenuation over the first three divisions and 12dB at the half-way setting. Output was zero at full-off setting.

Tests 1 and 5 show that the worst signal-to-noise ratio on a Hi-Z microphone input is 40dB (ratio of 1,500mV to 15mV or 100:1).

Test 6 shows that the microphone switch should only be used as an attenuator for very high sound levels which might overload the microphone preamplifier. The very slight improvement in bass response (3dB at 100c/s) is hardly worth-while in view of the bass response variations measured in Test 4.

The reason for the Test 4 results is very obvious from consideration of the block diagram, where the essential elements have been picked out. C10 should operate in conjunction with the relatively low input impedance of the main amplifier (approx 2K) to give the required bass cut—*but it will only do this if the source impedance is also low*—and it will be seen that this is only the case if the preamplifier gain controls are fully advanced so that the low output impedance is connected via the 3.3K resistors to the bass-cut circuit.

If both microphone channels are faded down, the source impedance from the low-gain channels is in the order of 50K (two microphone gain controls in parallel) and the change in impedance of C10 with frequency is completely swamped by the high source impedance, so that the bass-cut switch has no effect.

COMMENT

All the faults outlined above were design faults which could only be cured by circuit alteration. (I suggest microphone gain controls should be reduced from 100K to 5K.)

I give full marks to David's soldering and general construction work and to the very detailed planning of the construction manual which seems to take care of every eventuality (except basic design).

The preamplifier circuit is a slight variation of the well known high impedance 'bootstrap' circuit described by Gordon King in part 16 of his recent series ('Towards Better Taping' July 65), which gives an input impedance of about 1.5 M and an output impedance of a few hundred ohms.

The main amplifier is completely orthodox, with two fully temperature-stabilised earthed-emitter amplifiers feeding an emitter-follower to give a low output impedance to line.

My advice to constructors is to set the two switches under the flap to the left and forget about them, or, with the approval of Messrs Daystrom Ltd., replace the microphone faders with 5K pots similar to that used for the main gain control to open up the scale and reduce bass response variations. **A. Tutchings.**

MANUFACTURER'S COMMENT

We agree that, using 100 K microphone gain controls, there will be some variation of bass response and that the law of these controls will tend to be as described. We agree also that a reduction in value of these controls will improve the law and will give a more consistent bass response. However, such a change will give a reduction in overall gain of the mixer. Provided that this reduction is acceptable, then we agree that the lower value microphone gain controls would be of some advantage. To recover this gain, extra amplification would have to be introduced and this would increase the cost and complexity of an otherwise modestly priced unit.

On the subject of the bass cut switch, we realise that this is only operative on the microphone channels, but we would like to point out that this was intentional. The usefulness of this control is to minimise 'boominess' on speech which is often present when microphones (especially ribbon types) are being used in fairly close speaking conditions. The position of this switch in the circuit may lead one to expect it to be effective on all channels, but as you have pointed out, the relative impedances in the circuit make it effective only on the microphone channels.

READERS' PROBLEMS

Readers encountering trouble with their tape equipment are invited to write to the editorial office for advice, marking their envelopes "Readers' Problems —Tape". Replies will be sent by post and items of general interest may also be published in this column at a later date. This service does not, however, include requests for information about manufacturers' products when this is obviously obtainable from the makers themselves. Queries must be reasonably short and to the point, limited to one subject whenever possible. In no circumstances should such letters be confused with references to matters requiring attention from other departments at this address. We cannot undertake to answer readers' queries by telephone.

NOISY AMPLIFIER CONTROLS

Dear Sir, My *Peto-Scott* tape recorder has been functioning well for about four years but recently the volume, and to a lesser extent the tone, controls have developed an annoying crackle which is particularly noticeable on replay when the volume control has been used to vary recording gain. Could you please advise me as to the cause and elimination of this crackling?

Yours faithfully, **C.J.S., Windsor**

The crackling noise you are experiencing is probably caused by a worn carbon track in the volume control which also acts as gain control during recording. The tone control is probably affected in the same way. The latter, however, is only in circuit during replay.

If the deterioration is not too far advanced, a temporary cure may be effected by running a few drops of carbon-tetrachloride down the spindle of the control (with the machine disconnected) and rotating the spindle a few times, then following with one drop of fine oil. This allows the wiper blade to smooth out the irregularities of the carbon track. Alternatively, Thawpit might be used as a solvent, taking great care not to let any drop on plastic surfaces. Proprietary brands of switch-cleaner are rather too expensive to be purchased for one job alone, but the best cure is undoubtedly Electrolube.

You could, of course, replace the controls, the volume potentiometer being a standard 500 K Log and the tone control a 1 Meg linear with double-pole switch. It is advisable to use a good quality component for the volume control; preferably a 'moulded-track' type.

A HUMMING MOTOR

Dear Sir, I wonder if you could help me ascertain the fault that has developed on my Telefunken *M.96KB*. A high-pitched hum from the motor can be heard when switched to 7½ i/s. At 3¾ i/s the hum is a little less and at 1⅞ i/s barely audible. Some variation in speed has also been noticed.

Yours faithfully, **J.W., Edinburgh, 11.**

The high-pitched hum you note is sometimes caused by a worn bearing and the best method of alleviating it is to strip the motor, clean bearing and cup thoroughly, lightly grease the inner surface of the cup first with fine grease such as ordinary petroleum jelly, then pack with heavy grease. You may find that there is too much tension on the drive, causing this to be accentuated.

This is not really a basic motor fault, but a bearing fault, which is consequently altered when different speeds are selected, the best method of testing is to isolate the drive and check the smoothness of the spindle rotation with a varying pressure as can be imposed by a rubber band held in tension round a fixed post. It really needs workshop facilities for a thorough check and there is no simple cure.

FAULTY SWITCHING ON THE TK 830/3D

Dear Sir, Could you please help me with a fault on my *Grundig TK 830/3D* tape recorder? After I switch to replay on Track 1, the right-hand solenoid energises and remains so in both track positions. The left-hand solenoid will not energise, no matter how much I switch from track to track. Even on fast wind the right-hand solenoid is energised and consequently it will only track in one direction.

Yours faithfully, **E.B., Hull**

The switching circuit on the Grundig TK 830 is quite complicated. But when one of the relays remains closed in every mode, this indicates a short-circuit by-passing normal switching.

In the case of the right-hand clutch solenoid, all that is needed is a short-circuit to chassis on the return lead from the lead-out wire going to the switchbank, as the 25V relay line is connected permanently to the other side.

Of course, the trouble could be in the switching as well, and this will need careful tracing, a circuit diagram being imperative. Concentrate on the Track 1 bank, where the original connections are made—the short can hardly be beyond this if the clutch stays in for rewind also.

One necessary check is the discharge path and a possible fault is the short-circuiting of the 1μF capacitor across the switchbank, and in series to chassis with the 22-ohm resistor.

TAPE RECORDER SERVICE CONTINUED

circlip, and quite easily pulled off, but care must be taken with the ball-bearing on which it is mounted. A touch of grease at this point helps, but the usual strictures re avoidance of grease on friction surfaces need repeating. Especially, do not use a thin oil, or a grease which runs when hot, as the edge of the flywheel can be contaminated, and this item is driven by a neoprene belt from the main motor.

The writer has lately made a practice of selecting lubricants from the *Molyslip* range, whose products stay soft but do not get runny through the considerable heat range that can apply with a tape deck in a confined cabinet. These oils and greases are readily obtainable from garages, cycle shops and hardware stores, and the small outlay is justified by the many uses that can be found around the home.

Circuit-wise, as they say, there are one or two small points to mention. It will be noted that the record head (H1) is driven by a cathode-follower, consisting of the triode section of an ECL82. Hence the direct coupling to the grid of this triode from the anode of the preceding valve. As there is about 70V DC at this point, and the anode of the ECL82 triode is at full HT, great care must be taken not to short-circuit the cathode while testing.

Observant readers may have noted that the HMV DSR1 tape recorder is a derivation of this model. The circuit is practically identical—except that an EL84 oscillator is employed, there are a couple of small component changes, and the cathode-follower is dispensed with. The circuit changes are principally concerned with this : the Record level control is moved to the grid of V1b, the anode load reduced to 100K and the head feed taken off via a 0.1μF capacitor. The cathode resistor becomes 1.5K and the feedback loop is dispensed with, alterations to the V1a cathode and increase in decoupling electrolytics providing the necessary response curve.

One interesting alteration in this later circuit is the provision of a 5K variable resistor in place of R36 (in the given playback circuit), which then becomes a top frequency correction control. The overall tone control is then altered to a shunt circuit across the volume control. Readers who require information of these changes may apply, and we shall be pleased to advise them.

SUCCESSFUL HOME RECORDING CONTINUED

or small hall is necessary. Very careful placing of the microphones is required, and where ribbon mics are used they must be placed so that no direct sound from a brass instrument can reach them. The blast from a trumpet can blow the ribbon out of its mounting. Since the microphones have to be placed relatively far from the instruments—5ft. in the case of brass—acoustic problems can be troublesome. Nevertheless, although beginners should not attempt recording a jazz group, such work can be rewarding ; and those acoustic difficulties may be overcome by using genuine stereo techniques, where a 'coincident' microphone will make the recorded reverberation more pleasant for the listener.

Home-made tapes can be transcribed on to disc for around two pounds. A number of professional studios who advertise in the audio journals will undertake this work. Apart from recording entertainment and party pieces, there is scope at family gatherings, Christmas and New Year festivities. A good tape of a musical family get-together can mean a great deal to those who have been unable to attend because of illness or distance, and especially to those who have gone abroad and may never again share in the family parties.

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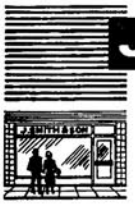

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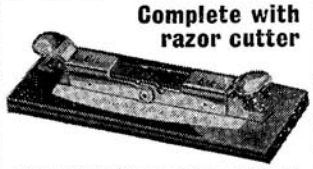
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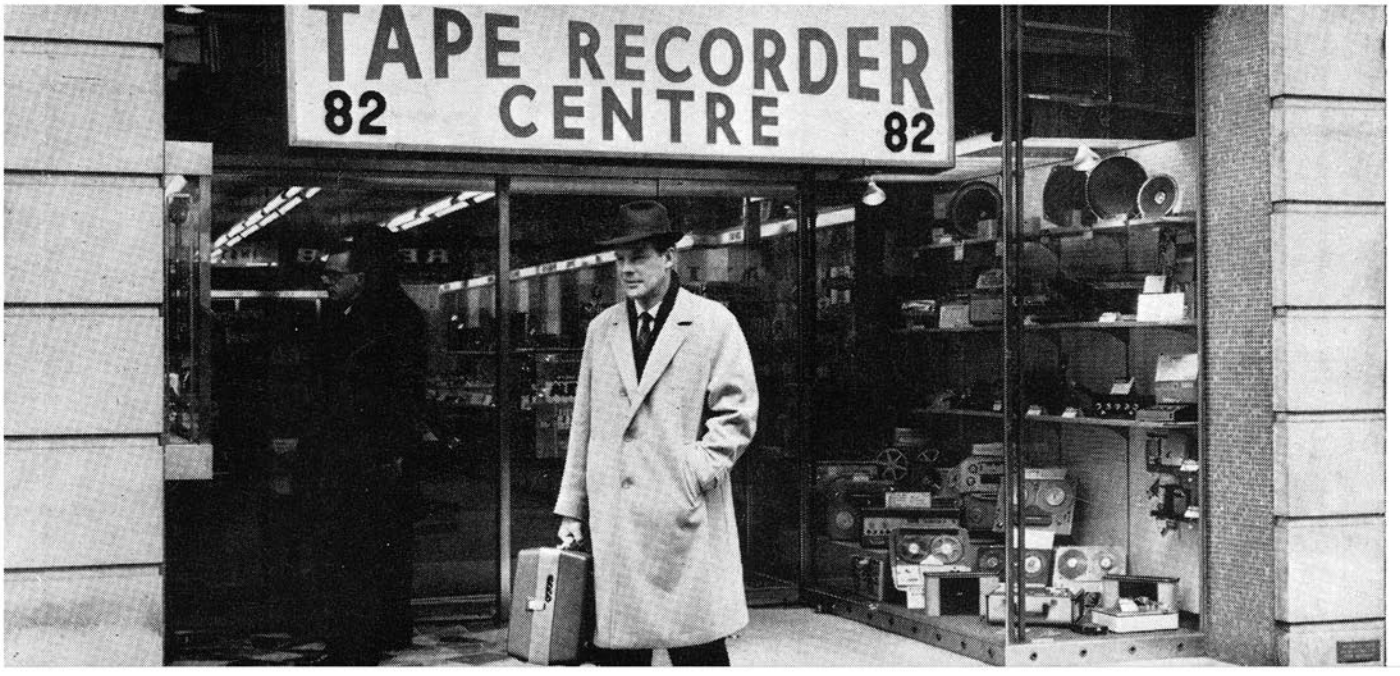

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