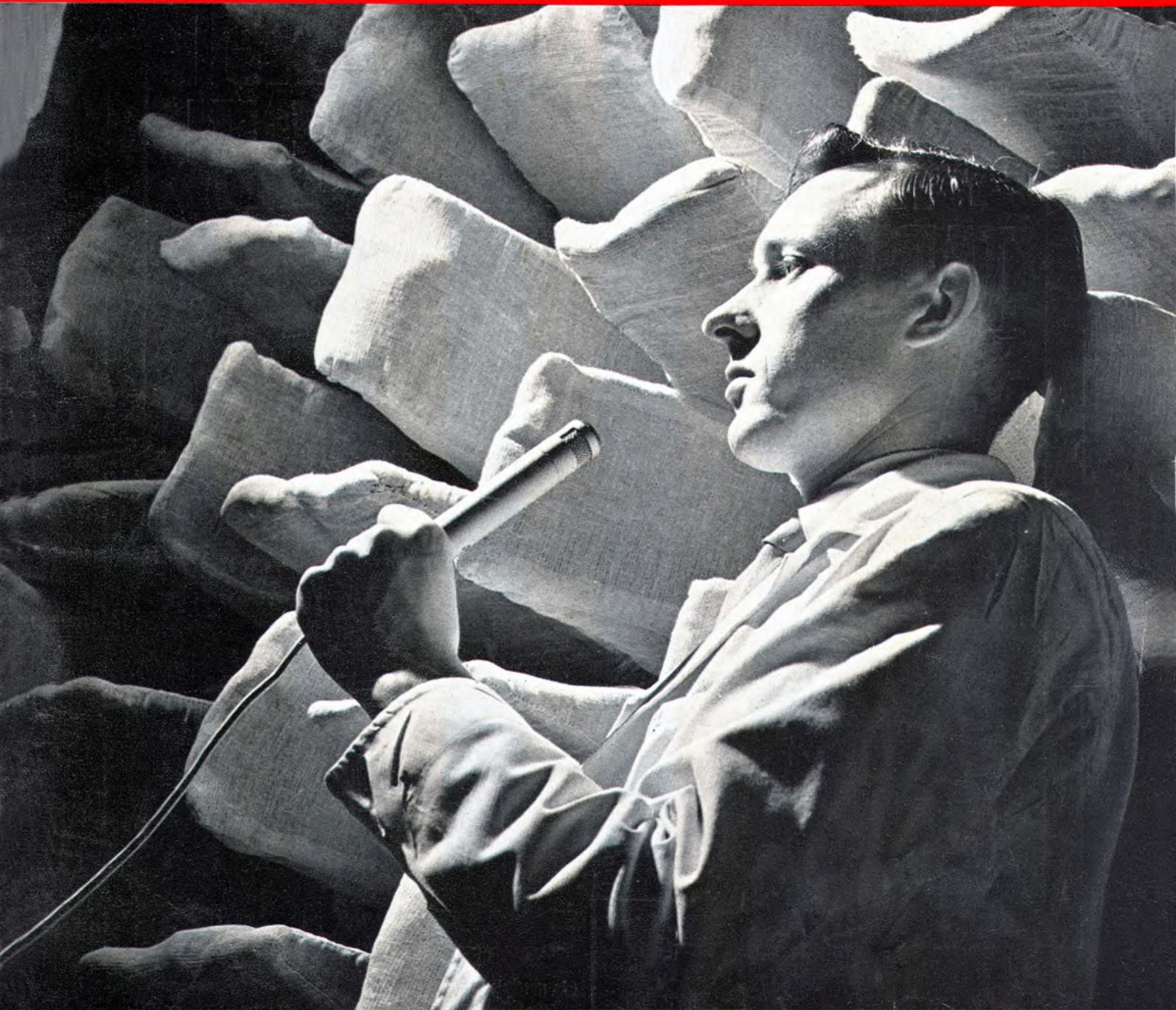


OCTOBER 1965 TWO SHILLINGS

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In portable tape-recorders* with power requirements around 300mA a standard battery will drop below the necessary voltage to power the motor and amplifier in a matter of hours. An Ever Ready High Power Battery in the same recorder will keep up its voltage for a working life at least 4 times longer.

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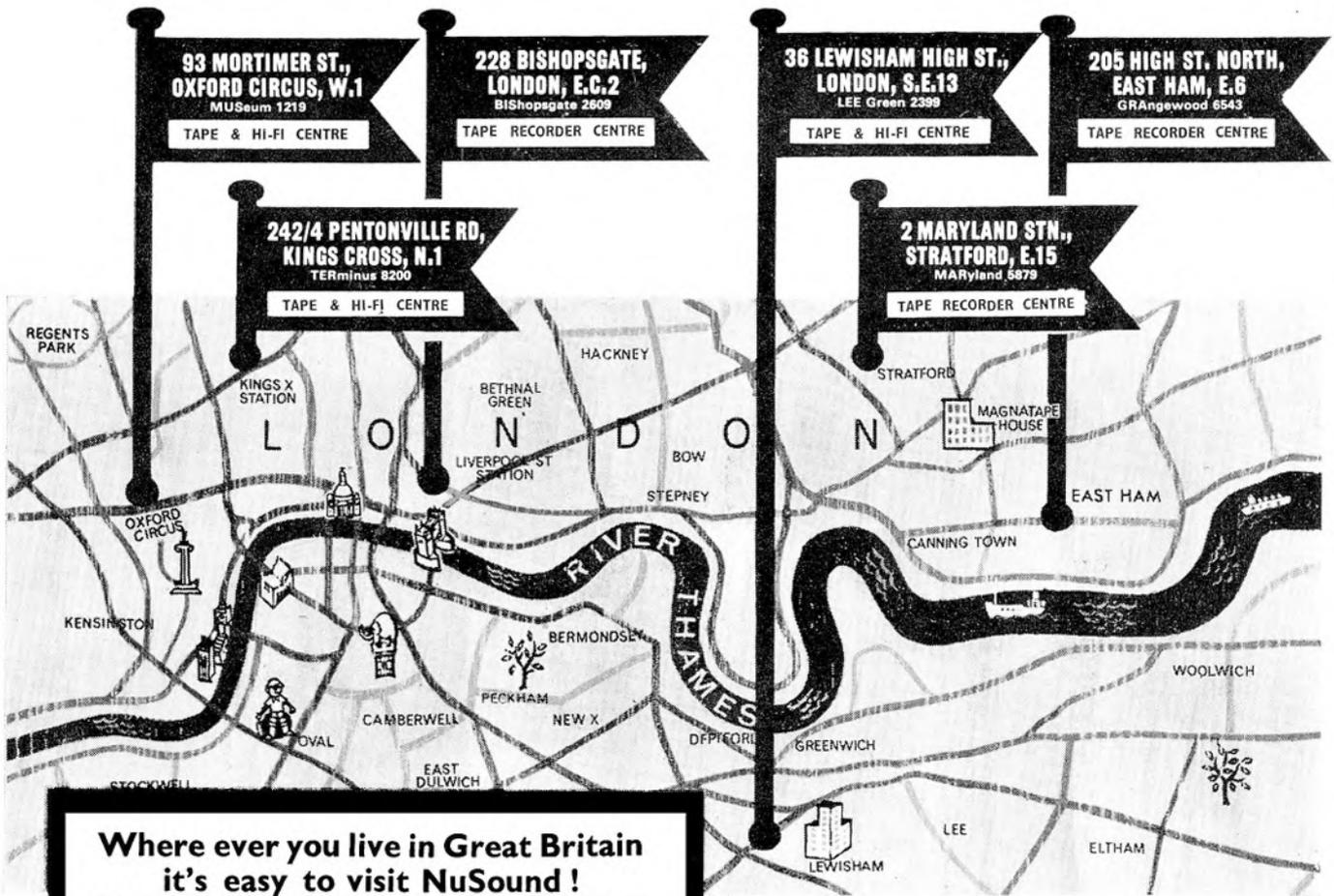
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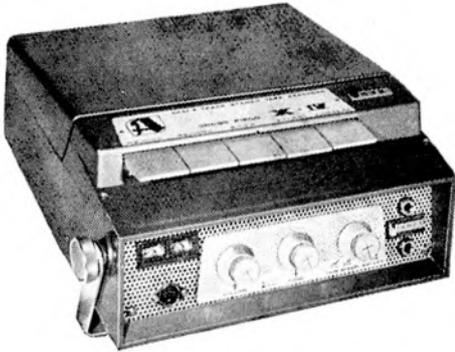
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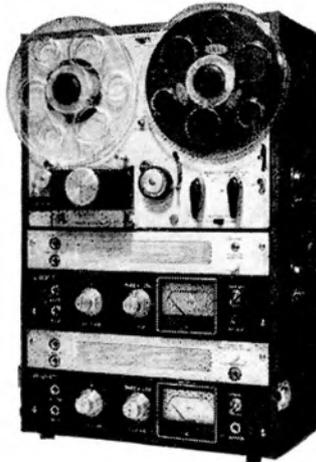
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THIS MONTH'S FEATURE

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THE MOST EXCITING TAPE RECORDER NEWS FOR YEARS!

the arrival of the NEW

UHER
4000 REPORT-L



the really complete portable tape recorder

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Price: 103 gns. (Including Microphone and Tape)



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(almost noiseless) for
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meter calibrated in db's
for really precise control.

NEW

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tape recorder

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editorial

TWO ITEMS concern us this month: one that may assist the advance in popularity of tape recording and another which may hold the seeds of destruction for this hobby.

First on our list is the *British Tape Recording Contest*, the results of which—for this year—are reported on page 391. It is hoped that *Tape Recorder* will play an active part in this competition's affairs from now on, despite adverse comments in this column from time to time. This year, criticisms of apathy appear to have had some small effect, as the total number of entries has risen to around 200. But although standards were high and the number of competitors has risen, we must look forward to the day when, say, one per cent of tape recorder owners feel impelled to 'have a go.' The resulting 10-20,000 entries might be a nightmare to judge, but what a wealth of material that would represent—and what a hobby!

In introducing our second topic it is useful to speculate about the future of the tape machine. Of one thing we can be fairly sure: the tape recorder of twenty years hence (if it uses tape at all and not magnetic or electro-static discs) is no more likely to operate at speeds of $7\frac{1}{2}$ and $3\frac{3}{4}$ i/s on two or four tracks of a $\frac{1}{4}$ in. tape than machines of twenty years ago were likely to have made headway at 60 and 30 i/s on single-track strips of carbon-coated paper. Much as we may regret it—and we do regret it—in fact, domestic tape recorders in the 1980's are likely to be modelled on the anti-hobby, anti-fiddle, cassette type of machine, though technical advances will probably mean superior performance at even smaller sizes than are presently available.

The announcement of a cassette model by a major European manufacturer just over a year ago was the first step in this direction; the second step has just been taken by three German manufacturers who, having agreed upon a standard cassette design, are giving it an enthusiastic launching by simultaneously introducing three recorders—one from each company—as well as a range of commercially-recorded cassette tapes. That the new cassettes should by some happy coincidence be interchangeable with the earlier design is as unlikely as it would probably be to the trio's financial disadvantage. A lot of manufacturers have made a lot of money out of the audio connector and adaptor market, and, unless prompt action is taken by manufacturers themselves to prevent the market being flooded with cassettes of different design, a lot of money will be made out of this new market before the bottom falls out of amateur recording—as it may if the recordist is subjected to ill treatment.

We shall accept the march against the spool only if and when these 'pioneers' are joined by other manufacturers in the rest of Europe, the

USA and Japan. The course to be adopted by others will be observed with great interest, as will the provision—or lack of it—made by the cassette designers for the creative chap who wishes to indulge in editing. This, of course, is the crux of the matter from the hobbyist's point of view, for if everything is to be available only in 'untamperable-with' boxes we shall either have to give up altogether or start using this magazine as a sort of take-it-to-pieces-yourself manual for those who don't wish to be ruled by the cassette.

But perhaps we are being unduly pessimistic, as photography, for instance, has survived as a hobby despite the 35mm. film cassette. We do, after all, have the advantage that our tapes are not sent away for chemical processing before they can be played, and splicing kits are cheaper than enlargers. Probably not many of those 200 competition tapes could have been submitted without some editing and splicing, so let us hope that the trend to cassettes—if it really is a trend—is balanced by consideration for the poor creative recordist who doesn't want his iron-oxide to turn into an iron-curtain between creative ideas and technical possibilities.

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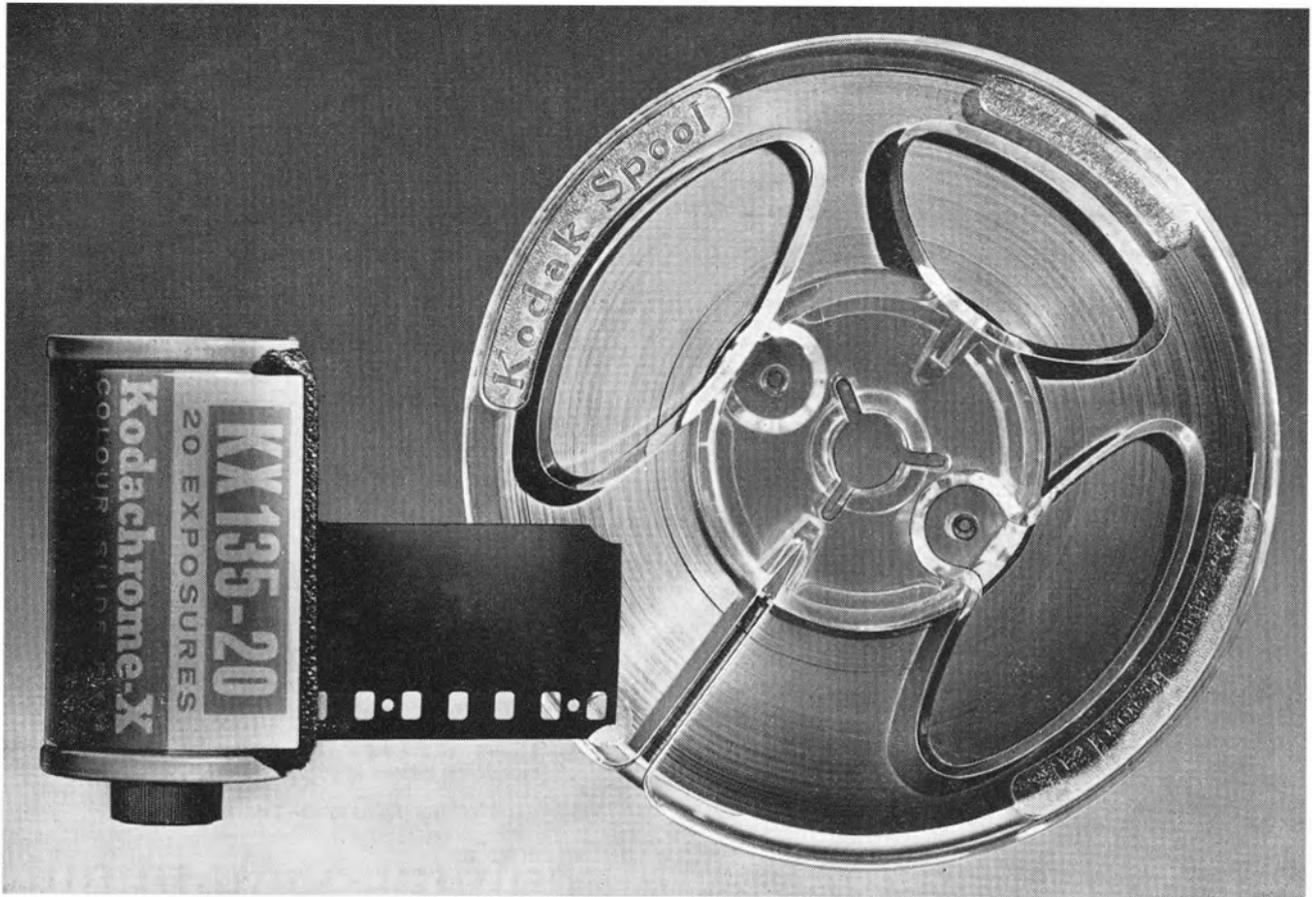
COVER PICTURE

Measuring the acoustic performance of microphones and loudspeakers is no easy task unless, like *Standard Telephones & Cables Ltd.*, you happen to possess an anechoic room. Fibreglass-filled muslin bags, carefully arranged in haphazard order, line the walls of such rooms and serve the task of reducing reverberation, which might otherwise detract from the accuracy of the measurements. A professional capacitor microphone is shown undergoing test.

SUBSCRIPTION RATES

Annual subscription to *Tape Recorder* and its associated journal *Hi-Fi News* are 30s. and 32s. 6d. respectively in the U.K. Overseas rates are 32s. 6d. (U.S.A. \$4.50) for each magazine, 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.



How Kodak's film-coating skills set today's highest standard in tape

Kodak know a lot about surface coating. More than any other manufacturer in the world, in fact. This isn't really surprising, because one of the reasons for the unrivalled high quality of Kodak colour films is the unique evenness of their emulsion coatings.

Now, Kodak have applied these advanced coating skills to the manufacture of sound recording tape. The result is a tape whose magnetic oxide layer is accurate to within *millionths* of an inch. No wonder that sound recording engineers all over the world have acclaimed it as the finest tape ever made.

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There's a Kodak Tape for every recorder, of course, including the world's only Quadruple Play tape, for use with battery

portables (5½ hours playing time on a single 3½" reel!). So next time you buy tape do the sensible thing and specify Kodak Tape. It will do full justice to your equipment. And it costs no more.



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world of tape

GERMAN TRIO ADOPT STANDARD CASSETTE

GRUNDIG, *Telefunken* and *Blue Spot*, three of the largest German audio manufacturers, have lately agreed upon a standard tape cassette design. The three companies are said to believe that cassette loading would help to popularise the tape recording hobby and all expect to market machines before the end of the year based on the new system. The cassettes will contain 300ft. of tape (the width of which is not yet known) and the new recorders, expected to sell at some £35, will give a playing time of 30 minutes and 1 hour respectively on two tracks at $3\frac{1}{2}$ and $1\frac{1}{2}$ i/s. The German Radio Show this autumn will probably see the first models, for which a series of commercially recorded cassettes will be available, taken from *Decca*, *RCA-Victor* and *Telefunken* disc recordings.

1966 AUDIO DIARY

OVER the past few months we have been preparing what is believed to be the first *diary* intended specifically for the tape recording and hi-fi enthusiast. Tape track positions and dimensions, tape playing time and playback equalisation will be found amongst 50 pages of data to be included, while information on VHF/FM aerials, decibels, equipment interconnections, frequency and pitch, loudness and hearing, lists of audio abbreviations, etc., make the diary a uniquely useful pocket companion. Further details of the 1966 diary, and the means by which it can be ordered, will be announced in our November issue; until then we ask that readers wait patiently for further information, as the precise details of supply arrangements have still to be finalised.

ROBUK OPEN LEEDS OFFICE

NEW premises were recently acquired by Robuk Electrical Industries Ltd. at 63 Great George Street, Leeds, 1. Stock and service facilities there will be available to customers north of the Southern Yorkshire and Lancashire border. It is hoped that the new depot, operating in close liaison with the head office in London, will lead to a greater operating efficiency.

RSGB EXHIBITION BOOSTED BY RADIO SHOW

ONE of the very few to benefit from the cancellation of the Radio Show is the *Radio Society of Great Britain*, an organisation for wireless enthusiasts which holds its own exhibition annually at the Seymour Hall near Marble Arch. The *International Radio Communications Exhibition* is being supported this year by *Grampian*, *Enthoven Solders*, *Daystrom* and *Imhof*, plus a host of manufacturers catering entirely for the amateur radio market. The cancellation, say the organisers, has resulted in a greater demand for space and an increased number of exhibitors.

THREE-IN-ONE TAPE HEAD

RECORDING, playback and erasure can be accomplished using a single double-gap head developed by *Sud-Atlas-Werke GmbH* of Germany. The problem faced in developing the component was that one limb of the three-limb core would be subjected to the magnetic flux on the tape during playback and the recording flux as well as erase bias during record. This has been overcome by placing a compensating winding round all limbs of the core jointly, in series opposition to the winding carrying the signal. The head screening can may form the core of this outer winding, which is so arranged that compensation may be varied by altering the coil position in relation to the head gap.

GRUNDIG LAUNCH COMPETITION FOR SCHOOLS

CLOSING date is 20th December 1965 for the School Recording competition announced recently by *Grundig*. Up to three entries are permissible from each school, in any of three sections—*Infants*, *Juniors* and *Seniors*. Tapes, recorded by pupils with or without the aid of a teacher, should be no longer than ten minutes and can cover any subject. Three *TK18L* Automatic tape recorders will be presented to the winners of each section. Further details are available from: *Grundig (Great Britain) Ltd.*, Newlands Park, Sydenham, London, S.E.26.



FACTORY TRAINING BY TAPE

HAVING been used successfully at the *SKF* factories in Gothenburg, Sweden, a new factory teaching system employing tape recorded instruction in the use of machine tools has been introduced at the *Skefko Ball Bearing Company* of Luton. Machine operators are taught, after a brief introduction to their task from a trained supervisor, from tape recordings, communicated over an induction loop and thence through a portable transistor amplifier to headphones.

COPYRIGHT CONFUSION ENDED IN GERMANY

AFTER a lengthy and bitter struggle between the German Performing Rights Society and tape recorder manufacturers and users, a solution has been found to the Copyright problem which, it is hoped, will please all concerned. A royalty of no more than 5% of the recorder's retail cost will be payable by the manufacturer for every machine produced. This will allow the user to record whatever he wishes, without recourse to further permission or payment.

NEW T.R.M. CATALOGUE

PLUGS, sockets, fuses, drive-belts and accessories are detailed in the latest *Tape Recorder Maintenance Pre-Packed Spares* catalogue. All items other than belts are illustrated and priced and include plug and socket leads from which almost any combination yet manufactured for the audio market can be connected. Sets of drive belts are available for *Philips*, *Cossor*, *Stella*, *Grundig*, *BSR*, *Korting*, *Walter* and *Minivox* machines with prices ranging from 22s. to 2s. 6d. Full details of model numbers, quantity of belts per set and cost are given.

Distributor: *Tape Recorder Maintenance Ltd.*, 323 Kennington Road, London, S.E.11.

NUSOUND INTRODUCE NEW SALES TECHNIQUE

WITHIN weeks of being taken over and expanded by *City & Essex Tape Recorder Centres*, the *Nusound* group of audio retailers have introduced an original sales technique aimed at the tape recording market. Three of the six London premises specialising in tape equipment will shortly be concentrating on displaying, demonstrating and selling the products of a single manufacturer. Customers may, therefore, look forward to a brighter winter of *Ferrograph*-months, *Revox*-months and *Akai*-months.

NEXT MONTH

CONSTRUCTION of a low-to-high impedance microphone booster will be described by Gordon King in a feature independent of his *Towards Better Taping* series, in our November issue, to be published on Thursday, 14th October. Also in this issue, Alec Tutchings will review the new *Magnavox Studiomatic Tape Transporter*, while Martin York offers advice on editing holiday tapes.



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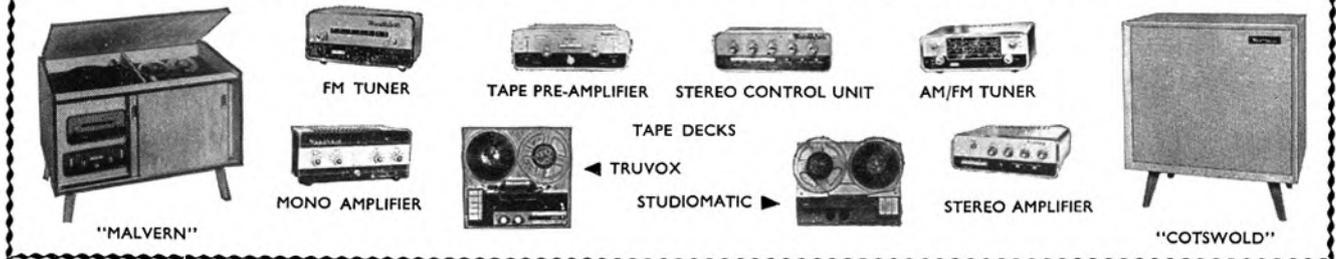
AUDIO
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Total price kit **£16 8 0**

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IF Amp and power supply. AFM-AI £22 11 6
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With high sensitivity necessary for ceramic pickups such as the Decca Deram.
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Within its power rating this is an outstanding amplifier.
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STEREO CONTROL UNIT USC-1
With variable filter, switched rumble filter, etc.
Kit £19 10 0. Assembled £26 10 0

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A reasonably priced unit. Inputs for Gram, Radio.
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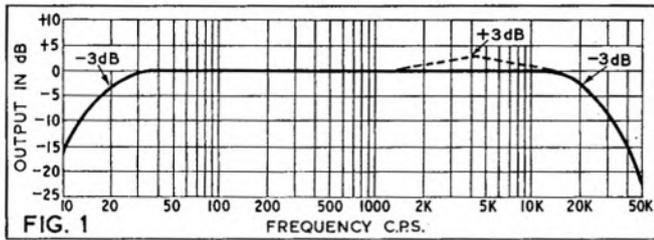


FIG. 1

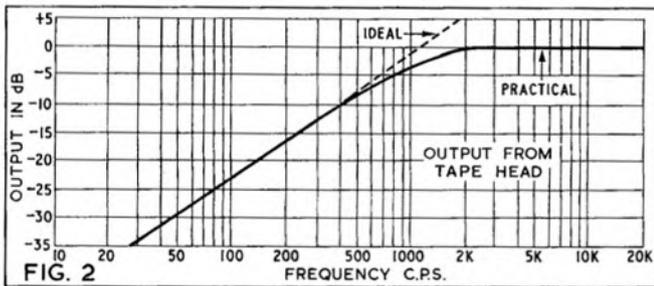


FIG. 2

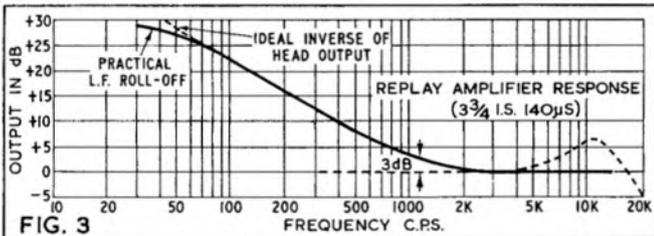


FIG. 3

variable-frequency tone generator would probably be somewhat better.

In practice, the response of even the most expensive semi-professional tape recorder would undulate to some extent over this range, though the undulation would be small, and manufacturers normally specify the variation in output level occurring between two frequency figures. This variation is measured in *decibels* (the name originated from that of the inventor of the telephone—Alexander Graham Bell—and is generally abbreviated to *dB*). Decibels will be examined in a later article, but for the moment we will content ourselves with the knowledge that the response in **fig. 1** is plus-or-minus zero dB (flat) from 33 c/s to 13 Kc/s, while stretching from 20 c/s to 20 Kc/s for variations of -3dB . If there were a *rise* to $+3\text{dB}$ at, say, 4 Kc/s (dotted line), the response would then be specified as 20 c/s—20 Kc/s $\pm 3\text{dB}$.

This would be analogous to the Meteorological Office announcing, for its own reasons, that water in the Thames Estuary is "flat" within plus or minus six inches, thus conveniently accommodating the ups and downs due to small waves.

Plotting a frequency response curve is an easy matter, requiring a signal generator, an AC voltmeter (preferably a valve voltmeter) and a sheet of graph paper. The signal generator is designed to produce constant tones, the frequency of which can be varied and at the same time read from a calibrated grille. Two important requirements of this instrument are that the calibration should be accurate and the output level constant over a wide range of frequencies. Connecting the generator to a tape recorder input, and connecting the voltmeter leads across a resistor in series with the record head, will show, in most cases, that the frequency response has remained approximately flat.

This gives constant current into the record head and corresponding equal magnetisation of the tape coating. On playing back the recorded tone sweep, however, it will be found that the replay head output is far from flat. High and middle frequency tones are more prominent than bass-frequencies, and careful plotting of the head output reveals

(continued on page 377)

A B C of tape recording

part 7

equalisation and time - constants

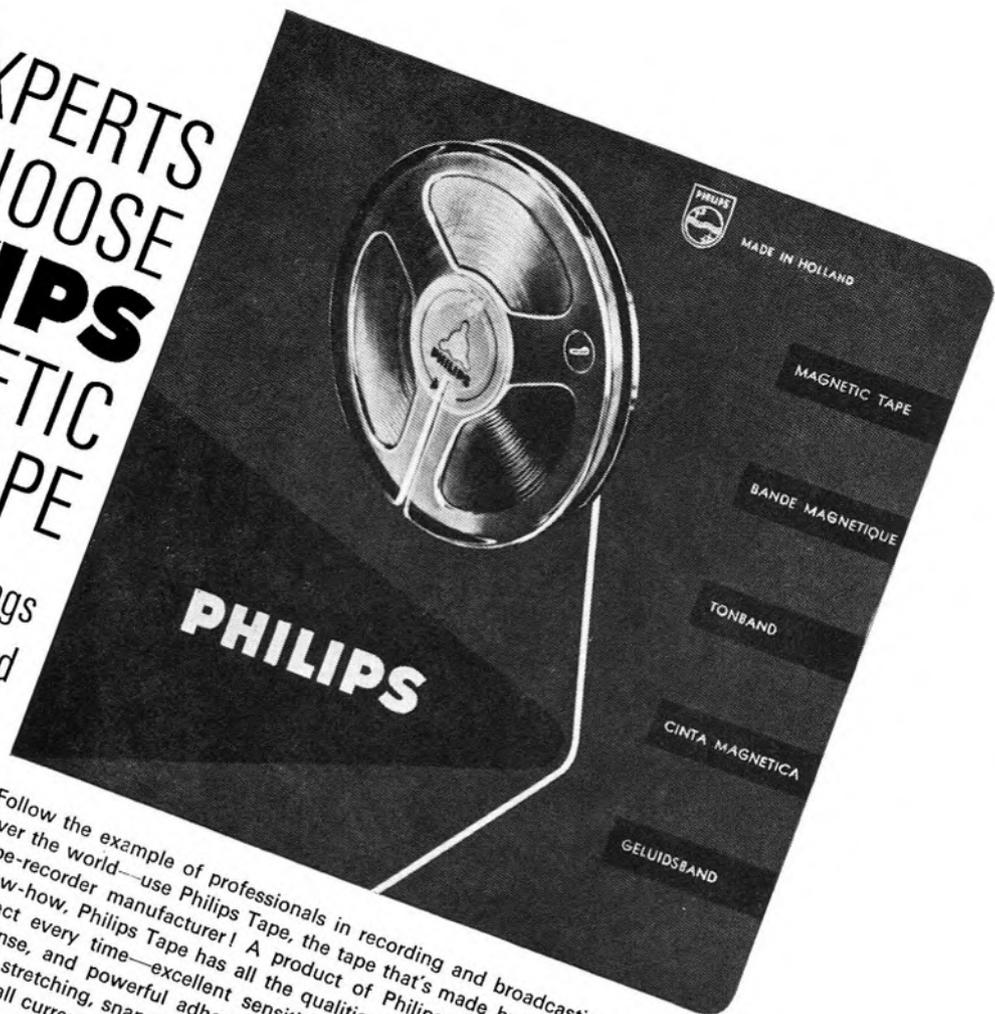
BY DAVID KIRK

WHEREVER tape recorders, amplifiers, radio tuners or loudspeakers are discussed, the term *frequency response* will be met. A typical response curve is shown in **fig. 1** (solid line) and this could apply to some of the above items. The curve tells us that the equipment operates just as efficiently in the region of 30 c/s as it does at high frequencies of around 10 Kc/s. To be more precise, it is "flat" from some 33 c/s to 13 Kc/s, and tones of a fixed input level will receive equal treatment between those frequencies, giving the same output. A frequency response as good as this would, in fact, be rather difficult to obtain from a tape recorder—though the output of a reliable



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that the voltage level doubles for every doubling in frequency, at least up to the 1-2 Kc/s region.

Many tape recording tyros with an experimental turn of mind who, having discovered just how far one can go without getting 250V across the fingers, have connected the output of replay heads (possibly the unused segment of a 1/2-track head) to a conventional amplifier, will have noticed the "tinny" quality that results. The explanation is quite simple. The voltage induced in the coil of a replay head is proportional to the *rate-of-change* of magnetic flux, which means that the constantly magnetised tape produces a field that changes direction increasingly rapidly as the frequency rises—hence the tipped response as in fig. 2 and the need for *equalisation*. Just as the hi-fi enthusiast might turn up the bass and turn down the treble of his amplifier to compensate for an excessively 'bright' gramophone record or radio broadcast, so it is necessary to distort the tape replay response to obtain the original "flat" condition. An *equaliser* is incorporated for this purpose in the replay preamplifier and is best pictured as a pre-set bass-lift/treble-cut tone correction, operating independently of the main tone control. The response of such a circuit is illustrated in fig. 3 (solid line), which is the approximate reverse of fig. 2.

It will be noticed that the steady slope does not extend to high frequencies. This is because practical replay heads have finite gap widths and, as the recorded wavelength becomes shorter, so the head's ability to 'resolve', the magnetic information declines. For this reason there are agreed standards for tape replay amplifier response curves, according to which the curve 'flattens' above a certain frequency, depending on tape speed. The solid curve in fig. 3 follows the current DIN/CCIR recommendation for 3 1/2 i/s, with a 'turnover' frequency around 1140 c/s. This is the effective point of departure from the horizontal, placed by convention at a distance of 3dB.

In addition to this basic replay equalisation, a certain amount of 'doctoring' takes place in most recorders to compensate for additional HF head losses—sometimes in the record circuits, sometimes on the replay side. The right hand dotted line in fig. 3 is an example of the type of replay frequency curve that might be found in practice, though the 'peak' might equally well appear in the record circuit response. In fact, we were over-simplifying matters slightly in saying that the signal

at 3 1/2 i/s is therefore expressed as 140µS (µS being a convenient abbreviation for microsecond). While we are on the subject, a thousandth of a second is termed a *milli-second*, in turn abbreviated to mS.

The connection between 140 millionths of a second and a curve on a frequency response graph may seem mystical. In fact 140µS refers not to the equalisation curve itself, but to the circuit needed to produce it. An equalising circuit with a *time-constant* of 140µS will produce a frequency curve of a certain shape—in fact the curve of fig. 3.

This time-constant is not, however, so suitable for tape speeds other than 3 1/2 i/s. Table 1 shows the recommendations of the three bodies for tape speeds from 15 to 1 1/2 i/s. The time-constant of 280µS for the lowest speed is not in fact a DIN or CCIR standard but is included in the same row because of its obvious logical relationship to the higher speed standards.

Whenever the tape speed switch of a domestic recorder—other than the very cheapest—is thrown, two things occur. The tape drive is altered—usually by moving an idler or pulley wheel to another position relative to the motor spindle—and a few equalisation components in the replay preamplifier are switched in or out of circuit. The two actions are generally achieved with a single control knob which operates the mechanical function and has a multi-way switch mounted beneath it. These components govern the time-constant of the tape amplifier and thus, by switching them in and out of circuit, the record/replay characteristics can be altered to suit the tape speed.

This time-constant business is not so mysterious as it might at first appear, for various types of response characteristic are obtained by combinations of resistors and capacitors, and any such combination has a time-constant which is quite simply the time taken for a capacitor to charge up to a certain agreed fraction of the applied voltage, in fact 63.2%. The actual t-c figure (in seconds) is obtained by multiplying the values of C in microfarads (µF) by R in megohms (M); thus the 140µS t-c is obtained by 1M and 140 picofarads (million-millionths of a Farad)—i.e. one times .00014µF=.00014 sec. or 140µS—or by 100K and .0014µF, and so on. So we see that *any* combination of R and C having this particular t-c will give the desired frequency response.

Capacitors have a property called *reactance*, a sort of resistance to AC. This rises as the frequency is lowered (with inductors it falls) and by combining capacitance and resistance it is possible to produce various types of frequency response. In a simple R/C circuit the frequency at which the reactance of the capacitor equals the resistance of the resistor is called the *turnover-frequency*, this being the point

TABLE 1 Equalisation Time-Constants

	15 i/s	7 1/2 i/s	3 1/2 i/s	1 1/2 i/s
DIN/CCIR	35 µS	70 µS	140 µS	280 µS
NARTB	50 µS	50 µS	90 µS	90 µS
Old CCIR	—	100 µS	200 µS	—

TABLE 2 Turnover Frequencies

	15 i/s	7 1/2 i/s	3 1/2 i/s	1 1/2 i/s
DIN/CCIR	4.5 Kc/s	2.3 Kc/s	1.14 Kc/s	570 c/s
NARTB	3.2 Kc/s	3.2 Kc/s	1.8 Kc/s	1.8 Kc/s
Old CCIR	—	1.6 Kc/s	800 c/s	—

applied to the record head is identical, except in overall level, to that at the input. In an attempt to counteract head-gap losses, the recording preamplifier itself often boosts HF signals slightly. This makes it necessary to ensure that tape amplifier designers adhere to standard *replay* responses in order to allow interchangeability of tapes from machine to machine.

To 'recommend' a set of frequency curves might seem a difficult task, especially as the curve already mentioned is one of *several* equalisation standards, known as *DIN*, *CCIR*, and *NARTB* (the latter often shortened to *NAB*). Verbal description would hardly be accurate, while graphical illustration is easy to misinterpret. The three bodies, therefore, use another method of describing the curves: they specify them, not in terms of frequency and level, but in *micro-seconds* (millionths of a second). The DIN recommendation for equalisation

where the response has departed from "flat" by just 3dB. Tape replay compensations may, therefore, also be defined in this way, and the turnover-frequency equivalents of the time-constants in Table 1 are given in Table 2.

Looking back to fig. 3, the turnover frequency is marked at 1,140 c/s, and a combination of resistors and capacitors giving a time-constant of 140µS will automatically produce a turnover at this frequency. The time-constant alone, however, does not necessarily convey all the information needed of the response curve, since a small additional treble "bump" has still to be accommodated in some cases, as explained in connection with the dotted part of fig. 3.

But I think we have gone far enough for this month, as further progress requires a closer look at the *decibel*, and space has been booked for this next month.

THE writer published, in the May 1963 edition of this journal, a method of drawing a stroboscopic disc. Later, J. A. Hamilton, in his article, *The Why and How of a Stroboscopic Tape* (February 1964), stated that in many taperecorders it was not possible to fit a stroboscopic disc to the capstan and that the ideal condition was to have a stroboscopic tape so that any change of speed due to drag or acceleration of the tape spools could be observed. He considered loops unsatisfactory and gave his method of hand-drawing a strobe tape.

The writer confesses that he is too lazy to try Mr. Hamilton's method of hand drawing, especially if a few hundred feet of tape are required ; but it was Mr. Hamilton's remarks on the theory of persistence of vision and the effect of any slight inaccuracies of drawing that set the writer thinking. Why not *print* a line of dots, such that one hundred dots covered a distance of $7\frac{1}{2}$ inches? The obvious thing was a cog wheel on which the tips of the teeth picked up ink and deposited it on to white leader tape.

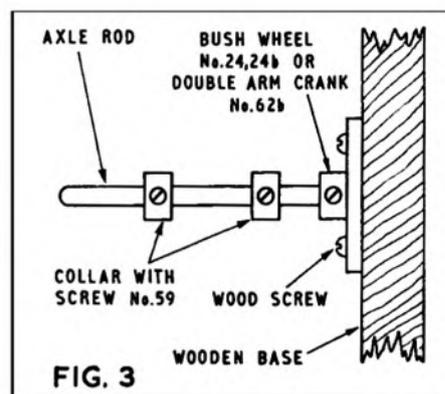
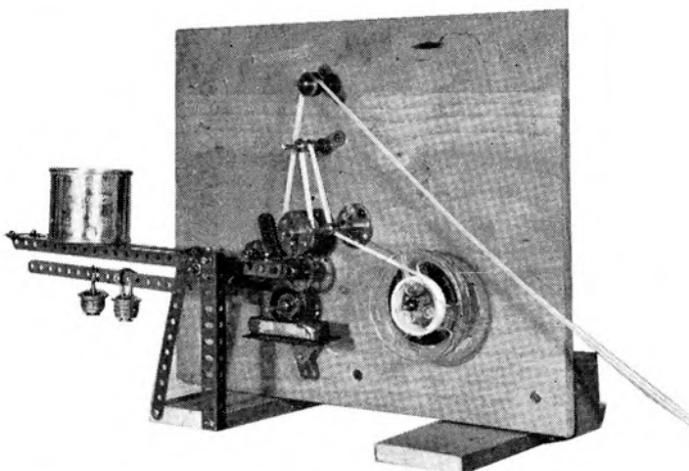


Fig. 2, left, shows the author's version of the printer.



Fig. 1 shows the general principle of a printer and fig. 2 shows the writer's home-made version. The first problem was to find a suitable cog wheel—the *Meccano* series unfortunately proved unsuitable and a well known firm of model makers were unable to help from their standard range. It was then decided to see if there were any gear wheels used in clocks that would be suitable. Fortunately one was found that could be slightly modified so that it printed exactly one hundred dots in $7\frac{1}{2}$ inches.

It is no use going to a high class jeweller ; one wants to find an old-fashioned clock repairer who never throws anything away. Fortunately for the writer a friendly watch repairer was found who was willing to co-operate after the problem had been explained to him. He produced from his workshop a large, very pre-war, biscuit tin full of an amazing assortment of cog wheels that had been stripped from all sorts of old clocks. He explained he had no time to spend on sorting out the tin, but the writer could borrow the tin and sort out what was wanted and return the rest, which was accordingly done.

The diameter of the cog is of no great importance, what is wanted is that it shall make one hundred marks or *very slightly less* (e.g. 97) in a distance of $7\frac{1}{2}$ in. If it makes, for example, 95 marks in $7\frac{1}{2}$ in. it means that its circumference is slightly too big and wants reducing. (The method of doing this will be given later.) If it makes more than one hundred marks then the circumference is already too small and nothing can be done to increase it, therefore the cog wheel is of no use.

The method of testing is simple. Take a sheet of smooth white paper and lay it down on a hard table top, next place on top of the paper a sheet of typewriter carbon tissue, carbon side against the paper. Take the cog wheel and run it along the back of the carbon paper, using a ruler as a straight edge. Be sure that the distance that the cog wheel is rolled is at least 8 inches. Remove the carbon paper and select a suitable tooth mark and measure off accurately $7\frac{1}{2}$ in. Now count the number of tooth marks in the distance of $7\frac{1}{2}$ in. If there are 100 you are indeed fortunate. If the figure lies between 100 and 93

then it should be possible to decrease the circumference so that, after modification, it will print exactly 100 marks in $7\frac{1}{2}$ in. If possible, select three or four suitable wheels in case one or two are spoilt in making the modifications. The writer's cog wheel before modification had a diameter of 3.4cm. and had 54 teeth. On test it gave 94 lines per $7\frac{1}{2}$ in., after its circumference was reduced it gave exactly 100 marks in the same distance.

Although the writer has a small lathe, it was decided not to use it because many readers may not have one. A popular home power tool was used instead. The power tool should be fixed rigidly in a horizontal position, preferably in its own bench clamp.

The cog wheel is fitted in the chuck and arranged so that its top rotates towards the operator. While the cog wheel is rotating at full speed, the top is very gently filed with a flat file ; care must be taken that the file is held parallel to the spindle of the cog wheel.

The work must be stopped frequently and the cog wheel removed and tested by the method given, until 100 marks are recorded over a

distance of $7\frac{1}{2}$ in. Accurate measurement is imperative at this stage.

It is not proposed to give exact details of construction because most experimenters will probably want to use as much material as possible from the junk box and will have different ideas of layout.

The following tips may be of help :

The writer used mainly Meccano parts left over from other experiments and because individual pieces can be bought.

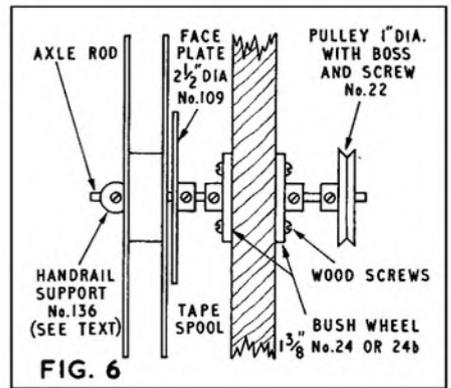
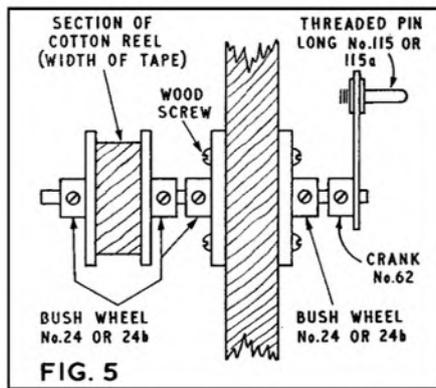
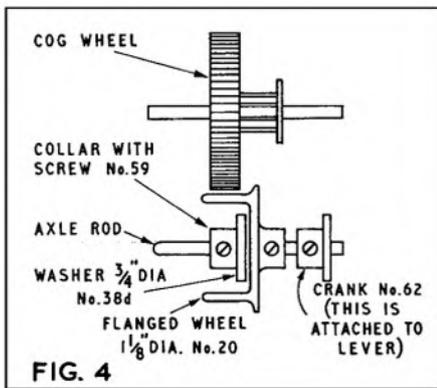
When buying Meccano parts it is advisable to ask to be allowed to test and select any of the parts that have to rotate, particularly flange wheels No. 20, bush wheels No. 24 and No. 24B. The best method is to slacken off the grub screw and spin it on an axle rod—select only those that run true.

Fig. 3 shows the method used in constructing the tape guides, while fig. 4 shows the inking roller, which was a No. 20 flange wheel. This was rotated by friction from the cog wheel, while the flange wheel picked up the ink from the trough and deposited it on the tips of the

correct viscosity for printing. A large number of experiments were conducted : Some ink could not be completely removed, and left a 'ghost' image, others flaked off when dry, and some easily smudged when dry, while others would not print onto the tape.

The following was finally adopted : Polycell wallpaper adhesive was used as the thickener in the ink. A small packet was obtained and one level teaspoon was dissolved in 1 pint (20fl.oz.) of cold water and kept for 48 hours before use, as the stock solution. Parker's Super Quink black ink (not blue-black) was chosen and must be added in four parts to every one of Polycell solution. This ink has proved satisfactory so far and can easily be washed off with water, leaving no trace, or ghost image. Plain white leader tape without any printing on it was found a satisfactory base.

It was found necessary to have two people to operate the printer. In the writer's case the unit was set up on the kitchen table (with much newspaper under it and with constant assurances to the 'better half'



teeth of the cog. Note that in fig. 1 and 2 the ink roller and ink trough are mounted onto a weighted lever, so that the inking roller is always under slight pressure against the cog. Rubber hot water bottle stoppers make good sliding weights.

The ink trough was made from a piece of tin (cut from an old fruit container) bent into a 'U' shape. Length was 7cm. and width 1.5cm. The open ends were filled in with a block of Plasticine (any modelling clay would do if you do not want the trouble of soldering tin pieces onto the ends).

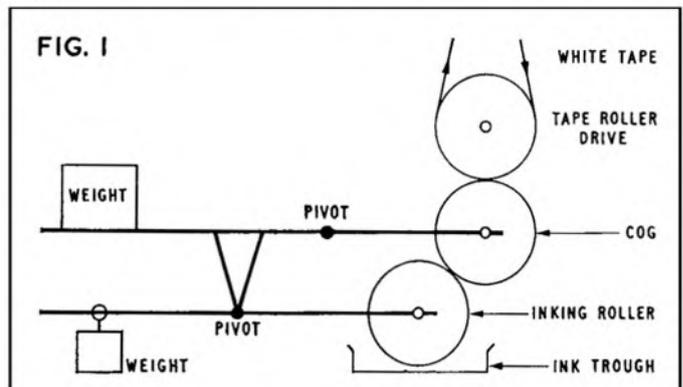
The tape roller drive (fig. 5) shows the method of construction. It is important that the width is exactly the width of the tape. The tape must not be allowed to wander from side to side ; if it does, the line of printing will not be parallel to the side of the tape. A wooden cotton reel was mounted on an axle rod (see fig. 6 for a method of mounting), and fitted into the chuck of a power tool ; one of the rims was filed off while it was being rotated. Then a section of the wood, the width of the tape, was cut off. This was done by keeping the cotton reel rotating and slowly sawing with a Junior hack-saw. By using this method the $\frac{1}{4}$ in. cut off the cotton reel had both sides parallel to each other. Finally, it was glued (*Evostick* or *Bostik*) between two bush wheels.

Fig. 6 shows the method of constructing the feed tape reel holder. The tape spool is pushed up against the $2\frac{1}{2}$ in. diameter face plate No. 109. Unfortunately the diameter of the hole in the spool is much larger than the diameter of the axle rod, and as there are no cones in the Meccano series of parts the hand rail support No. 136 is fitted into the spool hole and centres the spool. The rest of the projection of the hand rail support is cut off, so that one is left with a sphere that can be slid along the axle rod.

After the first few trials it became evident that the ink should have the following properties : It should be easily removed without leaving any trace so that the tape could be re-used if the printing went wrong. It did not smudge, did not flake when the tape was bent, and was of

that neither kitchen nor house was going to be wrecked), while his young daughter took hold of the free end of the tape and walked slowly in a straight line away from the printer—in this case, out of the kitchen and down the hall to the front door. The speed of the printer was controlled by the writer (about one turn per second) on the handle—see fig. 5. The helper only kept the film reasonably taught, after the maximum possible length of printing was done (length of kitchen plus hall) the tape was carefully layed face upwards on the floor and left to dry (about 15 minutes).

To resume printing the ink roller was held away from the cog and given a few turns to recharge it with ink and then the printing continued from when it had stopped. Any odd imperfections in the printing are easily touched up by using a little of the ink on a pen or very fine artists' brush.



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tape reviews

CLASSICS GEORGE GOODALL
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KODALY Hary Janos Suite, and other items. Philharmonic Symphony Orchestra conducted by Artur Rodzinski. **World Record Club TT396**, 3½ i/s twin-track mono. 29s.

PLEASANT though the *Dances of Galanta* and the *Marosszek Dances* are, it will be for the *Hary Janos* suite that people buy this tape record. Janos, with his tale of heroic deeds in battle, and of consequent recognition by royalty, was a sort of Hungarian Walter Mitty. It is his story that is the programme for this colourful suite.

I am sure that no one could be anything but charmed by the performance recorded here. I know I was, and the recording itself is very good too. In fact, in terms of recording quality this is one of the best mono tape records I have heard. It is well worth playing through wide-range speakers to hear with extra depth the bass drum cannons, and with extra vividness the clashes of percussion in *The Battle and Defeat of Napoleon*. Warmly recommended. **G.G.**

SAMUEL BARBER, FREDERICK DELIUS Concertos for violin and orchestra. Robert Gerle (violin) and Vienna State Opera Orchestra conducted by Robert Zeller. **World Record Club TCM59**, 3½ i/s twin-track mono. 29s.

POSSIBLY Samuel Barber's music is less well known to English concert goers than that of Delius. To my mind there is no real connection between the two works performed on this tape except that the lives of the composers overlap in time. Barber is American born and bred and his music is warmly romantic, demanding a degree of emotional involvement from his listeners. Delius, if it is possible to classify his work at all, is more like a French impressionist. Though English by birth, the more settled and productive years of Delius's life were spent in France and much of his music has a 'picturesque', rather formless quality that one associates more with Ravel or Debussy. Direct comparisons of this kind are not desirable, of course, but do sometimes serve to give an idea of a particular composer's style.

Samuel Barber's violin concerto is a splendid work, characterised in the main by rich melodies with an exciting 'presto' as a finale. There are occasional dissonances to remind the listener that this is twentieth century music. Robert Gerle is a violinist who is better known in America than over here. It is interesting to note that for a time he was a pupil of Enesco, who was also Menuhin's teacher for a time. His style is well suited to the music and he sweeps his way through the whole concerto with absolute conviction.

The Delius concerto is a different type of composition. Framed in one continuous movement, the outlines of its form are obscure, and the listener needs to hear the work a few times before the construction of the work becomes evident. In this work Gerle makes too much use of 'slides' and a romanticised style of performance not really suited to Delius, but this may well be a purely personal impression.

The sound of the orchestra is full and rich, the whole tape being very well recorded. For me at any rate, this was an interesting and enjoyable issue. **G.G.**

ME AND BUCK Humphrey Lyttelton (trumpet and tenor horn) and Buck Clayton. **World Record Club TT324**, 3½ i/s twin-track mono. 29s.

NOT very much mainstream jazz is played in Britain today; the Lyttelton band is the only group that has remained clearly visible on the British scene throughout the last ten years. But now there are some signs of a revival of interest in mainstream here. The widespread acclamation given to the recent reappearance of our most outstanding

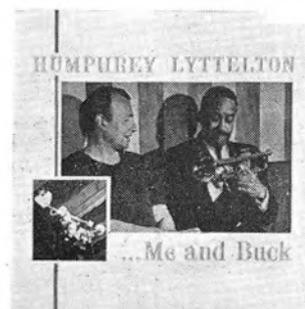
mainstream musician and leader, Bruce Turner, is encouraging.

Few mainstream jazzmen could have taken part in as many memorable sessions as Buck Clayton. It is therefore somewhat disappointing to find that the recorded results of the meeting of Hump and Buck are less satisfying than one might reasonably have expected. Despite some fine playing from all concerned, much of the jazz on this tape fails to achieve the easy relaxed atmosphere of good mainstream.

By far the best thing here is the beautiful slow blues *Fondue Head*, so named to celebrate an encounter baritone-player Joe Temperley had with a Swiss melted cheese dish. In a succession of fine solos, Joe Temperley deserves a special credit. Danny Moss is featured on *Autumn Leaves* in duet with Clayton, and what a fine tenor player is Moss.

Throughout, there is a great deal of Hump and Buck playing in combination and individually. Some especially fine moments occur on the Clayton original *Me and Buck*, with Buck playing trumpet and Hump blowing rich tones from a tenor horn. The other good numbers are *Tam* and a very pleasing arrangement of *Sentimental Journey*.

If you like Hump, Clayton and Mainstream then this is probably a worthwhile buy for five out of the eight titles. **T.F.**



BEN WEBSTER MEETS COLEMAN HAWKINS In a *Mellow Tone*, *Time after Time* and others. **World Record Club TT402**, 3½ i/s twin-track mono. 29s.



A MEETING of three giants of the tenor saxophone—Hawkins, Webster and Johnson—should have produced some memorable jazz. Perhaps after so many great recordings produced by the 'summit meeting' formula we have come to expect too high a standard from such get-togethers, but even after allowing for this, I still find this tape a disappointment.

It is suggested in the notes provided that we sample *De-Dar*, the closing item, first. Certainly this slow blues is very fine—it is a pity that most of the remainder doesn't even approach it. The saddest part is that Hawkins's solos are uniformly poor and overshadowed by those of Webster and Johnson.

It is really Webster who makes the best contributions throughout the forty-three minutes of this recording; all his solos are good and achieve great swing with a remarkable economy of notes. The ballad *Time after Time* features Webster playing the beautiful, breathy, delicate tones that only he can produce to such effect with slow numbers.

The single outstanding solo is that of Bud Johnson on a twenty minute version of *Mellow Tone*. Bud Johnson, who plays in the cool style associated with Stan Getz, deserves more recognition, not only for his playing but also for his little known but important rôle in the development of modern jazz in the mid-forties. The rest of the group consists of Roy Eldridge on trumpet, Jo Jones drums, Les Spann guitar, Ray Brown bass, and Jimmy Jones drums. **T.F.**

THE modifications to be described were originally intended for the Brenell Mk. 5 Series II tape amplifier, but could be applied with advantage to many other high quality domestic tape recorders.

The original amplifier is fairly conventional, having an EF86 first stage followed by half an ECC83 with switched feedback to the cathode of the first stage to determine frequency characteristics. After the volume control comes a triode driver stage and an output pentode EL84, which doubles as bias and erase oscillator during recording. On playback, feedback is taken from the output transformer secondary via the tone control to a small undecoupled resistor (shorted on record) in the cathode circuit of the driver stage. An EM87 magic eye, or ECC83 and meter, provide record level indication. A high impedance monitor output is provided from the anode of the driving stage and a low-level equalised output at high impedance is available on replay from the coaxial socket at the back of the amplifier, connected to a potential divider in the anode load of the first triode.

Basically this is a good circuit for a high quality domestic machine and is obviously the result of considerable thought and experiment. The wide prejudice against single-ended oscillators appears fairly unfounded in this case, as results compare very favourably with many push-pull oscillators in terms of purity of waveform and low residual bias noise. This is partly due to the valve being slightly under-run, which avoids saturation of the ferrite core in the oscillator coil. There is a tendency for bias frequency to be a little lower than quoted, but it may not be worth the considerable effort involved in squeezing out the extra few Kc/s, particularly as very few signal sources available to the average amateur contain much of any practical use over 10 Kc/s.

The bias is usually adjusted for the lower speeds, and to make full use of the potential of this machine at higher speeds it is worth adjusting the value of the bias feed series resistor to give optimum bias for the speed generally used (or it may be replaced with an adjustable control).

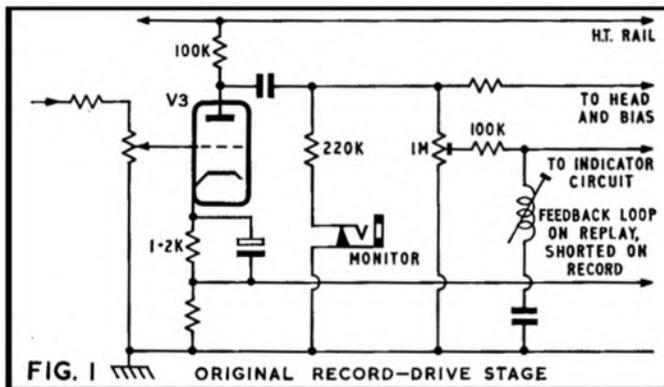
microphones. The harmonic distortion is approximately halved and subjective comparisons suggest that the intermodulation distortion may be better, provided there is adequate biasing. This gives one a maximum recording level determined by the tape rather than the amplifier, which is particularly worthwhile for master tapes at the higher speeds.

A small amount of additional pre-emphasis can be given to the highest audio frequencies if desired by connecting a very small capacitor across the now undecoupled 1.2K cathode resistor of the driver stage (fig. 2): the exact value must be found by experiment, depending on the bias adjustment and the tape used; in any case the emphasis is limited to 6dB (the amount of feedback introduced at lower frequencies) and the capacitor should be kept as small as possible to avoid lift too far down the high frequency spectrum which might result in high frequency distortion and unnecessary degradation of the signal-to-noise ratio. A value around 0.01 μ F or a little more should be adequate.

To exploit the reduced distortion, a better level indicator circuit can be provided. An ideal indicator circuit should measure accurately and with negligible overshoot all peaks lasting longer than about 2.5 μ s, and it should present a negligible load to the driving stage. It should have a logarithmic scale which is more useful than a linear one, as this covers a wider signal range; it should give one time to read the peak without strain but not mask the following peaks too much; and it should be stable. Except those fitted to some of the best professional equipment, most commercial indicators fall far short of this and are virtually useless except when recording from a source such as radio or disc where the programme material is already compressed so that all peaks come below a certain level.

The ideal is a true PPM circuit, but this is expensive and requires a considerable power supply which the Brenell power pack cannot deliver. If one examines the Brenell indicator circuits (fig. 3) one sees that the source-resistance is much greater than 100K, so that the

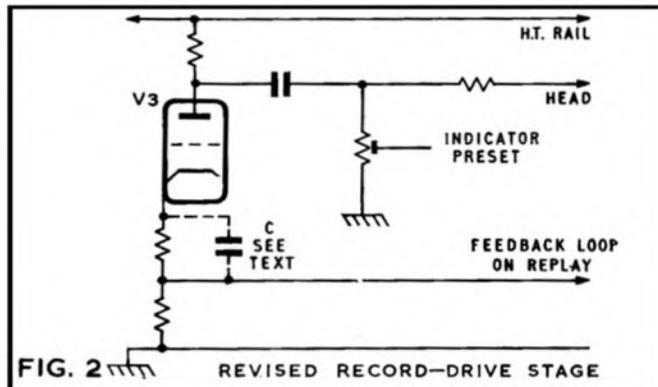
IMPROVEMENTS TO THE BRENELL TAPE AMPLIFIER



This has been dealt with in past issues of *Tape Recorder*.

As on most amplifiers of this kind, performance can be improved. Fig. 1 shows the original drive stage for the record head. The monitor output presents an unnecessary AC load to the anode of V₃ with consequent (very slight) deterioration of the possible distortion figure; this should therefore be disconnected (and the 220K resistor removed), as the high source-impedance is not suitable for some headphones and with the bias knocking around it could be difficult to use with external monitor amplifiers. Removing the resistor also increases the stage gain slightly.

An improvement in recorded distortion can be obtained by removing the decoupling capacitor in the cathode circuit of the driver stage. This change introduces about 6dB of feedback and therefore reduces input sensitivity by half, but as initial sensitivity is quite high the amplifier still remains suitable for use with low output ribbon



charging time-constant is greater than 10 μ s, which is too long. In the case of the magic eye, C cannot be reduced much as the discharge time-constant is limited by the back resistance of the OA81 (approximately 1 Meg.) and anything much shorter becomes difficult to read. There are no problems of inertia with the magic eye beam, of course, for this purpose anyway! In the meter circuit, C is already too small to give a satisfactory discharge time with the relatively slow-rising meter used.

The solutions in fig. 4 lack the ability of the PPM to read peaks on both halves of the cycle, but nevertheless peaks and not an average are read for one half cycle, and the difference in practice hardly justifies the expense of a PPM with equipment of this sort. If both halves of the waveform are to be read, the meter stage must be preceded by a phase splitter as in fig. 5.

Use is made of the high, but finite, back-resistance of a silicon

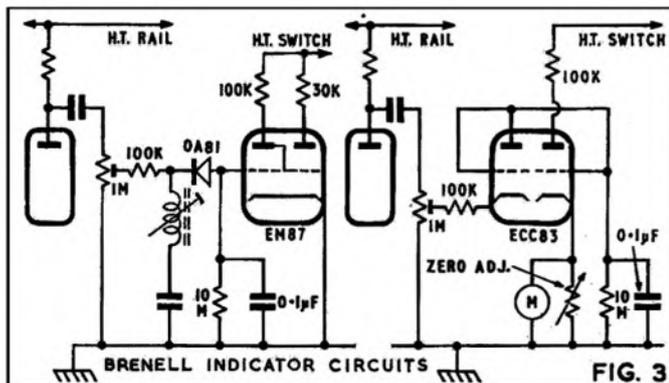


FIG. 3

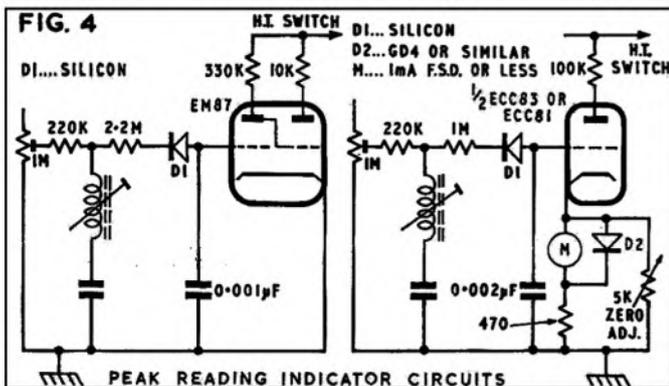


FIG. 4

PEAK READING INDICATOR CIRCUITS

some suggested
modifications
by J. H. Fisher

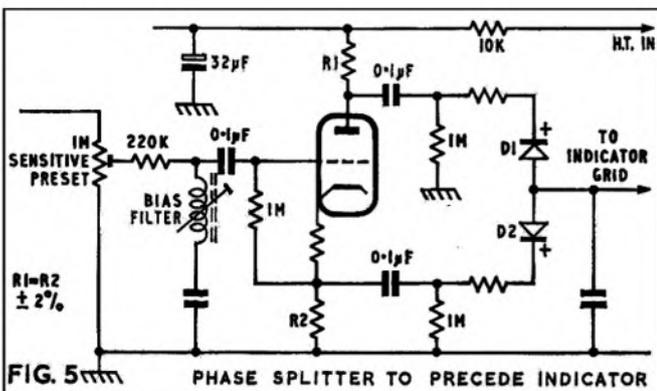


FIG. 5

PHASE SPLITTER TO PRECEDE INDICATOR

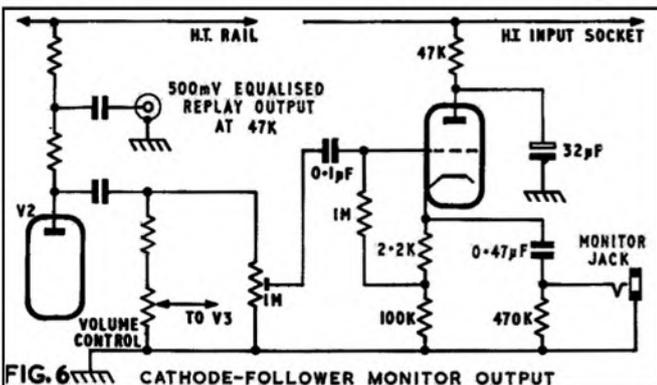


FIG. 6

CATHODE-FOLLOWER MONITOR OUTPUT

diode, which is used to provide the leakage resistance through which the charged capacitor between grid and earth slowly discharges. Cheap surplus silicon diodes can be used and these typically have a very high back-resistance — which is thermally stable as the diodes are silicon—and with the capacitors shown give the discharge time-constants of about one second for the ME circuit, and two seconds for the meter circuit, which can use a normal medium-speed meter movement (1mA or less) as found on some recorders, including one version of the Brenell. The capacitor may need adjustment in value if the diode has a significantly different back-resistance from that assumed (the capacitor itself should be ceramic for stability and low leakage) and the series resistance correspondingly altered so that the charging time-constant is maintained at 2-3mS. The relatively high values used for these resistors virtually swamp the effects of changed settings of the level preset control and of the forward resistance of the diodes. As surplus silicon diodes can be obtained so cheaply—from 3s.—it may be felt worthwhile to alter the diodes rather than the rest of the circuit.

The magic eye circuit gives an approximately logarithmic response over a usable range of about 18dB plus overload. To introduce non-linearity into the meter circuit, the meter is by-passed with a germanium diode which progressively shunts the meter as the voltage across it increases. A silicon device is not generally suitable here. The prototype used a battered *Brimar GD4*, but again surplus types should prove satisfactory and much cheaper! The response is not truly logarithmic over the voltage scale otherwise achieved. Some diodes give a 'better' non-linearity than others and if several are available it is worth experimenting to see which diode allows the smallest signal to register and gives the most nearly logarithmic response to the indicator. Half an ECC83 or ECC81 can be used in the meter circuit (and the phase splitter if required); an ECC81 gives one easier control of the zero current with a 1mA meter.

Some people find it very hard to determine the point of maximum acceptable distortion aurally when lining up and adjusting sensitivity of the indicator circuit on a pure tone. Using radio as a signal-source is not really satisfactory owing to the rapid fluctuations in mean level and the fact that maximum peaks occur only occasionally. A more satisfactory method appears to be to hum quietly or sing a high note (falsetto if necessary) and to record this at various levels, adjusting the sensitivity control to indicate peak level each time, until a level is found where the distortion just becomes unpleasant. This requires a certain degree of breath control and is best done while friends and relations are out! But it does have the advantage of simplicity and of being nearer the realistic programme material than a pure-sine wave, so that the onset of distortion is more easy to recognise. Radio or live recording can then be used as a check if required.

A further and very useful modification is to fit a cathode-follower output (fig. 6). This can use the spare half of the twin triode used for the meter circuit, unless this is used for a phase splitter, and can be either an ECC81 or ECC83. The take-off point for the signal can either be the coaxial socket at the back of the amplifier, which gives an equalised output of about half a volt on replay, or from the slider of a preset between the anode of the same triode and earth, which allows adjustment of the output level to avoid overloading an external amplifier. The low impedance output allows long connecting leads between the recorder and an external amplifier without high frequency loss and it is conveniently connected to the old monitor output jack socket.

On record, the output can be connected to a monitor amplifier (with treble cut to offset the treble pre-emphasis) or in the last resort it provides a better output to high impedance headphones than the old high-impedance monitor output; this allows prefade listening which is invaluable when recording.

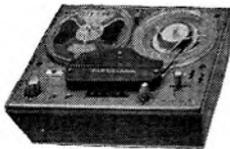
If all these modifications are to be accommodated the easiest way is to add a small sub-chassis in 16 SWG aluminium below the meter/magic-eye aperture in place of the tiny one fitted to support the magic-eye base, at a level corresponding to those on either side. Otherwise space for a valve on the switch chassis can be used, provided sufficient care is taken with the positioning of signal-carrying components to avoid pick-up in the low-level high impedance circuitry in that area.

In closing, it should be pointed out that Messrs. Brenell are in no way responsible for these suggested modifications and, of course, no modification should be attempted without their consent within a recorder's guarantee period.

"WHENEVER THE DEMAND IS FOR PRECISION RELIABILITY AND NATURAL SOUND REPRODUCTION —THE CHOICE MUST BE TANDBERG"

SERIES

6



Model 64 4 track
Model 62 2 track
Price 110 gns. each.

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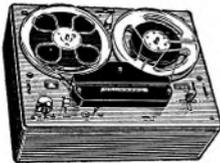


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8

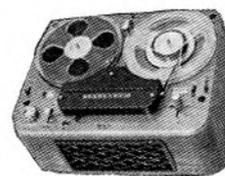


Model 823 2 track (teak case) 54 gns.
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High class monaural tape recorders suitable for home, business, education, photo sound, etc. (3 $\frac{3}{4}$ and 1 $\frac{7}{8}$ I.P.S. speeds—7" reels).

SERIES

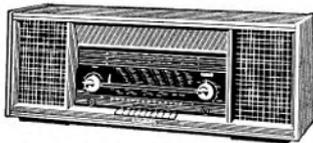
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Model 92 2 track only (teak case) 69 gns.

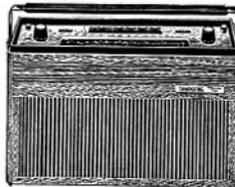
High class monaural 3 speed (7 $\frac{1}{2}$, 3 $\frac{3}{8}$, 1 $\frac{7}{8}$ I.P.S.) tape recorder, with quality comparable to the famous Stereo models. Extremely reliable machine recommended for all home and educational purposes, etc.

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Model 7-41 without speakers 80 gns.
Model 7-42 with speakers 87 gns.
Incorporate stereo amplifiers (for series 6 recorders) and outstanding radio performance so necessary in Scandinavia. F.M. and L.W. M.W. S.W.1. S.W.2. A.M. bands. Novel "Baby Sitter" circuit.

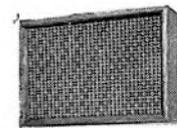
TRANSISTOR RADIO



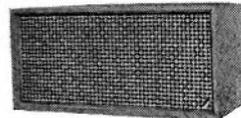
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Covers L.W. M.W. S.W. and F.M. bands
Special facilities for car radio use (special car accessories available) Handsomely styled in walnut. Fine performance and quality sound reproduction, separate bass and treble controls.

LOUDSPEAKERS



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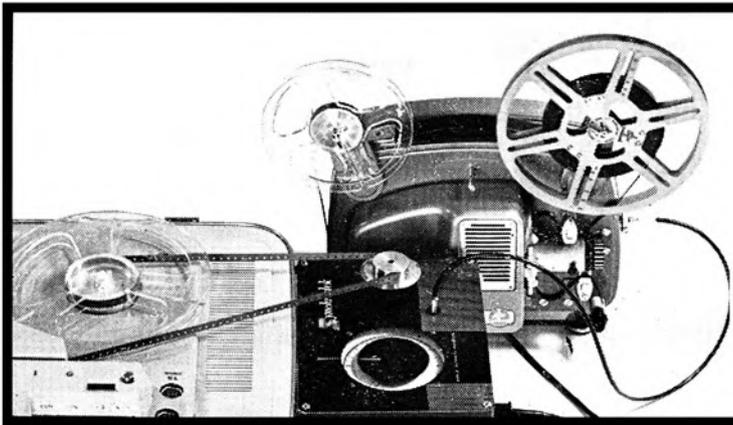
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In handsome teak cabinets specially designed for use with Tandberg Tape Recorders and Radios. Can High Fidelity reproducers. Dimensions: 22" x 10 $\frac{3}{8}$ " x 9 $\frac{7}{8}$ " deep. 14 $\frac{1}{8}$ " x 10 $\frac{3}{8}$ " x 5 $\frac{7}{8}$ " deep.

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sound and cine

LINKING WITH THE PROJECTOR
BY ANTHONY WIGENS

IF you want to make sound movies, first check your tape recorder. Nearly every mains model is suitable for linking to a silent cine projector. The basic requirements are that it should record at $3\frac{1}{2}$ i/s and that the spools are not recessed into the tape deck. You will need to pull a loop of tape out from the head and level with the deck, to establish the physical link with the projector, before it returns to the tape take-up spool.

Many silent projectors have variable speed motors, and for a good few of these tape-loop synchronisers are available. The best known device is the *Eumig Phonomatic*. It adds £8 15s. to the price of the *Eumig P8 Automatic Novo*, which is £41—the projector with its sound coupling becomes the *P8 Phonomatic Novo*, price £49 15s.

Some projectors have synchronous motors, and for them loop attachments are not available. The answer in these cases is to buy a *Synchrodek*, which is 19 gns. The tape from the recorder runs around the *Synchrodek's* capstan, but two connections have to be made to the projector, one mechanical, one electrical.

With some projectors (notably the *Bell & Howell* models and the *Bolex 18-5*) the cable link fits easily on to the inching knob projection of the drive shaft. With others it is necessary to drill through the body to make the connection. The electrical connection will also differ from make to make, so that many customers will require specialist assistance after they have bought the *Synchrodek*, especially as a number of different adapters are produced. If you find the inconvenience of being parted from your projector a little daunting, remember that this is a once and for all time conversion.

The *Synchrodek* itself is basically a differential gear-box with links to the tape capstan and the projector drive. Any difference in the running speeds is shown on a calibrated dial (which is also used for frame counting during editing and sound track compilation) and controls the on-off ratio of a rapid make-and-break switch, which is wired in series with the projector motor. The makers claim that synchronisation stays within half a second over a thirty minute film. If you use sprocketed tape (an extra £3 5s. for a *Synchrodek* sprocketed capstan) you should be able to achieve lip sync.

With either a *Synchrodek* or a loop synchroniser the sound track is compiled in basically the same way. First, start marks are established on both the tape and the film. If you ever intend entering for competitions or letting others project your films, it is well to start straight away using the standard synchronising method established by the *Institute of Amateur Cinematographers*. Allow two feet of leader for the film and five feet for the tape. The word "Start" is marked after the leader, on clear film with black lettering covering two frames for the projector, and black on white occupying at least $\frac{3}{4}$ in. of tape. These are positioned in the projector gate and over the sound-head respectively. After the film start mark there should be two feet of black spacing before the first visual. Sound can start before the first visual if necessary, but not earlier than three seconds after the start mark.

Controls should be set on both projector and recorder in advance. With the *Synchrodek* it is only necessary to put the recorder running

speed to $3\frac{1}{2}$ i/s for normal use (a separate rubber capstan is available for $7\frac{1}{2}$ i/s running, price £1 11s. 6d.). The projector and recorder can be started independently. When both are running, the *Synchrodek* provides compensation to re-establish sync.

With loop synchronisers a little more care is required. The projector must be set at its maximum running speed. The start of the film is controlled solely by the recorder, but the projector must be switched on first. The sequence is to give a preliminary warm-up run on the recorder, then switch off. Lace up the projector and close gate after checking position of start mark. Set up recorder with start mark over playback head, then pull off a loop from the take-up spool for lacing through the loop synchroniser. Lift rocker arm on the synchroniser and tighten tape to hold it in position. Check again that start mark hasn't been pulled out of position on recorder. Lastly, switch on the projector, which will not start until the recorder is switched on to begin the show.

If the rocker arm on the synchroniser is not raised, the projector will start running when switched on, just long enough for the rocker arm to rise. The film will then have to be re-threaded to bring the start-mark back into the gate.

This is the set-up both at the start of a recording session and at the start of a show. The simplest way to construct a sound track is to compile it, from a previously-made cue sheet, during the projection of the film. You can feed in music without picking up the projector noise, but unless you take steps to divorce yourself from the projector, commentary and sound effects fed in through the microphone will be joined by its running sound. Admittedly some of the noise will be masked by the same running sound when you play-back, but it is best to avoid it.

Normally the first run through is used for timing purposes only, and a script is compiled with timings in the margin, to which the sound track is subsequently fitted. There is then no need to run the film through the projector again, except as a final check and during actual shows. Unlike tape, film is subject to demonstrable wear on projection.

With the $\frac{1}{4}$ -track recorders you can use one track to note all the dubbing requirements as you watch the film, like this: "Cue grams, 'Sea Shanty' music at start of yacht race. Spot sound effect coming up, starter gun explosion, now. Start commentary as yachts go round marker buoy. Pause. Reference to capsizing coming up. Yacht heeling over now. Sail touches water now . . ."

The general timings and incidents will be known from the initial film editing. Otherwise it would be impossible to compile a cue track from cold, on first seeing a film. When it is completed the cue track can be run through and at each point where commentary, sound effect or music is required, switch over to the second track to record it.

One last point on the loop synchronisers. Although they must be set at maximum speed to function properly, the projector will probably be re-set to nearly minimum when you re-wind the film, to give it a gentler ride and avoid damage by 'cinching'. Don't forget to re-set the speed control to maximum before setting up for another show. Tape-film set-ups are fine when they work first time off, but infuriating when you overlook a point like this, causing the tape to spill and snarl because the projector cannot keep pace with it!

Above: *Synchrodek* tape synchroniser connects *Bolex 18-5* projector with *Grundig* recorder. Sprocketed tape is employed for closer sync.

TAPE DECKS ANALYSED

a close look at the
BSR TD10

TAPE decks come and tape decks go. Fashions change to suit market needs and to simplify mass-production. In many cases, evolution has meant improvement, though this is far from being a universal law where decks and recorders are concerned. But if the *Wearite* can claim to be the grandfather of the modern semi-professional tape recorder, the *BSR Monardeck* may make no less a claim to be the first truly domestic tape mechanism.

In many respects, the designer of a low-price medium-quality deck has greater problems with which to contend than the designer for whom price is no object. Domestic decks represent, not merely a compromise between cost and performance, but an attempt to produce a machine more reliable and versatile than a competitor can make at a similar cost. The ideal tape deck would be very accurately machined but would contain few components—something on the lines of the *Planet U.I* perhaps. A more complex design might achieve similar performance with wider machine tolerances though, in the long run, complexity serves none but the repair-man. Thus, if a golden rule exists to guide the deck designer, it is one that calls for simplicity and robust construction rather than unnecessary mechanical complication. Fortunately for Birmingham Sound Reproducers Ltd., many of their rival designers were neither fond of, nor adhered to, golden rules. In recent years this has led the one-time critics of 'over-simplicity' to favour the *Monardeck* as a device which, moderate as its performance may be, will run for years without fault. The *Monardeck* has a lifetime of some eight years to back up its theoretically slow rate of wear; modern recorders, particularly those of Continental origin, have yet to face the test of time.

To enthusiasts interested in dissecting and studying tape mechanisms, the *Monardeck* is almost the only model simple enough to understand without spending long periods tracing the action of individual rods, arms and wires beneath and around a maze of components. The new *TD10* is an even more suitable instructor, since it can teach the principle of speed switching at its simplest. And it is in the respect of tape speeds that the *TD10* differs from the *Monardeck*, apart from improved artistry above the deck. In almost every other way, the two decks are identical.

Our examination of the *TD10* begins with the basic drive system. **Fig. 1** shows the layout of idlers in relation to the motor, spool turntables and capstan, omitting the brakes and the system of levers used to position the idlers and turntables for fast winding, rewinding and playing. The deck follows standard practice in driving tape from left to right, precise speed being governed by the capstan. Irregularities in the drive are ironed out, to some extent, by a heavy flywheel attached to the lower capstan spindle.

The motor is the heart of a tape deck. Many decks, for simplicity, incorporate three motors; one for each spool turntable and one—often of superior quality to the others—to drive the capstan. It is the difficulty of transmitting drive to all three moving components that causes the complication of so many single-motor designs. *BSR*, however, have overcome these problems with a very straightforward drive system. The motor rotates immediately the deck is switched on at a constant speed in an anti-clockwise direction (when viewed from above).

The capstan idler is tensioned against the motor and flywheel by a spring, except when changing speeds, and consequently transmits any movement of the motor spindle to the capstan. Since the capstan turns at a rate designed to pull a tape at one of the standard speeds, it follows that a tape held against the spindle by another idler—the pinch-wheel (not illustrated)—must be driven at this speed. All that is required now is a mechanism that will power the take-up spool and so wind up the tape. This is achieved by a belt-transmission from a pulley on the capstan to a larger one below the spool turntable. But since the rotation speed on the take-up spool varies with the effective diameter of the tape on it, some form of clutch must be incorporated against which the turntable may safely drag. The belt is therefore attached to a metal disc (see **fig. 2**) upon which the plastic turntable rests. The turntable thus rotates with the disc unless tension from the tape becomes greater than the grip imposed on the disc by the felt friction pad.

A less complex clutch is fitted to the feed-spool turntable, which is lightly mounted on an axle and spins fairly freely in *PLAY* and *FAST FORWARD* modes. Some back-tension is, of course, needed during both these modes—to prevent tape spillage in the former case, and to ensure an even and fairly tight wind in the latter. This tension is supplied by felt rings beneath the left-hand turntable.

A three-position mechanical selector governs *PLAY*, when pushed

forward, *REWIND* when pushed to the left, and *FAST FORWARD* when located in the right-hand arm of its inverted T-slot. *Rewind* entails high-speed spooling of the tape from right to left-hand reels. To achieve this, the deck must be arranged in such a manner that the left-hand turntable is driven fairly quickly while the right is allowed to run free—or lightly tensioned as mentioned above. Since the motor spindle is rotating anti-clockwise barely an eighth of an inch away from the periphery of the left-hand turntable, the most economical and practical means of driving the turntable in a clockwise direction is to move it until it is locked against the spindle. And this, in fact, is just what occurs. The capstan continues to rotate during *rewind*, but this has no direct effect on tape speed, since the pinch-wheel is fully retracted.

The indirect effect on *rewind* speed, however, makes itself known through the capstan-right-hand turntable drive-belt which tries at all times to rotate the right-hand spool through the clutch. As will be seen from **fig. 1**, this attempted rotation occurs even when the machine is switched to *STOP* and only the brakes prevent such movement taking place. The result is that back-tension on *rewind* is a little greater than it should be and winding speed is nothing like as fast as that on three-motor decks. The *BSR* deck is by no means alone in having this 'fault', since a similar clutch and drive arrangement is used on many other single-motor machines.

Resistance from the right-hand turntable clutch is less marked on *FAST FORWARD* since the capstan-clutch belt is over-ridden by a separate idler giving direct transmission between motor and take-up turntable. But as the right-hand turntable rotates at a greater speed when *forward* winding than ever it would do during *playback*, the cotton pads slip in an anti-clockwise direction against the slower anti-clockwise moving clutch. The *fast forward* idler (so labelled in **fig. 1**) is hinged in a simple fashion between motor spindle and right-hand turntable periphery. During *STOP*, *PLAY* and *REWIND*, this idler is suspended limply and is free to engage either motor or the turntable, though one assumes that it remains centralised when operated in a horizontal position.

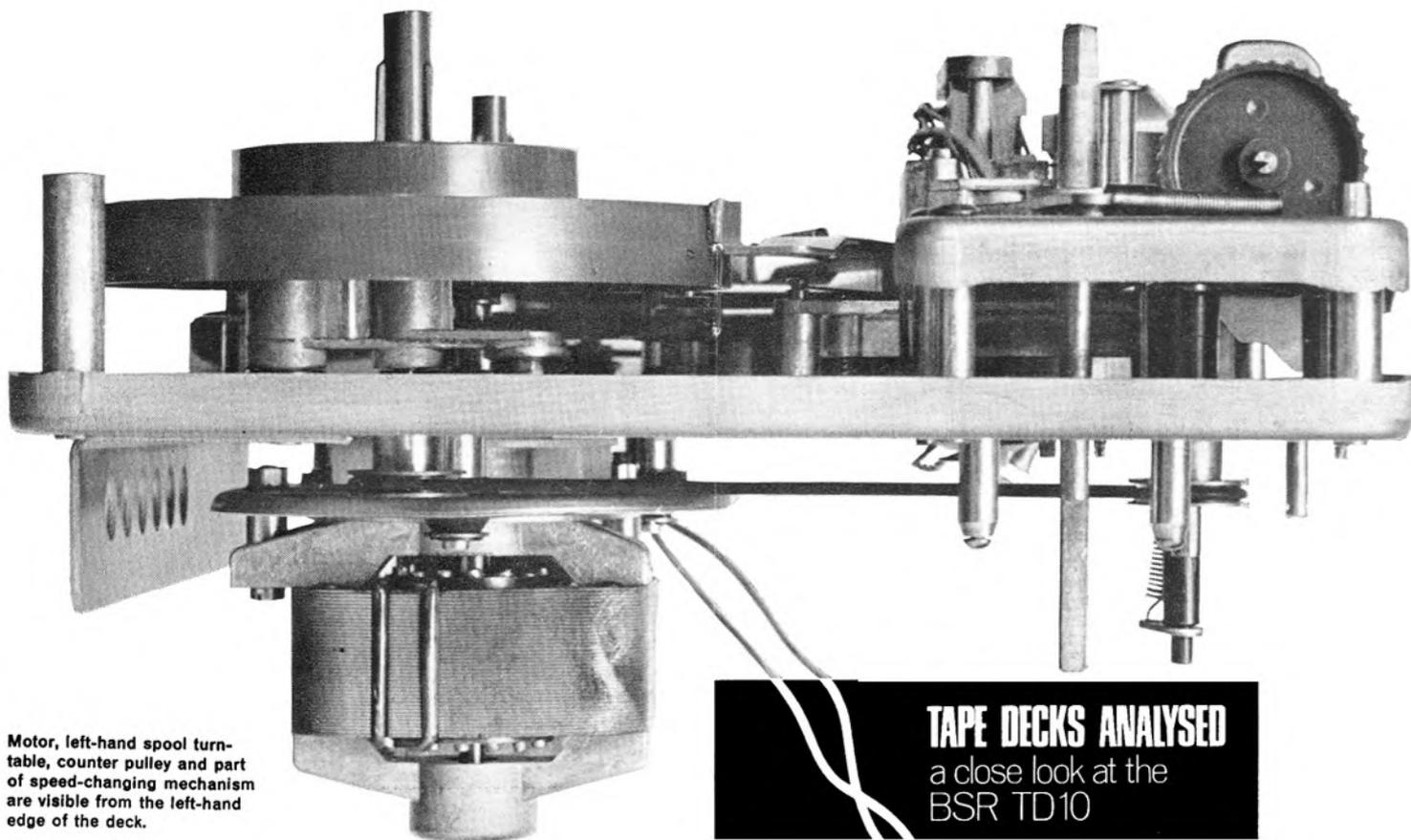
This, then, is the *BSR* approach to a single-motor tape drive mechanism, and in essentials that is all there is to the *TD10*. Rather more complicated to trace and understand are the brakes and the control mechanisms, responsible for positioning of each mechanical item. Nevertheless, their functions are simple—more so on this deck, perhaps, than on any other.

Fig. 3 provides a bird's-eye view of the head block and its connection to the mechanical controls. All three controls on the *TD10* are illustrated, though the speed switch is represented, for the moment, merely as a vertical metal bar protruding through a slot in the chassis. All these components are mounted on a platform raised from the base of the deck to the same level as the base of the spool turntables. Drive transmission and control levers all operate in the space of about $\frac{1}{2}$ in. between this raised plate and the base. The three-way lever shown in **fig. 3** and **fig. 4** is without doubt the most complicated single item on the deck. It is best described as a meeting place of levers. **Fig. 4** shows the levers in 'exploded' form. Uppermost of the four levers is that shown in **fig. 3**. The entire 'arm' is hinged about a point just left of the erase head and is held taut by a spring forward and to the right of the spindle. The spindle is mounted to the lowest of the four levers and is free to move forwards to *PLAY*, back again to *STOP*, right to *FAST FORWARD* and back left through *STOP* to *REWIND*. Each action, into or out of a mode, is resisted by an ingenious yet simple spring arrangement which, once the spindle has passed the half-way mark in its channel, reverses its action and forces the spindle into its destination. The spring is responsible for the very positive action of the switch and is a strengthened version of that used on early *Monardecks*.

The positioning of pinch wheel, pressure pads and record interlock catch are all governed by this, the uppermost lever. The action is simple enough. Pushing the control spindle to the left or right has no effect on the lever, other than a slight oscillation towards the heads as the spindle is drawn straight across the W-shaped mechanical lock. This W arrangement assists the spring in retaining the spindle when in a *STOP* position.

The second of the four levers, situated just below the raised chassis plate, operates a lock across the *RECORD* switch, preventing the latter from being switched into position during *fast forward* or *rewind*. The original *Monardeck* did not have this facility, and thus this new arrangement eliminates a fault—or useful feature, depending on how one looks at it—common to many machines which used the single-speed deck. On some single-speed *BSR*-decked recorders, high speed

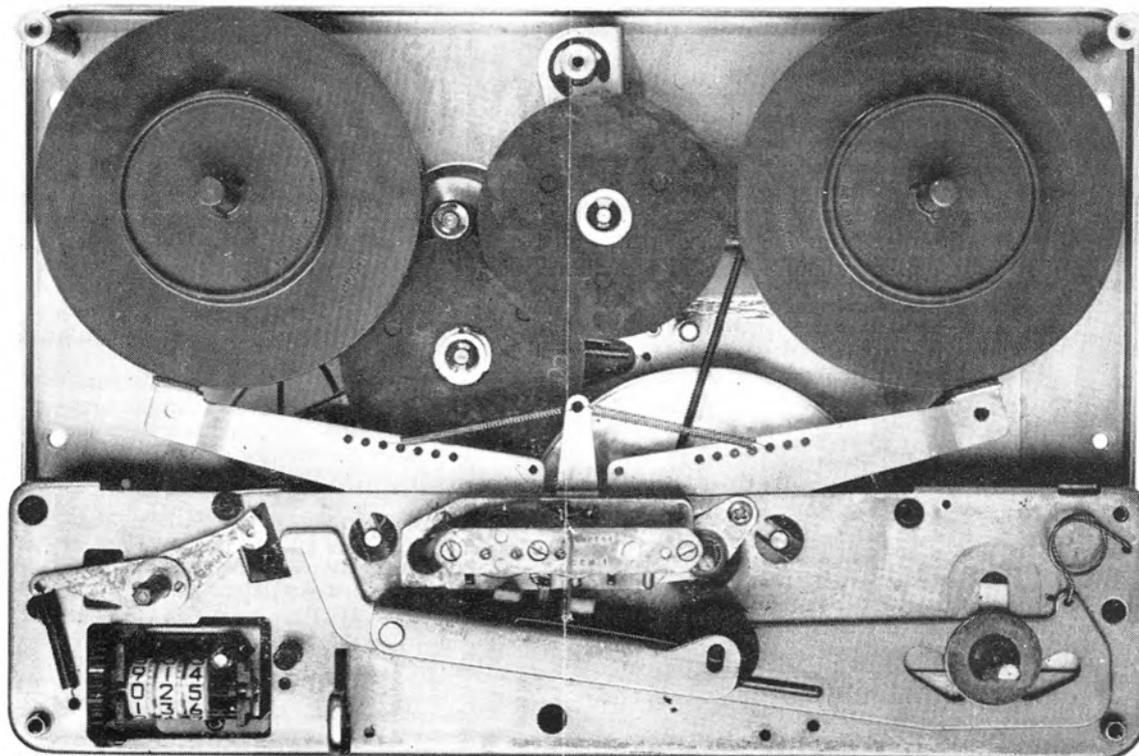
(continued overleaf)



Motor, left-hand spool turntable, counter pulley and part of speed-changing mechanism are visible from the left-hand edge of the deck.

TAPE DECKS ANALYSED
a close look at the
BSR TD10

Removal of five screws and two control knobs gives access to the heads, brakes and idlers.



erasure of a tape could be accomplished merely by fast winding the tape and at the same time holding the record interlock in the on position.

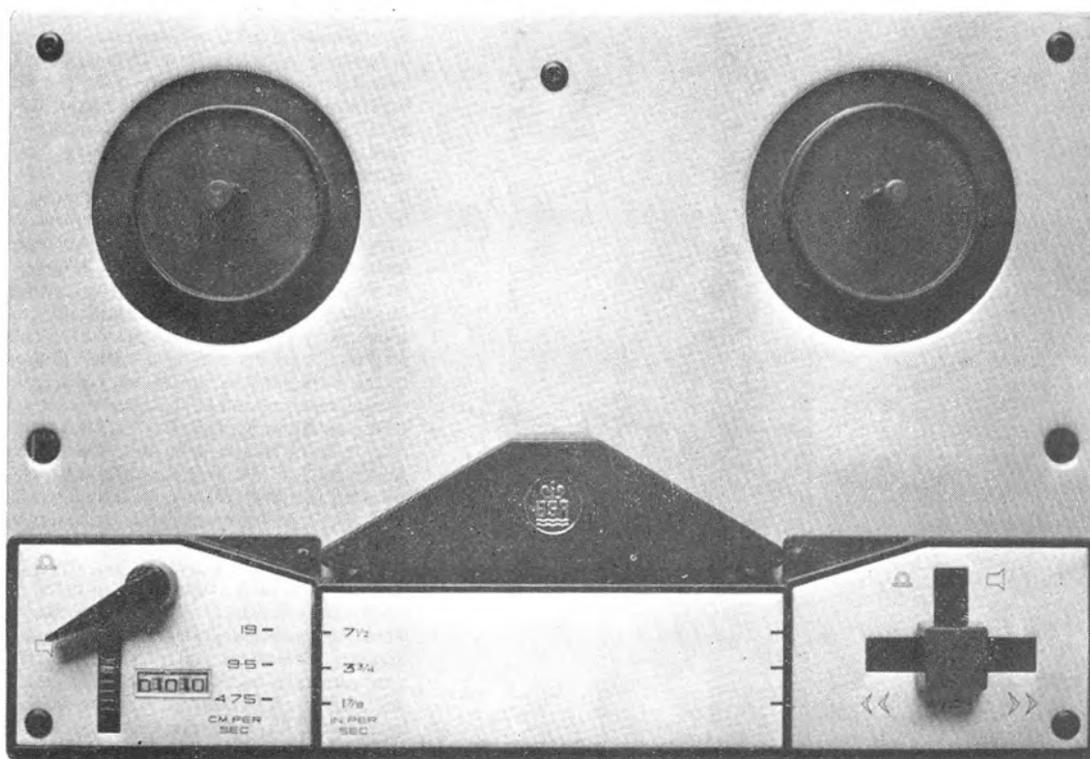
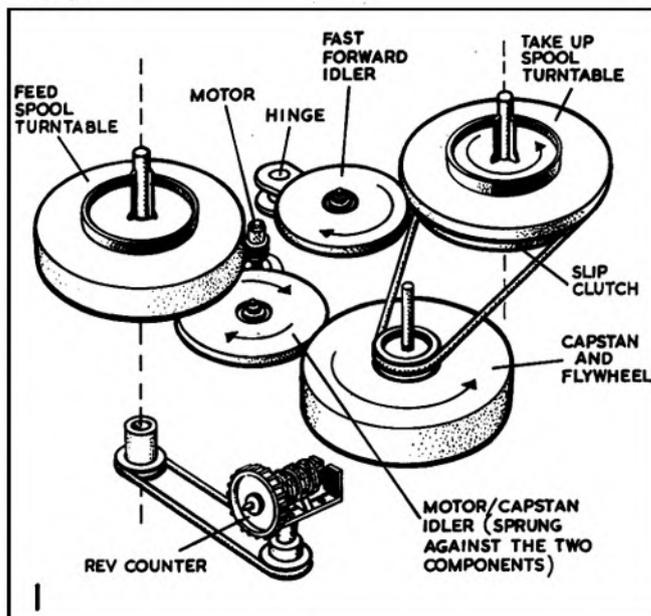
Third in the line of levers is the brake lever. This is presented to the selector switch as an inverted V-shape, the lever being pushed forward about its pivot whether the switch is moved to the left, right or straight forward. A protrusion from the lever passes the motion to the brakes which, in turn, swing about a pivot. The brakes are held against the two spool turntables by a pair of springs until the control lever forces them out.

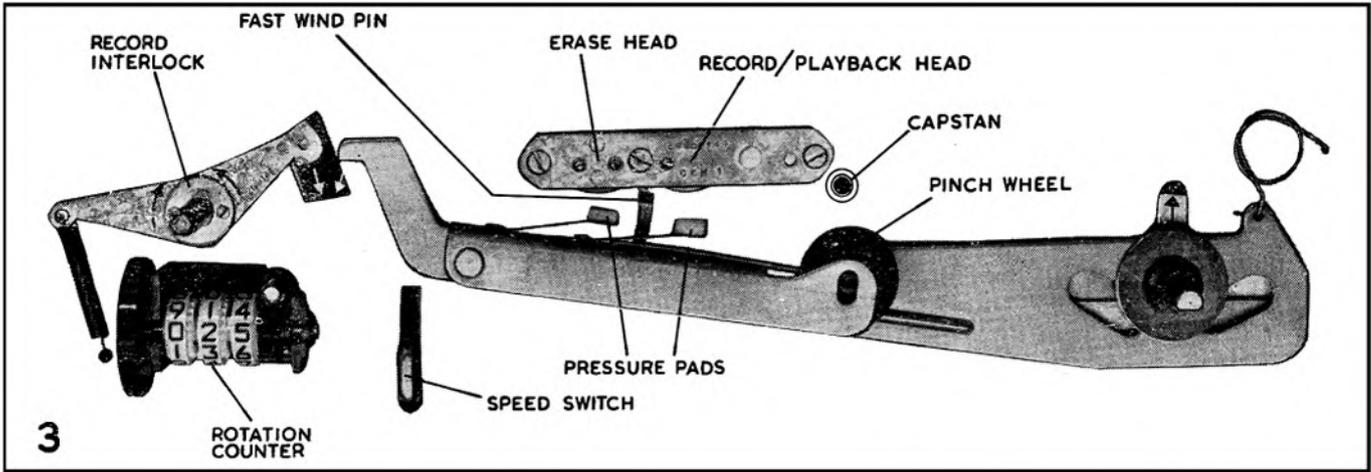
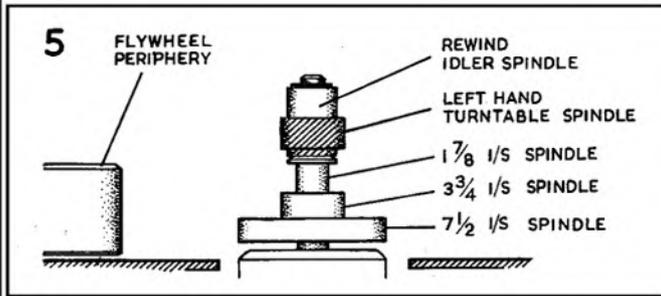
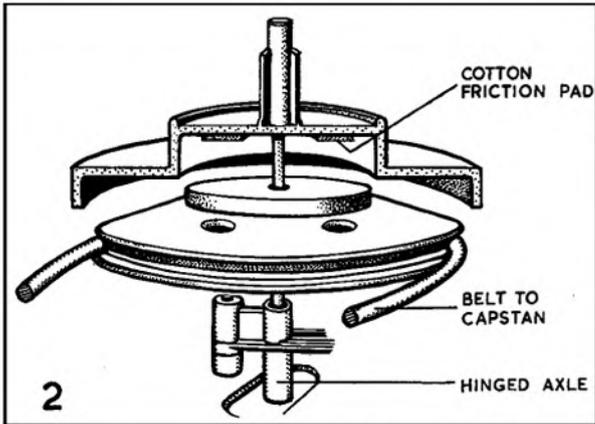
Most complex of the four levers is that at the bottom of the three-way switch. Again illustrated in fig. 4, this lever operates through 90° to move the spool turntables against the motor spindle. Pushing the switch to the right causes both turntables to move left, the right-hand one against a jockey pulley and hence the motor spindle. The movement of the left-hand turntable, in this case, is incidental and serves no real purpose. Pulling the switch into the left channel moves the two turntables to the right, the left-hand one direct against the motor spindle. At the point which engages the left-hand turntable, the spindle is tyred with rubber. The two idlers operate against metal.

Fig. 5 shows the rubber tyre and also the stepped spindle, doubling in diameter to give 1½ and 3¼ i/s, and further doubling to rotate the capstan, via the rubber idler, for a 7½ i/s tape speed. This brings us to the speed selecting mechanism. This is about as simple as it is possible to make a speed selector, though nevertheless fully effective. Fig. 5 shows the relationship between motor spindle and periphery of the capstan flywheel. It should be clear from the illustration that, since the motor turns at a constant rate, the speed of the idler, and hence capstan rotation, will depend solely on the vertical positioning of the idler in relation to the various steps. An 'exploded' view of the idler retracting and vertical positioning levers is given in fig. 6. As shown, this is set to the 7½ i/s tape speed, and pushing the control forward (in the direction of the arrow) causes the entire idler and supporting frame to move downwards. A peg, protruding from the frame into the stepped cutout on the sliding control, is supported against the steps by a spring which connects the bottom of the plastic support bar to the deck. The drop between each step in the cutout metal control slopes at about 45°, and slight friction between slope and peg as the control is pushed forward from slow to faster speed results in the entire idler bracket retracting for an instant from the motor spindle. This friction does not occur when changing down in speed, though it is not necessary

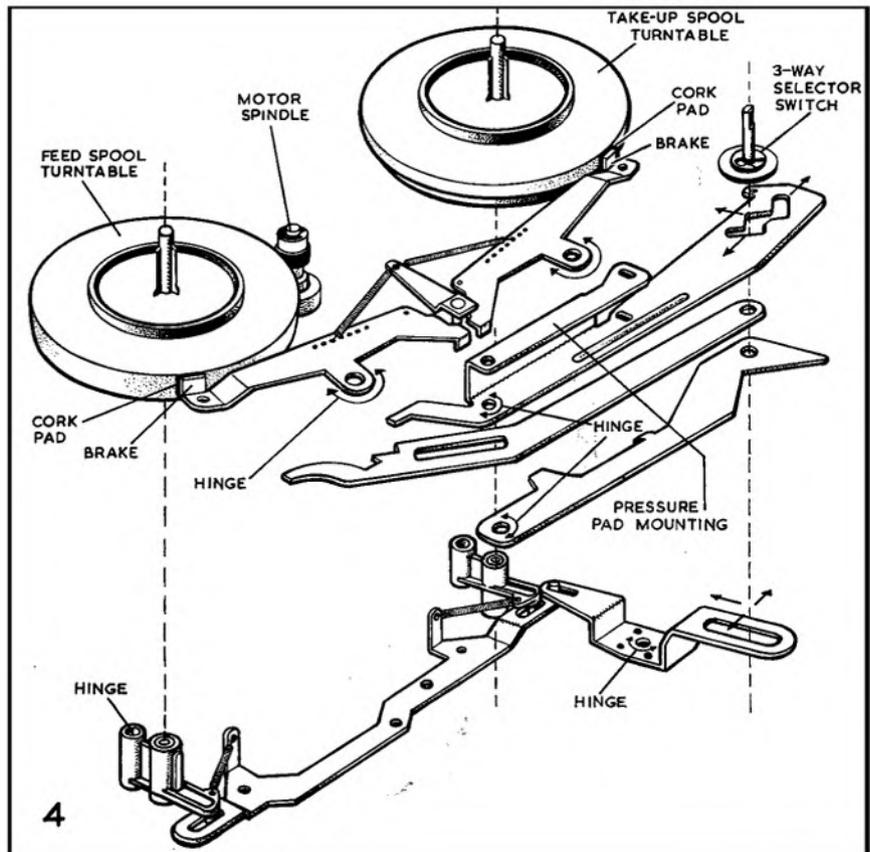
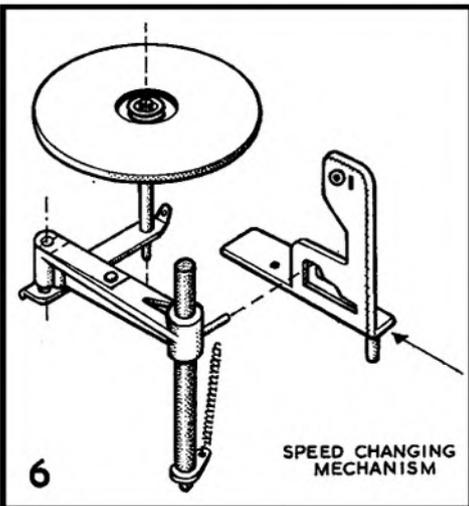
for the idler to retract—it merely jumps straight down from wide to narrow spindle periphery. Absurdly simple, but foolproof and reliable.

In closing, it might be of interest to note that of the deck's total retail price (£14 in ½-track form), some £5 is devoted to the erase and record/playback heads, while the motor costs a little over £2 10s. Out of the remaining £6 10s., BSR have built a deck as rugged and reliable as it is possible to buy. The reader may not own a Monardeck or TD10 himself but, even if not the 'peering under decks' type, he might find it worthwhile and interesting to examine his machine and determine the similarities, the better points, the worse; such a study can only result in a better understanding of the machine, which in turn will simplify the task, and increase the followers, of 'do-it-yourself servicing'.





TAPE DECKS ANALYSED
 a close look at the
 BSR TD10



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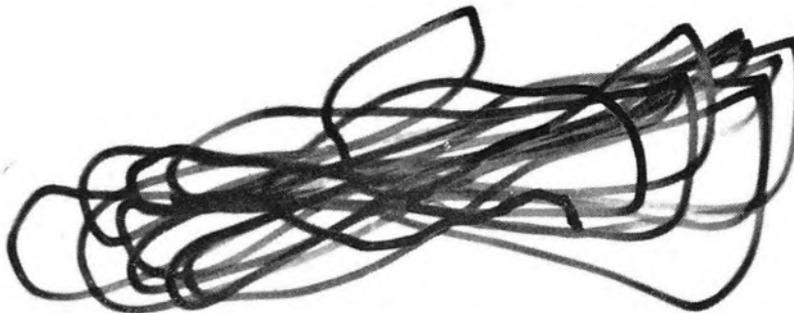
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BTRC 65



JUDGES' VERDICTS ON THE 1965 BRITISH TAPE RECORDING CONTEST

FINAL judging session of the ninth *British Tape Recording Contest* took place at Mullard House, London, on July 28th. Following a careful pre-selection and elimination process applied to the largest-ever total entry by the B.T.R.C. committee under its Chairman, C. Rex-Hassan, a panel of judges listened to twenty-five tapes in various categories. Ten awards were made, three according to the experience of the entrants, one for the 'Tape of the Year', and six for various subject sections.

The BASF Shield for the best *Schools* entry went to "A day at Grange School", a rather imaginative documentary prepared by 12-13 year-olds with the minimum of guidance and assistance from their form master. "Henry," an uproariously funny mock-ballad in neo-folk-music style submitted by Peter Cox of Plymouth, received the Acos Cup in the *Music* section, while the best *Clubs* entry was judged to be "Mushrooms", a gently philosophic but very absorbing and rather moving fantasy about the threat of nuclear war. This was submitted by Hertford College, Oxford, and receives the Amphlett Shield donated by the Federation of British Tape Recording Clubs.

In the *Documentary/Actuality* section the Kodak Shield went to Dr. A. C. Watt of Sunderland for his "Portrait of Caletta", a smoothly integrated holiday sound-shot album that conveyed some nice Spanish seaside atmosphere. In this same section, but not winning, were a rather quaint interview with a rag-and-bone man conducted by H. J. Bradley of Croydon and called "The Real Thing", and "Lovely things to look at", with sounds of antique out-of-tune keyboard instruments recorded by J. B. Cartnell in various Lancashire museums. *Humour* brought Ray King, last year's 'Tape of the Year' man, the Mastertape Trophy—this time for "The Nose", an admirable selection of sinus sounds projected in harmless sonic fashion. The BTRC *Stereo* prize goes to P. Lawson-Smith of Bourne End for "Thos Mortier Organ", a convincing recording of a Belgian fairground steam organ.

The three awards according to status were for Novices, Amateurs and Professionals. Oddly enough, one of the judges—disc-jockey Alan Freeman—qualified as a *Novice* by the competition's rules and his tape came up for consideration. Mr. Freeman left the team and then found himself impartially judged winner of the Philips Shield and £25 cash with his tape "Fan Club".

The *Professional* winner (Scotch Trophy from 3M) was Fred Judd,

Above: Laughter greets an excerpt from the *Humour* section

Editor of *Amateur Tape Recording*, who also had to leave the team of judges while his entry was heard. In fact his tape, "Tempotone," a concentrated and very effective piece of electronic music, had already been chosen by the BTRC committee to avoid professionals judging professionals, and was heard by the final judging team as it had to join the others for consideration as 'Tape of the Year'.

This last honour, for which the entrants receive the Emitape Challenge Cup and £50 cash, went to the Oxford team mentioned as winners in the *Clubs* section with their "Mushrooms" tape. This nine-minute drama-fantasy held the judges in complete and concentrated silence, with its intriguing combination of solemnity and sincerity.

A few tapes could not be placed satisfactorily in any of the Competition's sections, but were still considered worthy of hearing for this final judging. "No Title," a clever and fascinating sequence of electronically produced sounds prepared by T. F. Holmes of Redditch, was judged to be very good, and Mr. Judd offered to give a prize because of his particular interest in this field.

The British Tape Recording Contest is sponsored by the leading tape manufacturers. These are represented on the committee, which attended for observation during the final judging. The team of judges for this 1965 event comprised Donald Aldous (*Audio and Record Review*), John Borwick (author and broadcaster), Douglas Brown (*Tape Recording Magazine*, but unfortunately unable to come), John Crabbe (*Tape Recorder*), Timothy Eckersley (BBC), Alan Freeman (TV personality and disc-jockey), John Gilbert (Northern Polytechnic, but unable to attend), Fred Judd (*Amateur Tape Recording*), Eric Robinson (conductor and TV personality), and representatives from the Federation of British Tape Recording Clubs led by their Chairman, Alan Stapleford. We hope to report on the prize-giving and publish details of the 1966 Competition in a later issue.

Six entries from this British contest will now go forward to the International Amateur Recording Contest, to be held in London this year. We understand that there were more tapes submitted for the British competition this year than were received for any of the other national contests.



towards
BETTER
taping



PART 19 Stereo Tracking, Phasing and Balance

BY GORDON J. KING

CONTINUING on the subject of stereo, there are one or two things that should be made clear. We have seen that stereo recording and playback requires the simultaneous use of two tape tracks. Some stereo tape recorders feature special dual heads (stacked) with two $\frac{1}{2}$ -track gaps for making and playing back stereo tapes having two half tracks.

Last month, we saw that the true stereo tape recorder is one that features dual amplifier channels both for record and playback. Some models, however, while having the above facilities, call either for an extra speaker for the second stereo channel or for an extra playback amplifier *plus* an extra speaker for stereo.

It should also be understood that, while $\frac{1}{2}$ -track mono tape records can be played back on the majority of $\frac{1}{4}$ -track recorders, $\frac{1}{2}$ -track stereo tape records cannot usually be played back with the maximum of success on $\frac{1}{4}$ -track tape equipment. The reason for this is that the two head gaps of a $\frac{1}{4}$ -track tape head fail to embrace equal widths of the two tracks. This means that the head whose gap embraces the greater width gives a greater output signal than the head whose gap embraces the smaller width. Not only is stereo balance upset due to this, but the signal-to-noise ratio may differ on the two channels.

Nevertheless, experimental stereo is possible in spite of the shortcomings mentioned, and it may be possible to restore a reasonable stereo balance by adjusting the gains of the two amplifier channels accordingly.

Like mono, therefore, stereo can utilise either two half tracks or two quarter tracks. In the former case, the tape width can carry only one programme, while in the latter case, two stereo programmes can be accommodated on a full tape width, the second programme simply by interchanging the spools and thus inverting the tape relative to the heads.

Quarter-track stereo occupies tracks 1 and 3 for one programme

and, after inversion of the tape, tracks 4 and 2 for the other programme (or, of course, continuation of the first programme!).

In practice, of course, it does not matter much whether the right-hand stereo channel is recorded on the top track and the left-hand channel on the bottom track, or vice-versa, provided that the corresponding disposition is carried right through to the speakers on playback. The stereo effect still exists whichever way round the speakers are disposed, but a degree of reality is lost in music if sound in the true right-hand channel is coming out of the left-hand speaker.

Stereo recordings have been made with the top track on the right-channel and the bottom on the left-channel, and vice versa. An accepted practice, however, is to record the left-hand channel on the top track, that is when the tape is travelling from left to right with the coated side away from the observer. This would apply both to $\frac{1}{2}$ -track and $\frac{1}{4}$ -track stereo recordings, as shown in **fig. 1**.

Stereo recorders (the *Akai Series*, for instance) sometimes utilise the internal speaker (if there is only one) on the left-hand channel on stereo (a second speaker for the right-hand channel thus being required), and it is this channel which occupies the top track of the tape, thereby confirming what has just been said about left- and right-hand tracks. So much, then, for track identification. There can be no hard and fast rules here, and if the rhythm section appears on the wrong side of the room when playing a tape record, well, the solution is to change over the speaker leads.

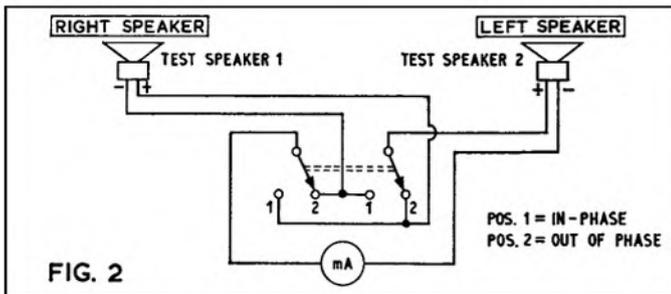
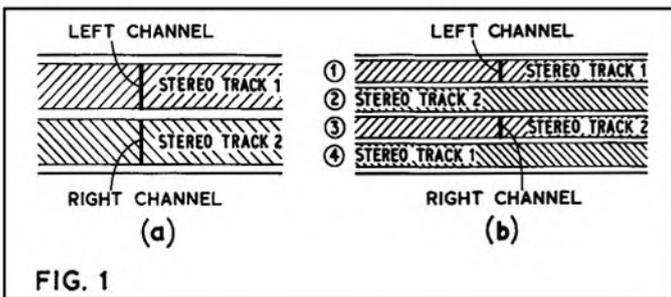
For good stereo effect it is also necessary for the *phasing* of the two channels to be matched. The phasing has to be correct right from the heads to the speakers so far as a correctly made stereo tape record is concerned, and if stereo recordings are made at home, then the phasing has to be correct from the microphones (during recording) to the speakers on playback.

Sometimes on proper stereo machines some method of speaker

phasing identification is incorporated (in terms of colour or + and - code). In this case, the amplifier phasing would be correct, as also would be the phasing relative to the heads and the input to the amplifiers. Correct phasing implies that a slow change in magnetic field across the gaps of the two head sections, say, from north to south pole at each gap, would cause the cones of the speakers both to go in or both to go out together. If one cone goes in while the other goes out, then the phasing is wrong.

It is, of course, virtually impossible to check for correct phasing by running a magnet across the gaps while observing the displacement of the speaker cones. Indeed, this would be dangerous practice as the head and steel or iron things around it would soon themselves become magnetised, detracting from the treble response and increasing the background hiss.

It is often possible to determine whether or not the phasing is



correct purely from a listening test with the speakers connected one way and then with one reversed. Out-of-phase symptoms are 'thin' reproduction with an apparent lack of bass response, giving the impression that the audio system lacks 'punch'. Certain stereo tape records are more prone to reveal anti-phase symptoms than others. Another symptom is a weak stereo effect, which shows up especially with the kind of stereo tape record that carries movement.

If a stereo test-tone tape is played on a stereo recorder, the cones of the two speakers should move in and out together, as already explained. This means, then, that if microphones are placed in front of the speakers (one in front of each speaker), the diaphragms of these will follow the movement of the speaker cones. This gives a more definite means of checking the overall phasing, for if the two microphones are themselves connected in series in phase, then their combined output voltage will be greater when the stereo system is correctly phased than when it is out of phase. This difference in output can be heard in a pair of headphones connected across the series-connected microphones.

Another method using this principle which has been suggested utilises a pair of speakers located one in front of each stereo speaker. These speakers need not be elaborate, but can be those salvaged from old radio or television sets. They are used instead of the microphones of the previous exercise.

The speakers are suspended so that their cones face the cones of the actual stereo speakers and they are wired in series, via a switch which can reverse their phase, as shown in fig. 2. In this case, the output from the series-connected speakers is indicated on a 0-100mA AC meter. Provided the test speakers are in-phase, then the reading will be larger when the stereo system itself is correctly phased than when it is out of phase.

The changeover switch can thus be marked "in-phase" and "out-of-phase". To check that the test speakers are, in fact, "in-phase" when the switch says so, the series-connected speakers should be connected

across a 1.5V cell and the connection of one reversed if necessary so that both cones go in or come out together when the battery connections are made or disconnected.

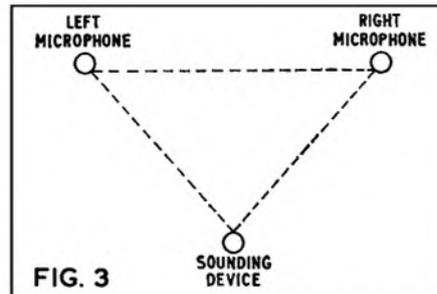
For optimum stereo, both channels need to be correctly balanced for gain (and/or signal). A stereo test-tape is useful for this exercise. Such a tape has both tracks recorded with tone at equal levels and frequency. The idea is to adjust the relative gains of the two channels until the sound image appears to exist dead-centre between the two speakers when listening on the centre line.

If the sound from the right-hand speaker, for instance is of greater intensity than that from the left-hand speaker the sound source will seem to lie more towards the right-hand speaker, and vice versa.

Some machines employ ganged volume controls, the single control knob operating both volume controls simultaneously. To afford a definite means of balancing the channels when this technique is adopted, a "balance control" is featured. This is simply a differential volume control which is common to both amplifiers, so that it increases the gain of one channel and decreases the gain of the other when it is turned in one direction from its centre position, and does the opposite thing when it is turned in the other direction.

Channel balancing can be facilitated by the set-up shown in fig. 2. For this adjustment, after phasing, the volume controls or the balance control should be adjusted either for maximum meter reading with the test switch in the "in-phase" position or for minimum reading with the switch in the "out of phase" position. Of course, for accurate results, the two test speakers themselves need to be of the same type.

The best stereo can only be realised by the use of a pair of matched speaker systems. These should be separated from each other by at least seven feet. It is a good idea to place the speakers in opposite



corners of the room, arranged at angles so that imaginary lines from the axis of the two speakers cross somewhere towards the centre of the room.

When the internal 'monitor' speaker of a stereo tape recorder is utilised for one channel and an external speaker for the other channel, first-class stereo cannot, of course, be expected. Nevertheless, depending upon the taped programme material, the stereo effect will almost certainly be present, and one is then often encouraged to invest in a matching second speaker system.

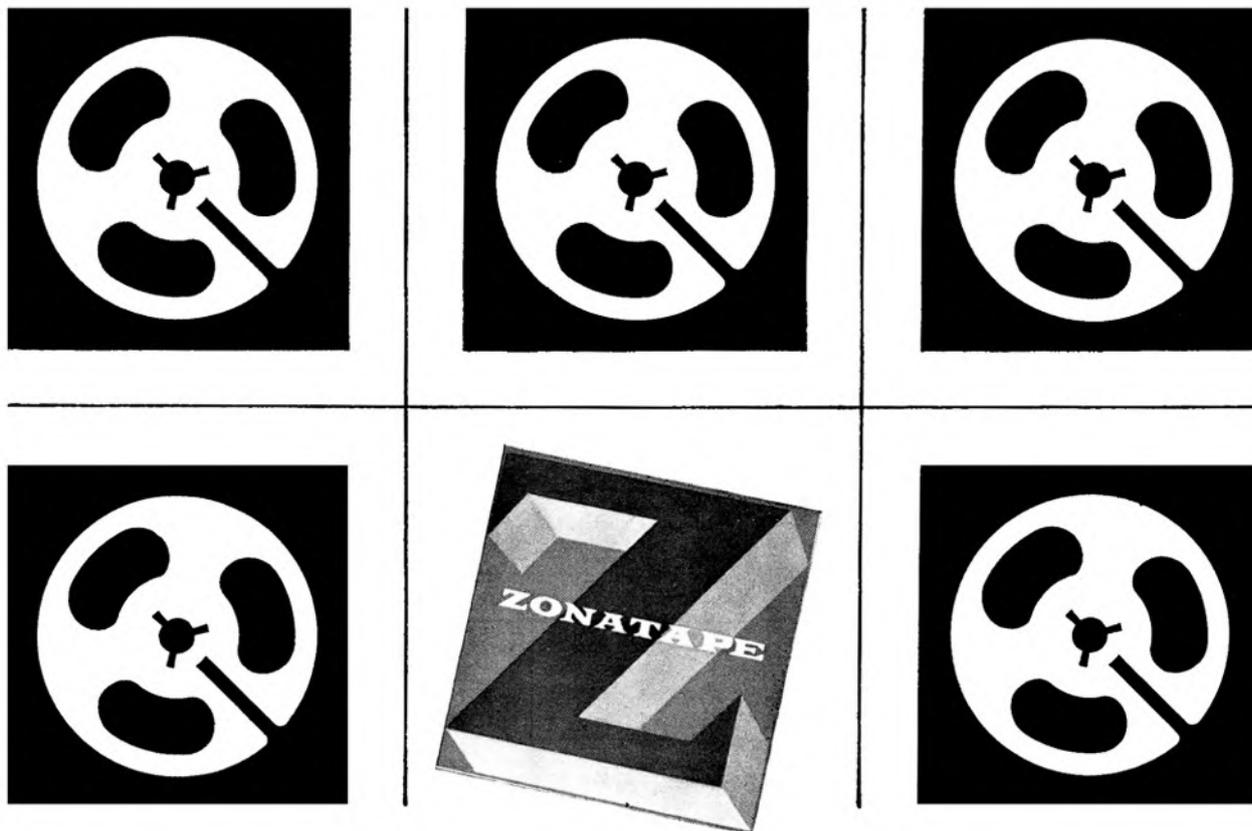
So much, then, for playing stereo tapes; but what about the making of them? There is no particular difficulty these days in producing stereo tapes. It is quite feasible, for instance, to record from stereo disc records and from stereo radio programmes (when they are available!).

In these cases, the problem is essentially that of conveying suitable signals from the two channels to the left- and right-hand inputs of the stereo recorder. Connections from the programme sources are no different from mono, and these are adequately covered in earlier articles in this series. For example, the signals from a gramophone amplifier or record player should be taken at low-level, from across the volume control tracks if signal output jacks are not fitted.

For recording stereo from radio either a special multiplex tuner is needed or an ordinary tuner plus a multiplex adaptor. Stereo transmissions occur only on an experimental basis (on VHF) at present, and the stereo programme time is very limited. Nevertheless, some interesting stereo recording experiments are made possible through the medium of radio.

The author's set-up which was used for recording some early stereo transmission from the BBC's VHF stations (not multiplex) is shown in the photo. Here, at the bottom of the trolley, will be seen a pair of VHF tuners, one tuned to the right channel and the other to the left

(continued on page 398)



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No 46

CONCLUDING
THE ELIZABETHAN
RANGE

BY H. W. HELLYER



The LZ24 tape recorder featured an Elizabethan deck.

YOU just can't win! On the one hand some readers object to lengthy coverage of certain groups of tape recorders, saying, not always so politely: "What's the matter with the So-and-So machine; are you obsessed by the 'big boys'?" On the other hand, certain peeved gentlemen demand a greater pound of flesh, wanting to know why the servicing coverage on their favourite model has been so inadequate.

Which is why this third in the short series dealing with Elizabethan machines may appear to have taken on a piebald aspect. It would need twice as many articles to cover the more recent models. Even as these words are being hammered out the trade papers are carrying announcements of Elizabethan's latest innovation, the LZ120. I am eagerly awaiting the first of these on my workshop bench, if only to take a closer look at what the photographs indicate is a completely different deck mechanism. If the machine is as good as its advance publicity says, I shall have to wait a long time.

We closed last month with the oscillator used on LZ29 machines prior to serial number 2914000. Later models incorporated a push-pull circuit built around an ECC82 double triode (illustrated in fig. 2b of last month's issue, on page 351). The oscillator is mounted on a small printed-circuit board which is fixed to the main chassis near the record/play switch. It will be noted from the circuit that the interlock switch now supplies HT to the oscillator, and incidentally shunts the 0.047 μ F capacitor as filter across the feed circuit. Cases of HT short-circuit on record only may be traced to this capacitor failing. Note that the erase head is now directly across the lower winding of the push/pull transformer, each track again being selected by the record/play switch, and that the bias is taken via a 33pH capacitor. There is still 45V bias obtainable, and about 30V erase, as with the Hartley circuit of fig. 2a. These readings must, of course, be taken with a high impedance AC meter, such as a valve-voltmeter. Using a normal multimeter will normally give an indication of about half this for the record/play head and about two-thirds for the erase head—perhaps even less with the push-pull circuit.

In this model, the LZ29L, the pentode of the ECL86 is in action as an output valve all the time (although in fact some monitoring is possible also with the basic 29) and there is no feedback circuit from

the output transformer secondary. But the treble control acts as a gain control for this stage by having its series capacitor shorted out and the slider taken to chassis during recording.

A different deck was the one attraction of the LZ30, some aspects of which have been previously discussed. Unfortunately, in the quest for simplicity, or, as a colleague cruelly put it, "to undercut BSR," reliability does not seem to have been the most important factor in its production, and the machine has since been superseded by better models. Too few have come in for service to date from which detailed service data could be prepared, and the Works have been singularly reticent. Despite repeated requests for data sheets to check my hasty scribbles, none has been forthcoming. I must add, in fairness, that there was no coyness about this; the factory is open to inspection any time we care to ask to visit. But service data—which in my humble opinion should be available to bona fide members of the trade as soon as a machine is put on the market—has been very much of an afterthought with some models. It is pleasing to note that the Automatic 200 and 400 is very amply backed by a beautifully produced manual and to be hoped that this trend will continue. With the abolition of RPM, the servicing angle assumes a much greater importance to the salesman—and to the customer.

Fig. 1 requires some apology. It is the result of hasty scribbling at the workshop bench, and reconstruction from memory, and purports to show the rudiments of the LZ30 deck. Prime purpose in showing this is to demonstrate the rather novel braking system, and the method of fast winding that is used.

The brake is a tough cord passing around part of the circumference of each brakedrum. As is well-known, this gives a form of servo action, maximum braking being automatically applied to the drum revolving 'into' the pull of the brake, with no alteration of basic braking action. The centre of the brake cord is sprung toward engagement and the brakes are held off during functions by the lever which couples to the main pressure arm acting against this spring. Fine adjustment of braking pressure can be achieved by alteration of the small brackets to which the ends of the cord are attached. All very simple, and quite effective, but perhaps it is just as well that the fast

(continued on page 397)

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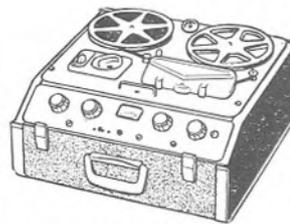
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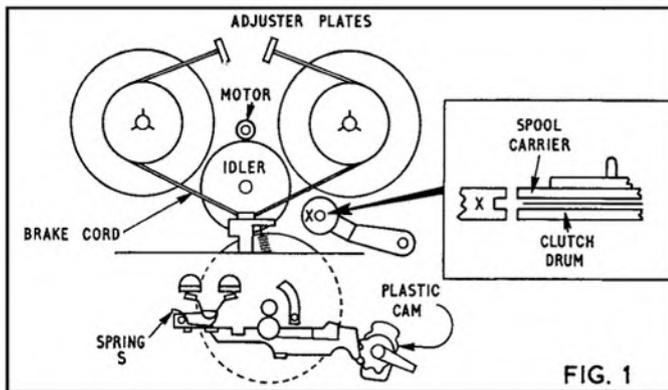


FIG. 1

winding is not so rapid as on some machines we could name.

The other aspect of this machine which has raised some queries is that very point—fast winding. As before, it is simple and effective. The machine is a single motor job, with idler wheel driving flywheel and clutch drum, and the usual two-section spool carrier that is found on such machines, with driven lower drum and a felt pad allowing a slipping take-up in proportion to the weight of the tape on the spool. There are many methods of 'binding' the upper drum to the lower, from the brute force of a solenoid drag to the bodily movement of either motor or spool carrier, with all sorts of belt variations and jockey pulleys between.

The method chosen by Elizabethan entails the movement of just a simple grooved pulley, marked X in the diagram. The lower drum is still driven but now it imparts its drive to the pulley X, whose upper section engages with the upper section of the spool carrier, turning it at the same speed as the clutch drum. For this reason, it is wise to engage the faster speed when winding on.

Other points to watch on this deck are: the spring S at the end of the swivel section of arm which bears the pressure pads; the slotted 'gate' of the speed-change mechanism at the rear of the cabinet, which must be correctly positioned and needs careful adjustment on re-assembly after the machine has been dismantled; and the plastic cam at the base of the main function selector. A smear of grease in the vital place can be a great help here.

Talking of grease brings us to the vexed question of lubrication, and to the popular decks that are used on most of the Elizabethan machines. Hence the reference to the piebald make-up of this article. Reason for the digression is the repeated requests for more information on BSR and Collaro Studio decks. Although articles on both these were among the first few of this series, more recent recruits to our ranks have asked specific questions which can possibly be dealt with here. Among them, lubrication.

It should hardly need repeating that over-lubrication is a curse. Oil or grease on rubber belts, idler wheels, pulleys, brake-drums, yes, and even the tape itself, gives the service engineer many a frustrating moment. The trouble appears to be that an enthusiastic laying-on of oilcans overlooks the fact that tape recorder mechanisms rely on spinning action for their operation, and oil creeps into all manner of upward places because of this spinning action.

Modern motors almost invariably have self-aligning rotor shaft bearings, which consist primarily of a sintered metal cup in a retainer which allows a certain amount of play, the whole being clamped together when aligned. Felt pads hold a certain amount of oil and the process of sintering forces oil into the metal under pressure, so that re-oiling is seldom needed.

But in practice bearings do get hot and run dry, or, as a result of over-oiling with too light a lubricant, have some of their inherent properties 'washed away'. One particular point that should be noted is the use of the correct type of oil—if any is used at all. Motors are meant to run fairly hot, and are designed to operate constantly over a pretty wide temperature range. Ordinary household oil is not suitable as it lacks the oxidation inhibitor that a true motor oil includes to maintain the viscosity over the temperature range. Without this additive, the oil tends to thicken after a time, becoming tacky and causing even more overheating. In extremely bad cases it has been known for the oil to turn to a sort of varnish and bind the bearing solid. Use a correct motor oil, as sold by several tape recorder accessories factors, or your local garage.

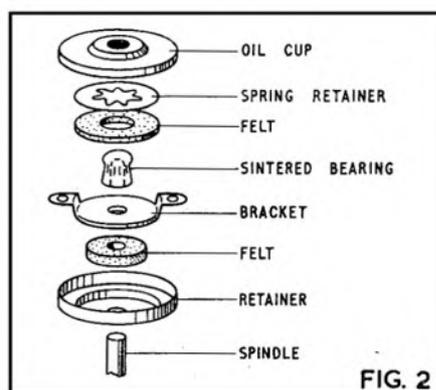


FIG. 2

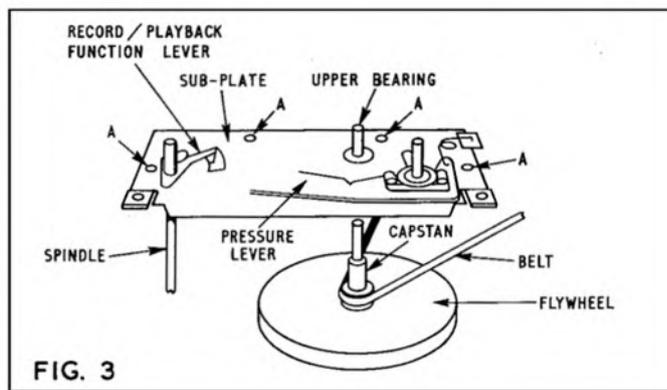


FIG. 3

If the bearing has become gummed up, a solvent will first be needed, applied sparingly. Petrol can be used—again with care to avoid rubber parts—and a couple of drops of paraffin will usually soften stubborn deposits. After this, the felt pads in the bearing cups can be very slightly moistened with one or two drops of motor oil. Access is usually obtained via a vent-hole, and the oil should not be applied by pouring down the spindle. Fig. 2 shows one type of bearing in 'exploded form', to illustrate the position of the felt pads and the sintered cup.

Note that worn bearings through lack of lubrication can cause a motor to seize altogether. But in the earlier stages, a light tap on the bearing housing with a wooden mallet or something similar, as the motor is running, can help to re-align a sticky bearing and save the cost of motor replacement.

Pivot points and sliding parts need a medium grease, in moderation. Although not always recommended by the makers, the author finds that a molybdenum graphite grease, as supplied by the motor trade under the name of *Molyslip*, can be very helpful. Its special virtue is that it never goes hard and gummy, despite extremes of temperature, and can be applied very finely where it is needed. Ordinary greases, such as petroleum jelly, are a very makeshift expedient, tending to soften and run as the machine gets warm.

The next point that has raised queries is that of belt-changing. This may seem a peculiar subject when talking of BSR and Studio decks, but several readers have found difficulty with the indicator belt of the LZ29 and the drive belt of the BSR deck. The former appears to be in an impossible position, between the upper and lower sections of the motor assembly of the left-hand motor. But the secret is first to remove the spool carrier by releasing the three top screws (not the central one, which is for height positioning). After this, the motor assembly, with its sub-plate and brake drum, band, etc., can be withdrawn sufficiently to slip the new belt over the brake drum and between the upper and lower sections and the sub-plate. The motor assembly is held by two 2BA screws and there is plenty of slack in the connecting leads to allow the belt-changing operation without the need for disconnection. The only problem is the end of the brake band, which needs careful slotting on to its lever. When re-assembling, take care to fit the mounting plate beneath the connecting block, and finally slip the belt over the indicator pulley and refit the spool carrier.

The snag with the BSR drive belt changing operation is the need to

(continued overleaf)

the unpaid assistant by DEREK LYONS

AT the end of the meeting I watched the seven other journalists close their notebooks and make a beeline for the bar. After three hours of verbatim note-taking they needed a drink. All I needed was a new set of batteries and a quiet corner to listen to my taped record of the discussions.

For the umpteenth time I was soon surrounded by diehard shorthand writers unable to decipher their outlines. "What was it he said about Gibraltar, old man," asked one. "Did you get his quote on naval bases," queried another.

"I got the lot" said I with superiority. "And so could you have done with this." It sounded like a television commercial but it was true.

Surprisingly, tape-recorders have not yet conquered Fleet Street. In many departments of newspaper production automatic has come to stay and every modern device for the transmission of pictures and news is employed. But for taking a note the peerless Mr. Pitman stands supreme. In spite of blunted pencils, aching fingers, outlandish outlines and tattered notebooks, few journalists have got the message that it is much easier to sit with a microphone in your lap than with a pad and pencil.

Apart from special assignments (notably that carried out by *The People* in the notorious soccer bribery case when a tape-recorder was concealed to record a vital conversation in a car) most journalists prefer to stick to shorthand. But because of my interest in tape-recording as a hobby I was quick to see its potentiality in my work as a reporter.

I have found that people more readily forget the presence of a microphone after the first few minutes than they do if one is constantly writing in a notebook. The very act of making a note draws attention to itself.

Furthermore, once the interview is over there is no puzzling over fuzzy outlines and sketchy notes. It is all there on the tape . . . the

subtle inflection in the voice, the emphasis, and the "mood" of the interview. It is taped as it happened.

I use two portables. My *Fi-Cord 1A* provides recordings of quality acceptable to the BBC, at $7\frac{1}{2}$ i/s when used with the *Grampian* microphone, protected during outside interviews by a home-made wind-shield made from half a practice golf-ball (the kind with holes) shielded by a nylon stocking fragment.

But for ordinary news coverage, when quality is relatively unimportant, I am happier with my portable Philips. That little needle flicking over as each syllable is spoken is a comfort. I know, provided the tape has been correctly threaded that I won't arrive home as I once did with my *Fi-Cord* to discover that halfway through the interview the mike lead had come unstuck, leaving me with 150ft. of blank tape to listen to on playback.

In official circles there is still resistance to tape-recorders. In courts of law, for example, it is permitted to take recorders but not cameras within the precincts. Nevertheless, little tin gods in uniform will often object and I always carry a cutting (pasted on a piece of stiff cardboard) from *The Times*, 19th August 1964 issue in which it was specifically stated that at Bow Street Magistrates' Court the previous day a man who was noticed to be recording the proceedings from the public gallery was in fact *quite within his rights* in doing so.

Said the magistrate to him: "You can sit there and play it to your heart's content, but you must stop it squeaking. If it causes any row I shall order you to take it out of court."

Even in the sacred corridors of the Houses of Parliament murmurs have been heard in favour of tape-recordings being made of the proceedings, instead of copious notes being taken as at present by highly-paid Hansard reporters. Mr. Arthur Woodburn, M.P. for Clackmannan and East Stirling and former Secretary of State for Scotland, commented last month when a sudden shortage of Hansard writers prevented the passage of the Race Relations Bill, that "in this day and age it was high time that modern technological boon, the tape-recorder, was introduced to Parliament."

In America pressmen have employed the tape-recorder widely for years; as in other things it is safe to assume that eventually England will get the transatlantic message. But me? I've already got it!

TAPE RECORDER SERVICE CONTINUED

remove the head plate from the main deck assembly. This has to be done very carefully so that the record play function lever spindle does not damage the Yaxley switch which is very often used in direct coupling. The switch wafer is slotted, and careless re-insertion can cause the central disc to crack. The result will be intermittent operation, not always easy to track down. Where a machine has a printed circuit attached directly to the motor plate (and not via a spring blade or 'knocker arm' for switch operation), it is strongly advised that this printed board be removed and held off to the extent of its leads before attempting work on the upper deck. The extra trouble involved is more than repaid by the freedom it allows.

The next step is to remove the upper plate by first taking out the four screws, fig. 3A (some machines use only three, depending on the escutcheon fitting), releasing the head cables from any restraining clamps, and gently working the plate upwards so that the flywheel capstan spindle comes free of the upper bearing.

At this stage, the flywheel will seem quite loose. On the older decks it is necessary to hold it with a makeshift clamp as the main drive belt tends to pull the flywheel assembly sideways. Later models use an idler wheel instead of this motor belt. To fit the clutch belt, first slip it over the spindle, taking care to avoid any contact with lubricating grease, and feed the loop into the pulley groove of the small section of the flywheel. Then, leaving the belt loose, re-assemble the deck plate carefully, making sure that the flywheel sits correctly in its lower bearing cup. Finally, pull the belt over the clutch drum, turning slowly as this is done to avoid excessive stretching.

An alternative method, rather more tricky as it means the belt has to rub across a greased bearing and must be subsequently cleaned, is to raise the assembly with flywheel and slip the belt under the flywheel and up over its periphery. There is less disturbance to the deck mechanism this way, and if the deck is switched to PLAY as the operation is made, the levers hold neatly in place. But a little practice is needed to avoid lever jamming, and the first method is advised for once-only repairs.

TOWARDS BETTER TAPING CONTINUED

channel. These fed into separate amplifiers (seen one on top of the other, above the tuners) and the amplifiers energised the two speakers.

While the stereo transmissions were being listened to on the speakers they were also being recorded on the *Truvox* from the 'monitor' output sockets of the amplifiers. The recorder used was essentially a mono machine, but was adapted for stereo by the fitting of a half-track stereo head and a second amplifier channel, seen directly below the recorder.

When making stereo recordings with microphones, the two microphones should be separated from each other by about 7ft. if omnidirectional types are used (though proper stereo recording is conducted with 'crossed-pair' microphones having directional sensitivity patterns), and the channel gains should be adjusted for balance. This is somewhat more difficult to achieve when recording than on playback.

Stereo recorders have a pair of record-level indicators or VU-meters. These may not necessarily need to be adjusted for coincidence, since the level of sound appearing at one microphone may differ substantially from that at the other. A good idea is first to adjust for record balance by placing a sounding device of some kind in the corner of an isosceles triangle formed by the two microphones and the sounding device, as shown in fig. 3. With a stereo crossed-pair, the sounding device should be 'straight ahead'.

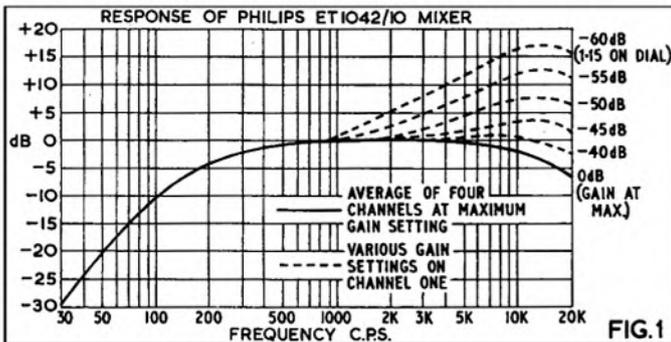
The record levels of the two channels should then be adjusted for equal deflection of the level indicators or meters. The sounding device can be almost anything that delivers an all-round noise. A ringing alarm clock has been used by the author, or a person producing a sustained whistle is an alternative. Once balance has been secured, the record level should be adjusted equally on both channels during the actual recording. There is certainly a new world of enjoyment in stereo tape recording and playback.

Next month's article concludes this present series and this will deal with the various terms used in tape recording and include a few other odds and ends.

equipment reviews

DESIGN of a high-performance amplified mixer, especially if self-powered and with matching transformers built-in, is no easy task. Results on each channel must be above reproach, otherwise studios will use a 'dry-mixer' preceded by, say, four straight mic-to-line raisers. Tests of gain and distortion, background and microphony, pick-up of external fields, and particularly transient and frequency response, must be made with this in mind.

In the mixing mode, interaction of controls and their effect on response, signal-handling and performance generally should be negligible. Signal should not appear from any channel with its volume-



control closed, whether other channels are open or not, i.e., break-through even at peak inputs should also be negligible.

Depending on price, features such as channel tone-controls or switch-in filters, pre-fade-listen and metering, stereo sub-division and panning, not to mention quadrant and group faders, may be desirable. But we could go on, and partly for these reasons this review was approached in reverse, so to speak, performance being obtained from scratch rather than comparing with the maker's figures or with other models.

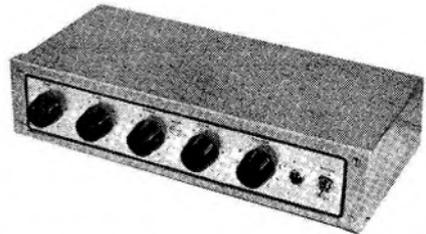
At the rear of the *Philips ET 1042/10*, the serial plate next to the 3-core mains flex calls for 15W from 210-245V 50 c/s—no voltage adjuster needed or provided. Four numbered screw-cover receptacles, similar to *Reslo* 3-pin but Continental in design, are for microphone inputs. An identical fifth spaced further along is labelled OUTPUT; it has no male-female pin-reversal to distinguish from an input, one type of cable-socket accommodating all. An 'output first' rule when plugging-up, as for power amplifiers, will prevent your best ribbon being mortally offended at getting line-level by accident!

The front-view, neat and attractive in black and silver-grey, shows five pointer-knobs headed ONE to FOUR and MASTER and identically scaled from 1 (almost closed) to 5 (fully clockwise) with dots for linear half-divisions. At the right-hand end, pilot-lamp and double-pole mains switch (ON is upward) complete the line-up; in a screened compartment behind them is fitted a $\frac{1}{2}$ A mains fuse. The mains-pack behind this is also screened.

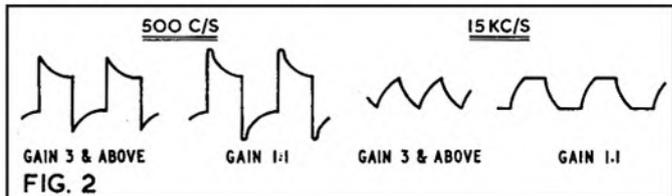
Three double-triodes provide the gain—four sections after the input-transformers, one after the master-control and finally a cathode-follower output. Exit signal after a fourth 9-pin valveholder, so wired that a line-transformer could be plugged in place of the link-plug fitted, or an alternative plug to select attenuation. Each input has two 'hot' pins, the third bonded to chassis, indicating screened-twin cable for balanced (or in fact, floating) microphone-lines. Output, of course, is unbalanced unless using a transformer, but the same cable is needed as the inner earth-busbar is held at a DC potential above chassis. The twin inner gives live and return with screening to the third pin, and a separate output-cable for balanced working is avoided.

Input and output impedances were first measured over the audio range to determine correct terminations. The input impedance varies between 25 ohms (at the extremes of 40 c/s and 20 Kc/s) and 90 ohms (2 Kc/s), indicating a nominal 30-50 ohm microphone input rather than 200 ohms. The output impedance falls towards 600 ohms at high frequencies, but is over 1K at 1 Kc/s and rises steadily below this, reaching 25K at 40 c/s. The reactance of a 0.15 μ F capacitor follows the same curve, so it was no surprise to find a nominal 0.1 μ F blocking

PHILIPS ET1042/10 FOUR CHANNEL MIXER



MANUFACTURER'S SPECIFICATION: Four channel mixer. **Input sensitivity:** 50 ohms, 0.2mV. **Outputs:** 50K at 200mV or 6.5K at 10mV. Four individual microphone gain controls and master. **Frequency Range:** 50 c/s—12 Kc/s with 6dB filter at 60 c/s. **Noise level:** -70dB. **Dimensions:** 13 $\frac{1}{2}$ x 7 x 3in. **Price:** £35. **Distributor:** Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.



capacitor in the output. Bass loss will occur if the following input is of too low an impedance, but the benefits of 600-ohm working are preserved in the treble on lengthy cables.

The available output before distortion is high. A 1Kc/s sine-wave shows no clipping until 15V RMS (into open-circuit), with distortion of 1 $\frac{3}{4}$ % at this point. At 10V out it is down to 0.4%, so at customary line-levels around 1V distortionless operation into following high-impedance can be relied upon, provided no very high levels overload the first stage(s) ahead of the volume-controls. A normal microphone, even used abnormally, was unable to do this.

On each input, loaded with screened 50-ohm resistor on microphone-cables, hum and noise output was measured (see Table 1). The high background on Inputs 2 and 3 was mostly hum picked up from the power end by input transformers; orienting them would be effective, but difficult because of the way they are mounted—'bucking' most of the hum was possible by rotating the load-resistor close to the power-inlet. The variance in noise between inputs practically vanished with primaries short-circuited, while omitting the load raised it 4-5dB on all channels. With main gain only open, the 'silence' was -77dB, or -75dB with it closed—some benefit from internal bucking, I suspect. Figures below a 10V output-level would, of course, be 20dB better; earthing gave no benefit.

Interaction was measured by observing variations in signal on any channel when all the remaining channels (silent) had their controls rotated together from minimum to 6dB below maximum gain, then to maximum; the master was varied separately (see Table 2). The 6dB point is about 3.7 on the dials with the logarithmic potentiometers fitted, and gives equal resistance between slider and either end; hold-off arrangements are such that this setting has most effect on other gains. Varying one other knob at a time produced one-third of the table amounts, and it is seen that different settings of the channel in use, and of the master control, vary the amount of interaction. In the 100 c/s case the impedances of coupling capacitors from the triodes add to the effect, but otherwise interaction is in fractions of a decibel, to be ignored for most purposes.

High background on inputs 2 and 3 made test-figures on break-through unrealistic by swamping, but on No. 1 with no input-signal, a tone sufficient to produce 1V was fed into each remaining channel with its gain at minimum. Rise in background due to signals breaking through is negligible at low frequencies, but in the treble it becomes noticeable, pointing to unwanted capacitive couplings. More of these later . . .

Fig. 1 shows the mean frequency-response of the four channels at
(continued on page 401)

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maximum gain (solid line). Falling bass-response is perhaps intentional; when dialogue filtering is required in Stage or Film work such bass-cut is used. It is produced here by choice of low-value coupling capacitors from the input triodes to the mixing network—2,200pF nominal.

As Channel 1 fairly represented a mean curve, further tests, to see if the response was affected by gain-control settings, were carried out on this channel (dotted lines). Below the -6dB point differences are small until really low settings are reached (1½ on dial and below); here, unwanted coupling again makes itself felt by a considerable treble-peak around minimum volume; this was also observed on Input 4, with some rising on 2 and 3.

TABLE 1: HUM AND NOISE (dB below 1V output)

	Without Earth	With Earthed Chassis
All gains closed:	-75dB	-70dB
Master gain open:	-77dB	— (earth dispensed with)

Maximum gain on: Transformer primary Without load on loaded 50 ohms primary

Input 1	-66dB	-62dB
Input 2	-45dB	— (timbre changes)
Input 3	-46dB	— (timbre changes)
Input 4	-67dB	-62dB

TABLE 2: INTERACTION (Mean of four channels)

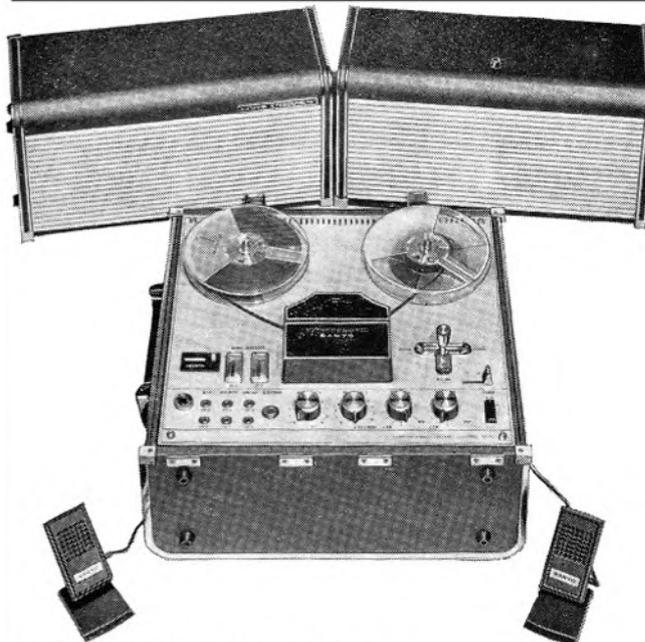
Tone Frequency	Silent Channels at Zero	Channels at -6dB	Channels at Max-imum gain	Tone Channel Position	Master Gain Position
100 c/s	0dB	0.8dB	1.2dB	Maximum	Maximum
1 Kc/s	0dB	0.6dB	0.3dB	Maximum	Maximum
10 Kc/s	0dB	0.5dB	0.2dB	Maximum	Maximum
100 c/s	0dB	1.1dB	1.5dB	-6dB	-6dB
1 Kc/s	0dB	0.9dB	0.6dB	-6dB	-6dB
10 Kc/s	0dB	0.75dB	0.2dB	-9dB	-6dB
100 c/s	0dB	0.3dB	0.5dB	Maximum	Low
1 Kc/s	0dB	0.5dB	0.25dB	Maximum	Low
10 Kc/s	0dB	0.7dB	0.2	Maximum	Low

Settings chosen produce most interaction effects between tone-carrying channel and remaining 'silent' channels as controls of the latter are advanced. No channel gain-rise can decrease set signal to a negative dB figure.

In later tests, feeding the input triode grids directly to check the transformer step-up ratios, both the falling bass and the low-volume rise in treble were still present, so the input-transformers would seem to have little to do with these effects. Just over 30mV on each input grid at 1 Kc/s produced 1V output, a voltage-gain due to the valves of about 30dB. 1V output can be realised with voltages between 700-1,000µV at the microphone (or even a little less, depending on impedance). One should bear in mind that the overall voltage-gain of 60-65dB thus arrived at only has significance in relation to the power-gain, which again depends on impedances. Table 3 shows the output when using various microphones, all referred to 0dBm (=0.775V or 1mW in 600 ohms).

Transient performance is indicated by the oscilloscope traces of fig. 2, for 500 c/s and 15 Kc/s square-wave inputs (to mic. transformer). The curving tops at 500 c/s show the influence of the falling bass response, and the triangular 15 Kc/s shape shows the falling of extreme treble at normal gain settings; at very low channel-gains the rising treble mentioned earlier restores much of the square shape at 15 Kc/s, and brings in a leading-edge overshoot at the low frequencies. Note

(continued on page 403)



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that this does not include any output transformer effects.

The mixer is not prone to microphony at normal levels—brisk taps on the outer case at full gain produced at most a 2-3dB jump in background reading, sounding highly damped and with no tendency to 'ping' or to build up acoustic howl even with high-gain on the following equipment.

The effect of random AC external fields is kept minimal by potting of the mic-transformers plus the outer steel case. For this test a nearby *Variac* was used!

TABLE 3:

Microphone	Type	Output	Level Below 0dB
STC 4038	Ribbon	0.14V	-15dB
STC 4021	Moving-coil	0.18V to 0.25V	-13 to -10dB
STC 4017	Moving-coil	0.25V to 0.3V	-10 to -8dB
Reslo RBL/T	Ribbon	0.025V	-30dB
Grampian GR1	Ribbon	0.075V	-20dB
Shure 545	Moving-coil	0.25V	-10dB
Shure 55S	Moving-coil	0.35V to 0.45V	-8 to -5dB
AKG D.19	Moving-coil	0.2V to 0.25V	-12 to -10dB
AKG D.11	Moving-coil	0.2V	-12dB
Grundig GDM	Moving-coil	0.25V	-10dB

Above figures are for talks, studio conditions and moderate speech; levels from music applications found to vary with content from 10-16 dB higher than the above, i.e., up to 2V output or a little higher in exceptional cases.

Re-reading the opening paragraphs, it is difficult to decide whether this mixer is for recording enthusiasts, professionals or PA work. It is particularly suited to stage groups who bring three or four microphones for use with their own amplifiers—here the limiting of bass is a distinct advantage, as also in speech-reinforcement, recording of meetings and court proceedings, etc. The intending user must assess its capabilities for the application in mind; if this dry dissertation has helped him, the exercise was worthwhile. **B. R. J. Plumtree.**

POSTSCRIPT TO THE KODAK TAPE REVIEWS

THE FOLLOWING comment (which, in its original form, was rather more detailed) has been received from *Kodak Ltd.* concerning the tape reviews published in our August issue. It is published together with Mr. Tutchings' reply:

DEAR SIR, We have just seen Mr. Tutchings' Kodak Tape review and, of course, are absolutely delighted that the result is so favourable.

We would not, however, want readers to think that there was no change in the frequency response of Kodak Tapes with change in bias, as the review seems to imply. It is true that the change is less than with many other tapes, and is confined to higher frequencies than those used in Mr. Tutchings' tests, but readers with good loudspeakers would find this change was still noticeable, although not necessarily important.

Yours faithfully

Messrs. Kodak quite rightly make the point that I should have qualified my review statement that overbiasing certain Kodak tapes does not alter the frequency response.

I agree that when the wavelength on the tape becomes comparable with the oxide thickness there will be a marked difference of recorded level with change of bias, but the Kodak Quadruple Play, which was the one I made the song and dance about, showed no measurable change in response up to 8 Kc/s even when bias was raised to drop overall sensitivity by 10dB, and the difference was only 1.5dB at Kc/s with this bias and quite negligible at 4V bias, which drops output by 5dB.

The audible effect on even a good quality domestic recorder would be very small. A glance at the microphone and overall acoustic responses in some of my recent reviews will show that the 'air to air' response seldom extends much beyond 5 Kc/s, however good the electrical response may be.

It was for this reason that I chose 5 Kc/s for my high frequency test at a tape speed of 3 1/2 ips, and I can assure the manufacturer and all my readers that, at this frequency and tape speed, altering the bias by 20%, which alters the response of normal tapes by 5-10dB, showed less than 1dB change on the thin-oxide high-coercivity Kodak tapes.

A. Tutchings.

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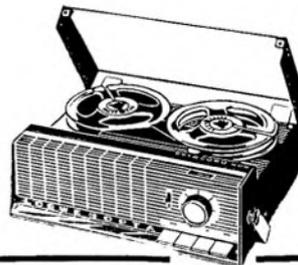
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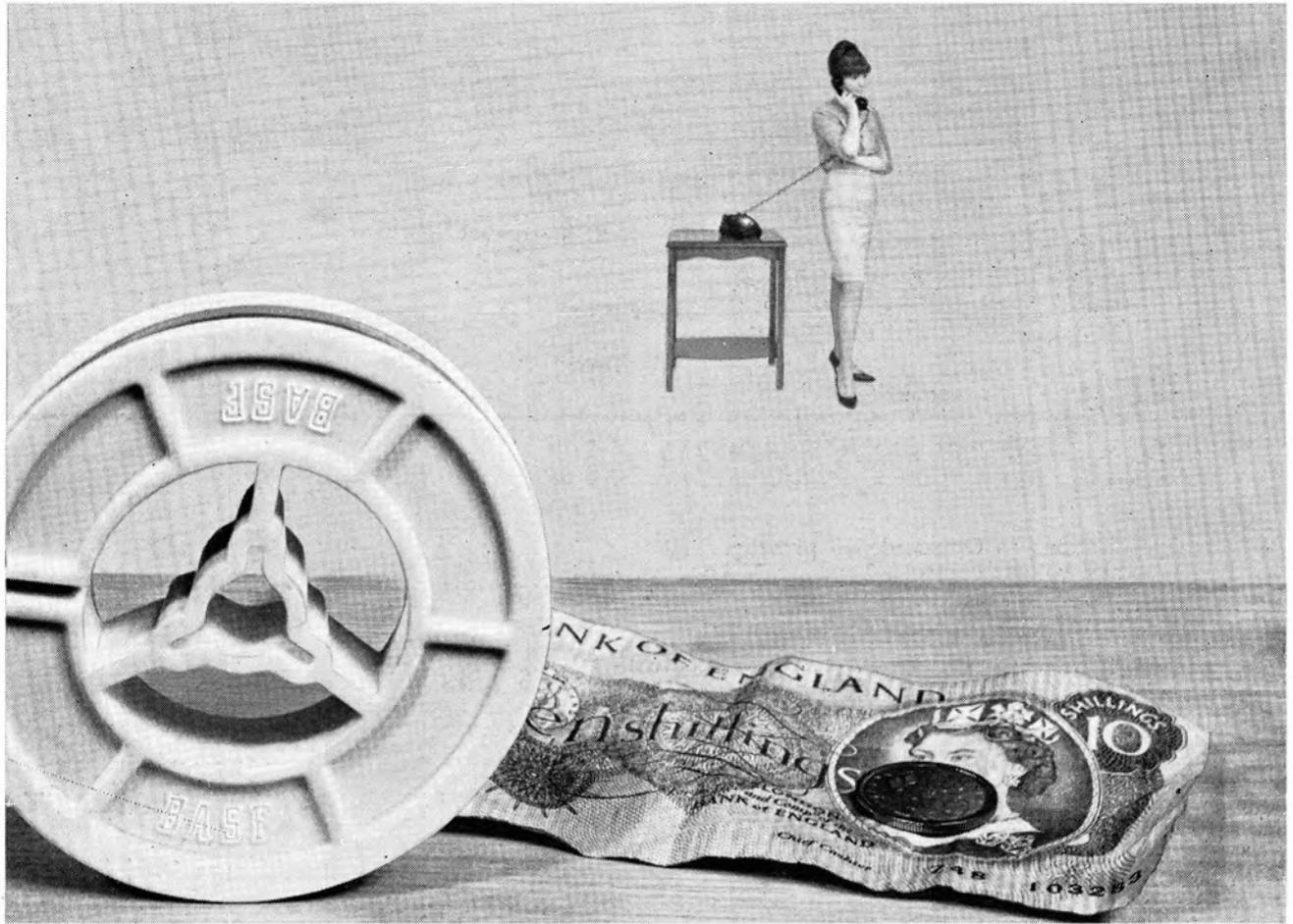
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