

DECEMBER 1965 TWO SHILLINGS

tape recorder



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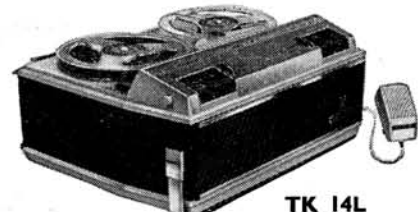
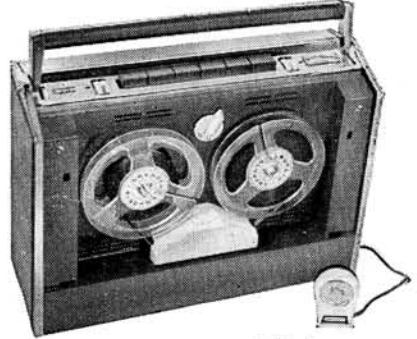
GRUNDIG

THIS MONTH'S



FEATURE

GRUNDIG

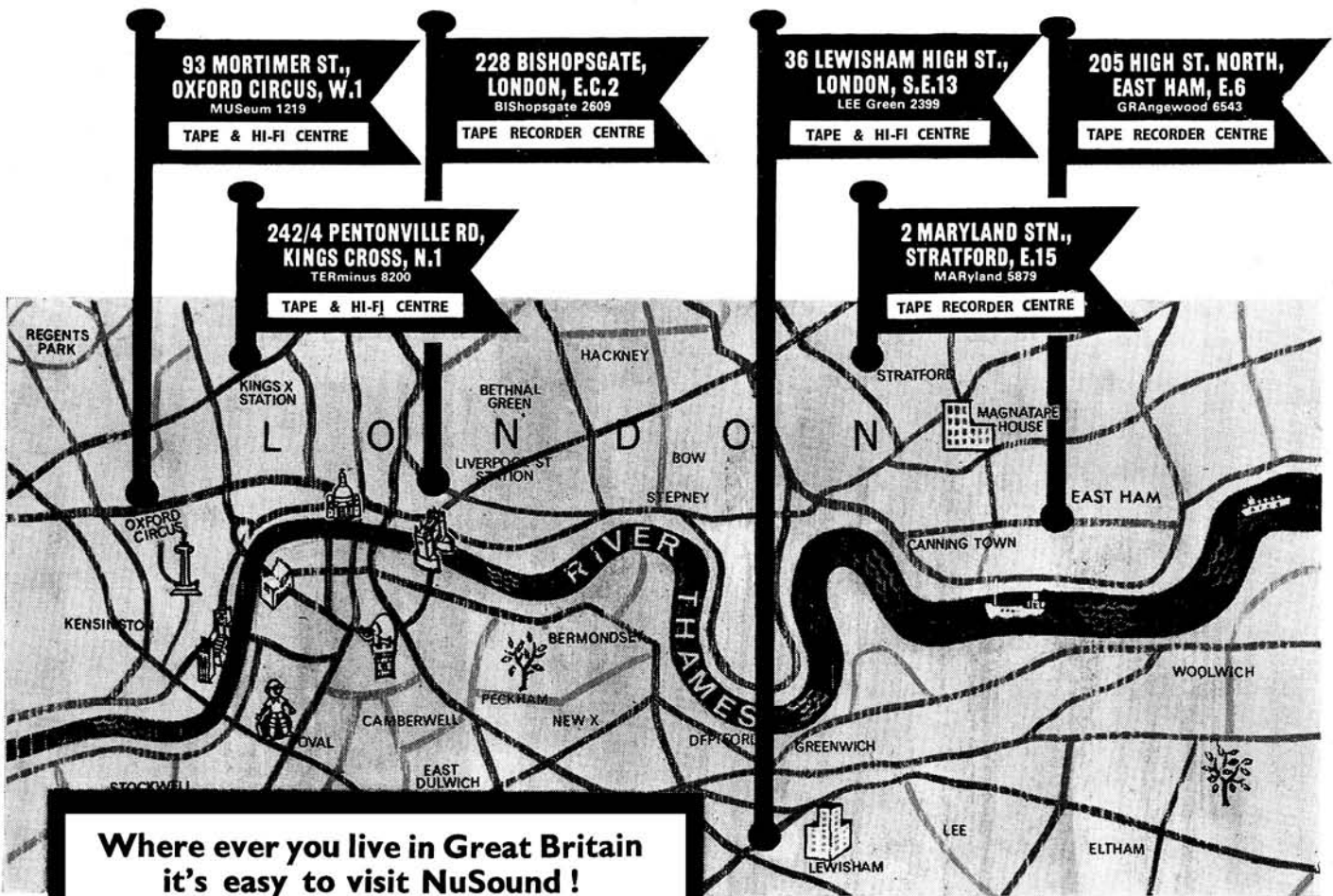
 <p>TK 40</p>	 <p>TK 14L</p> <p>The all-new push-button TK14L represents stunning value in tape recorders. It's a twin-track machine with Grundig's 'Magic Eye' recording level control. The TK14L plays at $3\frac{3}{4}$ inches per second, gives two hours' recording or playback time. A precision tape indicator, with press-button re-set, helps you locate instantly any part of the tape you wish.</p> <p>Price 37 gns.</p> <p>Four-track recording, three speeds ($1\frac{1}{2}$, $3\frac{3}{4}$, $7\frac{1}{2}$ i.p.s.) Double-play tape on a $5\frac{1}{2}$" spool gives 12 hours' playback. 7" spools extend this to a maximum of 16 hours. Press button re-set, a cine socket and built-in tape cleaner are included. Twin-track version available, called the TK41. This has 7W output and separate bass and treble controls.</p> <p>Price (TK40) 87 gns.</p>	 <p>TK 6</p> <p>The new Grundig TK6 goes anywhere—captures living sound wherever you are. It's the perfect portable recorder. The touch of a button gives you twin-track recording, two speeds and four hours' play-back in the finest Grundig tradition. No need to add extra amplifiers or loud-speakers—the TK6 is complete in itself. Battery or mains operation!</p> <p>Price 69 gns.</p>
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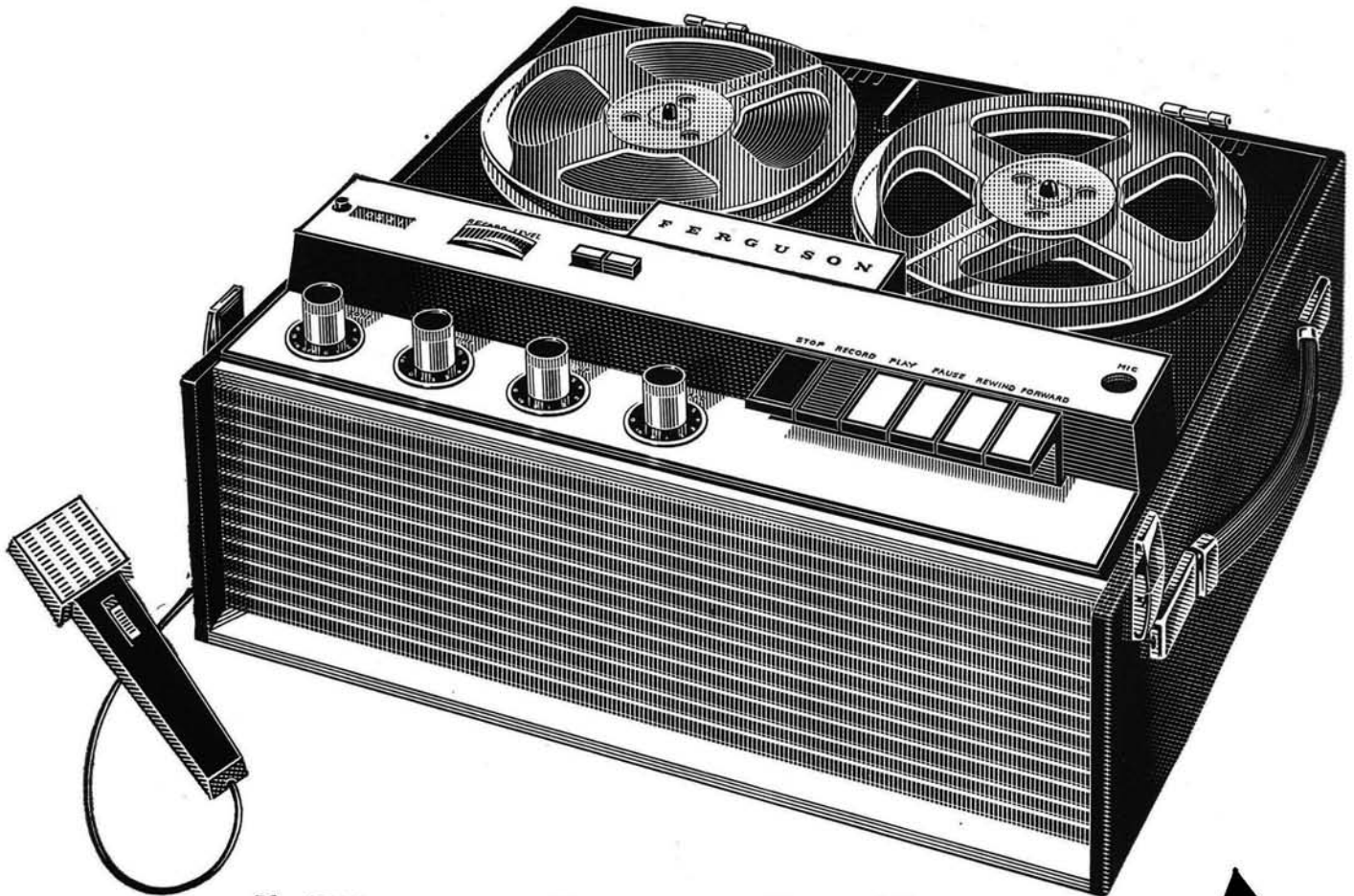
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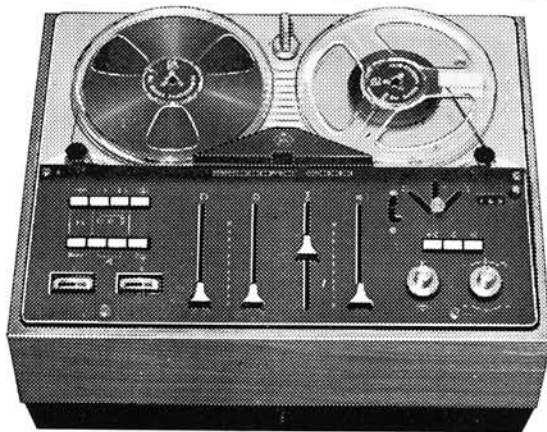
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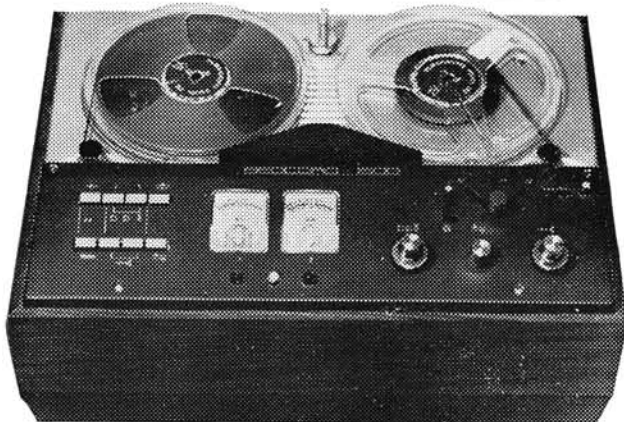
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Available only through appointed dealers of quality, Bang & Olufsen products are on permanent exhibition at our new London Showroom, 70/71 Welbeck Street, London, W.1.

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tape recorder

INCORPORATING 'SOUND AND CINE'

EDITOR **JOHN CRABBE**
NEWS EDITOR **DAVID KIRK**
ADVERTISEMENT MANAGER **ROBIN WELLS**

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editorial

THE WELSH NATIONALIST movement has been allotted five minutes broadcasting time on BBC television and radio each year. This announcement accompanied the introduction of winter broadcasting schedules. But while perusal of the *Radio Times* shows a marked increase in the number of educational and hobby programmes, there is one notable and tragic omission. Would-be linguists, the motorists, and now even the photographers, have a regular weekly series on BBC television, the former two having enjoyed considerable coverage in radio broadcasts. But, though we do not begrudge any political minority movement the time it manages to get, whatever became of *Sound*? That lively little programme, tucked away in a corner of the Sunday afternoon *Third Network*, was snatched from the audio fraternity many months ago with the soothing assurance that "There is no need to worry, it will probably be back soon anyway". "Soon" has long since departed, the probability factor of "probably" is approaching zero and we are beginning very much to worry.

The BBC must cater for mass tastes, of course, and there is no doubt that tape recording enthusiasts are outnumbered by linguists, motorists and photographers. But *Sound* was not aimed solely at the tape recordist—it was intended to assist all audio enthusiasts in their unceasing efforts to get just that little higher in the quality of their equipment than the designer would allow. And when the readerships of *Tape Recorder*, *Hi-Fi News* and all their contemporaries are combined—even allowing for cross-readership—one gets a fairly sizeable total.

But this total, amounting as it does to many tens of thousands, is probably small when compared with the potential audience for a programme on audio. The original *Sound* series catered mainly for the technically-informed enthusiast, but is it quite beyond the BBC to construct a programme—be it weekly, fortnightly, monthly or quarterly—that would capture and mould the imagination of some of the two million recorder owners and untold millions of radiogram users? We feel sure (though it is not unreasonable to suggest that we are biased) that such a programme would bring in a substantially greater audience, even, than the appeals of political minority groups.

What we do *not* want is an audible version of this, or any other tape or audio magazine. No radio programme could reproduce circuit diagrams, or could allow thousands of words to be spent in support of one thing, or criticism of another, any more than we can provide, in print, acoustic examples of two tones 'beating' or give a realistic description of the effects of intermodulation distortion. Not that either of the latter examples would captivate a mass audience to begin with. If *Sound* returns—as it may if enough fuss is created in the right quarters—it would have to commence at a simple technical level. It could show, in the realistic acoustic dimension, just what can be achieved when a common-or-garden tape recorder is loaded with an endless loop, when a tape is played backwards, when the microphone

is placed in a reverberant container, and so on. And just as important, it could show how the effects gained therefrom may be employed in producing creative recordings that might end up with the winning trophy in the *British Tape Recording Contest*. The feeling of futility that must deter many from creative recording might be ousted to some extent by introducing people to the delights of tape correspondence—or by displaying the work of gifted enthusiasts—on the programme itself.

The newcomer to high fidelity has many problems that could well be solved by listening to a broadcast of the *Sound* type. Admittedly, these difficulties might be solved by the simple action of thumbing through a printed magazine—but how many one-piece radiogram owners even know that such magazines exist?

There is no lack of material to keep both tyro and technician among the audience. And if the BBC considers the problem of balancing the programme between experienced and inexperienced to be critical—they might take another look at the first of their new series for motorists—which spent almost its entire thirty minutes describing how to start a car and how to turn left and right.

Our own suggested topic for a captivating opening programme would be a discussion by the Head of BBC Engineering on the problems of going stereo.

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COVER PICTURE

Stony silence greets the tourist as he attempts to record a flute. The situation is fully under control, however, as the silence is being monitored on headphones connected to the output of a *Uher 4000 Report* (you will have to take our word for that). All that is required now for a perfect recording is, well . . . more gain?

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.

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world of tape

METERS OR EYES ?

THE controversy on VU-meters versus magic-eye modulation indicators still rages. When asked their opinion on the subject by *Elstone Electronics*, the Norwegian manufacturer *Tandberg Radiofabrikk* replied with a lengthy comment to their distributors, a copy of which was recently forwarded to us. Quotation from this letter may help to overcome antiquated thinking regarding magic-eye peaks being too fast for the eye to follow, though one should remember that not all manufacturers take as much care in aligning the indicators—be they meters or eyes—on their products as Messrs. Tandberg.

"To secure the best possible signal-to-noise ratio, and at the same time to avoid overloading the tape, every (domestic) tape recorder is fitted with either a VU-meter or an electronic eye. There is no exact relation between the indication on the VU-meter and the actual peak value of the signal. Recent investigations in this matter show that the peak value of the signal may vary from +3 to +12dB for the same reading on the VU-meter, depending on the kind of music recorded.

"If a recorder tries to control the peaks of recording by means of a VU-meter, he will meet the following two problems: (1) To ensure that the VU-meter is indicating the peaks with sufficient safety margin, he will tend to under-modulate his tape and consequently come out with an inferior signal-to-noise ratio. (2) To increase the signal-to-noise ratio the customer will tend to turn up the volume to a high indication of the VU-meter. In this case he will be apt to overload the tape, having only his estimation to rely on when calculating the margin for overload on the meter.

"The VU-meter is mainly used in professional broadcasting to set the mean value of the programme level, providing the listener with a constant mean sound level in his living room. With limiters in the broadcast amplifiers, the danger of overload is eliminated and peak indicators are no longer necessary. In tape recorders it is a completely different matter. There are normally no limiters and the peak value is the deciding factor regarding distortion and signal-to-noise ratio. Consequently, for this purpose the electronic eye is preferable. The ideal solution would be a VU-meter and an electronic eye, which would give both mean and peak level indication. In Tandberg recorders the electronic eye has an extra refinement. The rise movement is extremely fast, while the return movement 'rides' on the peaks of the programme without flickering. This makes the setting of the recording level easier and makes the picture on the electronic eye clearer."

Fi-CORD AT THE HAMBURG GAS WORKS

TAPE recorders have a habit of appearing in strange corners of the world—and the Kattwyk Coke Works in Hamburg is as strange a location as one could expect in which to see a *Fi-Cord 101*. For this machine is used, not to record correspondence, but to note the temperature in each of many coke combustion chambers in the power station. Until some twelve months ago, a staff of two was required



for the endless task, one to observe and check the meter readings and another to note the measurements on paper. Then came the *Fi-Cord*, eliminating a possible source of error always present in hand copying, and freeing an employee for more useful work.

Despite the steam and grime to which it has been subjected, the 101 has played its part successfully, being used with a *Fi-Cord* lapel microphone.



TEACHING ENGLISH WITH TAPE

LANGUAGE tuition at a Baku high school in the Azerbaijan Republic of the USSR was recently supplemented with tape equipment. All class rooms are equipped with a recorder, and microphones placed on the desks enable each pupil to record phrases on a tape loop which is then replayed and analysed. The photograph shows an English lesson in progress.

Q-CORD PRICE INCREASE

FOLLOWING the recent price reductions, *Colin Braddock Ltd.* have just announced increases in the cost of *Q-Cord* tape recorders and accessories, for which they are the distributors in this country. As from 1st November, the Model *R.119K* will cost £33 12s., with the *203* selling for £35 14s. *NL.1* and *NL.2* mains adaptors are being increased to 5 gn. and 7 gn. respectively, while the 6V accumulator available as an alternative to dry cells will cost 6 gn. The distributors emphasise that, while prices are being raised with reluctance, they will not exceed those listed prior to the reduction.

BTRC PRIZE-GIVING

PRESENTATION of prizes to award-winners in the *1965 British Tape Recording Contest* was held at the Criterion Hotel, London, on 1st October. Committee members, judges and press representatives were among the guests assembled to hear the winning tapes, each separated by prize-giving for the recording just played. Most winners said a few words, with Ray King, whose piece on 'The Nose' received the Humour prize, offering a modest encore into his handkerchief.

Those present commented praisingly on the very wide range of subjects covered by the entries, and thanks were given to Mr. C. Rex-Hassan for his efforts in 'rescuing' the contest and achieving widespread publicity.

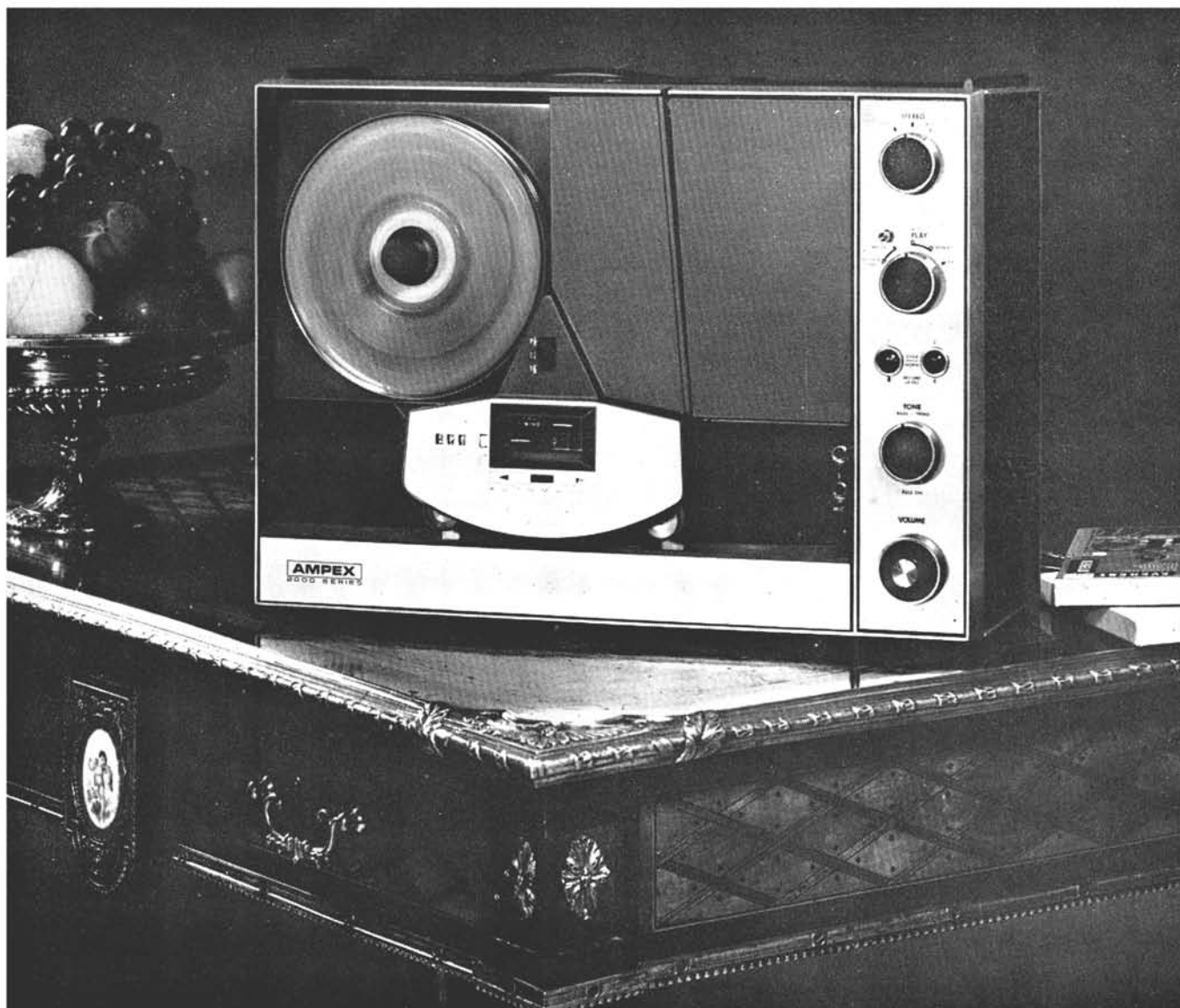
Several entries to the British contest will go forward to the International contest, to be held in London towards the end of October—just too late for a report in this issue. We hope to publish details of this event in the near future. (A report on the judging appeared on page 391 of the October issue.)

WESGROVE AND STC MOVE

WESGROVE Electronics Ltd., manufacturers of low-price television recording equipment, recently moved from Worcester to 1 Maddox Street, London, W.1. The head office of *Standard Telephones and Cables Ltd.* was also changed a few weeks ago, from *Connaught House, Aldwych*, to *STC House, 190 Strand, London, W.C.2.*

NEXT MONTH

The January issue of *Tape Recorder* will appear on Tuesday 14th December and will include a description of three circuits for transistor high-to-low impedance-matching units by A. Foord. Aided by Anscomb, we shall jump on to the seasonal bandwagon with a series of cartoons entitled *The Sounds of Xmas*, while the Rev. R. A. Sheekey describes a *Son et Lumiere* installation at Brabourne Church in Kent. All regular items, including tape and equipment reviews (the *Ampex 2073* will come under the Tutchings gaze) will appear, alongside Part Two of the Michael Gordon series *Battery Tape Recorders*.



STRICTLY FOR THE EARS OF PERFECTIONISTS —the Ampex 2000 series stereo tape recorders

If you can tolerate sound distortions when you listen to music, you need read no further. But if you are a lover of sound reproduced at its best, the Ampex 2000 Series has been made for you. Designed and built by dedicated sound engineers for the connoisseur, the Ampex 2000 Series is beyond comparison. It has dual capstan drive, automatic reverse for extra-long play and *exclusive* automatic loading. Special "Sleep Switch"

allows automatic shut off of everything—recorder, motor, amplifiers. 3 Ampex professional quality heads, coupled with rigid block suspension, guarantee perfect head alignment under all conditions. 3 playing speeds offer maximum fidelity at greatest tape economy. Automatic lifters are included and self-contained or separate speakers with solid state power amplification are offered. Automatic slide synchronisation is optional.

AMPEX

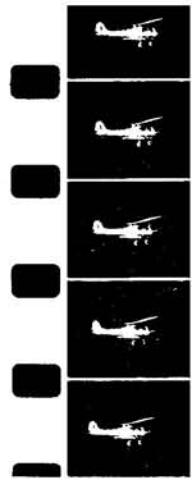
Ampex sales and service facilities are conveniently located throughout Europe and the Middle East. For more information write to: Ampex Great Britain Ltd., Acre Road, Reading, Berkshire, England. Telephone Reading 84411 • Ampex S.A. Via Berna 2, Lugano, Switzerland. Telephone 091/3.81.12 • Ampex Europa G.m.b.H., 6 Frankfurt Main, Düsseldorf Strasse 24, Germany. Telephone 25.20.01-05 • Ampex, 41 Avenue Bosquet, Paris 7e, France. Telephone 705.38.10.

BY ANTHONY WIGENS



Top left: *Eumig Mk. S* sound projector featuring magnetic stripe record/playback.

Below: Magnetic stripe record playback and optical sound playback are featured on the *Toei Talkie* 8mm projector which costs £99 10s. and is distributed by *Dixons*.



Speech cuts through a slushy background, like a man shouting by the Niagara Falls.

The new 8mm *Super 8* format is designed to give a wider stripe for sound, and we are likely to have magnetic sound for many a day.

Fairly recently some do-it-yourself striping machines have come on to the market. *Harringay Photographic Supplies* introduced their *Super Striper* at £8, with striping tape £1 10s. for 1,000ft. and cement 3s. 6d. a bottle. *Supersound Electronic Products* introduced their striping machine at £12 10s., claiming that striping costs could be brought down to ½d. per foot. Through a dealer, the charge would normally be 2d. a foot.

sound
and
cine

STRIPE GETS INTO ITS STRIDE



George Sewell, president of the Institute of Amateur Cinematographers, wrote recently, "Laminated stripe is, I am convinced, the most convenient and efficient means of adding stripe to edited 8mm film, and the do-it-yourself striping machines are going to give a great fillip to the use of magnetic sound on film". But he went on to give a warning that care should be taken in adding the stripe, and the film should be scrupulously cleaned first.

Another warning on stripe was sounded by Mr. N. Maltezos of *E.v.T. Magnetics*, who provide a laminated striping service. He has said, "We are rather concerned at the quantity of films now being sent to us for removal of laminated magnetic stripe". Over-simplification of the striping process has resulted in poor quality striping being carried out, he says. This has to be removed and replaced for good results.

With stripe only 0.8mm wide on standard 8mm, the sound head is running pretty close to the edge on a perfectly laid stripe. The result of a waver in its path is 'motor-boating', a blubbery effect which sounds dreadful.

But despite the warnings, there seems to be a definite downward trend in pricing.

The alternative to the laminated stripe, which is simply a sliver of magnetic tape, is liquid or paste stripe (extruded iron oxide). This is the method used for many of the big spectaculars in the cinema, and the specialist firm is *Zonal*.

If you have film striped, the laboratory will probably cover your cement splices with their own tape splice for peace of mind, as the non-stop 8mm loop goes through their machines. If you use tape splices you can get a cut-away patch that won't interfere with the laminated stripe. The *Quiksplice* designation for them is *T816M* tape.

For a really smooth sound track without drop-outs, you should edit your film before sending it for striping. If you do this, the stripe is unbroken, though with overlap cement splices it will undulate a bit at the join.

There is an ingenious method of eliminating this unevenness, by cutting the film across the outside of the sprocket hole, along the overlap line. One spur of film can then be eased away so that there is no overlap at this point, but simply a butt join without any adhesion. The overlap over the rest of the film's width gives sufficient strength, and the stripe when laid secures the free-flapping section of film—with no bump!

THE next real ferment in the world of 8mm is going to be over sound-on-film. Most of the groundwork is done. A reasonable camera has been made to record sound-on-film at the same time as the picture is recorded. That was the *Fairchild Cinephonic*, an American camera now out of production. I was in the middle of testing it some three years back, when it was withdrawn from the British market. Now, its successor—the *Fairchild 900*—is tooled up for possible production in the USA. Principal innovation is that the sound recording level is visible in the viewfinder.

The £100 barrier for sound-on-film projectors has been broken twice. First by a Japanese machine, the *Toei Talkie*, which can playback both magnetic and optical sound tracks on 8mm, and secondly by the *Eumig Mark S* sound projector, which is conventional magnetic only.

There has been plenty of time for the industry to mull over the dying controversy of 8mm magnetic versus optical sound, too. Reproduced photographically on the film's edge, rather than magnetically on an applied strip of tape, optical sound has the advantage of cheapness in mass production of prints, plus permanence. Disadvantage is that wear affects the sound quality, and home movie makers cannot record their own tracks. I heard the first demonstration of 8mm optical sound in this country back in November 1962, and on subsequent hearings have not noted any improvement in the low signal-to-noise ratio.

MY first tape recorder was awful. It was purchased from a London departmental store for a little under £30—to which it had been reduced from £48 through a “Frustrated Export Order”, or so the salesman said. Though inexperienced ears had yet to learn it, the frequency range was restricted to an estimated 5 Kc/s at $7\frac{1}{2}$ i/s and the background hum and cabinet buzz were abominably high. But assuming, as did our forefathers when they played their acoustic gramophones, that the emitted sound was lifelike, my enthusiasm was undaunted. What happened in the meantime I can only put down to the ‘gimmicks’—the superlative features which enabled disconnection of the erase head supply, mixing of gram and (crystal) microphone inputs, and monitoring of incoming signals through the internal loudspeaker. The recorder had been conceived before the trend towards utter simplicity: before the ‘fools’ were catered for by the ‘foolproof’.

‘Gimmicks’ play a very important role in tape recording, and it is intensely depressing to imagine the millions of recorder-owners who might have become ‘enthusiasts’ had the full potentiality of their machines been released by the designers. The keenness of even the most staunch tape recording hobbyist would undoubtedly be reduced, were he locked away with one of the many ultra-simplified recorders currently flooding the domestic market. He would have a microphone, he would have one reel of tape. He would be unable to mix, unable to monitor, unable to superimpose unless released from his prison to search out a dealer willing to take the trouble of ordering the accessory preamplifier that may or may not be produced by the recorder manufacturer. He would be rendered completely ‘tame’, unable to express his creativity in any manner other than straight into a lone microphone.

Gimmicks vary. On the one hand we have the features designed to simplify recording—namely automatic gain control, autostop, self-threading spools, cassette-loading and, now almost universal, interlocking record controls. On the other hand are the ‘extras’, intended for the creative chap and including mixing, direct and off-tape monitoring, echo, inter-track recording, and remote-control. Of these, echo is one of the most intriguing, allowing as it does the most unearthly noises to be created. Most of the better-quality recorders feature separate record/playback heads, these being an important asset to the creative enthusiast. Fig. 1 shows the layout of components required to achieve the effect. Echo, as anyone who has yelled from a Swiss mountain will know, is the delayed repeat of a sound reflected back from a distant object. The greater the distance between sound generator and reflector, the longer the echo will take to return. If one could shout loud enough, it might be possible to call a full sentence across the space between two mountain peaks before the echo returned. One would then hear a repeat of the entire sentence—reduced in volume of course. In the case of the tape recorder, echo is achieved not by throwing sound over some hundreds of feet, but by circulating magnetic impulses across an inch or two of moving tape. Speaking into the microphone of fig. 1, sound is converted to electronic oscillations which pass into the mixer (this may or may not be housed within the recorder itself) and thence to the record amplifier where it is added to a bias signal and fed to the record head. The journey from microphone to record head will have been at some enormous velocity and takes only millionths of a second. The real time delay occurs as the signal, now recorded on the tape, travels along at $7\frac{1}{2}$ or $3\frac{3}{4}$ i/s (or whatever the tape speed happens to be) to the playback head. Once in the playback head, the signal, converted back from magnetic to electronic impulses, takes barely an instant to pass through the replay preamplifier, where it is equalised and passed to a second input on the mixer. This brings the signal full circle.

The important thing, when setting up the equipment, is to ensure that the signal from the replay preamplifier is effectively lower than that from the microphone. Any Alpine climber who heard his echoed voice louder than his original call would probably fall off his perch in a state of utter shock—it just could not happen. With magnetic tape, however, it *could* happen, and happen very easily. The actual time taken for a noise to travel from microphone to replay preamplifier depends on two things—the distance between the record and replay heads, and the tape speed. If the two heads are $3\frac{3}{4}$ in. apart and the tape speed is $3\frac{3}{4}$ i/s, the delay will be one second. The speaker would thus be able to call one moderate-length word into the microphone before hearing it commence again in his headphones. If the second input of the mixer had been set carefully it would pass the word round the circuit again, and again, and again, until it was lost in background noise.

But supposing the echo was made louder than the original word ?

Turning the replay-preamplifier channel up on the mixer, the operator would call into the microphone, the resultant signal passing from tape head to tape head and back through the mixer at *higher level*, the process continuing until either the amplifiers or the tape are overloaded. The recordist would probably have long since removed his headphones, for, while the signal could only grow in volume to the point where the circuit is overloaded, the quality would continue to deteriorate with every echo cycle. It is interesting to note that the echoed words quickly combine into a continuous squeal very similar to microphone howl. Were the operator to monitor through a loudspeaker instead of headphones, he would probably experience this howl effect in any case.

The echo delay can, of course, be halved by halving the distance between record and playback heads, or by doubling tape speed. In practice, the distance between the two is between $1\frac{1}{2}$ and $\frac{3}{4}$ in., some professional recorders actually having sliding heads that give continuously variable echo speeds. The BSR TD10 features space for an ‘echo head’ that is very close indeed to the record head. The distance between the two is little more than $\frac{1}{2}$ in., giving an extremely fast and realistic echo at $7\frac{1}{2}$ i/s. The author’s aforementioned cheap and nasty recorder included space for such a head and was indeed fitted with one for an outlay of a little over £1. Again, inexperience led him to connect the head output direct to the low-level input without an intermediate preamplifier, though by a combination of coincidences the device worked perfectly.

The live-taped comparison system is illustrated in fig. 2. A radio tuner is shown connected to the record amplifier—no mixer being needed on this occasion. The tuner (preferably FM, since the output of this is more testing of a recorder’s capabilities than many other signal sources readily available) also feeds straight to a power amplifier, passing only through a two-way switch which it shares with the output from the replay amplifier. By operating this A-B Switch the recordist can compare almost instantaneously the ‘live’ tuner output (switch at A) with the recorded tuner signal (switch at B). The smallest fault in the recording chain can be observed in this manner. The brief delay occurring in the programme when the switch is transferred from position A to B can be disconcerting at first, but this is only another of the properties of the separate head system. An identical gap, but going forward in time rather than back, occurs when the switch is moved from B to A.



BY DAVID KIRK

PART 9

autostop
and echo
echo
echo
echo

Remote control and its blood relation—the autostop—are next on our list. There are two ways of achieving them—one electro-mechanical and the other more-or-less purely electrical. Of these, the electrical method is the simplest and cheapest. When a tape recorder is switched to play or record, two things occur: motors and amplifiers are connected to the power supply and the tape transport mechanism is engaged against the motor. The tape can be stopped either by retracting the pinch wheel from the capstan and simultaneously applying the brakes, or by disconnecting the motor from the power supply. The latter is a feature frequently met on battery portable tape recorders, where it is employed to give a form of remote control.

Fig. 3 shows the circuit arrangement. Under normal use, the battery supply would be switched on and off by the main start control, the motor also being powered by the fast forward and rewind switches, usually independent of the amplifier circuit. Inserting the remote control lead automatically breaks into the power circuit. Thus, provided the main start control has been switched on, the motor can be started by means of the remote switch, this normally being attached to about 4ft. of cable. It will be noticed that the full battery supply runs through the remote control lead. Since this is of a very low order, there is no danger of fire or shock being caused by frayed or snapped cable. Were such a device fitted to a mains recorder, the full mains potential would be applied across the lead.

Far too frequently, however, manufacturers and reviewers conveniently 'forget' to mention that this form of remote control, leaving as it does the mechanism in a tensioned unmoving position, tends to harm rubber idlers and pinch wheels. The amount of deformation that results when such components are left pressed against metal wheels and spindles depends on three factors: the durability or 'springiness' of the rubber composition ('rubber' being used here to mean all semi-flexible idler materials), the shape and size of the component against which it is pressed, and the force behind it. If a rubber wheel is compressed against an $\frac{1}{8}$ in. diameter spindle it will obviously suffer considerably more damage than one pressing with the same force on a $\frac{3}{8}$ or $\frac{1}{2}$ in. spindle.

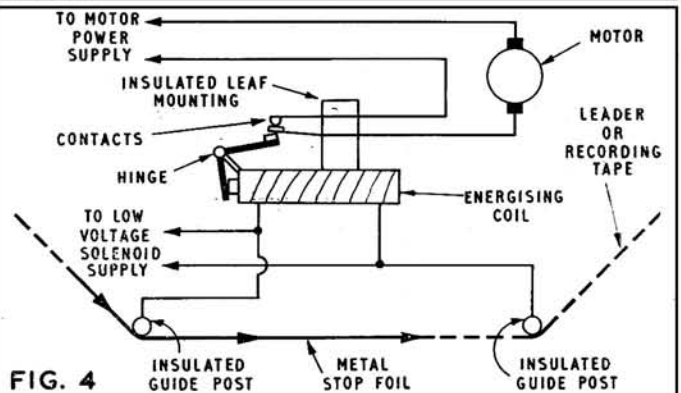
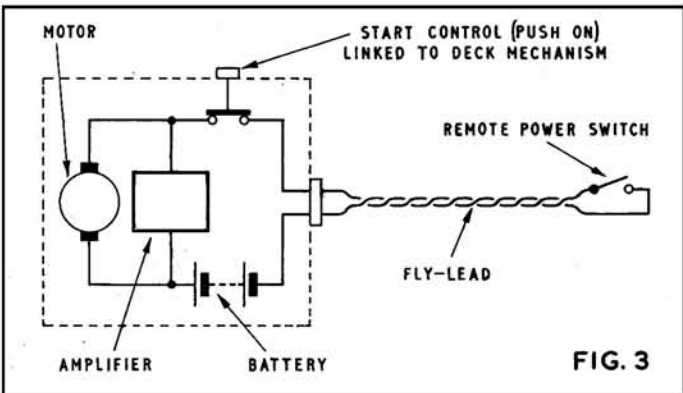
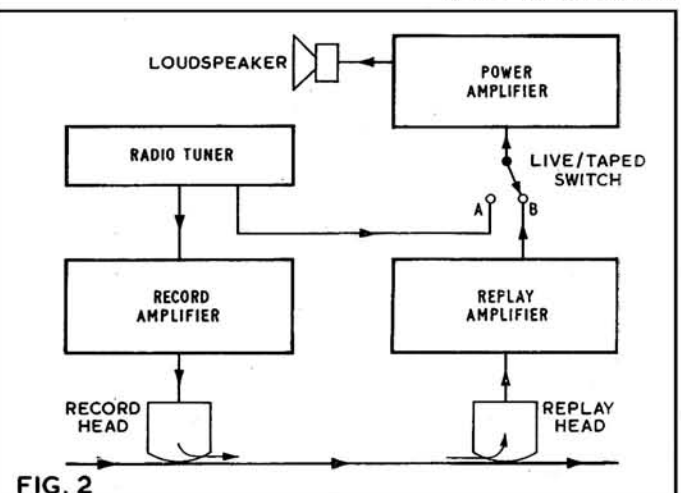
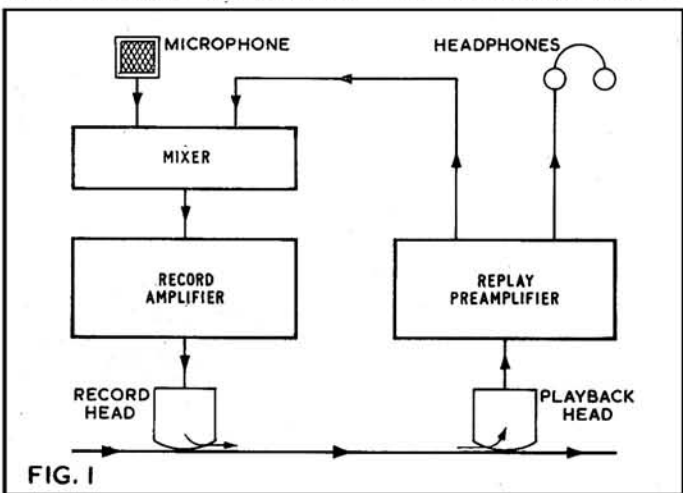
Deformation, unless it is of a really high order, usually 'runs out' of an idler when the latter is used for a period after being damaged. What remains, and what may never be run out, is a slight change in

flexibility of the rubber—usually a slight hardening—where the spindle left its mark. The tape enthusiast may turn a deaf ear to this argument; the gramophone user would think twice before even breathing on a turntable idler. The difference is that gramophone turntable idler deformation is heard through the pickup as an amplified 'bonk'. Though such a noise may easily be generated by the idler in a tape mechanism, it makes itself known initially in a sharply increased and regular wow. One assumes that most of the two million recorder owners in this country cannot detect wow.

A similar argument applies against the simple forms of autostop in use today. Fig. 4 shows a metal-foil system of the type employed to cut off the motor supply when the tape reaches the end of the spool. The metal foil forms a circuit across two insulated guide posts, shorting the low 'holding' current in the relay coil. When the solenoid supply is by-passed in this way, the core loses its electromagnetic pull on an in-built switch, in turn depriving the motor—and perhaps the amplifier—of its power supply.

Solenoids are rarely found in the mechanisms of domestic and semi-professional tape recorders (the term *mechanism* should not be confused with the purely *electrical* employment such as the aforementioned autostop), and *Planet Projects*, *Thorn Electrical*, *Telefunken* and *Revox* are practically the only manufacturers making fairly extensive use of the solenoid in the mechanical control of their products, discounting *Ampex* and similar companies catering almost entirely for the professional market. In fact, however, few tasks are too difficult for a solenoid—even the stiffest of press tabs or rotary controls. It is relatively easy to arrange a mechanism controlled by solenoids, since the control buttons may be mounted anywhere on the deck, connected to the solenoids by a handful of wires—not by an army of rods, bolts and bars. To place a 'punch' behind a solenoid it is necessary to apply a powerful current. It is all too easy to burn out the windings of a small solenoid when using currents of the order one would need, but the important point is that this powerful current need only flow for a fraction of a second to achieve the required physical force. Having once forced its way home, only the smallest of holding currents is needed to keep the relay, and its adjacent mechanism, in place.

Not all solenoid decks use the component in the same way. The
(Continued on page 511)





WHO SAID BEAUTY AND BRAINS DON'T GO TOGETHER?

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

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

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

Philips Family de luxe Model EL3558 42 gns.

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



Remember — PHILIPS Tape Recorders make ideal Christmas gifts!

To: Philips Electrical Ltd. (Dept. TR1), Century House, Shaftesbury Ave., London WC2
Please send details of Furniture Look recorders & free booklet 'All about Tape Recording'

Name.....

Address.....

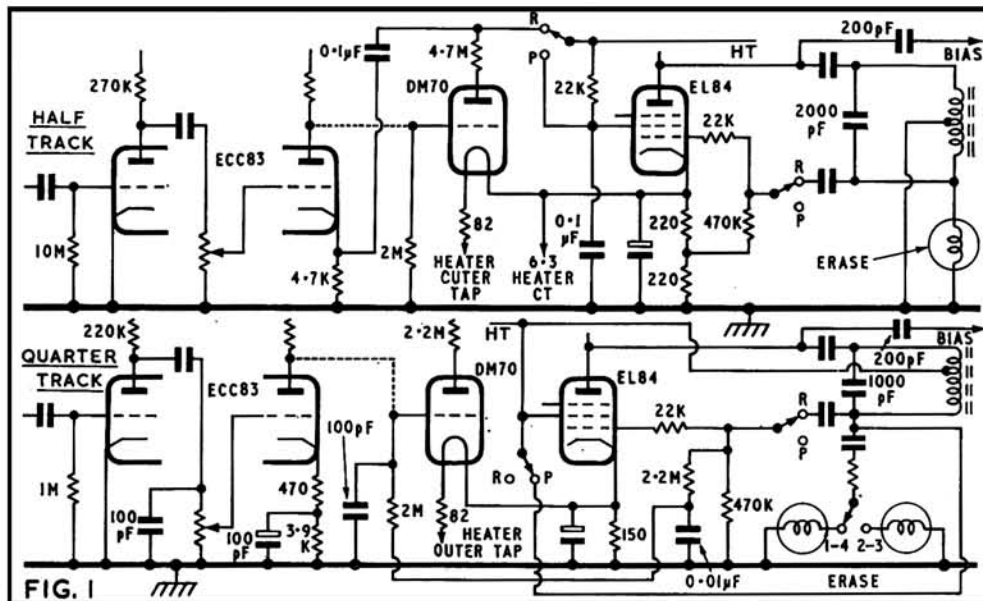
PHILIPS—THE FRIEND OF THE FAMILY

tape recorder service

BY H. W. HELLYER



NUMBER 48—FIDELITY AND SOME GENERAL FACTS



WITH the present contribution, this column is four years old. A great number of different decks and circuits have occupied our attention in that time, yet it seems we have hardly scratched the surface of the servicing information that our widening band of readers require. Many of the requests are for general facts, modifications, component and equipment choice, matching of disparate units, and so on. Others, unfortunately, are for data on obsolete equipment, which we are sometimes unable to unearth, despite the diligence of the research department. And still others ask for down-to-earth, practical details which never seem to enter the beautifully written technical treatises that make this magazine, and its sister publication *Hi-Fi News*, such a rewarding experience to struggle through! (Mr. Hellyer's own contributions are both beautifully written and down to earth—but we shall bear his remarks in mind. Ed.)

It is all very well informing readers to make such-and-such a test, or try the effect of this and that circuit, but all too often we receive this sort of plea in return: "Yes, but, short of using a meat-axe, how do I open the darned thing?"

Which is why, in several recent articles, a few general facts have wormed their way into the text; a procedure which, if the Editor will allow such mundane material to sully his pages, we shall attempt to continue. As we shall see later, this preamble has a direct bearing on

the present discussion of *Fidelity* machines.

This happily named company produces a popular range of transistor radios and a few tape recorders which have each, in their time, been a keen competitive match for their rivals. Using *BSR* decks, and favouring good, solid construction at popular price, *Fidelity* do not pretend to be in the 'professional' bracket. Their latest effort, the *Playmatic*, is too new to concern us here, but previous models on which some notes may be helpful are the *Argyll Minor*, the *Playmaster* and the *Major*.

The *Argyll Minor* was produced in two and four track versions. Valves used were an ECC83 two-stage amplifier and an EL84 output valve, doubling as oscillator during record. Modulation level indicator was a DM70 and the mains rectifier was an FC116, contact-cooled type, giving half-wave rectification from an isolated winding of the mains transformer and using a 32+32 µF electrolytic for smoothing in conjunction with a 4.7K resistor. This brings us to our first practical point: the smoothing capacitor is actually a triple electrolytic with common negative. The third capacitor section is the 25µF decoupling capacitor of the EL84 output valve. To reduce hum somewhat, it can be an advantage to isolate this component, using a separate 25µF, 25V working, tubular electrolytic and mounting it near the EL84 valve

(continued overleaf)

base, where there is adequate room. Points to watch are the correct connection, to pin-3 of the valve, across both the 220-ohm series resistors (the 1-track has a single 150-ohm) and to preserve the connection of the heater winding centre-tap, which goes to the output valve cathode and *not* to chassis.

One difference between the half and 1-track versions has already been noted. Although most data sheets on these machines state "Except for track switching, circuits are similar", this is by no means true. There are small but quite significant differences. As many readers write to ask for guidance toward converting 1-track to 1-track machines, some of these details can be outlined for both the Minor and the later machines. The obvious difference is the head itself. Both the record/play and erase heads are of a different impedance, and what is often of equal importance, may be of later design with some quite different characteristics. Higher efficiency will give improved high-frequency characteristics, needing changes in the equalisation, and perhaps in the pre-emphasis circuits of many machines.

Fig. 1 shows a skeleton circuit of the two versions of the Argyll Minor, with these differences outlined. Starting at the front end, we note that the grid leak of the first stage is reduced from 10M to 1M. This, I feel, was not entirely a matter of track switching difference, but the result of experience with hum troubles on earlier machines due to contact resistance and grid current, using such a high value of load. It is true that a crystal microphone input needs as high an impedance match as possible to get the best at the bass end of the spectrum, but a very high value of grid leak is not always the way to obtain the required matching. Anything above 4.7M usually leads to problems, especially in mounting and screening and cable-routing. Later models, however, revert to a 10M grid leak.

The anode load of the 1-track version (first stage) is reduced to 220K from 270K and a 100pF capacitor is fitted across the gain control. Another change involves splitting the cathode bias resistor of the second stage from the original 4.7K to a 470-ohm and 3.9K in series, the lower resistor only being decoupled by its 100µF electrolytic capacitor, omitted in the 1-track version.

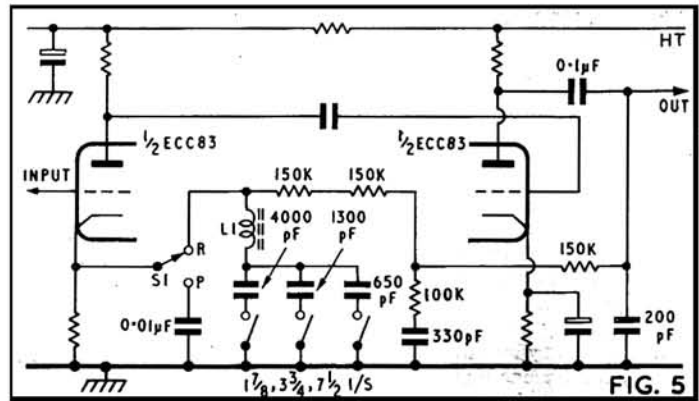
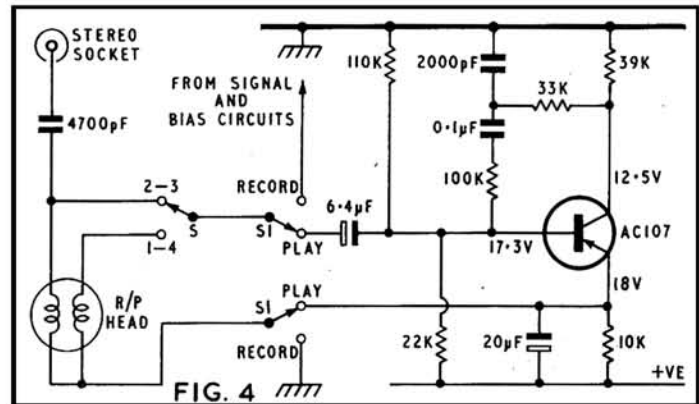
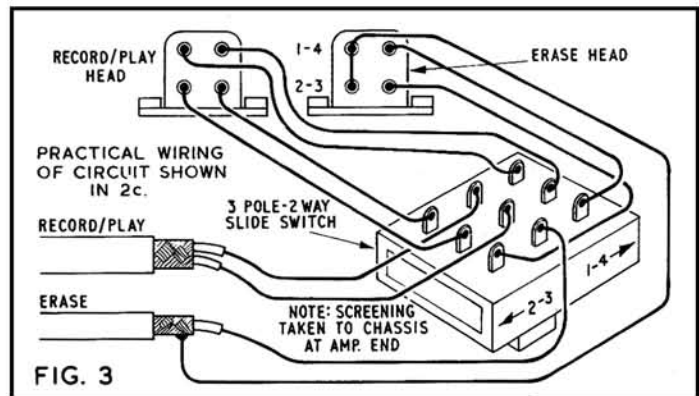
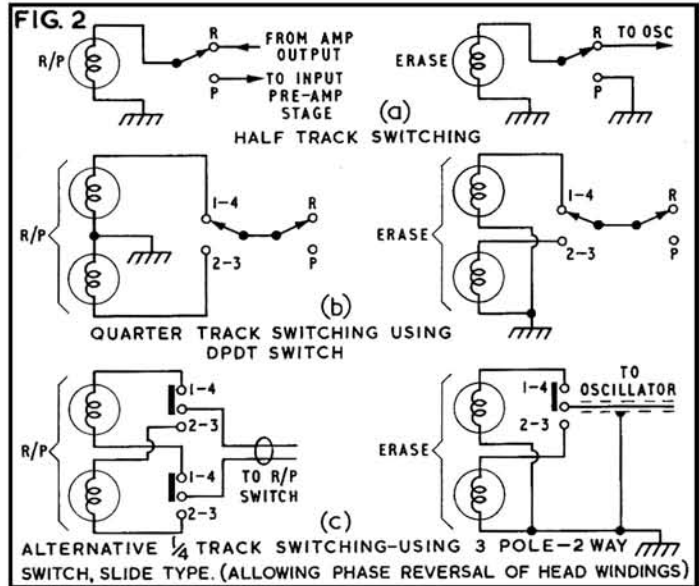
The constant-current resistor, series feed to the recording head, is changed from 220 to 270K. There are differences in the modulation level indicator circuits, both to allow for the difference in signal level and to help prevent interaction between signal and bias circuits.

Quite obviously, the oscillator circuits differ, but the design has allowed also for improved audio output by the un-tapped cathode of the EL84 and the changes in feedback circuitry. In particular, note the way the screen grid is supplied with HT. In the 1-track model, the record/playback switch short-circuits a 22K screen dropper resistor during playback, putting the decoupled HT to the screen grid. But in the later model, this is done by a quite different method. Another section of the switch short-circuits part of the oscillator coil, and the 1,000pF series capacitor which acts as a buffer during record is now placed across the output transformer primary. The 200pF bias feed capacitor is taken to chassis via the record/play switch. During record, a series network of 100-ohms and 0.1µF feeds the erase head. The latter is a buffer to keep HT from this winding, and the resistor attenuates the current to match the improved efficiency of the 1-track head. Head switching arrangements for 1- and 1-track operations are shown in Figs. 2 and 3.

The Fidelity Argyll is quite a different machine. A 1-track version appeared as long ago as 1959, but the following remarks can be taken to apply to the 1-track version, which superseded it. The general circuit is very similar except for small differences around the oscillator.

This model has an EF86 playback pre-amplifier, separate EL84 audio output and oscillator stages, and uses an EZ80 full-wave rectifier. Points of interest are the superimpose circuit, the trimmer used as a means of setting the bias voltage, and the EM84 modulation level indicator circuit. Other features are the tunable oscillator coil, the provision of a stereo socket, the straight-through amplifier facility and separate gain controls for mic/diode and gram inputs, giving some degree of mixing.

Superimposition is achieved by inserting a series 200pF capacitor (which at the bias frequency of 50 Kc/s represents a swamping impedance of some 16K to the erase head) and at the same time introducing a 560K resistor into the screen grid circuit of the oscillator. The bias voltage thus falls to 46V RMS from its original 70V. The



voltage at the erase head should be 16V (valve voltmeter measurement). To set bias voltage correctly, first adjust the oscillator coil for 70V reading at normal recording level. Then press the superimpose button and adjust the trimmer for a minimum reduced bias of 46V. Oscillator anode voltage is near maximum HT, namely 250V, during recording, and screen grid should be about 105V, measured with an AVO 8.

The Fidelity Playmaster—not to be confused with the later Playmaster Major—reverts to a similar circuit to the Argyll Minor, but is quite different in design and appearance. Again, there are $\frac{1}{2}$ and $\frac{1}{4}$ -track versions, and the differences consist of oscillator changes, a decrease in the capacitive bias feed from 200 to 56pF, decrease of the series resistor feeding the EM87 modulation indicator from 2.7 to 2M, and increase of the capacitor across the oscillator coil from 2,000 to 4,000pF. On the $\frac{1}{4}$ -track machine, the erase head windings have a 150-ohm resistor inserted in series. The oscillator coil is actually reversed so that the tapping point comes higher (with respect to the anode) for $\frac{1}{4}$ -track. Without wasting space on a circuit, we can see that the changes are pointing in the same direction: in general, bias current must be reduced when fitting a $\frac{1}{4}$ -track head. Modern heads usually have greater inductance than the older types and the head with its series capacitance feed form a tuned circuit, often resonant at near the oscillator frequency. This enables a greater bias voltage to be obtained by correct choice of component—which must be found by experiment to suit particular conditions.

Again, less signal current is required for later types of recording head, so the source resistance is increased. There are several circuits that provide correct matching by different methods, but, again in general, the addition of a series resistor that approximately doubles the existing resistance is a good point at which to start. The modulation level indicator may then need adjustment, as the signal level for overload is less, and if no adjustment of the level indication is possible, the network feeding the signal grid of the magic eye will have to be modified. As this network is also a virtual shunt across the signal feed, some care is needed with choice of components. When making the adjustment, use a signal with a good deal of treble in it, HF distortion being more apparent to the ear. Make a test recording, noting both level and distortion and make sure the bias is in order, then check for overload, adjusting the modulation level indicator to give 'maximum reading' at the point just below overload. Re-check, if possible, using a steady tone, when the overload point should be obvious both to eye and ear. The television test tone is a handy note to use if no signal generator is available.

Because of the improved treble response of later types of head, some change in the equalisation circuits may be needed and this will usually entail reduction in the series capacitance. Where a treble-boost capacitor is used in parallel with an inductance, decreasing this value can help, as can increasing any damping resistor across shunt capacitor networks. Experiment until the right values are found, use a test-tape as a check, and let the ear be the final judge.

And now, having commenced with a tilt at practical information, let us get down to basics: the dismantling of the Playmaster. There are five cross-head screws holding the top moulding, two of them within the head cover section. Remove these first (more about this later). Take off the moulding and the mechanism is laid bare, part of the printed board also becoming accessible. Next, prise off the chrome cover caps of the handle by levering gently with a screwdriver at the outer ends. For added protection, put a thin piece of metal or plastic between screwdriver blade and case. Unscrew the two countersunk screws. Pull off the control knobs and turn the machine upside down on a soft surface. Remove the four screws from the base—cross-heads again. Remove a further two cross-head screws from the rear of the cabinet and lift the cabinet off the assembly. This is much easier than

putting it right way up, struggling and breaking your fingernails.

To remove the U-channel from above the printed board for further access, take out the four screws. Then, the board can be pulled up gently to the extent of its connecting leads. The key word is 'gently'. When re-assembling, reverse the procedure, latching the handle clips in place with thumb pressure and taking great care with the positioning of the moulding over the edge controls before tightening all the screws.

This brings us to the Major, where again we have dismantling problems. As this machine uses the BSR TD10, three-speed deck, there is an additional control, the speed-change knob, to consider. This is held by a fairly long 6 BA screw, and should be removed first. The other two knobs simply pull off. There are six Philips screws fastening the top cover, and the recording level meter is a push fit in a hole in this cover, held fast by the shape of its clamp and 6 BA nuts. Take care, if removing the meter, to replace the insulating shield on the clamp bracket, and not to scratch the paint on the bracket, which can allow an intermittent short-circuit to a stray lead when re-assembling. The moulding will withdraw quite enough for most servicing without disconnecting the meter, but if you have to do so, observe the correct polarity for re-connection.

There are two hexagonal stand-off pillars to unscrew next, and three Philips screws securing the deck cover. To take the whole deck and chassis out, another four Philips screws must be removed from the wooden frame around the deck, and then four more holding the deck and chassis to the cabinet runners, leaving only the loudspeaker in the cabinet. Again, fairly long leads permit servicing without disconnection, for most purposes.

Having got this far, we are probably way ahead of the first-timer, who is still struggling to undo the screws. The cross-head screws on this model and the one described previously, seem to have been fitted at the Fidelity Works by a horny-handed Titan with a pride in his work. They are practically irremovable without danger of scratching the top plate or chewing the screw head to bits.

Old timers and dedicated home handymen may skip the next bit. For the benefit of the frustrated, let us talk about shifting these screws. The trouble seems to be that they are case-hardened, and fitted to a relatively thin plate in which the steel is not hard enough to retain the tapped ridges completely when a screw is driven home with some force—presumably by a machine tool. The result is a warping of the thread wall, and minute particles of swarf which bind the screw as we try to loosen it.

The remedy? Dislodge the swarf and release the binding action of the tapped thread and screw. To do this, it is imperative that a screwdriver which exactly fits the head of the screw be used. A Philips screwdriver is needed, and there are two main sizes, both of which should be in any engineer's kit, and should be considered as a useful acquisition for the layman. Using an ordinary screwdriver blade of $\frac{1}{4}$ -inch blade width or more simply burrs the slot. Using a grub-screw driver, although this sits more deeply in the slot, is equally futile, and will result in a ruined blade.

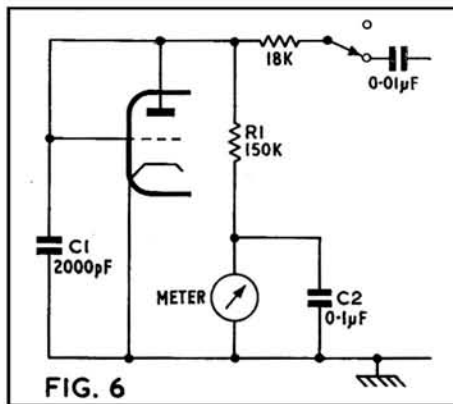
Having chosen the right tool, the next step is to move the screw. The word really is 'move', for once it has moved, unscrewing is relatively easy: one must break the initial binding action. Seat the driver firmly in the slot, press down hard and turn very slightly but firmly clockwise, as if attempting to tighten, and as soon as the screw shows the least sign of moving, reverse the torque and begin to unscrew.

When this fails, despite all efforts, it is useless to carry on until one's wrist is sprained. There are two alternatives remaining, both of which entail marking the screw and taking precautions not to mark anything else! One can cut a good slot in the screw and use a hefty screwdriver, or use a wrench on the screw. Either method requires first a protective shield of thin foil or even sticky brown paper over the adjacent panel, and the utmost care not to let the tool slip and cut through the shield. The action of sawing, particularly, needs circumspection.

The use of a grip is not to be despised. A good tool (the author favours the simple *Guy-Grip*), which first samples the size then locks firmly into place, allows a full concentration on the torque without the added need to apply squeezing pressure, as with pliers. The *Guy-Grip* and other types of mole wrench allow a good pressure near the base of the screw head by virtue of its flat-ended jaws.

A good deal of space has been spent on what may seem an elementary subject, but anyone who has had to drill out a screw shank and retap the hole after shearing off the head of a screw will agree the subject needs airing. The secret is steady pressure, a good tool, and patience.

(continued on page 502)





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BEWARE OF THE BIRDS

BY DAVID HAINES

a play for two voices



ANNOUNCER: We present a short play entitled *Beware of the Birds*.
(Scene : two bird-watchers are stationed in a wood.
Fade in birdsong.)

NOVICE: (restlessly) Isn't it time we had our sandwiches ?

ENTHUSIAST: (almost whispering) Don't make a noise! Don't move!

NOVICE: (unhappily, but quieter) But we've been crouching in this wood for nearly three hours. I'm hungry.

ENTHUSIAST: (sternly) Is your heart really in this hobby ?

NOVICE: Of course it is, but—

ENTHUSIAST: (interrupting) Patience and self-denial are essential if you wish to become, like me, an experienced observer of British birds.

NOVICE: (humbly) I've done my best to follow your example. But I simply must waggle my leg—it's gone all numb.

ENTHUSIAST: Keep absolutely still! I'm hoping to show you a white-throated sparrow. It's extremely rare and very shy. The slightest movement will be fatal.

NOVICE: (after a pause) Did you ever see that Hitchcock film?

ENTHUSIAST: (preoccupied) I never attend the cinema.

NOVICE: (after a pause) This film was about birds.

ENTHUSIAST: (irritably) What film ?

NOVICE: This film by Alfred Hitchcock. All about birds. It was very well done. The birds suddenly acquire intelligence—and start making organised attacks on human beings.

ENTHUSIAST: (scornfully) What utter rubbish!

NOVICE: They start pecking people's eyes out and so on.

ENTHUSIAST: I can't imagine anyone taking it seriously. (suddenly) Ssh! (dramatically) I can see a white-throated sparrow—the same little fellow I saw last Sunday at 11.32 a.m.

NOVICE: (hopefully) Can we now have the sandwiches ?

ENTHUSIAST: (urgently) Here—take my binoculars and see for yourself!

NOVICE: Thank you . . .

ENTHUSIAST: He's perched in the beech tree on the right-hand side of the oak—second bough, third branch along. Notice the pale brown legs and dark mantle-feathers. But the main characteristic is the head—observe the white throat, the black-and-white crown and the little yellow stripe above the eye. (pause) Well ?

NOVICE: (apologetic) I'm terribly sorry—there's nothing there.

ENTHUSIAST: (impatiently) Let me look. (pause) He's flown away. (angrily) You let the sun glint on the lenses—you've frightened him off!

NOVICE: (timidly) I'm very sorry. Would you like a cucumber sandwich ?

ENTHUSIAST: You've ruined the entire purpose of the expedition !

NOVICE: Or would you sooner have fish-paste ?

ENTHUSIAST: You'll never make a bird-watcher!

NOVICE: Or would you rather have mustard-and-cess ?

ENTHUSIAST: (exploding with rage—really loud for first time) I don't want any sandwiches! (birdsong terminates) All I want is a sensible and well-balanced companion—someone with whom I can share a common love for British birds!

NOVICE: (politely) I say, have you noticed anything ? All the birds have stopped singing.

ENTHUSIAST: (surprised) So they have—how odd!

NOVICE: They seem to be forming a gigantic circle—with us in the middle.

ENTHUSIAST: (puzzled) I wonder why ?

NOVICE: You're the expert—you tell me.

ENTHUSIAST: Yes, but you saw the film. (nervously) Do you think they're getting ready to attack ? (hysterically) They're creeping towards us through the undergrowth—they're closing in! We're surrounded! Look at their sharp beaks and shiny eyes!

NOVICE: I suppose they must be hungry.

ENTHUSIAST: (screaming) Hungry ? You mean they want to eat us alive ? To pick our very bones ? Help!

NOVICE: Keep calm. It's the sandwiches they're after.

ENTHUSIAST: (in relief) Then let them have the whole lot—and let's get the hell out of here! (in revulsion) Horrible, nasty, beastly birds—ugh!
(Fade out on last line)

THIS SHORT play is intended primarily for simple production in the open air (e.g., in a garden or woodland park). But it also exploits a 'trick' splice—which (in this case) requires that part of the dialogue be recorded in the same 'open-air' (dead) acoustic, but with a sudden disappearance of background noises, i.e., bird song. (A trick splice is a simple but valuable method of changing backgrounds and acoustics in drama-on-tape.)

Alternatively, the entire play can be produced indoors—utilizing any general background of birdsong (which almost every amateur will have recorded this summer).

If the play is recorded entirely indoors, acoustic damping should be as efficient as soft furniture, coats, sheets, etc., will allow, and birdsong recorded separately outdoors and superimposed. The slightest increase in reverberation when the bird song stopped would destroy the required effect.

Both actors speak *sotto* at very-close microphone voice-positions. Ensure levels match both sections.

Birdsong level will be correctly 'distant' if the actors are close enough to microphone and gain reduced accordingly.

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NO doubt the Little Woman had right on her side, but to describe the breadwinner, searching for a certain tape, as resembling "a one-armed paper-hanger with a wasp on his nose" was a little too much for the York dignity.

Gathering tapes from the sideboard, the paper rack, the mantel-piece (no, Dear, there was *not* one in the bread bin), he retreated in a huff to the dungeon. A solemn conclave with a crony, who did most of the work, and a couple of hours' sawing and hammering resulted in a most luxurious and efficient storage box. Sturdy, dust-proof and shock-resistant, one could almost hear the tapes purring . . .

The first step was the construction of the box (fig. 1). Our model holds 24 reels, but can be extended or shortened by allowing $\frac{1}{8}$ in. per reel on the length. Similarly, there should be no difficulty in altering the dimensions for other diameters of reels. Those given are for 5 in. reels.

A suitable material proved to be $\frac{1}{2}$ in. thick *Weyroc*, and the assembly was by impact adhesive, reinforced with simple nails, which were found to be more than adequate.

It will be observed that the front panel is recessed along its top edge for the full internal length. This is to accommodate the castellated strip (fig. 2), which is the basis of the suspension and selection system. Each spool is suspended in its own cradle of leader tape (fig. 3), and selection is made by pulling on the numbered tags, causing the chosen spool to rise as if by magic from its stowage.

The tags are formed (fig. 4) by planing softwood strip $\frac{3}{8}$ in. x $\frac{1}{2}$ in. to the shape shown and cutting into $\frac{1}{2}$ in. lengths. The ends of the cradle tape and the numbered papers are secured by transparent adhesive tape.

Since each reel is supported on the tape itself, each cradle must be adjusted to suit the amount of tape on the reel. This is most easily achieved by engaging the selection tag in its slot and pulling from the back until the spool is lifted very slightly clear of the bottom of the box. The leader tape is then cut and the end temporarily secured to the back of the box with Sellotape; odd ends are trimmed off after fitting the wooden securing strip (fig. 5).

A hinged lid, faced with baize around the edge, and with sponge strips as suggested in the heading sketch, serves to exclude dust and to

NEW THOUGHTS
ON AN ANCIENT
PROBLEM BY
MARTIN YORK

steady the tapes in transit. It must be remembered that the lid must span not only the width of the box, but the extra width of the wooden securing strip along the back. The dimensions of the lid will thus become $13\frac{3}{8}$ in. x $6\frac{1}{2}$ in.

Although the box is complete at this stage, there is nothing to stop the enthusiast adding such refinements as handles, locks or a false bottom for storage of leads and plugs. York, a creature of simple tastes and limited ability, decided to quit while he was winning !

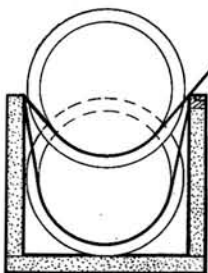
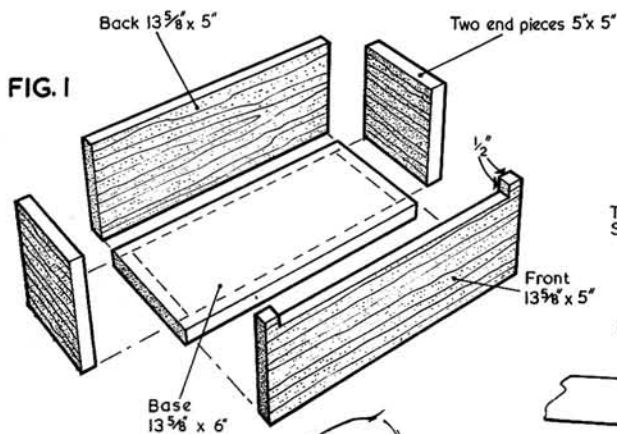
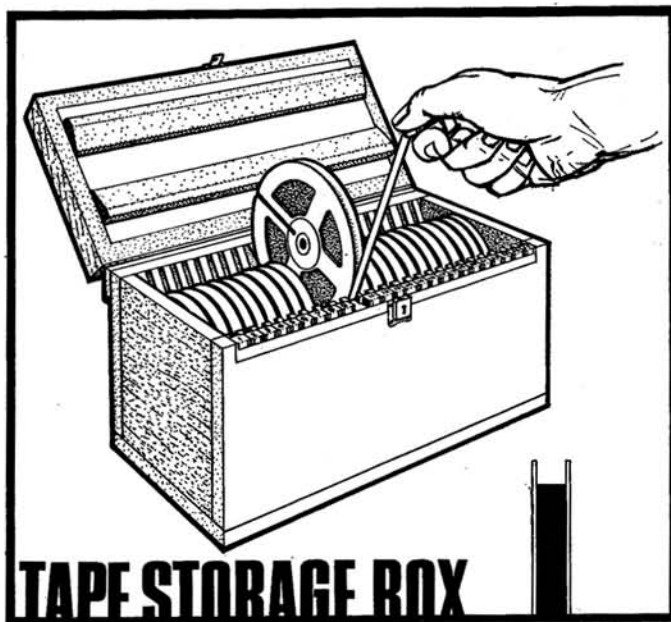


FIG. 3

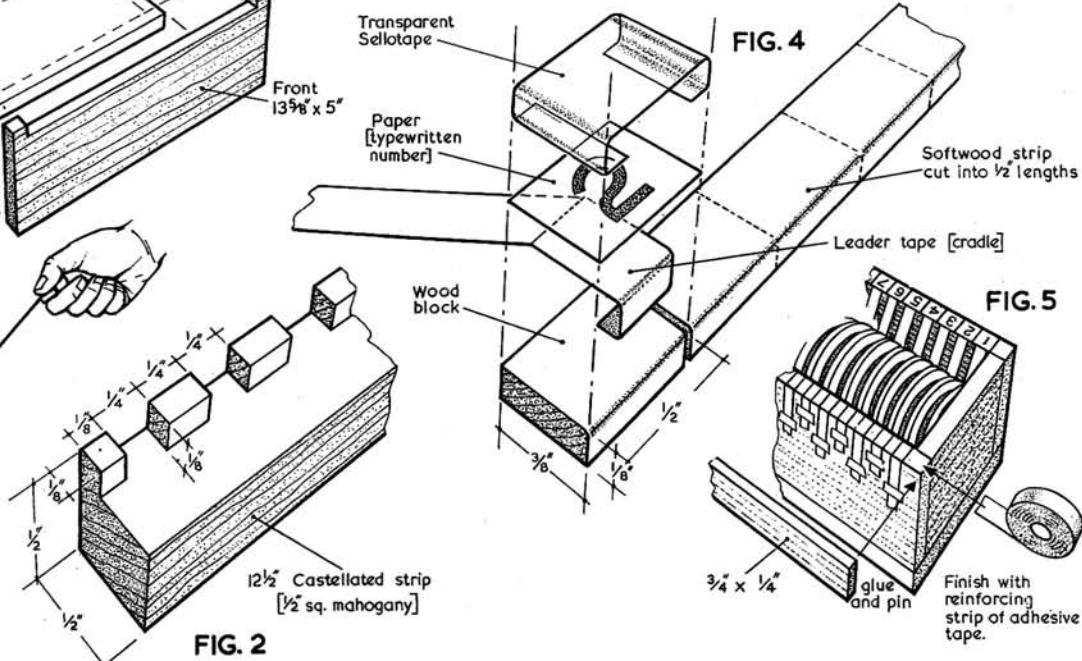


FIG. 2

FIG. 4

FIG. 5

WHEN is a tape deck not a tape deck? The only logical answer to this is: when it's a tape recorder. The difference between tape deck and tape recorder is as simple and well-defined as that between a British-made tape recorder and a foreign-made model. The trait of building on to decks, whether his own or that of another manufacturer, is almost entirely confined to the British producer. It has resulted in a 'tacked together' appearance being assumed by recorders from this country, compared with American, European and Japanese designs. Even the Russians, according to a recent survey, have followed the unit design technique. Without doubt, the tape recorder conceived as an entity can be made to look vastly more attractive than that resulting from a marriage of mechanical and electronic devices.

Of greater importance than appearance, however, is the performance of a recorder; and it can be shown quite conclusively that deck-plus-amplifier designs (British as it happens), far from suffering with lower standards, are in many cases substantially superior to integrated designs in terms of robustness. This certainly does not imply that they offer lower wow and flutter figures when new—examination of our review columns will quickly dispel that idea. It means, simply, that over a period of years a solid, carelessly made, deck will hold its moderately high speed consistency better than the finely adjusted, accurately machined and highly fragile light-weight integrated design.

Why the preamble? The recently introduced *Magnavox Studiomatic* has attempted to bridge the gap between integrated and deck-plus-amplifier recorders. Manufacturers employing this deck in their designs can fit all their electronic controls on the deck, or restrict them all to a separate panel in the hitherto conventional British manner. One of the beauties of Studiomatic is that it has ample space for gain and tone controls, track switches and modulation indicators but does not appear sparse and over-spacious when the space is not employed. *Elizabethan* were one of the first manufacturers to employ the Studiomatic, their range taking on a substantial visual improvement as a result. The *LZ102* is shown above right.

Should the name *Studiomatic* suggest otherwise, it is worth pointing out that this deck bears very little resemblance, above or below its semi-flexible plastic covers, to its predecessor, the eminently popular *Studio*. A similar capstan transmission is employed, a stepped motor spindle driving the capstan flywheel through an idler, though a single motor now serves where three were used before. General layout of idlers and rotating components is easily seen when the light grey deck plate and dark grey control panel are removed. Three plastic controls on the right of the deck govern, from left to right, rewind, play and fast forward respectively. They are each mounted across a central metal bar and a see-saw action eliminates the need for a separate stop control. To return the deck to neutral from any one mode, the relevant control is merely pushed back to its horizontal position. A simple yet foolproof interlock makes it quite impossible to press more than one control at a time or change tape speed while the machine is running.

The action of each control is quite simple to follow, though the brake mechanism took a little unravelling when the deck was first examined. When in a neutral position, the deck motor is unpowered and isolated from the surrounding idlers. Referring to the photograph labelled fig. 1, however, it will be seen that the rewind/take-up idler has a natural tendency to rest between capstan spindle and right-hand spool turntable. Nevertheless, there is no pressure behind it and the likelihood of a 'flat' forming on the idler or on the hard rubber-coated spindle is almost non-existent. All of the controls transmit their see-saw action to a metal arm—there are three of these—in such a manner that pressing the nearside of the control downwards pushes the rod away from the operator and towards a slotted plate at the rear right-hand corner of the deck. Fig. 2 shows this interlock and transmission arrangement as it affects the right-hand fast-forward control.

The other two controls operate through identical mechanisms, save for their lock-bar 'jaws' which are slightly different in shape. Pressing the front (left, in the illustration) end of the key causes the key to rotate about an axle rod (common to all three controls). This rotation is fed to a vertical metal plate which is loosely clamped to the inside of the plastic key by a protruding slot. As the control is pushed, the lower part of the vertical plate moves forward some one-and-a-half inches, carrying with it the horizontal control rod which is, in turn, pushed towards the rear of the deck. The bottom tip of the vertical plate is located in a slot cut from the bottom of the deck chassis. This slot governs the angle of turn through which the control may move. A spring connected between the vertical plate and the front deck panel gives the control a positive 'feel' holding the metal plate in place

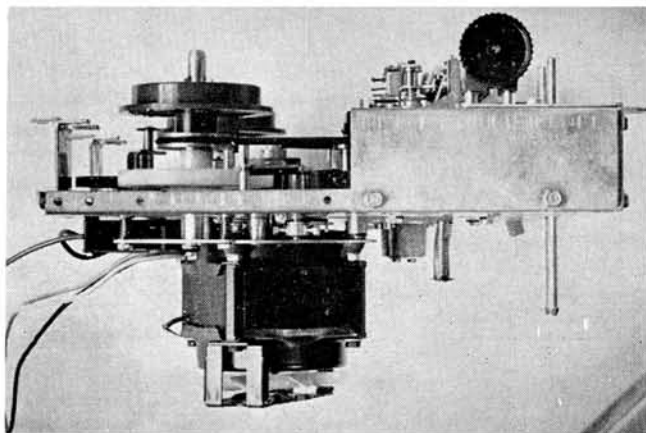
TAPE DECKS ANALYSED



THE MAGNAVOX STUDIOMATIC

when switched into action and keeping the key firmly horizontal when in a neutral position. This is another example (we met one recently during the *BSR TD10* analysis) of a spring being employed rather as a steep hill between two villages. The hill ensures that no vehicles are lost between the two villages, since they will always fall into the nearest location. The spring, here, is our hill, while on and off modes comprise the two villages. (On the *BSR* deck, incidentally, the spring acted as a hill between *three* villages.)

The lock bar, which prevents more than one key being pressed at a time, might be likened to a rather lengthy bit shared by three badly crippled horses. *Horse A*, perhaps having recently broken its neck, can only move its head downward from a horizontal position. *Horse B*, perhaps for a similar reason, can only move its head upwards from horizontal, while *Horse C* is incapable of moving its head from horizontal at all. Putting each horse into the role of a control key, it will be seen that if *Horse A* takes the communal bit into its mouth and moves its head downwards, horses *B* and *C* will be unable to grasp the bit. An opposite situation applies with *Horse B* while *Horse C* is so badly afflicted that the combined strength of horses *A* and *B* (acting in opposite directions) fails to remove the bit from its central position. A crude representation, but it serves its purpose. It would be wrong to imagine that the jaws are respectively down, up and horizontal. The Studiomatic designer found it sufficient to prevent



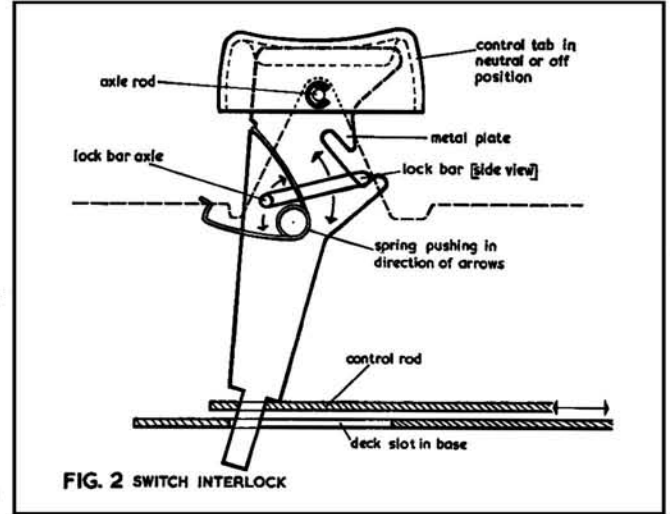
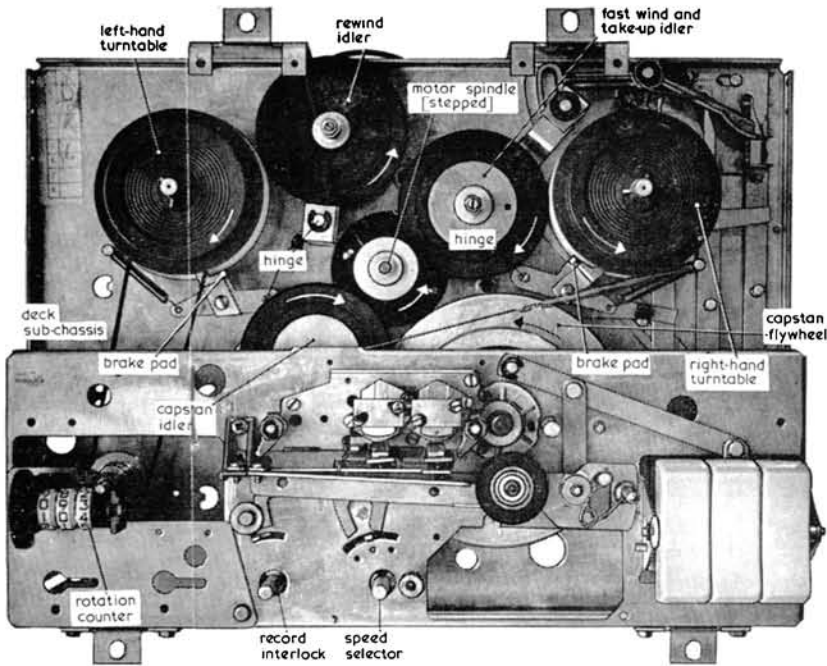


FIG. 2 SWITCH INTERLOCK

mechanical chaos merely to vary the upward angle of the jaws by a slight amount. The lock bar, of course, rests along the bottom of the three 'mouths' until one of the controls is operated.

Having described how the push-pull rod action is obtained for each of the three keys, we continue to describe in detail the results of each. The centre play switch is the first to receive description. Pressing the switch causes a stud located in the teeth (yes, we are back to jaws again) of a slotted plate to move forward into the angled slot. Since the moving rod is incapable of deviating from its angle parallel with the side of the deck, it is obvious that something must give way—and the slotted plate does just this, sliding a short distance to the right. Similarly, retracting the stud applies pressure to the slot sides, returning the plate to its original position. This plate is directly connected to the motor switch and, since the operation of any control will cause a studded rod to enter one of the jaws, the motor will be powered by any of the keys being pressed.

The brakes, too, are operated by the plate, being released whenever the plate is pulled to the right. Fig. 3 illustrates both this and the motor switch, showing the angled rod against the right-hand brake axis. Pushing against the brake spring removes both right and left-hand brakes, the latter being connected by a thick metal rod. Removing the control studs from the plate returns the plate to its original (left) position and hence releases the pressure against the brake springs,

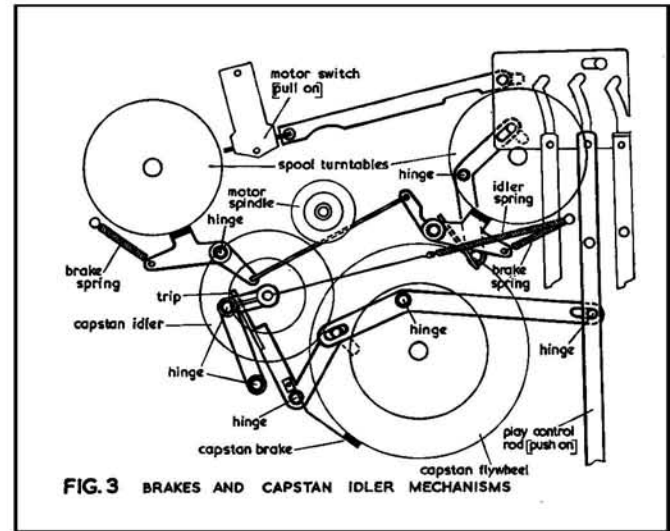


FIG. 3 BRAKES AND CAPSTAN IDLER MECHANISMS

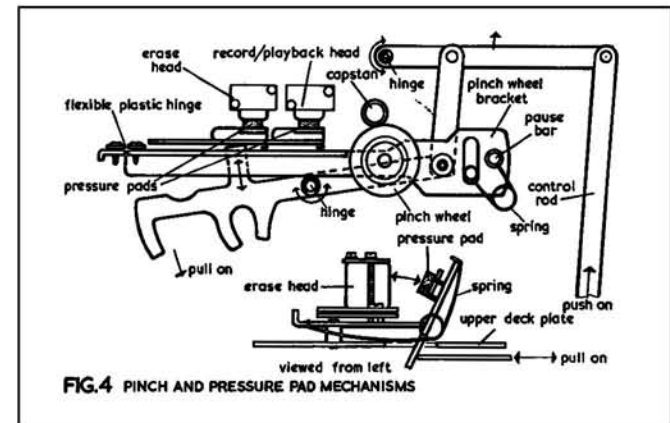


FIG. 4 PINCH AND PRESSURE PAD MECHANISMS

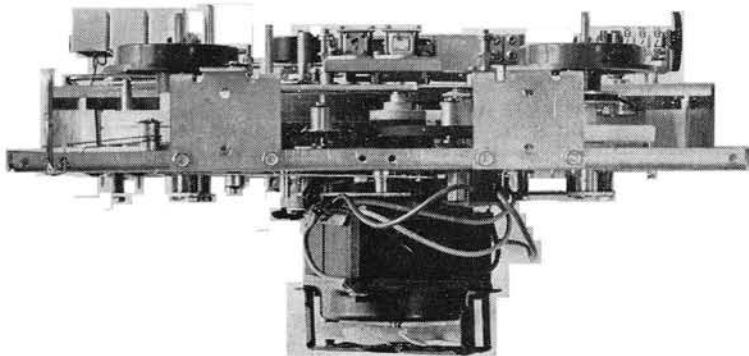


Fig. 1 (above left) shows the deck mechanism as revealed when the plastic cover plates are removed.

Far left: A side view of the Studiomatic. Note cooling fan on lower motor spindle and sprung turntable mounting below main chassis.

Left: A view from the rear.

(continued on page 493)



LOEWE OPTA

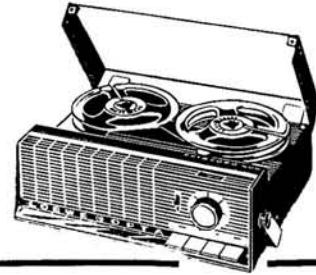
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Arding & Hobbs Ltd., Clapham Junction, S.W.11.	Brown, Muffs, Bradford 1.	Guildhall Tape Recorders, 33 Guildhall Street, Folkestone.	John King (Films) Ltd., Film House, East Street, Brighton 1.	Recording Machines Ltd., 119 Victoria Street, S.W.1.	Tape Recorder Centre, 30 King Cross Street, Halifax.
Audiocraft, 20 Kettering Road, Northampton.	Camera Thorpe, 6/8 Osmaston Road, Derby.	J. E. Hargreaves Ltd., 1 Railway Road, Blackburn.	R. S. Kitchen Ltd., 22 King Edward Street, Leeds 1.	Tom Reekie Ltd., 10 Bridge Street, Stafford.	J. H. Tate & Co. Ltd., 45 Crowtree Road, Sunderland.
Barkers Ltd., 31 Oxford Road, Worthing.	Campkins Audio, 21 Market Street, Cambridge.	Harveys, High Street, Guildford, Surrey.	Lancashire Hi-Fi Ltd., Tape Centre, 8 Deansgate, Manchester 3.	The Music Centre, 103 Risdygate Street, Bury-St-Edmunds Tel. 4324.	K. A. Cheeseman Ltd., 32 Crouch St., Colchester, Essex.
Barretts of Canterbury.	Chelsea Record Centre, 203 Kings Road, S.W.3.	Hamilton Electronics, 35 London Rd., Southampton.	Leech & Haige Ltd., 112 London Road, Oxford.	Ryland Huntley, 15 Old Bond Street, Bath.	Teletape, 33 Edgware Road, W.2.
Battys (Rhyl) Ltd., Rhyl. (Tel. 2621.)	Chiesmans Ltd., Lewisham, S.E.23.	J. Harris, 231 Baker St., N.W.1.	Massey's, 121/3 High Rd., Chiswick, W.4. CHI 2082.	Selfridges Ltd., Oxford Street, W.1.	The Recorder Co., 188 West End Lane, N.W.6.
Wilf Plant, Asfordby, Melton Mowbray, Leics.	City & Essex Tape Recorder Centres, 228 Bishopsgate, E.C.2.	House & Son Ltd., Blake Street, York.	James McKenzie Ltd., Grange Road West, Birkenhead.	Sheen Tape Recorder Centre, 8 Station Parade, Sheen, S.W.14.	Turners Photographic Ltd., 9 The Walk, Ipswich.
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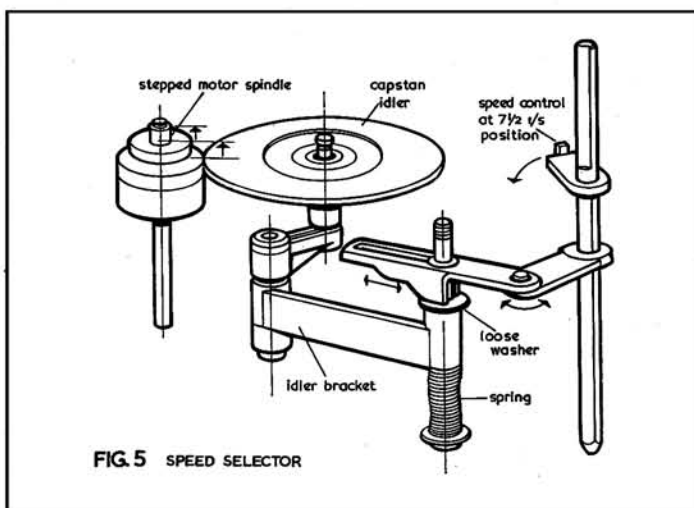


FIG. 5 SPEED SELECTOR

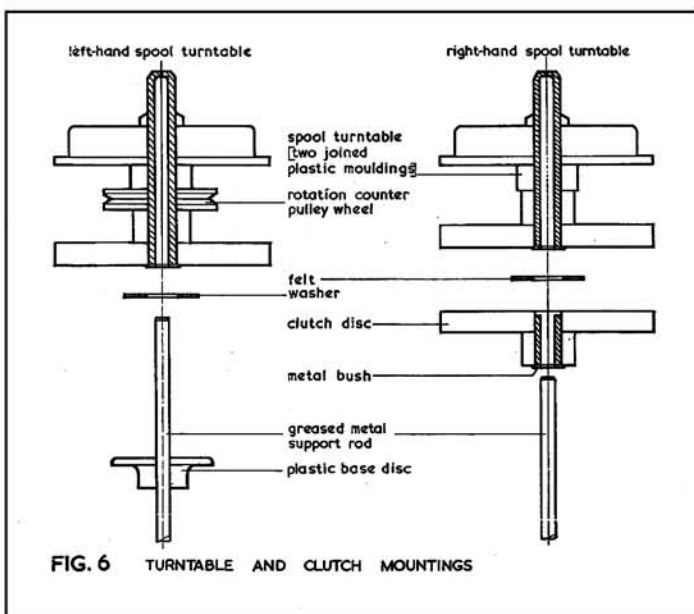


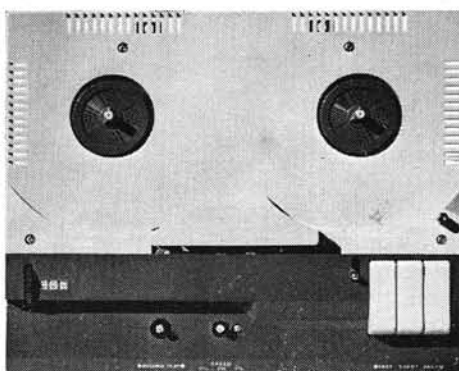
FIG. 6 TURNTABLE AND CLUTCH MOUNTINGS

causing the brakes to return to their positions against the spool turntables.

The capstan idler and flywheel brake are also, as one would expect, controlled by the play switch. A connecting lever is shown in fig. 3 and this is joined to the control rod through a slot in the bottom of the deck. The lever does not in itself move the capstan idler between the flywheel and motor spindle; it merely acts as a trip to the long idler spring. Just how it does this is seen by close examination of fig. 3. Pushing the control rod forward causes the connecting lever to rotate in an anti-clockwise direction which, in turn, rotates a trip lever clockwise and releases the flywheel brake. Since this trip is all that keeps the hinged idler bracket from moving (clockwise) in the direction of the tensioned spring, the idler is thus pulled between flywheel and motor (the latter, in the meantime, being switched on by the sliding plate) and the tape begins to move.

As simple as that? Not really; the pinch mechanism has still to be described, though its action is quite straightforward. Fig. 4 shows its relationship with the control rod. In fact, the connection to that rod is made through a metal pillar hidden beneath the plastic start key, the pillar being used to transmit the moving action from the deck base to the upper assembly. The drawing in the lower part of fig. 4 illustrates in rather more detail the pinch mechanism visible in the fig. 1 photograph. The drawing is accompanied by a side view of the erase head and pressure pad mounting, the latter pads resting away from the heads at an angle of some 60° until the play switch is pressed. As well as

operating the functions already described, pressing the play switch causes the metal bar (lower right in fig. 4) to move forward, transmitting its movement through a lever, hinged at the far end, to yet another rod attached to the pinch wheel bracket. And here we meet yet another example of the jump spring, connected between the pause bar on the pinch wheel bracket and a rod protruding from the upper deck plate. The hinged connection between control rod and pinch bracket is loosely achieved via a slotted hole through which the



Left: A view of the complete deck, less speed and record-interlock control knobs.

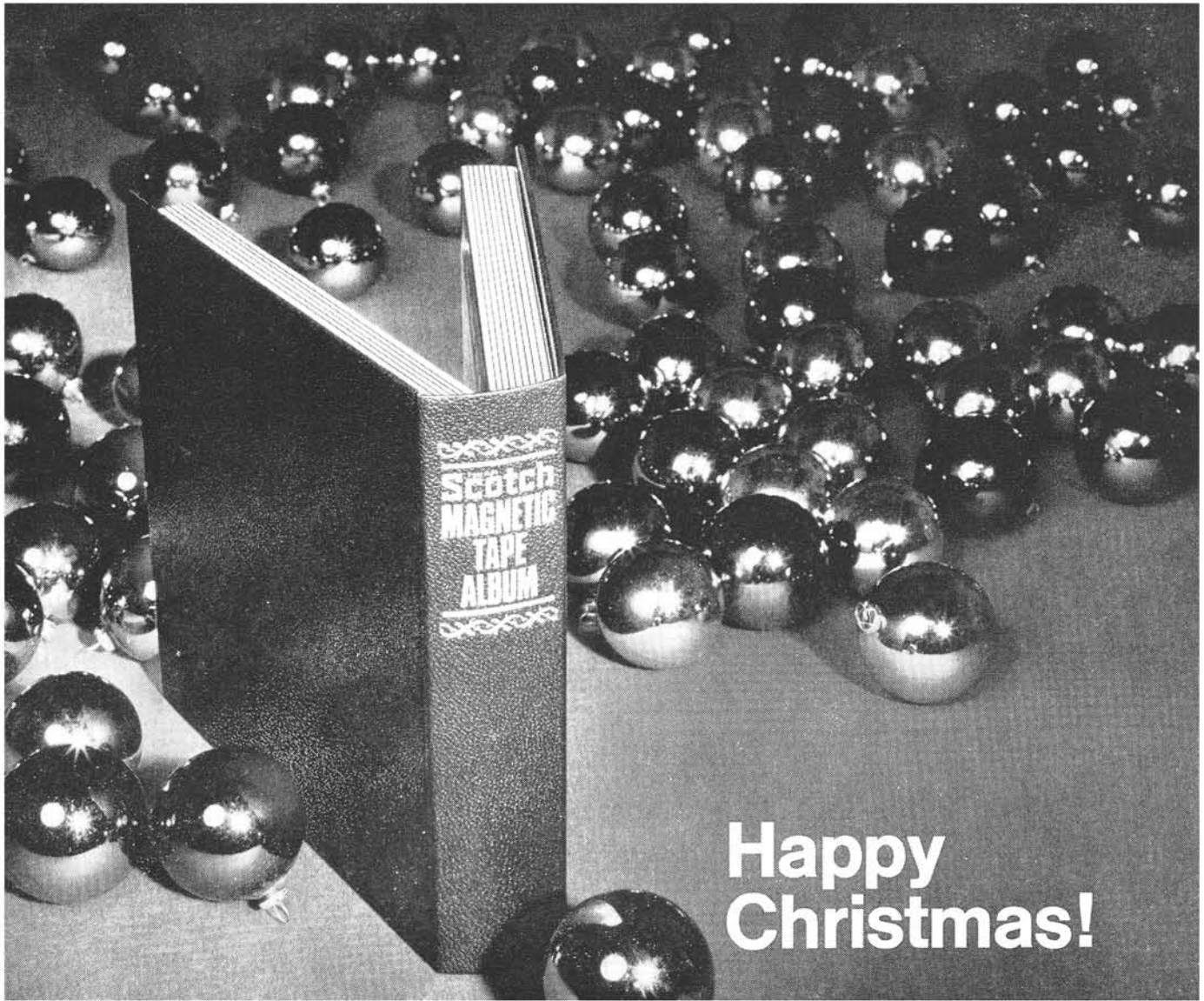
rod is screwed. This slot should not be confused with the larger slot through which the pause spring pillar is fed. A large washer hides the small slot in the fig. 1 photograph but this washer is omitted in fig. 4. Pushing the play switch, therefore, swings the entire pinch bracket forward about a flexible plastic hinge to the right of the illustration. The jump spring which initially resisted the angular movement now clamps the pinch wheel against the capstan though it does not, as we shall see, directly affect the pressure pads. Pulling back the pause bar (which is accessible through the plastic covering to the left of the rewind key) simply applies pressure to the jump spring, pulling the pinch bracket as far back as the small slot connecting the main control rod will allow. This is not far enough to take the jump spring over its 'peak' and consequently the pinch wheel returns to the capstan as soon as the pause control is released by the operator.

Also connected to the pinch bracket where it meets the control rod is a hinged bar that swings about a point near its centre when the play control is operated. The upper drawing in fig. 4 illustrates how this bar is mobilised and shows the protrusion, extending from the main bar at 90°, the tip of which is released from the pressure pad mounting when the play or record modes are selected. This mounting is shown rather more clearly in the lower part of fig. 4, which provides a view of head and bracket from the left. The head seen would, of course, be the erase head, though the bracket extends in much the same manner to the record/playback.

At first sight of the head mounting, incidentally, it would seem that no room had been left, as was included on the Studio deck, for a third head. Mounting holes and space are featured, however, to the left of the erase head and a special bracket with three pressure pads is available as an optional extra. The pressure pad bracket is attached to the deck by a hinge and is held away from the heads at an angle when not in use. A sizeable spring tries at all times to force the pads against the heads, but only when the hinged control bar is retracted can the spring exercise its power. Angling the pads back in this manner tends to make the deck rather easier to thread than its predecessor.

We turn our attention next to fig. 5 and the speed selecting mechanism. The speed selector is rotary and is located to the right of the rotary record interlock (both being visible in fig. 1). This rotary control is illustrated to the far right of fig. 5 and is attached to a stepped lever via a protruding arm. Positioned fully anti-clockwise, the selector locates the mechanism to give the slowest speed, namely 1 1/4 i/s. Travelling clockwise through a central position, the switch gives 3 1/2 and 7 1/2 i/s respectively. This speed change is achieved without fuss or over-complexity, the capstan idler merely being moved vertically to align with the correct portion of a three-stepped motor spindle. The lever to which the control arm is connected itself has three steps and rotating the control clockwise forces the stepped lever forward, pushing down the idler bracket against a strong spring. The lever is engaged to the spring rod by a fork running the length of the steps and visible from above. The fig. 5 side-view does not show this. The click action which provides some degree of lock when a speed has been

(continued on page 495)



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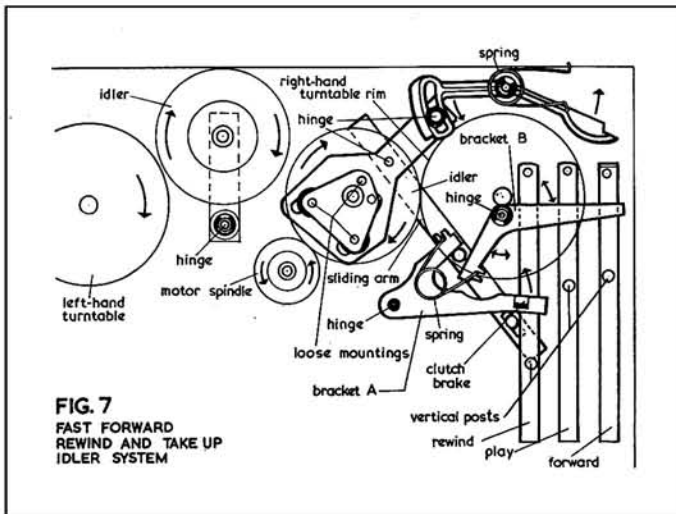


FIG. 7
FAST FORWARD
REWIND AND TAKE UP
IDLER SYSTEM

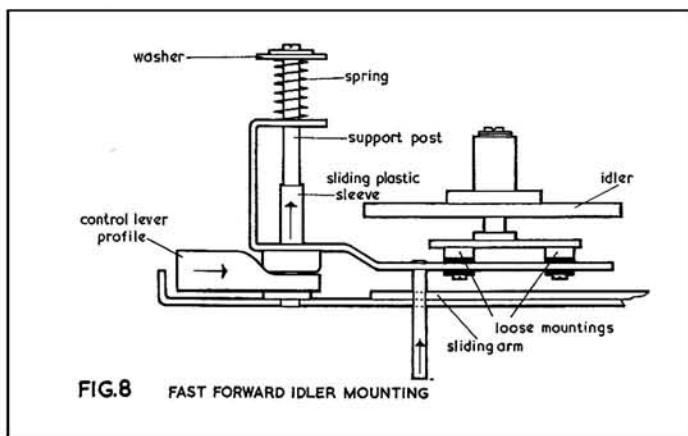


FIG. 8 FAST FORWARD IDLER MOUNTING

selected is rather cleverly achieved by locating a loose and fairly large washer between idler bracket and stepped lever. This washer resists horizontal movement of the bracket when moving 'up' (towards the floor) as tape speed is increased. On locating the 'flat' step segment, however, it clicks into place under tension from the spring. Similarly, when travelling 'downhill' as tape speed is reduced, the washer runs very quickly to its next step. All of which has the effect of moving the capstan idler up and down to face the motor spindle on its various diameters.

The speed control spindle extends below the deck and can be fitted with rotary wafer switches to operate equalisation circuitry. Similar extensions, incidentally, are found on the sprung record interlock. Both controls are locked in place during record and play by arms on the pinch mechanism which swing back to engage round small protrusions from the two spindles.

Before going on to the rather involved fig. 7, we turn to fig. 6 and the two turntable arrangements. The greased rod on which each turntable rests, is not connected direct to the deck base, but is attached to a metal plate beneath the deck, this plate being fixed to the deck by three sprung screws. These can be adjusted to provide exactly the right vertical turntable setting—namely that which prevents continuous rubbing of tape against one or other of the flange spools. On to the right-hand rod is placed a small metal washer and then a white plastic disc moulded on to a metal centre bush. The main spool turntable is then threaded on to the turntable, isolated from the clutch by a felt washer. This turntable also employs a metal bush, the lower part of which protrudes slightly to fit the small recess made by the lower clutch bush. The two white plastic mouldings have rims of some $\frac{1}{4}$ in. depth against which the take-up spool clutch acts. When switched to fast rewind, the turntable capstan is applied to the motor spindle and the upper of the two white disc peripheries. Being lightly mounted, the rotating movement is transmitted through the clutch to the lower disc. When the play switch is pressed, the turntable idler is applied

to the lower clutch disc. The upper turntable then rotates with the disc, slipping when a slow-moving tape spool is positioned on it.

Fast forward wind is achieved through two idlers—the right-hand turntable idler already described and also an adjacent idler which transmits movement to the left-hand turntable. The left-hand turntable resembles the right-hand component in design and mounting, though the clutch arrangement is simpler. A small plastic disc is fixed to the lower spindle section and the turntable rests on this, isolated by a felt washer. The friction generated across this washer is sufficient to prevent tape spillage when the deck is switched out of rewind or play modes, while being low enough to avoid overstraining the motor when forward wind is selected. This arrangement is illustrated in the left-hand section of fig. 6, which also shows the pulley wheel positioned between the two plastic mouldings. This wheel is connected to the rotation counter through a rubber belt giving a counting ratio of some two turntable revolutions to one digit. This counter, as can be seen from fig. 1, is of the three-digit knurled-wheel reset type.

This brings us to fig. 7 and the somewhat complex turntable idler arrangement. This complexity is brought about by the need for vertical movement combined with horizontal movement in two directions. The three control rods are shown on the right of the drawing and small inked circles near the centre of each represent posts rising from the main rod by some three-eighths of an inch. The rods are labelled after the controls to which they are attached—forward wind, play and rewind, from left to right respectively—and each of these is pushed forward when its tab is pressed, being retracted when the tab is returned to neutral.

Beginning, then, with the fast rewind mechanism, we push the left-hand control rod forward. This, in turn, causes the vertical post to move forward and engage the bracket labelled in fig. 7, for convenience, as *Bracket A*. This is moved forward about a hinge and performs two actions, one of which is to apply a small felt brake to the lower clutch disc of the right-hand spool turntable. This prevents the right-hand turntable running too freely as the left-hand spool rotates at speed to give the required fast wind. It will be noticed that *Bracket A* is in the path of, and is therefore only operated by, the vertical post of the left-hand control rod. The second of the two 'forks' is connected to *Bracket B* by a fairly strong spring and, in moving about its hinge, pulls *Bracket B* round in a clockwise direction, moving with it the right-hand idler. The action is transmitted to the hinged idler bracket through a vertical post attached to a sliding arm.

All of this accomplishes the required action of pushing the right-hand idler against motor spindle and left-hand turntable. In fact, it will be seen that yet another idler is employed to transmit the spindle rotation to the left-hand turntable. This latter is simply a hinged jockey located close to the lower disc periphery of the turntable. It will be noticed, incidentally, that the deck designer does not need to plan idler and belt positions merely so that they pass their rotary motion across a given distance. He must also note the direction of rotation of each component. Thus, since the motor spindle turns anti-clockwise and the left-hand turntable will need to be powered in a clockwise direction, an idler is used to convert the spindle motion to clockwise, thence through a second idler which rotates anti-clockwise, and so to the clockwise-moving left-hand turntable.

The central of the three control rods governs the play action. As we have already seen, the play switch is connected to several other mechanisms as well—namely the pinch, pressure pad, capstan idler and capstan brake systems. Like the fast forward and rewind controls, the play switch also operates the main brakes through a three-slotted plate in the manner described earlier. But whereas the fast rewind switch pulled *Bracket B* clockwise through the action of *Bracket A*, the play control rod acts directly on *Bracket B*, which it pushes anti-clockwise. The action described for the fast-forward mechanism is thus reversed, with *Bracket B* pulling the fast-wind idler through a spring attached to *Bracket A*. The idler does not move far, however, being pulled a fraction of an inch to the right-hand turntable clutch periphery. The spring between the two hinged control brackets is used to tension the idler against the right-hand turntable and capstan.

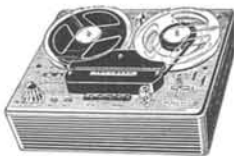
The fast forward control performs the same operations as the play control, with the additional action of moving the right-hand turntable idler up against the periphery of the spool turntable proper, instead of acting on the latter through the clutch disc. This vertical movement is quite cleverly achieved by a hinged lever, one end of which is pushed by the raised tip of the right-hand control rod while the other end inserts

(continued on page 502)

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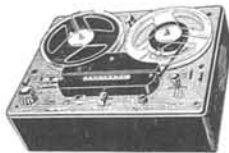


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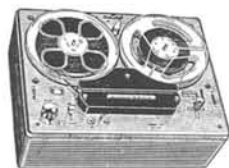


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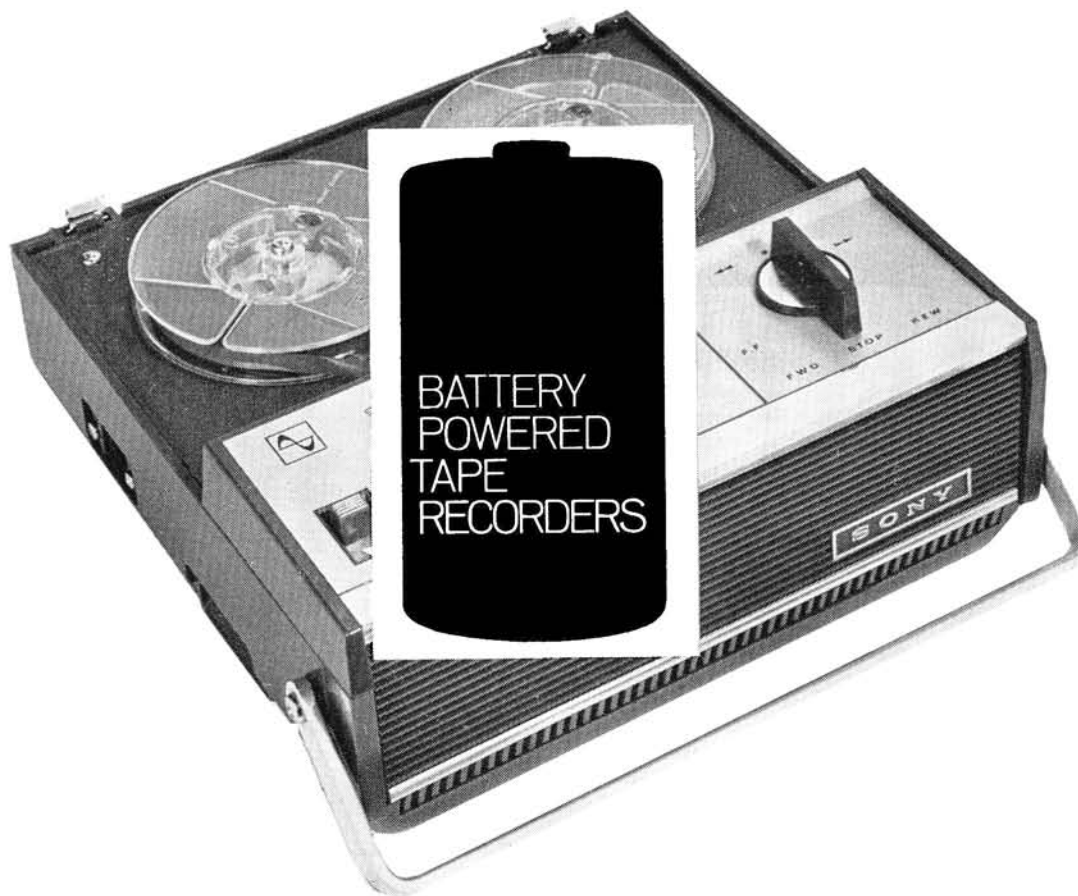
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**BY
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IN this series of articles it is proposed to explore the various channels associated with battery tape recorders and their powering, including the swing towards solid-state (i.e., transistor) recorders, problems arising from the powering of battery models from the mains supply and from car batteries, DC motor control and so forth.

Attention will also be given to the possibilities of energising valved recorders, designed specifically for mains powering, from car-type batteries through the medium of rotary converters or vibrator units.

Electronic circuit and electrical aspect of the new-generation transistor models will be investigated in some detail, and particular points of interest, including recent design ideas, will be highlighted.

As the series progresses, hints and tips will be introduced dealing with the operation and general maintenance of battery models, and ideas for the construction of mains and battery power units and voltage stabilisers will be presented.

Many electrical and electronic devices are becoming 'cordless'. This trend started a few years back in America and the first waves are now lapping at these shores. 'Cordless', as its name implies, refers to an electrical device that is now powered from an internal battery, but was previously powered from the mains supply. Typical cordless devices include electric shavers, food mixers, small fans, drills and like appliances. The development of these things has really stemmed from the small battery-powered electric motor. These are now fantastically efficient compared with their early counterparts.

On the electronics front we have the cordless radio in terms of the transistor portable, the cordless television set (undergoing second-generation redevelopment at the time of writing), the cordless record player, hosts of cordless electronic items from amplifiers of all kinds to signal generators and meters and, of course, the cordless tape recorder.

The battery-powered tape recorder has thus arrived on the scene at an opportune time for, as it is composed of both electronic and electrical items, it is in a position to reap the best from the developments associated with the small battery-powered electric motor, used in cordless appliances, and modern transistor techniques. While many of the items mentioned above have been undergoing cordless evolution for some time now, it is only relatively recently that the

tape recorder has been looked upon in a similar manner. There have been past transistorised tape recorders of various types, but nothing as efficient and elaborate as those now available to both amateur and professional.

Linked with electric motor and transistor progress has been the development of batteries for the powering of these cordless devices. Battery manufacturers have long appreciated the need for an efficient and portable power unit to suit the requirements of the cordless era, and a whole range of new batteries and cells has been created for the operation of small electric motors and transistors.

Everything is thus geared to the needs of the battery-powered tape recorder, and a study of the new models shows without any doubt that full advantage of the new and available developments has been taken by many manufacturers. Before we go on to look at these in detail, however, some comment concerning the new batteries themselves would not be amiss, for after all it is these that make the battery-powered tape recorder possible.

The requirements are for a small, lightweight, unspillable battery of lowish voltage and high capacity. In transistor tape recorders the battery has to supply the direct current for the capstan and wind motors and for the transistors. Unlike the thermionic valve, the transistor has no heater and it requires mostly *current* to bring it into operation, rather than the *voltage* that is called for by the anodes and the screen grids of valves. The HT supply rail of a transistor amplifier may be as low as $7\frac{1}{2}$ V (or even less), while the HT rail in a valve amplifier averages about 250V.

The heater (or filament) of a valve consumes quite a bit of power by itself, just to produce electrons for attraction by the anode, by way of the grids. A modern valve with a heater rated at 6.3V 0.3A, for example, burns up nearly 2W. Half a dozen such valves will thus account for 12W of power. Some power valves take more than a nominal 2W of heater power.

The anode and screen current is usually measured in tens of milliamperes (apart from high power valves), while the collector current of transistors may rise to hundreds of milliamperes. Nevertheless, the efficiency of transistors is greater than that of valves, even when

(continued on page 499)

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CONTINUED

the heater power is discounted. Power is used up in a valve in producing heat at the anode and screen grid (anode and screen dissipation), but very little residual heat is generated in a transistor.

Clearly, then, to operate a valved tape recorder from batteries, the batteries would have to supply on the one hand a low voltage at high current for the heaters, and on the other a high voltage at a low current for the anodes and screen grids. The former supply is called the 'low tension' (LT for short) and the latter 'high tension' (HT for short).

The LT battery could also supply the tape deck motor(s) or a separate battery could be employed for the motor(s) alone.

This method of operating a tape recorder is impracticable. For one thing the 12W or so of heater power would demand a battery of relatively high capacity to hold the heater current constant over a reasonable length of time, and the battery would have to be of an even larger capacity to cater also for the motor drives. These requirements could only be met by the use of a rechargeable secondary battery, such as a lead-acid accumulator.

While 250V or so of HT could be obtained from an ordinary primary battery, to handle the fairly high standing currents the battery would have to be pretty large. All these things add up to severe lack of portability.

Several attempts were made to produce a portable valved tape

recorder incorporating the 1.4V all-dry range of valves. These operate with a DC filament power of 1.4V at 25, 50 or 100 mA, depending upon the type and nature of the valve, and require about 90V or a little less on their anodes and screen grids. The drive motor was operated from a separate set of dry cells. Something approaching a portable configuration was thus achieved, using an all-dry combined HT/LT battery of the type adopted by the first-generation portable radios. The results were generally poor and this line of development came to nothing, pending the advent of the transistor.

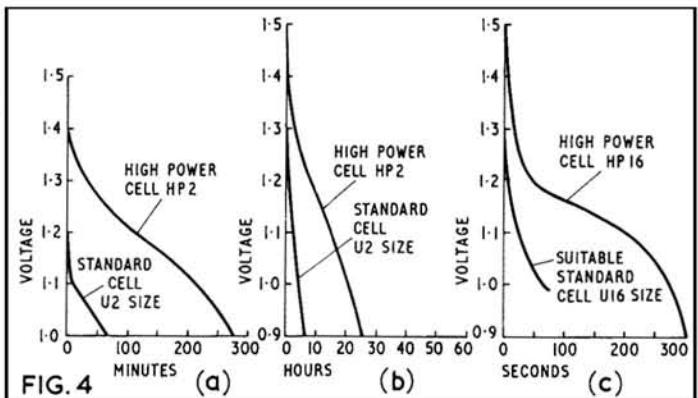
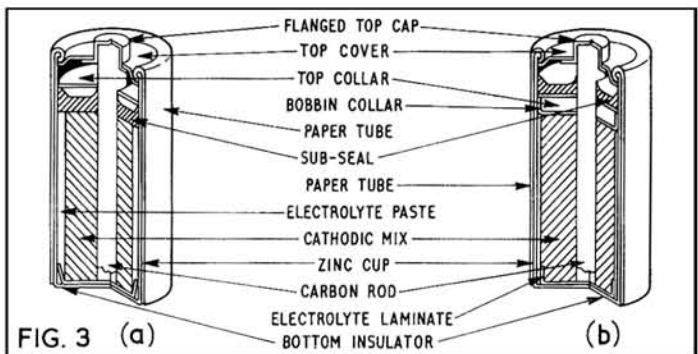
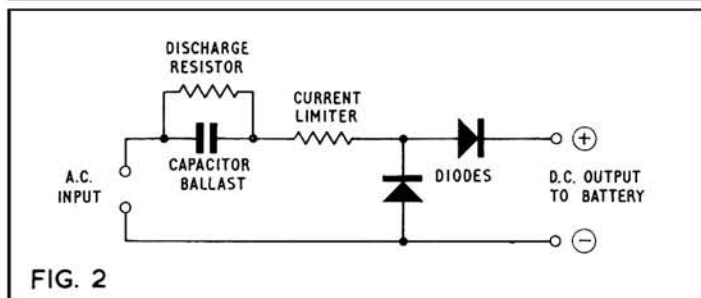
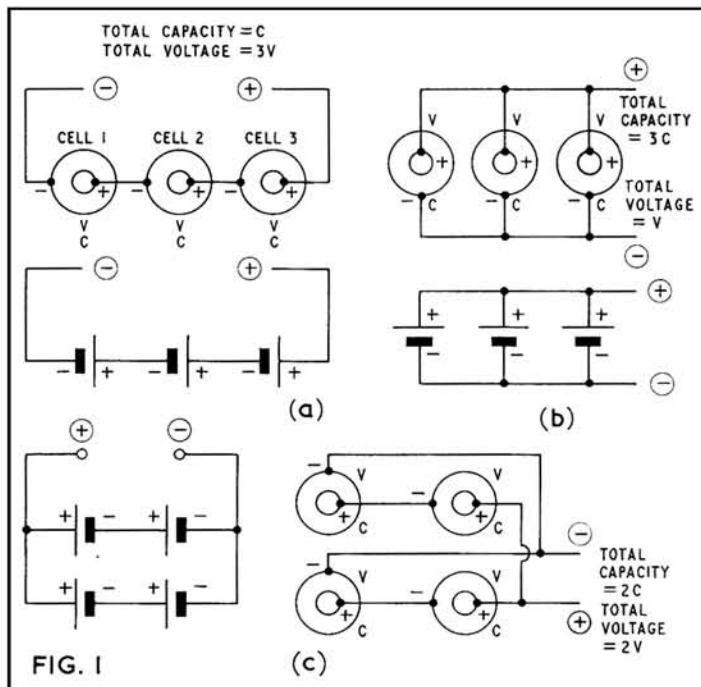
Some degree of portability was obtained by operating low-power mains recorders from 12V or 24V secondary batteries, such as lead-acid car batteries. This was—and still is—made possible by the rotary converter or vibrator unit which accepts 12 or 24V DC, converts it to AC and then steps it up to 200-250V for application direct to the recorder. More will be said later about this method of working.

Of course, the transistor and the efficient DC motor are ousting this old-style mode of portability. The lead-acid battery is rarely used nowadays. Just imagine what would happen to the works of a modern tape recorder with a battery of this kind bubbling away inside! Some of us will recall the problems that occurred with the use of so-called 'unspillable' accumulators in early portable valved radios.

Nevertheless, the lead-acid accumulator, or 'secondary battery' as it may be called—because its power derives from a charge—has a desirable aspect in that it is able to supply a relatively high current at a constant voltage for quite a long time, depending upon its capacity. The term 'capacity' of a battery, incidentally, is a measure of the length of time that it will deliver a certain current. Capacity is given in *ampere-hours*, and the term applies more to secondary cells and batteries than to dry cells, the current potential of which falls with use. The larger the capacity of any cell or battery, the larger is its size.

A *battery*, by the way, consists of a number of *cells* wired in series, in parallel or in series-parallel. When cells are wired in series the output voltage is equal to the sum of the voltages of the cells, and when they are wired in parallel the output voltage is equal to the voltage of each cell but the capacity is increased by the number of cells. The various battery configurations are given in **fig. 1**.

The lead-acid battery is used only to operate tape recorders when the battery is housed independent from the recorder. For instance, when the battery is that used in a motor car or caravan, or when it is carried essentially as part of a specific power supply. The nominal pressure per fully-charged lead-acid cell is 2V (a little above when fully charged or when being charged and a little below towards the end of the discharge cycle). Thus, a 12V car battery consists of six series-connected cells. *(continued on page 501)*



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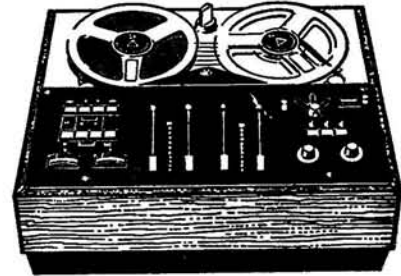
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CONTINUED

The capacity of this kind of battery depends on the physical size of the cells, taking in the volume of the lead electrodes, as already intimated. A typical capacity of an average 12V car battery is 32 ampere-hours. This means that when fully charged it should deliver one ampere for 32 hours, a half-ampere for 64 hours and so on. The rated output is thus seen to be the result of multiplying the current in amperes by the time in hours.

Another kind of secondary cell is called a *nickel-cadmium cell*, describing its basic construction. Unlike the ordinary lead-acid accumulator, this type of cell can be charged and discharged without producing corrosive gasses. Batteries of such cells, therefore, may be permanently installed, along with an inbuilt trickle charger (or with external charging facilities), in electronic equipment, including tape recorders without the likelihood of damage.

These cells are virtually indestructible. They can be stored for an indefinite period in a discharged condition; they can be charged and discharged at high rates; they cannot be overcharged in the same sense as lead-acid cells; and they do not necessarily need a vent of the kind normally associated with lead-acid accumulators.

Cells of this kind come in a wide range of types and sizes. Some have dimensions matching those of ordinary dry batteries. Some are designed particularly for powering electric shavers and similar cordless electrical devices. Larger ones are used in transistor television sets complete with charger, and there is a range which is suitable for battery-operated tape recorders. The *Akai X4*, for example, uses a battery of this type of cell, and charging facilities are provided by a plug-in charger (this being in the same unit as the second stereo audio output channel). It is interesting to note that the nickel-cadmium battery can actually be charged while the recorder is in normal operation.

The high capacity of the cells acts in effect as a very large value electrolytic capacitor across the charging voltage, thereby completely suppressing all traces of ripple current from the charger.

Then there are totally sealed 'button' versions. These can be soldered directly into a circuit if necessary, and they are charged by the introduction of a reversed current.

In one range, the positive electrode is basically nickel hydrate and the negative electrode cadmium oxide, with admixtures of graphite and iron oxide. The electrolyte is a solution of potassium hydroxide. A simple charging circuit for this style of cell is given in fig. 2. This consists of a pair of diodes, a capacitor ballast impedance (instead of a resistive voltage dropper), a discharge resistor across the capacitor and a current limiting resistor in series with the circuit. Full AC mains, however, is not always applied to this type of circuit, in which case a step-down transformer may be used for power isolation, particularly so far as tape recorders are concerned.

The chargers used in tape recorders may also incorporate automatic charging circuits which switch out when the battery has had sufficient charge. Semi-conductors are found in this arrangement, as in the charger of the *Akai X4*, mentioned previously. When the battery is almost fully charged a small button pops up and cuts out (or down) the charge.

The ordinary type of dry battery adopts the classic Leclanché cell principle. This type of cell is known as a *primary cell* because its EMF or output voltage is the direct result of the chemical action between the electrolyte and the electrodes. When that action is exhausted, the cell is 'run down' and must usually be replaced.

The early Leclanché cell consisted of a specially shaped glass container of ammonium chloride (sal-ammoniac) solution in which was immersed the positive electrode of hard carbon and the negative electrode of zinc. In action, hydrogen 'bubbles' accumulate around the carbon electrode, quickly reducing the effect of the battery and greatly reducing the voltage. This was slowed down by the use of a so-called 'depolariser', consisting of manganese dioxide (a black substance), round the carbon rod.

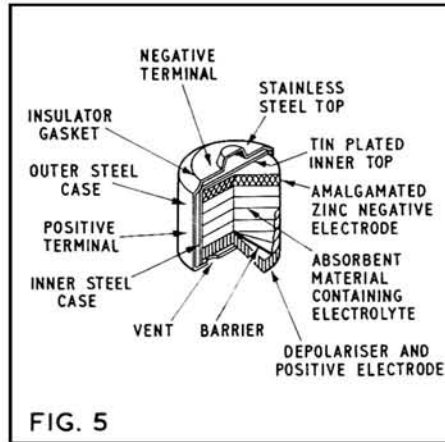


FIG. 5

This cell has developed over the years to make up the all-dry battery that we know so well today. Many batteries of this type are composed of a number of conventional single cells, each built into a zinc cylindrical container, itself serving as the negative electrode. These cells are wired in series, in parallel or in series-parallel, according to the power requirements of the equipment in which they are to be used.

Another style consists of a battery of flat cells compressed in series, one upon the other. This forms the 'layer type' of battery, adopted mainly by equipment that calls for a medium (or high) voltage at fairly low current. Batteries of this make-up are used in some portable transistor sets and in portable valved equipment, for they can be made smaller and lighter than batteries of cylindrical cell construction.

However, for tape recorders which generally demand greater power than small transistor radio sets, the cylindrical type of cell is desirable, and modern designs provide a considerably extended discharge time at a given current drain over the early type of cells.

The construction of a standard cylindrical cell by *Ever Ready* is shown in fig. 3(a). It will be seen that this has many features of the basic Leclanché cell, which is why it is often referred to as of Leclanché cell construction. It is far more sophisticated of course, than the early Leclanché cell, the electrolyte being in the form of a paste instead of a liquid. The 'cathodic mix' is the depolariser and the inner carbon rod is still the positive electrode with the outer zinc cup as the negative one.

(continued overleaf)

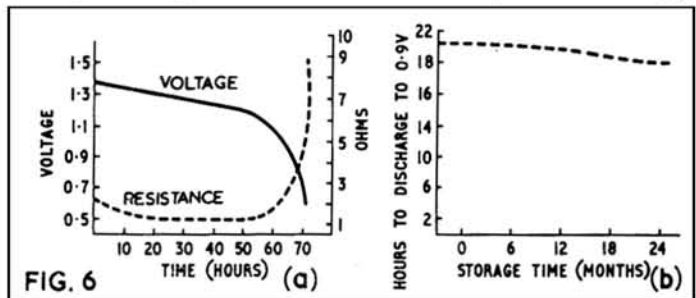


FIG. 6

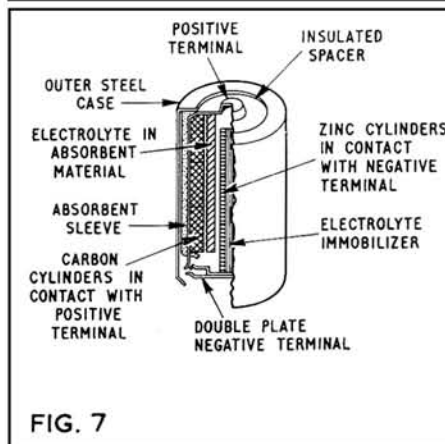


FIG. 7

BATTERY POWERED TAPE RECORDERS CONTINUED

Of recent design, however, is the 'high power' cell, signified by Ever Ready by the capital letters *HP* in front of the cell type number. The construction of this type of cell is shown in fig. 3(b). Basically it is similar to that in fig. 3(a), but it provides more cathodic mix in the same space by replacing electrolyte paste with electrolyte laminate. The top of the cell is also a little different.

The new design means that the cell can supply higher current drains for longer periods, in spite of its being dimensionally equivalent to the standard cell. In practice, this can mean up to four or five times the working life of the standard cell, and sometimes greater than this when the cell is used to power small electric motors.

Comparison discharge curves derived by Ever Ready are given in fig. 4. That at (a) compares the performance of a standard Leakproof cell with its high power counterpart in a shaver with a discharge rate of 750 MA constant current for ten minutes a day. That at (b) shows the performance of cells of the same type in a tape recorder operating for two hours each day, the recorder having a supply load equal to 5-ohms. The curves at (c) show the relative performance of a type *HP16* cell in a photo flash gun when discharged through a resistor of 0.75-ohm for two seconds, twenty times each day. Clearly, the advantage of the high power species of cell is revealed by these curves.

A battery of cells of this or the standard type are employed in some tape recorders. The *Philips EL3300* and *EL3301*, for instance, employ five *U11* type cells in series to give 7½V. The cells are also made in leakproof versions, which means that freedom from corrosion is assured under normal conditions of use. It is well worthwhile to employ this type of cell in tape recorders or, for that matter, in any electronic equipment.

Another primary cell that will be touched upon is the *mercury cell*. This differs notably from the Leclanché cell in that its internal resistance tends to drop, instead of rise with use. An effect of this is that the terminal voltage of the cell remains fairly steady throughout its useful life. At the end of the life of such a cell the on-load voltage

TAPE RECORDER SERVICE CONTINUED

With regard to a good tool, don't forget that Phillips screwdrivers have angled ends and these tend to burr after some use. Touching up with a ward file now and then allows them to seat more cleanly. When replacing screws, a touch of grease will prevent further trouble.

Returning to the more technical aspect of the Major, we can illustrate, in three small diagrams, the principal points that distinguish this very well-built machine. Fig. 4 shows the playback preamplifier stage, built around an AC107 transistor. Note the precise value of base network resistors and the feedback network from collector to base. An important point, not shown in the diagram, is the derivation of the supply for this circuit from the junction of a 110K and 12K pair of resistors, decoupled by a 200µF capacitor. If the voltages at the transistor electrodes are not as shown in the diagram (Play position), and the playback is slightly noisy, before accepting this preamplifier stage as being the cause, check the main HT line. This should be 250V at the top of the 110K resistor. Check also the 200µF capacitor, which can be found wired transversely on the printed panel below the microphone record level control. The two relevant resistors are adjacent.

Fig. 5 shows the pre-emphasis circuitry. In addition to the feedback network from output of the second triode to cathode of the first, a degree of treble boost is provided by the loading coil L1 and the three series capacitors, selected by speed-change switching. Note the way this circuit becomes a shunt instead of series loading when the switch S1 is turned to playback, and the 0.01µF capacitor bypasses the cathode resistor of the first triode.

Finally, the meter circuit is shown in Fig. 6. This is essentially simple, the signal being taken off at the anode of the second triode, and applied, via a series capacitor and resistor, to a triode connected as a diode (part of ECL86). This rectifies the signal, and the varying DC is applied to the meter, with R1, C1 and C2 acting as an AC filter and protection for the meter. These components are quite important.

As a postscript, we should mention that hum on this and other similar machines may be due to inefficient earthing. As the printed panel is not screened, this gives a 'hand-capacity' effect that can be

drops suddenly and the device that it is powering ceases to operate without warning.

While the Leclanché cell delivers an EMF of about 1.5V, that of the mercury cell is in the region of 1.35 to 1.45V, but closer tolerance versions for voltage reference purposes are available. Mercury cells are virtually unaffected by long storage, unlike the Leclanché.

The cells employ an electrolyte of a strong solution of potassium hydroxide and zinc oxide held in an absorbent material. The positive electrode is mercury oxide which is in contact with the main body of the case, thereby making the external polarity opposite to that of the conventional cell, while the negative electrode is made of amalgamated zinc and is in contact with the top of the case. The construction of the mercury cell is detailed in fig. 5, while the curves in fig. 6 show at (a) discharge and internal resistance characteristics and at (b) the effect storage has on the cell capacity.

The mercury cell is much more costly than the standard type of cells, but it has a capacity/size ratio almost four times that of other cells of comparable capacity. The cells come in a diversity of sizes, the smallest for powering wrist watches and larger ones suitable for small tape recorders. There is a battery which is about the same size as an Ever Ready *PP3* that has a capacity of 350 mA/hours with a 40 mA, 7.8V rating. So far, however, the mercury battery has not influenced the domestic tape recorder very much.

Finally, a few words about the manganese alkaline cell. This is also a primary cell and has some of the characteristics of the Leclanché cell. For example, its voltage tails off with discharge time, but more gradually than the standard cell, and the voltage tends to recover after heavy discharge periods. Its big advantage is that it is capable of delivering greater currents than the Leclanché cell, size for size. In other words, its inherent capacity is that much greater.

The basic construction of the cell is shown in fig. 7. The ingredients are similar to those of the Leclanché cell, but the carbon and zinc electrodes are transposed. The carbon element is in the form of an outer cylinder integrated with the depolarising agent while the negative zinc electrode takes the form of a smaller inner cylinder. The design of the cell is such that the terminals still retain the polarity of the conventional cell, as the diagram in fig. 7 shows.

Next month we shall investigate methods of stabilising DC motors.

quite annoying. The green lead of the mains cable should always be taken to true earth. Correct mains polarity for minimum hum can be chosen by first switching to play, with no tapes loaded (and preferably the motor supply disconnected) and trying connection each way. Then reconnect the motor and try again. If the polarities do not match, reverse the internal motor connection from the on/off switch.

MAGNAVOX STUDIOMATIC ANALYSIS CONTINUED

a stepped moulding between the deck base and idler bracket, forcing the idler up to the 'top' of the step. A profile of the stepped lever is shown in fig. 8. The idler bracket is loosely fitted to its hinge, movement being governed by the sliding arm already mentioned. Pushing the control lever in the direction of the arrow forces the idler bracket upwards, following the same principle as the speed change mechanism. On this occasion, however, the spring exerts its force in a downward direction and a curved plastic washer gives a much smoother climb and downward slide than the loose metal washer in the speed selector.

All of which would seem to complete our analysis. In closing, we would take the opportunity of suggesting a small improvement to the Studiomatic's manufacturers. For much of the duration of the deck's examination, the Studiomatic was allowed to rest on its motor, being elsewhere supported by the speed-control spindle and the nearside right-hand chassis edge. Being in this position, it was found that the right-hand turntable idler would frequently become jammed between clutch and turntable discs when fast rewind was selected. This tended to impair the idler's ability to transmit the motor spindle rotation. Admittedly, the deck was never intended to operate at such an angle, but the jamming effect did occasionally occur with the mechanism in a horizontal position also. Studiomatic owners, and perhaps even Messrs. Magnavox themselves, might care to note that a small elastic band (a spring would be even more suitable) linking the centre pillar of the rewind control rod with the tip of *Bracket B* completely eliminates the effect. (*The manufacturers inform us that such a spring had already been incorporated in the deck, the model submitted for analysis being produced prior to the modification. Ed.*)

tape reviews

CLASSICS **GEORGE GOODALL**
 JAZZ & FOLK **TONY FARSKY**
 SPOKEN WORD **MAURICE PODBREY**

ONLY THE BLUES. Sonny Stitt (alto), with Roy Eldridge, Oscar Peterson, Herb Ellis, Ray Brown and Stan Levey. **World Record Club TT 410.** 3½ i/s twin-track mono. 29s.

SONNY Stitt is not just a pale reflection of the late Charlie Parker, and it may well be that he has made a more distinctive contribution to modern jazz with the tenor saxophone. On this tape he plays alto, and I feel bound to say that if we had to judge Stitt's grade as a saxophonist by these performances it would not be very high. Throughout this session he is heard playing Parker phrases without the conviction and feeling he is capable of showing.

An off day for Stitt—what are we left with?

In compensation there is the trumpet of Roy Eldridge. Eldridge, who has been on the scene since the thirties, stands stylistically between Armstrong and Gillespie.

On *Cleveland Blues*, sounding very like Armstrong, he plays an extended open solo, which is fierce and intense, yet finely controlled. On *Blues for Bags* he plays an even better muted solo. Towards the end of this track, in a series of four bar exchanges with Stitt, he produces some superb improvisations, which leave Sonny all but floundering. It is also on *Blues for Bags* that Oscar Peterson contributes a fine swinging piano solo.

This tape, which runs for over forty minutes, offers some of the very best of Eldridge and as he is a rather erratic performer on record it is very good to have these tracks, sad though it is that Stitt, the leader of the group, has little to offer. **T.F.**

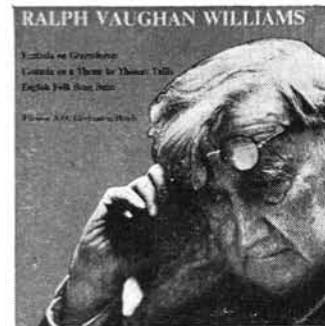
KINGS OF PERCUSSION. Gene Krupa, Buddy Rich, Louis Bellson. **Verve TA-VLP9088.** 3½ i/s twin-track mono. 35s.

THESE three drummers from the swing era are each featured in three numbers. As I almost always find drum solos unintelligible, my first sight of this recording filled me with misgivings. However, as it turned out I found some pleasant surprises.

Track One is mostly taken up by Buddy's *Blues* and Gene's *Blues*. Both drummers feature with a typical 'Jazz at the Philharmonic' group made up of Gillespie, Eldridge, Illinois Jacquet, Flip Phillips, Herb Ellis, Peterson, and Ray Brown. The result is typical of so many of Granz's JATP sessions: fast and loud, with a touch of hysteria. But sandwiched between them is a thoroughly delightful quartet lead by Louis Bellson (a rather more subtle drummer than Buddy or Gene), with some fine trumpet by Harry Edison in *Opus 711*.

Track Two starts with a nice fast run-through of Parker's *Now's the Time*, which also features Edison, with Buddy Rich at the drums. Gene Krupa leads small groups through *Showcase* and *Drumboogie*, while Louis Bellson appears with a star-studded big band playing *For Europeans Only* and *Skin Deep*.

This tape runs for well over fifty minutes and is good value, especially for those with more than a passing interest in jazz drumming. My only complaint concerning this tape is about the absence of any information apart from the titles and the names of the publishers; we are not even told which drummer plays which title. Surely it is not too much to expect EMI to at least make available with tapes the information that appears on the LP sleeves. **T.F.**



VAUGHAN WILLIAMS. Fantasia on Greensleeves, Seventeen Come Sunday, My Bonny Boy, Folk Songs From Somerset. Vienna State Opera Orchestra conducted by Sir Adrian Boult. **World Record Club TT 391.** 3½ i/s twin-track mono. 29s.

VAUGHAN Williams is probably best remembered these days for the results of his excavations of gems from older English music, and his presenting them in arrangements more acceptable to twentieth century concert-going music lovers. In fact he found inspiration for his own original compositions in Tudor English music, though these seem to be less often performed than during his lifetime. On this tape we really have both orchestral folk-song arrangements (in the very well known *Greensleeves* and *English Folk Song Suite*) and original music; for though based on a theme by the sixteenth century musician Thomas Tallis, the musical development of the *Fantasia* is Vaughan Williams'.

Sir Adrian Boult makes the Vienna State Orchestra produce very satisfying English sounds. The recording is clean and well balanced throughout and the only serious faults on the review copy were one or two momentary patches of drop-out, and these were not serious enough to interrupt the flow of the music. **G.G.**

HAYDN LONDON SYMPHONIES. No. 93 in D Major. No. 94 in G Major ('Surprise'). Vienna State Opera Orchestra conducted by Hermann Scherchen. **World Record Club TT 407.** 3½ i/s twin-track. 29s.

THERE seems to be a continual consumers' market for Haydn's symphonies, and not without reason, for they are easy on the ear with their often 'folky' tunes and rhythms. They are also the archetypes of classical symphonic form, and the twelve 'London' symphonies written during Haydn's two visits to this country in the late eighteenth century are often considered to be supreme among them.

The two symphonies recorded here are both well-known, the *Surprise* particularly so, with its unexpected fortissimo chord punctuating the delicate andante. One of my particular favourites is No. 93, with its very lovely largo. The opening phrase of the tune in this movement is so like one of the ideas in Beethoven's Pastoral symphony that it suggests no mere coincidence.

I think most people will find the performances given here by the Vienna State Opera Orchestra under Scherchen enjoyable. In the first symphony on the tape there are one or two ragged entries by horn and woodwind, but by the time we reach the last movement of the *Surprise* things are swinging along in fine old style. The dynamic changes, helped by the large orchestra and a good clean recording, come over very well and there is enough recorded reverberation to give the music life. **G.G.**

ELLA FITZGERALD SINGS THE JEROME KERN SONGBOOK. Arranged and conducted by Nelson Riddle. **Verve TA-VLP9080.** 3½ i/s twin-track mono. 35s.

TWELVE Jerome Kern songs by Ella make very pleasant listening. Included with such well established favourites as *Fine Romance*, *All the Things You Are*, *The Way You Look Tonight*, and *Yesterdays*, are several songs unknown to me. I was particularly taken with the cynical *I'll be Hard to Handle*. The Nelson Riddle orchestra provides a competent, but rather flat and uninspired accompaniment.

These performances cannot be judged as jazz. There is no doubt that Ella is more like a jazz singer on the less formal occasions when appearing with a small group. It is a pity that the great bulk of Ella Fitzgerald on record is in company with large orchestra, strings and all. **T.F.**

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our readers write . . .

. . . about two recent articles

From: V. W. Chelton, 90 Westfield Road, Yeovil, Somerset.

DEAR SIR, Thank you for publishing the articles on a variable speed rewind in June and a tape footage counter in August. In connection with these, the following points may be of interest to other readers.

Beginning with the variable speed rewind—allow plenty of room around the 2.5K potentiometer. I intend to use a *Cressell Torostat* 50W (£1 14s.) which has a temperature rise of about 160°C. when dissipating 25W (240°C. at 50W), so, if you intend to use the wind and rewind frequently, be warned.

Regarding the tape footage counter, if the pulley to be driven by the tape is made 1.194in. diameter, its circumference will be 3½in. (3.751 to be precise) and if the drive ratio between this and the counter is made 1:1, i.e., one turn for one count, the counter is reading directly in seconds and a four-figure counter will handle 9,999 seconds which is just over 2½ hours. The tape pulley is best made of a non-magnetic material; I intend to use aluminium alloy. A brass pulley might cause slip with the galloping rewind of my Wearite clock. Incidentally, the counters are quite reasonably priced at £1 3s. 7d. for a four-digit unit.

Yours faithfully

. . . about strobe tapes, wheels and daughters

From: M. E. Clarke, Almary Designs Ltd., 77 Cardinal Avenue, Boreham Wood, Herts.

DEAR SIR, As originators of the *Metrostrobe*, manufactured and distributed by *MetroSound*, may we respectfully suggest that your October article *Construct a Stroboscopic Tape Printer* is somewhat irrelevant to all but those with excessive time on their hands. The *Metrostrobe* was advertised in the issue concerned and received very favourable comment in your July edition.

The use of stroboscopic tape for checking recorder speeds fell into disrepute because of the difficulty in printing sufficiently accurate markings and because of the likelihood of tape stretch after several uses. We doubt if the former problem can be solved by a *Meccano* and *Quink* set-up on the kitchen table!

For a few shillings, the *Metrostrobe* is an accurate tool which is quick and easy to use, and we feel that Mr. Cloud might have mentioned the device if only for the benefit of those readers who have no young daughter to pull tape up the hall!

Yours faithfully

. . . about imperfect spooling

From: T. White, 91 Shaw Lane, Barnsley, Yorkshire.

DEAR SIR, After some study in the matter of imperfect tape winding, I have concluded that much of the trouble is due to plastic spools which have a radial slot on either side, set 180° apart. Many plastic spools leave much to be desired, the material being subject to deformation. The plastic spool causes bad winding, I believe, for the following main reasons: (1) distortion of reels due to shrinkage; (2) loose fit on spindles; (3) and, most important, by hitting the tape at each revolution—up by the bottom slot and down by the top one; even when the tape is carefully centred this still happens, probably for all the reasons mentioned.

A full rim helps a good deal in getting an even wind, since one can often adjust the tape to one side so that it is using the rim as a guide. When a tape has been wound badly it results in a great number of annular fins; these are very delicate and may very easily be doubled over on the edges by careless handling. The resulting effect is similar to dropout, due to the tape being momentarily lifted off the head on playback.

My own machine is a *Ferrograph* stereo and is of course fitted with their own hub lock device. This is not entirely satisfactory; it does not hold the spools firm and quite a small amount of wear can induce rattle and cause poor winding. I have taken the hub lock out of my metal spools (quite a saving in finger nails) and drilled the wind motor spindles, tapping them to 4 BA; screws were fitted and two aluminium alloy nuts were made. This has had a considerable beneficial effect on fast wind. It holds plastic spools as well of course.

Yours faithfully



CRITICISM AND A CASE HISTORY BY H. W. HELLYER

MAKE no mistake about it—there is an art in concealing the artifice with which the modern range of audio equipment is put together. Much backroom cerebration goes into the shape of that flange, the colour of that escutcheon, the placing of that fluted knob. Which makes it all the more amazing that the flange shall inevitably catch everything that passes, the escutcheon shall be unreadable in shadow, and the knob in a position where it will just escape the questing finger.

Circuits are science: styling is art. Science, like Pilgrim, plods ever onward. Every Audio Fair brings its fresh crop of "advances", making the fit that infinitesimal bit hi-er each year. What with loudspeakers with no moving parts (that we seem to remember discussing twenty years ago), and gramophone pickups that whittle the mechanical factors down to the square root of implausibility, pulse modulated amplifiers with a response as wide and flat as a salt marsh, and tape so thin that breathing is a danger, there was no shortage at the last Hotel Russell clambake; nor, do we suppose, will the backroom boys be short of ideas for the next—if there is a next!

At one time there was design simplicity. We bawled into one end of the ear trumpet while Grandpa listened at the other. Then came amplifiers that recognised that the shortest distance between output and input was not always a straight line, discs with a little less noise than signal, pickups that could be lifted without a crane, and loudspeakers which admitted that sopranos existed. There followed the great day of the microgroove, the LP and its attendant advances; a showering of styli, a conglomeration of cartridges, a plentitude of players, *et al.* Then the next landmark, tape—and all of a sudden a forest of banners was waving on the audio scene. We have been inundated with 'optional extras': mixers, preamplifiers, valved and transistorised, and more than ever, cleaning, marking, dubbing, editing, splicing, matching, storing, monitoring and measuring equipment.

There is, in fact, a rising pyramid of design, after Parkinson's Law. That is, as more units become available to perform the various functions of reproducing sound, so more and more ancillary equipment will be needed. This may be expressed as a simple formula:

$$x = \frac{T^d + \sqrt{A - S}}{af}$$

where x is the number of units of equipment, T the period since the innovation of electro-mechanics, d the demand (in plugs per pirate pop-song), A the advertising (in inches per page or dBs per programme), S the accepted standards (CCIR, NARTB, etc.), a the alternative means of entertainment (Bingo, Betting Shops, the Goggle-box, Sex), and f the frequency of fads (in cycles, of course).

This formula, which can be very handy to the salesman when computing shelf-space and the engineer when assessing stock replacement turnover, demonstrates plainly The First Law of Audionics: the more precise the function of a piece of equipment, the more elaborate the desirable ancillaries. A parallel is seen in the motor trade, where a

greater profit is derived from the sale of status symbols than from the fundamental car. Especially if it is exported.

As a corollary, we have the example of the transistor radio. This has grown steadily smaller, until we have almost reached the stage where the engineer is afraid to sweep his bench lest he inadvertently loses the set he is repairing. The paradox is that test gear has bloomed in complexity. We have the odd sight of a matchbox in gay plastic surrounded by the gaunt grey walls of signal generator, multimeter, Beta Tester, oscilloscope, and output meter. After which, the fault will probably be a dry joint on a printed circuit panel.

Which brings me to the Second Law: The simpler the fault in electronic equipment, the more complex the test gear and the greater the number of manhours needed to rectify it.

Design is swiftly becoming the technique of making the maximum change in styling with the minimum of actual alteration. Just consider what goes on behind the factory walls before a brand new product is launched. To quote a couple of sentences from *Thoughts on Design* which appeared in this magazine in January 1964: "... there are indeed a legion of boffins assiduously trying to shape a better mouse-trap. But it is a myth that the world will beat a path to their door if they succeed. This is what happens: an idea is born, a prototype developed, maybe a production mock-up sent as far as the board-room. Then, some black-trousered gent with a feint-ruled mentality begins paring away at the finer points. Modifications are made, often with the aim of reducing production costs. Afterthoughts are called for to allow for these modifications. Material supply enters the picture and drastic revisions have to be made. Mark 1 becomes Mark 2 and 3 and 4... Eventually a marketable product is launched, with the attendant ballyhoo that picks out the very points that the poor designer grew grey hairs trying to improve."

As an illustration, let us eavesdrop on the meeting of the design committee of that well-known industrial octopus, *Grozsound Ltd.*

Chairman: Now gentlemen, we come to item nine, the presentation of the new tape recorder. Mr. Er-er...

Secretary: The machine is designed around a totally new principle. Technical specifications have been placed before committee members. Briefly, there is a stacked, 8-track recording head, infinite range optically registered playback, and a delay device utilising the latest epitaxial planar solid-state inverted amplifier, enabling the remarkably low speed of $\frac{1}{4}$ inches per second. To allow for the slow speed, a stabilising...

Mr. Carp: In view of European Standards, what's that in metres?

Mr. Burk: Aye, let's 'ave it in plain language. Plain language, I always say.

Chairman: Indeed you do, Mr. Burk. Perhaps I should point out the exceptionally long-playing abilities of the machine. A five-inch reel of double-play tape will last...

Secretary: Um, 1,200 times 12 times fifteen over sixty-four times sixty times sixty—er, er—no, times sixty-four over fifteen, I mean...

Mr. Prink: Little over two weeks.

Mr. Burk: What? Well, that's it, the pooblic's not ready for it, that's a fact.

(It is also a fact that Mr. Burk has a hefty interest in the tape manufacturing division of *Grozsound Ltd.*)

The committee go on to discuss the regrettable backwardness of the public, and pass a minute to the effect that the new machine, with standard heads and speeds, be marketed under the name of *Innova*.

Chairman: I think, gentlemen, that settles Item Nine?

Mr. Bilk: Amendment, Mr. Chairman. I've been doodling here and it seems the *Innova* is going to be similar to last year's *Primata*, eh?

Chairman: Hm. I think we can leave it to the production committee to alter that. Shall we adjourn?

The production committee are only too pleased to slice a few coppers from costs by converting the pressed-steel cover to plastic, reverting to moulded knobs, adding, after much argument, rubber feet to the back edge to allow the *Innova* to be operated vertically in keeping with modern trends. The delay device, slightly modified, becomes a wide-input mixer, and is marketed at considerable profit as an 'optional extra'. By the time the publicity department have finished with the details, we, the public are welcoming with open arms, "The *Innova*—revolutionary breakthrough in tape recording by Messrs. *Grozsound*."

Much the same thing has happened with the *Grozsound* amplifiers, the re-styled pick-up arm, the bookshelf loudspeaker, the "universal" microphone... but I have said enough to invoke an angry response, no doubt. As I said, there is an art concealing artifice, even in audio design.

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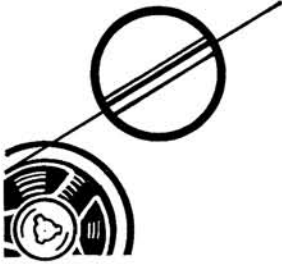
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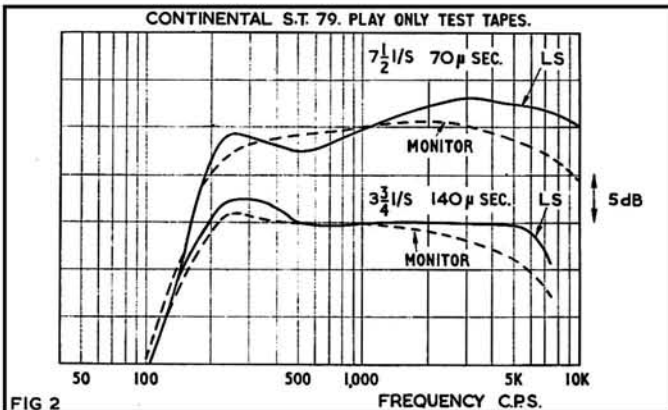
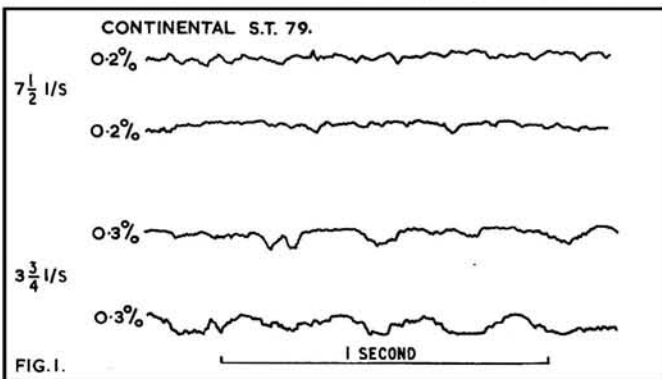
THIS is an example of a medium priced Japanese recorder, somewhere between the very cheap £5 battery powered recorders which can be seen in most radio dealers' windows and the £100 plus Sony of Akai luxury equipment.

Electronics are transistorised but the motor is driven directly from the mains supply. A tiny mains transformer and rectifier supplies DC for the transistor circuits.

The flywheel is belt driven from a continuously running motor, and the speed change control, which looks like a large switch, moves the belt from one pulley diameter to another. A slack fabric belt drives the take-up reel, and this belt is tightened to provide fast forward wind. Fast rewind is achieved by moving the supply reel hub into contact with the flywheel belt. Braking is obtained most economically by tightening a loop of string around the spool hubs. Reading the above description of the deck may give the impression that the mechanics are extremely primitive. They are certainly very simple, but it proved impossible to catch them out. Fast winding from a large reel to a small one and braking at any speed did not result in stretched tape or slack loops.

The actual tape speeds were found to be slow. At 240V mains voltage, the nominal $3\frac{3}{4}$ i/s speed was about 3% slow, and at $7\frac{1}{2}$ i/s the speed was 1.5% slow. Lower mains voltages gave proportionally slower speeds. The $3\frac{3}{4}$ i/s speed was nearly 5% slow at 220V.

The wow and flutter performance was poor. Fig. 1 shows pen traces of the short term speed fluctuations, with rms readings of 0.2% and 0.3% respectively for the high and low speeds. Not visible in these one-second traces is a rather more serious slow speed change of about $\pm 0.5\%$ which occurred at intervals of several seconds. The blame for all the speed variations can, I think, be placed quite squarely



EAGLE CONTINENTAL TAPE RECORDER



on the belt which was rough in texture and irregular in cross section, so that the ratio between motor speed and flywheel-capstan speed depended on how the belt happened to lie on either pulley at any instant.

Test tapes with 70 μ S and 140 μ S characteristics were played at $7\frac{1}{2}$ i/s and $3\frac{3}{4}$ i/s to give the responses of fig. 2. The outputs were measured at both the monitor jack socket and at the loudspeaker socket. It will be seen that the playback equalisations roughly correspond to the test tapes down to 200 c/s where a very sharp cut off occurs.

System noise and hum was extremely low at 50dB below test tape level with no tape passing the heads. This is due to the bass cut which eliminates the hum frequency of 50 c/s and its second and third harmonics at 100 and 150 c/s.

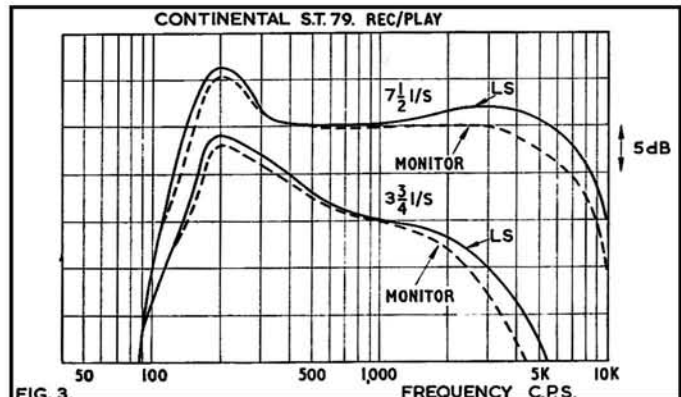
Test tones were recorded via the radio input jack, and the outputs again measured at monitor and speaker outputs. The responses are shown in fig. 3. It will be seen that the 200 c/s peaks also occur during record, and that insufficient recording pre-emphasis is used to record the extreme high frequencies at $7\frac{1}{2}$ i/s, or even the mid high frequencies at $3\frac{3}{4}$ i/s.

It proved difficult to measure the onset of recording distortion, as the cross-over distortion from the class B push-pull output stage obscured subtle changes in waveform, but very obvious distortion occurred as the record level meter needle entered the red sector of the scale. This overload point corresponded to a level only 6dB above test tape level.

The 'peak' recording level was erased and the ratio measured as 46dB. This may sound fairly good, but, as there was virtually no mains hum, all the measured noise was erase noise, i.e., system noise was 50dB below test tape level and bulk erased tape gave almost exactly the same reading, but tape erased on the machine gave a noise level only 40dB below test tape level, so that the tape noise had increased by 10dB and in fact sounded quite noisy to the ear. This shows that simple signal-to-noise ratio figures can be deceptive, particularly with a sharp bass cut as encountered on this machine.

For the sake of completeness, and as an aid to matching the subjective listening tests to the objective review measurements, the overall acoustic response was measured in the usual way, by recording bands of filtered white noise and the sound output measured on the speaker axis (at $7\frac{1}{2}$ i/s). The response of the microphone was also measured

(continued on page 509)



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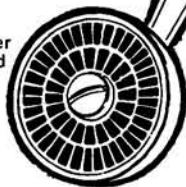
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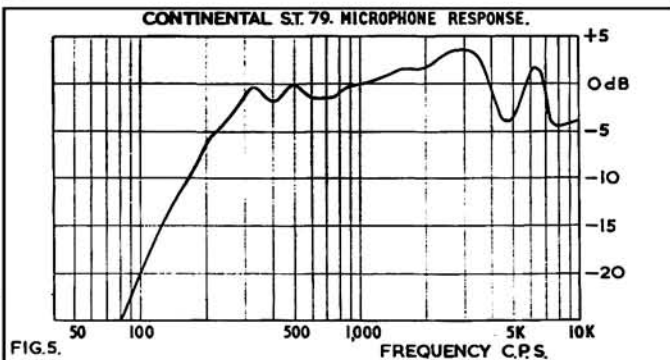
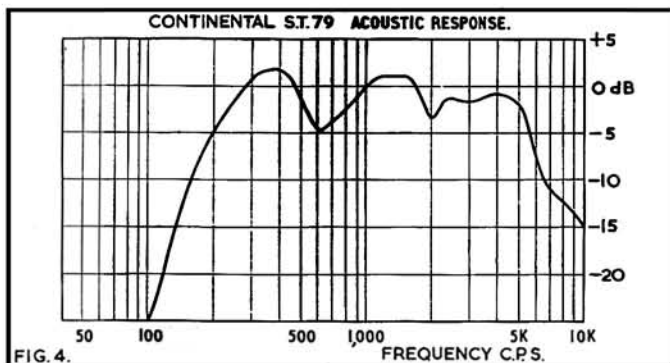
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in a white noise sound field. Figs 4 and 5. The falling response of the microphone below 300 c/s combined with the speaker cut at 5 Kc/s results in a well balanced response from 300 c/s to 5 Kc/s at $7\frac{1}{2}$ i/s, and a rather woolly response at $3\frac{3}{4}$ i/s due to the bass tilted electrical response shown in the lower curve of fig. 3.

COMMENT

This is the story of a recorder which is not quite good enough all along the line. Any one of the faults uncovered by this review would have been sufficient to lose it points, but added together they inevitably lead to the conclusion that it would not be a good buy at the price quoted.

The performance at $7\frac{1}{2}$ i/s is passable, but no better than that of similar priced machines at half or even a quarter of this speed.

The playback response at $3\frac{3}{4}$ i/s is just adequate for the playing of pop or tape records, but recordings made on this machine are very lacking in high note response, and the combined record and play wow and flutter can be very audible, even on fairly non-critical music recordings.

A. Tutchings.

BEYER M80 MICROPHONE

MANUFACTURER'S SPECIFICATION: Medium price dynamic microphone. Frequency range: 50 c/s-16 Kc/s. Output Level (at 1 Kc/s): 0.18mV per μ Bar (-50dB ref 1V) at 200 ohms. 3.3mV per μ Bar (-50dB ref 1V) at 80K. Directional pattern: cardioid. Cable: 5ft. terminated in 3-pin DIN plug. Price (with folding desk stand): £12 18s. Distributor: Fi-Cord International, Charlwoods Road, East Grinstead, Sussex.

THE frequency response shown in fig. 1 was measured in a white noise sound field and is a classic example of the kind of response to be expected from a relatively cheap single-element moving-coil cardioid microphone. This provides a cue for a short potted lecture on the design principles of this type of microphone.

Let us consider the directional response first. Fig. 2 shows that both sides of the diaphragm are open to the sound field, but that the sound has to pass through a heavily damped tube or slit to reach the back of the diaphragm. This resistance slit combination introduces a nearly constant delay at all frequencies which is made equal to the time the sound takes to travel from front to rear of the microphone capsule.

For sound approaching the front of the microphone, the delays add

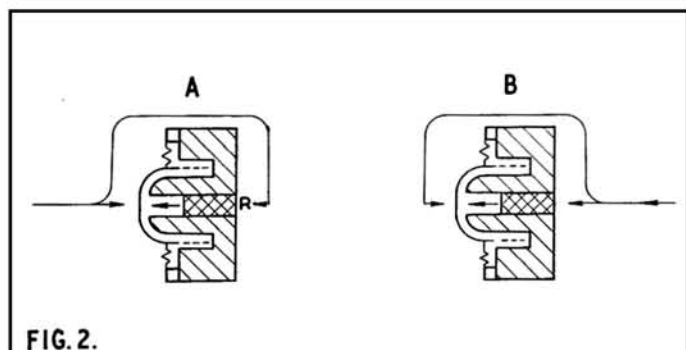
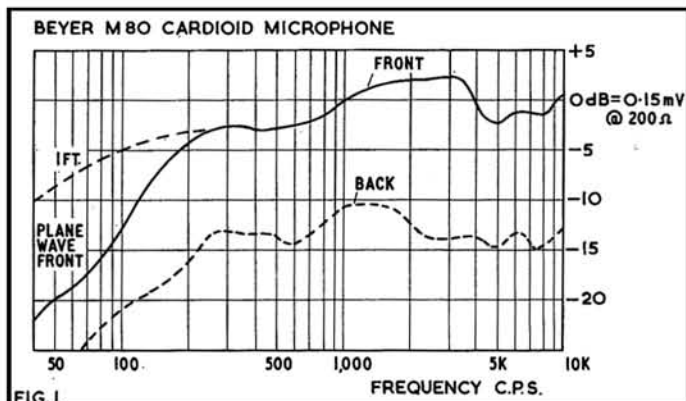
to produce a pressure difference which moves the diaphragm and coil and generates a voltage across the output terminals.

For sound approaching the rear of the microphone the delays cancel, as the delay in each path is the same, and there is therefore no pressure difference to move the diaphragm and so the output is zero. In practice, due to the finite size of the diaphragm and losses in the delay network, complete cancellation is not possible, but a theoretical front-to-back ratio of 10 to 1, or 20dB, can be obtained in free space with no sound reflections from room boundaries. Fig. 1 shows that in my fairly live laboratory the measured ratio was better than 10dB over most of the frequency range.

Now to frequency response. The mass-compliance resonance of the diaphragm and coil is placed in the mid-low-frequency range, in this case at 250 c/s. Above this frequency the system is said to be mass controlled and the velocity of the diaphragm and coil will fall 6dB per octave for a constant applied force. Below resonance, where the system is stiffness controlled, a constant force will produce a constant velocity. Thus to achieve a level response the velocity must be constant at all frequencies and the force moving the diaphragm must rise at 6dB-per-octave. This is done by making the unit as small as possible so that the total phase change at the highest frequency of interest is 180° , and the pressure difference is at a maximum. At lower frequencies, where the wavelength is longer, the phase change and pressure difference is correspondingly less. The desired 6dB-per-octave pressure difference can be obtained up to a frequency where the dimensions of the microphone approach a half wavelength of the incident sound. In the microphone under review this frequency is around 3 Kc/s. If it were not for a compensating effect to be described later the output would fall to zero when the total phase change was 360° , at around 6 Kc/s. Fortunately, due to phase changes across the face of the diaphragm, such complete cancellation does not occur and also, in this range, a new effect takes over which provides the necessary pressure difference. This is known as 'pressure doubling' where total reflection of the sound takes place from the face of the diaphragm; this also helps the polar response at very high frequencies where the normal phase cancellation effect described earlier has ceased.

At frequencies below the diaphragm resonance, the output falls 6dB-per-octave in a plane wave-front as shown by the solid curve of fig. 1 and the dotted curve of fig. 3. Fortunately the well known 'close talking' bass-rise effect comes to our rescue at this point, as sound from a point-source generating a spherical wave-front increases the phase difference at low frequencies to give the low note response shown by the dashed line of fig. 1.

(continued on page 511)



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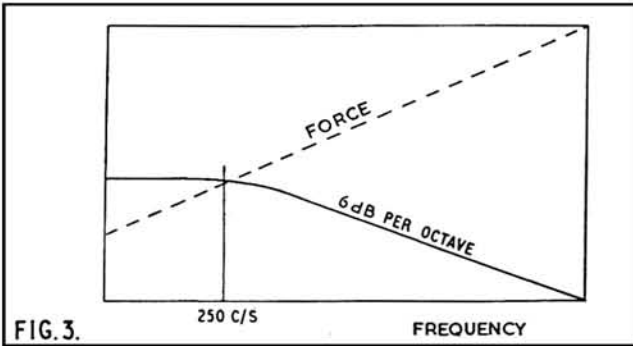
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I have described the broad design features of this type of microphone to show that a level response is the result of careful design and, what is equally important, the maintenance of tight tolerances in production.

The response as judged subjectively is smooth and completely uncoloured, showing that all resonances are tightly damped. Handling noise, which can be a problem in this type of microphone, is low due to the use of a heavy cast-aluminium case. A folding desk-stand is provided with the microphone. Styling and general finish of both units is excellent.

A side-by-side comparison between this directional microphone and a non-directional unit with a similar response demonstrates very effectively the advantages of the M80 in cutting down reverberation and room effects, and I can thoroughly recommend it for high quality speech recording in difficult acoustic surroundings. It is also very useful in reducing unwanted noise, from a recorder motor for example, or for picking up clean sound when the microphone has to be some distance from the sound-source.

A. Tutchings.

ABC OF TAPE RECORDING CONTINUED

Planet U.1 employs solenoids to switch in and out of all functions, play, fast forward, rewind and stop all being operated through light push-buttons.

The *Thorn* deck, however, uses one solenoid to retract the pinch wheel and apply the brakes when a pause switch (on the microphone) is operated, and another to halt the mechanism entirely. No facilities are included for switching into any mode and once switched to stop the mechanism has to be reset with normal press-tabs. A particularly interesting feature of the deck is that when putting the machine in a play or fast wind mode, the hand controls work against a spring mechanism. The main stop solenoid then serves merely to trip the spring, which provides the necessary force to neutralise the mechanism.

The mechanical autostop employs existing relays in the tape deck, metal foil being used to short-circuit the energising current holding the play or fast wind mechanism in place, or alternatively acting as a switch to power a trip relay—as in the *Thorn* deck. This type of autostop completely overcomes the problems of idler and pinch wheel deformation, since the mechanism is returned to its neutral position. The sleep-learners amongst us might note that one cannot connect a time-switch to the pause solenoid circuit, with a view to leaving the tape transport disengaged throughout most of the night, since although a solenoid is used to retract the pinch mechanism temporarily, removing the recorder altogether from the power supply will obviously halt the solenoid holding current and leave the mechanism jammed together.

A final autostop device is the microswitch. One or two machines employ these in the main power supply circuit, with the switch arm extending into the tape slot. The arm is sprung either to push or to pull against the tape, moving out to break the circuit when the tape is fully wound on one or other spool. This method has the advantage of eliminating the need for stop foil (it also stops the recorder if the tape snaps).

In the last article of this series, next month, it is hoped to outline some of the many features of the ¼-track recorder and then go into the subject of tape editing.

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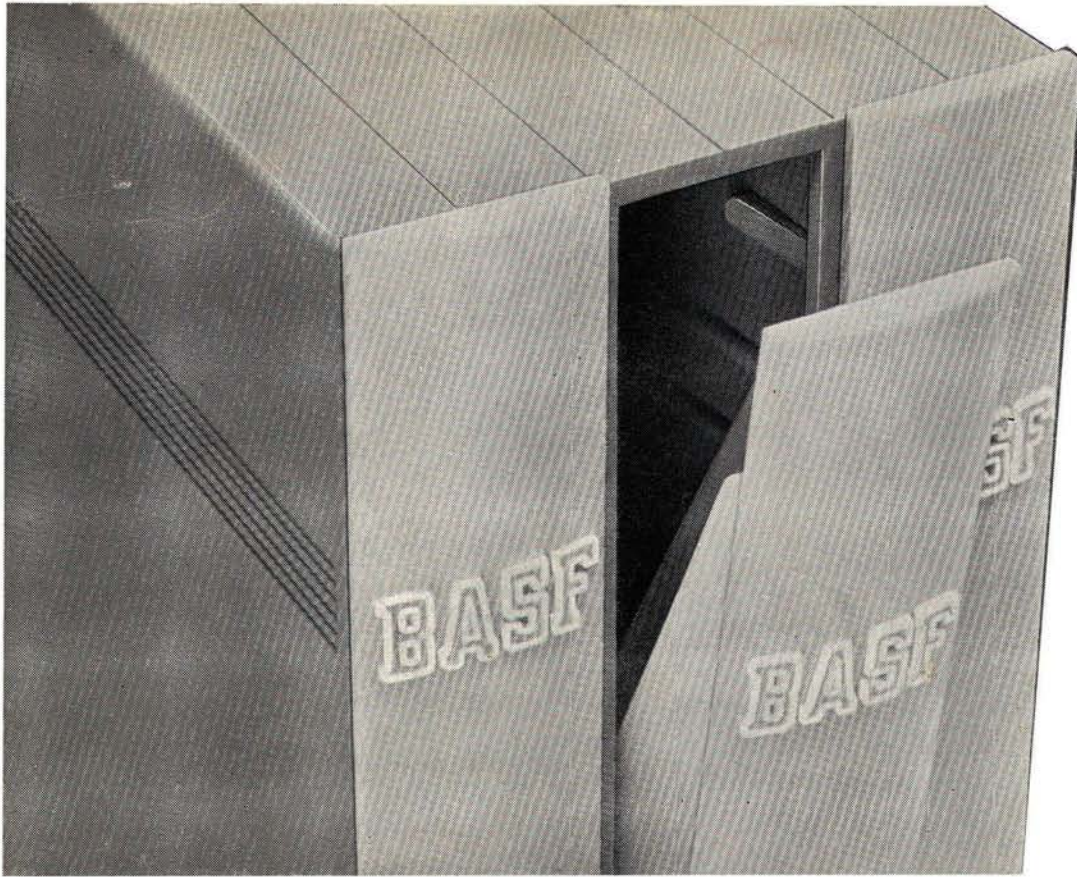
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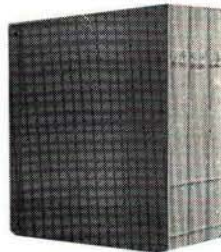
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