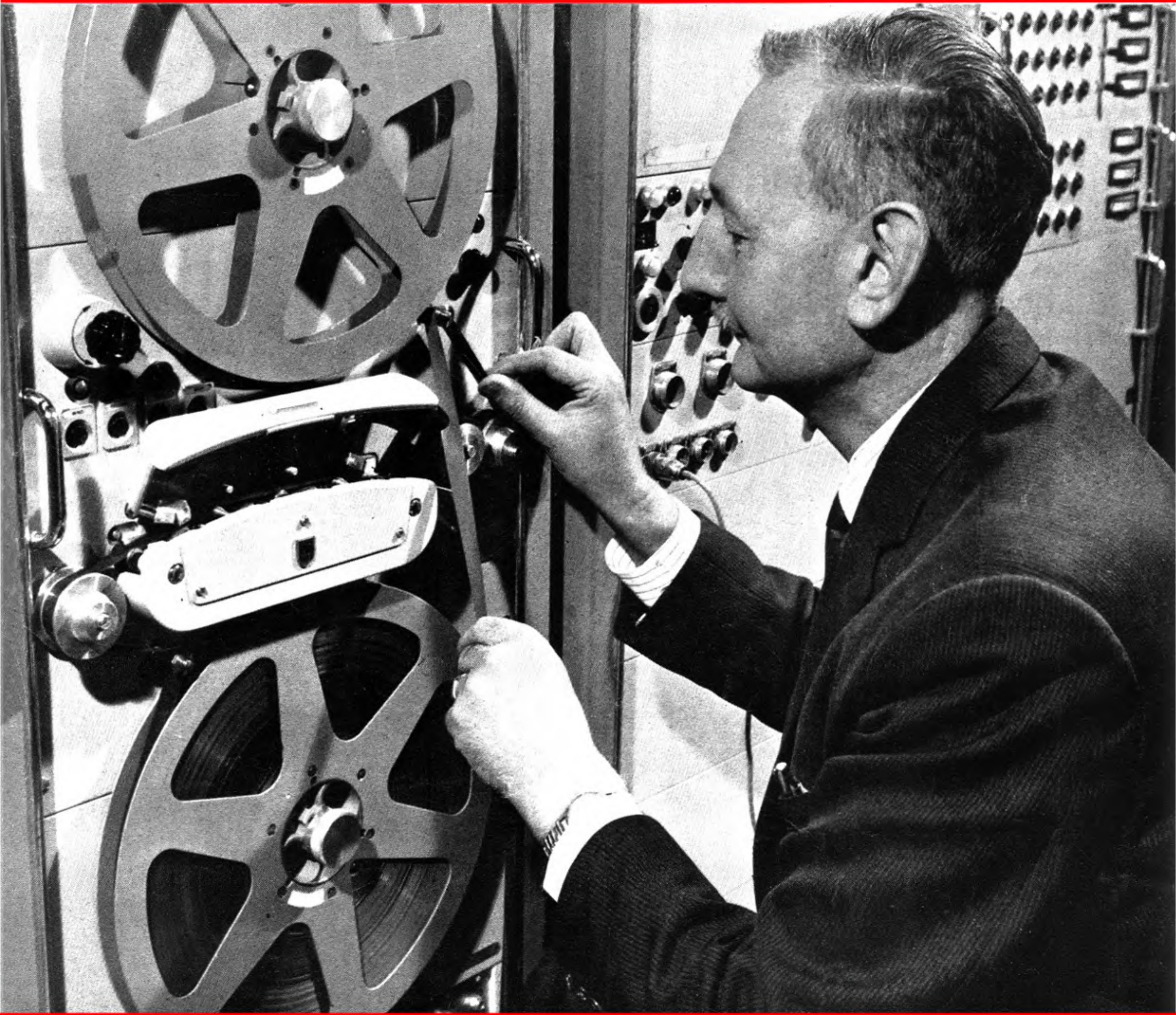
JULY 1965 TWO SHILLINGS

tape recorder



TAPE RECORDED EVIDENCE – AUDIO FAIR REPORT – WHO READS "WHICH"
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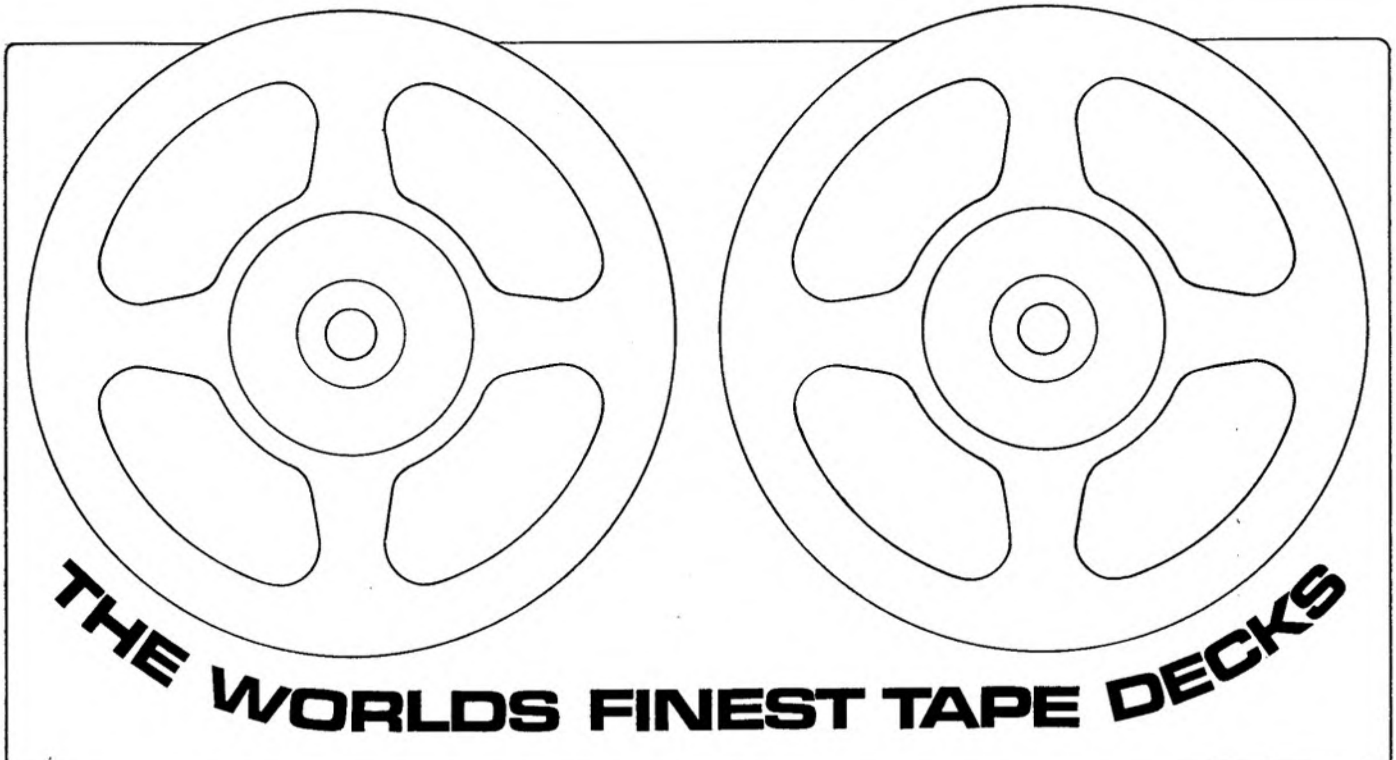

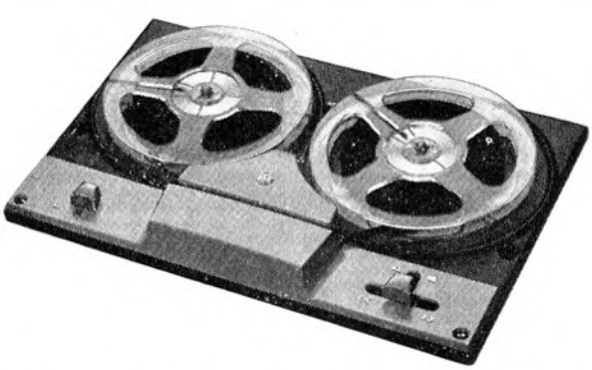

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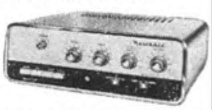

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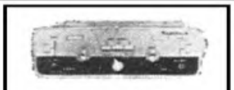

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Standard. High-quality stereo tape decks. D93/2 ½-track for highest fidelity **£36.15.0**
With TA-IM **£52.18.0**
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D93/4, ¼-track, for most economical use of tape. **£36.15.0**. With TA-IS **£58.10.0**

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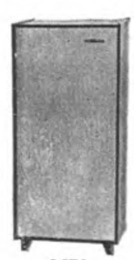
UMC-1



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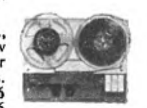

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editorial

THE SUBJECT OF REVIEWS is raised by Graham Balmain in this issue with his examination of last December's *Which?* report on magnetic tape, published by the Consumers' Association. But while Mr. Balmain's detailed comments on the limitations of tape reviews are valid, how easy it is to make similar criticisms of that complex device, the tape recorder. Indeed one could write a sizeable book on the limitations of reviews in contemporary magazines and in our own columns without even approaching the subtlety which he has applied to what seems a fairly straightforward product.

We have been looking at ourselves very closely over the past few months, wondering just what, in equipment reviews, field trials, tape tests and tape record criticism, the writers are attempting to reveal. Tape recorder reviews, since the admirably competent Alec Tutchings took over some four years ago, have consisted mainly of careful compilation of performance curves and fluttergrams from which the reader can weigh machine against machine for himself. The almost complete absence of personal opinion, outside his closing comment relating to his measurements, eliminates Mr. Tutchings from any conceivable criticism of bias for or against any one manufacturer. Such is the position at present and it seems likely to remain the case for the future, new contributors to the review column being obliged to use complex and reliable test gear.

But while facts—frequency response, wow and flutter, signal-to-noise ratio, output power—are measurable and speak for themselves, one of the most vital aspects of recorder design is rarely mentioned. It is never found in any manufacturer's specificational literature, yet it is responsible for more customer dissatisfaction than anything else. To put it in Balmainian question-and-answer terminology—**Q.** How does the recorder react to wear? **A.** It's very difficult to tell; not technically difficult, just highly impractical and very inconvenient.

To incorporate wear in a review would involve assessment of factory-fresh performance in present Tutchings manner and then a lengthy period of use and, finally, further measurements—particular emphasis being placed on speed fluctuation, since this gives good indication of mechanical wear. Further testing of electronic performance would not be essential, but, particularly with regard to deterioration of oscillator and magic-eye circuitry common to low-price machines, advisable. But what do we mean by "lengthy period of use"? The problem of determining how a recorder will react to five years of use—without taking five years to prepare the review—is almost insurmountable. The only practical system is to apply a condensed deterioration course to the recorder—for example by setting it up to record continuously for days on end and taking note when a component breaks down.

A device that would operate every mechanical control on a recorder —say one per second over two or three days—would not be too expensive to build, but it would be impossible to construct such a unit to suit every design that appeared on the reviewer's bench. And even then, what possible means could the reviewer have of telling when a certain succession of events was equal to a fixed number of years' wear? No. If wear is to be measured in any sense at all, it must be by comparison with other recorders. Of a number of different machines left running for a week, it would not be too difficult to assess which had come off better and which the worst.

But simple as this may sound, the problem of inconsistency between mass produced tape recorders is at least as great as between recording tapes. Supposing, for example, our tape recorder breaks down under the exhaustive tests envisaged for it. Unless another model is immediately to hand, work must stop for at least a fortnight while a new model is submitted by the long-suffering manufacturer—who, let it be remembered, is having to pay for our fun. But even with the second model, faults may occur. If a fault is particularly prevalent—say the burning out of a motor—the reviewer will be able to report that "On both occasions the motor burnt out" but, once again, he will be unable to provide wow and flutter readings after the week of wear.

For the reviewer, the mere act of leaving a recorder running for long periods either ties him to his bench, or subjects his laboratory —usually his home—to no mean risk of fire. Similarly, so much time would have to be spent on assessment of each machine that, particularly so far as domestic manufacturers are concerned, there would be a real risk of publishing reviews of obsolete recorders. Remembering delays in submission of equipment, preparation and publication of a review can take so long that an extra few weeks can mean a delay between manufacture and print of a year — ample time for the *Series 200, Model IIIA* to be replaced by Models *IIIB, C* and *D*!

Perhaps we shall find solutions to some of these problems eventually, but for the present we are confident that readers will find no reports more thorough and reliable than those published in this magazine.

JULY 1965 VOLUME 7 NUMBER 6

COVER PICTURE

Professional ¼in. wide tape running at 15 i/s between 13in. diameter spools is hardly a domestic proposition, but the equipment and operator shown on our cover are responsible for holding the attention of a large cathedral audience for an hour—not a task for a transistor portable. The Southwark *Son et Lumiere* scheme is described on page 254.

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.

world of tape

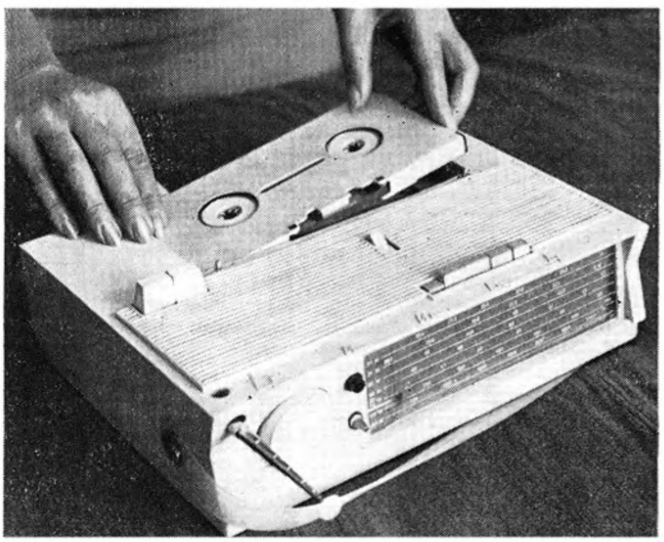
WYNDSOR IN FLAMES

PRODUCTION and service schedules have been delayed as the result of a recent fire at the *Wyndsor Recording Company* premises. Despite severe damage, however, the factory has not been brought to a standstill.

Customers with equipment in for repair have been contacted where their recorders have been damaged or destroyed. Incidental to this news is the announcement that increased prices bring the Wyndsor *Sabre* to £25 4s., *707/2* to £33 12s. and *707/4* to £36 15s.

BINDERS UP AGAIN

FOLLOWING their reduction from 15s. to 12s. 6d. last September, we regretfully announce that binders for *Tape Recorder* and *Hi-Fi News* are being increased to 13s. 6d. because of increased postal rates. Each binder provides an attractive and protective housing for twelve copies, plus, of course, the annual index which is now included in the final issue of each volume. The price includes postage, and orders stating Vol. Nos., should be sent to: **Modern Bookbinders Ltd., Walpole Street, Blackburn, Lancs.**

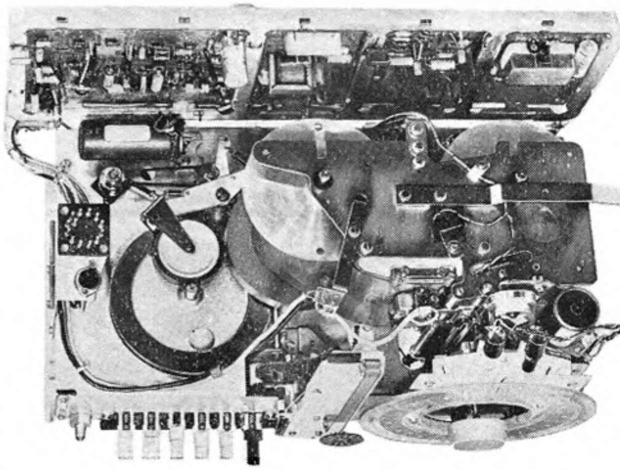


COMBINED RADIO AND BATTERY TAPE RECORDER

WITH the exception of the *Stuzzi Disc-Corder*, which also incorporates a disc-player, the Russian-built *Krung* tape recorder is, to our knowledge, the first battery model ever integrated with a radio. Exactly why such a portable has never been marketed in the West is a mystery. The transistorised Krung was designed and built at the Yerevan Instrument Works and uses removable cartridges containing some 300ft. of standard ¼in. tape. Total playing time per cartridge is one hour at 3¾ i/s on four tracks, while battery life is eight hours. Seven wave bands give the AM receiver coverage from 25 metres to 2 Km.

CANNED MUSIC ON 4-INCH TAPE

SIXTY-FOUR hours continuous playing time is one of many features offered by a novel tape system recently introduced in Germany by *Schaub-Lorenz*. Known as the *Music-Centre*, the device



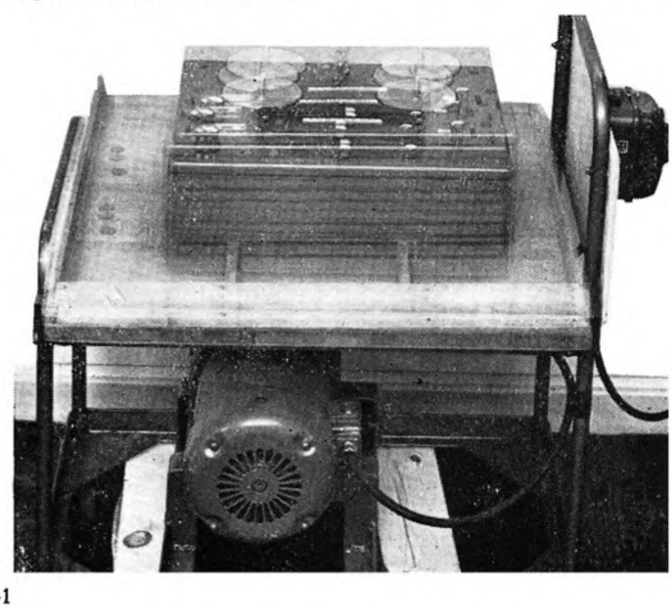
operates on 126 tracks, each with a twenty-two minute playing time on 4in. tape. Two models are available, one with built-in radio and the other with radio and disc-player. The twenty-two minute single-track playing time was selected to correspond with that of an LP disc and to record from disc or radio it is necessary only to press a single button.

Recording and reproducing heads are moved across the tape by operation of a simple large-diameter dial; tracks can be changed whilst the machine is running. At the end of each track the tape either rewinds itself or, if an automatic operation, steps on to the next track and reverses. Tape is wound on a large diameter drum which controls the tape speed; this varies from end to end of the 500ft. tape but averages 4 i/s. Drive is obtained from a 24V controlled-speed DC motor, a separate motor being used to give a rewind speed of 30ft. per second. No facilities are provided for changing the tape, which is considered an integral part of the machine. The 4in. tape is claimed by the manufacturer, *BASF*, to be the same as that normally supplied in ¼in. widths.

The Music-Centre (with radio) currently retails in Germany at approximately £130 and has been the subject of some controversy in view of stricter copyright regulations in that country. A model may soon be placed on the export market.

A SHOCKING TEST

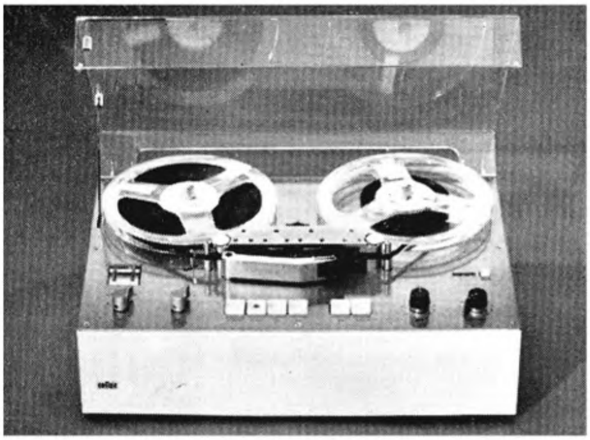
LITTLE has been published on the Norwegian approach to mass production, but a coloured brochure recently produced by *Tandberg* illustrates the modernistic factory and efficient quality control through which their recorders pass. Machines selected at random from stock are forced to endure a test at least as tough as any devised elsewhere. A Tandberg *74B* is shown undergoing forcible shaking on a powerful motor-driven tray.

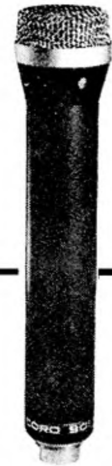


NEXT MONTH

TAPE RECORDING in Denmark will be the subject of an informal survey by Else Rasmussen in the August *Tape Recorder*, published on July 14th. David Haines will contribute a tape play requiring only one character, while Martin York suggests a novel way of 'minding your feet' with an inexpensive and accurate tape length counter. Adaptation of the Robinson Studio Mixer for hospital broadcasting will be detailed, with the aid of circuit diagrams, by L. S. R. Haynes.

in and around the fair..





Left: Fi-Cord 901 microphone.
Far left: Braun TG60 stereo tape unit.

THE stands have gone, music no longer echoes down the hotel passages—another Audio Fair is over. But if ghostly voices still remain, the young lady from *Agfa* who sadly bemoaned being dipped into sub-zero ethyl alcohol and boiling water some 2,500 times over the four days must ring out louder than the rest. What effect the two extremes of temperature had on the young lady—to be more correct, on Agfa tape—was not clear. The continuous loop, some 16ft. in length, certainly lacked treble, but this may well have been due to the loudspeaker mounted behind the large vertical board on which the loop was mounted. Nevertheless, an excellent display of the greatest originality.

NEW TAPE EQUIPMENT SEEN AT THE AUDIO SHOW

Grampian clip-on windshield.

YEAR OF SURPRISES

1965 certainly was a year of surprises in the tape field, and with the *Akai X-4* saw an astounding feat of miniaturisation and micro-engineering: a complete stereo recording system powered by batteries and light enough (12½lb.) to be carried over quite long distances. Demonstrated through external Akai loudspeakers, it made a very attractive sound. Other Akai models making their debut were the *M-8*, *44S* and *ST-1* mains stereo. All these models incorporate the cross-field bias system, whereby, rather than being superimposed on the signal supplied to the recording head, bias is applied by a separate head working through the tape opposite the record/playback head.

The somewhat sedate glass-case display organised by *AKG* gave their demonstration room a museum atmosphere. For the amateur, the most interesting exhibit was probably the *D66*, an attractive stereo microphone selling for £11 10s. Two other low-priced microphones making their first appearance were the *D14S* cardioid incorporating on-off and impedance switching, price £10, and *D501* microphone with built-in wind shield. Impedance is 200-ohms and price is £12 10s.

BUILT-IN REVERBERATION

Rather more expensive is the *DX 11 Echo Microphone* which has the unique feature of an artificial reverberation element built into the casing. Reverberation intensity is variable from zero to some two seconds delay and the element is said to be insensitive to shock or vibration. The DX 11 was first shown at last year's Fair, but importing arrangements have only lately been concluded and the price of the microphone is now fixed at £30 10s. Before leaving this company we should make some mention of the professional capacitor microphones for which AKG are famed. Latest model is the *C12A* which replaces the larger C12 and incorporates a nuvistor rather than the conventional valve. Nine different directional patterns may be selected from the separate power unit which is included in the £139 price.

BASF followed last year's practice of recording and giving away lecture tapes. No figures have yet been released on the division of interest between "Politics" and the three other topics!

An expensive luxury in the *Braun* (pronounced Brown) *TG 60* tape unit now being handled by *Argelane*, is the use of hysteresis synchronous motors not only for capstan, but for forward and reverse spool turntables. Speeds are 7½ and 3¾ i/s, with a choice of ½ or ¼-track stereo

Truvox PD102 stereo tape unit.

Truvox R.102 tape recorder.

recording, off-the-tape monitoring and three-input mixing. Price—around £200. The TG 60 is included in this report despite the fact that it was not exhibited at the Fair. Argelane inform us that the model intended for display was delayed in Customs.

Another high-priced new stereo tape unit was the *Brenell STB2*, a versatile machine with ½- and ¼-track recording at 15, 7½, 3¾ and 1⅞ i/s. A calibrated variable bias control has been situated in a prominent position on the front panel, contrasting with the conventional tucked-away pre-set incorporated on most equipment of this standard.

Revox tape-slide synchronising accessory.

BLISSFUL ISOLATION

Brown (pronounced Braun) enjoyed one of the most crowded demonstration rooms in the hotel. Their wide range of headphones placed wearers in blissful isolation from outside hubbub as they listened to music relayed from *Ferrograph* and *Grundig* equipment. Visitors raised on government surplus headphones must have been shocked by the clean sound and wide-range reproduction relayed by modern phones. Headphone stereo in particular is a unique experience which pleasantly surprises—or sometimes horrifies—enthusiasts hitherto interested only in loudspeaker reproduction.

Highlight of the *Butoba* exhibition room was the *MT 22* battery recorder, incorporating three motors, solenoid controls and—as if to horrify the thrifty battery user—an electric lamp. The loudspeaker grille occupies the entire cabinet surface on the opposite side to the tape deck, which may have accounted for the pleasant quality when demonstrated with recorded music. Speeds are 7½, 3¾ and 1⅞ i/s and spool capacity 6in. Also being handled by *Denham & Morley*, U.K. Agents for Butoba, are microphones by *MB Electronic*.

Nothing new to the tape scene was presented by *Clarke & Smith*, though the *TR634* attracted admiring glances as one of the most versatile mono machines on the market. Inputs at several impedances, internal mixing and comprehensive output facilities make the recorder as ideally suited to the creative amateur as it has proved to be in the field of education.

PROFESSIONAL CONSOLE

Along with the *L4* battery portable, *EMI* introduced a professional console—the *BTR 4*. Variable spooling in both directions, lockable pause and easily changeable head block are a few of the features of this machine. Equalisation is switchable between CCIR, NAB and IEC standards.

If you can afford the BTR 4, the products of *Elcom* may fulfil your accessory needs. Transistorised compensating preamplifiers, microphone amplifiers, equalisers and fading equipment are manufactured to professional standards—and professional prices.

Improvements to the *Fi-Cord 202* have culminated in the *202A*, latest in the line of battery recorders from a respected company. Retailing at £69 6s., the 202A offers 7½ and 3¾ i/s tape speeds, frequency response being 50 c/s to 12 Kc/s ±3dB at the faster speed. A very comprehensive range of accessories, including power pack, rechargeable battery, black leather carrying case and impedance transformers give

(*continued on page* 245)

Butoba MT55 battery portable.

Left: Metrostrobe tape speed indicator.
Far left: Telefunken M.203.

the machine no little versatility. Two new microphones, the *Fi-Cord 801* and *901*, were also shown. Prices have not yet been announced.

The new *Ferrograph Series 6* stereo tape unit made some very pleasant noises through *Quad* electrostatic speakers. Improved wow and flutter and a third tape speed are incorporated in the new *Wearite* deck around which the five recorders making up the Series 6 range are built. Electronics in the new models remain unchanged from the *Series 5* circuitry.

The *Grampian* reverberation unit, once again, attracted many visitors. A properly organised demonstration showed the unit's advantages in hi-fi and creative sound recording. One of the very few low-priced accessories introduced at the Fair was a clip-on windshield for Grampian *DP4* and *DP6* microphones. Specially designed to reduce interference from turbulent air without affecting microphone response, the windshield costs 17s. 6d.

Slides and sound were synchronised into a short programme demonstrating the quality obtainable from *Kodak* tape. *Leevers-Rich* and *KEF* equipment relayed the stereo accompaniment.

Two additions to the *Optacord* range of tape machines were the *408* and *416*. The former was introduced earlier this year and represented a departure from conventional portable designs—the cabinet being a sturdy metal casting, finished in grey, with chromium-plated speaker grille and control panel. Model 416 is similar in appearance to the well-known *414* and is identical to that recorder save for an additional speed (1⅞) now accompanying the former 3¾ i/s.

A two-way discussion between staff in the third-floor demonstration room and a roving recordist in the grounds of Russell Square effectively conveyed the quality and freedom from interference of the *Radiomic* FM microphone system. Not that the system was devised specifically for tape recording or broadcasting use. The *Lustraphone* catalogue suggests such applications as communication between factory and laboratory employees, surgeon to student discussion during operations, and to free the lecturer, entertainer, and car park attendant from the limitations of the public address microphone.

ORIGINAL AND USEFUL

Metrosound, manufacturers hitherto known only in the hi-fi field, have entered the recording market with a very original and useful accessory—the *Metrostrobe*. Tape speed strobes have been marketed before now, of course, but always at a price out of reach of the amateur. This device could not be simpler in design and operation—but why has it never been thought of before? Three speeds, 15, 7½ and 3¾ i/s can be tested in 50 or 60 c/s light, mains frequency governing which of the two calibrated sides are used. We have tested the accessory, which retails at 12s. 6d., on several recorders and find that quite small variations from basic speed can be detected.

The second video tape recorder to be demonstrated at the Audio Fair was shown by *Peto Scott*, U.K. agents for *Philips* professional products. Readers may remember the first, a *Precision* model shown last year by *3M* (Scotch). But while the *EL3400* may be rather more practically priced at a little under £1,000 Scotch can certainly claim to have given the better demonstration. From every viewpoint, a pre-recorded and illustrated discussion would have been more informative and sales inducing (if sales were expected) than the continuous recording and reproduction of traffic circulating outside the hotel. Which brings us to Philips—the domestic branch—who conformed to their usual pattern by displaying current recorders and accessory equipment.

UNUSUAL SIGHT

An unusual sight at the *Mastertape* exhibition room was Graham Balmain, known to many readers for his contributions to this magazine, demonstrating the rare strength of the Mastertape *Senda-Message* by the simple process of standing on it. Visitors to the Mastertape booth had the opportunity of guessing at the number of tape clips contained in a glass bottle. Twelve spools of 1,200ft. LP tape were won by G. H. Singer of Tunbridge Wells for submitting the nearest number below. Mr. Singer's estimate of 4,567 clips came quite close to the actual figure of 4,726.

The extreme simplicity of the new *Planet CD2* is in itself to be marvelled at. But while these comments apply to no little extent to the mechanics below deck, the layout above deck must have made many visitors wonder why past designers ever bothered with pressure pads and pins. The head block could not be simpler, comprising a head symmetrically placed on each side of the centre capstan. The tape slot is curved slightly in such a manner that the tape hugs the heads without resort to further guides. By placing a playback head on each side of the capstan in this fashion, the deck will operate efficiently in both directions, the head effectively in front of the capstan being used at all times. Planet claim the CD2 to be even more reliable than the original *U.1*. Two versions of the single-speed deck are available, operating at 3¾ and 1⅞ i/s respectively. Industrial and retail applications are envisaged, for which reason single-knob operation and very long playing time are featured.

Congratulations are due to *Revox* for their well-organised tape-slide programme which gave visitors the chance to see the Swiss factory from where the *736* and professional *Studer* machines originate. The Revox *Slide-O-Matic* accessory, incorporating printed-circuit pulse generator and miniature relay, sells for 17 gns.

The Mellotron 'pre-recorded organ' was seen by many visitors to the 1964 Fair, when it was shown by Agfa. Nevertheless, the new exhibitors, *Scotch*, were not mistaken in believing that the Mellotron's latest use would generate interest. The 'organ' has, in fact, found employment in a task far-flung from entertaining unmusical philan-

(continued overleaf)

thropists (it retails for about £900). No less a patron than the BBC are currently using the Mellotron Sound Effects Machine which provides instant access to 1,260 separate effects.

In an adjacent room, the *Revere* Tape Player (detailed in our February 1964 issue) was shown for the second year running. The machine, which uses cartridges, is expected to be placed on the British market this autumn, despite its failure to 'catch on' in its land of origin, the USA.

APPARENT CHAOS

The *Sony* demonstration room perhaps lacked organisation a little, but at least the machines were demonstrated. Despite the apparent chaos, it would be very reasonable to argue that Sony adopted the most sensible and honest demonstration technique possible, since each machine could be examined and operated at close quarters by visitors, with or without supervision from the staff. Models on show were the *TC500*, *600* and *777A* $\frac{1}{4}$-track stereo recorders, the lower priced *TC200* stereo which currently retails at £75 12s. and the TC801 battery portable offering $3\frac{3}{4}$ and $1\frac{7}{8}$ i/s tape speeds and permanent-magnet erasure at £70 7s. Two well-established stereo tape recorders, *Models 6* and *7*, were demonstrated by *Tandberg* through *Scott* amplifiers, both manufacturers being represented in this country by *A. C. Farnell.* Two comparatively new monophonic models, the *8* and *9*, were also displayed along with a control unit from one of the Tandberg language laboratories, representing the firm's interest in the field of education.

Surprise announcement by *Telefunken* at the Fair was a price reduction for the *M.300* battery portable by £10 to £51 19s. 6d. Two additions to the Telefunken range were the *Series 100 M104* and *II*, price £40 19s. and £65 2s. Both are single speed ($3\frac{3}{4}$ i/s) $\frac{1}{2}$-track recorders incorporating solenoid mechanical controls and automatic gain. A two-speed twin-track stereo machine, the *M203*, has also been introduced at £82 19s.

DEAD OR ALIVE?

Truvox exhibited a new range—the transistorised *100 Series*, with many features of special interest to the creative enthusiast. The Truvox *R102*, at £76 16s., is one of the lowest priced machines offering genuine monitoring facilities from a third tape head. Instant comparison between live and taped signals is obtainable at the touch of a switch and, indeed, the Truvox demonstration comprised a Series 100 stereo tape unit arranged in such a fashion that 'live' material was relayed alternately with the taped signal through two speakers. Truvox seem to have beaten continental designers at their own game, when their current styling is considered, while retaining the solid construction inherited, perhaps, from that branch of the company which manufactures industrial cleaning equipment. Other features of the improved tape deck include a new pressure system, retractable cover providing access to heads for cleaning and editing (the retractable cover is itself a splicing block), pause control operating on record, play and fast wind, instantly-reset counter and VU meters which make the VU's on most competitors' machines seem like toys.

MORE COMPLEX

What general impressions are to be drawn from the 1965 Audio Fair? Battery equipment is becoming very much more complex, as we have seen from the Butoba MT55 and EMI L4, both now using solenoids, and of course the stereo Akai X4 which, although it has no solenoids, incorporates just about every other feature imaginable in a tape recorder. It is good to see that all three recorders, as well as the Fi-Cord 202A, provide a $7\frac{1}{2}$ i/s tape speed; perhaps quality is returning to vogue after all! The trend towards Continental styling continues, while the European manufacturers ever increase their grip on the British recording market; one cannot help admiring the German tape equipment manufacturers in particular, who supplied ten exhibitors compared with nine from Britain.

With so many low-priced video tape recorders in the wind, the 1966 Audio Fair may well herald the second phase of the tape recording hobby—but we must wait and see.

tape recorded evidence

By Brian J. Ford

SOME COMMENTS ON A CHANGE OF LAW

AT long last the courts have decided in favour of tape recordings as evidence in criminal trials. With this decision will come no end of petty bickering, and a splendid new chance of fabricating evidence. Already our legal system is overcome with unscientific means of falsifying motives and misinterpreting facts: now we shall have a scientific way of doing it.

In practice, of course, tape recordings can be altered around, and their meanings changed in the process, more than any of the other forms of evidence used today. All users of tape recorders edit to some extent, albeit that this is usually limited to the cutting out of unnecessary passages of noise and so forth. Yet it is possible to make unnoticeable changes in sense by careful editing procedures, and the work I have done as a producer for BBC sound radio brings home just what can be achieved in that field. With care, the note of the voice, the character of intonation and the timbre can be so matched that the change of continuity is completely indistinguishable. I have also analysed sound patterns by recording at a high tape speed and replaying at a much slower rate. It is generally true that the pitch of the voice does not alter greatly whilst one word is quickly spoken; in this way the phrase "I was not there last night" can easily become "I was there last night"—a more than subtle change of meaning!

The possibilities are far greater than one might imagine; try it. Record in a natural voice at 7½ i/s the sentence "I was not there last night", just as you might ordinarily say it. Then rewind, and reposition the tape so that it passes to the other side of the rotating capstan shaft —not between the shaft and the rubber idling wheel—so that when the recorder is switched to PLAY the tape is not propelled through the machine. By turning the take-up spool manually it is easy to allow a very slow pass of tape over the replay head, and the words can be broken down into components. First one hears the slow staccato rumble as the letter "I" is pronounced (it resolves into individual peaks of sound at very slow speeds of pass). The word 'was' terminated with the hissing sound of the drawn-out "s", and at the end of this one can clearly hear the beginning of the "n" of "not". Move the tape back and forth over the head, narrowing down the junction between the two sounds until the tape can be brought to rest exactly between them. At this point on the tape a mark is made with chinagraph pencil, exactly over the centre of the head. The tape is then run on (slowly, by hand) until the short explosion of the 't' has appeared. This is the end of the word "not", and if it too is marked with chinagraph pencil in the same way you have the word marked out clearly on the tape. Careful cutting and rejoining allows you to lift it out in entirety, so that the tape now says, on replay, "I was there last night".

Of course, the obvious mark of the edit is the splice itself. Yet it is easy to eliminate this by copying the tape on to a fresh length and once this has been done there may be no trace of any interference—and no sign that this wasn't the original copy of the recording.

It has been suggested that normal twin-track recordings would be immune to editing interference—especially if the tape was marked. Not so, I fear. It would be an easy matter to copy the two tracks on to a single length of tape, edit this copy, and then re-record the edited version back on to the original tape (wiping the unaltered original in the process, of course). And there you are: an authentic-looking incriminating tape as well identifiable as any could be. A completely successful forgery.

As a trial paragraph, why not experiment with the following: "I do *not* believe he could: he is just *not* the sort of person to do that type of thing. *I don't see how* I can tell you about it—I *couldn't have* looked in there last night as I was *not* particularly interested to see what was going on and I had already arranged to be *nowhere* near that area all evening".

Then edit out the words in italics—carefully—and see how good a fabricator you would make.

In reaching the decision to admit this type of evidence, the judges of the Appeal Court state that they cannot see the difference in principle between a tape recording and a photograph: yet of course the principles at variance are legion. There are so many factors to the two-dimensional arrangement of silver grains that is a photograph that it is very difficult to forge. Depth of field, out-of-focus fringes, lighting and contrast are all too many to imitate successfully. But the linear configuration of impulses that is a tape recording is immediately open to re-arrangement of an undetectable nature.

There are differences, of course, in the field of application of tape recordings. After all, if a man with an identifiable voice states he knows nothing of an incident, but is on a recording heard to be discussing it, then this fact alone is sufficient to show he is deviating from the truth. In the case that changed the law the tape was probably perfectly admissible too, as it took the form of a gabbled conversation between two Pakistanis talking in a little-used dialect (not the sort of thing you or I would be able to alter usefully, I suspect). But in many other cases there will be all sorts of difficulties.

For instance, though one can sometimes hear a slight change of tone over an edited passage, this doesn't necessarily point to a forgery. As anyone who has tried to edit tape in a BBC studio knows, many people *talk* as though they have been badly edited!

So it may be, in some cases, a useful step to have taken. But let us hope that the agents of the law are fully aware of all the technical implications of the business, or there may be no end of trouble.

abc of tape recording

PART FOUR **BY DAVID KIRK**

HAVING examined, in last month's article, the bias system of overcoming distortion when recording a signal on to tape, we return to the erase head for a closer look at the process by which a tape is 'prepared' to accept a recording. Most of us have probably, at one time or another, magnetised a metal object by stroking it several times in one direction with a magnet. This process of inducing magnetism in a body can be continued until some sort of equilibrium is reached between the field of the magnet and that of the object undergoing magnetism.

Precisely what occurs when a metal bar is subjected to the magnetising influence of an electric coil or another magnet is not known. Modern theory suggests that the direction of rotation of electrons within the atoms, and the relative positions of the molecules into which the atoms are locked, all have a bearing on the ease with which a body can be magnetised and amount of magnetisation it will 'absorb'. For reasons of this sort, iron or iron-base materials are the most readily magnetised. It is convenient to think of each molecule within an iron bar as an isolated magnet. In its natural state, the metal will be composed of molecules scattered in a random fashion, their magnetic fields cancelling each other—**fig. 1** (a). When the bar is partly magnetised (i.e., with a very few strokes from another magnet, or from a weak current flowing within a coil) some of these molecules are forced about their axes to line up with the direction of the inducing field—**fig. 1** (b). The stronger the applied field, the more molecules will adopt a uniform direction. Ultimately a point will be reached where almost every molecule will be aligned—**fig. 1** (c), though a few unco-operative ones will always remain, however strong the applied force. Once a substantial number have been aligned in this way, their combined efforts give rise to an external field. Beyond this, however, the nature of magnetism is at present unknown, and in any case we have oversimplified things somewhat, for the molecules in fact work in magnetic clusters.

Since the 'magnets' within certain bodies can be aligned without too much difficulty, it follows that a system must exist whereby they can be thrown out of order, back to their original haphazard state. Heat and physical jolts, for instance, both contribute to the de-magnetising process. Two efficient ways of shaking the molecular magnets of an iron bar into a random position are (a): heating the bar until it glows red and striking it repeatedly with a hammer, and (b): placing the bar in an alternating field such as that within or near an AC-powered coil.

The latter is clearly the more convenient of the two de-magnetisation processes since, while the hot tip of a soldering iron might destroy a tape-recorded pattern, it would also destroy the tape! The erase head, therefore, is essentially an electromagnet into which is fed an AC signal. It must be borne in mind, however, that the 'magnets' induced in a recording tape are comparatively small and certainly of very low power. For this reason it is possible, in practice, to erase the tape simply by passing it over one pole of a permanent magnet or DC-charged electro-magnet; a practice frequently adopted on low-priced battery equipment. The disadvantage of permanent magnet erasure has already been described—'charging' the tape with a single magnetic polarity (or attempting to do such an impossible thing) induces a continuous background hiss which makes for very poor recordings.

An AC signal in an electro-magnet therefore, is the essence of the erase head. But why is the erase head connected to the HF bias oscillator? In the interest of economy, one might imagine the tape recorder manufacturer feeding the erase head from the mains 50 c/s supply, transforming the voltage down to a suitable level to avoid burning the head coil. True, this would effectively eradicate any previously recorded pattern, but in so doing the erase head would record a 50 c/s tone instead of presenting a silent tape to the record head. Since 50 c/s is comfortably within the lower frequency range of the human ear, the tone would make itself obtrusive on replay. The bias frequency, as was stated last month, is way above the upper limit of hearing, so even if the recorder is able to transcribe that frequency to tape, it would be impossible to hear the bias tone under normal circumstances. Under *ab*normal circumstances, however, it is not difficult to hear bias. Many domestic machines using the three-speed Magnavox and BSR tape decks are fitted with relatively low-frequency bias oscillators (some 30 Kc/s compared with the 100 Kc/s of high priced modern European and Japanese equipment). Recording 'silence' at $7\frac{1}{2}$ i/s and replaying it at $1\frac{7}{8}$ reduces the bias frequency four-fold to 7.5 Kc/s, though self-erasure keeps this at a very low level and often entails further reduction of speed with the aid of a finger dragging against the feed spool.

The recording process (with the exception of equalisation, currently being described very competently by Gordon King, though at a higher technical level than I shall attempt) has now been covered from input stage to recorded tape. To avoid clashing with my colleague, I return now to the foremost item in the audio chain—the microphone.

With the exception of electrical interference and electronically produced material such as that from the BBC *Radiophonics Workshop*, every sound heard from a radio or television broadcast, gramophone or tape recording originated from some sort of microphone. The microphone is a very simple device and is required merely to turn vibrations in the air (sound) to electrical vibrations.

There are four basic types of microphone in popular use today. These are the *moving-coil*, *ribbon*, *capacitor* and *crystal*. Of these, the crystal is the most popular microphone on the domestic scene, on account of its low cost, general ruggedness and high output signal. The growing popularity of transistorised recorders, however, has brought the moving-coil (dynamic) microphone back into the field and it may well ultimately take over entirely from the crystal. The moving-coil is generally the better microphone of the two but is less efficient—in terms of output—than the crystal. Superior to the moving-coil in many respects, the ribbon type is widely used where really high quality is required. It is expensive, but certainly not as costly as the professional capacitor microphone which can cost as much as £200.

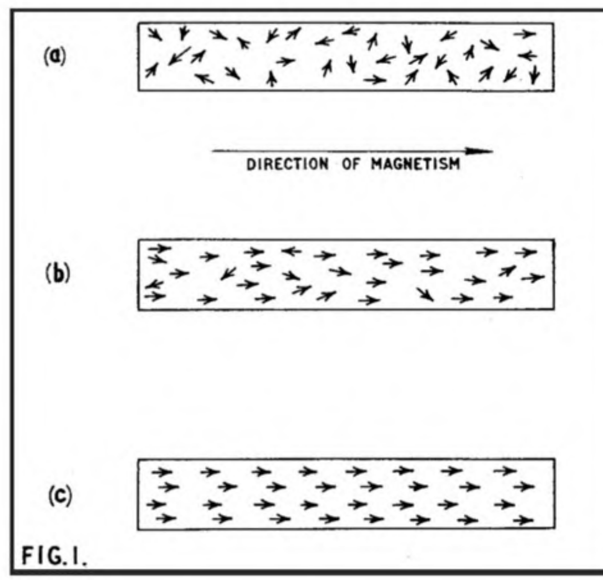


FIG. 1.

To understand the *dynamic* microphone we must return to first principles of magnetism. A current moving through a coil of wire produces a magnetic field within and around that coil; the phenomenon may be reversed—a magnetic field moving through a coil of wire induces an electrical signal in that wire. **Fig. 2 (a)** shows the mechanism of the moving-coil microphone. Vibrating air striking a diaphragm causes a coil to vibrate within a magnetic field supplied by a permanent magnet. A coiled conductor moving in a magnetic field causes a voltage to appear across the output leads, which varies in accordance with the original sound vibrations. The output leads can thus be connected to a tape recorder, the small signals being amplified and passed to the recording head.

The advantage of the *ribbon* microphone—**fig. 2 (b)** is that the absence of any mechanical coupling between diaphragm and conductor eliminates a possible source of distortion. The metal ribbon, in fact, serves as both diaphragm and 'coil' since vibrating air passing it causes the ribbon to vibrate within the surrounding magnetic field, producing a very small voltage across the output leads. Corrugations in the ribbon increase the efficiency by making it easier for the ribbon to move in sympathy with the sound waves. The biggest drawback of the ribbon microphone is its extreme sensitivity to wind and breath noise, making the ribbon almost useless in gusty outdoor weather. Similarly, the ribbon is less robust and more expensive to produce than crystal transducers and many moving coil types, since the corrugations in the ribbon diaphragm can, in some cases, be blown out of true by close, heavy breathing.

The *crystal* microphone shares with the moving-coil type a circular diaphragm. Instead of electro-magnetism, however, it relies on the *piezo-electric* effect. The strange property of certain crystal types is that they will vibrate if an electric current is applied to them, while in the opposite fashion their vibration, via a diaphragm, will generate an electric signal.

Least widely used of the four basic types of microphone is the *capacitor* (previously called *condenser*) microphone. This makes use of the electrical property of capacitance—the temporary storage of electric charges. A capacitor is quite a simple device and can be made up from two metal objects in fairly close proximity. The essential thing about the metal 'plates' is that they must be electrically insulated from each other—separated by air, wax, or similar *dielectric* material.

Consider, for example, two metal dinner plates stacked together but separated by a thin cloth; wires can be taken from each plate to opposite terminals of a battery. The moment contact is made with the battery, electrons in the circuit hurl themselves from negative towards positive poles but find their way impeded by the cloth dielectric. Electron flow therefore stops an instant after the battery is connected. If the plates are now disconnected from the battery our primitive capacitor is left with an imbalance of electrons—a lack of electrons on one and excess quantity on the other plate. Such an electron imbalance constitutes a *charge*. Thus by applying an electric lamp across the plates, we might expect a brief flash of light while the electrons on the excess plate raced through the lamp to the positively charged plate. In fact we would not get such a light, since the ability of the dinner plates to store electrons (the capacitance) would not be very high. The value of a capacitor can be increased in two ways. The use of larger plates (whether they be thick metal or thin foil is of little importance) increases the area over which the electrons may be 'suspended', while positioning the plates closer together, with some suitably thinner dielectric, similarly increases capacity. Effective area and relative position of plates therefore govern the quantity of electrons which may be stored.

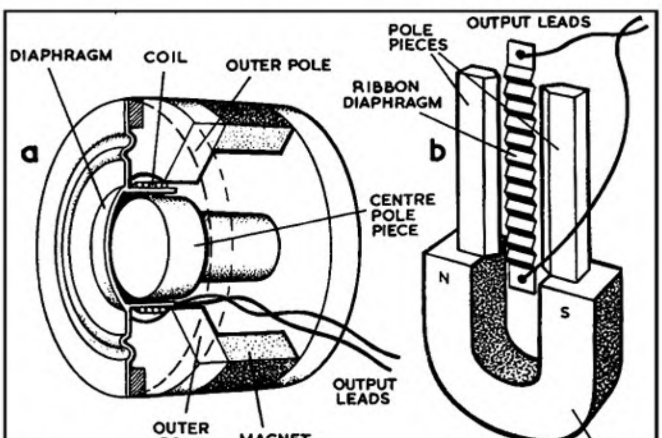
The capacitor microphone makes use of the latter effect to change air vibrations into electric signals. But whereas the moving-coil ribbon, and piezo-electric transducers actually generate the signals, the capacitor microphone can only act through an external polarizing circuit. This brings us to our first meeting with the *circuit diagram*. **Fig. 3** is a simple circuit showing, in conventional 'shorthand', the layout of electrical components around a capacitor microphone. The microphone, however, is not shown in 'shorthand' but appears more or less as it would be seen in real life (it goes without saying, of course, that in 'real life' the plates of the capacitor microphone and also the transducers of **fig. 2** are housed in some sort of protective casing). The plates of a capacitor microphone are so designed that one is light and flimsy while the other is fixed rigidly to the rear microphone casing, suitably insulated. The 'fixed' plate is illustrated as a thick metal sheet. When sound waves strike the thinner of the two plates (the diaphragm) the distance between plates alters and therefore the capacitance of the microphone changes. In this case, the dielectric is air, offering little impedance to movement of the diaphragm.

Now the change in capacity of the two plates, even though it corresponds to the input sound pattern, in no way generates an electric signal. To work effectively, the plates must be connected to a DC supply to enable the plates to 'charge'. **Fig. 3** shows how this 'polarizing' is accomplished. The device in question does not employ batteries, however, and we find the charging terminals labelled HT+ and HT—. These are abbreviations for ***High Tension positive*** and ***HT negative***—'tension' being in this respect voltage.

Following the lines, which represent connecting wires, the plates are not connected directly to HT+ and HT—. The diaphragm connection is made through the zig-zag pattern that represents a resistor (**resistor 1**). Since the HT supply is expected to feed power to other parts of the tape recorder, it is unreasonable to expect the HT to be at exactly the right voltage to suit the capacitor microphone. The resistor is therefore incorporated to hold back (resist) the flow of electrons in much the same way as a stretch of narrow country lane between two lengths of motorway would produce a bottleneck of cars. The value of the resistor is chosen to suit the microphone and surrounding circuitry.

So far, then, we have constant DC *charge* across the two plates of the microphone—though no current is actually flowing, since electrons cannot flow across the dielectric between the two plates. What

continued overleaf



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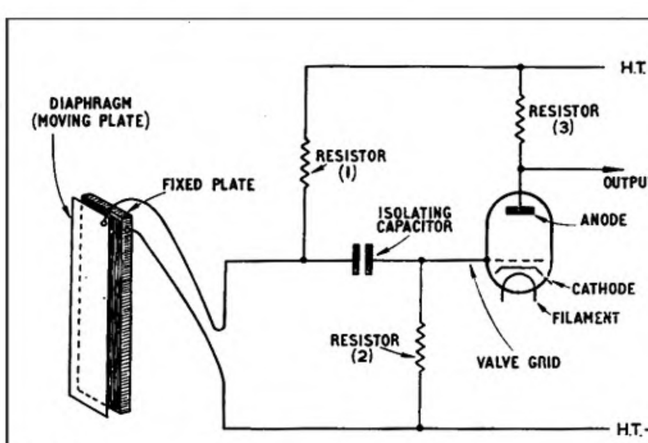

FIG. 3.

happens when the plate distance is varied is that the microphone's capacity changes in a way closely corresponding to the sound waves striking the diaphragm. As the diaphragm approaches the base plate, capacity increases, and vice versa.

Now the resistor and its electron bottleneck comes into play, for its value is chosen so that in conjunction with the capacitance of the microphone element it is impossible for electrons to move to and from the plates at audio frequencies. As the electrons cannot move but the capacity does change, the electric *forces* across the capacitor plates have to change also, thus providing what we want—a *voltage* varying in sympathy with the sound waves. This AC signal is produced across the two output leads of the microphone and therefore across resistor 2, which is directly connected to the plates, but for an isolating capacitor between it and resistor 2. The purpose of the isolating capacitor is simply to prevent the DC voltage across the microphone from 'flooding' the valve grid. Consequently, the voltage at the valve grid is varied only by the AC signal from the microphone.

The difference, then, between the moving-coil transducer and the capacitor microphone is that the moving-coil generates an AC signal which can be fed straight into the grid of a valve, from where it is amplified and passes through a network of components, finally ending at the record head, while the capacitor microphone requires a polarising voltage, often provided from the recorder itself, before it can supply a signal suitable for amplification.

It is worthwhile describing, at this point, the rudimentary workings of the valve amplifier. It is common knowledge that valves glow and become quite hot when working. Each valve contains a filament closely resembling that in an electric light bulb. The purpose of this filament is to provide not light but heat to warm up the cathode which is wrapped around it. In circuit shorthand, the cathode is illustrated as a line with bent ends, sharing a glass bulb with the *grid* (represented by the broken line) and the *anode*—a conductor separated from the cathode by the grid. Like the torch bulb, the valve *heater* (filament) requires very little power and is often fed from a low-voltage source of its own, isolated from the main circuit. When the 'horse-shoe', representing the heater, is left disconnected as in **fig. 3**, this is accepted as indicating that it is wired to a low-voltage supply.

Assuming **fig. 3** is powered and working happily, the following will occur within the valve. The filament will glow to a considerable heat, raising the cathode temperature, whereupon the electrons will begin to jump away from the cathode surface. The cathode, in fact, is made from a material with a surplus of 'free' electrons. At the opposite end of the glass bottle is the anode, positively charged since it is connected to the HT+ supply. This positive/negative situation gives the anode a perfectly good excuse to take some of the electrons thrown off by the cathode. Thus a current flow takes place between cathode and anode, electrons passing through the grid. A very little change in voltage on the grid, such as would occur when sound was fed into the capacitor microphone, would cause a very considerable change in electron flow through the valve. The situation can be likened to the small boy opening and closing a gate against an onrush of elephants. The energy used by the boy to open and close the gate is much smaller than the energy within the elephants he controls. An analogous action takes place within a transistor, with the exception that electrons are not flowing across a vacuum within a glass bulb and consequently much lower working voltages are possible.

The small voltage across the valve grid can be said to have modulated a current flow within the valve, producing an amplified version of the grid signal on the anode, where the current flows through resistor 3 to produce relatively large voltage changes between the anode and HT line. Further amplification can now be achieved by the simple process of connecting the anode of the first valve to the grid of a second, third, fourth . . . and so on, via, of course, further capacitors to isolate the grids from the HT supply. The minor complexities of circuit design are endless. Like the tape head, the valve requires bias, namely a small voltage to which the input signal can be added and subtracted to prevent the anode being flooded with or starved of electrons. But we are wandering from the original subject.

There is much more that can be said of the microphone than description of its physical construction, and we shall continue, next month, by describing the acoustical peculiarities of one against the other and general aspects of microphone technique.

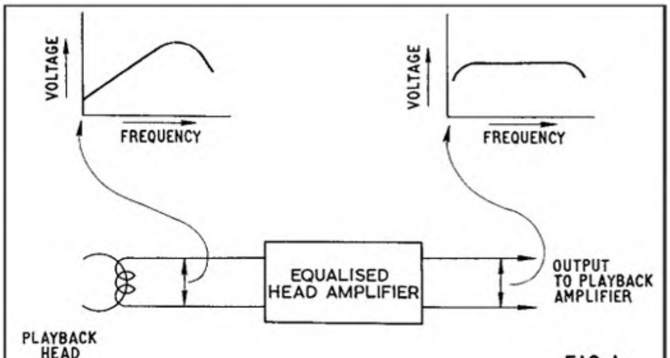

FIG. 1.

towards better taping

PART 16 — INDUCTANCE AND EQUALISATION

BY GORDON J. KING

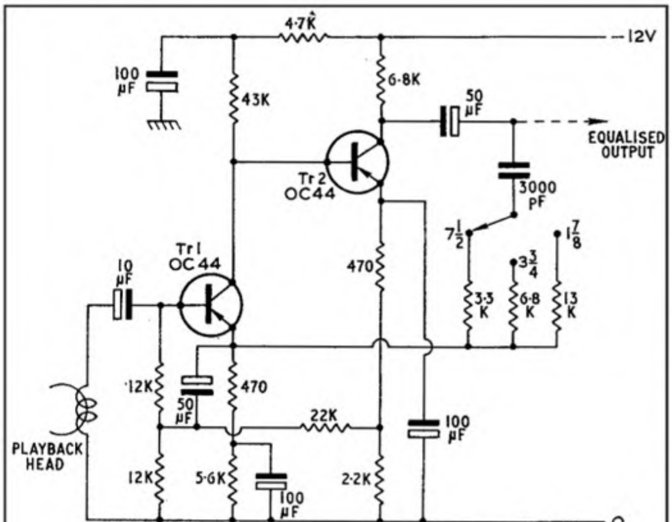

FIG. 2.

LAST month we saw the need for playback equalisation. We saw that the EMF induced into the playback head winding rises constantly at 6dB per octave up to the turnover frequency, at which point the EMF commences to drop slowly at first and then fairly rapidly. Previous articles in this series have shown why this happens.

Also last month we saw how equalisation is sometimes translated to a time-constant and how in valve circuits frequency-selective negative feed-back is adopted to provide an output flat with frequency from the head output which rises as told above. This is summarised in the diagram **fig. 1.**

We shall probably remember that the negative feedback equalising arrangement discussed last month automatically causes the feedback to increase with increase in frequency. In that way the gain of the head amplifier is caused to decrease with increase in frequency. In effect, then, the flat output from the head amplifier is not specifically a function of bass lift, but more a function of treble attenuation.

There are various ways of getting 'frequency-controlled' treble attenuation, one of which is by the use of frequency-selective negative feedback. Another way is by putting some sort of frequency selective filter in the circuit between the playback head and the input to the head amplifier. This is not a very good way of tackling the problem because it means that the signal applied to the head amplifier from the head is always below its maximum value and this way of doing things always causes trouble from the signal/noise ratio aspect.

To secure the best possible signal/noise ratio the first valve in circuit must receive the strongest possible signal from the head winding. Let us consider an example. Say the playback head is delivering a signal of 500µV and that the head amplifier is producing a 'noise signal' with an equivalent level at the input to the head amplifier of 5µV, then we have a signal/noise ratio of 500-to-5, which is the same as 100-to-1. This is neither a good nor bad signal/noise ratio. Noise on the signal would just about be heard as a hiss. For the noise to be completely pushed into the background the ratio would have to be in the order of 200-to-1. That is, either the signal from the head would have to be doubled or that the equivalent amplifier noise signal would have to be halved.

Now, before we go on let us get one or two things clear. Firstly, a signal/noise ratio below 100-to-1 is definitely bad. The noise generated by the amplifier would sound from the speaker as a hiss. This is the normal manifestation of amplifier noise. Secondly, noise is produced in all conductors, whether they be wires or components, due to the random movement of electrons in the conductors. Thirdly, the noise signal so produced appears at the input of the amplifier, along with the required signal (from the playback head, for instance), as an 'equivalent noise voltage'. Thus, the amplifier is effectively in receipt of two signals, the required signal and the noise signal. The ratio between the two represents the basic signal/noise ratio. Fourthly, noise signals are produced due to the emission of electrons between the cathode and the anode of a valve. This is more of a thermal noise signal, as distinct from the random movement of electrons in conductors. Nevertheless, it contributes to the general noise signal. Transistors are also prone to noise effects, but not thermally, as is a valve. Of course, this is because there is no heater or thermal emission in a transistor.

Equivalent noise signals are usually very small indeed and are measured in microvolts, a µV being equal to one-millionth of a volt. We already probably know about the millivolt (mV), which is equal to one-thousandth of a volt. Thus, 500µV is equal to a 0.5mV. It is just as well to become accustomed to the use of sub-multiples of the volt, as they are used extensively in tape recorder practice.

NOT POSSIBLE

Unfortunately, it is not possible to eliminate noise signals. We have to live with them. What we can do, however, is to take steps to keep the signal/noise ratio sufficiently high to prevent the noise from affecting the reproduction. This can be done in two ways. One, by increasing the level of the signal applied to the low-level amplifiers and two, by taking steps in the circuit—and by the choice of components—to keep the noise signal generated as small as possible.

Earlier we saw that a head signal of 500µV and a noise signal of 5µV produces a signal/noise ratio of 100-to-1. This could be improved to 200-to-1 either by doubling the head signal (as seen by the amplifier input terminals) or by halving the noise signal.

Conversely, the signal/noise ratio would be worsened either by reducing the head signal or by increasing the noise signal. Clearly, this latter could happen by putting some sort of attenuating filter for equalising between the playback head and the input to the amplifier. If the attenuator is frequency-selective, as it would need to be, then the signal/noise ratio could worsen progressively towards the treble

(*continued on page 253*)

UHER

4000 REPORT-S

the incredibly versatile portable tape recorder

Ready for recording and playback anywhere and at any time the UHER 4000 Report-S satisfies the most exacting demands of both amateur and professional and offers virtually every facility provided by a mains-operated recorder. It requires only five flashlight cells as a power supply, and is even more economical when operated from a re-chargeable "dryfit" battery. It can also be used with any type of storage battery from 6 to 24 volts.

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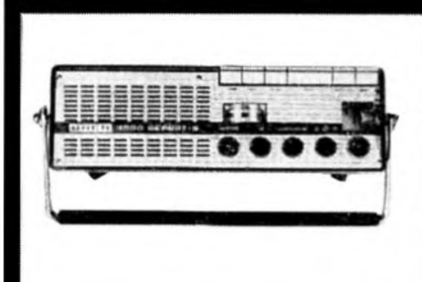

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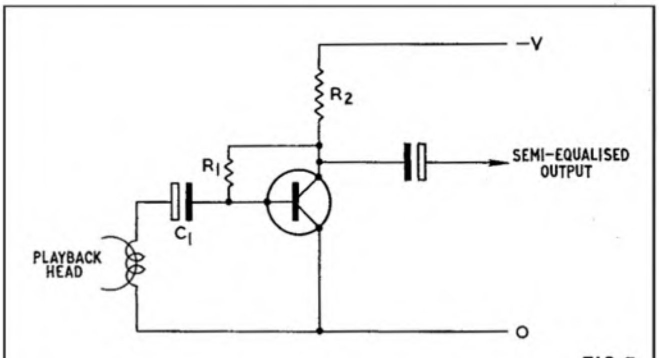


FIG. 3.

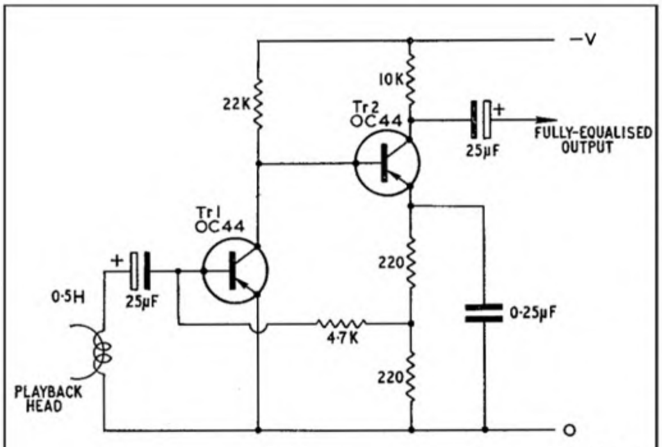


FIG. 4

end of the spectrum, since the filter would cause a progressive reduction in signal from the head to the amplifier from the bass end up to the turnover frequency. Moreover, the insertion loss of the filter would reduce the nominal signal applied to the input of the amplifier from the head.

To some measure this trouble is prevented by the use of frequency-selective negative feedback for equalising. While the effective gain of the amplifier is reduced with increase in frequency by the reactive feedback loop, the full head signal is applied to the input of the amplifier, and in that way the best possible signal/noise ratio is retained. Indeed, the rising head output up to the turnover frequency results in a progressive improvement in signal/noise ratio. It should be pointed out that there are other somewhat technical factors involved, but these fall outside the scope of this present series of articles.

EXTREMELY POPULAR

In transistor head amplifiers which are now becoming extremely popular for monitor amplifiers in conjunction with the inactive winding of a quarter-track head, frequency-selective feedback of the nature described for valve circuits last month may or may not be employed. Since a transistor is a current-operated device, as distinct from the valve which is voltage-operated, a somewhat different technique can be adopted for equalisation. However, before we go on to investigate this, let us look at a transistor circuit using the equivalent of the frequency-selective feedback of a valve circuit.

Such a circuit is shown in **fig. 2.** This is a useful circuit as it can easily be made up to form a practical head amplifier for monitoring or for stereo in conjunction either with a separate playback head or with the spare winding on a quarter-track head, as we have seen.

Two transistors in a DC coupled circuit are employed. The collector of Tr1 is directly coupled to the base of Tr2. The circuit is stabilised DC-wise due to the DC connection from the emitter of Tr2, via the 22K resistor, to the base circuit of Tr1. Signal feedback occurs from the 50μF capacitor on the emitter of Tr1 via the 12K resistor on the base of the same transistor.

This feedback greatly increases the input impedance of Tr1 and thus allows the use of a head of almost any inductance to be coupled direct to the amplifier. In this way the head inductance does not unduly affect the equalising characteristics. The feedback equalising loop is connected from the collector circuit of Tr2, via the 3,000pF capacitor and the selected equalising resistor, to the emitter of Tr1. It will be understood, of course, that the equalising is switched for three tape speeds by the switching in of the 'R' element to provide the corresponding time-constant, as explained last month.

The amplified and equalised output is extracted from the collector of Tr2, at which point the impedance is in the order of 25K, this being a value suitable for direct connection to a medium-impedance, unequalised 'radio' or 'auxiliary' amplifier input.

So much, then, for frequency-selective feedback equalisation in transistor amplifiers. It is seen that this differs very little from the same technique adopted in valve amplifiers. With transistor amplifiers, however, this sort of equalisation usually demands a medium to high input impedance at the head terminals, which is accomplished by local feedback in the first stage. The input impedance to a valve, of course, is normally high.

LOW IMPEDANCE

Now, if the head amplifier is designed to have a low input impedance, as normally occurs when local negative feedback is not applied, the inductance of the playback head itself can be arranged to assist with the equalisation.

We know that a playback head (or record head, for that matter) consists of a large number of turns of wire wound round the core material, which is often laminated metal. The head winding, then, has *inductance*, and its inductance value (given in Henries—or sub-multiples, such as microhenries and millihenries) is governed by the number of turns of wire forming the winding. The greater the number of turns, the greater the inductance value. The type of metal core employed on the head also influences the value of inductance.

Inductance controls the amount of signal current flow in the head circuit. This is because the head—or any inductance—has a value of *reactance*, called *inductive reactance*. The reactance is measured in 'ohms', like ordinary resistance, and its value is related to the value of head inductance and signal frequency in accordance with the expression $2\pi fL$, where f is the signal frequency in c/s and L is the inductance in henries.

This simple expression shows that the inductive reactance rises with increase in both signal frequency and inductance. The amount of signal *current* in the head circuit is governed by the reactance (exactly the same as direct-current is governed by the resistance in a DC circuit). Clearly, then, the current in the circuit is greatest at the lowest frequency and falls as the frequency increases. It is this feature which is employed as an equalising artifice in some transistor head amplifiers.

Let us look at the simple circuit in **fig. 3.** Here we have a single-stage transistor amplified where R1 sets the base current and R2 is the collector load. The base demands *signal current* to make the transistor work. This signal current is derived from the playback head and is coupled by C1, which isolates the DC from the head, yet passes the signal.

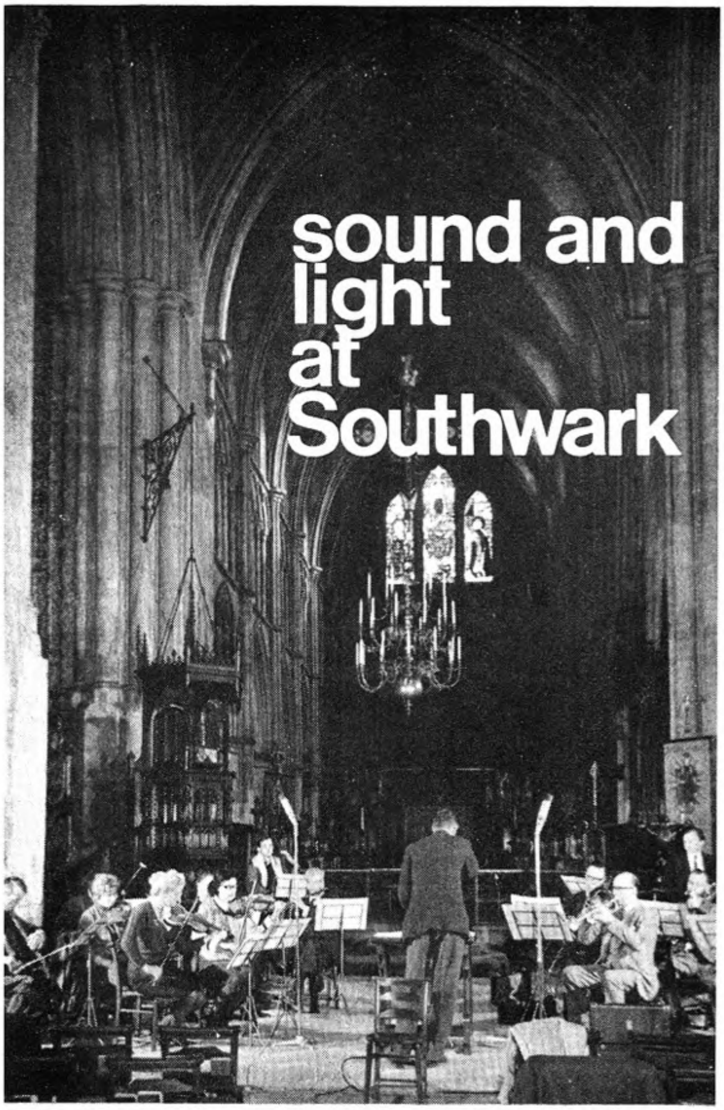
At low frequencies the head EMF is low, but so also is the reactance. Thus, maximum current is passed from the head into the transistor base circuit. This is just what is wanted. Now, as the signal frequency increases, so does the reactance of the head and the EMF in the winding. The affect is that the head current into the transistor base is automatically reduced as the frequency is increased. Thus, the rising head EMF with frequency does not produce a rising current in the transistor base. By a suitable marriage of head inductance and transistor input impedence almost perfect equalisation can be achieved relative to the 6dB per octave rise in output from the head.

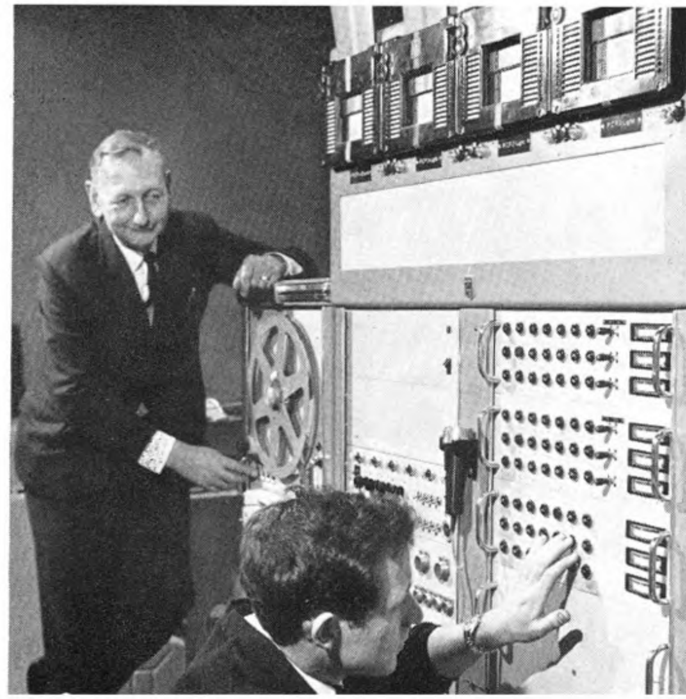
Unfortunately, the head signal current coupled into the transistor base circuit continues to decrease beyond the turnover frequency. This is highly undesirable, of course, since it pulls down the treble response. The problem can be overcome, however, by a simple corrective feedback arrangement which is incorporated in the circuit in **fig. 4.**

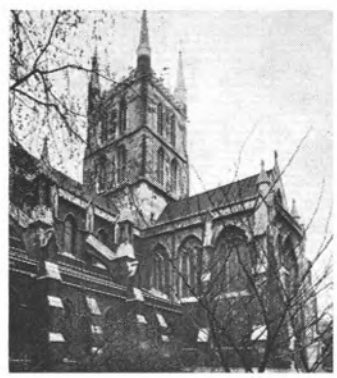
Here we have a two-stage amplifier which is usually needed for a

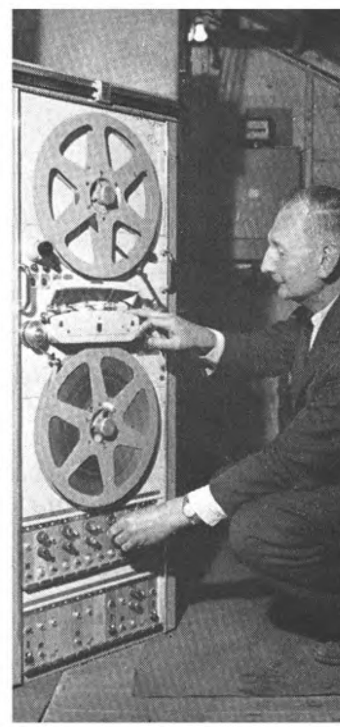
(*continued on page 272*)

sound and light at Southwark

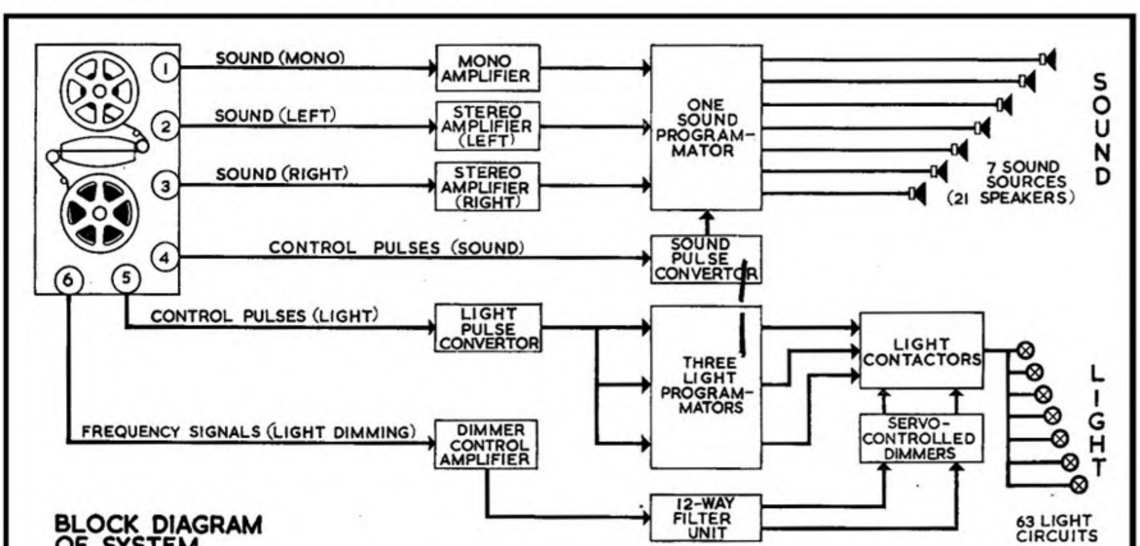








AUTOMATIC TAPE CONTROL FOR *son et lumière* IN A CATHEDRAL



Picture at top-left was taken during a recording session in the cathedral, while above we see engineers operating the control equipment illustrated in block diagram form on the left.

SOUND AND LIGHT AT SOUTHWARK

THE use of sound, light and architecture to produce pleasing effects has an extended and honourable history. Handel's *Royal Fireworks* music, for instance, was produced in accordance with a well established tradition of splendid sounds for splendid visual occasions, while today the spectacle of massed pipes and drums illuminated against a dramatic setting is a highlight of the Edinburgh Festival. But technical developments in the control of light and the recreation of sound have opened up new and more subtle possibilities, a fact grasped by the Frenchman M. Paul Robert-Houdin (grandson of illusionist Houdini), who has created what is virtually a new art-form called *Son et Lumière*—sound and light.

Fine buildings with many historical associations have provided settings for impressive and moving presentations, the combination of suitable music, cleverly controlled lighting and apt commentary being particularly effective after dusk on a warm summer evening.

The English climate being what it is, Son et Lumière has not been imported on a large scale, though some successful events have been staged. In 1963 the Tower of London was used for a programme called *A Fair White Tower*—this was popular despite the need to view the Tower from mid-river by boarding boats; but knowing our sea-faring tradition perhaps this was the secret of success! This scheme was planned and implemented by *Philips Electrical Ltd.*, who used tape recordings not only for the music and commentary, but also incorporated pre-recorded control signals for the various changes in light and sound locations, etc. This eased production problems by reducing manual synchronisation of effects and making all the programmes more nearly identical. Coloured lighting sequences were also used extensively for the first time.

DIAMOND JUBILEE

On April 28th this year an *indoor* Son et Lumière was given its première at Southwark Cathedral in London. Entitled *The Four Seasons*, this is being staged to mark the diamond jubilee of the Cathedral and Diocese and will run until September 11th. Philips are again in charge and the control system has been still further refined so that a complete one-hour programme is given entirely automatically from a single six-track tape recording.

The object was to produce a spoken story based on the theme of the Four Seasons, tracing the history of Southwark and its church through the centuries. The atmosphere and incidents of times past and not so distant were to be conjured up by the skilful use of music, with coloured light tinting various facades of the neo-Gothic architecture to symbolise the changing seasons, and particular facets or sculptured characters picked out where appropriate in the story. Such a project may be likened to an operatic production, with much detail to be integrated into a convincing overall programme.

The production was managed by Talbot Hainault of *Pageantry Productions Ltd.* with the assistance of John Boud—who wrote the script—and Southwark organist Harold Dexter, who composed and adapted the music. The dialogue was recorded by a cast including Dame Peggy Ashcroft, Anthony Quayle and Patrick Wymark, while the music was performed and recorded in the Cathedral itself by a group of players under Mr. Dexter. The final prerogative in matters of theme and presentation was, of course, in the hands of the Bishop of Southwark.

In practice it is impossible to separate engineering and artistic matters in a complex exercise of this sort, and at an early stage, lighting expert John Layton from Philips and sound engineer Charles Pryer from *Peto Scott Electrical Instruments Ltd.* were put in charge of technical aspects of the operation. Peto Scott were involved as the suppliers of Philips professional sound equipment, and the electrical installation work was carried out by E. J. Brown of Peckham.

As the acoustic and visual possibilities of the cathedral were studied, so, gradually, a scheme emerged permitting dialogue, music and light to coalesce into a pleasing and stimulating pattern in time. A major problem arose from the very elongated shape of the building, making it difficult for an audience to see all the lighting changes; but a discreet combination of effects around the clerestory and at the screen end of the church was eventually evolved. Altogether, 135kW of lighting is employed, of which up to 30kW may be in use at one time. Many special fittings were installed together with a variety of projector lamps, tungsten-iodine devices, and some coloured pressed-glass floodlights.

On the aural side, 21 loudspeakers are used to provide seven separate sound sources, including a pair for music in stereo in addition to others for special 'sound travelling' effects. The total audio power available is 70W.

As mentioned, the musical items were recorded in the cathedral (see picture), thus enabling the players to react naturally to the acoustic and permitting easy blending of the recorded sound. Highly directional stereo is obviously not appropriate, though separate spaced microphones were employed to help musical antiphony. We heard that during one recording session a choir boy let off a cap-gun, but such is the acoustic confusion in a building of this type that another boy some distance away was wrongly chastised. However, this episode was not used in the final version!

Having devised an hour's programme requiring 108 and 121 changes of light and sound respectively, the problem was to 'automate' things so that a single multi-track tape recording could control the complete operation.

Starting point of the system is the tape machine itself, shown on our front cover with Mr. Pryer in charge and reproduced again here. Up to ten tracks are possible on $\frac{5}{8}$in. LP tape running at 15 i/s, the 13in. spools carrying some 5,000 ft. In the Southwark system only six tracks are used, three carrying recorded sound and three with keying signals for the sound and light changes.

The block diagram outlines the operational scheme, with the sound and light functions separated. The dialogue recording (mono) and the two music signals (stereo) are fed to a sound 'programmator', together with a control signal comprising pulses, or tone-bursts, occurring at moments in the sequence when changes of sound source are needed. The programmator employs a ribbed card (see top of photo showing complete console) encoded to switch sound signals to the various speakers as needed, and as each pulse comes along from the tape the card moves down one step on a rachet and performs the necessary re-routing.

SIMILAR SYSTEM

A similar but more complex system is used for the lighting, three programmators being operated by light control pulses from the tape. Lights have to be dimmed and brightened as well as switched, requiring another recorded signal to feed servo-controlled dimmers via a filter unit. This sixth output from the tape comprises signals of twelve fixed frequencies but varying length, to be sorted into specific 'instructions' by twelve narrow-band filters. The light contactors, in conjunction with the dimmers, feed 63 light circuits.

This whole control system is housed in a small wooden hut tucked away at the back of the cathedral, with an array of cables disappearing over a wall from one end and a modest door fitted with a large burglar alarm at the other.

The audiences come, take their hour of entrancement and leave, for the most part unaware that Southwark's story in sound and light all comes from a band of thin oxide-coated plastic.

But the immense amount of effort expended in producing that 1,500 meters of 6-track recording was well worthwhile. This new art of Son et Lumière is a thing of fleeting experiences to be remembered but not seen again, yet Philips' master-tape of "Southwark—Summer 1965" is, in one sense, like a musical score—an abstract record that could again be brought to life. But that is part of the magic of the tape recorder.

tape reviews

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

BASIE-ECKSTINE INCORPORATED Billy Eckstine with Count Basie and his orchestra. **World Record Club TT398,** 3¾ i/s twin-track mono. 29s.

THE Basie Band has been associated with many great singers. In the late thirties and early forties it was Jimmy Rushing who stood out in front and shouted the blues; in the fifties Joe Williams rose from obscurity as the band's featured vocalist; Billie Holiday also appeared with Basie for a brief period. More recently the Basie band has made some memorable recordings with Sarah Vaughan, Ella Fitzgerald and Frank Sinatra.

Although Billy Eckstine has been a big star in the U.S.A. for twenty years, he has never enjoyed wide acclaim in Britain as an entertainer or as a singer. But it is fairly certain he will have a place in the history of jazz. In the period 1944 to 1947 he led a band which included a very large number of the creators of modern jazz. Charlie Parker, Dexter Gordon, Lucky Thompson, Dizzy Gillespie, Miles Davies, Fats Navarro, Art Blakey and Tommy Potter found encouragement with the Eckstine band during the transitional period.

The more the pity, then, that there is nothing in *Basie-Eckstine Incorporated* to recommend it to jazz fans, in fact there is nothing in this recording to recommend it to anyone. The songs for the most part are trite, and the performance is dull and dreary. **T.F.**

NUTCRACKER SUITE (Tchaikovsky) Casse - Noisette, Op. 71. Philharmonia Orchestra conducted by Efrem Kurtz. **HMV TA-ALP1609.** 3¾i/s twin-track mono. 40s.

AFTER listening to this tape, the thought left uppermost in my mind is: "What a wonderful craftsman Tchaikovsky was with an orchestra". This, I feel, is at once fair comment on the music and on the performance given here. The Philharmonia under its conductor Efrem Kurtz gives a precise and charming account of the suite which, to me at any rate, draws attention to the colourful way in which the different instruments are used. Even in the perhaps rather hackneyed *Valse des fleurs* the fruity tone of the clarinet is a delight to hear.

The recording quality is 'old fashioned' and needed bass lift to produce adequate balance (the recording was first published in 1958). A more serious defect on the review copy was drop-out. This occurred towards the end of track one and during the second half of the *Divertissement* which opens track two. They were isolated momentary snatches, but nevertheless disturbing. The recorded balance seemed to improve towards the end of track two. Users of smaller loudspeakers need not worry overmuch about the lack of prominence in the bass, I feel, but if possible it would be as well to check to see if the patches of drop-out occur on the intended purchase. **G.G.**

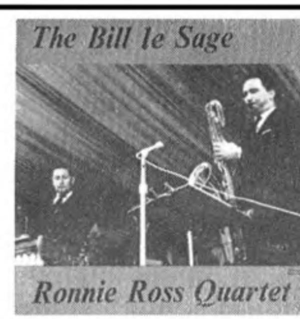
BEETHOVEN PIANO CONCERTO No. 3 in C minor. Hans Richter-Haaser (Piano) and The Philharmonia Orchestra conducted by Carlo Maria Giulini. **Columbia TA-33CX 1903.** 3¾ i/s twin-track mono. 40s.

THERE is a quality of firmness and authority in Richter-Haaser's playing on this recording that completely carried me along with him throughout the whole work on first hearing this tape, and repeated hearings have enforced the first impression. To my mind, the aspect of his technique that gives rise to this quality are the details of articulation, the way the notes are joined together within their phrases. The rising scale passages of the first piano entry have an essential solidity, and the detached notes of the rising arpeggios that follow are made neither too short nor too long, giving them a certain definitive sound. Throughout all three movements each note is made significant.

The tempo Richter-Haaser chooses for the opening 'allegro' of the last movement is perhaps more moderate than some may prefer, but I felt that details were in this way brought to light that a more spanking pace would obliterate. The music does not flag and change of tempo to 'presto' at the end of the movement is made the more significant.

There were some minor defects of recording quality on the review copy. Fluttery sounding drop-out during the opening bars of the slow movement at the beginning of track two was distracting. Otherwise the sound quality was warm and clean, the piano being very well balanced with the orchestra. The orchestra? It occurs to me that I have not mentioned them. For me this was Richter-Haaser's tape and I wish to be complimentary when I say that Giulini and the Philharmonia Orchestra in no way detracted from this impression. **G.G.**

BILL LE SAGE/RONNIE ROSS QUARTET. Ronnie Ross (baritone saxophone), Bill le Sage (vibes and piano), Spike Heatley (bass), Alan Ganley (drums). **World Record Club TT346,** 3¾ i/s twin-track mono. 29s.



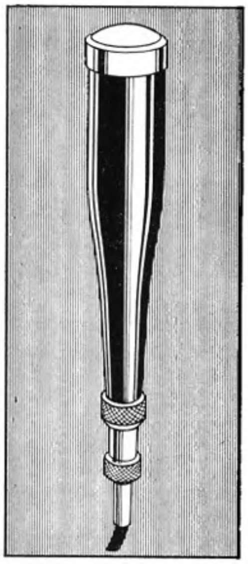
IT is a rare thing for a British jazzman, working in Britain, to reach a position whereby it is possible to make a favourable comparison with his American counterpart. This recording, which is a showcase for Ronnie Ross, serves to spotlight one of these rare occasions, which is probably more likely in the field of modern jazz, than in traditional, or mainstream.

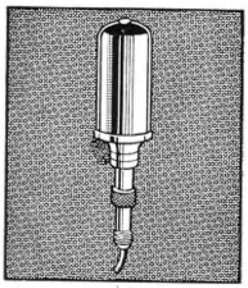
The baritone sax is a large and cumbersome instrument, but Ronnie Ross produces from it, both the cool sound associated with Gerry Mulligan, as well as more robust and forceful tones on the up-tempo numbers. The other three members of the quartet are all leading British Modern jazzmen, Bill le Sage on vibes and piano, Alan Ganley drums, and Spike Heatley bass.

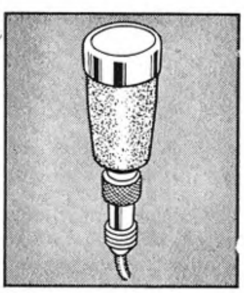
The music on this tape ranges from a real oldie, *If You Were the Only Girl in the World,* to five compositions from members of the quartet. Bill le Sage offers *Autumn in Cuba,* while *The Cheaters, Country Squire* and *Pitiful Pearl* are by Ronnie Ross; Spike Heatley contributes *Benny South Street.* This last delightful number deserves to become a standard in the popular as well as in the jazz sense. Among the other items we find Ellington's *Satin Doll,* and a beautiful but seldom heard Hoagy Carmichael number *New Orleans.*

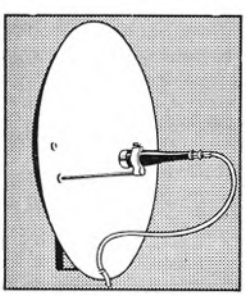
Altogether, an excellent and welcome release, and it is to be hoped that World Record Club will follow by releasing tapes by other British Modern groups. **T.F.**

Here's a family of many talents









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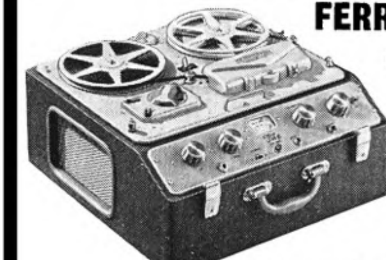

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tape recorder service

BY H. W. HELLYER

AT the time this article is being prepared, news has come that *Philips* are taking under their wing the marketing arrangements for Messrs. *Cossor* and *Stella*. I think the City term is 'streamlining'. If this means an end to the confusion that exists in some readers' minds about the differences (and similarities) where tape recorders are produced under the three brand names, one harassed technical writer, at least, offers up his vote of thanks.

The present short section on Philips machines was undertaken in answer to a number of queries. Almost as fast as our workshop data can be sorted, checked against the maker's published facts and knocked into some sort of article, the backroom boys whip out another model or two. At the rate of dealing with one machine, or group of machines, in each article, we shall be tied to this prolific company for the rest of our days. The result may be either that readers will get the impression we are giving them undue publicity, or that the boffins from Philips' will take offence at the inference that the tape recorders are always going faulty. Let me hasten to say that both would be wrong!

For this month's attempt then, let us try to deal with some of the points that have arisen, discussing several aspects of one of the most popular stereo machines.

Once or twice before we have touched upon the *EL3534A*, which is a four-speed fully stereophonic, transistorised mains machine. There has been insufficient space to deal fully with all the adjustments and those hints and tips about servicing which some of our readers have been kind enough to commend. Many of the mechanical details and some of the electrical ones are similar to other models, and we need waste no time in referring back to previous articles. The 3534 made something of the ***Multiplay*** facility, and this, too, has been discussed by other writers. It seems that the information most wanted to fill in the background is the purely practical matter, such as dismantling, adjusting the key lock and checking the auto-stop—features peculiar to this type of deck.

Also, some confusion exists about the differences between marks. There were five versions of this machine, differentiated by the coding *WR00*, *WR02* . . . *WR05* printed on a label inside the socket panel

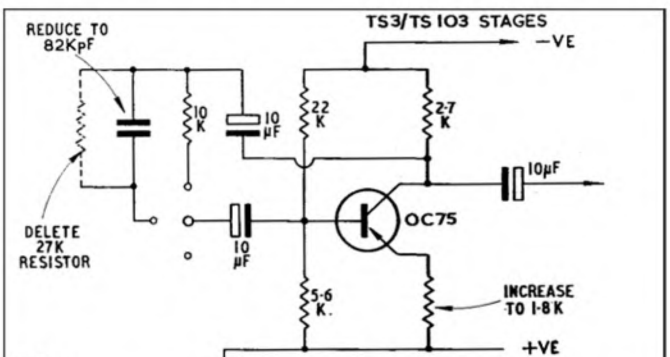


FIG. 3.

compartment. The basic machine is the *EL3534A/15*, and unless otherwise stated, this is the type to which we shall refer. Differences were in the rewind drive mechanism, which was altered after the WR00, the friction pad bracket which applies a slight braking action on the tape as it passes the left-hand tape guide, the speed change cam assembly, modified on later marks to allow some adjustment; the brakes, of which six different versions were used; the stop relay, about which more hereunder; the relay series switch which closes when the brakes are released, and which had to be altered to accommodate brake changes; and a modified speed selector assembly which allowed easier adjustment, on the WR05 version only.

Electrically, the differences were also to do with the STOP relay, changes to improve the signal-to-noise ratio, pilot lamp variations, improved transistors and component changes which are intended to prevent the possibility of burning out the output transistors by overloading.

First: the attempt by Messrs. Philips to make life a little easier for the serviceman has resulted in some rather disconcerting slips by those unfamiliar with the machines. In particular, the printed panel which is accessible after the main baseplate has been removed. This hinges out to enable us to get at the component side, and if care is not taken it can be damaged when swung back because the Record/Playback switches engage with actuating arms attached to the deck mechanism. Hence, if any alteration to the function switches is made while the panel is open, the arms will not line up with the switches on re-assembly, with results that can be disastrous, especially if a little force has been applied to screw the panel back in place. Incidentally, the two screws which must be removed to un-hinge the panel are those at the right-hand corners when the machine is stood vertically, base facing you.

To dismantle the complete chassis, first pull off the knobs, remove the washers and keep them safe, take off the control escutcheon, which is secured by two screws, and then the balance control knob, partly hidden by the escutcheon. The head cover will detach with a vertical pull. There are five screws holding the main cover and eight screws (that is, two in each corner) holding the chassis to the cabinet brackets. If the chassis is raised slightly at the rear, then the mains lead pulled through into a loop, removal is much easier.

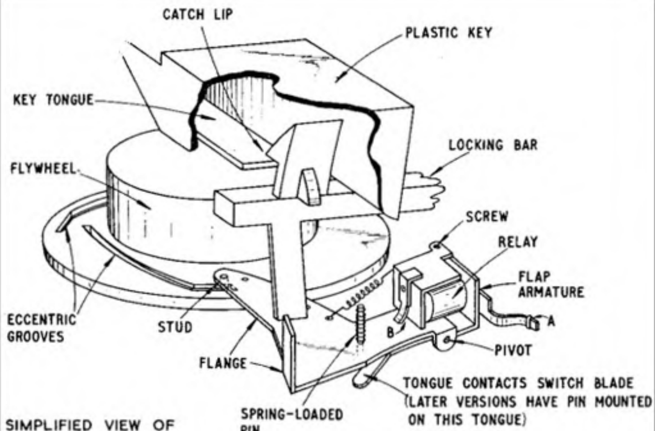
One stricture that must be made is that the output transistors should be kept clear of metal-work. Short-circuiting the heat-sinks of these to the chassis will inevitably result in damage to the metal rectifier used for HT. rectification. A second—that simply must be said—is that these articles are not an invitation to delve into unfamiliar machines. If you have no experience of electro-mechanical repairs, or if the machine is still within the guarantee period, do please make use of the expert service facilities of one of the hi-fi dealers. It is true that you have to pay for their attention—often more than you may consider the repair merits—but this is surely better than ruining a good machine and being faced with an even larger eventual invoice.

The particular feature of this machine that has aroused interest is the key-locking and stop mechanism. There are many devices used for interlocking where press-keys or push-buttons are employed instead of a simple switch. Most of them rely on a sprung plate, which flips into engagement when the key rod or arm moves. The EL3534A/15 is no exception, but the action is a little more involved.

Inside each key is a metal plate. When the key is depressed this plate forces a shaped piece away, and spring pressure allows it to return just sufficiently to lock the key. When the STOP key is depressed a similar action begins to take place, but as the tongue which is pushed by the plate does not have a lip, the key can return to its neutralised position. Thus, depressing STOP releases any other key.

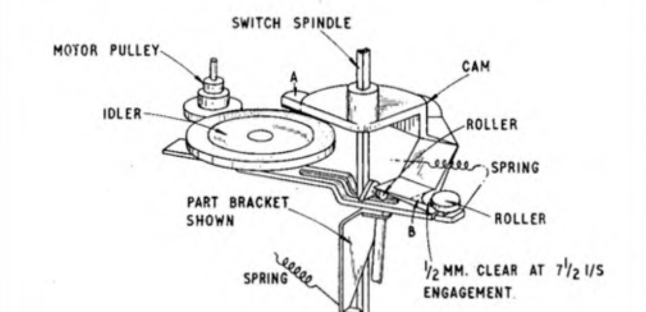
The autostop is a very interesting extension of this device, which does away with the need for heavy solenoids, and the noisy 'clunk' that characterises so many of these autostop designs. There are a couple of eccentric grooves on the upper side of the lower flange of the flywheel (see **fig. 1**). A relay is energised by the shorting of metal foil across the right-hand tape guide and a pin secured to the chassis via the insulating collar and bush, carrying a connection which completes the relay return circuit in the usual manner. The relay, however, is coupled via a 'flap' bracket and spring-loaded pin to a flange with a stud on the end. The stud sits in the eccentric grooves when the relay energises, rather as a stylus sits in the run-out groove in the end of a disc cutting. The flange bracket is thus steered inwards until a vertical tongue strikes the lower extension of the pivoted locking bar. And, 'presto', the stop action is applied with no more fuss than if you had put your finger on the button.

Unfortunately, there are quite delicate adjustments to the settings of the flange bracket, the flap or armature and the relay mounting itself, and, in later models, a different bracket assembly is used.



SIMPLIFIED VIEW OF AUTOSTOP ACTION

FIG. 1.



PART OF SPEED SELECTOR ASSEMBLY

FIG. 2.

NUMBER 43 PHILIPS EL3534A/15

Points to be watched are that the whole bracket assembly has not worked loose, giving erratic, and unwanted stop action, that the key locking is correct by the spring pressure returning the locking bar and that the front locking bar which is actuated by the FORWARD and REWIND keys does its job of locking the RECORD, PAUSE and PLAY keys in the 'up' position. It may be necessary to bend the hooked tongues which engage the angled front ends of the key metals to make sure of this.

To check the adjustments, first note that the stud on the end of the flange bracket is 1 mm. above the flywheel rim at rest. If not, reposition the whole relay assembly—do not bend the bracket. A screw will be found securing the relay hinge, allowing the whole assembly to be raised or lowered. The pivoting motion which puts the stud in the right vertical place to descend to its groove is adjusted by bending an angled tongue to the right of the relay itself. Another tongue, at the left of the relay, is bent to ensure a correct 3 to $3\frac{1}{2}$ mm. clearance between relay bracket and top edge of armature at rest. Later models use a slightly different arrangement, and the pin on the left end of the armature flap opens the contacts which are of a simpler shape. Then, a slot in the bracket allows insertion of a screwdriver for a twist adjustment to give a $\frac{1}{2}$mm. clearance of contacts at rest.

The modification to the pressure pad assembly need not concern us much : it simply consists of a slightly different angle-piece and spring mounting from the end of the pivoted bar attached to the locking plate previously discussed. As before, adjustment of both this pressure pad—engaging the left-hand guide—and the main head pad, can be achieved by alteration of the tension spring. When altering spring tension, the author finds it advisable to insert a broad-bladed screwdriver between adjacent turns and levering rather than stretching from the ends. But every man to his method !

The speed selector mechanism on this machine looks formidable at first (**fig. 2**). There are four steps on the motor pulley and a single idler which transmits the drive to the flywheel. This idler is moved sideways and vertically together by the switch cam. Two rollers are provided : one sits beneath the switch cam and the other in a scooped portion at the front lower end of the cam. As the switch is rotated, the idler is forced away from the motor pulley then allowed to slide back into correct alignment. There are intermediate 'off' positions between the switch speed positions and these are selected by a shaped plate beneath this roller assembly in conjunction with a microswitch. At the same time, this plate steers a rod to a correct switch position for frequency equalisation.

In later marks, some WR04 and all WR05, the cam assembly has been altered. The extensions marked *A* and *B* in my drawing are sawn off as indicated. This helps adjustment of the stop plate above the cam mechanism (two slotted screws) to obtain the correct positioning of the 'side action' roller. This little chap must be exactly half a millimetre from the cam when the idler is engaged in the $7\frac{1}{2}$ i/s position. Also, when the assembly is in the 'off' position, there should be a 0.2 to 0.8mm. clearance between the top of the microswitch plunger and the concave sections of the bottom plate of the cam assembly. A screw which secures this plate to the flatted portion of the spindle allows this vertical adjustment to be made.

If the guide wheel moves freely in its bracket, and the rollers are not fouled up and sticking, yet the wheel tends to engage two speed settings at once, or slips at the edge of the pulley step, make sure that the pulley is correctly set. There are two grub screws holding it to the shaft, and there is a lower screw to set the armature bearing for a 1.5mm. projection above the stator *when running*. This is most difficult to assess without experience, and no adjustment to this locknutted screw should be made unless one is absolutely certain that the trouble lies in the armature setting. Finally, if all these points are in order and the fault persists, take a horizontal look at the idler bearing bracket and if this is not quite level, resort to the old expedient, bend it ! But make sure you do not upset the free sliding of the idler in its slot.

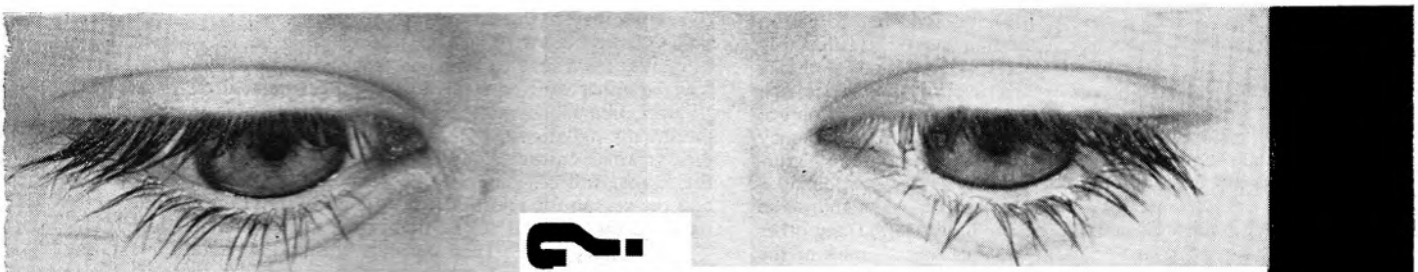
The rewind drive assembly differences are another modification to machines after the WR02 mark which need not bother us. Briefly, they consist of dispensing with a tensioning pulley which was a possible source of noise, anyway, the fitting of an alternative belt, and a slightly stronger spring to tension the pad which engages the right-hand clutch drive wheel to induce a little drag during rewind.

Brake changes were quite extensive, and there is just not sufficient space to go into them here. They are mainly concerned with the brackets which actuate the relay series switch. A word about the relay circuit may, however, be appropriate.

The action of the stop relay has been described previously. Its supply comes via a switch beneath the locking bar assembly also described and normally held closed until the PLAY, FORWARD WIND or REWIND keys are fully depressed. Then, the circuit is via the switch actuated by the brake levers, which is therefore open at rest. The relay contacts actually adjacent to the relay are across the foil circuit so that when the relay is activated they hold it on. Then the action of the flywheel releases the locked key which opens the main supply to the relay. The function of the brake-operated switch is to prevent functioning of the autostop circuit when the keys are fully depressed, and eliminate 'relay chatter'.

The pilot lamp modification is also worth a mention, if only to avoid fruitless searching by some unfortunate who has blown one of the early ones. Later marks used a 100mA (18V) in place of the 200mA version, and thus the replacement is simple—just short out the series resistor and fit a 100mA type which is more easily obtainable.

Two principal electrical changes can be made. First is to fit the better AC107 transistors in the preamplifier stages to replace the OC59 types. There are two in each preamp section, and matched pairs should be used wherever possible to preserve the advantage of the improved characteristics. (*continued on page 267*)



who reads which?

By GRAHAM BALMAIN

REFLECTIONS ON THE CONSUMERS' ASSOCIATION SURVEY OF RECORDING TAPE

READERS who saw last December's issue of *Which ?* may have been reminded of that notorious survey of tape recorders in January 1961, which was immediately dubbed "The Great Which-Hunt". Re-reading it, one wonders now what all the fuss was about, for there is a lot of sound commonsense in the text, and the tests seem to me to reflect very well the needs of average users of tape recorders. Apart from the objections common to any survey of this kind, I see only two particular to this one. Firstly, how were the sixteen test machines chosen from a possible 180-odd ? Secondly—and a huge clanger—*Which ?* named a best buy from a group whose prices ranged from £15 to £85, and their purposes just as widely.

Although the ground might have seemed much safer, that mistake has not been repeated in the 1964 survey of recording tape ("No tape could be ideal on all tape recorders . . . "). Otherwise the approach is much as before and the sense as common. And this survey does cover pretty well every brand name of any consequence on the British retail market.

Twenty-seven brands have been tested, all but two in the Long-Play versions only. Of other versions, *Which ?* observed merely : " . . . the sound quality of a brand could vary from one thickness to another." In fact, significant intentional differences in performance between the Standard Long and Double-Play versions of a brand are rare. (Triple and Quadruple-Play may vary, of course, because their coatings usually have to be thinner than the others !). Since LP tape is the biggest retail seller, and is usually also the best choice for novices on technical grounds, the approach seems fair.

SIMILAR TREATMENT

Many people have objected—as they did after the recorder survey—that there were too many overall results given and not enough of the data on which they were based. I cannot agree. Tabulation and analysis of detailed test results could easily have occupied all 28 pages of the issue instead of six. Who then would have read it and understood it fully, even among enthusiasts ? What would they have said about similar treatment of some other subjects in these two issues ? For instance : cider and perry ; a pram rocker ; a draught beer . . . (er . . . well . . .) ; an exposure meter ; or canned salmon ?

No, *Which ?* is aimed at consumers in general, not at enthusiasts or experts in any particular subject. And neither tape nor tape recorders are such special products that they must be assessed by everyone in just the way enthusiasts or experts, or even their manufacturers, think they ought to be.

Nor, of course, are they so commonplace or uniform that subtle differences between types cannot be recognised and appreciated. The alleged inadequacies of the *Which ?* survey do emphasise the need for other, more serious reviews of tapes, in the kind of detail which is both relevant to their audible performance and helpful to really discriminating users.

Four possible sources of such reviews come to mind. One is the strictly private survey undertaken by official or commercial organisations which want to use tape or to market it. Another is the survey made by a private society for its own members' benefit. This kind could reach other interested users, but seldom does for lack of organisation ; in any case, the resources available are rarely sufficient to guarantee unquestionable technical accuracy.

A third source is the tape magazines ; but they seem to have almost abandoned serious reviews of tape, unfortunately. Lastly, one might hope for an independent organisation, a specialised Consumers' Association to do the job. It could hardly make a living from reviewing tape alone—for audio use, anyway—but might do so if it also examined equipment, although the latter is already covered excellently by the tape and hi-fi magazines. It seems the only practical hope at the moment lies in prodding *them* into action again.

Whoever does it, the main snag is the high cost of equipping and running a reliable tape-testing laboratory. The basic equipment can hardly cost under £5,000 and it would be only too easy to spend twice that or more. Perhaps 20% of this would represent gear which could be used for other audio purposes, but much of the rest would be for apparatus built especially for testing tape, and otherwise therefore, a dead loss. Running costs include not only staffing (a difficult problem in view of the many odd kinds of specialist knowledge needed) but also buying enough samples sufficiently frequently to give a fair assessment of each brand and version.

This brings me to two of the main problems of any *Which ?*-type survey : How many samples of a product is one supposed to test before one can make a fair assessment ? And where is one supposed to get them from ?

The first can only be solved by getting on and doing it. Starting

(continued overleaf)

from scratch, one would expect to have to get five samples of each kind of tape under review to start with. About half of these sets of samples, with reasonable luck, should give a fairly definite indication of the quality of the kind of tape they represent: that is, a 90% probability that its average properties lie within the central third of the range covered by the samples, which is a reasonable risk in the circumstances. But there is a strong likelihood of having to get up to five more samples in some cases if the first five do not lie fairly symmetrically about their average. For subsequent periodical checks three more samples will usually suffice each time, or fewer if the tape appears to 'behave itself'—unless, of course, they do not confirm the initial assessment, in which case the quality of the tape may have changed and the whole process will have to be repeated. Naturally, all samples must be obtained individually and at random.

The tester's sources present other difficulties. Commonsense suggests ordinary retail purchases, to ensure he gets what any other customer gets. But random sampling demands that samples of the same kind bought at the same time should each be bought at different shops in different distribution areas, and that the same shop should generally not be used more than once in succession. This may need considerable organisation, not to mention knowledge of distribution arrangements which may not be readily available.

Then there is always the risk of getting an obsolete type, or stock which has deteriorated in storage—always possible in small, out-of-the-way or badly-managed shops. That the ordinary customer may also get such stock is not really a valid reason against avoiding it, for he has only to return it to the manufacturer or agent to get a replacement and to ensure the retailer's stock being checked and replaced. Wholesalers are more reliable from this point of view, although some makers do not distribute through them.

One can also ask manufacturers for samples, of course, but these should obviously be used to check one's results, not to establish them, because the procedure if always open to misinterpretation.

DIFFICULT TO CONTROL

All this discussion of tolerances and the necessity for random sampling might lead you to suppose that tapes vary more than their makers say. Well, some do and some don't. Tape is one of those products whose quality is rather difficult to control because it can be made neither by true mass-production nor in small batches—not to be economic, that is—but something in between which seems to have the virtues of neither and the disadvantages of both. It is really a continuous process which has to be interrupted at intervals when the rolls of base film come to an end. Thus one expects more variation from batch to batch than within batches, and this is borne out by most tape specifications: "Variations within reels $\pm \frac{1}{4}$ dB, reel-to-reel $\pm \frac{1}{2}$ dB", or words to that effect. The reels here are assumed to come from different batches; those from the same batch will usually show the smaller variations.

Many users do not realise there are two possible interpretations of the term "variations", at least as applied to tape. One is to treat it as if it means absolute limits which the performance will never exceed, which is the sense most people assume. The other and, in my view more practical, way is to regard it as what the statisticians call a *Standard Deviation*: that is, to expect that the performance of any given sample is twice as likely to be within the quoted figure as outside it.

Although this may seem a rather arbitrary quantity, the standard deviation is actually a very useful practical concept. It is perhaps easier to visualise its meaning in this way: if a large number of reels have a standard deviation of sensitivity (for instance) of $\frac{1}{2}$ dB, then about 68% of them will actually fall within the limits of $\pm \frac{1}{2}$ dB, about 94% within $\pm$ 1 dB, and over 99% within $\pm 1\frac{1}{2}$ dB. Less than 1% of the reels will be outside this and the chances of one being $\pm$ 3 dB, for example, is practically negligible. This is hardly likely to worry domestic users, although test-conscious professionals may object to it and insist on absolute limits.

In fact, such 'absolute' limits cannot be guaranteed absolutely without a very expensive 100% inspection being applied to the tape during the later stages of manufacture. What usually happens is that batches for professional use are selected from the bulk during the routine inspection process—rather as close-tolerance resistors are selected from the mass—and these may then undergo further and more searching tests. The standard deviation of such stock is then much smaller than that of the rest, and the chance of a reel having outside results, though still finite, is very small indeed.

The snag here is to determine which of the two interpretations is right in any particular case. I have never seen the term Standard Deviation used on any tape specification, although I am sure this is what must be meant in some cases. Just one more problem to worry the unfortunate tape-tester.

Yet another is the cheap tape (really cheap, I mean—say well under £1 per 1,200 ft.) which, as *Which?* observed, may show changes in quality from time to time and from batch to batch. Cheap tape may be either rejected stock from good manufacturers or a special product, like shoddy clothes for sale. The latter is the better buy, despite my unflattering comparison, since it is at least made in conditions which ensure some degree of uniformity in the tape, whereas the former will obviously change according to the source of supply and the reason for rejection. One thing is certain with either: the name on the box will not be that of the actual manufacturer.

This shocks you? Then consider the cost of a tape plant, say £¼ million upwards, and whether as many factories as there are brand names could possibly be supported by the existing markets. There are actually four genuine tape makers in Great Britain, another half-dozen in the USA; at an outside guess, 20 altogether in the world. About half of these are represented among the brands surveyed by *Which?*, and no prizes are offered for guessing who makes what.

Nor can I answer the question begged above: "How do I tell manufactured cheap tape from mere throw-outs?" I don't know, although it is fairly safe to assume that you have the latter if you can hear obvious differences between reels of what are sold as the same version of the same brand—apart from obvious faults, of course. And does it matter? You take that kind of risk if you pay that kind of price. Sometimes, as with pre-war *Woolworths* watches, you get a jolly good one.

I see I haven't really got very far towards answering the question of how to be a more technical kind of independent tape-tester, although I seem to have done my best to put off anyone who might be thinking of trying. The problems really are these:

Q. Who is the tester trying to inform?
A. Anyone who will pay enough to make it worth while starting.
Q. What do they want to know?
A. Anything which *appreciably* affects the quality of reproduction in their particular applications.
Q. How can he test economically and yet produce enough accurate data to satisfy them?
A. Concentrate on a hard core of essential 'indicator' tests which can be expanded or suggest others if they give interesting results.
Q. What are those tests, and what minimum equipment does he need for them and other likely ones?
A. . . . ?

I hope shortly to devote another article to examining these questions in some detail—especially the unanswered one—from the point of view of a manufacturer. Tape-makers are in perhaps the best position to know what worries and pleases tape-users most about their own tapes and other peoples'!; regrettably, their experience is never likely to become available to help those users. They also probably know best what tests are most useful in bringing out the best and the worst in a tape, and here the quickest way is not always the obvious way described in the textbooks; nor can performance under one set of conditions always be predicted from that under another set, even though the conditions differ only in degree. To give two very simple examples, good or bad HF, performance at $7\frac{1}{2}$ is does not necessarily mean correspondingly good or bad HF performance at $1\frac{7}{8}$ is, and overloading behaviour at mid-frequencies gives no guide to overloading behaviour at HF.

Anyone who sets up in this testing business without British Standards to give detailed guidance will inevitably put his personal feelings and experience into his testing, both in what he looks for and how he does it. Monopolies in testing are not, therefore, a good thing. If there should eventually be a choice of surveys, they will undoubtedly emphasise very sharply the present need for the BSI to tie down tape-testing as basically as possible. Until then, a most important question for all concerned will be: who reads which?

NEW PRODUCTS NEW PRODUCTS NEW PRODUCTS

THREE NEW FERGUSONS

TWO ¼-track recorders, models *3208* and *3212* selling at £34 13s. and a ½-track *3210*, price £25 4s., have just been announced by *Ferguson*. The 3208 and 3212 are identical, save for external appearance, the former being supplied in a portable cabinet with handle and the 3212 plinth-mounted to blend with existing audio equipment. Main feature of the *Thorn Mk II* deck used on these two machines is that of remote control through solenoid switching. Light press-tabs govern mechanical functions, including fast wind, rewind and pause. Superimposition, speeds of 3¾ and 1⅞ i/s, magic-eye modulation indicator and tone control are included, together with fully automatic stop. Output power through forward-facing 7 x 3½in. speaker is 3W. Various accessories are available for cross-track recording, slide synchronisation multiplay and stereo playback.

The single speed (3¾ i/s) ½-track 3210 is styled after the 3208 and does not include remote control facilities. Weight is 18 lb. (1 lb. lighter than the ¼-track models) and dimensions are 14 x 12½ x 6¾in.
Manufacturer: Ferguson Radio Corporation Ltd., Thorn House, Upper St. Martins Lane, London, W.C.2.

ADASTRETTE 3W AMPLIFIER

IDEAL for use with ¼-track tape recorders, connected via an equalised preamplifier, the *Adastrette* amplifier provides inexpensive facilities for reproducing pre-recorded stereo tapes. The 3W unit incorporates tone and volume controls mounted on a floating panel and has many applications in the amateur recording field. Output power is 2.5W for 250mV input, 3W peak. The amplifier is operated from AC mains and incorporates an EZ80 rectifier and ECL82 on printed circuit board. Price of the Adastrette is £3 17s. 6d., and its 10 x 6 x 6¼in. cabinet is £1 15s.
Manufacturer: Adastra Electronics Ltd., 167 Finchley Road, N.W.3.

HOROCONTROL ELAPSED TIME INDICATOR

FOUR new elapsed-time-indicators have been announced by *Industrial Instruments*. Each *Horocontrol* is designed to work from 50 c/s mains supplies. Suitably connected to a tape recorder or audio equipment, they will show the precise number of hours the apparatus has been used. The four models comprise the *H1*, reading up to 9,999.9 hours (in tenths) and price £2 19s. 6d. Model *H2* costs £5 16s. and registers up to 999.99 hours (in hundredths). While the latter two are designed for wall-mounting, Models *HE1* and *HE2* are intended for location on control panels. They read 9,999.9 and 999.99 hours respectively and cost £5 4s. 9d. and £6 7s.
Manufacturer: Industrial Instruments Ltd., Stanley Road, Bromley, Kent.

AMERICAN TAPES AND THREE-INCH SPOOLS

SOLE agency for a wide range of American tape records has been secured by *Recotape*. Over 2,500 different tapes under twenty-five labels are now available in 4-track stereo and many also in 2-track stereo and mono versions.

Many of the current range of Recotape recordings are being made available on 3in. spools for the benefit of owners of small machines. Improved quality is also claimed, as a result of a new duplication arrangement. Full details of these and the American brands are obtainable from: **Recotape Recordings Ltd., 10 Wells Avenue, Southend-on-Sea, Essex.**

TAPE RECORDER SERVICE CONTINUED

Next, a small alteration that can be made to better the signal-to-noise ratio. The emitter resistor of the first OC75 (**fig. 3**), following the preamplifiers, is increased to 1.8K from its previous 1K value (which should always be done if the AC107 pairs have been fitted). Then the feedback loop over this stage is altered by removing the resistor from the parallel pair (the 27K component in parallel with a .22μF) and decreasing the capacitor to .082μF. This feedback loop provides overall bass boost common to the four speeds, and is not switched. A 2dB improvement in the signal-to-noise ratio is claimed for this modification.

Certainly, this writer is not disposed to argue. Fed into a couple of high-quality speakers, the results from this machine (and I have handled several, in various stages of usage), are comparable with those from some much more ambitiously specified. This is a tape recorder I should like to own. Pity we don't all have a rich Aunt.

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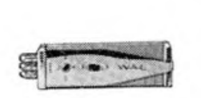

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GRUNDIG TK23A AUTOMATIC

MANUFACTURER'S SPECIFICATION: Quarter-track automatic-manual tape recorder. **Spool capacity:** 5¾in. **Tape speed:** 3¾ i/s. **Valve line-up:** EF86, EF83, ECC81, ECL86, EM84 and three metal rectifiers. **Wow and flutter:** +0.2%. **Frequency response:** 60 c/s 12 Kc/s +3-5dB. **Input sensitivity:** Microphone—2.2 to 45mV, Diode—2.2 to 45mV, Gram—100mV to 2V. **High impedance output:** 700mV. **Speaker output:** 4W, **Earphone:** 12V. **Signal-to-noise ratio:** 45dB. **Loudspeaker:** 5¾in. x 4¾in. elliptical. **Weight:** 20lb. **Dimensions:** 13¼in. x 10¼in. x 6¾in. **Price:** £47 5s. 0d. **Manufacturer:** Grundig (Gt. Britain) Ltd., Newlands Park, Sydenham, London, S.E.26.

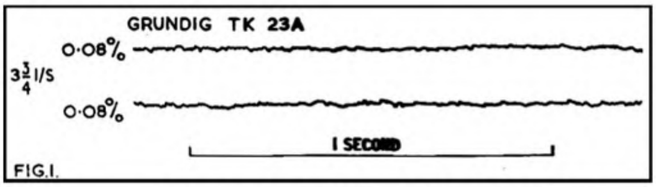

FIG.1.

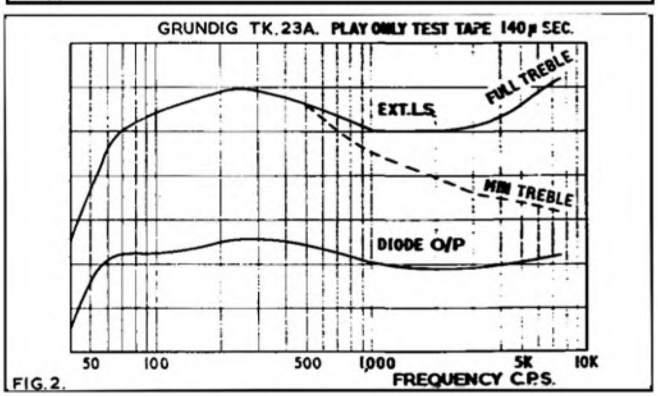

FIG.2.

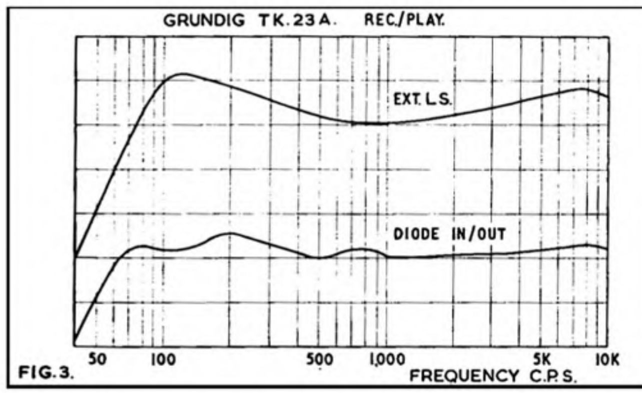

FIG.3.

IN August 1963 I reviewed the *Grundig TK18* Automatic recorder and fell into the trap of underestimating the time constant of the AGC circuits. H. W. Hellyer dealt with this circuit in some detail in No. 36 of his excellent Tape Recorder Service articles in the December 1964 issue. The *TK23A* is fitted with a magic eye record level indicator and a switch to change to manual operation if desired. This makes observation of the action of the automatic control circuits easier, and I shall give some facts and figures later in this review.

Let us first run through the standard tests to which any recorder submitted for review is subjected.

The tape speed was first measured and found to be exactly 3¾ i/s within the limits of my test equipment. Wow and flutter were exceedingly low at a steady 0.08% rms, and the fluttergram or pen trace of the short term speed deviations is shown in **fig. 1.** They are well within the specification limits of 0.2% peak, or 0.4% peak to peak.

PLAY ONLY RESPONSES

Next a standard test tape, with a surface induction characteristic corresponding to a 140µ S time constant, was played and the signal measured at the speaker socket and the diode output. These responses are shown in the upper and lower curves of **fig. 2.** The dotted response was obtained with the tone control at maximum top cut. It will be seen that the playback characteristic closely conforms to the now common DIN and CCIR 140µ S time constant. Identical responses were obtained on the top and bottom tracks.

The azimuth setting for the two tracks also corresponded exactly with that of my test tape, and a vertical alignment test showed that the placement of the tracks was correct to within a few thousandths of an inch. Such accuracy is the result of meticulous alignment procedure during manufacture and is so common on Continental recorders that I seldom mention it, but it was not so common a few years ago even on expensive equipment, and our own manufacturers could well devote a little more time to this phase of the testing procedure.

System noise, with no tape running, was 35dB below test tape level.

The record-play tests were performed on the manual setting of the record switch so that the automatic gain control did not affect the results. Test tones were applied to the radio input and measured on replay at the Ext. L.S. terminals and diode or radio outlet socket. The resultant responses are shown by the upper and lower curves of **fig. 3.** They match the play-only responses very closely, proving that the recording characteristic is also to the desired 140µ S response.

500 c/s overload tests showed that the record level indicator beams just closed at a level 11dB above test tape level, and that this also coincided with just visible waveform distortion on the recorded signal. Erasing this tone on the machine gave a noise level within 1dB of system noise, making the signal noise ratio 46dB.

Bands of filtered white noise were recorded and the sound output measured on the speaker axis to give the response shown in **fig. 4.** This is free of speaker or cabinet resonances with the response only 6dB down at 125 c/s. This is excellent for such a small cabinet. The slight rise from 5 to 8 Kc/s, on the speaker axis, falls at 10° to 20° off axis, so that the high note response is well maintained without critical placement of the recorder or listener.

The GDM311 moving coil microphone response is shown in **fig. 5.** The slight peak at 3 Kc/s gives 'presence' to voice reproduction and the fall in bass response will not be noticed if recordings are played on the internal speaker of the recorder, as it also falls below 200 c/s.

AUTOMATIC OPERATION

With the gain control fully advanced, peak recording level (indicator beams just touching) was obtained with an input signal to the diode socket of 0.1V rms when the control was on 'manual'. Switching to 'automatic' dropped the recording level by 2dB. The maximum specified input signal of 2V caused violent overload on 'manual', but on 'auto' the overload only persisted for about five seconds while the AGC circuit generated enough bias to reduce the gain so that the beams were again just touching and the recorded signal was undistorted. For 1V input signal, the AGC operating time was 3 seconds; for 0.5V, 2 seconds; for 0.25V, 1 second, and for 0.1V the AGC did not have to operate. Between each test the machine was switched to 'PLAY' to discharge the AGC bias capacitor. The maximum gain

(*continued on page 271*)

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