JULY 1967 TWO SHILLINGS

tape recorder

A VISIT TO KUDELSKI - THE CARE AND REPAIR OF PLASTIC CABINETS
REPORT ON THE APRIL QUESTIONAIRE - A CONSOLE FOR THE FERROGRAPH

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tape recorder

JULY 1967 VOLUME 9 NUMBER 7

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COVER PICTURE

While the *Nagra* needs no introduction, the five-channel microphone mixer on which it stands is perhaps less well known. Produced by *Feldon Recording* for *Carston Electronics*, the unit features separate tone, presence, input- and output-level controls on each channel, with an additional line input. The Carston-Feldon mixer will operate from internal batteries, the Nagra battery pack, or from the mains.

SUBSCRIPTION RATES

Annual subscription rates to *Tape Recorder* and its associated journal *HI-Fi News* are 30s. and 38s. respectively. Overseas subscriptions are 32s. 6d. (U.S.A. $4.50) for *Tape Recorder* and 38s. (U.S.A. $5.40) for *Hi-Fi News*, from Link House Publications Ltd., Dingwall Avenue, Croydon, CR9 2TA.
Tape Recorder is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.

GEORGE BERNARD SHAW caused one of the characters in his *St. Joan* to think of himself as an Englishman, a curiously eccentric idea in an age when most men were still the loyal servants of this or that baron, duke or princeling, and when the nation states of Europe were only just being forged into unities out of feudal chaos.

No doubt some future playwright will present the startling idea that as recently as the mid-20th century the individual boroughs within the county of Europe were struggling along trying to run themselves as entirely separate communities, with many citizens actually believing that allegiance to the immediate locality was more important than the evolution of wider unities. And this despite the fact that technology and industry, upon which the economic and social fabric was erected, daily became more international.

It took the 'hundred years war' for the people of France and England to establish their self-conscious identities, and a further thirty years of dynastic dispute over the monarchy before we had something like a unitary state in England. Let us hope that in a rather shorter span of time Britain's application to join EEC will lead us to regard *Land of Hope and Glory* with the same amused tolerance as *Devon, Glorious Devon.*

There is the language problem, of course, despite Watt, Gauss, Maxwell and Hertz; but modern communications, an increasingly international culture at the popular level, more continental travel, massive industrial organisations cutting across frontiers, the practice for many years of audiences bolting out of cinemas to avoid the embarrassing and stuffy irrelevance of the National Anthem—all these and many other factors suggest that we are, as a people, more nearly ready to abandon our national self-righteous isolation than some politicians (of both left- and right-hand channels) and national newspapers would have us believe.

What on earth has this to do with *Tape Recorder?* Not much, we must admit, apart from the fact that the audio industry is itself very international and that we feel it appropriate—having very strong convictions on the subject—to join in the general journalistic clamour now that Britain is having another go at swimming with the tide of history.

We shall probably be doing some swimming ourselves before long in response to currents revealed by our recent readership survey. For reasons explained on page 277 we are reporting on this in two stages, this issue carrying an analysis of opinion on editorial features and details of tape recorder ownership, to be followed in due course by a look at readers' attitudes to our hobby, equipment owned, etc. Regarding editorial balance, we are gratified to find that only one or two regular features are noticeably unloved.

The distribution of recorder ownership is intriguing, for it both reflects a known U.K. sales pattern favouring *Philips* and *Grundig* (with 20% and 8% respectively) yet places the three leading British 'semi-professional' firms next on the list before descending below the 5% level. Vis-a-vis the Common Market and all that, is there a moral here? Our provisional interpretation is that the small British firm which takes another manufacturer's deck and puts it into a box with some electronics does not inspire trust, many readers preferring —for domestic use—fully thought-out integrated machines from Holland and Germany. However, the reader wanting hi-fi quality still tends to buy British, with *Ferrograph*, *Truvox* and *Brenell* making, between them, nearly 20% of all the recorders owned by those who answered our questionnaire ($7\frac{1}{3}$, $6\frac{1}{2}$ and $5\frac{3}{8}$% respectively). When we enter the Common Market, import duty will be removed from tape recorders made in EEC countries, boosting still further the competitive advantage of continental machines and probably trimming from the lists a good few of the less impressive British domestic 'manufacturers'.

On the showing of our survey, the small firms most likely to survive are those who both specialise in high quality machines *and* make their own decks, thus carrying into our European future that amalgam of technology and enthusiasm which, though peculiarly British, may have value in a less insular age.

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Falla: Three-cornered Hat (complete ballet).
Villa Lobos: The Little Train of the Caipira.
Eugene Goosens, Barbara Howitt (Soprano) with the LSO/Jorda.
Played with verve and audacity, Jorda inspires Falla's evocative score with authentic fire. "Jorda feels the music from the inside". (Audio Record Review). "Stereo startlingly real". **TP 164** Tapes, mono only; Discs, mono and stereo.

Choose any one of these WRC recordings and keep it for the very special price of 9/11. When you receive your choice give it the attention its quality demands —compare it with any other record in your collection and you will find that for sheer quality it is unsurpassed by *any* other recording selling at any price. *Anywhere!*

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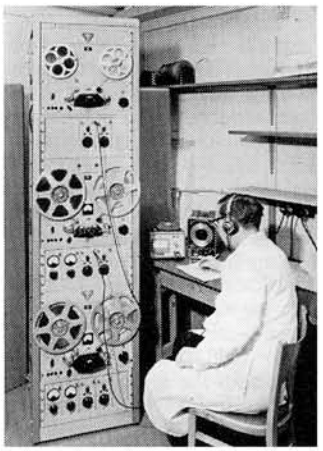
WORLD OF TAPE

VOICE OF 'DOWN UNDER'

TWO hundred and forty lounge chairs await the visitor to the Australian Pavilion at *Expo 67* in Montreal. Connected to each is one of a bank of tape machines positioned in the base of the chairs. These are automatically switched on when a chair is occupied and relay a four-minute talk on aspects of Australian life. Green furnishings cater for French-speaking visitors while orange chairs are for the English-speaking.

'Speaking chairs' were first suggested by Australian architect Robin Boyd, who designed the pavilion, and were developed by the *Civil Aviation Airways Engineering Laboratory* in Melbourne. Thirty million visitors are expected to pass through the Australian pavilion during the course of the exhibition.



LEEVERS-RICH FOR SWEDEN

FIRST export order to be received by *Leevers-Rich* for their new professional high-speed tape duplicating system has arrived from the Linguistics Department at the University of Stockholm. The system comprises a master player and two slave record mechanisms mounted on a vertical frame. The three transports may be operated from a single set of controls or employed individually when required. Speed-to-speed copying at single, double, quadruple and reduced speeds is possible with reels of up to 11½in. diameter. Plug-in twin-track and single-track head blocks are provided. The system permits up to two dozen 600ft. copies to be produced per hour and has already been supplied to Universities in Britain.

BBC LAUNCH SECOND COMPETITION

'ON the Move' is the theme of the second amateur tape recording competition to be organised by BBC North Region. The contest is open to all residents of Great Britain not engaged in sound recording as a profession and carries a first prize of £50 and £25 second-prize. Entries, which must reach the BBC not later than 30th September, 1967, may be up to five minutes in length and recorded on full- or ½-track equipment at 3¾ i/s or more. Where ½-track recorders are used, the unused track must be clean. Competitors are asked to record their name and address, the title and duration of the recording, at the beginning of each tape. Up to three separate entries may be submitted by any one individual or group of individuals. Further details are obtainable from **Broadcasting House (BBC Tape Recording Competition), Piccadilly, Manchester 1.**

FERROGRAPH ACCESSORIES

RESLO and *Grampian* microphones available for *Ferrograph* machines are now being supplied complete with *TA30/GL* matching unit and desk stand. The Reslo *RBL/TM* Ribbon is offered in 30-ohm form with 18ft. screened lead and plug at £17 3s., while the 25-ohm Grampian *DP4L/M* Moving-Coil costs £13 12s. complete. Matching units are available separately at £3 10s. from **Ferrograph Company Ltd., 84 Blackfriars Road, London, S.E.1.**

B & O MAKE A MOVE

BANG and Olufsen U.K. Sales Division of *Debenhams Electrical and Radio Distribution Ltd.* recently moved from Mercia Road to premises in Eastbrook Road, Gloucester. Their new telephone number is Gloucester 21591.

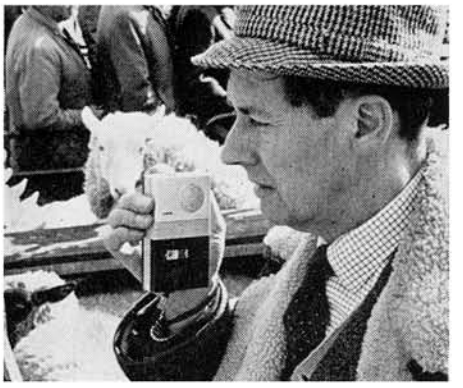
THE REAL ALBERT

SOME confusion in interpreting the substantial number of photographs submitted for *An Amateur Stereo Spectacular* in the June issue has resulted in two changes of identity. To avoid possible future embarrassment for the gentlemen in question we would like to point out that the author, Albert Pengelly, was not in fact shown in the illustration on page 208. To the right of Donald Aldous were John Penty (standing) and Peter Cox (sitting at the mixer).

AMPEX BATTERY VTR

A PRICE tag of £23,000 will be attached to the latest *Ampex* video system when it is introduced to the British market in 1968. The *VR3000* battery portable video tape recorder is designed to speed up television news reporting and may be strapped to the back of the operator while a Plumbicon camera is mounted from his shoulder. The complete system, which weighs under 50lb., made its European debut at the recent Montreux Fifth International Television Exhibition.

No price has yet been announced for the *Sony* battery video recorder, news of which came recently from Japan. This machine weighs 9lb. and operates at 7½ i/s for up to 30 minutes on a 5in. reel of ¼in. tape. A machine of similar specification, employing 1in. tape, has been developed by the American *Westel Company* to sell at £3,500.



PHILIPS MINIATURE DICTATION MACHINE

THERE has long been a demand for a low-price dictation recorder, the emphasis of which was on miniaturisation rather than quality. *Philips* are now catering for this with a cassette recorder measuring just 4¾ x 2½ x 1¼in. and retailing at 25 gns. Only a little larger and just twice the thickness of the cassette employed in the Philips *EL3302* battery portable, the new *85 Pocket Memo* incorporates a combined microphone/loudspeaker unit and has automatic gain control.

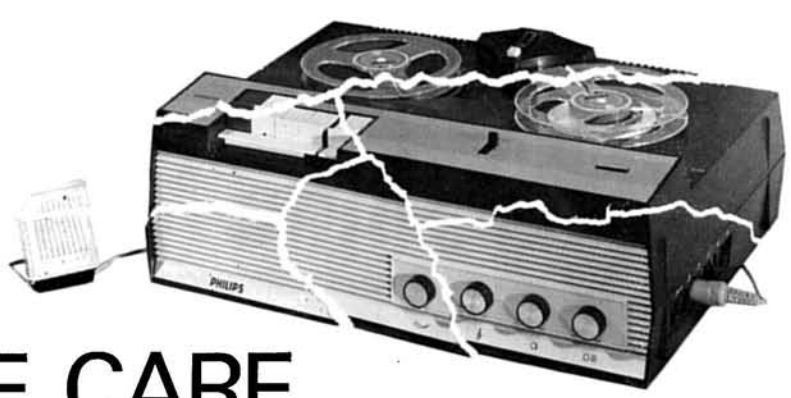
The cassette itself is of similar shape to the earlier design but measures only 2¼ x 1¼ x ⅝in. This houses 0.15in. tape and permits a total recording time of 20 minutes on two tracks. Rewind takes a little over two minutes. Spare cassettes are 17s. 6d.

Philips emphasise that this is no machine for the outdoor recording enthusiast, for which reason it is included in the general news column rather than *New Products*. The cassette is rim-driven at a speed varying between 1⅞ and 2¾ i/s. Permanent-magnet erase and AC recording bias are employed, the combined operation of rewind and record buttons permitting bulk tape erasure. A socket is provided for recording from and feeding certain external equipment. Claimed output power is 100mW with a 300Hz to 4kHz frequency range.

Sensitivity is adequate for close speech, within a few inches of the mouth, but the recorder is not designed for sound pick-up over a greater distance. The cardioid microphone/loudspeaker permits intelligible recordings to be made in noisy surroundings. Current consumption is in the region of 35mA, giving a claimed 10 hours intermittent operation from a single *PP3*-type battery. The recorder weighs 12oz. and is finished in grey and black plastic and chrome. It is being sold through office equipment retailers and will not be available from audio dealers.

NEXT MONTH

A COMPREHENSIVE SURVEY of tape recording accessories will be featured in the August issue, to be published on 15th July. The *Sony TC800* mains/battery recorder will be reviewed and field-tested. W. H. Myall will offer *A Closer Look at Wow and Flutter*. It is also hoped to complete, in this issue, our breakdown of the April Questionnaire.



THE CARE AND REPAIR OF PLASTIC CABINETS

BY V. D. CAPEL

OVER the last few years we have seen increasing use of plastic materials for the cabinets of tape recorders. The ease of moulding has been one of the main factors influencing manufacturers to adopt them, this leading to lower manufacturing costs and lower prices for the user.

There are many different types of plastic used for this purpose, some of which are very flexible and hence are claimed to be 'unbreakable'. Most, however, do not possess this characteristic and as a result are susceptible to various forms of damage. Many of the more elaborate mouldings can be quite expensive and by the time they are obtained from the manufacturer or importer—and fitted by the dealer—considerable delays can be incurred. Whilst of course it is not always possible to repair some of the more severely damaged cabinets, many can be made good by the methods to be described.

The most common form of damage to a plastic cabinet is that of a crack or a break. The best method of dealing with these is by welding the parts together using a solvent. Most of the plastics used can be dissolved with trichloro-ethylene and other fluids used by radio dealers for cleaning switch contacts. These soften the plastic and partially dissolve it, but it regains its hardness when the fluid has evaporated. In order to repair a break, the edges of the plastic cabinet must be moistened with the fluid. This must be done very carefully and will make all the difference to the appearance of the finished job. It has been found in practice that the best way to do this is to apply the fluid sparingly with a camel-hair brush such as used in children's painting outfits.

OUTSIDE AWAY

Having removed the cabinet from the recorder, it should be held with the outside, that is the part that shows, away from you and the interior towards you. This will make it easier to vary correctly the amount of fluid applied across the width of the surface to be treated. Hardly any should be applied to the edge nearest the side that shows, otherwise when the two sections are pressed together, excess fluid will be expelled to form a raised ridge along the length of the outside of the join. If the case is held as described, this outside edge will be the furthest away and hence will be treated only with the tip of the brush. Really it is better to leave the plastic dry for a slight distance in from the outside edge rather than use too much, as the fluid will in any case tend to spread out to it from the rest of the area. Rather more can be applied to the edge nearest you, which will be the inside surface of the cabinet—this will not be on view and a raised ridge here will help to strengthen the join.

TREATED SPARINGLY

Both sections to be joined should be treated sparingly with the fluid and left for a few minutes until the edges are tacky rather than wet. These solvents evaporate very quickly so only a minute or two at the most should be allowed to elapse before the edges are brought together. Do not touch either of the edges while they are wet as the contours will be altered and a perfectly fitting joint will not then be produced. This is one reason why a soft brush is best for applying the fluid, as it will not, on contact, deform the plastic to any noticeable extent.

Finally, the two surfaces can be brought together. Once more, extreme care must be taken if a first class job is to result. Try to bring them together in the right place first time with the minimum of sliding or relative movement because this too will mar the contours. Once together, a gentle pressure can be applied to make sure that contact is made all along the join. Do not use excessive pressure as if using glue, or the softened edges will deform. The joint will weld quite quickly but it is as well to let it harden off for a while before refitting the cabinet to the recorder.

Sometimes a cabinet will suffer from a crack starting from the edge of the material. In such a case access to the surfaces to be joined cannot easily be obtained by using a brush. It is not wise to try to force the crack apart in order to apply the solvent, as this may extend it further. The best thing here is to dip a piece of thin porous paper in the fluid, hold the crack just sufficiently apart in order to insert the paper in it and thus dampen the two surfaces. A strip of newspaper is ideal for this purpose. As with the complete break, the fluid should be applied from the inside of the cabinet so that any excess will stay on this side and hence will not show. Slight pressure to bring the edges of the crack together can be applied as before.

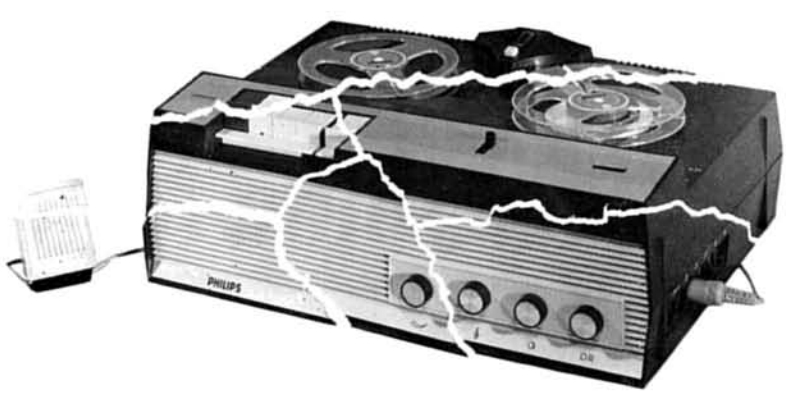
If either the break or crack is in a position where it is likely to be subject to some stress, then it can be reinforced on the inside. This can be done once the joint is completed by running some fluid along on the inside surface of the crack with the brush and then using a screwdriver blade to knead the two surfaces together. This will, of course, disfigure the surface but as it is on the inside it will not matter.

Welding by using a solvent is more effective than using a glue for these reasons : Being of the same material, it should possess the same strength—if successfully done—as the original. Also, there will not be a layer of glue between the two sections so the join should be less noticeable than if glue were used, because the two sections should make a perfect fit. Furthermore, many glues are coloured and these can disfigure any edge joints that may be made with them.

ANOTHER FORM

Another form of damage that is often sustained is where self-tapping screws are driven into the moulding and the thread in the moulding has been stripped. Using a larger screw, as is sometimes done, is no real remedy unless the hole is drilled to the proper size to take it, as forcing it in will only crack the plastic. The best way out of this difficulty is to plug the hole. This can be done with a piece of PVC sleeving. Some sleevings are much softer than others, and a fairly hard piece is best.

Select a piece which slides easily into the hole. A piece of sleeving a little less in diameter than the hole is preferable to one that is too large. Trim it so that it is of the right length and then slit it along its length. This will



THE CARE AND REPAIR OF PLASTIC CABINETS

BY V. D. CAPEL

allow the sleeving to open out and fit flat against the walls of the hole when the screw is inserted. It will also be easier to start the screw, and the sleeving will not be pushed down to the bottom of the hole as the screw is driven home. Actually, slitting the sleeving is the secret of making a successful plug using this material.

Next, the sleeve must be inserted in the hole. If it is opened out flat first, it will be found to spring back against the inside of the hole and not drop out before the screw is fitted. The screw can then be screwed up at least as tight as the original.

It may not be too easy to obtain the sleeving required. This sort of sleeving is frequently used by radio dealers in their repair workshops, though more usually the smaller sizes for sleeving individual wires are used. There are, however, quite a range of diameters manufactured and many dealers' service departments keep most sizes. It is just a question, then, of trying around the various shops in your locality. If difficulty is still encountered it may be possible to improvise by using the plastic outer covering from some of the smaller diameter flexible cables.

Plastic cabinets are rather prone to scratches. They do have one advantage though, namely, that scratches are more easily dealt with than those on a wooden surface. As the colour of the plastic is the same all the way through, removing scratches is simply a matter of polishing them out. A flatting paste or valve grinding paste can be used to get the worst out, and then the final polishing and minor scratch removing can be done with *Brasso* or a similar metal polish. The whole operation can be carried out with metal polish, but it will take a lot longer.

If really deep scratches are to be polished out, they will produce a depression in the surface of the plastic cabinet. This may not be noticeable on a curved surface but could be detected on a flat one. The effect can be minimised by extending the polishing to well beyond the scratched area and then tapering off.

Polishing out scratches, especially if they are deep, can be rather laborious—time and 'elbow grease' will be needed in plenty. It is, however, surprising what can be done with this method. The writer had to try and make good some mouldings from an expensive tape recorder which had been splashed with switch cleaner. The resulting rough indented surface seemed impossible to restore, but polishing out was tried and the result far exceeded expectations: it was not possible to tell where the damaged area had been.

PRONE TO DIRT

Most plastic cabinets seem to be very prone to collecting dirt, especially if the surface is dimple or crackle finished. One effective way of dealing with this is to remove the cabinet completely and to scrub it with a nail brush with plenty of water and detergent. The cabinet of course should be quite dry before the instrument is refitted. If dismantling the recorder in this way involves too much trouble, then dirt can also be cleaned by using a little methylated spirits on a clean rag. A small area should be cleaned at a time and the rag should be kept turned so that a clean surface is constantly applied to the work. This tends to leave dull smears on the surface, but these can be easily removed by polishing with a clean dry cloth, provided this is done immediately afterwards.

LOST LETTERS

One thing to watch for is lettering or other forms of indication that have been printed on to the plastic. These will often be completely removed by the application of any form of spirit. When using methylated spirit for cleaning, be careful to clean around any such markings. Afterwards these areas can be cleaned with a damp cloth.

Another cleaning problem may be presented by the milled edges of the control knobs. These collect dirt very rapidly which is subsequently difficult to remove. In order to clean them they should be removed either by pulling them off if they are of the push-on type, or by slackening the grub screw if they are secured in this way. Then they can be scrubbed with a nail brush in soapy water and rinsed off under the tap. They should be scrubbed toward the open end of the grooves so that the dirt will be carried out.

Most of the plastics used for the cabinets of tape recorders are good insulators of electricity. This means that over a period an electrostatic charge may build up on the surface of the casing. In turn this results in the attraction of fine particles of dirt and grime that may be in the atmosphere. So it is that a plastic cabinet tends not to stay clean for very long. Readers who are also gramophone enthusiasts will recognise a similar effect with modern micro-groove records. These often present cleaning problems which can only be resolved by using special anti-static cleaners made for the purpose. These make the surface of the record very slightly conductive and so any static charge that may be developed leaks away before it can accumulate to an appreciable level.

CLEAN AND PRESENTABLE

This gives us a clue as to what can be done to keep the plastic cabinet of a tape recorder clean and presentable. After cleaning off as we have described, give the surface a treatment with one of these disc cleaning preparations. This may be in the form of a liquid which must be applied on a cloth or it may be sold as a cloth already impregnated with the anti-static agent. These cloths offer perhaps the most convenient way of introducing anti-static properties, and the cabinet can be given a periodic rub over with one when it is felt to be necessary.

Whether one of these cloths or an ordinary duster is used to clean and polish the cabinet, care should be taken to see that it is free from grit or other particles of foreign matter. Otherwise these could be rubbed into the cabinet, scratching it or even producing deep scores.

Whilst the major consideration of a tape recorder user will be for the mechanical and electrical components, some time and attention spent on the cabinet will maintain the instrument in its original smart appearance

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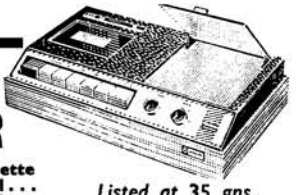

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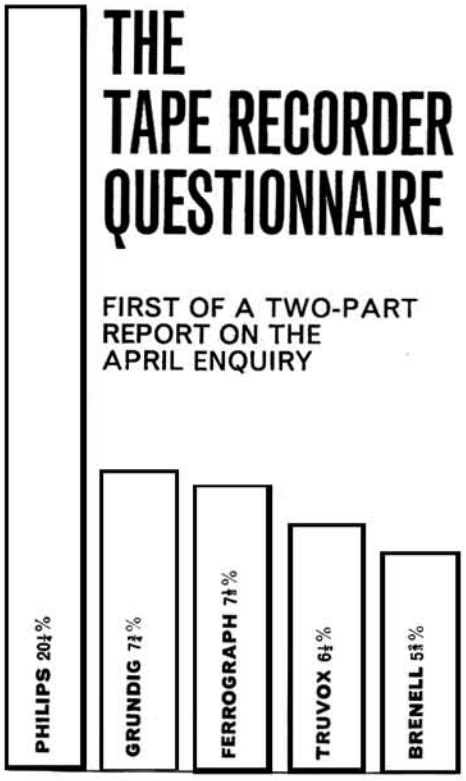
THE TAPE RECORDER QUESTIONNAIRE

FIRST OF A TWO-PART REPORT ON THE APRIL ENQUIRY



PERCENTAGE BREAKDOWN OF RECORDERS BETWEEN 5% AND 1%

Magnavox	4½	Sony	2½
Revox	4	Uher	2½
Fi-Cord	3½	Fidelity	1½
Tandberg	3½	Akai	1½
Thorn	3½	Vortexion	1½
Elizabethan	3½	Robuk	1½
B & O	3	Sound	1½
Telefunken	3	Wyndsor	1½
		Reps	1

NUMBER OF RECORDERS BELOW 1%

(actual numbers of models)

EMI	18	Planet	5
Simon	13	Bradmatic	4
BSR	12	Baird	4
Ampex	11	Stuzzi	4
Reflectograph	11	Saba	4
Walter	10	Gramdeck	4
Butoba	9	MSS	4
Standard	9	KB	3
Alba	8	Körting	3
Dansette	8	Motek	3
Q-Cord	8	RGD	3
Garrard	6	Siemens	3
National	6	Eltra	2
Optacord	6	Leevers-Rich	2
Sanyo	6	Nagra	2

PERCENTAGE POPULARITY OF COLUMNS AND FEATURES

	MORE	RETAIN	LESS
Readers' Problems	47	47	6
Equipment Reviews	47	50	3
Constructional Articles	47	41	12
Tape Decks Analysed	38	52	10
Tape Recorder Service	38	52	10
Articles for Beginners	37	52	11
New Products	35	63	2
Readers' Letters	27	64	9
Factory Visits	23	47	30
Tape Record Reviews	21	44	35
World of Tape	18	69	13
Field Trials	18	57	25
Commercial Equipment Descriptions	18	53	29
Humour	16	49	35
Sound and Cine	14	37	49
Tape Plays	11	37	52
Book Reviews	8	57	35

WE approached the idea of a Questionnaire with trepidation, wondering whether results would justify the cost in space, labour and postage. Yet our fears were unjustified, a heartening response being evoked from 10% of our readership.

From the replies a picture is being pieced together, fact by fact, showing precisely what readers require from a magazine in the way of editorial and technical balance. A breakdown of *Question 17* from the April reply-paid form is reproduced here, showing the relative popularity of regular and semi-regular features. In its original state this question asked readers', "favourites, or pet hates", space being provided beside each title for the purpose of indicating "more space", "less space" or, where the correspondent was satisfied with present coverage, "retain".

Some allowance must obviously be made for mis-representation, which is bound to occur when we are able only to *sample* readers opinions, even on this scale. As the psychologists would say, those who bother to fill in questionnaires are more highly 'motivated' than those who don't, so we shall not jump to any bold conclusions except where the bias of opinion is very marked. However, it can be confidently deduced that *Readers' Problems*, *Equipment Reviews* and *Constructional Articles* between them are extremely popular. The fact that *Tape Decks Analysed* and *Tape Recorder Service* follow close in this popularity rating supports the impression that the average reader is far from being a non-technical beginner. In the limited time available for the preparation of this report, we can but promise that the *Problems* column will be a much more regular feature in the future. The demand for more reviews and more deck analyses may ultimately be met by including a description of the internal mechanism and construction of each recorder placed before the Tutchings' gaze, as well as each deck.

Where constructional articles are concerned, we are dependent to a great extent on you, the reader, contributing an account of home-designed equipment in your installation. We have always thought twice before rejecting a constructional article; now we shall think *thrice* before coming to a negative decision.

At the low end of the scale we find *Sound & Cine*, *Tape Plays*, *Humour* and *Book Reviews*. Why *Book Reviews* should have fallen so low we cannot understand, though the explanation may lie in the centre column : 57% of our readers wish to retain the present space allowance. Even this amounts to a limited degree of space, since a relevant new book, like a new tape deck, is to be seen only occasionally.

We are committed, by the demands of 49% of our sample, to abandon *Sound & Cine* as a regular column, though the subject of still- and cine-photography will be given occasional coverage in more specific feature articles. The effective combination of sound and film may be difficult for the amateur, but ingenious gadgetry is being introduced almost monthly to link the galloping frames-per-second with the critical 'i/s.'

Tape Plays, too, will be less frequent in future, though occasional works of genius—if such they prove to be—will sometimes be aired in our columns.

We hoped to obtain a definite ruling from readers on the demand for humour in *Tape Recorder*. Several readers commented that they preferred *Punch* as the source for their amusement and we can only praise their taste. A slight brake on light-hearted contributions, then, but no total rejection.

Question 13 asked readers to name any aspects of tape recording they have not seen covered in the magazine and which they considered of interest. The replies will keep us going for years. We do not propose to introduce a tape exchange column, as a few readers suggested, since this provides no protection from lost tapes. (The threat of expulsion from the major tape correspondence organisations usually prevents misuse of this type of service.)

Electrostatic recording (for which one needs a *sharp* razor-blade), musique concrete, electronic music, underwater recording, programmed model control, monthly listing of events suitable for recording, experiments in sleep-learning, international club activities—these are some of the many basically practical suggestions that are being given careful consideration for eventual features or columns. A little less practical, at present, were the requests for information regarding construction of a helical-scan video recorder, amateur Son et Lumiere and "hints from makers on servicing". Alas, even in this enlightened age many manufacturers consider the consumer too humble a soul to be permitted a circuit diagram, let alone servicing information. However, there are now so many routes through the trade barrier that almost anyone may obtain the data he seeks.

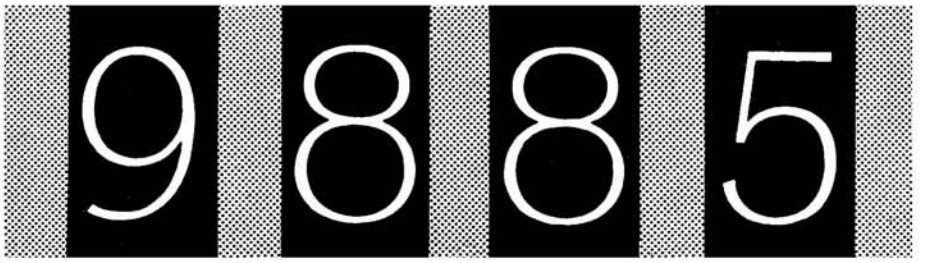
Turning now to the second question in our enquiry, we have been able to determine the proportion of brands of recorders owned by readers. We do not claim the ratio shown to be typical of sales figures in this country, but nevertheless trust that *Ferrograph*, *Truvox* and *Brenell* will take some pleasure in observing their popularity among our circle of enthusiasts. *Philips* and *Grundig* were expected to top this particular poll, so little comment is needed! The Philips figures incorporate, incidentally, those of *Cossor* and *Stella*, whilst *Thorn*—rather lower on the list than we expected—incorporates *Ferguson*, *Ultra*, *HMV* and *Marconiphone*.

The substantial number of *Magnavox* users comprises, mainly, constructors who have built their own electronics around one of the two *Collaro* decks or a Magnavox *Studiomatic*. A few readers have also built tape amplifiers around *BSR* decks, as can be seen, but this does not give an accurate indication of BSR sales. Their decks are, of course, incorporated in many *Elizabethan*, *Fidelity*, *Sound*, *Wyndsor*, *Alba*, *Dansette*, *Baird*, *KB*, *RGD* and *Eltra* machines.

A total of 2.1% of the readers who replied possessed no recorder. Even when they are included in the count, however, the 'average reader' boasts 1.624 recorders.

In addition to the breakdown of recorders in the two tables are 140 machines which could either not be identified or were obsolete or rare brands. These comprise a large number of home-built machines plus an almost endless string of individual *Hartings*, *Verdiks* and so on. The *Leevers-Rich* and *Nagra* entries must be accepted as editorial conceit ! The best cure for this, of course, is hard work. Analysing the remaining 14 questions from the Questionnaire in time for the August issue should prove an excellent cure.

how much time left?



TECHNIQUES OF DECIPHERING SPOOL ROTATION COUNTERS

I AM a comparative newcomer to the hobby of tape recording and have been surprised by the lack of uniformity in the counting systems used for indexing tape. When I first purchased a recorder two years ago I very soon discovered that the counter on my machine operated from the supply spool and did not give a direct indication of the length of tape which had been used. It was difficult to estimate the recording time left on a partly used reel of tape merely by noting the counter reading, and I made several unfortunate mistakes when recording long items from the radio. It was most disconcerting to think that there were 46 minutes of recording time left in which to record a performance scheduled to take 44 minutes, only to find after 42 minutes that the tape had come to an end so that the last few bars were lost.

I therefore decided to tackle the problem mathematically and prepared a set of figures showing the recording time left in terms of the counter reading for all grades of tape on a 7in. reel. I found that my calculations compared favourably with times observed by stop watch and I was able to forecast instantly the recording time left on any partly used 7in. reel by checking the counter against a chart.

My confidence in this system was very soon shattered when a little later I purchased a second recorder. I immediately found that my carefully prepared figures were completely useless on the new machine, which had a counter driven from the take-up spool, counting two digits per revolution, whereas my old machine counted one digit for three revolutions of the supply spool.

I feel that this lack of standardization does much to spoil the enjoyment which many amateurs would otherwise get from a tape recorder. Quite apart from the arithmetic required to estimate time left on a track, it is often difficult to find a particular item on a tape which is being played on a strange machine with a different counting system to one's own recorder. In the hope that I may help others who have encountered these problems for the first time and who may have been dismayed by the work required to compile the necessary chart, I have set out here some results of my own calculations. I have considered only a 7in. reel, as this is the largest size normally used on a domestic recorder and the problem of estimating time on smaller sizes is not so difficult.

As the tape unwinds from the supply spool

TABLE 1 Number of turns on full 7in. reel

Tape	Length (ft.)	Turns	Time per track (3¾ i/s)
Standard	1200	1050	64 minutes
LP	1800	1575	96
DP	2400	2100	128
TP	3600	3150	192

TABLE 2 Recording time left on partly-used 7in. reel

Counter Reading		000	010	020	030	040	050	060	070	080	090	100
Time Left	Supply Count	100	85.5	72.0	59.5	48.0	37.5	28.0	19.5	12.0	5.5	0
	Take-up Count	100	94.5	88.0	80.5	72.0	62.5	52.0	40.5	28.0	14.5	0

BY J. A. COOK

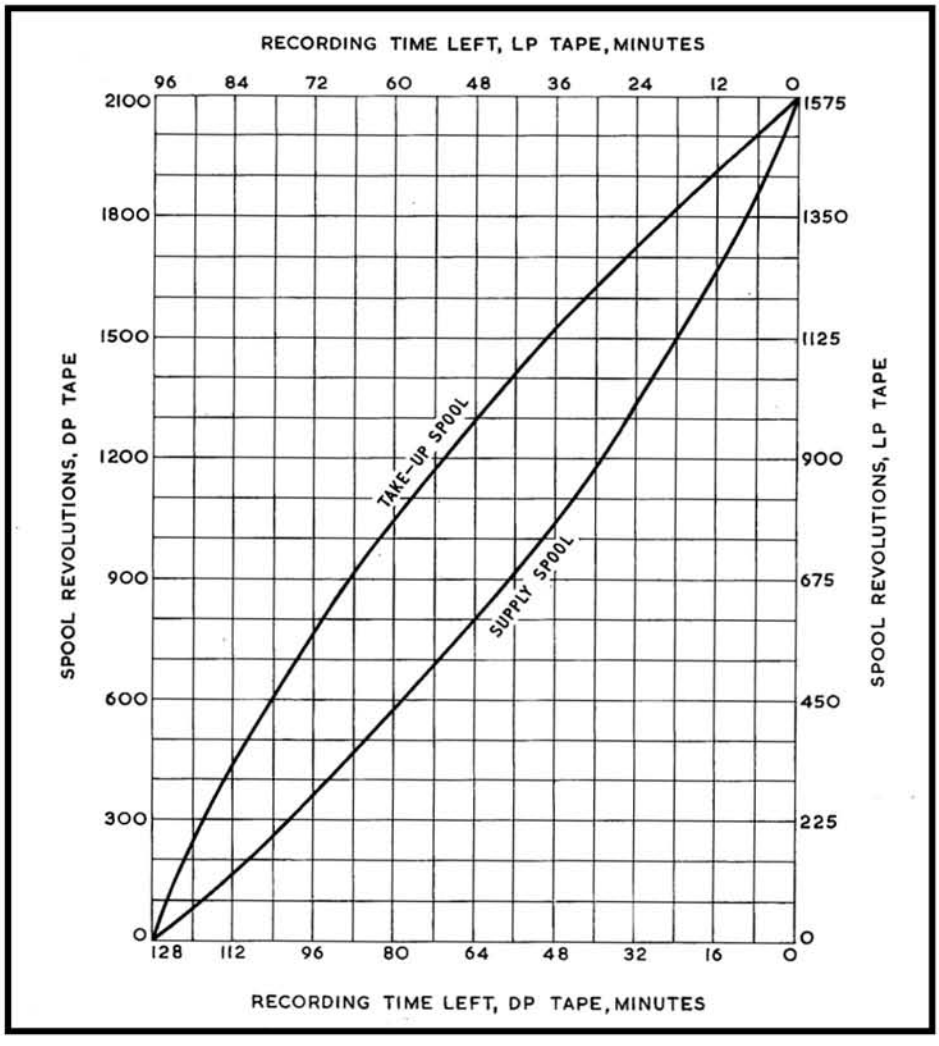


TABLE 3 Recording time left on a 7in. reel of 2400ft. DP tape at 3¾ i/s

Ratio 1:3	000	070	140	210	280	350	420	490	560	630	700
Ratio 1:2	000	140	280	420	560	700	840	980	1120	1260	1400
Ratio 1:1	000	210	420	630	840	1050	1260	1470	1680	1890	2100
Ratio 2:1	000	420	840	1260	1680	2100	2520	2940	3360	3780	4200
Supply count (minutes)	128	109	092	076	061	048	036	025	015	007	000
Take-up count (minutes)	128	121	113	103	092	080	067	052	036	018	000

the length per turn becomes less and less, whereas at the same time the length of each turn on the take-up spool progressively increases. There is a non-linear relationship between the number of revolutions of either spool and the length of tape which has been used. For a complete reel the total number of revolutions of each spool is the same, provided that the tape tension is constant and both spools have the same hub diameter. The total number of turns may be estimated by considering first the average length. The average diameter of the turns on a full 7in. reel is about 4⅜in., so that the average turn length is $\pi \times 4.375 = 13.7$in. The total number of turns on a full spool is then calculated by dividing total tape length by length of mean turn. The results obtained are shown in **Table 1.**

The counter reading for a full 7in. reel should be related in some simple way to these figures, depending on the ratio of counter digits to spool revolutions. For example, a counter which reads one digit for three spool revolutions should have a total count of about 700 for 2400ft. of DP tape on a 7in. reel.

The lengths of successive turns are related by an arithmetical progression, but, not wishing to take up valuable space with the incidental mathematics, I have compiled **Table 2** which shows recording time left in terms of counter reading. The figures are all shown as percentages of the values for a complete 7in. reel. In making these calculations I have assumed that the external diameter is three times the hub diameter, which is not precise but is sufficiently accurate for our purposes.

Table 2 shows that at 50% of the total count with supply-spool counting there is only 37.5% of the tape left but on a machine with take-up counting there is as much as 62.5% left unused. The count for half the tape used is theoretically 62 for take-up counting and 38 for supply counting.

ADAPTABLE FIGURES

The figures in **Table 2** may be adapted for any machine which uses spool-revolution counting, but the method of counting must be known. **Table 3** shows some possible results for 2400ft. of DP tape on a 7in. spool with various ratios of counter digits to spool revolutions.

Note : For 1200ft. of SP tape multiply all values by ½, for 1800ft. of LP multiply by ¾, and for 3600ft. of TP multiply by 1½.

The information in **Table 3** is not in an ideal form, as the time intervals are uneven and a certain amount of interpolation is necessary. It is far more convenient to work from a graph, and the chart shown is one way in which the figures may be plotted on squared paper. On this chart scales for both LP and DP tape have been shown and the times are for a speed of 3¾ i/s. The scales must be changed to suit counter ratios other than 1:1, other speeds, etc, but this is easily done. The chart also forms a convenient means of changing the index of a tape recorded with supply counting into an index suitable for use on a machine with take-up counting and vice versa.

BEGINNING of REEL

It must be emphasised that in order to use the chart the counter zero must be set at the beginning of the reel. When employing fast-wind to reach an empty space at the far end of a track the counter reading is likely to differ slightly from that obtained with normal playing speeds. This difference is not sufficient to cause great inaccuracy in estimating time left, but the interested reader should realize that such times can only be estimated to the nearest minute on a 7in. reel of DP tape.

I conclude with the suggestion that it would be a great help to those who buy recorders for the first time if the manufacturer took more trouble to explain the operation of the counter in the handbook. Also, a simple chart or a few figures such as I have given would save many new enthusiasts from initial disappointments in their attempts to estimate recording times left on partly used reels. Is it perhaps true that so long as recorders continue to sell, the manufacturers will not take that little extra bit of trouble to explain clearly how their product may be used to best advantage ?

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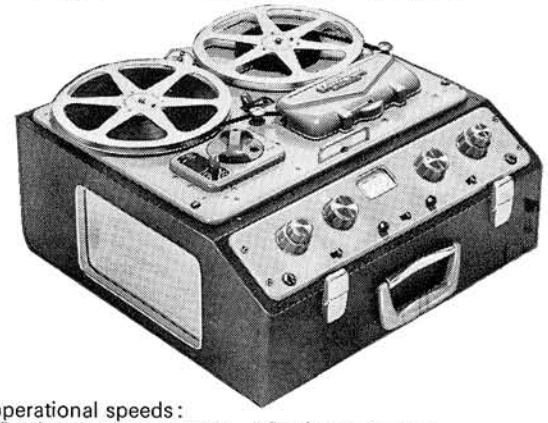

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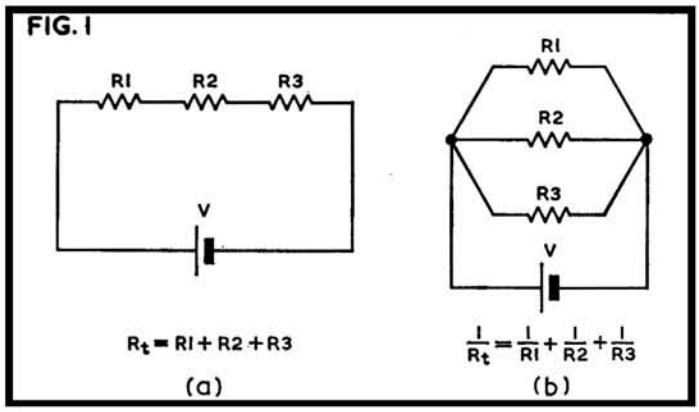
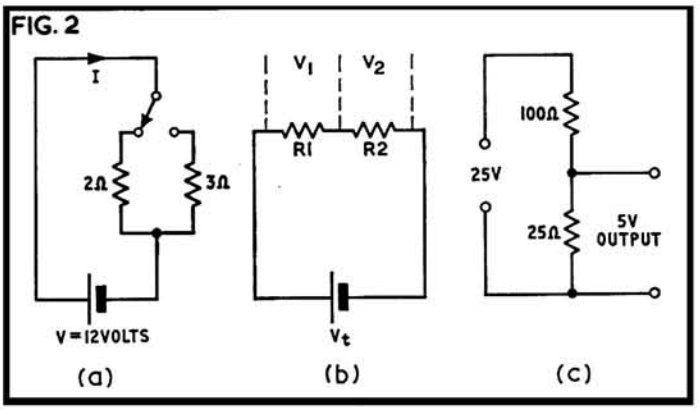




ELEMENTS OF TAPE RECORDER CIRCUITS

PART TWO

RESISTANCE CAPACITANCE & INDUCTANCE

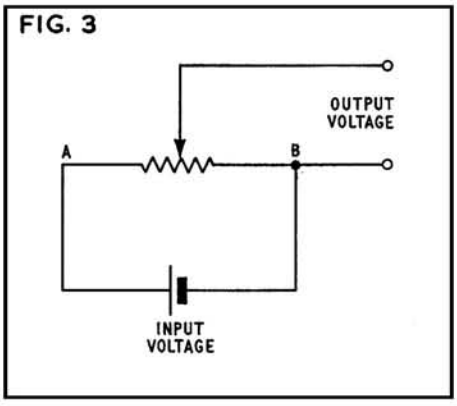
BY G. T. ROGERS

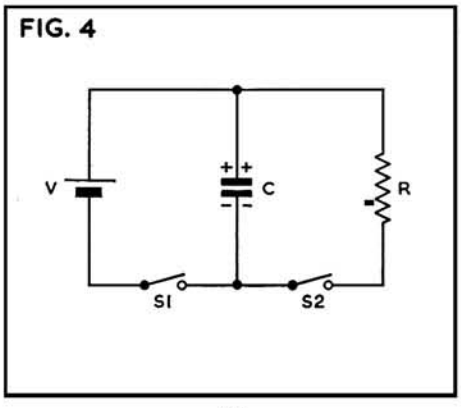
LAST month we saw the Ohm's Law relationship between the current flowing in a conductor of given resistance and the voltage applied. Let us start now by making use of this important law to consider the situation when resistances are connected together.

When they are arranged in series so that current flows through them one after the other as shown in **fig. 1(a)**, the total resistance is equal to the sum of the individual components. The same current will flow through each resistance and its value can be calculated from Ohm's Law ($V=IR$) so long as we know the total resistance ($R_1+R_2+R_3$) and the voltage V.

If, on the other hand, the ends of the resistances are connected together as shown in **fig. 1(b)** they are said to be connected in parallel. In this case the same voltage will be applied to each resistance but the value of the current flowing in each of these components will be found from Ohm's law to be: $I_1=V/R_1$, $I_2=V/R_2$ and $I_3=V/R_3$. Hence the current flowing through any resistance will be in inverse proportion to that resistance, and the greater the resistance the smaller will be the current, assuming that the applied voltage remains the same. The total resistance R_t of the circuit in **fig. 1(b)** is therefore given by the formula $1/R_t=1/R_1+1/R_2+1/R_3$.

Resistors are available in various nominal resistances and are generally graded according to their stability. A high grade resistor might, for instance, have a tolerance rating of plus or minus one per cent ($\pm 1\%$). In high quality tape recorders, resistors with a rating of $\pm 5\%$ or 10% are quite common. They are made either from special resistance wire whose resistance is accurately known per standard length, or (more commonly) from blocks containing powdered carbon.





Moving on now to some simple circuits, we can see how resistors may be used to control current on the one hand and voltage on the other. Applying Ohm's Law to the circuit shown in **fig. 2(a)**, the current will be six or four amps depending on whether the switch is turned to the left or right. If, however, the two resistors are connected in series, **fig. 2(b)**, the same current will flow through both and its value will depend on the sum of the two resistances. Again applying Ohm's Law, we can easily show that there are three voltages thus: $V_t=I \times (R_1+R_2)$, $V_1=I \times R_1$ and $V_2=I \times R_2$. Therefore the total applied voltage V_t has been divided into V_1 and V_2 and the ratio between these voltages is the ratio of the two resistances R_1 and R_2. A resistor can therefore be used as a potential divider. **Fig. 2(c)** is a practical example of **fig. 2(b)** and, as shown, an output of 5V is obtained across the 25-ohm resistor when an input of 25V is applied.

Potentiometers or variable resistors are constructed from standard resistance wire or from carbon and are usually mounted in the form of a small loop enclosed in a protective case. A sliding contact then takes current

(continued on page 283)

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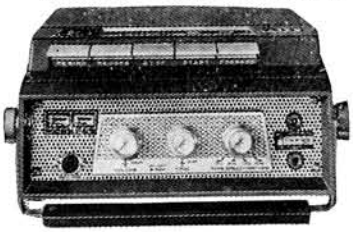

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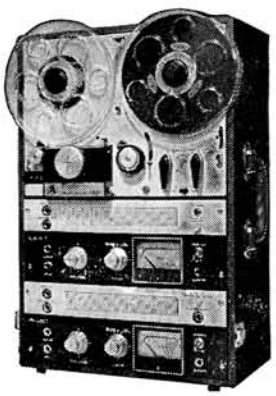

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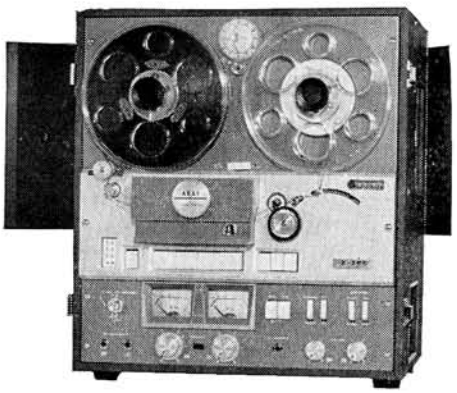

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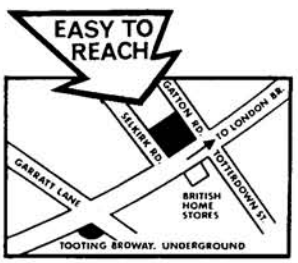

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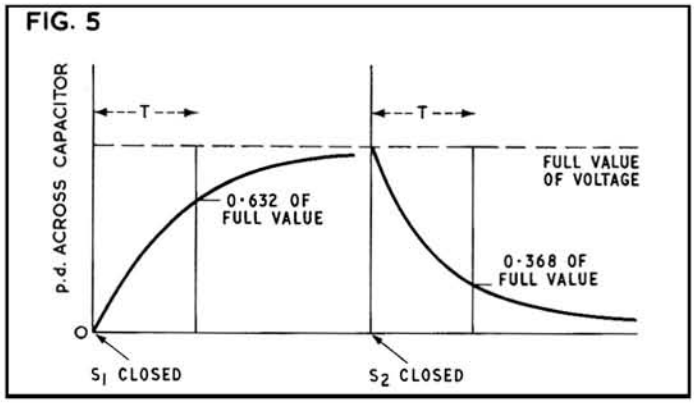
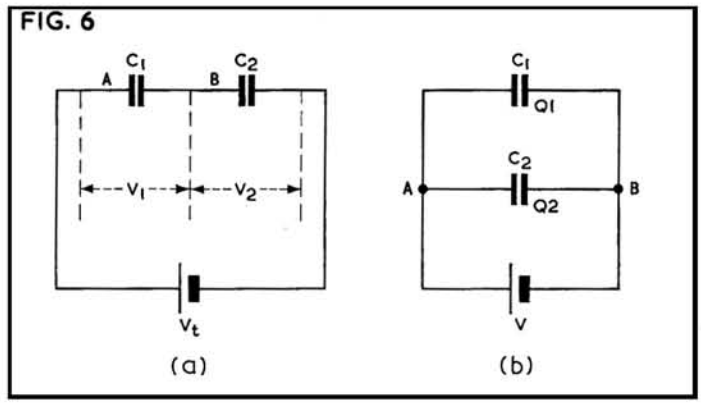


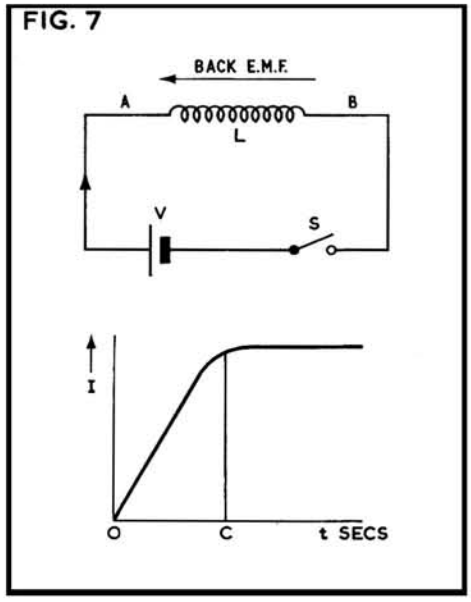


from variable positions on the loop and hence a continuous variation of voltage can be tapped off. The circuit of a simple variable potential divider using a potentiometer is shown in **fig. 3,** where maximum output is obtained when the slider is at **A,** and zero output when at **B.**

Before we leave resistance, it is worth considering the power dissipated when a potentiometer or resistor carries an electrical current. In a closed circuit like that shown in **fig. 2(a),** all the energy in the 2-ohm resistor will be converted into heat as a result of the 'free' electron collisions with the atoms while the current flows. The power consumed by the resistor is the rate at which the latter uses the energy supplied to it, and is given by the formula : Power=I x V. The unit of power is the Watt and is the power consumed by a circuit which, when driven by a potential difference of one volt, causes a current of one amp to flow. In **fig. 2(a)** the power consumed will be 6 x 12=72W. For use in various circuits where widely different voltages and currents are encountered, it is necessary for resistors and potentiometers to be constructed so that they can stand up physically to the dissipation of energy in the form of heat. Common power ratings for resistors are half, one and two watts dissipation, although larger values up to, say, thirty watts are sometimes required. Potentiometers are used for volume and tone controls in amplifiers and gain controls in tape recorders and sound mixers. Pre-set potentiometers are employed when minor adjustments are required in a circuit, and would more likely be used by an engineer during servicing than by the operator himself. Potentiometers with very high ratings, in the order of 30-50W, are sometimes used in tape recorders where continuous control of the fast winding is required.

The next important component to consider in this brief introduction to tape recorder circuits is the condenser or capacitor. This is an arrangement for the storage of electricity and usually takes the form of two metal plates separated by an insulator called the dielectric. This insulating medium is sometimes air but more usually waxed paper or mica.

Consider first the circuit in **fig. 4.** When the switch S_1 is closed electrons will flow to the positive terminal of the battery and away from the negative terminal. This, of course, is a basic law : like charges repel, unlike charges attract. Since the medium between the plates of the capacitor C is an insulator, no current can pass through and a condition of strain is set up with the plates charged as shown. On opening S_1 this charge is held and if the other switch S_2 is now closed current will flow through R until the capacitor is discharged.



We shall come back to this shortly, but let us first get some basic points clear.

The quantity of electricity Q stored by a capacitor can be measured using an instrument called a ballistic galvanometer. In this instrument the first deflection or throw of the pointer, when connected to plates of a charged capacitor, is proportional to the stored electricity. Experiments using this sort of galvanometer have shown that for a given capacity the quantity Q is directly proportional to the applied potential difference. Thus Q/V is a constant. This constant is very important and measures the ability of the capacitor to store electricity ; it is known as the *capacitance* and is given the symbol C. When the charge is measured in coulombs (1 coulomb=3 x 10^9 e.s.u. (electrostatic units of charge)) and V in volts, the capacitance is given in Farads (F). In practice, however, this unit is far too large and the micro-Farad and pico Farad are used. (1 micro F or $\mu F = 1/10^6 F$, and 1 pico F or $pF = 1/10^{12} F$). In electronics, capacitors ranging from 10pF to 100μF are common.

The capacitance of component is also directly proportional to the area of its plates and inversely proportional to the distance between them. This can be expressed by an equation and, for a parallel plate capacitor, where the plates are separated by air, the capacitance C is given by $C = KA/4\pi d$, where C is in e.s.u., K the permittivity of the air, A the area of the plates in sq. cm. and d the distance between them in cm. When an insulator or dielectric is inserted between the plates the capacitance is increased, and if this dielectric completely fills the space between the plates, it is found that the ratio

$$\frac{\text{Capacitance of capacitor with dielectric}}{\text{Capacitance of capacitor with air}} = \text{a constant K.}$$

This is called the permittivity or dielectric constant of the insulator with respect to air and the greater its value the greater will be the capacitance of the capacitor.

Returning now to **fig. 4,** theoretically, an infinite time is required to charge the capacitor fully (i.e. to make the potential difference—p.d.—across the plates equal to the applied voltage). When the charging current flows, the electron drifts build up a back-EMF on the plates and this tends to oppose the applied voltage. The growth curve of the p.d. across the capacitor, **fig. 5,** is thus asymptotic, and never actually reaches the dotted line corresponding to the applied voltage V. A similar situation exists for the discharge of the capacitor through the resistance R. On discharge the electron drift reduces the discharge current, making the successive drops in p.d. smaller and smaller. The rate of decay of the p.d. across the capacitor is therefore greatest at the moment S_2 is closed and then gets slower and slower as shown in **fig. 5.**

ARBITRARY BASIS

Because these curves are asymptotic, an arbitrary basis has to be used for comparing the rates of growth and decay of p.d. in different combinations of capacitance and resistance. Any such combination has a so called *time-constant* (T) and this refers to the time taken for the capacitor to charge up to a certain agreed fraction of the applied voltage, in fact 0.632 or 63.2%. Its value in seconds is numerically equal to the product of C in μF and R in megohms (M). The time-constant also represents the time it takes for the capacitor to fall to 0.368 of its original magnitude, as

(continued overleaf)

shown in **fig. 5.** A knowledge of time-constants of various resistor-capacitor circuits is important, as we shall see when we consider tape equalisation circuits in a later article. Time-constants in relation to tape equalisation are discussed in the articles *Playback Equalisation* by Gordon J. King (June 1965), *Equalisation and Time Constants* by David Kirk (October 1965), and *The Miniflux Universal Tape Preamplifier* (April 1967).

ALTERNATE STRIPS

The types of capacitor currently found in tape recorder circuitry are the paper, disc ceramic, tubular ceramic, silver mica and the electrolytic. The paper capacitor is made by rolling alternate strips of waxed paper and tin foil tightly together so as to form a multiplate component. These capacitors have the advantage of being very small, though they do absorb more power in an alternating current circuit than a mica equivalent. Electrolytic capacitors are constructed by immersing two aluminium plates in an electrolyte such as ammonium borate paste supported on cloth. Electrolysis takes place and a very thin film of aluminium oxide is coated on the positive plate. This film acts as an insulator and hence a dielectric between, on the one hand, the positive aluminium plate and, on the other, the borate electrolyte. Since the capacitance is inversely proportional to the distance between the plates, and this distance is very small, the capacitance of an electrolytic capacitor is very large. An electrolytic capacitor thus generally has a greater capacitance for a given physical size than the mica, ceramic or paper types. From the working of an electrolytic capacitor it is essential that it is connected so that the positive plate always remains positive with respect to the other plate, and because of this the positive terminal is always marked by a plus sign or red colouring.

Like resistors, capacitors are often connected together and in this case it is useful to know their combined effect. When two capacitors are arranged in series the charges Q on their plates are equal. Considering the circuit in **fig. 6(a),** the potential difference across capacitor A is given by $V_1=Q/C_1$, and the potential difference across capacitor B is $V_2=Q/C_2$. As they are arranged in series, $V_t=V_1+V_2$, but $V_t=Q/C_t$ where C_t is the capacitance of an equivalent single capacitor Hence $Q/C_t=Q/C_1+Q/C_2$ or $1/C_t=1/C_1+1/C_2$.

PARALLEL ARRANGEMENT

In the parallel arrangement, **fig. 6(b),** the charges Q_1 and Q_2 on the plates are not equal but given by $Q_1=C_1V$ and $Q_2=C_2V$ respectively. On disconnecting the battery and discharging through a ballistic galvanometer (by connecting the later to AB) it is shown that the quantity of electricity Q_t which is equal to Q_1+Q_2 is obtained. Now an equivalent capacitor, with a capacitance C would have a charge Q_t on it when a potential difference of V was applied, so $Q=CV$. Since $Q_t=Q_1+Q_2$, $C_tV=C_1V+C_2V$ and $C_t=C_1+C_2$. The resultant capacitance of two components in parallel is therefore the sum of the individual capacitances.

Before we conclude this article we shall introduce one other component, the inductor. This is simply a coil which has the property called inductance, which can be illustrated by considering the diagram in **fig. 7.** When the switch S is closed the current in the coil L rises from zero to a steady value in a very short time, represented by OC in the accompanying graph. As the current rises the *flux* through the coil increases. An induced EMF is then obtained in the coil and this opposes the growth of the current. The induced back -EMF, as it is called, is greatest at the instant the current starts to flow from zero and gradually decreases until it is zero at C. Similarly, when the switch is broken, the change of flux in the coil, for a very short instant, produces an induced EMF which is now in sympathy with the current and maintains the flow. The unit of inductance L is given in Henries when the EMF is in volts and the rate of change of current is in amps per sec.

As we shall discover later, with AC the current in a coil is constantly changing and the flux at any instant is proportional to the current I at that instant. Since the induced EMF is proportional to the rate of change of flux, it follows that the induced EMF is proportional to the rate of change of current. The importance of this will be seen next month when we talk about alternating current theory and see what happens when we apply AC to resistors, capacitors and inductors.

A VISIT TO KUDELSKI

DAVID KIRK DESCRIBES THE WORK THAT GOES INTO THE ULTIMATE PORTABLE

A CERTAIN erudite gentleman, runs the tale, once carried his *Nagra* out to the middle of the Sahara, incurred a fault as soon as he started to work, and then steamed straight back to Camden Town even hotter than the sand he left behind him. *Livingston Laboratories* repaired it while he waited—simply by cleaning out the sand that had spilled in to the mechanism. Quite a long journey for ten minutes work with a soft brush.

The Nagra is unique among battery tape recorders. It embodies a speed stabilising network so sophisticated that, in the words of a Kudelski technician, when wow occurs one hardly knows where to look.

Three Swiss factories are currently engaged in the production of Nagra tape recorders and accessories. We were privileged, recently, to visit two of these, situated in the suburbs of Lausanne on Lake Geneva. The Nagra deck components are manufactured at Paudex, one mile from a smaller block of offices at Renens. Administrative and assembly work is carried out almost entirely at the latter location, away from the din and clatter of toolroom and machine-shop.

There is little superficially unusual about the Paudex factory—a four-storey building situated in an attractive area of a colourful town. Beneath the noisy exterior, however, lies the skill and quality of men and machines capable of almost the ultimate in precision engineering. This is where the Nagra capstan is produced—to an accuracy of three microns (just over one tenth of a thou'). Here, too, are made the metal cabinet, the peak-reading *Modulometer*, the tape-head laminations and shells, the control knobs, the *Plexiglass* lid—almost everything, in fact, except the electronic components.

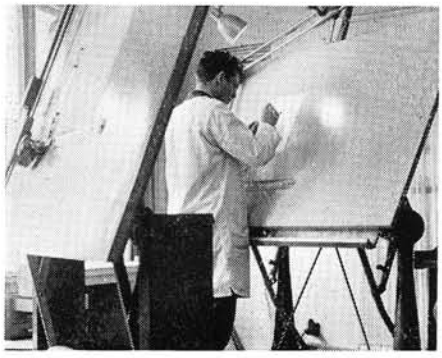
Mechanical and electronic sections of the Nagra are separately assembled in the upper and lower chassis respectively. Electronically, the recorder comprises a substantial number of unit circuits, each being assembled as a module, complete with rectangular screening can. Very recently, plug-in modules have been adopted. These units, which are equally neatly laid out in the Nagra circuit diagram, comprise microphone preamplifier, modulation meter and automatic level control, recording equalisers, oscillator, voltage stabiliser, playback preamplifier, playback equalisers, playback amplifier, line amplifier, output transformer, tachometer amplifier, frequency discriminator and motor servo-amplifier. In addition, some versions incorporate a 2W power amplifier and a neopilot amplifier.

All recorders feature most of the aforementioned circuitry, though tachometer and motor servo-amplifier, along with the frequency discriminator, are rare indeed. These component units, in fact, form part of the Nagra stabilising system.

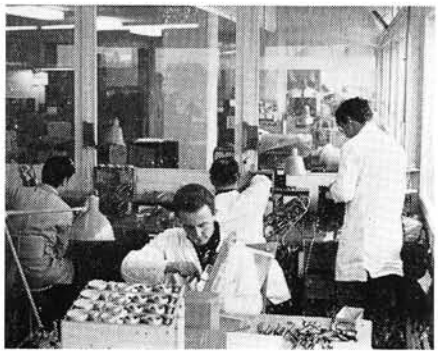
At first sight, the Nagra drive system seems an ideal one—a substantial motor providing direct drive to the tape via a capstan that is simply an upward extension of the motor spindle. Substantial, too, is the capstan diameter—in the order of one centimetre. Closer examination, however, reveals that the motor is basically a DC device. How do Kudelski overcome the inherent acceleration and de-acceleration that occur each time the brushes make and break contact with one of the motor coils? This fluctuation, which would otherwise create appalling wow at the slow motor speed necessitated by the capstan diameter, is ironed out by means of a feedback network. Variations in the motor speed are made to cause opposite variations in the supply voltage. Thus, if the motor endeavours to slow down, the supply will automatically and

(*continued overleaf*)

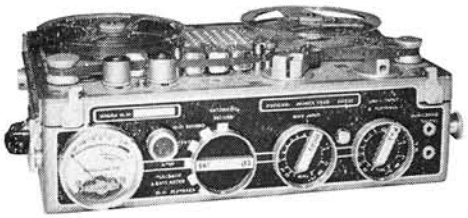
Two views of Renens premises . . drawing office ..



. . . and mechanical-assembly room.



Exterior view of the Paudex factory.



instantaneously increase, bringing the speed back to normal.

The tachometer amplifier 'senses' the motor speed through an electromagnetic head positioned close to the capstan flywheel. At the periphery of this flywheel are a series of regularly-spaced small metal teeth. These induce a small pulse in the magnetised pickup head as they pass close by the head gap. The pulse frequency is determined by the nominal tape speed and any doubling in tape speed obviously doubles this frequency. Having been amplified, the pulse is fed to the frequency discriminator, which is tuned to the frequency corresponding to the tape speed. Altering the position of the speed selector is therefore simply a matter of switching new tuning components into the discriminator circuit. A voltage fluctuating in proportion to frequency variations is supplied by the discriminator to the motor, having first been amplified to a usable level by the motor servo-amplifier. The fast-forward-wind button (labelled *Accelerator*) simply short-circuits the servo-amplifier and allows the motor to race at a higher current level.

So effective is this system that wow and flutter are held well within professional standard —less than $\pm 0.08\%$ p-p at 15 i/s. Absolute tape speed is equally accurate throughout useful battery life, and from one end of a spool to another, namely between $\pm 0.05\%$ and $\pm 0.1\%$. And while discussing specifications, the frequency response of a Nagra is within ± 1dB from 30Hz to 16kHz at 15 i/s. A bald claim is turned into discernible fact, in this case, by the supply of response curves and performance measurements with each machine.

The Nagra deck sits upside-down on its Plexiglass lid while being assembled. In this position, many of the features that contribute to its mechanical reliability are visible. While the tachometer keeps minor speed changes constant, for example, an elegant pair of tension pulleys ensures that varying spool diameter does not contort the motor speed beyond the efficient working range of the frequency discriminator.

We are all accustomed to the high cost of Mu-metal shielding. This is normally seen only in the minutest quantities in the structure of tape heads and gap-shields. The Nagra motor is encased in a Mu-metal cup some 3in. high, with a diameter of 2½in.—and an internal lining of wool. This provides a costly but entirely effective insurance against radiated motor interference.

Take-up and rewind turntables are driven by thick rubber belts. Being anodised, neither the turntable nor the drive pulley 'grounds' the take-up belt, so a small brush is positioned to prevent static build-up and possible consequent interference.

Reviewing the Nagra in September 1963, Alec Tutchings made reference to "that indefinable feel of perfect engineering". The guide rollers and flutter filters certainly share this 'feel', which seems to stem from an absolute lack of vertical play and minute level of rotary friction. This is a product of intricate and accurate construction—a whole host of tiny bearings and disc springs being housed in each of the flutter filters.

Each deck is subjected to an initial series of tests before being married to Nagra electronics. Motor consumption is checked on a meter to ascertain whether any component in the electronic or mechanical stabilising systems is causing excessive friction. A reading of 20-25mA shows that all is well. Next, the take-up tension is measured on fast rewind—a 600gm. reading being anticipated.

In addition to assembling the deck, Kudelski employees at Renens produce the erase, record, replay and pilot heads from parts made at Paudex. The head coils are wound on caustic-soaked laminations, the pole pieces then being surfaced on a *Payne* grinder. A thin sheet of mica is inserted between two wound laminations, forming the head gap, after which the complete assembly is oven-baked in *CIBA* plastic metal. The head surface is turned in a lathe, after baking, after which the face is polished by hand with petrol paper.

VACUUM DEPOSITING

Two thicknesses of mica sheet are used for the record and replay heads, to give respective gap dimensions of 21 and 6 microns. It is hoped, at some future date, to employ vacuum-depositing techniques in place of foil.

In terms of electronic construction, the Nagra must rank as one of the neatest recorders ever conceived. The pilot-head Nagra has no less than 38 transistors within its modest dimensions, built around the modular circuits. Modular assembly—and the modular layout of the circuit diagram—make electronic servicing simpler than on some £30 domestic designs. This task has been made still easier by the recent incorporation of plug-in component boards.

All circuitry, save the tachometer amplifier, oscillator and monitor amplifier, are built on the lower chassis, and the Renens electronic assembly floor is basically a series of such chassis, each being fitted with one component board or another at a desk. The atmosphere more closely resembles that of an office (minus typewriters) than a factory. The cabinets are covered with adhesive brown tape, as are the head faces, to protect them from scratches during the various stages of assembly. Similar protection is given to the underside of the printed circuit boards—a semi-permanent application of *Araldite* guarding against component movement or short circuiting. Kudelski manufacture their own microphone and mains transformers; the printed boards, however, are made to their specification by an outside firm.

SIMPLE COMBINATION

The final stage in assembly comes with the combination of deck and lower chassis—a task involving a few screws and equally few solder connections.

Now begins the final testing—probably the most rigorous examination that has ever been applied to any commercial battery recorder. The first step is speed alignment. Any major variation from standard speed, due, perhaps, to a combination of inaccuracies within the component tolerances, are corrected by substitution of capacitors in the speed control circuit. Minor variations are compensated by pre-set controls.

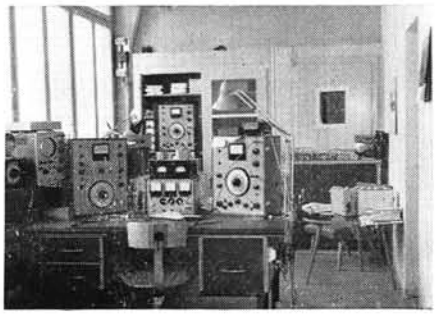
Ten recorders per day pass through the test-room, heads, oscillator, pilot-tone regulator, playback gain, record/replay response and wow and flutter being checked—and then re-checked. Each model is compensated for *Scotch 102* tape, but can be set for alternative brands to special order. 0dB line output is adjusted to 200 milli-Maxwells.

The Nagra design is now in its ninth year and is expected shortly to be replaced, or complemented, by a stereo model. Work is also going on to develop a recorder of much smaller dimensions than the Nagra III's 8¾ x 12½ x 4½in. These units, too, will incorporate the Kudelski stabilising system.

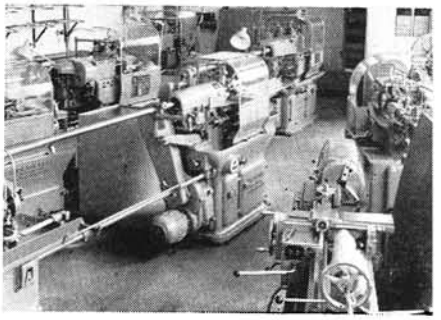
Probably the only real competitor to the Nagra was the late *Stellavox*, and it makes an ironic closing point to state that the Neuchatel factory where these were made are now owned by Kudelski and engaged in producing Nagra accessories.

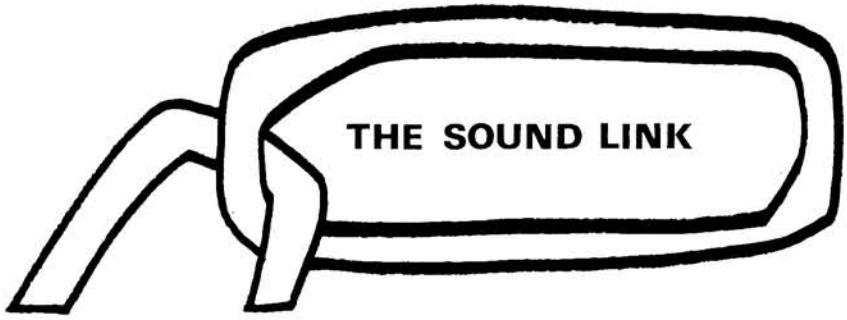
Electronic-assembly floor at Renens . . .

. . . and one of several well-equipped test benches.



The Paudex tool-room.





BY EDWARD ROESKEN

TAPE CORRESPONDENCE SEEN THROUGH THE EYES OF AN AMERICAN ENTHUSIAST

A NEW dimension has been added to person - to - person correspondence in recent years. The written word is being replaced by the voice. This is done by means of a microphone and a magnetic tape recorder, together with a 3in. reel of tape which moves from one person to another by mail at a cost of little more than a letter. It can also bring groups together through the spoken word. Families, clubs and school classes, though physically separated by thousands of miles, can be thus brought into intimate contact.

There are at least 25 organisations seeking to promote correspondence between owners of tape recorders. Thirteen of these are based in the United States. The others are in Britain, Canada, Denmark, Norway, France, West Germany, Australia, New Zealand and South Africa. They issue directories of members, giving addresses and personal interests. By joining such an organisation for a nominal fee, a person can find congenial 'tape friends' in forty or more countries.

One ardent tape correspondent numbers among his friends a dentist in Australia, a New Zealand high-school teacher who recently visited him, a newspaperman in Canada, a Tennessee lumberman, a physician in Indiana whom he recently visited, a retired New York banker, an architect in Dorset, a restauranteur in Devon, a mapmaker in Hampshire, a photographer in Worcestershire, a college teacher and a fireman in Derby, and a Linotype operator on the Isle of Wight.

A few of the organisations bring together those with special enthusiasms and interests. An example is the *Organ Music Enthusiasts of America*. Most clubs are of an internal character, with such names as *Tapeworms International*, *International Voices of Youth*, *World Tape Pals*, *Worldwide Tape Talk*, *International Tape Fellowship* and *Universal Tape Network*.

Some have appointed representatives who instruct new members, via tape, in the art of producing interesting recordings. All agree that there is no need for elaborate written preparation in the making of a tape.

In the United States, many organisations are proud of their contribution to the *People-to-People* programme, inaugurated by President Eisenhower and now directed by him. They realise the programme is promoting world understanding at the level of the common man.

The equipment required for tape corresponding is not expensive. A good battery or mains machine can be purchased for as little as £25, the average price for a domestic machine being between £35 and £45. A 3in. reel of magnetic tape can be purchased for about 3s. (*Our American contributor's original copy quoted fourpence. This may or may not have been a mistake* !—**Ed.**) Postage on a reel of this size, sent from Britain to the United States, is about 10d. by surface mail and 2s. 6d. airmailed by unsealed *Phonopost*. A single reel of tape can be used repeatedly, shuttling indefinitely back and forth between correspondents. Or, if one desires to keep a particular tape, a new reel and tape may be substituted when replying.

When completed at the usual recording speed of 3¾ i/s on two tracks, ready for mailing, the 3in. tape (containing between 150 and 600ft., depending on the thickness of the tape chosen) runs for 16 to 64 minutes.

The secret of good tape correspondence is to note the points raised in a message when it is first replayed, using the notes when replying. Subjects of correspondence are unlimited. These often relate to current activities, hobbies, work, the international situation, politics, stories and music—any subject which may be of mutual interest.

Whilst the 3in. reel is perhaps the most popular, some enthusiasts prefer to use larger tapes—often at 7½ i/s. Tape is most economically purchased on 7in. reels and spun off on to smaller spools. Discarded 3in. 8mm. cine spools are often used in tape correspondence, being less brittle, lighter and cheaper than conventional audio spools.

SMALL GREEN DECLARATION

Sending tapes abroad presents no particular problems with Customs authorities. A small green contents-declaration, obtainable free at Post Offices, is all that need be added.

Many recorder-owners produce descriptive tapes to accompany the showing of their 35mm. colour slides. Photography enthusiasts often send these slide shows to their tape correspondents who have 35mm. projectors. The first slide shows circulated in this way often comprise pictures of the sender and his family, combined with scenes in and outside his home, particularly of the room in which the tapes are made. Later, shows may present scenes taken on holiday trips, showing places of interest in the sender's town or country. In exchange, he receives similar shows depicting the area in which the correspondent lives. When this is a foreign country, much can be learned of the people, scenery and customs. A group of 20 or 30 postcards, in colour, numbered serially and sent with an accompanying descriptive tape is also a popular and inexpensive means of visual communication.

'Round Robins' are very popular with owners of tape recorders. These consist of blank tapes sent out to a series of persons in other countries. These are the names of individuals with whom the sender may already have corresponded and others of whom he knows likely to be interested in participating and who would see that the tape continues on its course. The sender may, at the beginning of the tape, introduce himself and ask each one to devote a given number of minutes to making observations on a designated subject of general interest. The first to receive the tape offers his thoughts each succeeding recipient hearing the thoughts of those before him and adding his own remarks or steering to a new subject. A very interesting and informative tape usually results for the sender, adding to his tape library a cross-section of thought from widely separated places.

SUBSTANTIAL LIBRARY

A number of organisations have a section for members willing to record music and printed fiction and non-fiction for the blind. One American club has a substantial library of such material, including a taped course in *Fundamentals of Electronics*. In a related area, bed-ridden invalids of all categories are brought much pleasure by tape correspondence.

Musical ability can enter into the correspondence. If a would-be soloist has two recorders, it is possible to play the accompaniment on one recorder, place the microphone of the other model between recorder and performer, and then play or sing the melody. The resulting tape—a combination of melody and accompaniment, can then be copied and played for one's friends or sent around the circuit of tape correspondents. Or, if one correspondent is a pianist or organist, he may record a specified musical item on tape and send it to another soloist who can combine his talents by adding the harmony or other accompaniment.

Here, then, is tape correspondence—a means of enlarging one's circle of friends—a way of bringing the accents and atmosphere of a distant country into the living room.

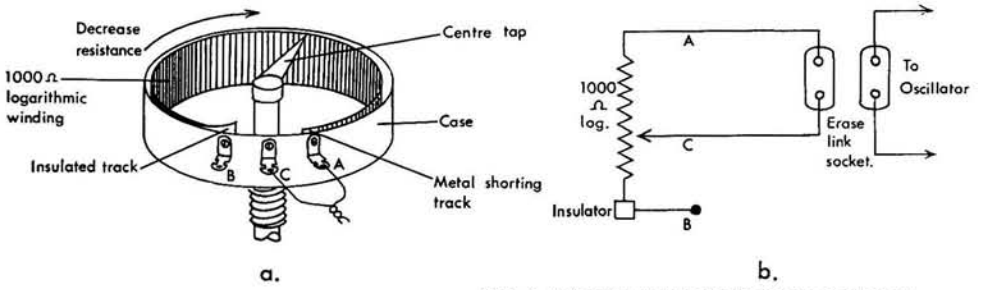


FIG. 1 DETAILS OF INTERJECTION CONTROL

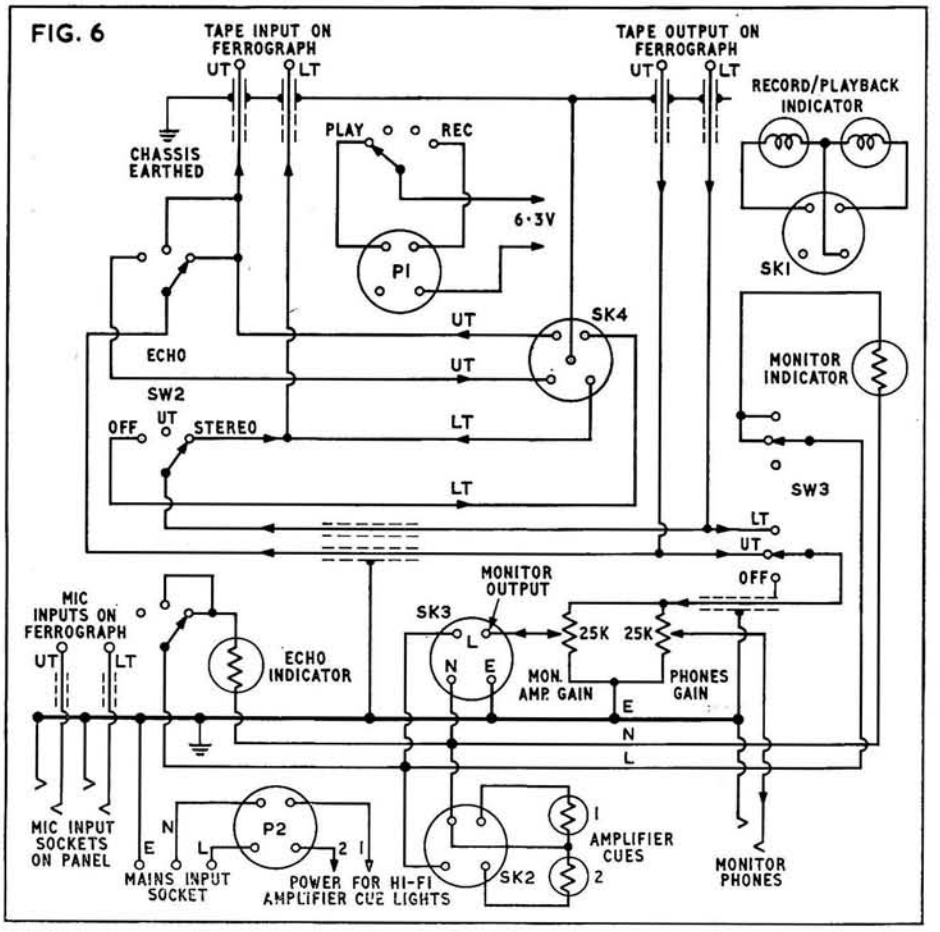


FIG. 3 TOP PANEL DIMENSIONS

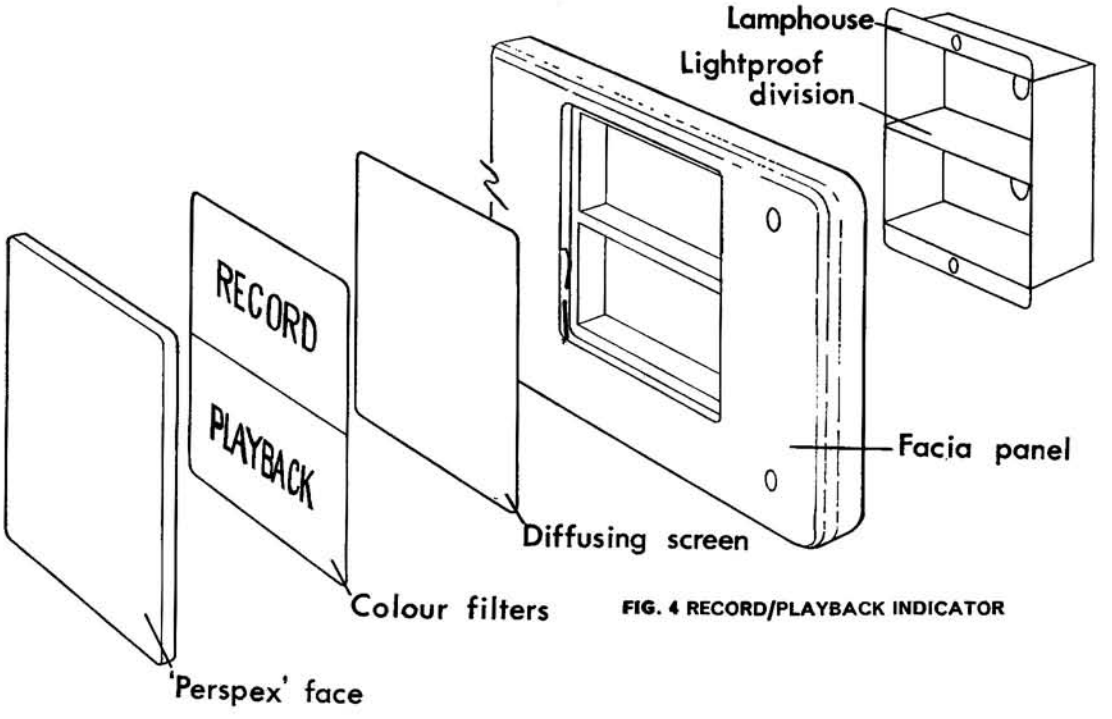
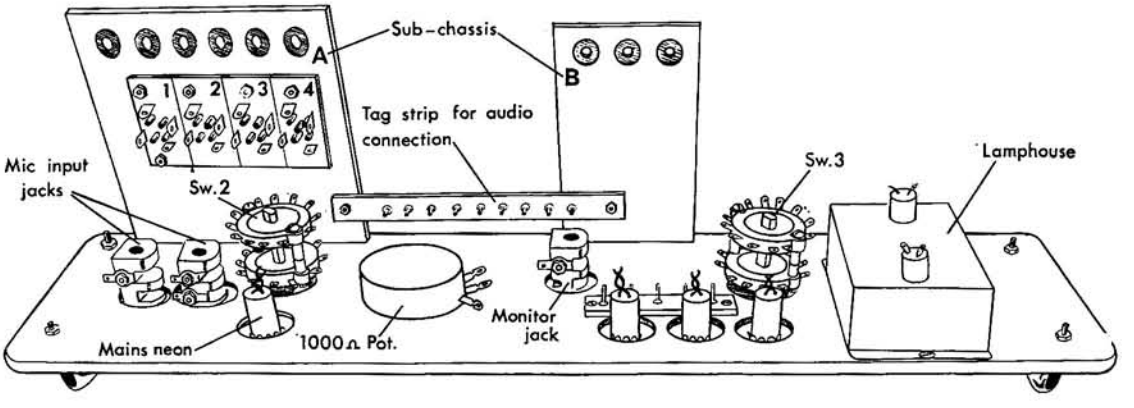


FIG. 4 RECORD/PLAYBACK INDICATOR

FIG. 5 LAYOUT OF COMPONENTS UNDER PANEL



a console for the FERROGRAPH

G. T. ROGERS AND J. P. FABER DESCRIBE SOME MODIFICATIONS TO A 422U

IN an earlier article (*Tape Recorder*, June 1965) a circuit was described which enabled the *Wearite* tape deck to be modified so that its fast-spooling speed could be continuously varied in either direction to assist in scanning long programmes when editing. This modification proved so popular that it is intended in the present article to describe further developments to the *Ferrograph 422U* recorder which have proved extremely useful, especially when recording sound tracks for films and colour slides, and plays with sound effects. Let us first look generally at some of these developments and then discuss the particular circuits used in the authors' installation, together with constructional details of a transportable console which is used to house all the equipment.

One essential requirement for anyone seriously concerned with good quality recording is a means of monitoring the *recorded* signal either by headphones or through a power amplifier and loudspeaker. In this way a constant check on the technical quality can be obtained and this is bound to facilitate the correct placing of microphones, for instance. In professional equipment, monitoring during recording is taken for granted, but there are many domestic and general purpose machines which do not offer this facility or make provision for it. Some models, however, do have space on the tape deck for the addition of a third monitor playback head, and this can be connected to a suitable amplifier with the appropriate equalisation to match the particular head in question. Other machines, like the Ferrograph 422U, using separate upper-track and lower-track playback amplifiers in addition to the record amplifiers and also a separate two-track playback head, are fully equipped for monitoring.

In the modified equipment to be described in this article, a jack socket for headphones and in addition a monitor output for an amplifier and loudspeaker are both switchable to either the upper or lower track output of the Ferrograph. Both monitoring outputs have variable attenuators so that suitable monitoring levels are possible without altering the main gain of the recorder, which is set for normal listening using low-sensitivity electrostatic loudspeakers. The monitoring amplifier (*Quad II* power amplifier) is housed well below the recorder and a switch is provided so that it can be switched off when not required.

Another usefu feature is a means of interjecting new recordings into an existing one. One obvious use is in the introduction of a spoken commentary into background music for use as a sound track for films. One way of doing this is to stop and start the machine, changing from playback to record every time the commentary is made; but the recording tends to be spoilt by switch clicks and sudden discontinuities. To do this unobtrusively, however, with the minimum of effort, a system is used which provides a gradual but complete fade-out of the previously recorded material with a smooth insertion of the new, followed by a gradual restoration of the original.

In the 422U this can be done by replacing the plug in the erase link socket by a similar plug attached to a 1K wirewound rheostat with a logarithmic characteristic and modified in such a way that the circuit is completely broken when the slider is in the maximum resistance position, **fig. 1(a)**. As indicated in the diagram, this can be achieved by inserting a piece of mica or similar material between the winding and the outer case so that the centre tap rides on it in the maximum position, thus breaking the circuit. When the sliding tap **C** is at **B, fig. 1(b)**, the oscillator supply to the deck is cut off and no erasure or recording can take place. When the slider is at the minimum resistance position **A**, however, the rheostat shorts the erase link, both erase and bias are now fully operative, and new material can be recorded.

Echo effects are popular with some recordists who wish to simulate a 'reverberant' atmosphere for their recordings. Professionally this is more satisfactorily achieved by the use of an isolated sound chamber which is simply a room with a fairly long reverberation time (see 'Acoustics and Sound Reproduction', *Hi-Fi News*, December 1965). Some of the output from the studio microphone is fed to an amplifier and loudspeaker carefully placed in the echo chamber. The output from this speaker, suitably coloured by the reverberation, is picked up by a microphone also in the chamber and combined with the main output from the studio. By skilful use of the mixing controls it is possible to get any desired coloration in this way, although the set-up needs to be permanently installed and is necessarily expensive.

An alternative method, which is more suitable in domestic surroundings, is to use artificial reverberation which can be obtained

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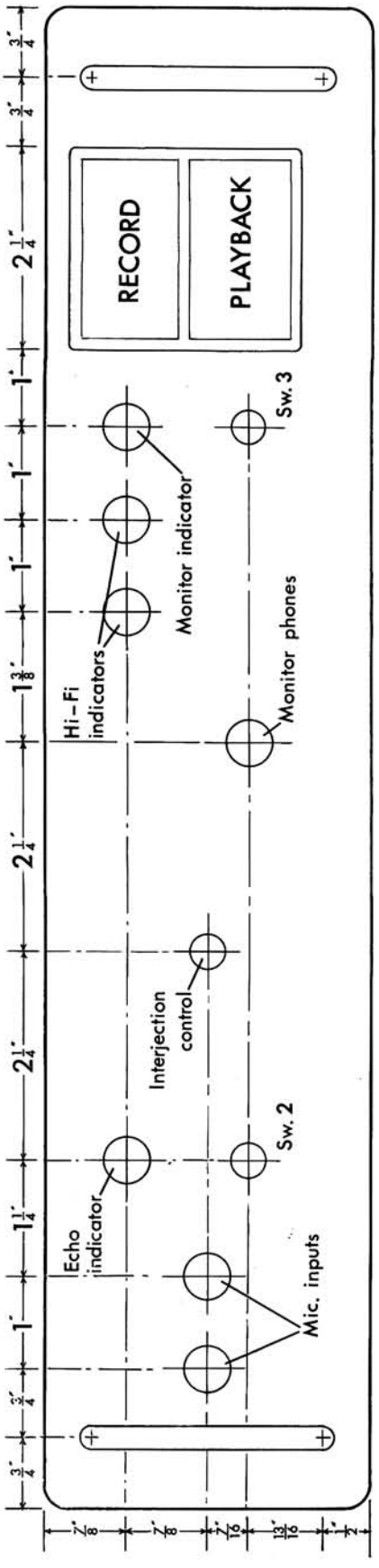


with a recorder supplied with a separate playback head and amplifier. **Fig. 2** shows how this effect can be obtained. After the signal is recorded on to the tape it is picked up by the playback head and *some of it* is fed back to the record head through the playback and record amplifiers forming a closed loop circuit. The precise amount of feedback can be controlled by the playback gain on the recorder and, as in true reverberation, it should be considerably attenuated to prevent instability. With the control properly set, the echo itself is re-recorded, picked up by the playback head and amplifier and again recorded, and so on, with reduced strength until it finally disappears. Obviously the time between successive echoes depends on the distance between the record and playback heads and also on the tape speed used.

In addition to the above facilities it was also decided to include a system of indicators so that the function of the machine at any time during a busy recording session is immediately obvious. This of course greatly simplifies control during all types of recording and playback and guards against operational mistakes which are time consuming and may mean valuable recordings being lost for ever.

The largest indicator, **figs. 3** and **4,** is the record/playback indicator which shows up red when the main function switch on the Ferrograph is turned to recording and green when the switch is at playback. Its construction will be described shortly. Other small mains neon indicators are coupled to the monitor selector switch, the echo switch and the monitor amplifier power switch. In addition, two cue lights are coupled to an external hi-fi system and indicate whether one or both channels are switched on for recording or playback. The advantage of these indicators becomes apparent when the recorder is used in a neighbouring room for playing back through a high quality amplifier in the listening-room. Incidentally the advantage of a flexible monitoring system under these circumstances cannot be over-emphasised.

As shown in the photograph, **fig. 8,** the main body of the recorder and the monitoring amplifier are housed in a console. This supports the Ferrograph tape deck, its control panel and an additional control panel in a convenient operating position. It also protects the additional wiring, switches and the monitor amplifier from damage and, since the console is mounted on large trolley wheels, it enables the whole equipment to be moved safely and easily at any time. The removable panel, at the front beneath the main deck assembly, houses the monitor amplifier on/off switch and pilot light, the two monitor gain controls and a 15-ohm (speaker) monitor output socket.

Considerable thought went into the design of the top panel (**fig. 3**) on which are mounted the various indicators and switches. For convenience the two microphone input sockets at the rear of the Ferrograph are duplicated and mounted on the extreme left of the panel so that the mic. cables are kept clear of the other controls. Reference to **fig. 3** will show the exact position of the panel components, but two points are worth mentioning at this stage. Firstly, the interjection control knob, which has to be operated smoothly during an actual recording, should be large and not surrounded too closely by neighbouring components. Secondly, the record/playback indicator should be mounted in-line with the recording meter on the Ferrograph panel. This is important, as the professional appearance of the top deck of the console as a whole depends on the correct position of this component (see **fig. 10**).

The panel itself (16⅜ x 3½in.), cut from three eighths thick plywood, is carefully shaped to match the panel on the Ferrograph. Using the positions given in **fig. 3** it is then drilled to take the two switches, the neon lamps, jack sockets and rheostat for the interjection control. The size of these drillings will of course depend on the selection of components, but ⅜in. is common for switches and potentiometers, whilst ½in. is more likely for the jack sockets and neon indicators. Finally, drillings are made to take the two handles which protect the panel when it is turned on its face for wiring. At this stage a recess for the record/playback indicator (2¼ x 2½ x $\frac{3}{16}$in.) is made in the panel and then the two windows (2 x 1in.) cut in the recess as shown. After carefully sanding, the panel is sprayed with a cellulose primer and then with several coats of cellulose car finish to match the Ferrograph. The panel is later labelled with *Lettraset* dry transfer system, which should be protected with a sparse application of picture varnish.

LIGHTPROOF DIVISION

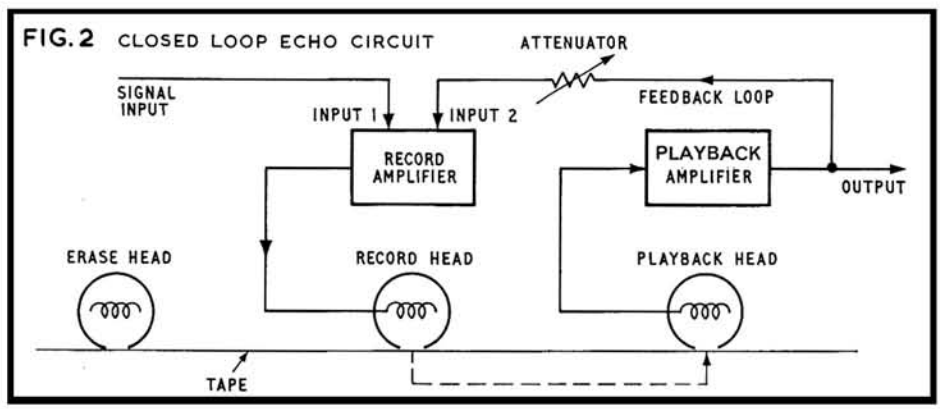
The lamphouse for the record/playback indicator (**fig. 4**) is made from aluminium and has an internal lightproof division. It is faced up to the back of the panel opposite the two windows with the division between them. A hole in the back of each half of the lamphouse takes the two 6.3V lampholders, which are fed from a transformer via the main function switch on the Ferrograph (see **fig. 6**). The face of the indicator, made from $\frac{3}{16}$in. Perspex mounted in the recess on the top side of the panel, supports red and green transparent film over the top and bottom window respectively, and also a diffusing screen to prevent glare. To complete the assembly the coloured screens are labelled with Lettraset, red with RECORDING and green with PLAYBACK.

Fig. 5 shows the layout of components on the underside of the panel. Two four-way sockets (Sk.1 and Sk.2) on the sub-chassis **A** are used for connecting power to the record/playback indicator, the hi-fi output cues and the neon indicators for the echo and monitor controls. A third fourway socket (Sk.3) is reserved for the monitor output (power for the amplifier and the audio signal) whilst a fiveway socket (Sk.4) connects the main audio inputs and outputs for each channel (see **fig. 6**) to sockets at the rear of the console. The six coaxial cables, terminated with jack plugs for connecting to the Ferrograph (mic input, high level input and output for each channel), are permanently wired to the panel and clamped by feeding them through rubber grommets mounted in the sub-chassis **A.** Sub-chassis **B,** in addition to supporting a tag strip for the audio wiring, also clamps three coaxial cables feeding the monitor signal to and from the gain controls on the lower front panel.

Switch Sw.2 is a miniature three-way six-pole (two-bank) ceramic and is wired with the indicator power on the lower bank away from the audio connections on the upper bank, which are protected by a small aluminium screening can. A similar component is used for Sw.3, special care again being taken to screen the audio. It is also a good idea to screen the microphone jack sockets since these are close to the mains connections on Sw.2.

The circuits used in the installation are given in **fig. 6** and the wiring itself with the screen cans removed is shown in photograph **fig. 9.** To avoid hum, coaxial cable is used for all audio connections except when the circuit is protected by screening. Ordinary colour-coded insulated wires are used for the indicator power, and these should be lashed tightly together and routed on the opposite side of the panel away from the tag board carrying the audio wiring.

To simplify **fig. 6,** arrows are used to indicate the direction of the signal in various parts of the circuit. Reference to this diagram will show that Sw.2 is wired so that the tape output on either channel is passed to the main output at the rear of the console, *only when this switch is in the off position.* This is essential to avoid feedback instability. The other two positions of Sw.2 are for mono and stereo echo respectively. In the former position the upper track tape output is connected to the high level (UT) tape input and hence the closed loop circuit mentioned earlier will exist and an echo can be obtained. In the stereo position both upper and lower tracks form a closed loop. Although the external output is not available when the echo is used, the recording can of course still be monitored using either of the two monitoring facilities already mentioned.



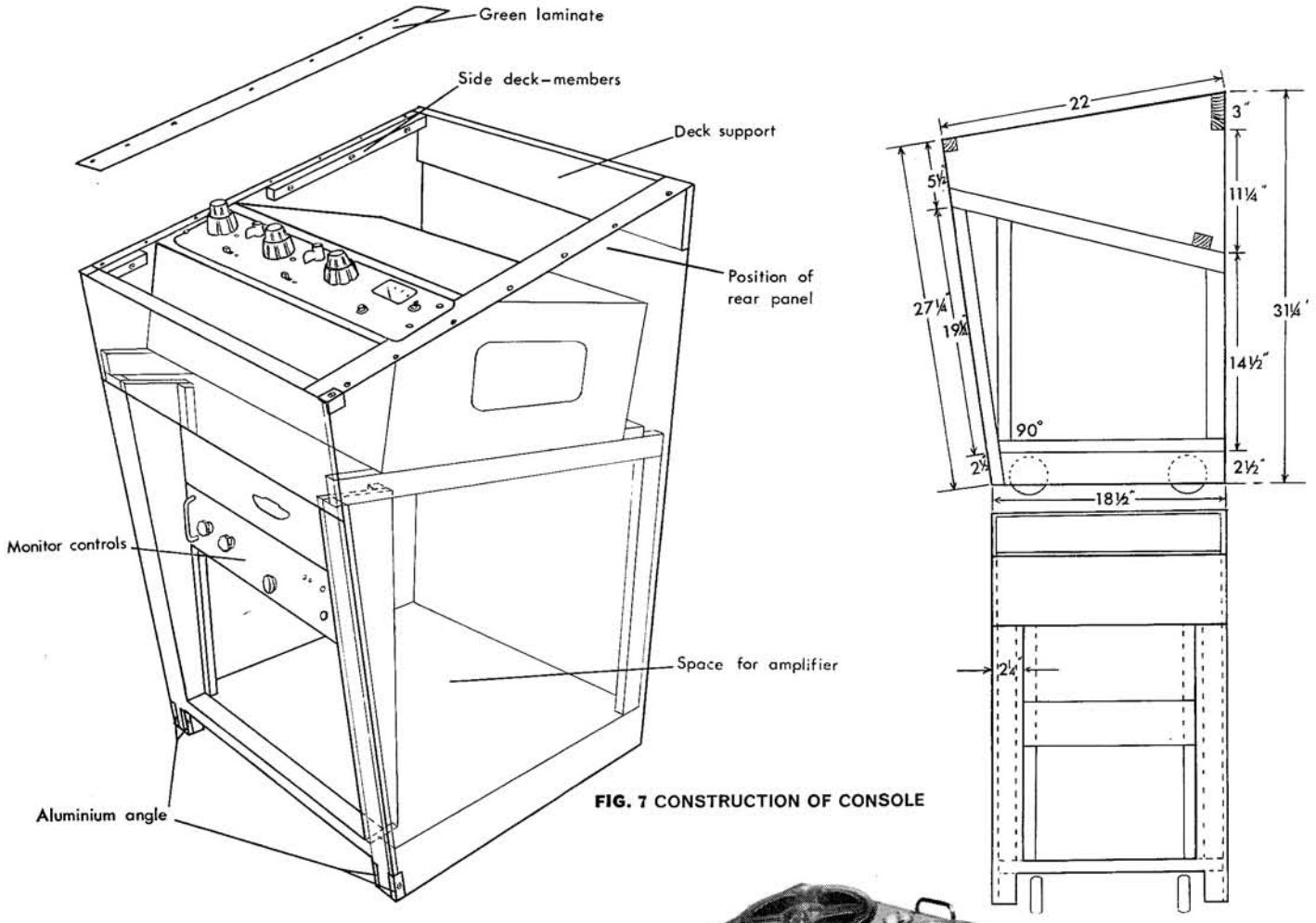


FIG. 7 CONSTRUCTION OF CONSOLE

Indeed, this is essential if multiple echoes and instability are to be avoided.

Switch Sw.3 simply selects either the upper or lower track output from the Ferrograph and passes this signal via a coaxial cable to the two 2.5K potentiometers and then to both the 'phones' socket and the monitor power amplifier.

Audio connections to the external hi-fi system are taken via four *Belling and Lee Screenector* coaxial sockets (two outputs and two inputs) which are mounted on a panel at the rear of the console. These sockets and the associated plugs are expensive, but in addition to making a good screened electrical contact are mechanically strong and lock together to prevent accidental decoupling of the cable. The power for the hi-fi output cues is fed to a four-pole male socket (*Plessey*). These are sometimes available on the surplus market and, being mechanically strong and with adjustable keyway, are very suitable for mains voltage connections. A similar four-pole female socket—but with the keyway adjusted to conform with the electrostatic loudspeaker output on the hi-fi—is available for a monitoring electrostatic speaker which requires both audio and polarising connections. All the sockets on the panel are protected by dust covers when not in use.

The spare pole on the main function switch on the Ferrograph, Sw.1, is used for the record/playback indicator. The movable rotor

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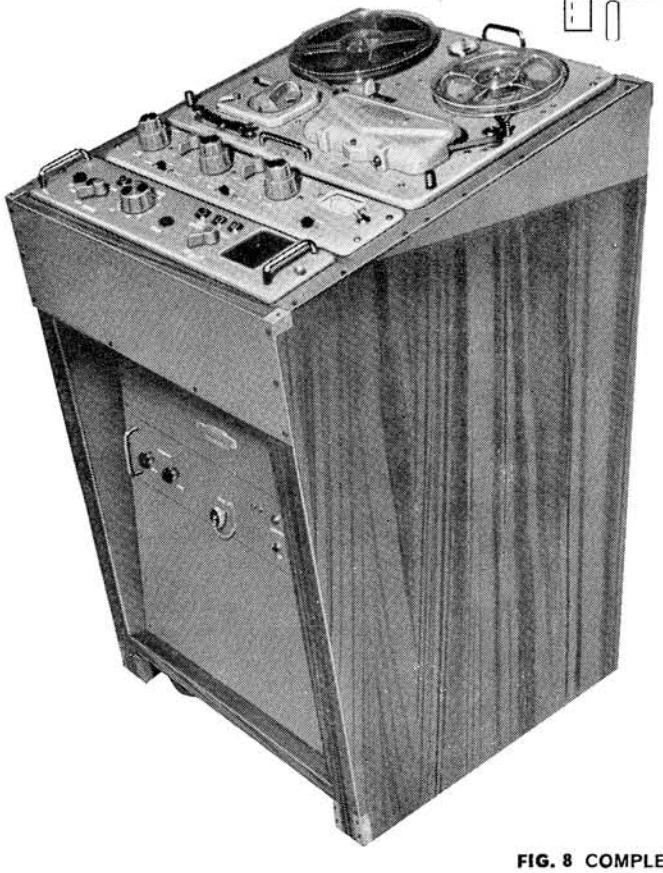


FIG. 8 COMPLETE INSTALLATION

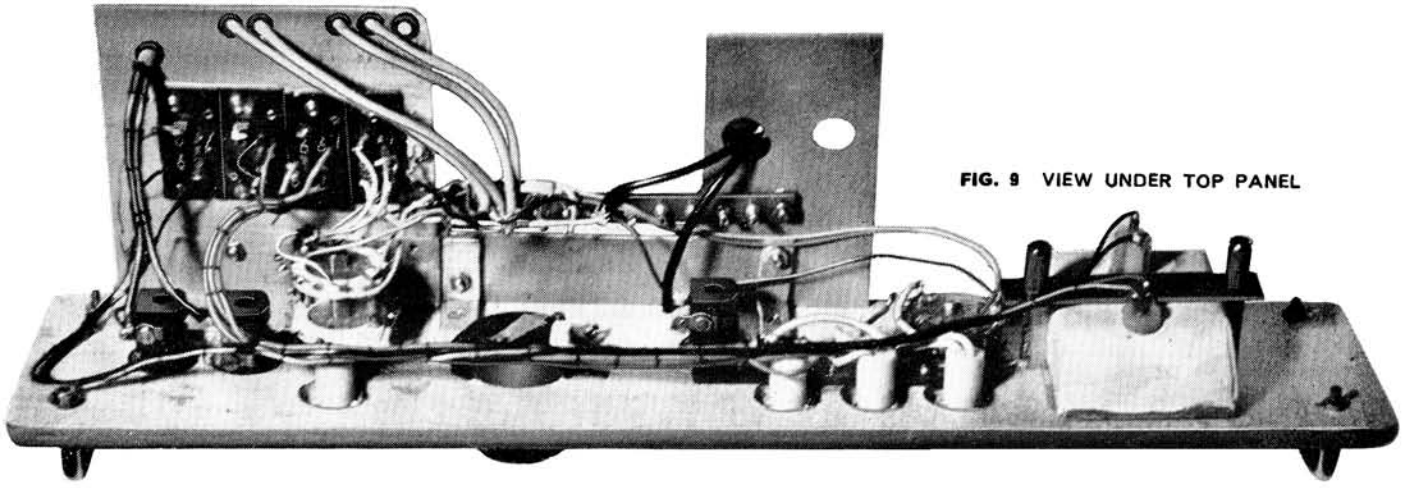


FIG. 9 VIEW UNDER TOP PANEL

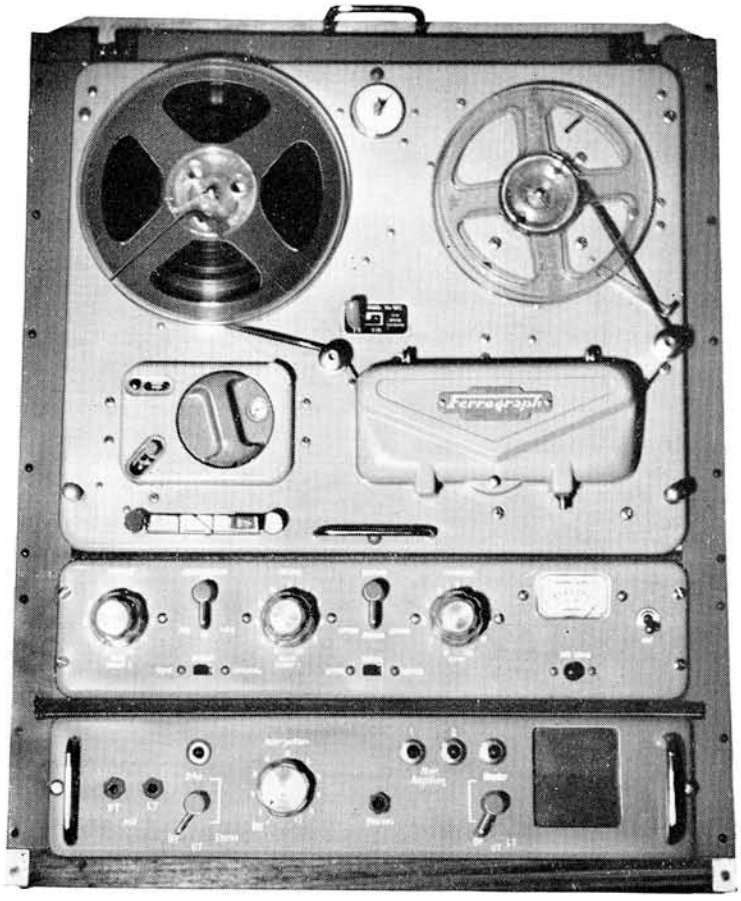


FIG. 10 VIEW OF TOP DECK

in this switch carries 6.3V which is fed to either the record or playback indicator lamp according to whether the switch is turned to the record or play position. The 6.3V can be taken via a 2 x 56 ohms series resistor from a 19V tapping on the Ferrograph transformer, or more easily from an external step-down transformer which should be switched by the on/off switch on the recorder. In the latter case, use can be made of the auxiliary socket on the rear of the instrument.

The information given in th s article describes the authors' own installation which is based on the 422U. This instrument lends itself to useful modification and this is on account of its sturdy construction, its versatility and, above all, its superlative performance. The hinged tape deck makes it very easy for routine service without dismantling the console, but the design of the installation is such that the recorder can be lifted out in its *original* case, after the side deck members are taken off the deck hinges unscrewed from their wood support and rebolted to the original case. This only takes a few minutes and will be required from time to time when a factory overhaul is necessary or when the recorder is used on location.

There are, of course, other machines which would be suitable for such an installation; however the general layout of the top panel and the dimensions of the console would almost certainly have to be altered to suit the recorder used. Indeed, different facilities such as a comprehensive sound mixer (the 422U only has a two-way inbuilt mixer), might be required and this could easily be accommodated in a console built on the general lines of that described here.

The construction of the console, given in **fig. 7,** is from ½in. thick plywood and prepared wood members (1 x 1½in.), with a hardwood beam at the rear to support the hinges for the tape deck. The base, on which are mounted the four trolley wheels, is made from blockboard (¾in.). The console is finished in a teak veneer and olive-green plastic laminate as shown in the photograph, **fig. 8,** aluminium angle being used as indicated for protecting the corners when the console is moved.

The lower front panel, which is recessed as shown, is made from plastic laminate and mounted on plywood (¼in.) and divided into three parts. The centre one is used for the monitor controls as already explained, whilst the lower panel is left blank, although it could well be used for other controls in due course or modified to take a small low-quality monitoring loudspeaker.

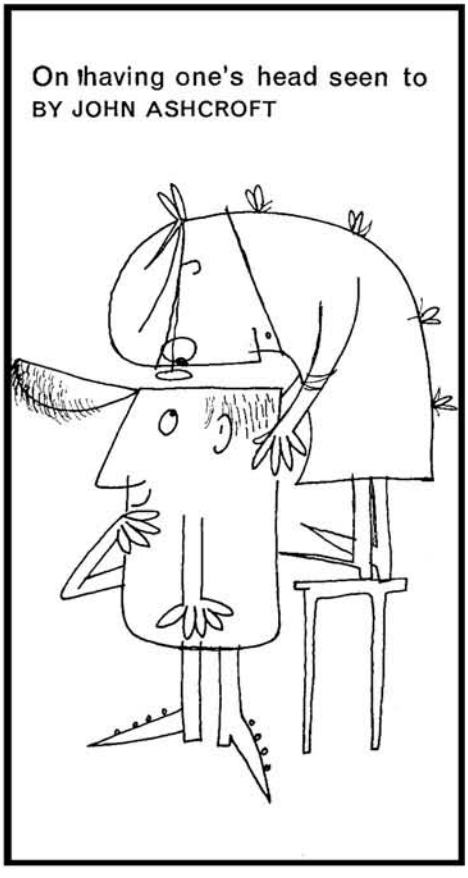
The removable side deck-members, see **fig. 7,** are made from the green laminate supported underneath by a strip of wood attached to the inside edge of the console. These side members are essential to support the sides of the heavy tape deck, the back being supported by the hinges and the front by the original Ferrograph case. Blocks glued on to the side members are drilled to take the thumb screws for holding down the deck. The top panel, **fig. 3,** is secured by screwing down on to two similar blocks nearer the front of the console. The knobs for the top panel and the 1K rheostat were obtained from Ferrograph.

Tele-Radio (1943) Ltd., 189 Edgware Road, London W.2 can supply the Screenector plugs and sockets, whilst the Plessey connectors can be obtained from *Wirecomp Electronics, 323 Edgware Road, London W.2.* All other materials are easily available.

PERSONAL BIAS

On having one's head seen to

BY JOHN ASHCROFT



WHEN did you last have your head demagnetised?

You must admit, it's an effective conversation-stopper. Its *outre* flavour and hint of insult leave the uninitiated baffled but feeling got at, and as likely as not the educated will look guilty and start hedging. Either reaction is satisfying to the bloke who pops the question.

This de-fluxing is a weirdly personal process. First time a visitor caught me in the act, I felt as though the Boss had spotted me chivvying a cob of wax from one lug'ole with the office pencil (the one chained to his desk). And when the visitor politely asked what the blithering bloodbuckets I was playing at, I answered quite honestly that I was just demagnetising my head, but this didn't reassure him . . . if anything, he edged closer to the door.

But you easily acquire a fascinated audience. They lean over and peer as, with infinite delicacy the de-fluxer is brought to the head-face, gripped firmly, as though all the imps of Hades are wrestling with you for possession of it, and then gently withdrawn and switched off. You feel like the tribal witch-doctor casting out demons.

See how the spectators respectfully and silently lean aside to avoid whatever is being coaxed from the machine, and then close in again; like those inevitable oglers around a hole in the road who automatically move aside as each spadeful of earth is flung out and then close in again wordlessly, to and fro, in a sort of rapt rhythmic ritual. It can give you delusions of grandeur.

But it makes me feel no end of a twit. The process looks improbable, to start with, and explanations just sound unconvincing to put it mildly.

It's all right for the deadpan Ebenezers who can airily blind the peasants with gobbledegook. Me, I go red, get stuck for words, and mutter and stutter . . . "It's . . . er, well, it's gotter be done, y'know—because the . . . er . . ." Let's face it, I don't want visitors while I'm de-fluxing my head.

Oh, and I mentioned gripping the gadget as though unseen powers of evil were struggling for possession of it. First time I used a de-fluxer nobody warned me about the physical sensation of handling it when the brute came to life; it gave me the creeps as it began trembling and vibrating with suppressed fury, then got out of control, rattled around the heads, clung to the capstan, and looked for another victim when I managed to wrench it away. And the button jammed down so I couldn't switch it off. I panicked and dumped it on the table near the machine. A razor blade once used for splicing came slithering from under the recorder, sprang on to the de-fluxer's rod, and performed an incredible shuddering dance.

By this time I was compressing myself into the opposite corner of the room and gibbering for help, in case it took a fancy to the iron in my blood. And I've mistrusted these gadgets ever since, even though I use one every week as a matter of routine. Not that the instructions issued with them inspire much confidence . . . I mean, think of the simple, obvious and sensible questions which any novice might be expected to ask!

Do you switch it on *before* bringing it close to the head?

How *close* to the head should it be held?

For how many *seconds* (minimum) should it be kept near the head?

How *slowly* should it be withdrawn from the head?

At what minimum *distance* should it be switched off?

And should it be used on the erase head *as well* as on the record/replay?

Well, I only asked.

The literature abounds with imprecision. "Close to . . . for a while . . . slowly . . . well clear . . .", and as for that business of the erase head, it takes some doing, getting a straight answer. Some people assure you that erase heads are automatically de-fluxed; others insist that they can remain magnetised. So I treat the lot: heads, capstan, guides, autostop trigger.

By the way, anyone who can't afford a de-fluxer can find a cheap alternative. The magnetic properties of a metal can be jarred out of existence by a few good sharp taps. Ebenezer has invented a neat little gadget, a metal mallet, and you simply give the head-face half a dozen healthy clouts with it. The hiss vanishes from your recordings immediately. So do a few other sounds, but at 7s. 6d. this mallet is a very good buy, and can also be used for breaking home-made treacle toffee on Bonfire Night. What more could one ask?

Years ago, fine weather inspired me to complete a message-tape in the garden. I stood the microphone by a chair on the grass, trailed the lead indoors, plugged it into the recorder, set the gain level, and sprinted out and settled down as the leader-tape began winding past the heads. Birdsongs, occasional tractors, and once the lazy clipclop of a passing horse added atmosphere while I chatted casually for ten minutes. A glance at the stopwatch (oh, I'm highly methodical) confirmed that the end of the track was approaching, so I rounded matters off with impeccable timing and sauntered indoors feeling very satisfied.

The spools were already motionless, the tape having been halted by a strip of stop-foil on the end of the leader. Fair enough. Yeah—but it was on the *front* piece of leader: the machine had halted just as I was about to begin speaking!

That did it. I stripped the stop-foil from every tape (and still do, even though one of my recorders is designed for stop-foil halting). I'd been having doubts about the stuff long before this fiasco. Mysteriously developing clicks, near the ends of thin tapes, coincided with the spool rotation and position of stop-foil . . . obviously printed through the tape from the foil. And tapes with stop-foil developed a fearful crackle on fast-wind: in dim light you could actually see great sparks flying around the hubs. And official reassurance be blowed, I never really liked dragging the stuff across the head-faces.

Nor had I been fond of the manifestations accompanying a stop-foil halt. I'm deeply allergic to things that fizz and bang and flash, and stop-foil halting can produce some frightening effects. So I've rejected the stuff outright; I attach lengthy leaders allowing me to cross the room and settle down with the microphone and come in on cue for a message tape, without those irritating burps and clicks often caused by jumping past the stop-foil and engaging the record function on the tape proper.

Not that it solved my outdoor tapesponding problems. I tried again, another fine day, and came back to find only a faint hiss on the tape. I'd left the machine running with the gain set at zero. On another occasion, when a relative joined in the garden chat, we returned indoors to see that I'd set the gain to an adequate level but made a small error, you know, one of those minor, unimportant things that can happen now and then. I had forgotten to plug in the microphone.

tape recorder service

No. 64 THE BRENELL RANGE

BY H. W. HELLYER

'REGULAR Reader of Peckham Rye' will be disappointed with this month's contribution. So—as usual—will 'Disgusted of Huddersfield'. According to their answers to the recent Questionnaire, this column spends too much time looking back over its shoulder. They would have us ferreting around the factories, little notebook concealed in our bowler, bringing back the secret gen about the models for the season after next. A look at one of the stalwarts of the British tape recording scene hardly falls into this category. Especially a stalwart whose product appears to have remained unaltered for very nearly a decade.

The *Brenell Mark 5* is a machine that has formed part of the solid backbone of our trade, and the *Series 2*, *Series 3*, and now the *M* versions incorporate only minor changes to a well-proven basic design. We shall skate over the less well-fated *Three-Star* model and concentrate on the marques of the *5*, even though to some of our knowledgeable readers the information may seem to be 'old hat'. My personal correspondence shows that there is a great amount of interest in these machines, as in the earlier *Ferrographs*, by people who are 'graduating-up' from their tyro purchases of mediocre tape recorders, cannot afford the prices of top-quality modern machines, with perhaps many more facilities than they need, and have the occasional chance of a second-hand bargain.

SECOND-HAND 'M'

Unfortunately, the depreciation rate of these dependables is not high. Very few appear in the 'For Sale' columns, and those few are probably snapped up before the ink has dried on the advertiser's pen. I've been looking for a second-hand 'M' at a price I can afford for some considerable time—without success; and I am in the trade.

This is one reason why the accompanying circuit has been given and why more space can be requested next month to outline the later variations. Despite the transistorised wonders, the complicated Common-Market-type switching and interconnections, and the fining-down of fundamental mechanics that modern tape recorders possess, the fairly straightforward design of Brenell, and a few others, is the subject of general interest. So our friend 'Disgusted' will have to curb his impatience, or turn to the reviews for his light reading.

One little piece of literature that might have come his way was our original *Tape Recorder Service* article (No. 12 of the series), dealing with the Brenell Three-Star and Mark 5 decks. To paraphrase a well-known political gentleman . . . "But, you know, as I said in December 1962," the mechanical details should need only the briefest reminder. It is only lately that we have been able to publish circuits, and these need a few words of discussion.

One of the formidable features of the accompanying circuit is the selector-switch wiring. To be sure, if one has to trace out the wiring for any reason, the physical layout makes it even more difficult, and the type of switch employed by Brenell is not conducive to simple observation. But the laborious circuit-tracing beloved by so many novice engineers, apprentices, and chaps like you and me with a frustrating problem to solve, is very often quite unnecessary. The logical tracing process is not to follow the wires along, like chasing snakes in a Christmas game, but to use the meter, or other test gear, and check conditions at each end of the wire. A few quick continuity tests are worth a wealth of probing, and a swift disconnection and measurement beats all the angled eye-strain.

EXPECTED SOURCE

The trick with unravelling devious circuits is to determine first what the arrangement *should* be doing, then select a point from which to start and trace through the switch toward the *expected* source, when the wiring will seem to fall into place as you inspect it. To give an example—in **fig. 1** the circuit is drawn in the record mode. We know this because the selector switch emblems at the top are shown in record. But what if the draughtsman, like so many of his kin, had not given us that clue? Look first to the input—in this case, the grid of the first stage, the EF86. If in record, we expect this to go to the microphone socket, perhaps via a coupling circuit or splitter network. So we trace the connecting line back from pin 9 and, where it approaches the switch, hold it in our mind's eye and go the other way, toward the microphone socket. From the press-up contact here we trace another lead to the same switch-bank, the top face of the lower wafer, and, as expected, to the same three-pole section. Note that the common terminal of the three-pole switch section is the longest terminal.

This may seem very obvious to old hands, but my conversations with readers and that uniquely one-sided conversation that so much of my mailbag becomes, makes me certain that the small hints and tips of day-to-day working are welcome to a wide section of readers. As usual, I am confident that I shall soon be disabused if I am wrong!

Many manufacturers choose to draw the switch banks in symbolic form, number the sections and then show the individual switches as if they were small single- or double-pole contacts on the appropriate parts of the diagram. *Philips* and *Grundig* both do this, and until one is used to the system, tracing one mode of operation when the diagram is drawn in another can be quite difficult; especially when relay contacts are also involved. Brenell's method, although rather old-fashioned in appearance, is at least a semblance of the actual layout and aids circuit tracing. Although the writing is sometimes hard to read, they are also to be applauded for inserting component values on the diagram. Nothing is more annoying to the busy engineer than to have to keep leafing through a manual to reconcile the components to their values. And as for the growing habit of drawing all resistors and capacitors as little blocks, identified by some curious code—a plague on the originators!

On the subject of components, it is as well to note that there may be some differences in the production run of the early machines. Where Brenell employed *Bogen UK100* record/play heads, the following changes were made: C8, C11 and C32 were removed. C12 becomes 200pF; C23 150pF; R8 12K; R12 220K; R13 470K; R14 1M; and L2 was tuned to 14kHz at 7½ i/s. Erase heads were also changed, to UL117 types, and in this case a 5,000pF capacitor is fitted in series.

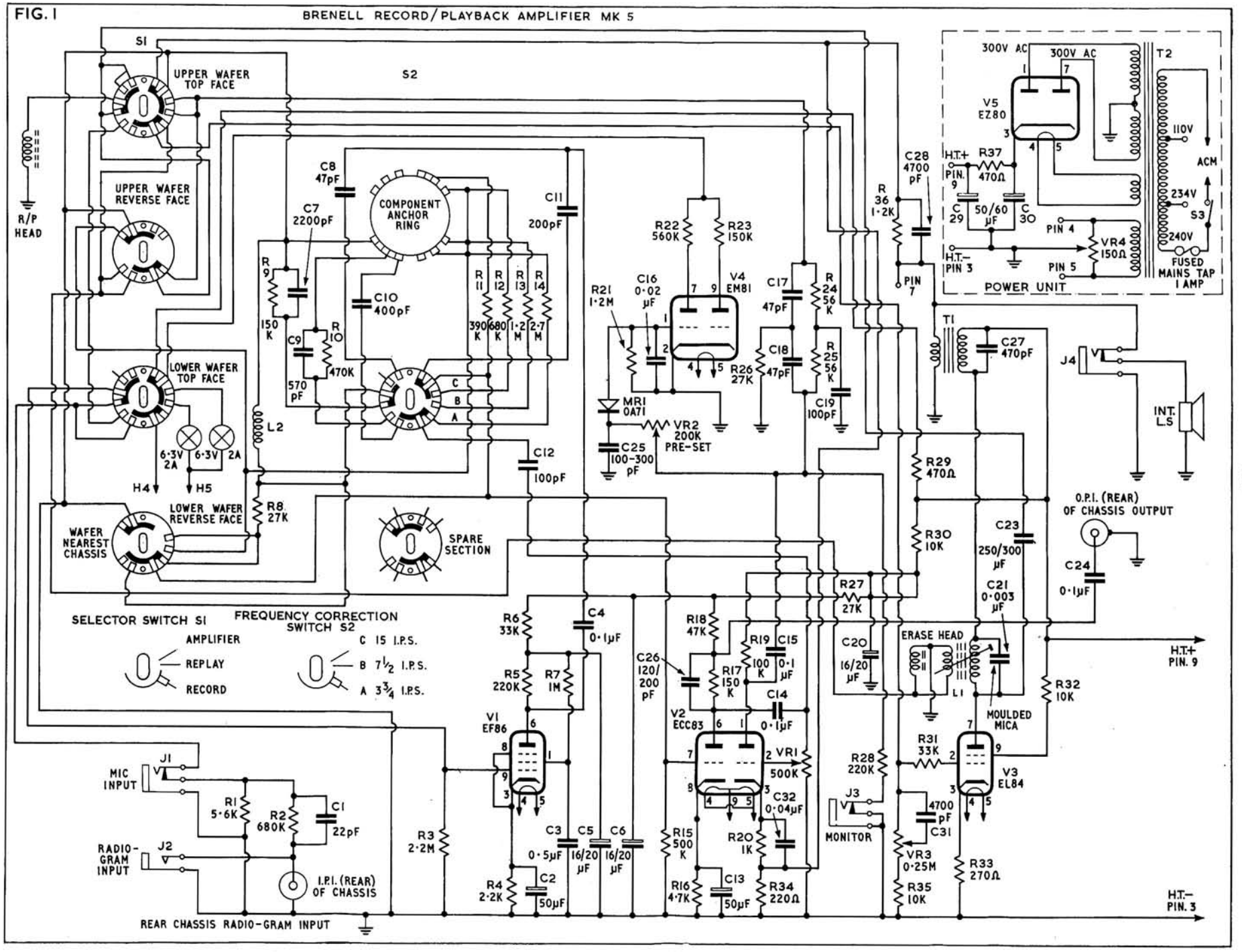
The Series 2 was a re-styled version, with a natty cover-plate over both the amplifier and deck top-plate, which was all very fine except that one had to remove head covers, knobs and the new feature, a rotating guide, to get the top plate off and unscrew the deck fixing bolts. It is important to use the right size of screwdriver for this operation, as the steel grub screws can easily snap off at the slot when carelessly attacked. As a part recompense, the four amplifier knobs were changed from the 'pointer' type so characteristic of Brenell, to the round fluted ones.

Other obvious changes were the bringing of the external loudspeaker jack socket to the front panel, the addition of a superimpose control (which is a purely mechanical device to remove the tape from the erase head), and the use of an EM87 magic-eye, with bar-light indication, in place of the 'leaved' EM81. There were other, less obvious changes. Most important was the difference in input sensitivity. R2 is 150K on the later models and the radio input sensitivity is increased from 250mV

(continued on page 296)

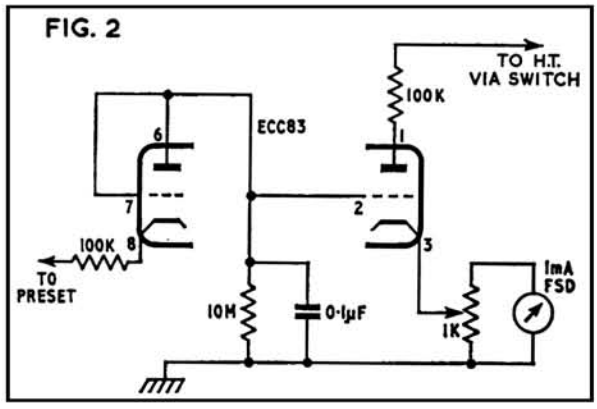
FIG. 1

BRENELL RECORD/PLAYBACK AMPLIFIER MK 5



tape recorder service

No. 64 THE BRENELL RANGE



into 700K to 75mV into 150K, much more realistic.

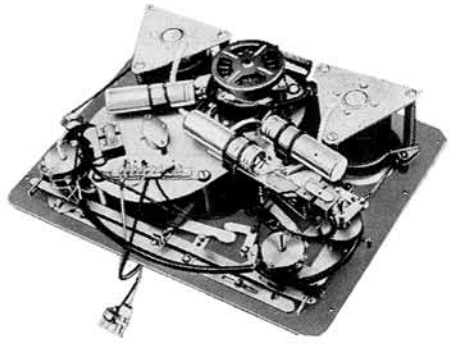
On the subject of inputs and outputs—it may perhaps be mentioned that the monitor output is used very often as a link to an external amplifier—and it is quite suitable for the job in many cases, giving 2V across 100K, but of course the level is determined, on Playback, by the setting of the volume control. The correct External Amplifier output is from the coaxial socket on the rear of the chassis, from where 500mV across 47K is obtainable, and, of course, this is independent of the volume control setting, coming from the anode of the first half of the ECC83 via C24.

Microphone sensitivity and impedance are better on the Series 2 range, being 2mV into 1M against the original 2.5mV into 2M. Many people use this input with a moving-coil microphone or a ribbon such as the *Reslo RTB/L* and the low-to-high matching unit, which will amply realise the capabilities of the Brenell Mark 5. This is one machine that can give good output results through its own output stage and 15-ohm loudspeaker. But no tape recorder is really intended as a self-contained high fidelity amplifier, whatever the brochures may say. At least, do it some justice by using a decent external loudspeaker. Better still, take off the signal at the preamp output socket and feed an external hi-fi system. This is the sort of thing that really separates the sheep from the goats, and proves why Brenell has earned and kept its good name.

Earlier, mention was made of the change of magic eye. Some of the earlier machines, and most of the later ones, had meters fitted instead. The type of meter, a round movement with rather a cramped scale, may not seem as pretty as many later meter designs, but it is excellently damped and fed by a stable circuit so that one is really reading the true signal, and not an overlay of noise and rectified bias, as with many other unmentionable machines.

RIGHT-HAND ZERO

The meter is a right-hand zero type, so that when the machine is switched to record a standing current flows and the needle moves to the left of the scale. To zero, first reduce the input gain control to its anti-clockwise position. For an accurate check, feed a 1kHz signal into the radio socket and adjust for a reading of 1.5V across a 47K dummy load plugged into the monitor socket. Then the preset level control can be adjusted to give correct indication. This is when the leaves or bars of the magic-eye just close or the meter needle rises to Calibration 7. Details of the meter circuit as used in the Series 3 models are given in **fig. 2.** It can be seen that this is simply a 1mA movement shunted by the variable control and forming the cathode bias component of the second half of what is, in effect, a valve-voltmeter. Note that this preset is the zeroing device. The preset for the meter circuit is a 1M type, employed in a similar position to RV2 in the magic-eye circuit of **fig. 1.** HT for both circuits is derived from the main line via a switch section, closed during record. The system allows the setting up of correct levels before the motor is started, i.e., before recording commences—another feature that should really be standard on any decent machine.

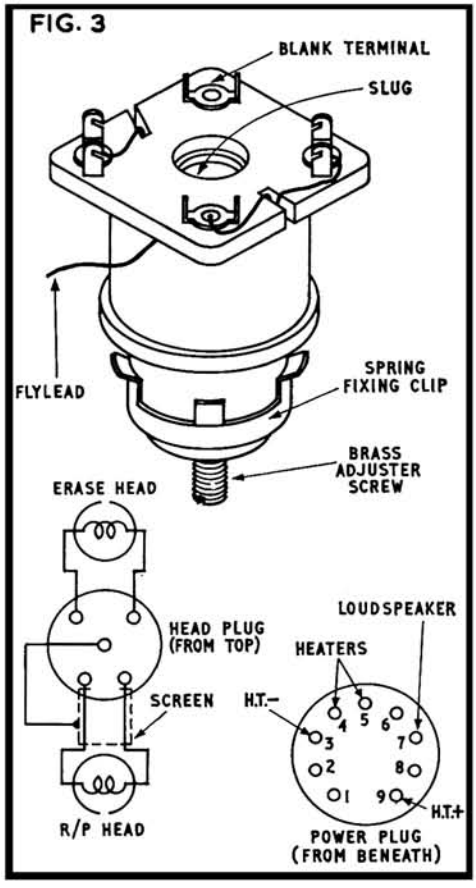


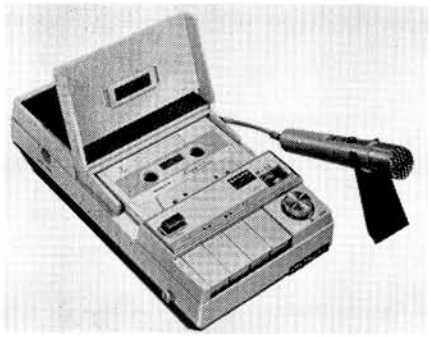
PLUG AND SOCKET

Our **fig. 3** shows the plug and socket connections for both the head unit and the power supply to the main amplifier unit. It also shows a view of the oscillator coil. The reason for this is to overcome some of the snags that we have found to arise when servicing this range of machines. Burned-out oscillator coils are some of the faults that give the most trouble. The coil has four tags on its upper face, but the lead-out wires are only taken to three of these, and the fourth lead is a flylead, coming out from the side of the coil, often lipped closely under the upper Paxolin cheek and appearing to be connected to one or other of the tags. This is actually the earth return of the secondary, and care must be taken to route it carefully away from a 'hot' tag. Note that these 'hot' tags are colour coded red and yellow, the former being the HT connection and the latter going to the anode of the EL84 valve. Sometimes these are adjacent, and sometimes diagonally opposite on the top of the former, depending on the production run. This point *must* be watched. As an old hand, this contributor always checks coils with a meter before inserting them. Nothing is more frustrating than to instal a complicated piece of hardware and find that some gremlin has changed the colour coding or modified the windings. A little extra time at the outset of a repair job can save much juggling later.

For the rest, there are quite a few differences in later marques. The Series 3 equalisation circuit is switched between the cathode of the first stage and the anode of the second and needs a separate diagram to explain it, for which no space is available in this issue. The tone control circuit is also quite different, and this, too, will have to wait.

(continued on page 305)





SANYO PORTABLES

ONE battery and two mains/battery portables have been announced by *Sanyo*. The first is designed for *Philips* cassettes, operates at 1⅞ i/s, and features AC bias. Claimed wobble is 0.5%, frequency range being 100Hz-6kHz. The *M.18* costs £24 3s. complete with cassette, microphone and accessories.

The *MR.130* sells at £30 9s. and operates at 3¾ and 1⅞ i/s. Spool capacity is 5in. Automatic gain control is featured and powering is from mains or six *U2*-size cells.

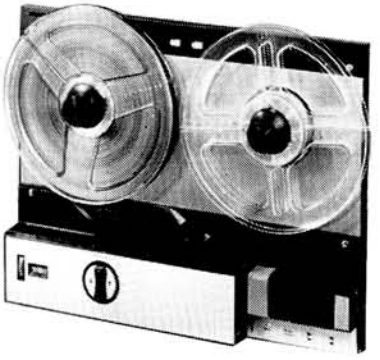
Quarter-track stereo recording facilities are included on the *MR.151*, which has speeds of 3¾, 1⅞ and 15/16 i/s and takes 5in. spools. Output power is quoted as 0.9W per channel through internal side-facing speakers. Pause control and twin VU-meters are incorporated. This model operates from six *U2*-size cells or mains and has a 35dB signal-to-noise ratio. Price has yet to be decided.

Distributor: Sanyo Service and Sales, Marubeni-Iida House, 164 Clapham Park Road, London, S.W.4.

QUARTER-TRACK TANDBERG

IN addition to their £72 9s. ½-track model, *Tandberg* are now producing a ¼-track version of the *Series 9* three-speed mono recorder. This machine is similar to the existing *Model 843* but has the advantage of 7½ i/s operation.

Distributor: Elstone Electronics Ltd., Hereford House, North Court, Off Vicar Lane, Leeds 2, Yorkshire.



VAN DER MOLEN DECK

THE tape transport employed in certain *Van Der Molen* recorders is now available without surrounding electronics or cabinet at £15 15s. This mechanism, which will normally be supplied with ¼-track erase and record/play heads, operates at 7½, 3¾ and 1⅞ i/s, for which respective wobble figures of 0.15%, 0.25% and 0.35% are claimed. Fast forward, rewind and press-controls are incorporated, spool capacity being 7in. The deck includes a three-digit spool rotation counter and will function in a vertical position.

Manufacturer: Van Der Molen Ltd., 42 Mawney Road, Romford, Essex.

SEMI-MINI SPOOLS

HALF-way between the standard 3in. spool and the miniature *BASF* and *Mastertape* designs is a 2⅜in. reel now being distributed under the *Synchrotape* label. This is being supplied with 200ft. of LP PVC tape to retail at 5s. 9d. A 300ft. DP version is also available at 8s. 9d.

Distributor: Adastra Electronics Ltd., 167 Finchley Road, Swiss Cottage, London, N.W.3.

COMPONENTS AND EQUIPMENT CATALOGUE

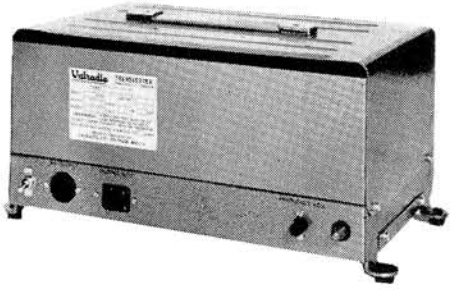
FIRST catalogue to be produced by *G. W. Smith* (*Radio*) is an ambitious 154-page publication covering all aspects of electronics and audio. It is available by post at 5s., refundable on orders of £2 or over. A deduction of 2s. 6d. from the cost will be made on orders between £1 and £2

Publisher: G. W. Smith & Co. (Radio) Ltd., 3 Lisle Street, London, W.C.2.

VALRADIO CONVERTORS

NEW generation of battery/mains convertors now being produced by *Valradio* comprises four models stabilized to better than 0.25Hz at 50Hz and within ±10% of 115V or 230V output. All units provide a sine-wave output suitable for powering mains audio and video tape recorders from a car-battery. The *B12/120S* gives 120W output from a 12V supply and costs £47 2s. *B12/200S* provides up to 200W from the same supply at £67 12s. Models *B24/120S* and *B24/200S* give 120W and 200W respectively from 24V and cost £48 18s. and £69. All versions are 15¾ x 9¾ x 7¼in. in size and incorporate carrying handle and mounting feet. The 120W models weigh 21lb. while the 200W transverters are 26lb.

Manufacturer: Valradio Ltd., Browells Lane, Feltham, Middlesex.



GRUNDIG SLIDE ATTACHMENT

AN improved version of the *Sono Dia* synchroniser is now being produced by *Grundig*. The attachment will fit any open-spool recorder where the spools are not recessed into the deck, and permits automatic operation of solenoid slide projectors. Price is £18.

Distributor: Grundig (Great Britain) Ltd., Newlands Park, Sydenham, London, S.E.26.

NEW HEATHKIT CATALOGUE

WITH their latest catalogue, *Daystrom* have added a transistor AM/FM stereo tuner and several items of amateur radio equipment to the *Heathkit* range. The tuner is being marketed at £32 7s. Promised for the future is a mains stereo tape recorder with full record and replay facilities and internal speakers. For their existing *TA-1M/S* tape amplifier, the company are now distributing *Truvox Series 100* decks at £39 15s.

Manufacturer: Daystrom Ltd., Gloucester.

FERGUSON 3214

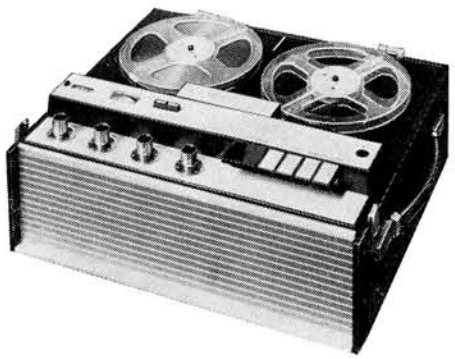
THE Ferguson 3214 is in the same family as the *Marconiphone 4210*, the *HMV 2208* and the *Ultra 6206*, all made by the *Thorn* group of companies who together will probably make a considerable impact on the Common Market if we do join and start exporting tape recorders to Europe. How do they compare with Continental machines in the same £40-£50 price range?

They use valves instead of transistors, wooden instead of plastic cabinets, crystal microphones instead of moving coil units, and may be thought to be slightly conservative in styling and construction. But valves have lower inherent distortion than transistors and also produce more power output with less trouble; wooden cabinets sound better in most cases than plastic resonators. A dynamic cardioid microphone is at least included amongst the very considerable range of accessories offered for use with this recorder.

Six press-tabs control all tape movement and record-play switching and the record key may be locked down to use the recorder as an amplifier for radio tuner, record player or microphone. The four rotary controls are clearly marked and calibrated so that levels may be set exactly to predetermined adjustments. A meter type record level indicator is used, and the four-digit tape position counter can be zeroed by a single push button. Press keys control track selection and they both may be locked down for 'multi-play'. A DIN type microphone socket is provided on the deck panel and all other inputs and outputs, also using DIN sockets, are located at the rear of the machine.

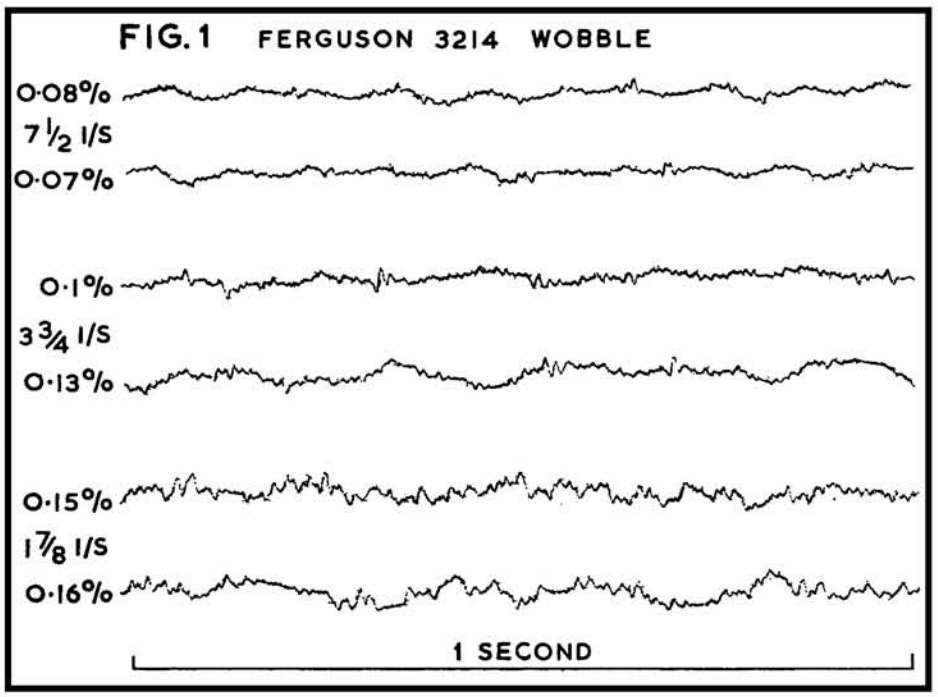
Tape motion was smooth and free of snatch or tension, and tape speeds were found to be within ±2% limits at all parts of a 7in. reel. Short term tape speed irregularities were low as demonstrated by the fluttergrams of **fig. 1.** RMS readings of 0.07% to 0.08% were obtained at the highest speed with extremely low high frequency tape flutter. At 3¾ i/s, the readings ranged from 0.1% to 0.13% as the 5Hz capstan wow cancelled or added due to record and play phasing altering slightly with tape placement. At the lowest speed of 1⅞ i/s, the worst reading was still only 0.16% with slightly more tape flutter and the capstan wow reduced to 2½Hz. Only at this lowest speed could capstan wow be detected on sustained chords or notes on music, but it was completely satisfactory for reasonable speech quality recording.

The playback equalisation was tested by playing tapes recorded to the CCIR/DIN standards of 70, 140 and 280μS at the three tape speeds. The responses of **fig. 2** indicate that the electrical equalisation is exact but that there is a slight low frequency irregularity due to the short pole face heads, where a secondary 'gap' effect is produced by the sharp profile of the pole faces which beats with the output of the primary gap. This is purely a playback effect and it will be seen that the shape of the curves are not further affected by the recording process (**fig. 3**). The level record-play responses show that record pre-emphasis is also very close to CCIR requirements.



MANUFACTURER'S SPECIFICATION

Quarter-track domestic tape recorder. **Tape Speeds:** 7½, 3¾ and 1⅞ i/s. **Wow and Flutter** (respective): 0.15%, 0.2% and 0.25%. **Frequency Range** (respective), 40Hz-18kHz, 40Hz-14kHz and 40Hz-7kHz. **Signal-to-noise ratio:** 40dB unweighted. **Spool Capacity:** 7in. **Inputs:** Radio—1mV at 68K; PU—180mV at 200K; Auxiliary—75mV at 3.3M. **Line output:** 1V at 22K. **External speaker output:** 3W at 3 ohms. Solenoid remote-pause from microphone. Straight-through amplifier. **Dimensions:** 16½ x 14½ x 8in. **Price:** £46 4s. **Manufacturer: Thorn Electrical Industries Ltd., Thorn House, Upper St. Martin's Lane, London W.C.2.**



SYSTEM NOISE

System noise with no tape passing the heads was rather high at 24dB and 22dB below test-tape level on top and bottom tracks respectively. CRO examination of the noise showed this to be due to low-level mains hum picked up on the heads from the drive motor. Valve hiss and microphony were low.

Overload recording tests at 500Hz proved that a level 12dB above test-tape level could be recorded at less than 5% 3rd harmonic distortion, so that the measured unweighted signal-to-noise (hum) ratio was between 34 and 36dB against the specified 40dB. The hum however was reproduced at fairly low level on the internal loudspeaker, and tape hiss was extremely low due to the use of a push-pull bias and erase oscillator, so that the subjective impression of signal-to-noise ratio was excellent.

The overall acoustic response of **fig. 4** was obtained by playing a standard one-third octave white noise 70μS test tape at 7½ i/s and measuring the sound output on each of the 25 noise bands on a calibrated microphone. It will be seen that the response is well balanced about the mid frequency of 1kHz and is within plus or minus 5dB limits between 120Hz and 9kHz. The sound quality from a good tape was solid and smooth up to quite high listening levels without distress or cabinet vibration.

The microphone response was also measured using the white noise technique to give the response of **fig. 5.** The broad peak at 3kHz caused some sibilant splash at the lowest speed

(continued on page 300)

FIG. 2 FERGUSON 3214 PLAYBACK RESPONSE (TEST-TAPE TO LINE OUT)

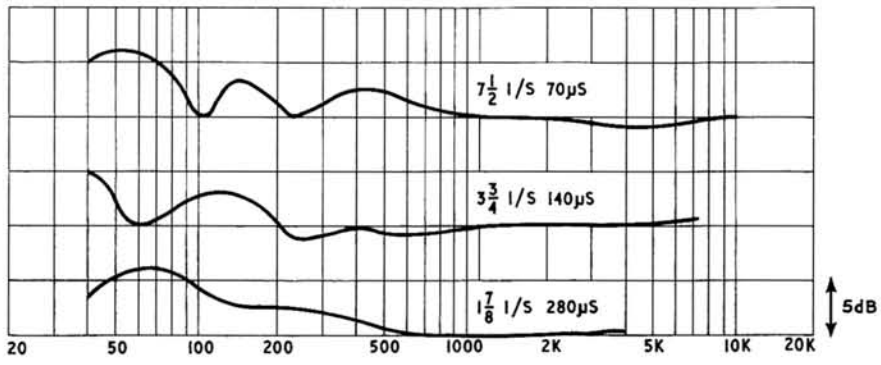


FIG. 3 FERGUSON 3214 RECORD/PLAY RESPONSE (LINE IN-OUT)

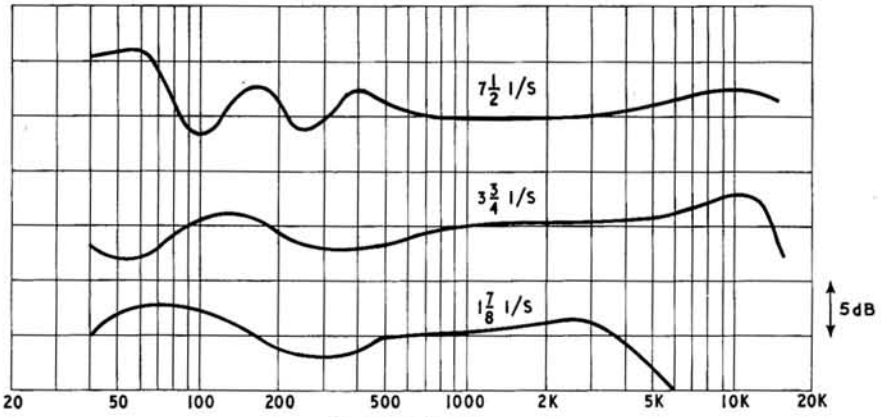


FIG. 4 FERGUSON 3214 ACOUSTIC RESPONSE

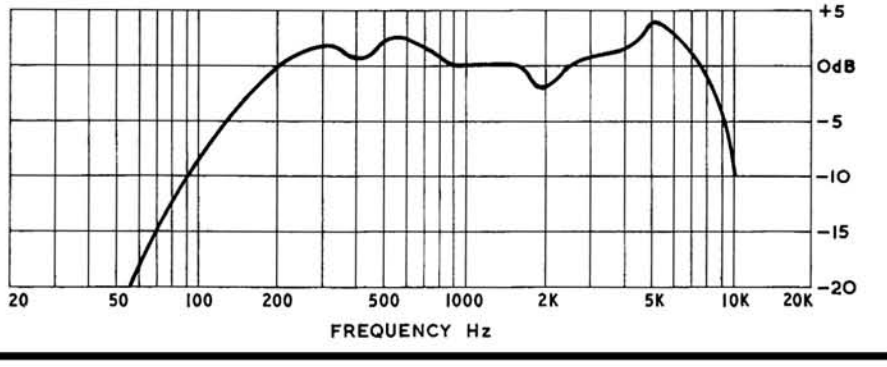
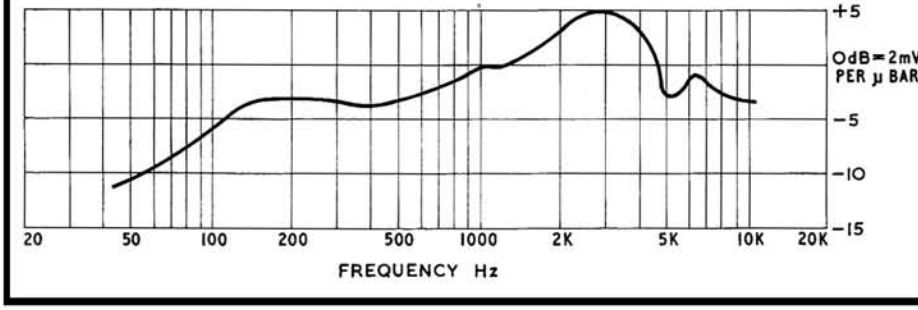


FIG. 5 FERGUSON 3214 MICROPHONE RESPONSE



of $1\frac{7}{8}$ i/s unless the recording level was reduced to less than half scale deflection on the record level meter. At the two higher speeds, full recording level could be used with only a slight hardness of the voice quality due to the microphone response. Voice quality on broadcast recordings was extremely good.

COMMENT

To answer my question in the opening paragraph, the Ferguson 3214 certainly scores on the very important factor of sound quality. Most Continental recorders are weak in output-stage and internal-speaker quality. Frequency responses to line output are at least up to the standard of comparable European recorders and should meet all their requirements regarding standard DIN plug and socket fittings.

The hum level is slightly high on my review model, but it would only obtrude on a wide range speaker system or a radio-amplifier speaker combination with a low frequency cabinet resonance.

The solenoid remote control on the microphone is a valuable feature for some applications and I would draw readers' attention to the notes on the use and abuse of this facility in Mr. Hellyer's *Tape Recorder Service* article in the June 1967 issue. A lot of further information on the drive system and a full circuit diagram is also provided in this article.

To sum up then: The 3214 is an excellent example of a mono $\frac{1}{4}$-track recorder in the middle price range, with better than usual sound quality.—**A. Tutchings.**

READERS' PROBLEMS

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

A VERDIK SOLENOID

Dear Sir, I own a *Verdik S.1* tape recorder and would appreciate information concerning the solenoid which operates the brakes of this machine. I have no particulars concerning the specification and am finding it impossible to obtain a replacement.

Yours faithfully, **R.C.O., London S.W.6.**

Occasionally, a dealer may get an old machine (usually the HMV DSR1) in part exchange and keep it for 'robbing', and in this way there is still a rather sluggish circulation of spare parts within the trade. However, they will seldom sell such things as solenoids across the counter.

One source from which spares were obtainable up until a short while ago was the HMV Service Department at Penleigh Works, Wells, Somerset, but whether they would deal direct is another matter.

As this is not an unusual type of solenoid—though it has absolutely no identification—you may match it at Lasky's or Proops, both of which have a very wide selection of ex-Service solenoids to choose from. You are near enough to be able to get into the 'surplus heart' of London, along and around Edgware Road, and with the solenoid in hand, may even be able to get an exact replacement. This is what we would advise, rather than the frustrating round of letters to makers, etc. It is a 5K solenoid which operates with a series 2.7K resistor from 200V HT.

A word of warning is necessary if you are lucky and have to fit a substitute—or even an exact replacement. You will have to remove the tag panel and make or obtain an angled spanner of odd size—somewhere near 3BA—holding the nut while using a narrow screwdriver to turn the screw, and the eventual adjustment is very touchy indeed.

FAULTY BIAS ON THE TK5

Dear Sir, I have a *Grundig TK5* tape recorder and am having trouble with recording and erasure, although replay is in good order. The fault seems to have developed since I plugged a telephone pick-up into the diode socket, after which it would neither record nor erase. I have replaced the EF86 and ECC81 valves without success.

Yours faithfully, **S.T., Oldham.**

As you are having trouble both with erasure and recording on the Grundig TK5, we would assume your fault to lie in the EL42 oscillator stage. The valve can be tested by substitution with the output stage valve as these are both EL42 and we presume playback is normal.

Most likely trouble is breakdown of the 5K resistor that provides HT for this stage (oscillator) and the clue is a dulling of the magic-eye, which derives its HT from the same source. Next most likely culprit is the 0.002μF capacitor across the oscillator transformer primary, and then the 0.01μF decoupler of the screen grid.

You should also check the 500-ohm cathode resistor of the EL42. This undecoupled component has a habit of suffering through overheating especially if there has been a previous valve fault.

A DISTORTING COSSOR

Dear Sir, My *Cossor 1604* tape recorder has given me the greatest pleasure for a year or so (I am not seeking the highest of fi) but has now developed a fault. The symptom is that everything sounds grossly distorted, although the magic-eye gives normal indication and the gain control is not turned up more than usual. It distorts in the same way when used

as a straight-through amplifier, but tapes recorded before the trouble are unaffected. *Philips* will not give me a circuit diagram though I am trying to obtain one via 'back-door' channels. In the meantime, can you suggest where I should commence looking for the trouble? If it is relevant, I should perhaps add that the recording level indicator flickers a little on playback: so far as I remember, it used not to do so.

Yours faithfully, **B.R.C., Burgess Hill.**

The trouble with your Cossor 1604 is almost certainly a switch fault, especially if playback of previously recorded, known good tapes is in order. You mention playing back through the diode socket to an external amplifier—does this mean that playback through the internal output stage and speaker is not in order? This sounds doubtful, as the trouble is more likely to be earlier in the—record/play switching.

However, if playback through the internal amplifier is not in order, look for the return lead from the volume control, or even the control itself. An open circuit at the earth end will cause the fault you describe, and give the additional symptoms you enumerate.

FITTING ADJUSTABLE GUIDES

Dear Sir, Could you please tell me if it would be possible for me to fit a pair of *Ferrograph* adjustable tape guides to a *Sony TC-500?* There seems to be room on the deck but the main problem would be attaching them to the top cover. *Yours faithfully*, **B. H., Preston.**

It should be possible to fit the Ferrograph adjustable guides to the Sony TC500 deck by drilling a clearance hole and using a thin nut fastening beneath the main plate. Drilling and tapping is not advisable, as the tendency of a screwed support is to work loose with tape tension (rather as the Brenell type are inclined to do when the locking collar is not tight). Moreover, the thickness of the deck is not really sufficient support.

You must thus choose your placing very carefully. In fact, we do not think this is a very good idea on the 500 as the tape take-up is carefully balanced for vertical operation and clutch action may be impaired by extra tensioning. In addition, any guide to the right of the capstan will affect the entry angle of the tape and may give jerkiness at the beginning of a recording. This would have to be an experiment with a hand-held roller guide first, to determine the effect.

We are not sure why you want to make this modification, unless it is to fit a stroboscopic disc. Are you having trouble with the tape drive?

A RUMBLING STUDIO

Dear Sir, My *Elizabethan LZ29* has developed a grinding rumbling at 3¾ i/s. The noise is mechanical and does not occur on fast-wind, or at the other two speeds, although after being in use for some time the forward wind becomes slow and noisy. The manufacturers have supplied me with service sheets for the deck (*Magnavox Studio*) and amplifier, so that I can carry out any necessary repairs.

Yours faithfully, **J.R.H., Keighley.**

There would appear to be two separate faults. The grinding and rumble on one speed only indicates the rubber idler wheel is rubbing on the flat surface of the larger step of the motor capstan, and this latter has probably slipped. You can check this quite easily, with the aid of a good light, and with the machine switched off and Play position selected. There are grub screws securing the capstan, and the only difficulty is in holding the spindle while slackening these and retightening. Patience and a gentle touch is needed.

You should check the idler for possible rough surfaces, and also look for small rubber deposits on the flywheel. Clean with methylated spirit and apply a single drop of medium oil to the idler hub and the hinge point of the bracket, and a light grease to the ramp slide.

The second fault is slackening of the right hand spool carrier on the motor spindle. This is a very common fault. When it occurs, the steel motor spindle tends to 'chew-up' the alloy carrier at the cap point, and you should remove (three screws), clean the swarf and reassemble before tightening the axial screws (or bolts, if used) on the drum. Some types used a sleeve bush where this has worn. Removal, slotting at the bottom with a small hacksaw and reassembly to allow the screws to clamp it more firmly on the spindle, could effect a complete cure. Make sure there is no oxide trapped in guide flanges —another common cause of sluggish wind—and that motors are correctly lubricated.

PHILIPS EL3542 HEAD WEAR

Dear Sir, I have had a ¼-track *Philips EL3542* for some four years. Recording and playback are still quite good on tracks 2 and 3 but not acceptable on the outside tracks (1 and 4). The machine records on the latter, but at a much lower level and with poorer quality. Playback of known-good recordings is still quite good. Could you please suggest the probable cause as I would like to put this matter right myself if possible?

Yours faithfully, **F.R., Romford.**

The problem with your Philips EL3542 is almost certainly head wear. This type of record/play head was rather prone to wear, particularly if the tape gathered dust and acted as an abrasive agent. Evidence of tape oxide in the cavity beneath the shield would confirm this.

If you look at the head facing with a strong light, and, if possible, with the aid of a magnifying glass, you may note a horizontal ridge either above or below the shim strips that run across the heads at gap level. This ridge in the hard plastic is worn by the edge of the tape and prevents the tape from sitting tight to the gap, as required. There is no cure except replacement of the head, and this, through a Philips agent, would probably cost in the region of 50s.

Playback is always better, and playback of a good tape will give little apparent drop in output, but the recorded and replayed tapes will immediately show this fault.

The other possibility is a lack of bias. This machine has separate series capacitors (of the beehive type, mounted on a small sub-chassis) and if you have a millivoltmeter or a good AC meter, you can measure the bias at each head winding, terminals accessible at the rear of the

(*continued on page 303*)

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head, and check this point, adjusting the capacitor for equal bias level—not maximum voltage, it should be noted, but a little less.

However, from experience, we would suggest the trouble is much more likely to be head wear and urge you to check this first.

SOLENOID POWERING

Dear Sir, I have a *Revox* tape recorder which functions perfectly one day for about eight hours and, the following day, begins slurring and stopping after some three hours' operation. If switched off for an hour the machine resumes normal running. The agents and local studios have been unable to suggest the cause of this intermittent fault and I would be grateful for any advice you can offer.

Yours faithfully, **J.W., London N.9.**

We are surprised to hear that the Revox agents cannot locate the fault you describe, even though it is something of a 'long-term intermittent'.

But there is one discrepancy that may have been overlooked. This sounds like solenoid trouble, and you will be aware that the gate solenoid (at the left of the machine, just in front of the switch bank) has a limited thrust, with a loose link connection. It is vital that this thrust and adjustment are accurate, and the only permissible adjustment for the 'throw' is the positioning of the solenoid itself. Mounting screws, accessible through the top deck, are in slotted holes to facilitate this.

However, it may be that the solenoid is not adequately powered, and if the mains voltage at your house is less than that at the studios, it is quite possible that the fault did not show up for them. The trouble may be the special rectifier used to provide low DC volts to the solenoid —but first check that the mains voltage tapping is correct for the actual voltage you are receiving. And please don't believe what the Electricity Board stamp on their meter! Far better to obtain a test meter and check the incoming mains voltage for yourself.

A BUZZING ROBUK

Dear Sir, I own a *Robuk RK44* tape recorder and, on the whole, am very pleased with it. Lately, however, I have become aware of an annoying buzz on playback, when monitoring while recording, and also when using the recorder as a straight-through amplifier. The loudness of the buzz is dependent on the monitor setting and is not affected by the input gain control. It sometimes disappears or changes pitch when the function buttons are pressed. I would appreciate your suggestions regarding a cure.

Yours faithfully, **F.R.A, Mansfield Woodhouse.**

The buzz you describe has all the symptoms of an output stage fault, and seems to indicate that the transformer itself is the culprit. You should check the clamp bolts of the output transformer and note whether a screwdriver blade wedged between the bottom of the laminations and chassis makes any difference to the buzz.

You can eliminate the loudspeaker by using an external speaker and muting the internal one—I presume you will have made this obvious first test.

The one discrepancy in the symptoms you describe is that increasing the input gain does not increase the volume of the buzz whereas increasing the main gain (monitor) does. This is the one factor that would lead to the possibility of the gain control itself, or its earth return lead, being faulty. I must confess that I would suspect these controls automatically, having had a great deal of trouble with the edgewise type on this and previous models. But they usually develop noise rather than a buzz.

One source of an annoying noise on playback is inefficient head shielding, and you may experiment with physical earth returns from the head clamps to adjacent screws to eliminate this fault if it crops up.

A CASE OF MAINS

Dear Sir, A friend of mine has a *Grundig TK30* which he wants to sell. I am interested in buying it but would like your advice on one point.

Returning home from sea, he forgot to reset the mains tapping on the transformer from 117V to 240V with the result that the TK30 does not work. Could you tell me if I shall have to get a new mains transformer or just a few replacement components?

Yours faithfully, **E.B.C., Liverpool 19.**

If the Grundig TK30 has been plugged in to 240V AC when set to 117V you may have been fortunate enough to escape with a blown AC fuse. This is the one inserted in the plug tap which selects the voltage. You do not mention whether you tested the fuses.

Otherwise, it is almost certain that the mains transformer has suffered. A quite distinctive smell of scorched resin should give you the clue.

Your best method of checking is first to remove the HT fuse, then replace the mains fuse (500mA for 240V), plug in and note whether the valve heaters light. If not, the mains transformer primary has suffered. If they light and there is no smell of burning, switch off, fit the 125mA fuse, switch on and note again whether the transformer heats up. Check whether the magic eye glows green—if so, the HT is in order and you can proceed with tests.

We shall not go deeper, as we suspect it will be unnecessary. We hope your mains transformer has not burned out, but fear it may be. Luckily, because the motor is fed from a tapping, this item will not have suffered.

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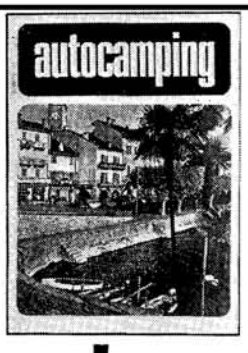

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"DOCTOR, the aspirin you gave me three weeks ago was no good at all. I have a headache again!"

Ridiculous? You may think so, but that is a rough parallel to the sort of remark the service department of the tape recorder and hi-fi dealer has thrown at it several times a week.

In the television servicing business, conditions are even worse, and the number of supposed 'Second Complaints', i.e., recalls to jobs done on site, are something of a trade joke. A rather wry joke to the poor chap who has to try and make the service department pay.

In our own department, *Bristol Hi-Fi and Tape Recorder Centre*, a strict rule is enforced. Exact records of work done must be made and these are filed. A guarantee is given, and the customer gets free service within the guarantee period if the second complaint is valid, or if the failure is in the same section of the equipment that was previously repaired. Outside the guarantee period, a small handling charge is made but, of course, there is no charge for parts replaced under the maker's guarantee.

Note two important points from the foregoing paragraph. 'Valid' and 'section of the equipment'. Very often, a supposed S.C. turns out to be something stupid: an oxide-cluttered head caused by poor tape, or a microphone connection pulled adrift. At other times the fault is quite unconnected with the previous trouble. After a belt change, the oscillator packs up. Must we add a crystal ball to our toolkit?

No use arguing that tests should have foreseen failure. That is rather like blaming the garage mechanic when you get a puncture on the way home from the routine grease-'n-spray.

In the end, it rests with the service manager, who must check the previous work record. He will also have to explain the hard facts to his customers. Sometimes, the explanation is difficult. Example: this week we had back a *Grundig TK18* which had previously suffered from a touchy record/play switch. This time, the trouble was "No Erase—Poor Record", an obvious case of oscillator failure. But preliminary tests quickly established a small AC voltage at the output from the oscillator section and it took a little while longer to discover that the oscillator slug had slipped down from the ridiculous little spring clip that is supposed to hold it and was nestling in the bottom of the former, supported only by the sticky tape that protects the adjustment hole. Quite unpredictable, and damaging to goodwill, but who would you say was to blame? And were we right to ask the customer for a token handling charge?

Actually, the hi-fi dealer takes a particular pride in his work. He relies on the continued enthusiasm of his customers, who may graduate from the cheap portable through the intermediate range to a *Nagra*—well, someday! Goodwill is the greatest sales aid. For this reason, every possible effort is taken to reduce these second complaints. This, in turn, means a higher than average standard of servicing—and necessarily higher costs. The service department is seldom a profit-making enterprise, in terms of hard cash. And accountants are notoriously reluctant to insert that elusive asset 'good will' in the balance sheet.

We are lucky in that the average hi-fi enthusiast is likely to be a cut above average intelligence. He can be relied upon (a) to ensure that his complaint is genuine before invoking flames of wrath, and (b), listening to reason when the technical facts are laid before him. I'll go farther and admit that it is usually a pleasure to deal with him—even if he does occasionally come back with a second complaint.

TAPE RECORDER SERVICE CONTINUED

Mechanical details were covered fairly fully in our original article of December 1962 and there have not been a great many changes; but for the benefit of readers whose files do not go back that far, a few hints about the most prevalent maladjustments may be useful.

The stabiliser brake, which is a special Brenell feature, presses gently on the left-hand spool drum during record/play. This is a felt-pad brake and the felt should be soft and clean. Check for imbedded particles which can cause drag and wow. Excessive pressure will cause wow, and the brake must be adjusted so that there is just enough pressure to prevent a full reel of 7in. tape unwinding jerkily when recording or replaying. A little care taken with this adjustment is worthwhile, especially if one intends to use varying spool sizes. There is a 4BA clamping nut on the deck mounting bush.

The main brakes are of the servo type, and as fast winding is really fast—45 seconds for 1,200ft. of tape—good braking is important. Perhaps we may be permitted a remark on operation: old hands, please do not be insulted. To achieve really good braking, a quick, positive use of the rewind/stop control is essential. But to make a really professional job of it, let the electro-mechanical function of the motor loading help you. Switch from whichever fast wind is engaged to the other directly, and then, just as the motor torques begin to oppose and the spools brake swiftly, revert to stop. There is no exact rule about this, much depends on the amount of tape spooled, but a little practise will soon make one proficient and save those loops of spillage that clumsy or tentative handling can cause.

Adjustment of the main brakes should be made at the 4BA screws at the free ends of the brake shoes, where the release bars act. There should be a $\frac{1}{32}$in. clearance between the ends of the bar and the ends of the brake shoes. If the spillage still occurs, adjust the springs (brake return) but do not adjust the fulcrum points of the brake assembly unless good braking can not be gained by any of the above resorts. The fulcrum points are at the outer edges of the deck, where the brakes pivot, and usually these will be paint-sealed or factory adjusted and marked.

CLASSIFIED ADVERTISEMENTS

Advertisements for this section must be pre-paid. The rate is 6d. per word (private), minimum 7s. 6d., Box Nos. 1s. 6d. extra. Trade rates 9d. per word, minimum 12s., Box Nos. 2s. extra. Copy and remittance for advertisements in **AUGUST 1966** issue must reach these offices by **19th JUNE** addressed to: The Advertisement Manager, Tape Recorder, Link House, Dingwall Avenue, Croydon, CR9 2TA.

Replies to Box Nos. should be addressed to the Advertisement Manager, Tape Recorder, Link House, Dingwall Avenue, Croydon, CR9 2TA, and the Box No. is quoted on the outside of the envelope. The district after Box No. indicates its locality.

FOR SALE—PRIVATE

Prinz 8mm cine editor-viewer with 3½ x 3in. frosted-glass screen and swivel arms. Built-in splice marker. Good condition but needs new bulb. £5. Box No. 515 (Southend).

Brenell Mk. 5 recorder, 4 speeds, 8¼ spools, studio-mic., stand, V.U. meter. Complete cost over £90, £35 o.n.o. 'Phone 804-4592 (London).

'Tape Recorder' 1959, 1962, 1963, 1964, 1965. 2/6 each. Enquiries s.a.e. Northcott, 11 Thornberry Terrace, Penzance, Cornwall.

Brown Type K Moving Coil Headphones. Suit Beolit, Beocord, etc. Easily converted for stereo-£5; Telefunken TD7 omni-directional microphone with table stand, 4ft. cable, 3-pin DIN plug. Has been extensively used for recording railway sounds. Perfect order—£3; Lustraphone Low Z Ribbon Microphone less fittings, transformer—£5. Further details (S.A.E.) Mr. Uden, 7 Carrington Road, Aylesbury, Bucks.

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Brand new tape. B.A.S.F. LR56 1200 feet 7" spool list 37/6, Sale 20/-. 900 feet 7" spool list 27/6, Sale 15/-. Scotch 202 2,400 standard play 10½ N.A.B. spool list 100/-, Sale 80/-. P. and P. 2/- all. Barry Heath, 175 Newbury Gardens, Stoneleigh, Surrey.

Hi-Fi catalogue. Price 4/6. Inc. postage. Fully illustrated. Holdings of Blackburn Ltd., 39/41 Mincing Lane, Blackburn, Lancs.

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W.H.M. Wow and Flutter Meter Model 3, £48. Literature and specification on request. 35 Villiers Road, Watford, Herts.

Petersfield Camera Centre Ltd. supply the trade with A.K.G. Microphones, Uher Tape Recorders. Deliveries ex stock. 37 Lavant Street, Petersfield, Hants. Telephone 2651/2/3.

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WANTED

Lee Electronics. The Tape Recorder and Hi-Fi Specialists wish to purchase good quality Tape and Hi-Fi Equipment for cash. 400 Edgware Road, W.2. Phone: PADdington 5521.

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Piano recordings. Collector urgently seeks radio tapes etc., by Moiseiwitsch, Ogden, Cherkassky, Pouishnoff, many others. Box No. 514 (Staffs.).

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J & B Recordings. Tape to disc—latest high level disc cutting, all speeds. Mastering, pressings. Studio, mobile. 14 Willows Avenue, Surrey. MITcham 9952.

Professional mobile and dubbing. High quality mobile recording; Tape/Disc copying and mixing; quantity pressings; custom built equipment; professional tape recorders, etc., serviced. L.F. Recordings, 24 West Kensington Mansions, Beaumont Crescent, London, W.14. 01-385-0697.

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7" 1200'	35/-	28/-
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5" 900'	28/-	22/6
5¾" 1200'	35/-	28/-
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4½" 900' (BASF)	30/-	24/-
5" 1200'	42/-	33/8
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7" 2400'	77/6	62/-
TRIPLE PLAY		
3" 450'	22/-	17/8
4" 900'	39/-	31/3
4½" 1200' (BASF)	49/-	39/3
5" 1800'	66/-	52/10
5¾" 2400' } (BASF)	90/-	72/-
7" 3600' }	115/-	92/-

SCOTCH

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5¾" 900'	27/6	22/-
7" 1200'	35/-	28/-
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3" 300'	9/6	7/6
4" 450'	14/6	11/8
5" 900'	27/6	22/-
5¾" 1200'	34/6	27/6
7" 1800'	49/-	39/-
8½" 2400'	72/6	58/-
STANDARD (ACETATE)		
5¾" 850'	24/6	19/6
7" 1200'	30/-	24/-

DOUBLE PLAY	List	Our price
3" 400'	16/6	13/2
4" 600'	24/6	19/6
5" 1200'	41/9	33/6
5¾" 1800'	55/-	44/-
7" 2400'	76/6	61/-
TRIPLE-PLAY		
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DYNARANGE (L/P		
5" 900'	32/3	25/10
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A SPECIAL OFFER OF THIS FAMOUS PREMIUM GRADE TAPE

Brand new, boxed, with full leader, and polythene sealed (4" size has stop foil). Multiples of three 4" size can be supplied in the BASF 3-Compartment Plastic Library Cassettes at no extra cost.

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Brand new, Premium Grade, Polyester Base Tape from this famous manufacturer. Boxed with full leader, stop foil and polythene sealed at exceptionally attractive price.

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Also available at substantial reductions :					
PE 31	1200' L/P 5¾" reel	35/-	24/6	71/-	137/-
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Brand new, fully guaranteed, Premium Grade Magnetic Tape. Complete with the specially designed Grundig Tape Storage Container. Full leader and stop foil at both ends and suitable for use with all makes of tape-recorder.

DON'T MISS THIS RARE OPPORTUNITY, SEND NOW!

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GS 15 (TSP2) ...	900' S/P 5¾" reel	28/-	15/6	45/-	84/-
ALSO AVAILABLE AT SUBSTANTIAL REDUCTIONS					
GL 15 (TLP2) ...	1200' L/P 5¾" reel	35/-	24/6	71/-	137/-
GL 18 (TLP3) ...	1800' L/P 7" reel	50/-	29/6	86/-	165/-
GD 15 (TDP8) ...	1800' D/P 5¾" reel	52/6	42/6	126/-	246/-

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A bulk purchase of premium grade, top quality POLYESTER MAGNETIC TAPE from one of the world's foremost experts in film coating technology. With FULL LEADER stop foil, Polythene wrapping and in original manufacturer's boxes. Available in long-play base only at these BARGAIN PRICES!

	LIST PRICE	ONE	THREE	SIX
900' on 5" reel	28/-	16/6	48/-	90/-
1200' on 5¾" reel	35/-	22/6	65/-	125/-
1800' on 7" reel	50/-	28/6	84/-	160/-

Please add 2/- P. & P. ORDERS OVER £3 POST FREE.

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A large purchase from a "SHY" world renowned manufacturer enables us to make this unique half-price offer. Brand new, fully guaranteed, premium grade Polyester Base Tape with FULL LEADER and stop foil. In original maker's boxes and polythene wrapped at these EXCEPTIONALLY LOW PRICES!

	List Price	One	Three	Six
1800' on 5" reel	66/-	34/-	101/-	198/-
ALSO AVAILABLE AT SUBSTANTIAL REDUCTIONS				
450' on 3" reel	22/-	14/-	40/6	78/-
600' on 3" reel	27/6	17/6	51/-	99/-
900' on 4" reel	39/-	24/6	72/-	140/-
2400' on 5¾" reel	90/-	55/6	165/-	324/-

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Brand new, fully guaranteed, premium grade, polyester base magnetic tape, double coated for the electronic industry.

SCOTCH (150 D/C) Polyester L/P, 900' on 7" reel. **ONLY 15/6**, P. & P. 2/-. Three reels for 45/-, post free ; six reels for 84/-, post free. Boxed add 1/- per reel. Can be supplied on 5¾" reels at special request.

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Tape Head Demagnetiser, essential for any enthusiast! Ready for immediate use. Fully guaranteed. Worth 50/- ... ... **Only 27/6** P. & P. 2/-
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20% off all Grundig and Philips equipment

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Please supply your lists and goods as detailed below :

Qty	Description of Goods	Amount
	Total for post and packing	

I enclose my remittance for Total £.....
NAME.....
ADDRESS.....
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July 1967

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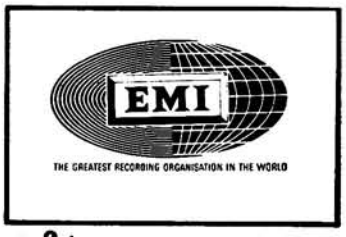

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