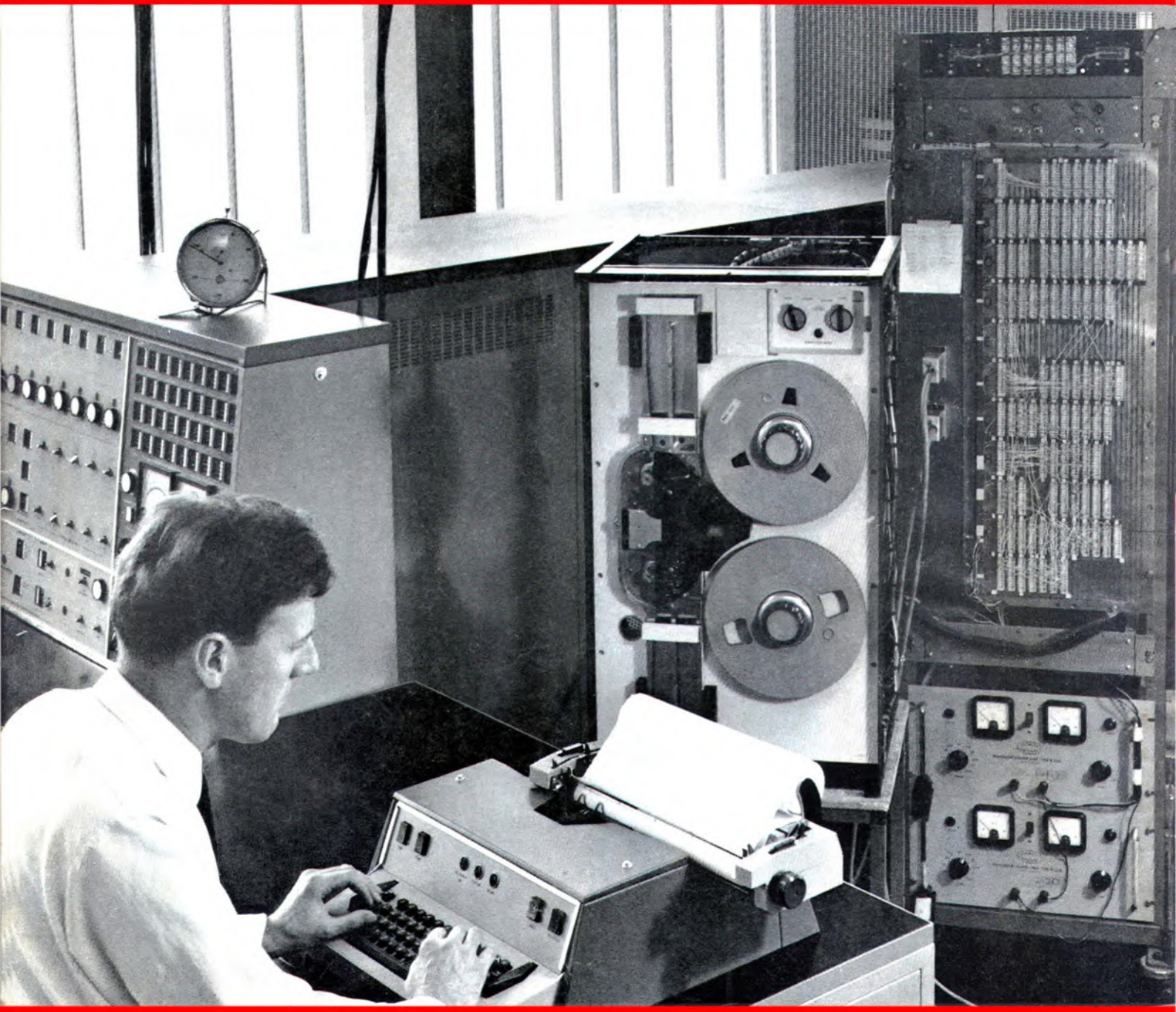
SEPTEMBER 1965 TWO SHILLINGS

tape recorder



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REVOX 736 REVIEW — SURVEY OF STEREO RECORDERS — SOUND AND CINE

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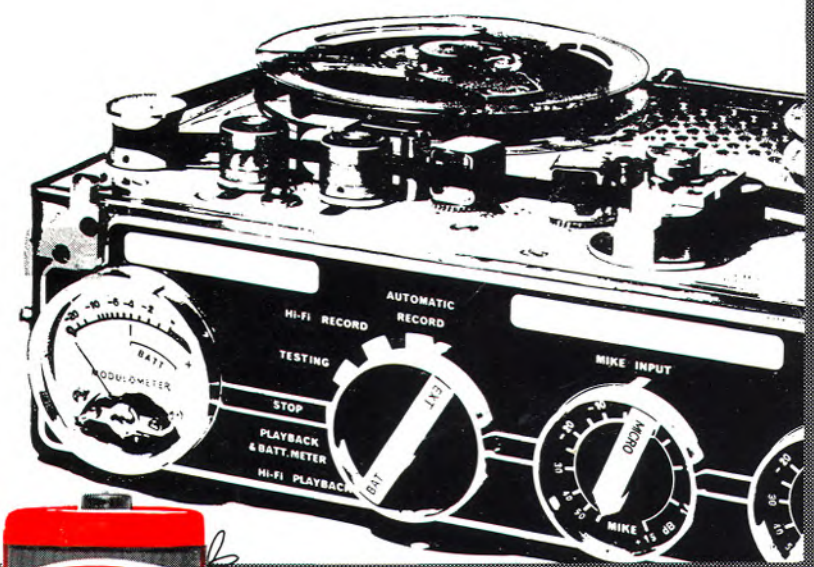

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*Record players too.

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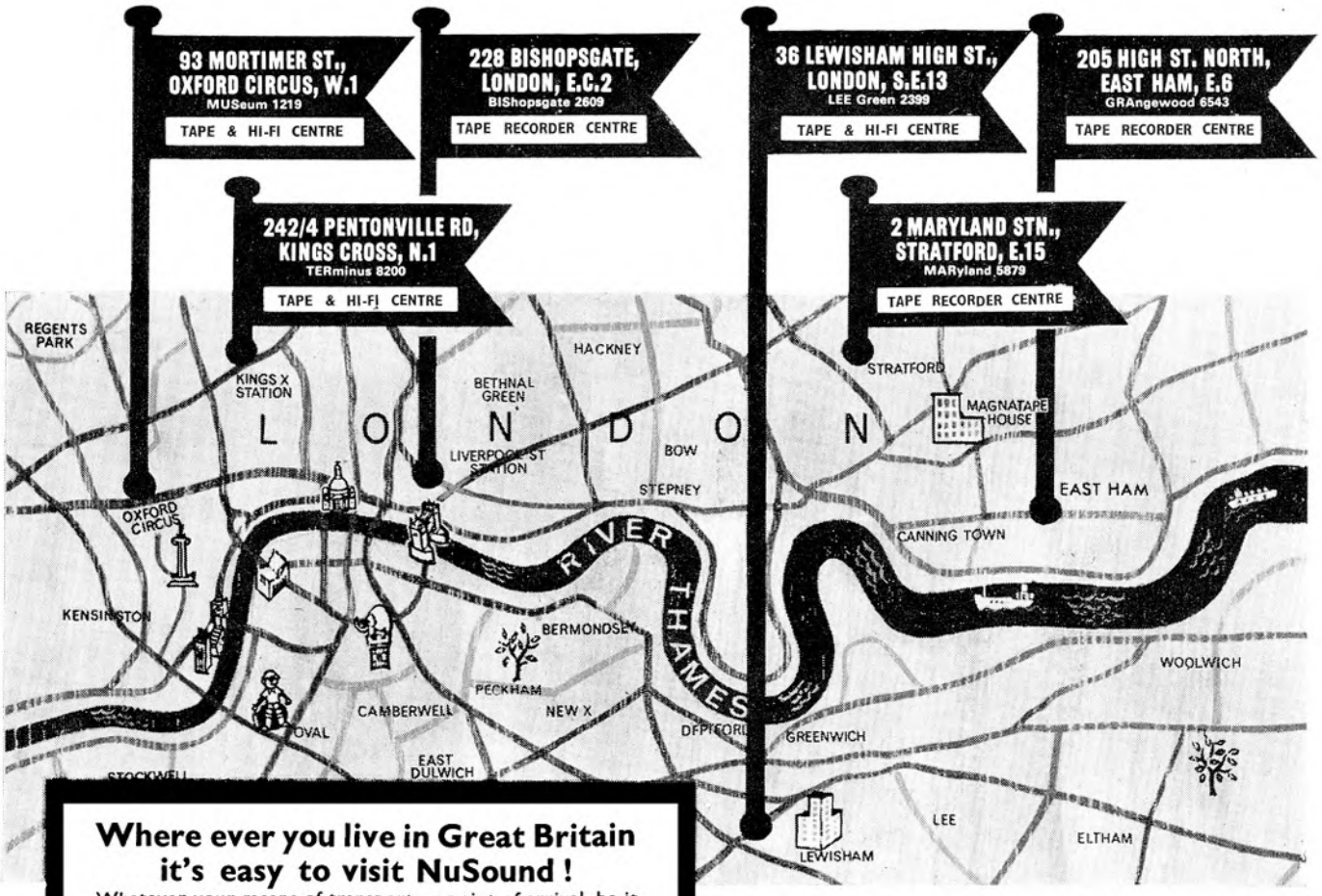

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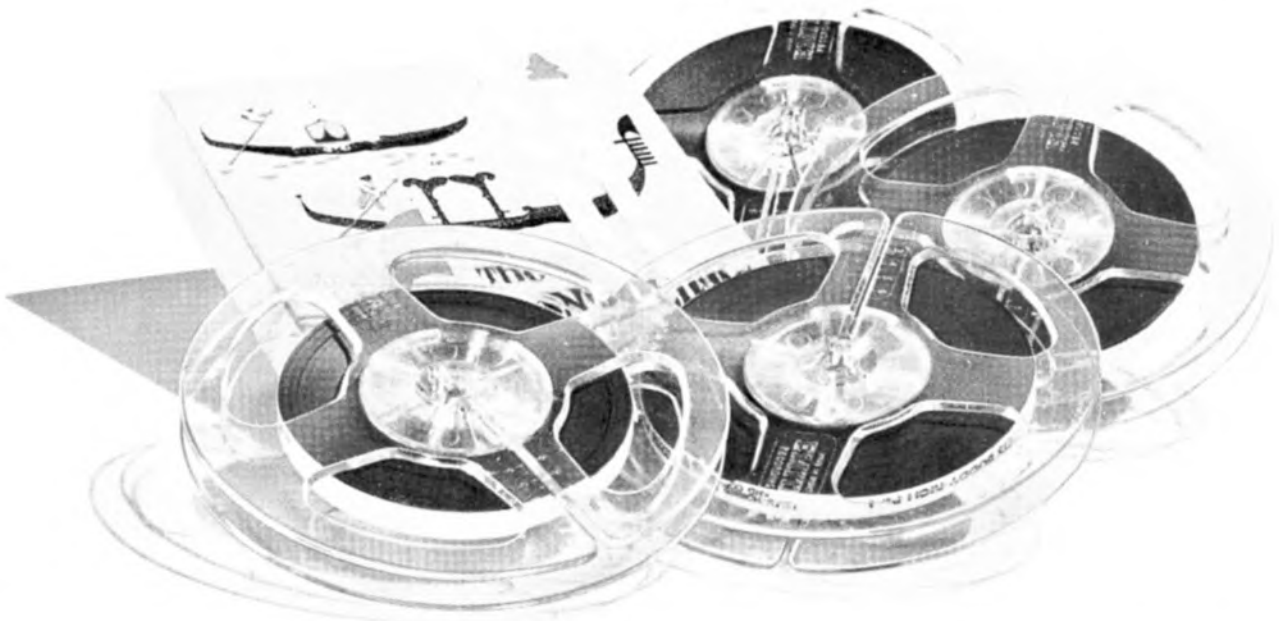

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25 Ian Wallace, Joyce Blair and chorus. Some Enchanted Evening, I'm In Love With a Wonderful Guy, and all the unforgettable songs from this great musical.
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59 The silken voice of Nat King Cole in Walkin' Because, You're Mine, You'll Never Grow Old, Baby Won't You Say You Love Me and 8 more.

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10 Tchaikovsky Violin Concerto. Tossy Spivakovsky with Walter Goehr and LSO in a superb performance of this melodious work.
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11 Dvorak Symphony No. 5—From The New World. Leopold Ludwig conducts the London Symphony Orchestra in a dramatic and moving performance.
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12 Beethoven Eroica Symphony. Josef Krips conducts the London Symphony Orchestra in a masterly performance of this monumental work.
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63 Cuban Carnival, Yesterdays, Blues in My Heart, and eight more great numbers played by George Shearing with vocals by Dakota Staton.

74 Superb Sarah Vaughan in ten great numbers. If I Loved You, Saturday Is Delovely, You'll find me There, etc. Every one a hit.

108 Storms, Weather, Sweet Chariot, Somebody Loves Me, Hold Me, I Can't Give You Anything But Love, 7 more top numbers all with fabulous Peggy Lee.

106 Mel Torme's velvet voice in 12 top numbers. Body and Soul, 'Round Midnight, Blues in the Night, That Old Feeling, Where Can I Go Without You, etc.

14 Tchaikovsky Symphony No. 5. Sir Malcolm Sargent and LSO combine to give this famous symphony a dramatic and colourful rendering.
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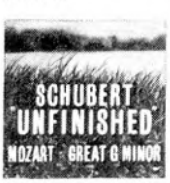

44 Leopold Ludwig and LSO combine brilliantly in an exciting 'double': two of the world's greatest symphonies receive vivid new interpretations.
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53 These two suites, containing some of Bizet's most thrilling music are given magnificent performances by the Sinfonia of London under Muir Mathieson.
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54 Tchaikovsky's last and greatest symphony, is here given a splendidly moving rendering by the Sinfonia of London conducted by Muir Mathieson.
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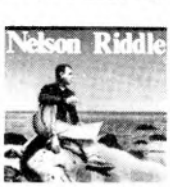
77 In the Mood, Bugle-Call Rag, Chattanooga Choo-Choo, Serenade in Blue 9 original tracks by the immortal Glenn Miller and his band.

48 Deep in My Heart, Drinking Song, Serenade—all the old favourites fresher than ever with Marion Grimaldi, Linden Singers and Orchestra.
Also in stereo.

30 Ian Carmichael, Joyce Blair, star cast and orchestra. As Long As He Needs Me, Consider Yourself, all the hit numbers from Lionel Bart's great show.
Also in stereo.



71 The smooth sound of the Nelson Riddle Orchestra in Touch of Your Lips, Body and Soul, The Tender Touch, As you Desire Me— 11 favourites in all.

117 Strauss' most popular waltzes Blue Danube, Emperor, Vienna Woods, Voices of Spring, Roses from South, Vienna Symphony under Rudel.
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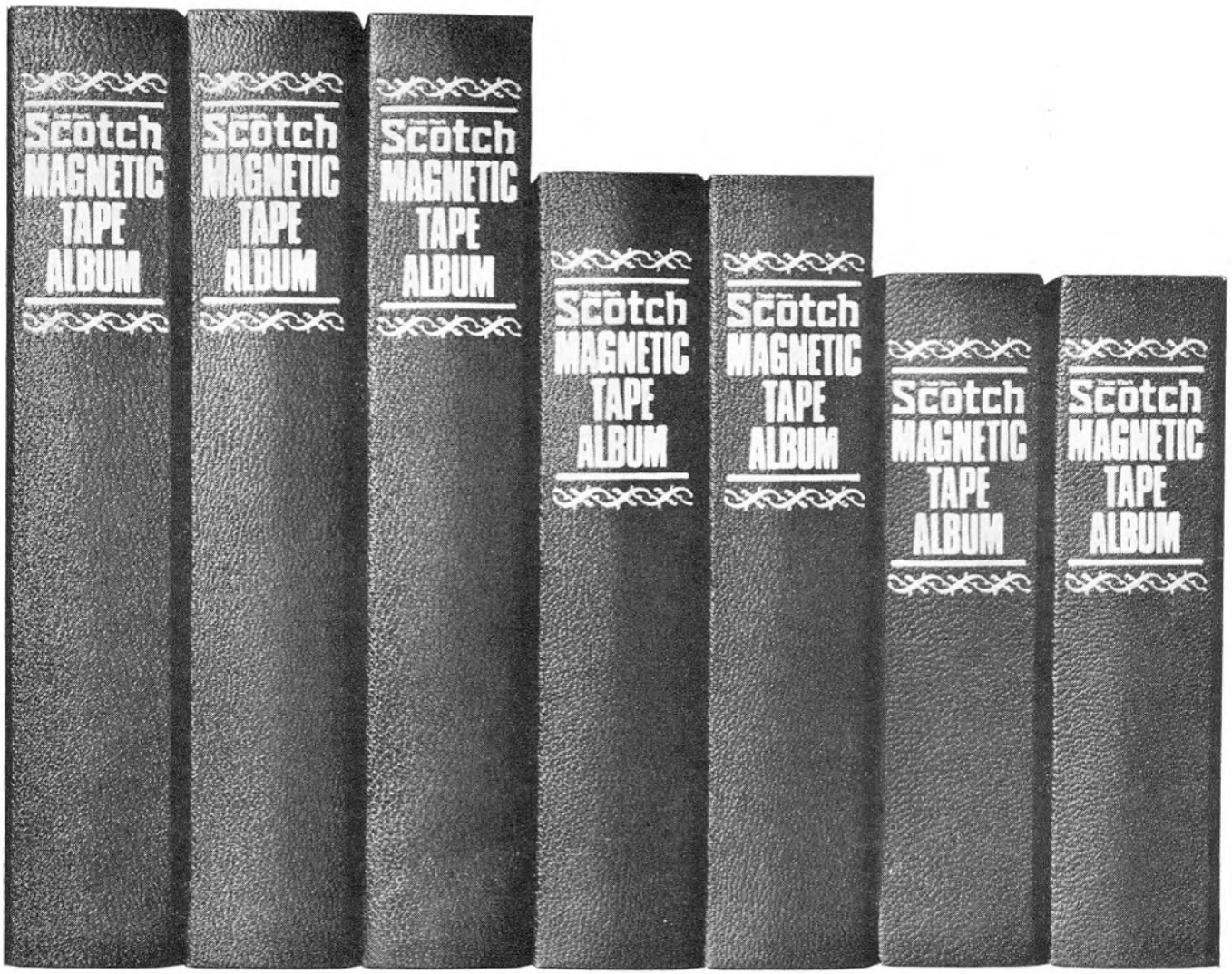

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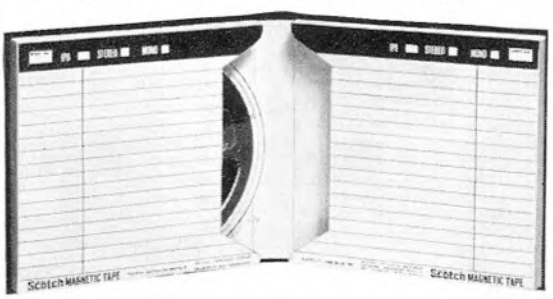

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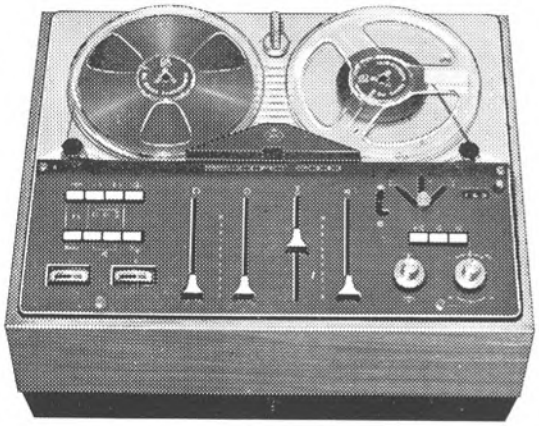

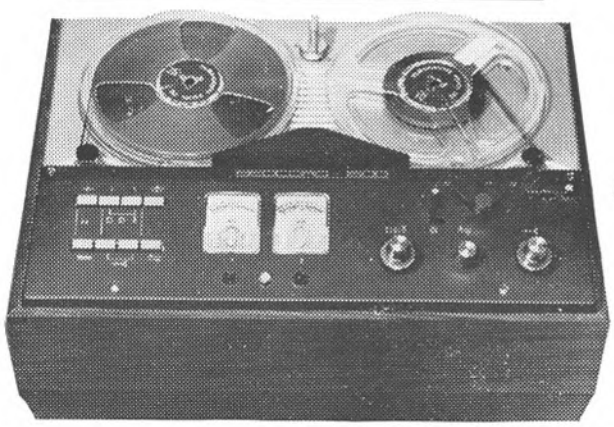

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And introducing a new Tape Recorder Centre exclusive – package deals for

Hi-Fi at Lo-Cost

To meet the growing demand for ready-to-listen-to fine sound equipment, the Tape Recorder Centre have designed a series of Hi-Fi Package Deals at various prices. All self-contained units, pre-matched and assembled, ready for plugging in, ideal for putting on room-dividers and shelves, into built-in furniture. For instance:—

Three-unit stereo Package:
Turntable, amplifier, loudspeakers, 37 gns.
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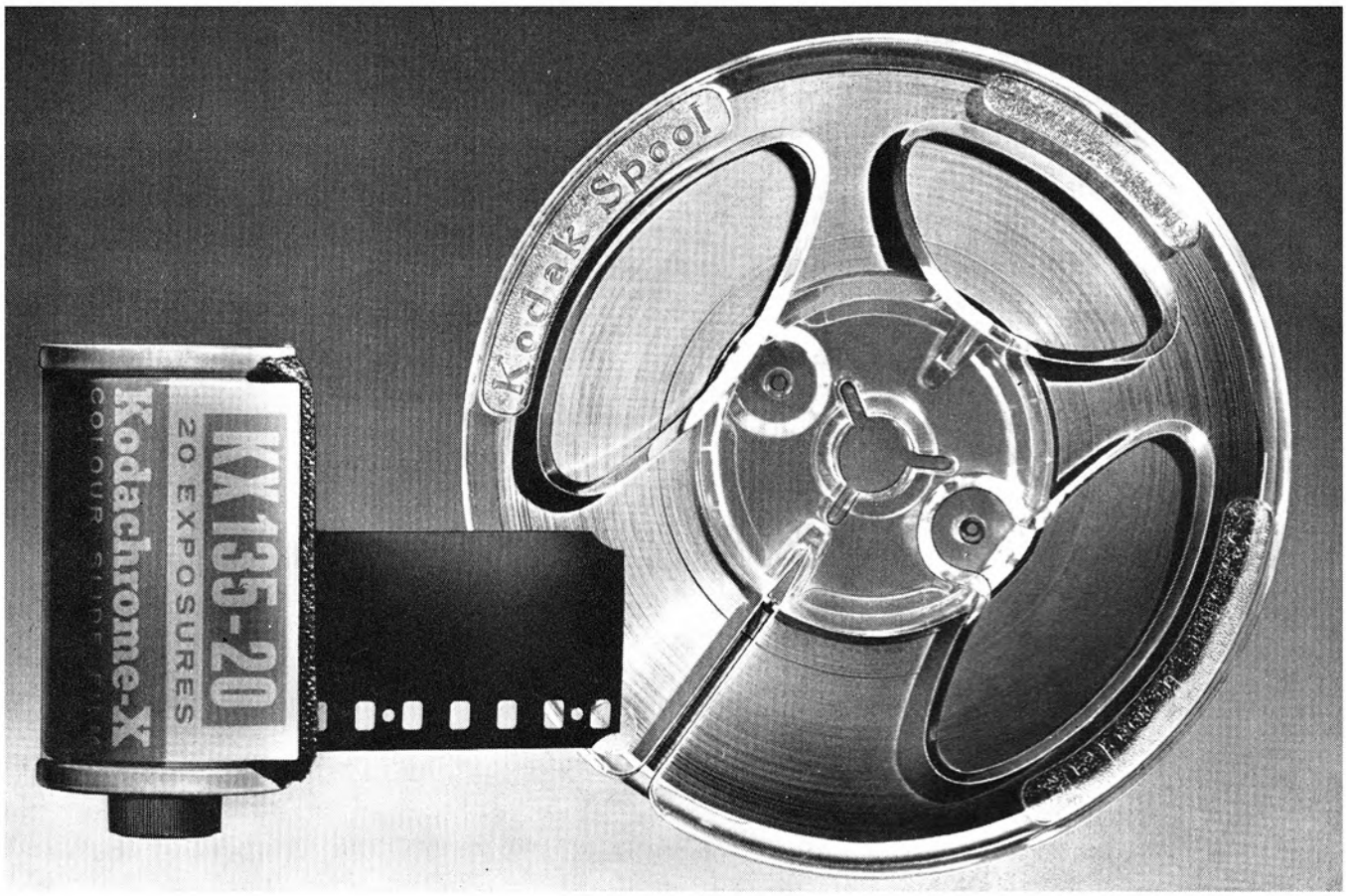

How Kodak's film-coating skills set today's highest standard in tape

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

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

Play it as soon as you can. You'll be getting a higher signal-to-noise ratio, better frequency response, a remarkable freedom from drop-out and print-through, and, above all, a *total* uniformity in performance.

There's a Kodak Tape for every recorder, of course, including the world's only Quadruple Play tape, for use with battery portables (5½ hours playing time on a single 3¼" reel!). So next time you buy tape do the sensible thing and specify Kodak Tape. It will do full justice to your equipment. And it costs no more.

Post this coupon today.

Please send me full details of Kodak Sound Recording Tapes.

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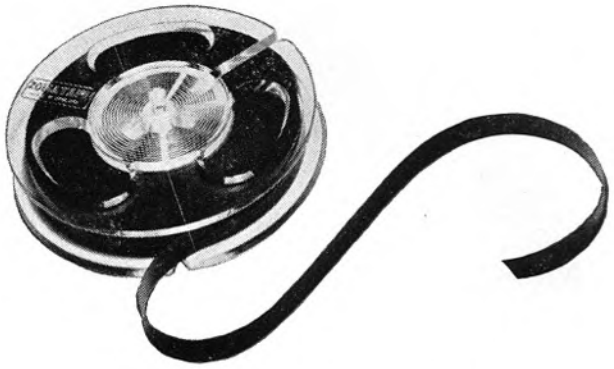
6

Kodak sound recording tapes... the best tapes in the world



In 12 minutes you can record on this reel of Ilford Zonatape a 1500-word letter it would take you an hour and a half to write

What's more, when you use Ilford Zonatape you get a recording of your voice up to professional standards.
Ilford Zonatape gives you this flawless reproduction because it's made by Zonal, the people who made the sound track for such films as The Yellow Rolls-Royce and Lord Jim. Ask your supplier for Ilford Zonatape message Tape.

ILFORD
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Zonal Film (Magnetic Coatings) Limited
A subsidiary of Ilford Limited, Ilford, Essex.

tape recorder

INCORPORATING 'SOUND AND CINE'

EDITOR **JOHN CRABBE**

NEWS EDITOR **DAVID KIRK**

ADVERTISEMENT MANAGER **ROBIN WELLS**

Editorial and Advertising offices

LINK HOUSE, DINGWALL AVENUE, CROYDON, SURREY

Telephone MUNicipal 2599 (16 lines)

editorial

STEREO TAPE RECORDING is the theme running through this issue—details of the stereo machines available, notes by Gordon King on how non-stereo or semi-stereo models may be adapted, some advice on stereo microphone and mixing techniques by David Robinson, and (more by luck than judgement) a field trial of a battery stereo recorder and a review of an elaborate mains stereo model. Even Anscomb—a confirmed mono man—manages to use a *pair* of microphones for one of his orchestral interludes.

What is this stereo business all about? Why do two channels or tape-tracks in use simultaneously make so much difference? Is the technique really important for the amateur tape recordist anyway? Questions of this sort are bound to crop up, so let us attempt some brief answers.

Essentially, stereophony is about reproduction of sound in a way that lets our ears work in a more natural manner. We hear in three dimensions, but a monophonic (single channel) system is only able to recreate the dimension of distance. Even if we widen the mono sound-image artificially by means of reflectors, multiple speakers, and so on, small sound-sources such as voices or solo instruments are broadened unnaturally. Stereo keeps the near-and-far feature but also offers up to 90 degrees of the full circle around us, and as we normally wish to concentrate attention within the 180 degrees out in front, this is a big step in the right direction.

Our second question concerned the how and why of two channels. Fortunately it is possible to fool the hearing system of most people and to create sensations of sounds apparently coming from between two loudspeakers. There are difficulties, of course, and the listening area in which the effect operates properly tends to be limited—depending on loudspeaker behaviour and other factors. But when everything works correctly a 'sound-stage' is created with the same lateral spatial make-up as the acoustic scene in front of the recording microphones. This in itself is an advance towards realism, for the individual elements in any compound sound-source are able to retain their separateness within a balanced overall picture.

But this is not all, for when sounds are recorded in any location other than the open air or an anechoic chamber, the reverberation of the surrounding space is also picked up by the microphones. Although we are not normally consciously aware of this acoustic ambience in real life, our ears do take note of it, and just how much of it there is becomes very obvious to the beginner when first he records a voice at some distance from a microphone and then replays it in the same room. The recorded reverberation sounds impossibly exaggerated because it comes with—and cannot be separated from—the wanted voice. Even if the recording is played in the garden to avoid multiplying the room acoustics by two, the voice still sounds excessively coloured, whereas a live voice in the room itself sounds quite normal. This is because our ears 'sort things out' and enable us to concentrate on the wanted signal to the apparent exclusion of the reverberation. With a mono recording this aural selection process is inhibited, because the ears depend on the missing differences of direction between original and reflected sound.

Apart from the obvious lateral separation and its ability to produce a 'big' overall sound without making the individual sources unnaturally broad (a distinct advantage when recording groups of musical instruments), good stereo also helps the ears by providing an impression of the studio or recording-room acoustics detached from any particular element on the sound-stage. It is this 'sense of the hall' out in the space between and beyond the loudspeakers that gives stereo its particular appeal to many music lovers. Though subtle when compared with dramatic left/right ping-pong effects, the more natural presentation of acoustic ambience is quite as important and—for the amateur recordist—may provide part of the answer to our third question.

All recordists who have advanced beyond mastery of basic tape techniques and who are intrigued by sound, microphones and room acoustics, should take a long, hard look at stereo. Its fascinations are endless, and for anyone carting a machine around for live recording sessions in a variety of settings it very soon becomes indispensible. Also, as Mr. Robinson points out in this issue, stereo recording is often *easier* than mono because balancing problems are sorted out by the ear and reverberation is not such a bugbear. Tape recording in mono is a fine hobby—but that extra dimension can make a big difference.

SEPTEMBER 1965 **VOLUME 7** **NUMBER 8**

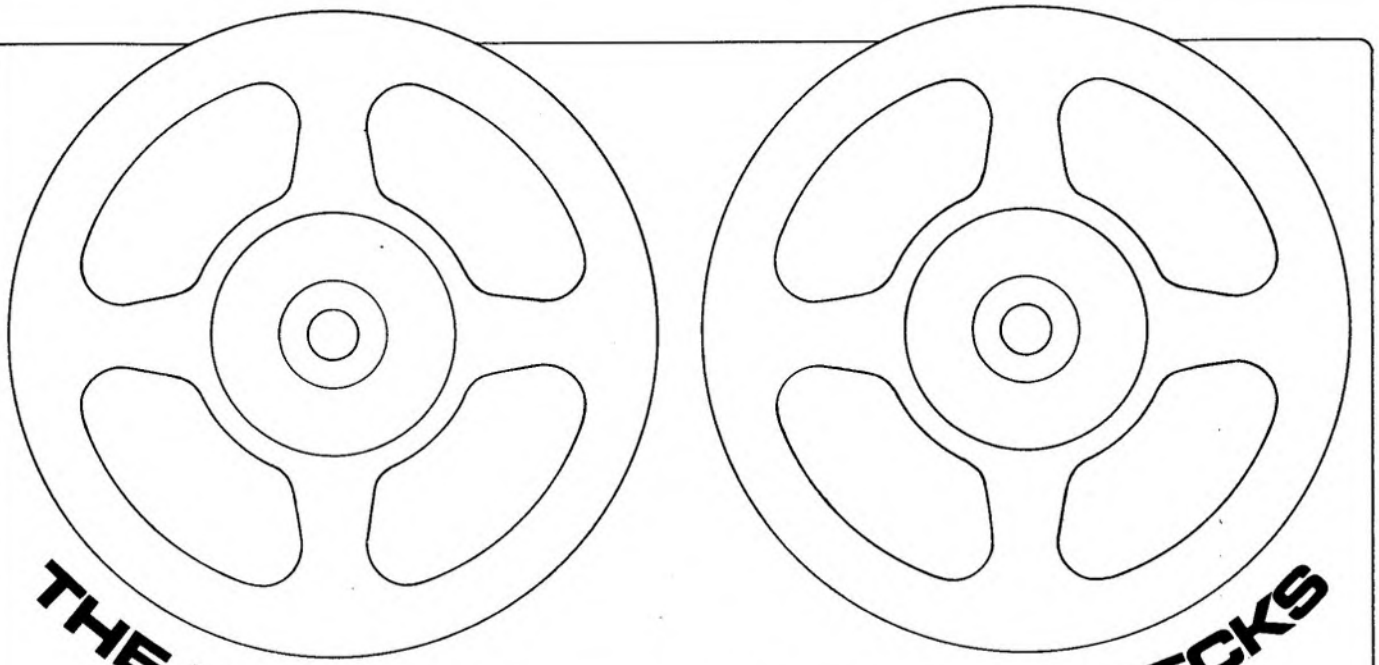
COVER PICTURE

An item of equipment which we shall not be buying Mr. Tutchings is illustrated on this month's front cover. An *ICT* 1301 computor is shown analysing a tape deck destined for the 1900 *Series*. Results from this system, which is believed to be unique, are printed on the foreground typewriter.

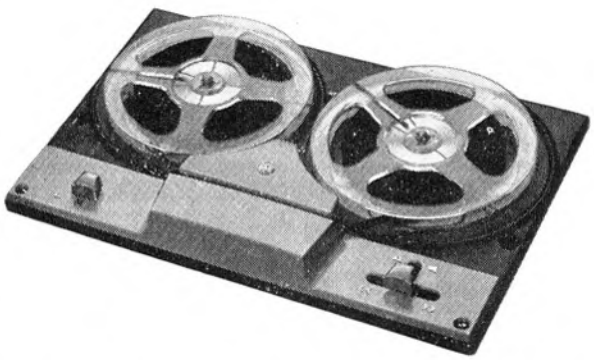
SUBSCRIPTION RATES

Annual subscription to *Tape Recorder* and its associated journal *Hi-Fi News* are 30s. and 32s. 6d. respectively in the U.K. Overseas rates are 32s. 6d. (U.S.A. $4.50) for each magazine, from Link House Publications Ltd., Dingwall Avenue, Croydon, Surrey.

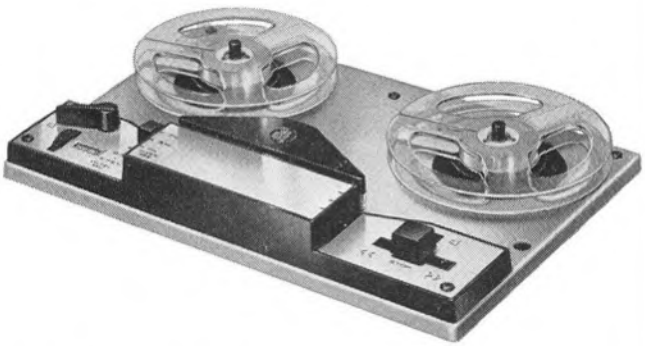
Tape Recorder is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.



THE WORLDS FINEST TAPE DECKS



Take a look at the precision built and quality tested T.D.2. Listen to its superb performance — only BSR can combine this proven reliability with such truly magnificent performance. Takes $5\frac{3}{4}$" reels playing at $3\frac{3}{4}$" per second.



Look, too, at the elegant T.D.10 — a tape deck of functional excellence that sounds as good as it looks and is an established favourite throughout the world. Takes up to 7" spools with a choice of 3 speeds. It has fast forward and fast rewind, a 3 digit counter and space for a third head for monitoring which is available as an extra.

BSR

Send for full technical details and illustrated leaflet.

The world's largest manufacturers of Tape Decks and Record Changers

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world of tape

JELLY-BABIES, FIRE AND A DUCKING

A FIVE-YEAR old *TK* 830 tape recorder, we learned from a recent issue of the *Grundig Gazette*, was brought in for extensive overhaul just before Xmas and returned to its owner in time to capture the Yuletide festivities. A few weeks later the machine was returned with a bitter complaint that it had failed at the owner's New Year's Eve party. The Grundig Service Department removed the top deck in his presence, extracted several ounces of mangled jelly babies and handed them to a rather sheepish customer. His young son, apparently, had taken to posting the sweets through the ventilation slots.

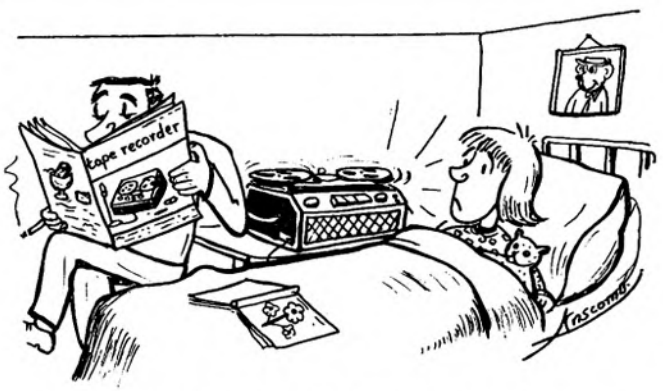
Sent in for repair after being seriously burned in a fire, a *TK*46 played back despite a melted cabinet and charred mechanism. Not quite as healthy, but in repairable condition, was a Grundig recorder which survived three weeks under water, after being thrown into a reservoir by thieves.

BRENTFORD TAPE RECORDING COURSE

THE London Borough of Hounslow Education Committee will be running a course on Tape Recording Technique at the Centre for Adult Education, Clifden Road, Brentford, beginning on September 21st. Of particular interest to teachers will be lectures describing applications of tape in the classroom and in language tuition. Advice on recording technique, constructing and repairing equipment and synchronising sound with film, will form a major part of the course, which is to be held on Wednesday evenings from 7 to 9 p.m. Enrolment may be arranged from 7 to 9 p.m. on September 9th and 10th, 13th, 14th and 15th. Fee for the two terms is £1.

RECORDING UNDERGROUND

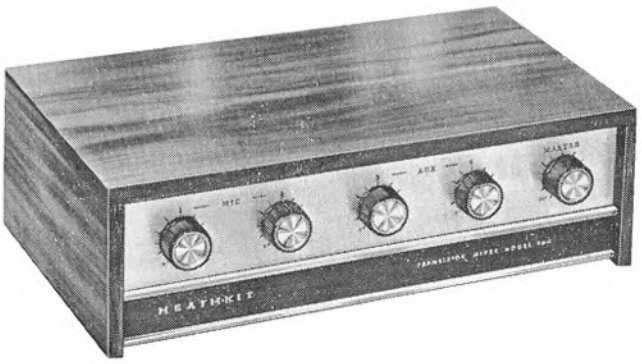
HAVING acquired most of the equipment needed by their photographic unit, the *British Caving Expedition to Morocco* are hoping to arouse the interest of a manufacturer or recording enthusiast who would be prepared to loan them a battery-portable recorder and a supply of tape. The expedition will explore a network of caves in the Diai Chiker Valley of Morocco and leaves Britain in September. **Treasurer: K. J. Nunn, 'Pleck Cottage,' High Street, Coleford, Gloucestershire.**



Then Daddy Bear said "Who's been eating my porridge?"

HEATHKIT AUDIO MIXER

SUITABLE for use with high and medium impedance crystal and dynamic microphones, tuners and other audio equipment, the *TM-1* four-channel mixing unit is the latest addition to the *Heathkit* range. Input characteristics, for an output of 200mV RMS are as follows: *Channel 1*: 1.5mV at 1 Meg. and 4.5mV at 2.5 Meg., switchable. *Channel 2*: 1.5mV at 1 Meg. *Channels 3* and *4*: 180mV at 250 K. Seven OC44 transistors in circuit give an overall frequency response of 15 c/s—30 Kc/s ±3dB and better than 0.2% distortion at full output. Each channel is equipped with a rotary gain control and all pass through



a master fader. A SPEECH/MUSIC switch gives dB cut at 150 c/s (to reduce voice 'booming') and a linear response in the latter position. Powered by a 9V battery (or Heathkit eliminator), the mixer weighs 4½lb. and is finished in gold anodised aluminium with oiled walnut cabinet. Dimensions are 11¾×7½×3¾in. and price, in kit form, is £11 16s. 6d. Assembled and tested, the TM-1 costs £16 17s. 6d. **Manufacturer: Daystrom Ltd., Gloucester.**

AMPEX BREAK VIDEO PRICE BARRIER

LOOKING remarkably like the *Bang & Olufsen Stereomaster*, plus a rotating head, a new *Ampex* domestic video tape recorder may appear in Britain before the expected *Sony Videocorder 2000*. Although, at £400, the Ampex is twice the price of its Japanese competitor, it is still substantially cheaper than the £1,000 *Philips* machine, which is currently the lowest-priced helical-scan television recorder available in Britain. Demonstrated recently at the *Chicago Music Merchants Show*, the recorder is being manufactured in single speed (9⅜ i/s) and double speed (9⅜ and 4⅝ i/s) versions, to sell in Britain for £400 and £450 respectively. Cost of a complete recording system—camera, tape machine and display television—will be in the order of £650, while the one-inch wide tape will sell for £23 per 2,900ft. reel. Frequency ranges at the faster and slower speeds are 3.2 Mc/s and more than 2 Mc/s respectively. The price breakthrough is claimed to be a result of important developments in the design of helical recording heads, an air foil assembly being used for higher timebase stability. Tapes recorded on these machines will be interchangeable with domestic colour TV recorders now being developed by *Ampex*.

A SENSE OF PRIORITY

MANY service engineers will vouch for the fact that in some households the television receiver holds a position of greater importance than the life and welfare of friends and relations. Recently, however, the staff at Holdings of Blackburn obtained definite proof that the tape recorder is also gaining this position.

A lady entered the shop asking for a lead for her tape recorder and after much difficulty the junior engineer, Mr. Yeadon, established that the lead was required to make direct recordings from her radio. After even more difficulty, he discovered the make and model of the recorder. "Now," asked Mr. Yeadon, "What kind of plug will you require for the other end of the lead?" "Oh, that doesn't matter," replied the customer, "My husband is fitting the socket to the radio and he will see to the plugs at that end." "It is not an AC/DC radio, is it?" enquired Mr. Yeadon, "that could be dangerous." Seeing her puzzled expression, he added, "You see, if it is, he could kill himself, or damage the tape recorder". "Oh," exclaimed the customer, "I had better go and tell him because we don't want to damage *the tape recorder*, we have only just bought that".

NEXT MONTH

IMPROVEMENTS TO the *Brenell* tape amplifier will be suggested by J. H. Fisher in our October issue, to be published on Tuesday, 14th September. Also in this issue will be a detailed analysis of the *BSR TD10* three-speed tape deck, a review of the *Philips ET1042/10* professional mixer and the second in the *Sound & Cine* series. Construction of a stroboscopic-tape printer from *Meccano* will be detailed by G. A. Cloud—just the thing to keep one occupied during the lengthening autumn evenings.

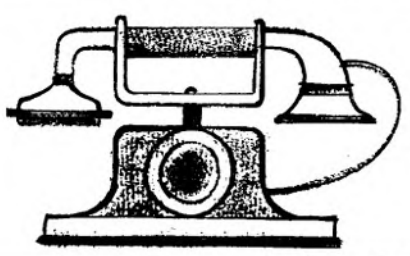
THIS SOUND-PLAY is of equal interest to actors and engineers. The setting is domestic, calling for naturalistic treatment by both. The actors' role is to get on to tape the gently mounting tension, whilst simultaneously making the comedy points which arise naturally out of the situation. The 'engineers' have straightforward effects to cope with. Their contribution to the imagined visual scene—particularly with regard to the house-geography and the telephone—is very important, but, in the result, unobtrusive to the point of being almost unnoticed.

The characters are so written that they may be played by groups with a wide range of ages. Ideally the children should be teenagers, the girl the elder; but these parts may be played by adults who can assume youthful voices. The comedy aspect will be heightened by playing all the parts in a local accent, provided it is kept authentic and not broadened.

The sound effects are easily within the compass of anyone prepared to take a little trouble in advance of the recording session. It should be noted that whilst conversation is going on during the ringing of the telephone the sound effect should be kept down so as not to obscure the dialogue. Provided it can be heard, it will have the desired effect.

BY ROY RUSSELL

the new arrival



A PLAY FOR TAPE RECORDING

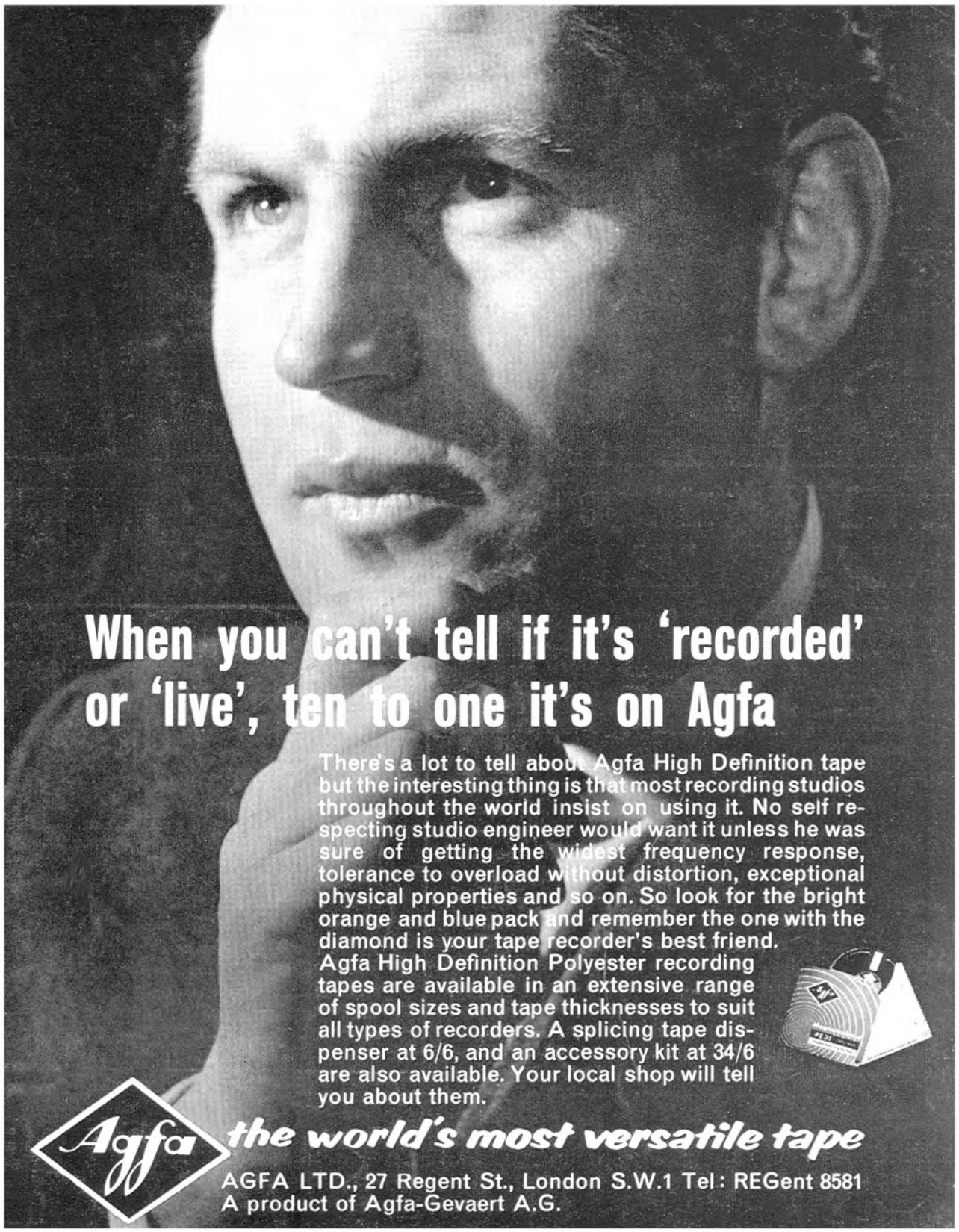
CHARACTERS

Voice on telephone (*preferably male*)
Telephone engineer
George Newcombe (*father*)
May Newcombe (*mother*)
Clare (*daughter*)
Roger (*son*)

TELEPHONE ENGINEER : O.K. miss. Lovely. Thanks. (*Phone replaced*) That's it, Mister . . . er Newcombe. It's all yours. You're on the phone.
ROGER : Smashing.
CLARE : Oh, good.
GEORGE (*Pleasantly*) : At last. It's taken long enough.
ENGINEER (*Justifying*) : I've not been twenty minutes, have I?
MAY : No, what my husband means is, we've been on the waiting list so long.
ENGINEER : Oh, that's not my department. We put 'em in as soon as we get the O.K. Well, I've another job yet tonight so . . . thanks very much.
(*Lounge door opening. Closing. Slight change of acoustics*)
GEORGE : You're working late then?
ENGINEER : Sometimes. We've always somebody on. Then there's this bloke the police are after. Ringing up people—you know.
(*Front door opening. Faint traffic noise*)
GEORGE : Oh yes ; I saw it in the local paper. Must be a nut. It affects you, then?
ENGINEER : We've had to change a few numbers, where it got too bad. It's all extra work. Well, g'night.
GEORGE : G'night. Thanks.
(*Front door closes. Cut traffic. Lounge door opens. Acoustics revert to opening sequence*)
ROGER : Hey dad, bags me use it first.
(*Lounge door closing*)
GEORGE (*Mild reproach*) : You get back to your homework.
MAY : Now who would *you* ring, Roger.
ROGER : I dunno ; I want to have a go. Anybody.
GEORGE (*Instructions*) : Roger, you don't use it without permission, understand? Every time you pick that up it costs me money.
ROGER : What's it for then? To look at?
MAY : Your father's right. We'll get one of those little cash boxes and you and Clare can put the money in the slot towards the bill.
ROGER : Aw, you can't have it both ways. We got to get permission and we got to pay.
GEORGE : Now that's enough. I'm not having you two monopolising the thing. I might be trying to get through to your mother. On something urgent.
CLARE : What could be that urgent?
GEORGE : You never know. I might have been run over or something.
ROGER : Then you couldn't ring her.
GEORGE : I could if it wasn't too serious.
ROGER : Then there'd be no point in ringing ; you'd come straight home.
GEORGE : Look, I don't want any arguments.
CLARE : But dad, what have we got it for if we can't use it?
GEORGE : Well, you don't think I've had it put in for you to chat to your boy friend all night, do you?
CLARE : Well, his father will let him ring me ; because Alan said, soon as I know the number would I give it him.
MAY : Oh, that's all right, dear. Incoming calls don't cost anything.
ROGER : Is that all we got it for? So other people can ring us?
GEORGE : It isn't just the cost, May. We want it there when we want to use it. Now if we have any more arguments I'll have the damn thing taken out.
ROGER (*to Clare*) : The number will be in the book, so he can't stop people knowing it.
GEORGE : And I'll have it ex-directory if there's any more of that.
MAY : Oh, you mustn't do that, George. We must have our name in the book. That's half the fun. I agree with Clare and Roger. We *should* ring somebody. To christen it.
GEORGE : Now don't you start. This phone's to be used when it's needed. Not unless. Now is that clear?
ROGER : When Billy Hawkins went on the phone they had printed cards and sent them to everybody they knew.
GEORGE : They didn't, you know.
ROGER : Yes they did. His dad gave him one ; he showed it me.
GEORGE : They didn't send them to *everybody*, because they only give you a limited number, clever.
CLARE : Did we get some then dad?
MAY : Your dad said we weren't sending them until it was put in.
CLARE (*Disappointed*) : Then you knew the number all the time.
GEORGE : Well, we didn't want people ringing us up before we were on. We would have looked fools.
ROGER : We would. Answering a phone we hadn't got.
GEORGE : You know what I mean. You're getting too cocky these days.

CLARE : Oh come on dad. It's in now. Let's do the cards. Where are they?
GEORGE : In the sideboard.
ROGER : We'd better just check it's working first, then. Eh?
(*Drawer opening*)
MAY : The man tested it.
ROGER : Well let's just see. (*Receiver lifted. Dialling tone*)
GEORGE (*Strictly*) : Roger! Put that down!
ROGER : I'm only testing it. It won't blow up, you know.
(*Drawer closing. Background sound Clare counting cards sotto voice*)
GEORGE : I said put it down!
ROGER : It doesn't cost anything to listen to the dialling tone.
GEORGE (*Deliberately*) : I said *put it down*! Somebody might be wanting to ring us.
ROGER : But nobody knows our number.
MAY : Put it down Roger. When your father says!
ROGER (*Disgusted*) : O.K.
(*Receiver replaced. Dialling tone stops*)
MAY : I still think we should ring someone, George.
GEORGE : We *will*. Soon as we have a good reason.
ROGER : That could be weeks.
CLARE : There aren't many of these postcards are there?
GEORGE : Thank you, Clare. Er . . . All of them. Please.
CLARE : Can't I keep one? Just one.
ROGER : Yes, dad. One each. Please.
MAY : Let them, George.
GEORGE : Well, just one each. There aren't enough as it is.
CLARE : Thanks dad. Who are you sending yours to?
ROGER : That's telling.
CLARE : Oh come on, Rodge. Who?
ROGER (*Joking*) : That man in the paper last week.
CLARE : Which man?
ROGER : You know. The one the police are after ; keeps ringing people up, saying nasty things.
MAY : Roger. That's enough.
ROGER (*sudden mischievous thought*) : Ooh, supposing he rings here?
GEORGE : I'd soon tell him where to get off.
ROGER : He *wouldn't* get off, dad. That's it. He goes on and on, the paper said. Why do they listen if they don't like it? I mean why don't they hang up?
MAY : Roger. You're not to read such things.
ROGER : Does he use *very* bad swear words, mother?
MAY : I don't know what he does. And I don't want to.
CLARE (*Naïve on the subject*) : He's just very rude to people, isn't he dad?
GEORGE : Fill those cards in, and stop this silly talk.
ROGER : No need to ask you who yours is for. "To my darling sweetheart, Alan." Love and kisses.
CLARE : Mother ; stop him. Please.
MAY : Roger! George, give me one for Mum and Dad.
GEORGE : You're not sending them one. They'll *always* be on.
MAY : They *must* have our number. What did we have it put in for.
ROGER : As an ornament.
(*Sound of slap*)
ROGER : Ow.
GEORGE : Any more of that, you'll get another one.
CLARE : He was joking, daddy.
GEORGE : Any more from you, and you'll get one too.
MAY : You're *not* to hit her, George.
GEORGE : I'm beginning to be sorry we had the damn thing put in at all. We've had nothing but argument since.
MAY (*Reflecting*) : And to think how we couldn't wait. We were so looking forward to it. And the letters you wrote about the delay.
GEORGE : Well, another time I'll know better.
MAY (*Regretfully*) : And I'd always wanted to be on the telephone.
GEORGE : Well, now you are, dear, so be satisfied.
MAY : Yes, but I want to use it. Ring up somebody. Just to break the ice. We *should*.
GEORGE : Go on then. Anything for a bit of peace. Go on. It's there looking at you. Ring somebody.
MAY : All right.
ROGER : Mind it doesn't bite.
MAY : Roger! I'm trying to think. What about Freda and Harold?
GEORGE : Heavens no. That's a trunk call. Just to say we're on the phone? We'll send them a card. Perhaps when they get it, they'll ring us.
MAY : Auntie Mabel?
GEORGE : You'd never get her off.
MAY : What about Mrs. Alexander?
ROGER : She only lives three doors away. You could shout.
MAY : Well, if you're so bright. Who then?
ROGER : Let me ring Billy Hawkins.
GEORGE : No. Your mother's making the first call.
CLARE : *I* know. Ring Mr. and Mrs. Roberts, mother.
MAY : I only know them slightly, what would I say?
ROGER : "Hello, Mr. and Mrs. Roberts. Do you know your Alan is knocking about with my Clare?"
CLARE : That wasn't why I suggested them.
ROGER : Not much.
GEORGE : What did I tell you? Nothing but argument.
ROGER : We could dial the police. Or an ambulance.
CLARE : Whatever for?
ROGER : See how long it takes them to get here.
CLARE : You can be fined for that.
ROGER : That's the fire brigade, silly.
MAY (*Sudden thought*) : *I* know.
CLARE : Who?
MAY : No. They're not on the phone.
ROGER : Well that leaves that chap they're after for ringing people.
GEORGE : I'll stop taking the local paper if I have any more of that!
(*Phone rings. Continues*)
ROGER : What did I tell you. That's him.
CLARE : Who can it be, dad?
MAY : Nobody knows our number.
GEORGE : Probably a wrong number. Are you sure none of you've been at those cards?
CLARE : I haven't ; honest.
ROGER : You're the only one who knew the number, dad.
GEORGE : Your mother did. Who've you told, May?
MAY : Nobody. George ; answer it.
GEORGE : You're sure?
MAY : Honestly.
CLARE : Oh answer it dad. Please!
GEORGE : Then it must be a wrong number. Unless . . .
MAY : Unless what, dear?
GEORGE : The telephone chap said they'd had to change some numbers because of him. Supposing our number . . . was one of those they'd changed.
ROGER : Yea. And he's still using it.
GEORGE : Quiet. Everybody.
(*Cradle lifted. Ringing stops*)
GEORGE (*tentative*) : Hello.
CLARE (*Almost in a whisper*) : You should give the number, dad.
GEORGE : Shsh. Er . . . 6494 speaking.
CLARE (*Again in a whisper*) : And the exchange.
GEORGE : Sh, will you! Hello! Who's there? Who are you?
(*Dialling tone*)
GEORGE : Funny. Nobody there.
(*Replaces phone*)
MAY : *Must* have been a wrong number.
GEORGE : Then why didn't he say?
ROGER : Who, dad?
GEORGE : Whoever it was.
ROGER : If mother or Clare had answered he'd have talked to them. He rings off when a man answers. It said so.
MAY : Roger!
(*Phone rings again*)
ROGER : Let mother. Then he'll talk.
MAY : I'm not speaking to him.
GEORGE : Quiet. Everyone. Not a word. Leave this to me. I'll handle him . . . I mean if it's a wrong number or . . . er, whoever it is.
(*Receiver lifted*)
GEORGE : Hello, er, 6494.
VOICE ON PHONE (*Telephone fidelity only*) : Mr. Newcombe?
GEORGE : Yes?
VOICE : Is the telephone engineer still there?
GEORGE (*Anxious questions, without pause for reply*) : What's that to do with you? How d'you know my name? This is a private telephone. What right have you to check up on who's here. Who is that? What's your name?
VOICE : It's all right, sir. I tried to get you just now but I got the

(*continued on page 352*)



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tape reviews

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

SONG OF THE WANDERER Kid Ory (trombone), Darnell Howard (clarinet), Marty Marsala (trumpet). **World Record Club TT389.** 3¾ i/s twin-track mono. 29s.

AT 78, Kid Ory is the oldest living jazzman still playing. Fifty years ago Ory played trombone with the legendary Buddy Bolden, and was leader of his own band in New Orleans which at one time included Louis Armstrong and other now famous players from that city. In the '20s he took part in some of Armstrong's classic recordings.

In the late '40s and early '50s, following a period of retirement from the jazz scene, he was very much associated with the revival of traditional New Orleans jazz, and made a series of outstanding recordings. Unfortunately the music on this tape is far from outstanding, although it's easy to listen to and thoroughly enjoyable, it is a great pity we could not have had a more typical example of Ory's revival groups.

A possible reason why this is not equal to most Ory sessions of this period may lie in the choice of the other players. Darnell Howard's clarinet playing does not belong with a New Orleans group, and although Marty Marsala is a fine trumpet player, he comes from Chicago not New Orleans.

The numbers played are mostly New Orleans standards such as *Tiger Rag*, *Baby Won't You Please Come Home*, and *Mahogany Hall Stomp*. Apart from some forceful ensemble and solo playing by Ory, the most interesting solos are provided by Cedric Haywood on piano.

T.F.

BEETHOVEN SYMPHONY No. 9 in D minor, Opus 125. London Bach Choir and London Symphony Orchestra conducted by Pierre Monteux. **World Record Club TT415** (1st, 2nd and 3rd Movements). **TT416** (4th Movement and Rehearsal.) 3¾ i/s twin-track mono. 29s. each.

BEETHOVEN'S 'Choral' symphony holds a unique position in all symphonic writing. It is considered to represent the culmination of Beethoven's ideas in this medium and it is certainly a long and impressive work. Beethoven himself can only have heard the music in his mind, since he was very deaf by the time the symphony was first performed.

There are the conventional four movements, but there is a departure from convention in making the scherzo the second movement rather than the third, and, of course, in the addition of choir and solo voices to the last movement. The involved structure and dramatic character of the last movement can have the same effect on both listener and performer that the carrot has on the donkey, a hustling forward towards the proffered prize. Not so with Pierre Monteux and his team. Each movement receives the same careful study and an impression of profundity is evoked that is often lacking in performances that are more obviously dramatic. The last movement is splendid. In places the choir's vocal line is obscured slightly by the orchestral parts, but this is not seriously disturbing.

The length of the ninth symphony has always been a problem to recording companies. Here it is issued on two tape records, the second track of the second tape being taken up with a recording of the orchestral rehearsal. This is interesting enough in itself, and serves to draw attention to details the listener may otherwise miss, and is of course a tribute to the man himself. There is also an impromptu performance of the *Marsellaise* by the orchestra, again a gesture of regard for Monteux, but even so this is an expensive Beethoven's ninth in terms of hard cash, I feel.

The recording quality, whilst not the most vivid, is adequate for ordinary machines. There is a slight distortion to the voices in the louder passages, but this is of short duration only. The dynamic range between 'piano' and 'forte' is marked, but between 'forte' and 'fortissimo' much less so.

G.G.

MEMPHIS SLIM Eleven items by Memphis Slim (piano), including The Hustler, Olympia Boogie, West Side Trot. **World Record Club TT384** twin-track mono, 3¾ i/s. 29s.

PETER (Memphis Slim) Chapman, in company with other blues artists from the U.S.A., is a regular visitor to Britain. He has been described as one of the most authentic blues artists of his generation.

It will be a disappointment for some that his fine singing is not heard on this tape. Recorded in Paris in 1961, it is made up of eleven blues and boogie piano solos. On the faster numbers such as *Panic Street* and the *Hustler* the playing has a strong flavour of Meade Lux Lewis. Most of the very varied programme consists of slow blues which are full of interest and fine feeling.

Sonophone Boogie and *Musing* feature Memphis playing celesta. The bell-like tones of the celesta played with the right hand, against the strong boogie figures by the left hand on the piano, produce interesting and pleasing results.

This tape is the complete answer to those who believe that boogie is dull and monotonous. There is something different in every item, interest is well maintained throughout, and the recording quality first class.

T.F.

SYMPHONY No 1 (Elgar) Op. 55 in A Flat Major. The Philharmonia Orchestra conducted by Sir John Barbirolli. **HMV TA-ALP1989.** 3¾ i/s twin-track mono. 40s.

TASTE and fashions change in music as with other things, and Elgar's symphonies have tended to be eclipsed by more popular works in recent years. Elgar devotees will doubtless welcome this issue on that score alone. This is an age when all things savouring in the least of pompousness tend to be out of fashion, and this may account for the lack of popularity of the first of the Elgar symphonies, particularly. It must be said, however, that Elgar himself towards the end of his life was not pleased with the jingoistic interpretations that had already been attributed to some of his work.

The symphony opens in the best *Land of Hope and Glory* tradition with a noble tune over a marching bass. In fact 'noble' and 'stirring' are epithets that come to mind frequently when trying to describe the music in this symphony, except when we come to the slow movement where the rich harmonic progressions and orchestral texture are truly beautiful.

The treacherous winds of fashion obviously leave Sir John Barbirolli unbuffeted and secure. The performance is devout and intense and we are left in no doubt that for him this is a tremendous piece of music. The Philharmonia orchestra gives him full support in a very serious performance where all possible banalities are well suppressed.

The recording quality is good in the main. There is a restriction of frequency range which deadens string tone on wide-range speakers, but the wide dynamic range imparts its own sense of freedom and one feels that the playing does not suffer much from recording inadequacies.

G.G.

ABC of tape recording

PART SIX BY DAVID KIRK

MATCHING PROBLEMS

HOW pleasant it would be if everyone spoke the same language; no need for interpreters, no confusion and misunderstanding when travelling abroad, one less subject on the school syllabus. And how much nicer, also, if we did not have to worry about *impedance*. Different impedances require translators (the precise term is *transformers*), impedance matching causes no end of confusion, and mis-matching often results in poor quality sound. But learning the ins and outs of electrical matching is, fortunately, a good deal easier than learning a foreign language.

Recently, when discussing resistance, we referred to a resistor as being the electrical equivalent of a short stretch of country lane interrupting two lengths of motorway—acting as a bottleneck to electrons trying to pass through. Impedance is less simple to describe since it refers to *alternating current* (AC)—which oscillates backwards and forwards. It is possible to insert a component (capacitor) in the path of a direct current to block the flow of that current without having an appreciable effect on an AC signal. Similarly, by using an *inductor*, it is possible to cut down AC flow without very much effect on DC.

Returning to the subject of microphones, which occupied last month's article, the units discussed can be listed not only under acoustic pick-up characteristics, but under impedances. The crystal microphone is at the top of this list, having a very high impedance—up to several million ohms at low frequencies. Capacitor microphones are also high on the list, having impedances of a similar order. Next in line are the moving-coil microphones, with impedances of up to 50-ohms or—when equipped with built-in transformers—up to several thousand ohms. The impedance of the moving-coil itself depends on the thickness of wire and the number of turns.

At the lowest end is the ribbon microphone, which has an extremely low impedance, invariably stepped up to a moving-coil level by a built-in transformer.

For convenience, the three most frequently used impedances in tape recording are referred to simply as: *high* impedance (250K and upwards), *medium* impedance (100-ohms to 5K) and *low* impedance (25-50-ohms). When purchasing a microphone, one of these impedances must be specified for the simple reason that most tape recorders will only have sufficient input sensitivity for the sort of signal obtained from microphones in one particular impedance category. The average domestic recorder has a high impedance, low sensitivity input stage and will accept crystal microphones without complaining. But while a low or medium impedance input can be a costly feature in valve recorders, medium impedance inputs are quite cheap to incorporate in transistorised equipment—even if only the first stages are transistorised. Thus, it is common for transistorised battery recorders to be supplied with cheap moving-coil microphones capable of better results than most crystal units. But to equip a recorder so that it will accept low-impedance ribbon microphones or higher quality moving-coil types involves using transformers to raise the impedance (and signal level) to an order acceptable to the transistor (300-ohms) or valve (500K) amplifier. Many high quality recorders, including those made by Ferrograph and Revox, do not incorporate such transformers and have only high impedance, low and high-level inputs. Where low-impedance microphones are to be used, the necessary transformers are connected either in the cable between microphone and recorder or in a mixing unit. The tape recorder input sensitivity needed to take the resulting signal from a transformer is in the region of a millivolt or so.

The practical advantage of low-impedance microphones is that they may be connected by as much as a mile of cable to the recorder. High impedance microphones, on the other hand, are limited to around 10ft. of cable and are usually fitted with much less. Medium impedance microphones will tolerate rather longer cable connections than the latter, though limited to some 30ft., depending on the particular equipment in use and the location.

The longer the cable between high impedance microphone and tape recorder input, the greater likelihood of picking up hum—and thus lowering the signal-to-noise ratio. Electrical fields produced by the house wiring and the tape recorder itself induce an AC signal in the microphone cable—the longer the cable, the stronger the signal. It is important to remember that 10ft.—or 6ft. or whatever length of cable the manufacturer has chosen to fit—is no magic figure beyond which hum will begin to show itself. If the microphone were connected to the recorder by only 6in. of cable, hum would still be present to some extent. Hum level tends to increase with cable length until—at about 20ft.—the level might be so high as to drown the voice signal which it is hoped to record. In another location, perhaps using another recorder, more than 30ft. could be tolerated, since interference might be of a lower level.

A high impedance cable electrically resembles one plate of a capacitor. Thus, if positioned close to another conductor such as the mains wiring—in which the voltage varies—something of that variation would be induced in the microphone cable. If located near a DC conductor (and this applies as much to the high-impedance conductor as to the plate of a capacitor) no signal would be induced across the space between the two. The high-impedance conductor, like the capacitor, can only detect variation in voltage (AC). It is, of course, fortunate that DC is not capable of being induced capacitively—or we might find our torch batteries exhausting themselves through a capacitive link between positive and negative terminals! Varying AC fields abound within the region of a mains tape recorder and its 50 c/s power supplies, and it is to be marvelled at that crystal microphones may be satisfactorily used at all in the home.

Medium and low impedance microphones also exhibit something of the properties of a single capacitor plate, but the impedance is so low in relation to the sensitivity that hum pick-up can be negligible.

The thin diaphragm forming the heart of the ribbon microphone comprises, in effect, a single 'turn' of a moving-coil, and the voltage generated across it when moving through the surrounding magnetic field is too small to be of practical use. Within the casing of every ribbon microphone, therefore, is a small transformer to step up the impedance—and hence the voltage—from a fraction of an ohm to some 30-ohms. Since one cannot produce energy from nothing, as

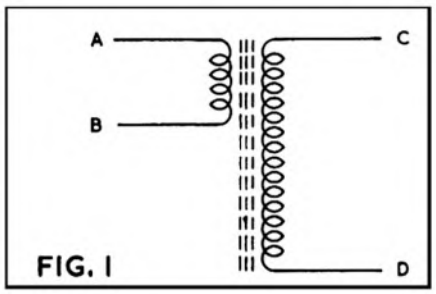


FIG. 1

voltage goes up, the transformer must reduce the current.

A transformer comprises two separate coils of wire wound round a core in much the manner of an electromagnet. It can, in fact, be thought of as a pair of electromagnets on a single metal core. **Fig. 1** illustrates the coils and core diagrammatically. If the signal from the ribbon microphone diaphragm is applied across the two terminals of the left-hand coil (**A** and **B**) in this illustration, the core on which both left- and right-hand coils are wound will become magnetised first in one direction and then the other—depending on the frequency of alternation of the microphone signal. This magnetic field, in turn, induces a signal in the right-hand coil but, since the right-hand coil contains more turns of wire than the left-hand, the voltage taken out across C and D will be greater than that applied to A and B. This does not mean the amount of *power* (or energy) has been increased; on the contrary, it has been reduced owing to small losses in the transformer. But voltage increase has been obtained at a cost of reduced current, which is another way of saying that the impedance has been raised. The transformer works backwards too. A signal of moderately high voltage and impedance applied to C and D would induce a similar signal across A and B, but of lower voltage and higher impedance than the original. The fact that, in this case, we might damage the microphone is irrelevant!

Transforming impedance is no more difficult than transforming voltage. Still with **fig. 1,** the impedance to AC of the left-hand coil will depend on the 'load' connected across the right-hand winding, and vice versa. It is in a coil that the difference between (AC) impedance and (DC) resistance become most noticeable. DC resistance is a function of conductor length, diameter and conducting material. The resistance across **A** and **B** can be measured as a certain number of ohms. The fact that the wire between **A** and **B** is wound round a metal core has no effect on the resistance, which would remain constant even if the transformer was unwound and the coil pulled straight.

The impedance, however, while dependent on conductor length, diameter and material, would change markedly if the coil were unwound as described. This is because the coil imposes a drag on the AC signal due to its *inductance*, trying to slow down the process of alternation. When a flow of electrons making up one cycle of alternation enters the coil it is slowed momentarily as it begins to build up a magnetic field in the coil. At the peak of its oscillation, the flow then begins to travel back out of the coil, causing the magnetic field to collapse and reappear with opposite polarity. This collapse and regeneration is a fractionally slower process than the reversal of voltage, and strives to impede that flow until it has 'caught up'. This sluggishness becomes more and more noticeable as the number of turns in a coil is increased, it being *incidental* that resistance also increases as extra wire is used to make the extra turns. Coil **A-B** thus has a lower impedance than **C-D,** the precise value being determined by the number of turns and their relation to the core. Far from being the same thickness, coil **C-D** in a commercially-made transformer would probably be wound of much thinner wire than used in **A-B.** This would permit a greater number of turns to be wound in a relatively small space.

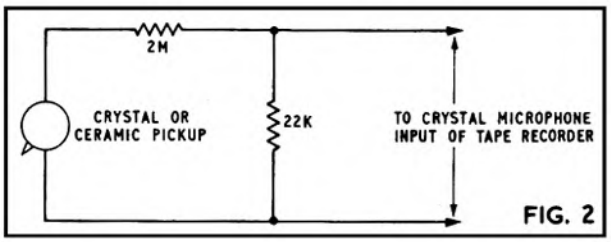
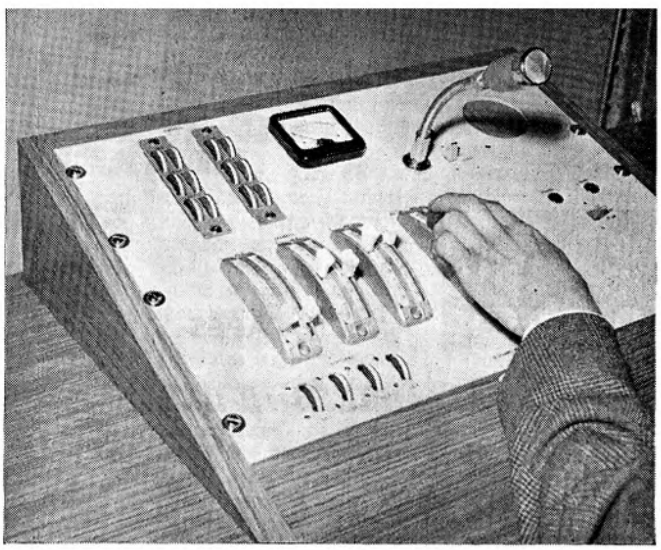


FIG. 2



The type of impedance involved here is inductive, and in a good transformer properly used the inductive impedance of any winding is chosen to be greater than the impedances of any microphones, amplifiers or other audio equipment which might be connected to it. Inductive impedance is proportional to frequency, so that at low frequencies a point is sometimes reached where a transformer ceases to work efficiently because its internal inductive impedance equals or falls below the impedances being transformed. Impedance transformation, incidentally, is just a trifle more complex than plain voltage transformation, because it follows the *square* of the simple turns ratio. For instance, a transformer with a step-up ratio of one to a hundred would convert 10mV to 1V (× 100), but an impedance of 10 ohms would appear at the secondary as 100K (× 100^2 or 10,000).

It is possible to purchase a ribbon or moving-coil microphone for direct connection to a high-impedance tape recorder input. Such models have the transformer built in to the transducer casing. The flexibility is limited, however, because the high-impedance output from the transformer is subject to the same length restrictions as a conventional high-impedance microphone. Whether the transformer is built into the microphone, spliced into the cable, or housed inside the recorder, the output from its high-impedance tapping must be joined to the input amplifier by as short a cable as possible.

The advent of the transistor has seen the introduction of a new type of impedance matching unit. In place of a transformer, these devices have a low-impedance input and high-impedance output stages, sometimes with the addition of a preamplifier stage to boost the relatively low output of the ribbon microphone. An example is the *Reslo GE1* transistor coupler (illustrated) which will match any impedance microphone to a high impedance (100K) input; it costs £7 7s.

Mixing units often incorporate the appropriate transformers, or transistor circuitry, to match medium and low-impedance microphones to tape equipment, though the output of a mixer is usually sufficiently strong to feed straight into the high-level input of the tape recorder. Often described as the GRAM input, this socket will accept the output from another tape machine, a radio, tuner or gramophone. Having already passed through an amplifier, the output from any of the latter requires no further preamplification, unlike the crystal microphone.

It is sometimes possible with gramophones using crystal or ceramic pickups to obtain adequate disc dubbing by connecting the output of the pickup to the low-level (microphone) input with a suitable attenuator. A simple circuit for doing this is shown in **fig. 2,** though the valve of the 22K resistor is very nominal and can be changed up or down to suit the pickup and recorder in use. Magnetic pickups, however, bring with them the additional complication of impedance matching and equalisation.

A good amateur mixer will cater for two or three microphones, of varying impedance, and have at least two high-level inputs suitable for other audio equipment. Readers who have seen the occasional photographs of high quality mixers showing how 'the other half' live, may have queried the advantages of sliding controls over the rotary faders fitted to all but the most elaborate commercial equipment. The main advantage, gleaned not so long ago from D. P. Robinson, is that the BBC and others have found it physically impossible to turn a rotary control perfectly smoothly through 320°, whereas a smooth fade is quite easily accomplished by carefully pushing a quadrant or horizontal control. From a practical point of view, most of the low-price horizontal slide faders are apt to develop worn and noisy contacts. The *Elcom* equipment illustrated left, as well as Mr. Robinson's original mixer, are certainly not in this category, operating as they do on a more sophisticated and reliable principle.

Next month will see a diversion to the subject of record/replay equalisation.

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sound and cine

BY ANTHONY WIGENS

THE FIRST OF A NEW SERIES

KEEPING IN STEP

THE majority of films shown in the home are run in an uneasy silence. The audience is aware of it and feels compelled to murmur audible appreciation of the better scenes. The home showman is aware of it and usually offers explanatory comments on the film. Clearly, something is missing.

But the effective use of recorded sound combines with room blackout to secure almost total concentration on the film.

The track can simply be an accompaniment, a piece of music selected to be in sympathy with the mood of the film. A nimble projectionist could use a record player and several records to build quite a sophisticated pattern of moods. However, extensive rehearsal would be needed and the logical progression would be to record them all on tape, starting the recorder on playback when the projector was switched on.

Not all information can be put across visually with full effect. Some travelogue sequences might be improved if you could tell an anecdote about the area or introduce some episode from the country's colourful past. This calls for commentary. Again, the tape recorder saves you having to speak it afresh at each film showing.

With very general commentary it may be good enough to start recorder and projector at the same time ; but when you make remarks concerning specific shots in the film you can start to land in trouble.

With a variable speed projector you may get right out of step with the film. After ten minutes of country faces and places on screen you may project a colourful close up of a boar, then cut to a red-faced farmer at the market just as your commentary says : "Now here's a splendid porker. He's a Wessex saddle-back . . ." When you introduce comedy it should be intentional.

Once you introduce devices to keep recorder and projector in step, the challenge is to improve on their accuracy until exact synchronisation exists. There are a number of methods of running the two machines so as to approach this degree of accuracy, and before choosing one it is wise to consider what you want of a cine-sound system. Here are the main factors :

(1) *Price.* How much can you afford now, and how much later ?
(2) *Flexibility.* If you progress to sound on film (with a magnetic stripe projector) will your present sound equipment still be useful ?
(3) *Availability.* If you lend films and tapes to friends, or enter for competitions, how difficult will it be for others to match your sync system ?
(4) *Simplicity.* Consider recording techniques and the time spent in setting up for a show.
(5) *Accuracy.* How close will the system approach to lip synchronisation ?

Lip sync is the goal of all film-makers who add sound. Sooner or later you will want to show a person talking on screen and let the audience hear the voice, every syllable matching the related lip movements. It is feasible, but the challenging fact is that on an amateur budget you can use professional film-making techniques at every stage of film production except sound recording. Here, the cost of specialist equipment rules it out, and all that is left is compromise.

Specialist equipment cannot solve every problem for the professional and sometimes even he must compromise. Often it is not feasible to record good quality sound at the same time as the picture is filmed, and the sound is dubbed afterwards. With post-sync speech, professional discipline is required to match a voice exactly to a mute image of the speaker, but it can be done.

The same possibility exists with the magnetic sound projector, which incorporates its own recording and erase heads. You can shoot a film, have an edge stripe of magnetic material added, and then dub synchronised sound while the picture is projected. If you achieve this once there need be no trouble on subsequent projections as there is only one machine to set up and no link to arrange.

To the tape enthusiast the sound projector has one major disadvantage. It costs at least as much as a projector and a tape recorder purchased separately (upwards of £100) and yet it will not function separately as a tape recorder. In fact, for any complex track, a tape recorder is a necessary accessory to the sound projector.

This series will deal with machines, materials and techniques involved in both tape and stripe sound movie-making, but only the individual can decide which method will be best for him in the long run. Here, as a guide, is a list of popular sound methods marked according to their drawbacks and virtues :

Sound stripe : Flexible, simple to use and accurate in synchronisation. Cost is the one drawback. *Eumig Mark S* and *Silma Sound 2* are of notable value.

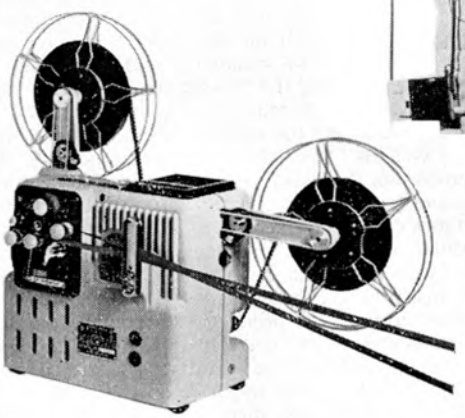
Loop Synchronisers : Flexible and readily obtainable for use with many projectors, notably *Eumig*. Used with conventional tape recorder.

Sprocketed Tape Loop Synchronisers : Reasonably priced and quite versatile, though not the simplest of arrangements to work with. Accuracy is high. A tape recorder designed for this application is the *KGM Cinecorder*.

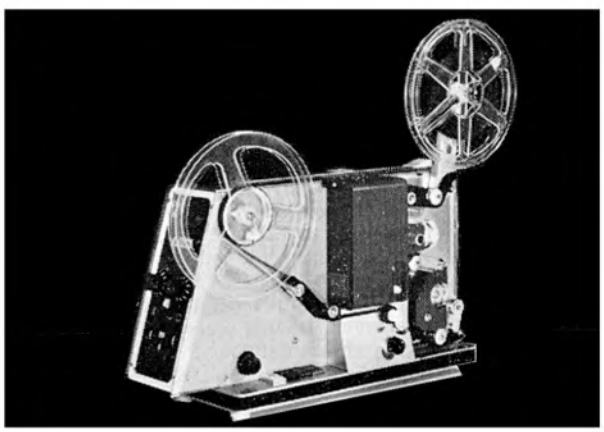
Double Commutator Electric Synchronisers : Bauer system, operating with a separate tape recorder. Reasonably priced and quite flexible.

Differential Gear Synchronisers : Operating between projector and tape recorder, these are not too expensive and are very flexible. The *Synchrodek* is a good example.

Controlled by the start/stop switch on the camera, the *Eumig T5* recorder was ideal for location work. Distribution halted recently by the T5 is still to be found on the second-hand market



Tape coupling and sound stripe projectors are shown left and below respectively. The latter is the *Carena*.



STEREO techniques

STEREO recording is so much more satisfying than mono, with an interesting and lifelike finished result, and it is a pity that so few people attempt it. Forget the sceptics who say that it is more difficult to record in stereo ; it is often easier—the added 'information' makes up for deficiencies that would be glaring in mono. But this should not be interpreted as an advocation of mediocre stereo recordings, since a first-class tape provides an exhilarating sound. Once having experimented with stereo tape, you will not return to single channel. Tape provides a cleaner, more solid sound than disc, probably due to the reduced crosstalk and distortion that can be obtained ; listeners to the experimental stereo transmissions will verify the major improvement in the sound which occurs when a BBC tape is played.

First of all, let us clear up a few technical terms. There are two systems of stereo recording in use at present, known by the initials A-B and M-S. A-B is the simplest method, and the most commonly used; the left-hand sound is recorded on the upper track (A) and the right-hand (B) on the lower. M-S stands for mid-side, which is derived from a method of producing the two signals, which are sum and difference. Thus A plus B is recorded on the top track, and A minus B on the lower. What are the relative advantages and disadvantages of the two systems? For the broadcast authorities, the M-S signal can be processed, with such parameters as reverberation and width, each individually available for manipulation. A compatible signal from difficult tapes can be produced with less difficulty ; also, it is suitable for feeding direct to a multiplex encoder for stereo broadcasts. On the other hand, the disadvantages outweigh these advantages even for many of the broadcasting organisations, and A-B recordings are more normal. To produce M-S, complicated and expensive matricing transformers are needed, or else two different types of microphone—the latter of course introducing great problems in phase matching, particularly in the upper frequency ranges. If there is no manipulation of the signal, then at the loudspeakers the sound in stereo is the same in both cases, and the straightforward A-B system is to be preferred, certainly for amateur use.

The equipment required is not significantly greater than in mono ; the stereo recorder itself is the greatest expense for most systems. If a mixer is used, often merely splitting a mono type in two is sufficient, as stereo recordings usually use *less* microphones, so that the lack of channels is not embarrassing. If much fading is necessary, then ganged controls are a useful feature, either on the mixer or on the tape recorder. Quadrant faders are also suitable, and have the advantage that they can easily be used individually for mono recordings. It is virtually impossible to perform an accurate stereo fade using two rotary controls, as unless the two outputs are to within 1dB (that is 10%) of each other, the stereo image will appear to be moving in an erratic manner, which is most disturbing.

There is one specialised control that is useful in stereo, the *panning* control or 'panpot' as it is known colloquially. This is a device to enable a mono source to be added to a stereo recording, and positioned somewhere in the sound-stage. Except for special effects, it is not satisfactory to add such a signal firmly to one side—it sounds highly unnatural. The pan-pot divides the signal into any desired ratio and adds the outputs to the two channels. Figs. 1(a) and (b) show two such devices ; the first has the advantage of being extremely simple, and the disadvantage of coarseness at the extremes of the range. The other system (b) is more expensive, but is extremely good as a pan-pot. Moving away from the centre position, one channel is virtually unchanged while the other decreases slowly. Many good preamplifiers use this type of control—it is a case of paying your money and making your choice.

Some kind of level metering has to be provided on the mixer, if used, or built into the recorder, and the best low-cost version is the side-by-side magic-eye, either as two separate valves or the more recent two in one envelope. Some recorders have twin VU-meters which, while giving widely different readings with different programme material, should be sufficient to indicate any differences between channels. Twin pointer peak-programme-meters are the best, but at a price of about £11 for the meter, before any amplifiers are bought, they are only for the professionals, the wealthy, or the really dedicated amateur! A happy compromise is a normal *ppm* with the electronics arranged to indicate the greater signal, regardless of which actual channel this is on. This will protect the tape from overload, and your ears will tell you the differences between channels for balancing purposes—they are, after all, considerably more sensitive than normal meters! If they tell you one story, and the meters something else, ignore the meters.

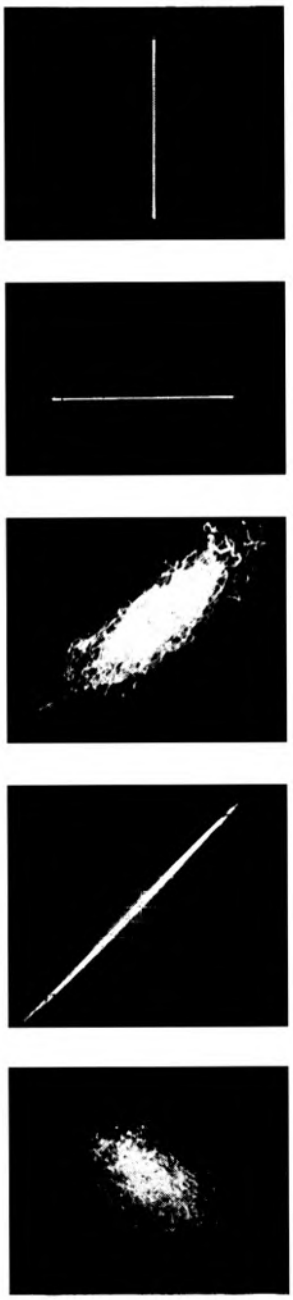


Fig. 2 (left, top to bottom): **a**/ Left channel only. **b**/ Right channel only. **c**/ Stereo input. **d**/Same input as **c** but in mono. **e**/ Out of phase stereo

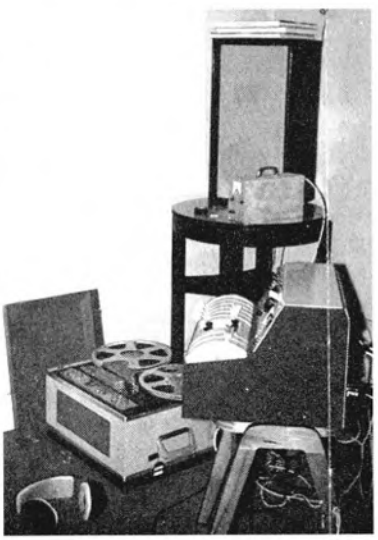


Fig. 3 (above): The author's equipment prepared for recording in somewhat cramped conditions

If you are using a mixer, make sure that there is provision for reversing the phase somewhere, unless you only use your own equipment which has been thoroughly checked. The best place is at the input to the mic transformers, if fitted. Using a recorder and its own supplied microphones, there should be no problem as the manufacturer should have checked for this, but in more ambitious equipments there may be many and varied mics and mixers in use ; also when recording in large halls it often helps to use the cables that many of them have already installed, and these will probably have a phase reversal somewhere in their length.

Phase checking in most cases can be done quite simply by one of several methods. The first and simplest is to listen to the stereo output while operating a phase changing switch—for example simply reversing the leads to one speaker. Out-of-phase signals lack body and it is very difficult to locate the various sounds on the 'stage' ; in most cases there is no doubt about the correct phase. It is also helpful if the two speakers are placed temporarily very close together to give a greater signal when in phase. Another technique uses either an oscillator or the signals often transmitted by the BBC after close-down in the evenings, for checking the transmitters. If using this last source, wait until a frequency of about 1 Kc/s appears, and place the two microphones as close together as possible, and about a foot from the loudspeaker. If a mixer is normally used, the two mics are fed into two channels and the gains of each adjusted individually to be the same ; the mixer is then switched to mono and the two signals added. The output from the mixer will increase if in phase, and decrease if not. If no mixer is used, the two leads from the mics can be joined together at the input terminal ; the level connected one way round will be greater than when one of the pairs of leads is reversed—but this last test depends on the two microphones being quite well matched.

The easiest way of all, and by far the quickest (if you have the gear), is to display the left and right signals on an oscilloscope, and this has the added advantage that a good indication of balancing is also given. In a recent recording at Cambridge, the performers were in a very echoic room, and the monitoring was done in a reverberant room, so that it was extremely difficult to decide on the correct phase—and in fact it was guessed wrongly. This prompted construction of a simple display, using surplus equipment, to show the left signal on the Y plates, and the right on the X. It is a very easy matter to determine the correct conditions (**fig. 2**). This piece of gear is now invaluable! With the Editor's blessing it may be possible to describe this unit at a later date if readers are interested.

The final piece of equipment is the tape recorder. The first subjective reaction on first making stereo recordings is that the noise has increased considerably ; however, this is in fact not true. Tape noise is random in nature, so that the noise coming from the upper track is not the same as that from the lower track. This gives it a stereo 'position', and since it is always changing, the image is moving about rapidly. This gives the subjective impression of an increased noise. The same effect is noticeable on stereo disc records—in particular here where scratches and imperfections are most distracting.

There is a solution, applicable to most tape recorders. The ear is not so sensitive to distortion in stereo than it is in mono, so that the input to the machine can be raised to give a better signal-to-noise ratio. Professional machines, when correctly biased, are set to give about 2% distortion (3rd harmonic) at the peak indicated recording level, and the corresponding figure for domestic machines is usually 3%. If a graph of the distortion is plotted against input level, from a very low level through these points and on, the distortion goes up by four times for a doubling of the input signal (thus the graph is linear on a dB scale). Increasing the input by 6dB would thus give a distortion of 8% on a professional machine and 12% on a domestic version. This practice, while maybe horrifying the purists, is now adopted by some authorities, and the peak input is set to give 4-6% third harmonic distortion. But here again, let your ears be the judge ; you will not notice the difference in stereo, but you will in mono, so remember to readjust the levels when changing from one to the other.

Economics in tape use obviously play a part in deciding whether or not to adopt stereo. If tape is limited, don't be too tempted to record at 3¾ i/s, unless your machine is very, very good at this speed ; wow and flutter are objectionable in stereo, since they contribute to a moving indistinct image. Rather in this case buy a four-track machine and record at 7½ i/s ; the cost will be the same, and the signal-to-noise ratio will improve as less equalisation is required in the tape recorder. If you are really hard-up, then it might *have* to be four track 3¾ i/s . . .

Deliberately discussion of the microphones to use has been left until now ; here again there is a choice of how to place a stereo pair, They can be mounted very close together ('coincident' or 'crossed-pair'), or they can be spaced some distance apart. In this latter method it is difficult to achieve a first-class result, the common errors being 'hole in the middle' and an ill-defined image. However, the technique is still used in the U.S.A. A variant on the two together is to place the microphones either side of a baffle or dummy head, approximately where the ears are, and good results can be achieved in this way. It is possible to buy brackets to suit particular microphones which space them about 8-9in. apart, giving essentially a dummy-head effect.

Finally, there is the true coincident pair, either two separate units or two assemblies in a common case, which should be designed so that one can be rotated a little with respect to the other. In the opinion of the author, this last method produces superior results ; the only advantage of the spaced mics is that omnidirectional units can be used (since there the stereo information is by time differences, whereas in the other systems it is by amplitude differences), but the newcomer to stereo may well have two such units with which to experiment, while not possessing two directional types.

For mics used at one point, either figure-of-eight or cardioid are the most popular. The angles between the two cells are best set at about sixty and ninety degrees respectively, to give an overall picture that is convincing without any changes in level as a sound moves across the stage. Different directional characteristics should not be mixed, and two different makes should be treated with care as there could be differences in both the phase and frequency responses, which will cause the image to wander.

In most cases one mic—that is one pair—will be sufficient for a

(*continued on page 358*)

STEREO techniques

ADVICE AND EQUIPMENT FOR IMPROVING QUALITY

BY D. P. ROBINSON

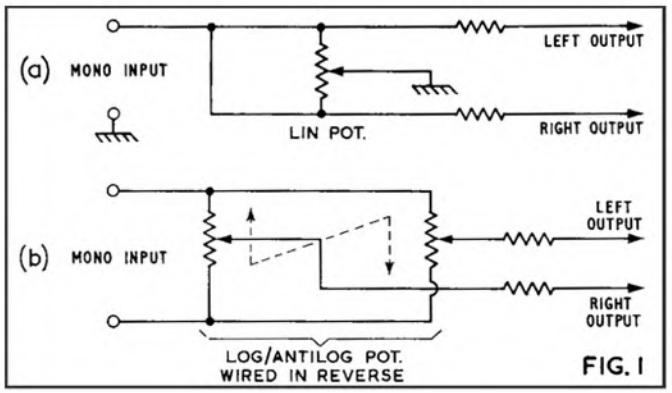
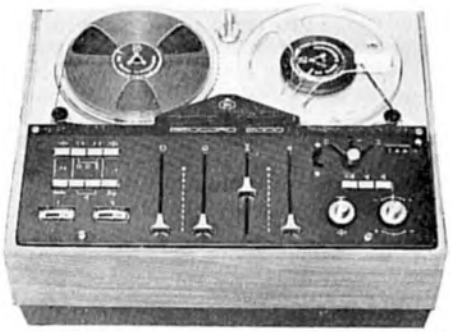


FIG. 1

Tandberg Series 6
Tape Unit



Bang & Olufsen
Stereomaster 2000

Sony TC200

Truvox PD104
Tape Unit

survey of stereo tape recorders

THE stereo tape recorder is essentially two machines in a single cabinet. For the music-lover and the sound collector it offers unquestionably higher quality than its monophonic equivalent but for the creative enthusiast it offers a great deal more than this. By definition, a stereophonic recorder is a double-channel recorder (though one might not think so judging from the cross-talk level on a very few) and a double-channel recorder can either record two signals, or play and record at the same time. The latter facility is particularly useful to the enthusiast who, having perhaps sold his original machine to help pay for the stereo model, finds himself without a second recorder. All stereo machines embody the electronic and mechanical components of such a second recorder (though not all have switching facilities to bring it to the surface), permitting multiple dubbing and controlled superimposition, and electronic synchronising with slide projectors or other electrical gadgets.

There are three types of stereo recorder: (1) the tape-unit, incorporating record and replay preamplifiers but no power amplifiers or speakers. (2) The complete recorder, with all components from inputs to loudspeakers, the speakers either in detachable 'cabinets' or with stereo monitors inside the main recorder case. Finally (3) the stereo tape unit with single power amplifier and speaker. There are comparatively few machines in this last category—the *Revox 736* is the most notable example—and these should really be considered stereo tape units with mono monitoring facilities.

The advantage of a tape unit over a complete recorder is that, having no power amplifier, the cost is absorbed entirely in the manufacture of *recording* circuitry and mechanics—leaving only a minimum for inherently low-cost replay equalisers and preamplifiers. The audio enthusiast who already owns a good quality stereo amplifier and two speakers is thus not forced to waste money on buying another—probably inferior—set of equipment. He has merely to connect the tape unit to his existing system to have complete record and replay facilities. Headphone monitoring is possible with most, if not all, units and compensates for the absence of speaker monitoring facilities when recording on location.

The following survey lists all domestic and semi-professional stereo recorders known to be available in the U.K. at the present time. For convenience both in compiling and comparing the information, all specificational figures—wow and flutter, frequency response and signal-to-noise ratio—are given for a $7\frac{1}{2}$ i/s tape speed unless otherwise stated, even when the maximum speed may be higher. Where no details are given of output power of speakers, and 'Output from preamplifiers' is quoted under FEATURES, the machine can be taken as a *tape unit*. All recorders in the survey, tape units or not, incorporate some form of preamplifier output from which an external amplifier can be fed, or recordings made.

AKAI M8. SPEEDS: 15, $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RESPONSE: 30 c/s—25 Kc/s ±3dB. OUTPUT POWER: 6W×2. SPEAKERS: 4in.×2. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two VU. MICROPHONES: Two moving-coil. WEIGHT: 47lb. DIMENSIONS: 20×13×9in. FEATURES: Cross-field bias, interchangeable capstans. PRICE: £153 6s. DISTRIBUTOR: **Pullin Photographic Ltd., 11 Aintree Road, Perivale, Greenford, Middlesex.**

AKAI ST-1. SPEEDS: $7\frac{1}{2}$ and $3\frac{3}{4}$ i/s. WOW AND FLUTTER: 0.17% rms. FREQUENCY RESPONSE: 40 c/s—15 Kc/s ±3dB. OUTPUT POWER: 3W×2. SPEAKERS: Two 7in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two VU. MICROPHONES: Two moving-coil. WEIGHT:

42lb. DIMENSIONS: 13½×21×9in. FEATURES: Interchangeable capstans, illuminated meters. No pressure pads or pins. PRICE: £129 3s. DISTRIBUTOR: **As above.**

AKAI 44S. SPEEDS: 7½, 3¾ and 1⅞ i/s (15 i/s with accessory capstan). WOW AND FLUTTER: 0.15%. FREQUENCY RESPONSE: 30 c/s—17 Kv/s ±3dB. OUTPUT POWER: 3W×2. SPEAKER: 5in. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. MICROPHONES: Two moving-coil. WEIGHT: 33lb. DIMENSIONS: 15½×10×8½in. FEATURES: Interchangeable capstans, no pressure pads or pins. PRICE: £112 7s. DISTRIBUTOR: **As above.**

AKAI 345. SPEEDS: 7½ and 3¾ i/s (15 i/s with accessory capstan and pinch wheel). WOW AND FLUTTER: 0.08% rms. FREQUENCY RESPONSE: 40 c/s—21 Kc/s ±6dB. SIGNAL-TO-NOISE: 42dB. OUTPUT POWER: 10W×2. SPEAKERS: Two 6½in. SPOOL CAPACITY: 7in. (10½in. with accessory arms). TRACKS: Two or four, to order. LEVEL INDICATORS: Two VU. WEIGHT: 73lb. DIMENSIONS: 16×12½×17½in. FEATURES: Automatic and remote control (latter with £8 11s. 9d. accessory). Bi-directional operation and solenoid switching. Automatic Protecting Circuit. PRICE: £229 19s. DISTRIBUTOR: **As above.**
● **Review:** September 1964.

AKAI X-4. SPEEDS: 7½, 3¾, 1⅞ and 15/16 i/s. WOW AND FLUTTER: 0.16% rms. FREQUENCY RESPONSE: 40 c/s—20 Kc/s ±3dB. OUTPUT POWER: 2W×2. SPEAKER: 5in. elliptical. SPOOL CAPACITY: 5in. LEVEL INDICATORS: Two VU-meters. MICROPHONES: Two cardioid moving-coil. WEIGHT: 12lb. DIMENSIONS: 10×9⅓×4in. FEATURES: Powered by rechargeable nickel-cadmium battery; mains unit and charger supplied. Battery life is six hours per charge. Cross-field bias. PRICE: £137 11s. DISTRIBUTOR: **As above.**
● **Field Trial:** Page 349 of this issue.

AMPEX F4452. SPEEDS: 7½ and 3¾ i/s. FREQUENCY RESPONSE: 50 c/s—15 Kc/s ±2dB. OUTPUT POWER: 1½W×2. TRACKS: Four. LEVEL INDICATORS: Two VU. WEIGHT: 28lb. DIMENSIONS: 13×5×7½in. FEATURES: Suitable for rack mounting. PRICE: £240. DISTRIBUTOR: **Ampex (G.B.) Ltd., 72 Berkeley Avenue, Reading, Berkshire.**

AMPEX F4460. Mounted version of F4452. WEIGHT: 36lb. PRICE: £250. Other specificational details as above.

BANG & OLUFSEN STEREOMASTER 2000. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.75% rms. FREQUENCY RESPONSE: 40 c/s—16 Kc/s ±2dB. OUTPUT POWER: 8W×2. SPEAKERS: Two, mounted in detachable lids. SPOOL CAPACITY: 7in. TRACKS: Two or four, to order. LEVEL INDICATORS: Two VU. WEIGHT: 33lb. DIMENSIONS: 17¾×14×7½in. FEATURES: Slide faders, of-tape monitoring, echo. PRICE: £122 17s. (Plinth model, less speakers available for £117 12s.) DISTRIBUTOR: **Debenham's Electrical & Radio Distribution Ltd., Eastbrook Road, Eastern Avenue, Gloucester.**
● **Review:** June 1965.

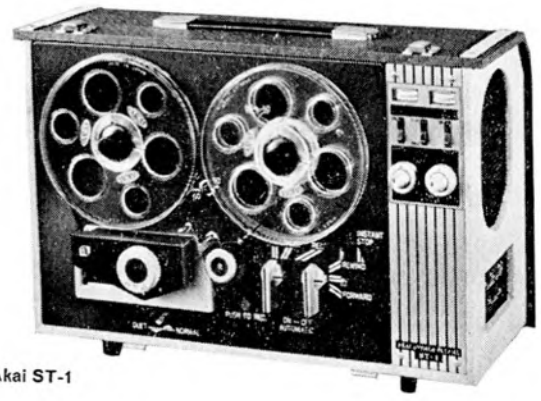
BANG & OLUFSEN 1500. PRICE: £93 9s. Specificational details as for Stereomaster 2000, but excluding playback power amplifiers, speakers and slide-faders.

BRAUN TG60. SPEEDS: 7½ and 3¾ i/s. TRACKS: Two or four, to order. LEVEL INDICATORS: Two VU. SPOOL CAPACITY: 7in. FEATURES: 3-channel mixing, separate record and replay heads. Output from pre-amplifiers. PRICE: £220. DISTRIBUTOR: **Argelane Ltd., 251 Brompton Road, London, S.W.3.**

BRENELL STB2. SPEEDS: 15, 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.1%. FREQUENCY RESPONSE: 40 c/s—15 Kc/s ±2dB. NOISE LEVEL: —50dB from peak. SPOOL CAPACITY: 8½in. (10½in. NAB available at extra cost.) TRACKS: Two track record, two and four track replay, through separate heads. LEVEL INDICATORS: Two PPM. WEIGHT: 48lb. DIMENSIONS: 19½×17½×9½in. FEATURES: Interchangeable capstans, mixing and variable bias level. Output from preamplifiers. PRICE: £150. MANUFACTURER: **Brenell Engineering Co. Ltd., 231-235 Liverpool Road, London, N.1.**

COSSOR CR1607. SPEEDS: 3¾ and 1⅞ i/s. WOW AND FLUTTER: less than 0.6% peak-to-peak. FREQUENCY RESPONSE: 80 c/s—15 Kc/s ±3dB

(*continued on page* 345)



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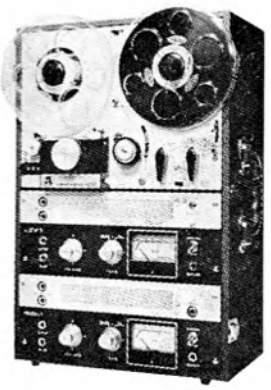
SURVEY OF STEREO RECORDERS CONTINUED



Akai M8

Korting MT3623

at 3¾ i/s. OUTPUT POWER: 1½W×2. SPEAKERS: Two. SIGNAL-TO-NOISE: greater than 40dB. TRACKS: Four. LEVEL INDICATORS: Two meters. MICROPHONE: Concentric stereo moving-coil. WEIGHT: 20lb. DIMENSIONS: 17×13½×7in. DISTRIBUTOR: **Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.**
● **Review :** August 1965.

DUAL TG12A. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: ±0.15%. OUTPUT POWER: 3W×2. SPEAKERS: 7in. elliptical×2. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. WEIGHT: 32lb. DIMENSIONS: 13½×15½×10½in. PRICE: £98 14s. DISTRIBUTOR: **Dual Division, Celsa Electric Co. Ltd., Kelway Place, London, W.14.**

FERROGRAPH 632: SPEEDS: 7½, 3¾ and 1⅞ i/s. FREQUENCY RESPONSE: 30 c/s—15 Kc/s ±3dB. SPOOL CAPACITY: 8¼in. TRACKS: Two. LEVEL INDICATOR: PPM. WEIGHT: 48lb. DIMENSIONS: 18½×17½×8¾in. FEATURES: Separate record and replay heads. Four-track (634) and 15, 7½ and 3¾ i/s (632H) versions available at extra cost. Output from preamplifiers. PRICE: 632—£120 15s., 632H—£126 6s., 634—£126 6s. MANUFACTURER: **Ferrograph Co. Ltd., 84 Blackfriars Road, London, S.E.1.**

GRUNDIG TK46. SPEEDS: 7½, 3¾ and 1⅞ i/s. FREQUENCY RANGE: 60 c/s—18 Kc/s. OUTPUT POWER: 3W×2. SPEAKERS: Two 6¼in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Magic-eye. WEIGHT: 33lb. DIMENSIONS: 20×15×7in. PRICE: £103 19s. DISTRIBUTOR: **Grundig (G.B.) Ltd., Newlands Park, Sydenham, London, S.E.26.**

GRUNDIG TM45. SPEEDS: 7½, 3¾ and 1⅞ i/s. SPOOL CAPACITY: 5¾in. TRACKS: Four. LEVEL INDICATORS: Magic-eye. WEIGHT: 20lb. DIMENSIONS: 14×13×6½in. PRICE: £73 10s. DISTRIBUTOR: **As above.**

KORTING MT3623. SPEEDS: 7½ and 3¾ i/s. OUTPUT POWER: 2½W×2. SPEAKERS: 7in. elliptical × 2. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two magic-eyes. WEIGHT: 23lb. DIMENSIONS: 16½×13×7½in. PRICE: £72 19s. 6d. DISTRIBUTOR: **Europa Electronics Ltd., Howard Place, Shelton, Stoke-on-Trent.**

KORTING MT3624. SPEEDS: 7½, 3¾ and 1⅞ i/s. OUTPUT POWER: 3W×2. SPEAKERS: Two 7in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two magic-eyes. WEIGHT: 35lb. DIMENSIONS: 20¾×14×8in. FEATURES: Separate record and playback heads. Equipped with clip-on spool turntables to dub recordings from one tape to another. PRICE: £102 18s. DISTRIBUTOR: **As above.**

LUXOR MP423. SPEEDS: 7½, 3¾ and 1⅞ i/s. OUTPUT POWER: 2W × 2. SPEAKERS: Two 7in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two magic-eyes. WEIGHT: 24½lb. DIMENSIONS: 14×11½×6¾in. PRICE: £77 14s. FEATURES: Mounted in teak plinth. DISTRIBUTOR: **Britimpex Ltd., 16-22 Great Russell Street, London, W.C.1.**

NATIONAL RQ-753. SPEEDS: 7½, 3¾ and 1⅞ i/s. SPEAKERS: 6¼in. elliptical and 6in. circular. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Meters. WEIGHT: 28lb. DIMENSIONS: 14×13½×9½in. PRICE: £84. DISTRIBUTOR: **United Africa Mechanical & Electrical Co. Ltd. United Africa House, Blackfriars Road, London, S.E.1.**

PHILIPS EL3534. SPEEDS: 7½, 3¾, 1⅞ and 1⅞ i/s. WOW AND FLUTTER: 0.6% peak-to-peak. FREQUENCY RESPONSE: 60 c/s—16 Kc/s ±3dB. NOISE LEVEL: —40dB. OUTPUT POWER: 3W × 2. SPEAKERS: 7in. elliptical and 6½in. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Meters. MICROPHONE: Concentric stereo moving-coil. WEIGHT: 35lb. DIMENSIONS: 18½×15×10in. PRICE: £96 12s. DISTRIBUTOR: **Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.**
● **Review:** May 1963.

REVOX 736. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: ±0.1%. FREQUENCY RESPONSE: 30 c/s—18 Kc/s ±2dB. SIGNAL-TO-NOISE: 52dB. OUTPUT POWER: 6W. SPEAKER: 8in. SPOOL CAPACITY: 10½in. TRACKS: Two or four, to order. LEVEL INDICATORS: Two VU. WEIGHT: 45lb. DIMENSIONS: 18×13×11in. FEATURES: Separate record and replay heads. Solenoid switching; remote control and slide synchroniser available. PRICE: £130 4s. DISTRIBUTOR: **C. E. Hammond Ltd., 90 High Street, Eton, Windsor, Berks.**
● **Review:** Page 359 of this issue.

SABA TK230S. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RANGE: 40 c/s—20 Kc/s. OUTPUT POWER: 5W × 2. SPEAKERS: Two 6¼in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATOR: Magic-eye. WEIGHT: 30lb. DIMENSIONS: 16½ × 14½×7½in. PRICE: £98 14s. DISTRIBUTOR: **Saba Electronics Ltd., Eden Grove, Holloway, London, N.7.**
● **Review:** December 1964.

SIMON SP5S. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: 0.15% rms. FREQUENCY RESPONSE: 30 c/s—20 Kc/s ±3dB. SIGNAL-TO-NOISE: 50dB. OUTPUT POWER: 6W × 2. SPEAKER: 10in. elliptical and 4in. tweeter. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. WEIGHT: 50lb. DIMENSIONS: 21×21×9in. PRICE: £111 6s. FEATURES: Separate record and replay heads. Mono version available. MANUFACTURER: **Simon Equipment Ltd., 48 George Street, London, W.1.**
● **Review:** May 1962 (mono version).

SONY TC200. SPEEDS: 7½ and 3¾ i/s. FREQUENCY RESPONSE: 30 c/s—18 Kc/s ±2dB. OUTPUT POWER: 1½W × 2. SPEAKERS: 6in. × 2. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. WEIGHT: 27lb. DIMENSIONS: 15×16×9in. PRICE: £72 9s. DISTRIBUTOR: **Debenham's Electrical and Radio Distribution Ltd., Eastbrook Road, Eastern Avenue, Gloucester.**

SONY TC600. SPEEDS: 7½ and 3¾ i/s. OUTPUT POWER: 3W × 2. SPEAKERS: Two 6in. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. WEIGHT: 48lb. DIMENSIONS: 16¾ × 18¼ × 10¾in. PRICE: £124 19s. DISTRIBUTOR: **As above.**

SONY TC500: SPEEDS: 7½ and 3¾ i/s. FREQUENCY RESPONSE: 60 c/s—14 Kc/s ±2dB. OUTPUT POWER: 3W × 2. SPEAKERS: Two 6in. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. WEIGHT: 55lb. DIMENSIONS: 18½×16¼×12¼in. PRICE: £110 5s. DISTRIBUTOR: **As above.**
● **Review:** May 1965.

(*continued on page* 347)

"Q"-CORD

THE FINEST MAINS/BATTERY PORTABLE RECORDER UNDER £40

FANTASTIC PRICE REDUCTIONS WHILE PRESENT STOCKS LAST. TWO SUPERB MACHINES R119K (as illustrated) 33 Gns NOW 29 Gns. TYPE 203 34 Gns NOW 29 Gns.

Complete with: dual impedance mike 200/50K. 1,200' TP tape, empty 4¼" spool, Radio lead, batteries, circuit and instruction book.

60-10,000 c/s ± 3db. sig/noise 38db. below test level 50db. below peak. weight 5lb.

3¾ I.P.S. NARTB standard, wide tone control, 4¼" spools, over 2 hours recording time, 2-track. Heads by Bogen, AC bias and erase. Straight-through amplifier.

Accessories, headphones, remote control mike, foot control, accumulator, mains adaptors, 110V—240V AC.

Delivered anywhere in the U.K. carriage and insurance paid.

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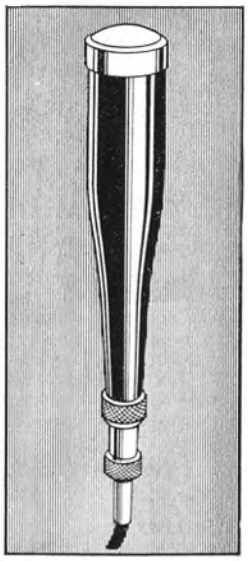

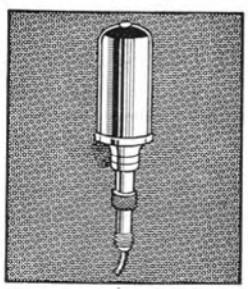

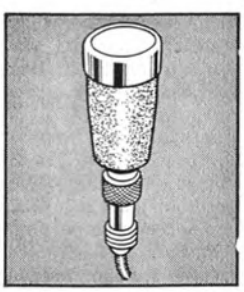

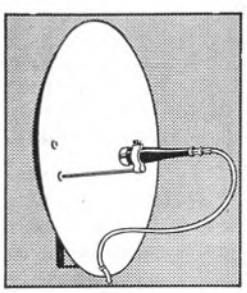

The family resemblance shows in the workmanship, the efficiency, the downright reliability, the integrity that's a feature of every Grampian microphone. There's the DP/4, sensationally successful in the medium price range, now world famous. The Grampian Ribbon Microphone is rightly considered one of the finest of its kind on the market today. The DP/6, too, finds ever-increasing favour—wherever a high grade but amazingly small microphone is required. For further details about them and about the stands, transformers, matching units and the Parabolic Reflector, which are available, ask your Grampian Dealer, or:—

Grampian

SOUND EQUIPMENT

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HANWORTH TRADING ESTATE, FELTHAM, MIDDX. FELTHAM 2657

SONY TC600. SPEEDS: 7½ and 3¾ i/s. OUTPUT POWER: 3W×2. SPEAKERS: Two 6in. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. WEIGHT: 48lb. DIMENSIONS: 16¾×18¼×10¾in. PRICE: £133 7s. DISTRIBUTOR: **As above.**

SONY TC777A. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RESPONSE: 30 c/s—17 Kc/s ±2dB. NOISE LEVEL: —55dB. OUTPUT POWER: 6W. WEIGHT: 42lb. DIMENSIONS: 16×19×10½in. PRICE: £162 15s. DISTRIBUTOR: **As above.**

STELLAVOX SM5. SPEED: 7½ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RESPONSE: 40 c/s—12 Kc/s +2, —3dB. NOISE LEVEL: —50dB. SPOOL CAPACITY: 3⅜in. TRACKS: Two. LEVEL INDICATOR: VU. WEIGHT: 6lb. DIMENSIONS: 10×5½×2½in. FEATURES: Powered by rechargeable battery. Mono version available. PRICE: £276. DISTRIBUTOR: **F. W. O. Bauch Ltd., Chaddlewood, Cockfosters Road, Cockfosters, Barnet, Hertfordshire.**

TANDBERG 6. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.1%. FREQUENCY RANGE: 30 c/s—20 Kc/s. NOISE LEVEL: —55dB. SPOOL CAPACITY: 7in. TRACKS: Two or four, to order. LEVEL INDICATORS: Two magic-eyes. WEIGHT: 25lb. DIMENSIONS: 16×12×6in. FEATURES: Output from preamplifiers. Separate record and replay heads. PRICE: £115 10s. DISTRIBUTOR: **Elstone Electronics Ltd., Edward Street, Templar Street, Leeds, 2.**
● **Review:** April 1962.

TANDBERG 7. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RESPONSE: 40 c/s—16 Kc/s ±2dB. NOISE LEVEL: —53dB. SPOOL CAPACITY: 7in. TRACKS: Two or four, to order. LEVEL INDICATORS: Two eyes. WEIGHT: 28lb. DIMENSIONS: 16×12×6in. PRICE: £97 13s. DISTRIBUTOR: **As above.**
● **Review:** April 1963.

TELEFUNKEN 97. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RANGE: 30 c/s—18 Kc/s. NOISE LEVEL: —40dB. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATOR: Magic-eye. WEIGHT: 29lb. DIMENSIONS: 16¼×11½×9in. PRICE: £99 15s. DISTRIBUTOR: **Welmec Corporation Ltd., Lonsdale Chambers, 27 Chancery Lane, London, W.C.2.**

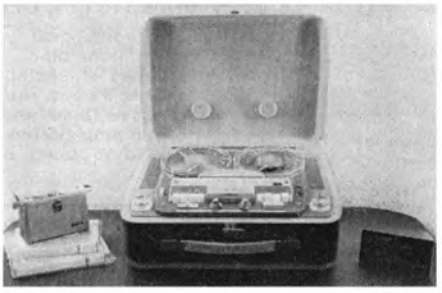
TELEFUNKEN 98. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RANGE: 30 c/s—18 Kc/s. NOISE LEVEL: —50dB. OUTPUT POWER: 2½W. SPEAKER: 10×3in. SPOOL CAPACITY: 7in. TRACKS: Two. LEVEL INDICATORS: Magic-eye. WEIGHT: 29lb. DIMENSIONS: 16¼×11½×7¾in. PRICE: £99 15s. DISTRIBUTOR: **As above.**

TRUVOX PD102. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.1%. FREQUENCY RESPONSE: 30 c/s—17 Kc/c ±2dB. NOISE LEVEL: —50dB. SPOOL CAPACITY: 7in. TRACKS: Two. LEVEL INDICATORS: Two VU. WEIGHT: 28lb. DIMENSIONS: 16×16½×8in. FEATURES: Separate record and replay heads, output from peamplifiers. Operates at any angle between horizontal and vertical. PRICE: £97 13s. MANUFACTURER: **Truvox Ltd., Neasden Lane, London, N.W.10.**

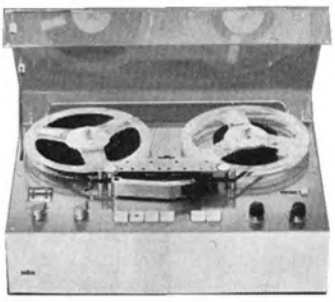
VORTEXION CBL. SPEEDS: 7½, 3¾ and 1⅞ i/s (15, 7½ and 3¾ i/s version available at £180). WOW AND FLUTTER: 0.16%. FREQUENCY RESPONSE: 40 c/s—15 Kc/s ±3dB. NOISE LEVEL: —50dB. OUTPUT POWER: 3½W×2. SPEAKER: 7in. elliptical. SPOOL CAPACITY: 8¼in. TRACKS: Two. LEVEL INDICATORS: Two PPM. WEIGHT: 68lb. DIMENSIONS: 27½×18¾×16in. FEATURES: Separate record and replay heads, mixing. PRICE: £172. MANUFACTURER: **Vortexion Ltd., 257-263 The Broadway, Wimbledon, London, S.W.19.**

UHER STEREO 784. SPEEDS: 7½, 3¾, 1⅞ i/s and 1⅞ i/s. WOW AND FLUTTER: ±0.15%. FREQUENCY RANGE: 50 c/s—20 Kc/s. NOISE LEVEL: —50dB. OUTPUT POWER: 2W × 2. SPEAKERS: Two 5in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two VU-meters. WEIGHT: 23½lb. DIMENSIONS: 15×14×7in. PRICE: £135 9s. DISTRIBUTOR: **Bosch Ltd., 205 Great Portland Street, London, W.1.**

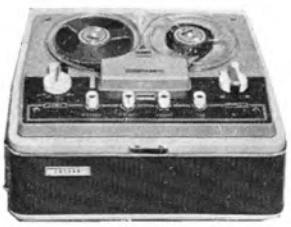
Saba TK230S



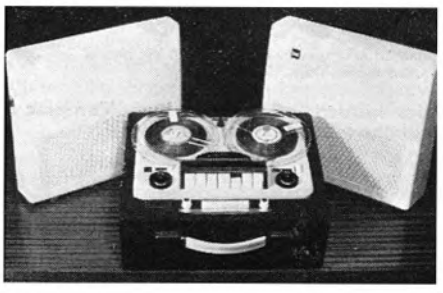
Grundig TK46



Braun TG60 Tape Unit



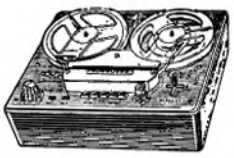
Cossor CR1607



Dual TG12A

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

SERIES 6

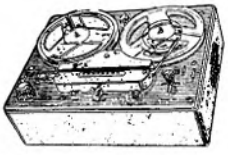


Model 64 4 track
Model 62 2 track
Price 110 gns. each.

Semi professional Stereo/mono tape recorders with cathode follower output. Three speeds — Three heads — Four amplifiers — "Sound on sound" etc.

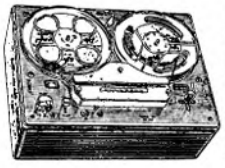
SERIES 7

Model 74 4 track
Model 72 2 track
Price 93 gns. each.



Build-it-in or carry-it-around. Complete stereo/mono record and playback with own power amplifiers and speakers. Three speeds — dual record indicators — output for hi-fi pre-amps— centre channel for language teaching or cine work.

SERIES 8



Model 823 2 track (teak case) **54 gns.**
Model 822 2 track (Portable with lid) **57 gns.**
Model 843 4 track (teak case) **59 gns.**
Model 842 4 track (Portable with lid) **62 gns.**

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

SERIES 9

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

High class monaural 3 speed ($7\frac{1}{2}$, $3\frac{3}{4}$, $1\frac{7}{8}$, I.P.S.) tape recorder, with quality comparable to the famous Stereo models. Extremely reliable machine recommended for all home and educational purposes, etc.

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Send for further information and specifications stating the model number you are interested in, to:-

Elstone Electronics Limited, Edward Street, Templar Street, Leeds 2. Telephone: Leeds 3-5111 (7 lines)

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ELIZABETHAN LZ27 list price 27 gns.
R.E.W.'s SALE PRICE ONLY 19 gns.

ELIZABETHAN LZ30 list price 32 gns.
R.E.W.'s SALE PRICE ONLY 22 gns.

FERROGRAPH 808 STEREO list price 105 gns.
R.E.W.'s SALE PRICE ONLY 69 gns.

REVOX STEREO TYPE F36 list price 112 gns.
R.E.W.'s SALE PRICE ONLY 85 gns.

REVOX E36 list price 110 gns.
R.E.W.'s SALE PRICE ONLY 75 gns.

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R.E.W's stocks of Tape Recorders are among the largest in the country. If you can call, you can take your pick of the world's leading machines—hear them and use them in our demonstration rooms—for "off-the-shelf" delivery. Interest free terms arranged quickly and without fuss. If you cannot call, our Mail Order department has the know-how and experience to handle your order quickly and dependably.

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Telephone : BALham 9174-5

FIELD TRIALS OF battery portables

BY DAVID KIRK

NUMBER 12—AKAI X-4

ONE hundred and thirty-seven pounds eleven shillings is a great deal to pay for a battery portable tape recorder; indeed this price makes the *Akai X-4* the fifth most expensive battery machine known to us. Let us consider what the X-4 has to offer in return for this outlay. It offers ¼-track stereo recording, tape speeds of 7½, 3¾, 1⅞ and $\frac{15}{16}$ i/s with cross-field biasing to give, according to the manufacturer, improved high frequency response at low speeds. Accessories supplied with the recorder include two directional moving-coil microphones with detachable stands, two connecting leads with jack plugs and crocodile clips at either end, and a combined mains-unit/battery-charger/power amplifier.

The X-4 operates from a rechargeable nickel-cadmium battery, said to provide six hours running time before falling below nominal operating voltage. At any time during, or at the end of, this six hour period, the battery may be charged by connecting the mains unit to the domestic electricity supply and then to the recorder via a DIN plug and socket. The charger is switched on and a small blue button in its side depressed. Used in this fashion, the recorder may be worked direct from the mains at the same time as the battery is charging, or left unused while the charging takes place. Once the battery has been filled to capacity, a solenoid isolates the charger from it and from the mains. Thus one can confidently leave the charger operating overnight and expect it to be switched off, the operation completed, in the morning. To reduce the net weight of the X-4, the designers saw fit to include only one power amplifier and speaker with the record and playback pre-amplifiers. This allows the operator to check recording quality 'in the field' either monophonically through the speaker or stereophonically through headphones. To reproduce in stereo through two loudspeakers, the X-4 must be powered from the mains, whether battery is under charge (blue button depressed) or not. This prevents excessive strain on the battery when the second power amplifier is in circuit. The DIN connection on the rear of the X-4 (do not confuse it with the output DIN socket below the VU-meters on the front panel) is used to full advantage in transporting both power supply and preamplifier audio output.

A jack socket in the charger provides an outlet to the right-hand loudspeaker which may be paired with the speaker inside the X-4 or, preferably, a superior external left-hand speaker connected to the output jack on the rear.

External design is very eye-catching. I particularly liked the layout of the mechanical controls—large press-tabs labelled, from left to right, REWIND, RECORD, STOP, START and FORWARD. The size of these controls—each is about 1½in. square—not only adds to the recorder's attractive appearance but serves the practical function of making the machine easy to operate. Rotary controls on the front panel govern recording and playback gain, tone (treble cut and lift) and tape speed. Gain and tone controls were of the dual concentric type, allowing independent setting of each channel. The four-position tape speed selector was knurled to ease gripping. A small white switch just left of the input jacks selects characteristics to suit MIC or LINE signals. It may seem a disadvantage that one cannot, with this system of input matching, connect a microphone to one channel and a second tape recorder to the other for multiple recording, but it seems reasonable to me that anyone who can afford a machine of this type can also afford a few extra pounds for a mixer.

Another feature of the X-4 is an instantly-reset counter—a delight to use when one considers the manual labour involved in zeroing the knurled wheel type of counter. Two miniature VU-meters give some indication of recording level and channel balance, though a slightly larger reading scale would have been very welcome. The left-hand meter reads battery voltage during playback. An original spool-locking device, which I very much hope will be imitated on other machines, permits the recorder to operate in any position from vertical to upside-down. Each spool hub is capped by a sprung plastic 'spider' with three legs to engage the spool centre-slots. Having been so engaged, the spool drops beneath the spider and is realigned to the three protrusions from the hub base. At this point, the spider, which is protruding from above the spool, may be pulled upwards and twisted, then released to grip the upper surface of the spool. An ingenious and very effective system.

So much, then, for the features and facilities of the Akai X-4; but how well did it work? First impressions were good; a stereo demonstration tape supplied with the machine and recorded at 1⅞ i/s gave little indication of its speed. But, whatever the theorists may say of cross-field bias, it was the *low*-frequency and not the high frequency component that seemed to be improved. With treble controls set at minimum, the bass at this speed was amongst the cleanest I have ever heard from tape. This was marred, however, by slight background hum. When the tone controls were advanced to full treble, motor interference was noticeable—though of a tolerable level—while a sharp fall-off at the treble end of the scale gave what I can only describe as 'odd' sound.

Mono recordings taken from an FM tuner at each of the four speeds showed no audible difference in quality between 7½ and 3¾ i/s—motor noise being detectable at both speeds. At 1⅞ i/s the quality was perfectly good for speech recordings and acceptable on music; but this could certainly not be said of the $\frac{15}{16}$ i/s performance. The HF fall-off was so sharp that, comparatively clean as the bass might have been, even speech had an annoying and vaguely gritty quality. The 'grit' may have been a drop-out effect, or just one of the results of cross-field bias.

The first practical use to which the X-4 was put was in dubbing a stereo gramophone record for the benefit of an American tape correspondent. Dubbing completed (at 7½ i/s), the copy was played back and found to be pleasantly clean, though marred by two or three long wows at intervals along the ten-minute passage. These speed variations each covered a period of some two seconds and can only be attributed to sudden variations in battery output—the mains unit was not in use at the time—or to an intermittent fault in the driving system. During the recording process, the signal going into the X-4 had been monitored and, played on a *Garrard 301*, certainly showed no sign of turntable wow. The fault has not been noticed in subsequent recordings, whether live or of radio or disc material.

Outdoor stereo recording presents problems, not least of which is finding suitable sounds to record. I can confirm Mr. Tutchings's comment in the recent *Cossor CR 1607* review, that "marching up and down in front of the microphone" quickly loses its capacity to entertain. A similar situation exists for motor cars shooting and hooting from left to right and electric railway trains thundering through the window and into the chimney breast. My own uses for a stereo portable were limited to tape corresponding from the garden or the local park (gimmicky), and accompanying a very amateurish performance on an acoustic guitar. The latter experiment revealed a serious drawback to the X-4: there is no provision for inter-track recording and 'sound-

(*continued on page* 352)

SOME time ago, preparing an article on the *Grundig TK18*, your scribe stuck his neck out by inviting a controversy on the subject of Automatic Recording Level. "To the enthusiast, this is almost blasphemy . . . " I said, and waited for the brickbats.

Surprisingly, there were very few. The design staff of Grundig came back smartly with some additional facts about their system, and my colleague Mr. Tutchings has dealt with its operation in some detail in his review of the *TK23A*, which appeared in the July 1965 issue. His final comment was most interesting: " . . . I can foresee many enthusiasts using the recorder in the usual way (manually) and leaving it on 'auto' for the less skilled members of the family".

Despite all these provocative statements, there has been very little response from those readers who normally seem to sit in wait, with sharpened pens, for each monthly publication. "I beg to differ . . . " writes one. "There would appear to be some error . . . ", says another, and, more succinctly, if less politely, "Why doesn't . . . wrap up?" explodes the third. On the subject of Automatic Recording Level, even these gentry have remained taciturn. Why?

My own view is ambivalent. At first I saw it as some sort of gimmick. "Here is another tape recording advance," the advertisements seemed to say, while you knew, dear reader, and I knew, that AGC in some form or another had been in use for quite a while. The *Nagra* and Fi-Cord portables used it quite effectively, for example. And this is a clue to my changing point of view, for the main reason for their successful employment of automatic recording level, or preset gain, whichever you like to call it, was the release of the operator from yet another fiddling adjustment. By making one preliminary adjustment, then forgetting the gain setting, concentration could be placed on what mattered—in most cases, microphone technique. As I see it, the same applies to the auto machine that we are now discussing—the *Elizabethan Automatic 2* and *4*. Whether the 'enthusiast' or the 'lesser skilled members of the family' are using the machine, the pre-setting of gain level for existing conditions gives freedom to concentrate on other things.

Nevertheless, for the chap who likes to feel he is in full control of his machine, the presence of an over-riding switch, such as both *Grundig* and *Philips* have provided on their latest automatic tape recorders, is desirable. The Elizabethan machine does not have this MANUAL facility.

From the servicing point of view, automatic recording level, like all other gimmicks, simply gives another headache. Faultfinding can be tricky, and the adjustment must be exact. To demonstrate these points,

tape recorder service

CONTINUING THE ELIZABETHAN RANGE

NUMBER 45

BY H.W. HELLYER

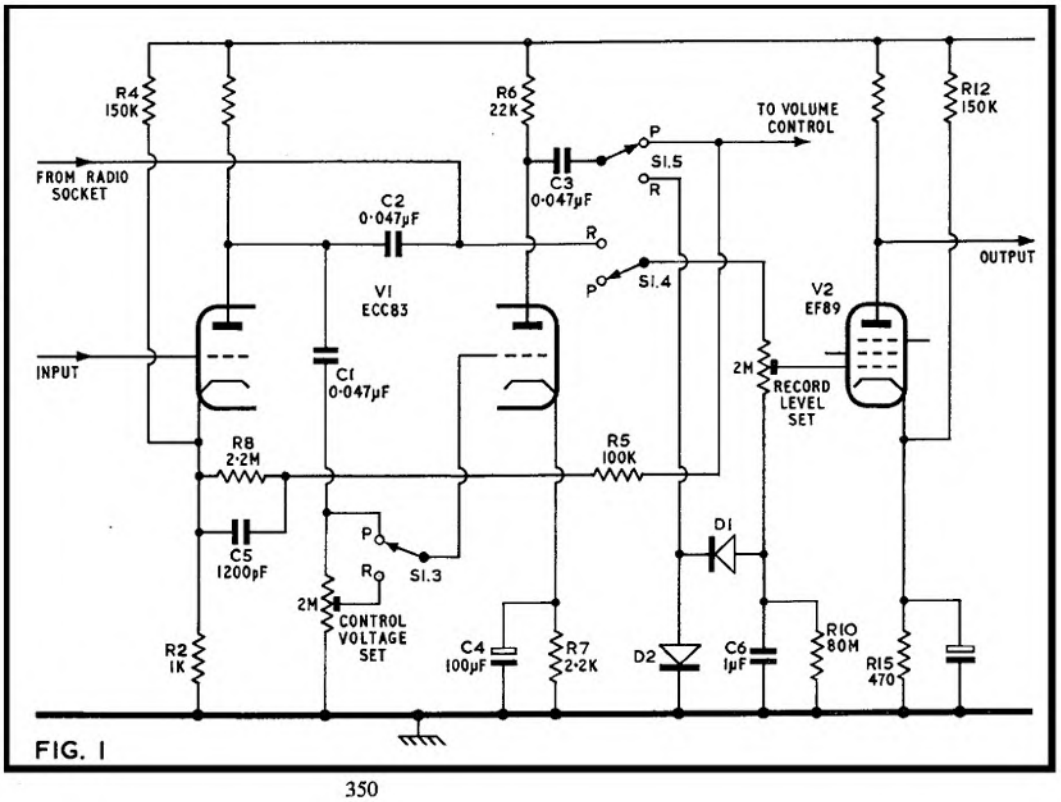

FIG. 1

the circuit of **fig. 1** is given; an extract from the circuit of the Elizabethan Auto 2-4.

The action of the circuit is as follows: the incoming signal from the microphone is taken to V1a grid, amplified in this triode (half of an ECC83) and passed, via the record/play switch section S1.4 to the grid of V2, an EF89 vari-mu amplifier. Bias for this valve is derived from two sources, the fixed bias obtained from the potential divider across the HT and chassis (R12 and R15) and a variable bias from the control circuit which is applied to the grid.

This variable bias is in proportion to the incoming signal and is obtained from the amplified input to V1b (second half of the ECC83). The input is taken from the anode of V1a and passed via C1 to the 2 Meg. preset resistor which acts as a control voltage preset control. V1b has a fixed bias supplied by R7, decoupled by C4 and the amplified signal is developed across the anode load R6. From this point, it goes, via C3 and the record/play switch section S1.5 to the diodes D1 and D2, which form a voltage doubling circuit and have C6 as the charge capacitor and R10 as the load. The negative voltage developed is applied to the grid circuit of V2.

The output from V2 is passed via an equalising network to the grid of the driver stage, the triode section of the ECL86. During recording, and a signal of 2mV fed into the microphone input socket. The capacitor C6 is then short-circuited temporarily to discharge it and the record level set control is adjusted for a 12V reading on the valve voltmeter. The input signal is then increased to 20mV, and the control voltage set control is slowly turned until the valve-voltmeter reading again reaches 12V. It is essential to turn slowly, as rapid movement causes the control setting to be exceeded and then C6 must be discharged and the whole procedure gone through again. If the setting is made correctly, an increase of input to 100mV will give a valve-voltmeter reading between 6 and 24V. Reducing the input and discharging C6 should again give a reading of not less than 8V. To identify the two preset resistors it is only necessary to remember that the record level set control is nearest the EF89 valve, mounted on the printed circuit.

There are a few additional servicing points to note on these machines. Differences between the ½-track and ¼-track versions are very small, consisting of head switching and minor component changes. On the ½-track model, there is sometimes a hum-bucking coil in series with the record play head; occasionally this is omitted. The erase head does not have this coil, but the leads are twisted together between the head and the sub-panel and this twist must be maintained if the leads

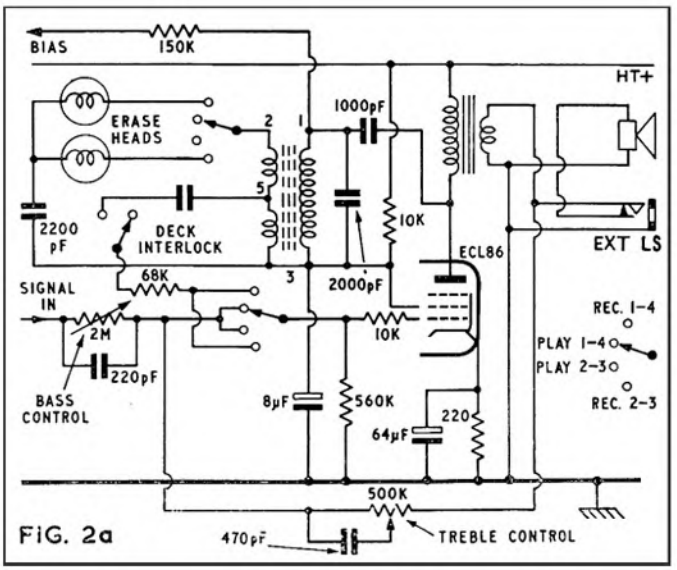

FIG. 2a

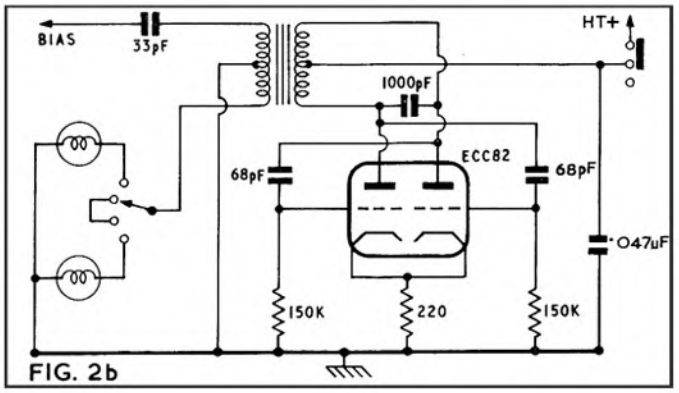

FIG. 2b

the manually operated volume control is out of circuit. During playback, it is the grid load of the triode

On later models a measure of tone compensation was achieved by fitting a 47K resistor across this 500K potentiometer.

The necessary delay in the falling-off of the bias voltage is obtained by the long time-constant of C6 and R10, 1µF and 80 megohms. This means that a loud sound will cause the bias to build up quickly and then fall away very slowly, so that peaks cannot overload. The setting of the two preset controls determines the level of the bias that will be brought into action by a peak input and also the steady bias that will follow this. Correct setting-up procedure really needs a valve voltmeter and a measurable signal source, as from an audio oscillator or signal generator. However, even those without access to test instruments appear to be interested in setting-up methods, to judge by our correspondence, and the method for the Auto 2-4 is as follows: First, switch to RECORD and check that no greater than 4V AC can be measured at the anode of the ECL86 triode section. This is virtually the head feed line, with the bias filter components between the test point and the head. The 4V reading is the maximum permissible 'backlash' from the bias. If the reading is greater, the routing of the leads to the heads should be investigated. Quite a small movement will often improve matters.

Next, the control voltage set potentiometer is turned fully clockwise

are disconnected and re-connected during servicing. Note also that the screening of the record/play head lead is returned to the chassis line on the printed circuit, which is the outer edge. Do not connect to any part of the trick (or track) switch for convenience. On the ½-track version, this assembly is the trick switch for superimposition, with several of the tags unused; on the ¼-track model, this is the 1-4 and 2-3 track switch. On the ½-track model, hum-bucking coils will be found in each head lead to the record/play head, but suspended in the wiring at each side of the head assembly.

Component changes are in the feed capacitor from the oscillator transformer to the erase head, which is 4,000pF in the ½-track version, 3,300 pF in the ¼-track. In the ½-track model, operation of the trick switch disconnects the erase head and puts a 470-ohm resistor in its place to maintain oscillator loading and avoid changes in bias. *Bradmatic* heads are fitted for the ½-track and *Marriott X* type for the ¼-track.

Two more machines that come into the 'Popular' bracket, though not so named, are the *LZ29* and *LZ30*. The first has a Collaro Studio deck and is in two versions, the later model *LZ29/L* having several improvements which will be dealt with below. The LZ30 was the one model which used an Elizabethan deck, although the circuit was very similar. Again, there are no 'gimmicks', circuits being straightforward and well constructed. Faults, accordingly, are those which may be found on any tape recorder. (*continued overleaf*)

In each machine, as in the Popular 200-400, the first two stages are two halves of an ECC83, driving an ECL86, whose pentode doubles as output valve during playback and oscillator during record. An EM84 magic eye is employed. A similar line-up is met in the LZ30. The differences are in the oscillator circuits of the two versions of the LZ29, with the later version (after serial number 2914000) having an extra valve, and ECC82, as a push-pull oscillator. This releases the ECL86 pentode to be used as a monitor amplifier, which means that the treble tone control (playback) functions as a gain control during record, and must be turned down to avoid acoustic feedback. The tone control system is thus modified, and some of the switching has to be altered. To avoid long explanations, **figs 2a** and **b** give the alternative versions of the LZ29. Except for the absence of track switching, an increase of the erase head feed capacitor from 0.0022 to 0.04μF, and the absence of the deck interlock switch which prevents accidental erasure, the LZ30 has a similar circuit. The LZ29/L can be identified by its use of grey control knobs.

The combination oscillator/output circuit of **fig. 2a** is a conventional Hartley oscillator shunt-fed from the pentode output stage, with the grid switching selecting either the feedback line for the oscillator or the tone control network for output. Bias is taken, via a 150K resistor, from the upper end of the main winding of the oscillator transformer. Feedback is via a 680pF capacitor and the interlock switch on the LZ29. The LZ30 and the Popular models, have a section of the record/playback switch performing this selection. LZ29 has the rather different arrangement of no separate track switch, but individual track positions on the record/play switch. While this removes one servicing pitfall neatly, it introduces another by the interlock switch, which can be mechanically intermittent and should be checked first if the symptoms are: good playback, distorted recording, no erase.

The next most likely component to cause this trouble is the 1,000pF capacitor from the anode of the ECL86 pentode to the transformer. It should be replaced by a high working voltage component—there is quite a pulse across it—and the author favours a 0.001mF, 1,000V disc ceramic for safety. The accompanying capacitor, a 0.002mF across the winding, is not so prone to failure.

This oscillator coil is not one of the tuned former types, and the choice of capacitors helps determine and fix the frequency of 55 Kc/s. The transformer is the 'dice' shape with six connecting wires pinned through and held by the outer insulating wrap. Quite often, an open-circuited transformer can be traced to a break of the very fine winding wire from its support wire, and a razor blade, a modicum of patience, and a steady soldering iron can put a dead machine back into commission. For the purpose of identification, the transformer block is spotted (usually with yellow paint) at the pin corresponding to number 4. Numbering is from 1 at bottom left, clockwise to 6 at bottom right (thus four is top right). The windings are: Primary, pins 1-3, resistance reading approximately 25-ohms; Secondary, split, 2-5, resistance reading about 1½-ohms, and a further ½-ohm or so to the end of the winding at pin 3.

It should be unnecessary by now to enjoin readers of this magazine to take care when making ohm-meter readings on tape recorders, not to apply a meter across the head windings. This will magnetise them, due to the flow of direct current. Even the presence of a series capacitor is not a complete safeguard, as this component, if large enough, and if charged by, say, a 15V battery as some meters use on the high ohms range (naturally, I am taking the worst case for argument's sake!) will pass a discharge pulse through the head winding.

on-sound'. A conventional monophonic ¼-track recorder can be adapted, with an inexpensive and simple preamplifier, to permit sound-on-sound recording and it does seem wasteful that a stereo recorder should be so wired as to render the facility unobtainable. Unobtainable, that is, without making one's own circuit alterations and drilling a few holes to insert a fresh socket. Perhaps the manufacturers will take up this point—and at the same time provide independent MIC/LINE switches for each input channel.

The moving-coil microphones supplied with the X-4 were separate stick types, allowing experimentation with microphone positioning. The highly directional units functioned at their best when arranged as a crossed-pair, using the stands supplied, though it was pleasing not to be 'spoon fed' with an integrated concentric stereo microphone. The problem of what to do with the microphone when reporting outdoors (in mono) was solved by using the lavalier neck cord.

Two small points regarding the X-4 cabinet. This is sturdily made from steel plate, finished in dark fawn. The lid, which is not removeable, did not close positively and, when closed, a little pressure on either side of the lid resulted in one end dropping lopsidedly towards the deck. Similarly, when the base plate was removed for a 'look at the works', it could only be replaced with the greatest difficulty—apparently indicating stress or force in construction. One does expect the four corner screws of a rectangular metal sheet to align when incorporated in a machine of this price.

Overall reactions, then, are mixed. The Akai X-4 records very well, and in stereo, at 7½ and 3¾ i/s. But a machine of this price *should* record well. I cannot help feeling that a conventional bias system might have improved the performance at the higher speeds, even at the cost of 1⅞ i/s performance. This, and the replacement of the gimmicky 15/16 i/s with a 15 i/s tape speed, might bring the X-4 into the truly professional class, even if it did mean spending a few more shillings on tape.

Editor's Note: *We regret that, for space reasons, it has not been possible to include the Akai X-4 specification in the Field Trial. The specification will be found, however, on page* 343 *of the Stereo Tape Recorder Survey.*

dialling tone. It's the engineers here. I've an emergency breakdown for that engineer to go to, in the next road from you, and I thought if he hadn't left yet . . .

GEORGE : Oh I see. I'm sorry. No, I'm afraid he went. About ten minutes ago.

VOICE : Oh. Sorry to have troubled you, then. Goodbye.

GEORGE : Goodbye. (*Receiver replaced*)

MAY : Who was it dear?

GEORGE : The engineers. Wanted the chap that put the phone in.

MAY : What for?

GEORGE : To tell him to take it out again.

ROGER : No!

CLARE : Oh, why dad?

GEORGE : Because they've made a mistake. *We* don't come next on the list for months yet.

MAY : Oh no!

CLARE : It isn't true.

ROGER : You're joking.

GEORGE : I *am*, as it happens.

(*Sounds of relief all round*)

MAY : You'll want this, George.

GEORGE : Your address book? I don't want that ; what for?

MAY : Freda and Harold's address. For their card.

GEORGE : Oh, er . . . thanks, yes.

ROGER : Uncle Harold won't ring us when he gets it. He's too mean.

MAY (*Scolding*) : Roger! (*Second thoughts*) Well, he hasn't got as good a job as your father.

CLARE : Auntie Freda wouldn't let him, even if he *wants* to ring us.

GEORGE (*With some thought*) : Er . . . this is *their* phone number? (*Nobody replies. Phone picked up, dialling tone. Trunks operator number being dialled*)

ROGER (*Astounded but happy*) : Dad, what are you doing?

MAY : George! You're not ringing them, all that way.

(*Phone replaced on cradle*)

GEORGE : Now, I'll have to start again. Will you be *quiet* whilst I'm dialling. Please.

(*Phone picked up again, dialling tone*)

MAY : But what are you ringing them for?

GEORGE : To tell them we're on the phone. What *else* is there to tell them?

MAY : But it's a trunk call! *You* were on about the cost.

GEORGE : I don't care if it's Australia! (*Dialling trunks*) I'll get no peace in this house until the first call's made. Let's get it over with so we can carry on as if we've had the damn thing in for years! (*Ringing tone commences*)

(*Fade out on general approval and everyone talking indiscriminately*) *Mix in closing music—fade out.*

Careful microphone placing
and two channels are
needed for stereo

Try to obtain the co-operation
of the musician

Do not obstruct the musician
in his work

Always place your equipment
in the best possible position

Remember at all times to
keep out of sight

Not too near the tympani

recording an orchestra

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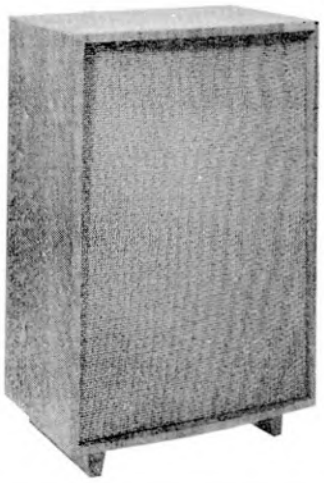
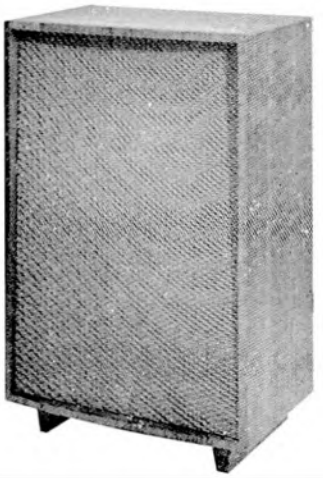


towards better taping

THE PROBLEMS AND REWARDS OF STEREO

PART 18

BY GORDON J. KING



AN entirely new world of listening pleasure is made available through the medium of stereo tape records and the stereo tape recorder. The improvement in sound reproduction brought about by the stereo disc record is vast, but a good stereo tape record—in the author's opinion—has the edge even on this.

Generally speaking, channel separation tape-wise leaves very little to be desired, but crosstalk between disc channels can sometimes be a bit embarrassing, depending on the nature of the stereo pickup and so forth. But this is not really our problem. We have others!

There is little doubt that better audio *can* be stored on tape than on disc, and now the quarter-track recorder is in vogue, quarter-track stereo is becoming popular. Quarter-track recording, as has been expounded in past articles in this series, implies that the tape width is divided into four tracks with narrow 'safety lanes' between them. A quarter-track record/playback head has, in effect, two head assemblies in one body. That is, two gaps, pole pieces and windings. Either assembly can be worked independent of the other and for stereo both can be worked together.

We have already seen that if the four tracks are numbered consecutively 1 to 4 starting from the top of the tape, then the gaps of the four-track head embrace tracks 1 and 3 or, with the tape inverted, tracks 4 and 2.

Clearly, it becomes possible easily to utilise simultaneously tracks 1 and 3 or tracks 4 and 2 to provide two-channel stereo. Fully-fledged stereo tape recorders embody two complete record/playback amplifiers for making and playing back stereo tape records. Most 'domestic' models of this kind employ the quarter-track technique. The 'semi-professional' type of recorder, on the other hand, may adopt the half-track principle, whereby the tape is divided into two tracks in the ordinary way and then employed to give simultaneous record and/or playback. Again, this gives two-channel stereo, but this time with a better signal-to-noise ratio owing to the greater width of each track.

Early half-track stereo systems employed separate heads placed side-by-side. The latest arrangement, however, is to use stacked heads, as with quarter-track stereo, but with each gap embracing the two half tracks instead of two quarter tracks.

Proper stereo tape recorders have either a pair of amplifiers and partnering monitor speakers or one complete amplifier for single channel use plus a preamplifier (or head amplifier as it may be called) for use with the second head assembly when the machine is used for playing stereo tapes. Alternatively, there may only be facilities for head connection on the second channel, meaning that for stereo playback the call is for a separate complete amplifier system and a second speaker system.

As mentioned earlier, the fully-fledged stereo tape recorder contains

(*continued on page* 357)

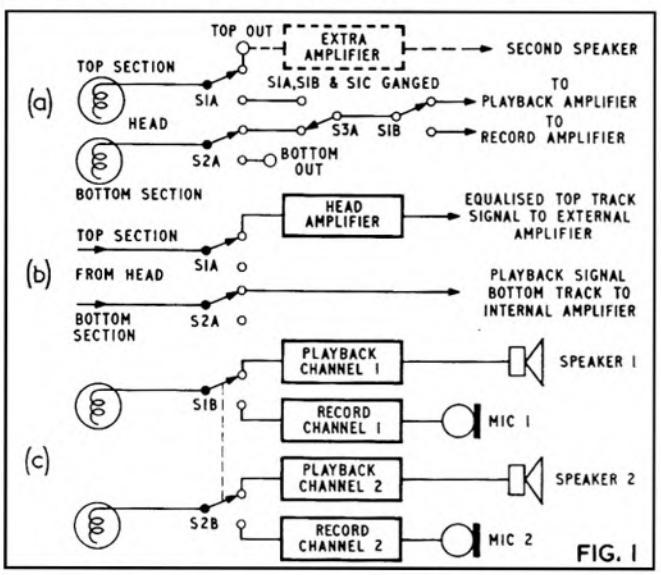


FIG. 1

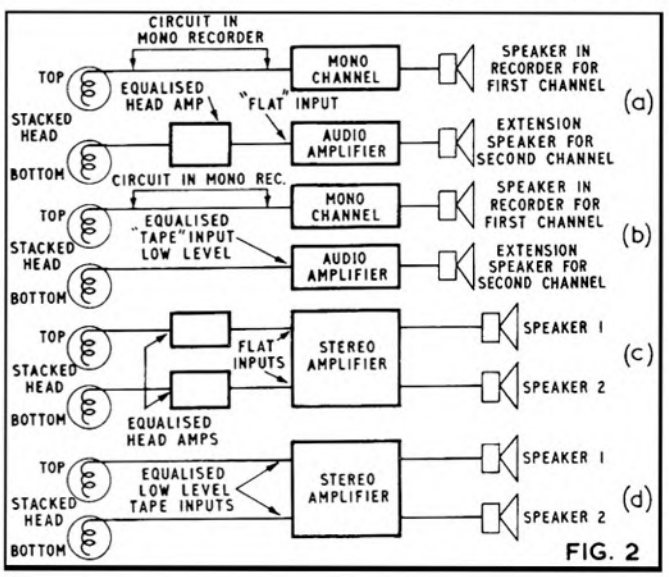


FIG. 2

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7"	1200'	16/-	12/-
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5"	900'	11/6	10/-
5¾"	1200'	16/-	11/6
7"	1800'	23/-	15/6
Double Play			
3"	400'	6/-	5/-
4"	600'	8/6	7/6
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7"	2400'	39/-	23/-
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5"	1800'	29/-	28/6
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7"	3600'	49/-	47/6

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two complete record channels and two complete replay channels, the latter right up to and often including the speakers.

There is always one monitor speaker, but not always two speakers in a stereo tape recorder. The monitor speaker can generally be used for replay on one channel, so that for mediocre stereo one needs only to connect a speaker to the second channel. Of course, the best stereo effect is possible only by the use of a pair of matched external speakers.

This means that a stereo tape recorder may only be a part of the complete outfit, as compared with a mono tape recorder which is invariably complete within itself, along with its own speaker which, alone, may be capable of quite good performance.

Thus, the enthusiast contemplating converting from mono to stereo should be prepared to spend more than the basic cost of the stereo tape recorder. While such a recorder may provide some sort of stereo without any extras, the extremely good stereo performance possible from tape will only be realised with proper signal and acoustic balances, by the use of the correct speakers and by their correct placement in the listening room.

Then, of course, there is the question of making stereo recordings. A fully-fledged stereo tape recorder, given two microphones and a little skill, should produce quite useful stereo tape records. Not so with the 'semi' stereo recorder which has only one recording channel.

A mono tape recorder with stereo playback facilities usually requires a second record/playback amplifier channel to match that contained in the instrument proper. Stereo facilities in this case generally refer to the fact that the machine has a quarter-track head with an arrangement of switching to permit the second head section to be used at the same time as the first

As all these things tend to bewilder the tape beginner, the various stages of stereo build-up are illustrated in **fig. 1.** At **(a)** is shown the basic head switching of a four-track recorder. Switches S1A, S2A and S3A are ganged to operate together, while switch S1B is simply the head record/playback switch. This is shown in the playback position.

The signal from the bottom head section is thus taken through S2A and S3A to the inbuilt playback amplifier, via S1B. Under this condition it will be seen that the top head section is connected to the 'top-head-output' terminal, via S1A. The machine is thus set up to play a mono tape through its own amplifier and speaker and if a stereo tape were run through the machine, half the information would be lost, of course. However, the missing half would be delivering a signal at the top-head-output terminal. Stereo replay could thus be secured simply by connecting this terminal to a playback amplifier and speaker system to match that already in the recorder.

Some firms provide a matching record/playback channel for stereo conversions. The arrangement necessary for stereo playback is shown in broken-line in **fig. 1(a).** It will be understood, of course, that if switches S1A, S2A and S3A were in the opposite position, the top section of the quarter-track head would then be supplying signal to the internal playback amplifier and the stereo second channel would be supplied by the bottom section of the head and appear at the bottom-head-output terminal. In this case, the second channel playback amplifier would be connected to that terminal. Some machines may not have switching quite like this, but there are facilities for connecting to the second head section for stereo applications.

For making stereo recordings, the second channel would also incorporate a record section. This would be coupled either to S1A or S2A through a playback/record switch to partner S1B—as shown as S2B in diagram (c).

The diagram in **fig. 1(b)** shows how a head amplifier may be connected to the second head section for feeding to a second amplifier. It is supposed here that the major part of the switching set-up is similar to that shown in diagram **(a).**

Diagram **(c)** shows the fully-fledged type of stereo recorder with all facilities. Here there are two of everything. Switches S1B and S2B are ganged so that they operate together from a common control knob, giving playback or record in both channels simultaneously.

The true stereo tape recorder of this kind will probably have headphone monitoring facilities and twin modulation indicators, these items being necessary for the creation of good quality stereo tape records, as we shall see in a later article.

Assuming that only a single monitor speaker is embodied in the recorder, an additional speaker will be required to get some sort of stereo effect, using the monitor speaker on one channel, as already explained. An enthusiast graduating from mono to stereo would probably get his first taste of stereo in this way. It would not be long, however, before he decided to invest in two external speakers to secure the best of the stereo effect.

Many stereo recorders contain playback amplifier sections on both channels capable of delivering up to about 3W (per channel) with a total harmonic distortion approaching 5%. At powers below the full output power of the amplifiers, quite reasonable quality is available from this kind of recorder and it is certainly surprising just how much difference a pair of correctly enclosed hi-fi (or medium-fi) speakers make to the reproduction, especially stereo reproduction, where it seems that a little more overall distortion can be tolerated than in a single channel mono set-up.

So much, then, for the true stereo tape recorder. But what about the mono tape recorder with stereo facilities? Conversion to stereo in this case should first lead to an investigation to see whether the makers do, in fact, supply a second record/playback channel to match that already in the recorder. If they do the extra channel would be connected via the switches as shown in **fig. 1(c).**

If a second channel is not easily available or if an enthusiast wishes to exploit the second section of a ¼-track head, then a different arrangement must be adopted. There are two ways of tackling this problem. One is to continue using the existing mono channel in the recorder for one channel and then establish a second channel by the utilisation of a commercially produced tape amplifier. The other is to employ a hi-fi type stereo amplifier for replay on both channels. This means abandoning the playback amplifier in the recorder. The use of an external stereo amplifier has much to commend it, as both channels can then be properly balanced.

At this stage in thought, however, one must decide whether or not facilities for stereo *recording* are really necessary. If the answer is yes, and the makers do not produce a second stereo channel for the recorder, it would probably be best to contemplate the purchase of a true stereo recorder. In many instances, however, the requirement will be for stereo replay facilities only.

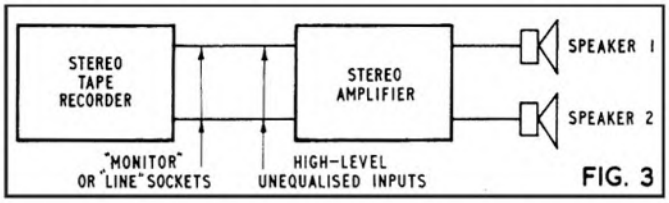


FIG. 3

In this event, one would use simply a second replay channel connected as at **fig. 1(a).** Alternatively, if a stereo hi-fi amplifier is available with tape-head input facilities, the output from the head sections of the recorder could be switched to the amplifier for stereo replay, reproduction then being through the existing hi-fi speakers.

If the amplifier does not accept a tape head signal direct, equalised preamplifiers must be used between the head sections and an unequalised input pair on the amplifier. The transistor head amplifiers as described in past articles in this series would be suitable, and they could be powered from a battery, from the amplifier's power circuits, or from a small mains power unit (see Part 17, last month). The head amplifier would be connected as shown in **fig. 1(b)** to feed one channel of an external amplifier for the second channel, the first channel being accommodated by the existing electronics in the recorder.

The various arrangements for achieving stereo replay are illustrated in **fig. 2.** At **(a)** and **(b)** the first channel is accommodated by the existing mono channel and speaker in the recorder, while at **(c)** and **(d)** a stereo amplifier is used in favour of the recorder's replay electronics. **(b)** and **(d)** reveal the need for equalised head amplifiers where the replay amplifiers will not accept a head signal direct.

If a stereo hi-fi amplifier system happens to be available and in use, then far better quality is generally possible from even a fully-fledged stereo tape recorder by feeding into the GRAM or unequalised inputs from the line-out or monitor sockets of the tape recorder. The signals at these sockets are usually at high impedance and at a level high enough for acceptance by a high-level 'radio' or similar input on the amplifier. The signals, of course, are fully equalised at the line or monitor sockets of the stereo recorder. The idea is shown in **fig. 3.**

Next month we shall identify the left-hand and right-hand stereo channels and give hints and tips on stereo recording and replay.

recording, whereas in mono sometimes quite a few are needed to obtain a satisfactory balance. To this extent it is easier to record in stereo. If it is felt that more than one mic is needed, it is most important to make sure that the two pairs give the same directional information : that is a sound from somewhere on the stage appears to come from the same place when listening to either mic. It will probably sound further away on one, but that does not matter—the image will still be solid. The same will apply to soloists' injection microphones when they are being used to bring out a particular performer.

Let us finally consider some typical types of performance, and their stereo taping. For large orchestral items, the one mic may well be enough, and a good place to hang it in the first instance is so that it forms an equilateral triangle with the stage, and about 15 to 25 feet up depending on the size of the hall. The angle between should be sufficient to cover the stage without increasing it over the figures mentioned earlier. The cardioid gives a very good sound in most halls, and moving it further away from the stage will increase the relative pickup of the hall acoustics. Here the variable characteristic mics are ideal, as by changing from, say, cardioid to figure-of-eight the acoustic added can be varied without actually moving the instrument. For soloists who tend to be drowned in the hall, a single injection mic can be used, placed correctly by the panpot to recover the correct balance.

With chamber groups and small dance assemblies the main problem is to make the artists spread out—they tend to sit close together to hear all the counter-rhythms, and this makes it difficult to achieve good stereo ; the mic has to be brought close to discriminate between them, and this sounds very forced and unnatural. By moving them apart, and using figure-of-eight with the players all around, a good balance can often be obtained. However, it is very easy to be dogmatic about the type and position of any mics, and in the final choice it is your ears alone which can guide you into the best combinations of mics and positioning.

GREAT SCOPE

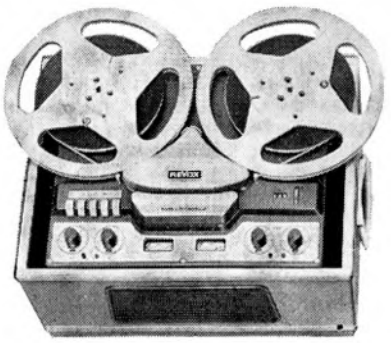
Finally the 'pop' group, which offers great scope for dual channel working—not the same as true stereo, but very enjoyable to record once in a while. Here it is possible to use separate microphones (mono types) for everyone, with the mics in close for good rejection of other performers, and the final sound built up at the mixer. Each instrument can be located exactly, and it is then easy to add any extra special effects—echo on one or all channels, echo on the right from a source on the left, moving performers bodily, and so on. **Fig. 3** picture was taken while setting up for one of these recordings, and shows some of the author's equipment in use. Space was a little crowded, so only small monitor speakers could be used. The mixer is facing the second speaker, so that there was about six feet between the two. The small instrument in front of the visible speaker is a stereo limiter ; modern pop music seems to demand its use!

This multi-mic technique can also be used successfully to record dramatic productions, but it does require a few panpots on the mixer for the best results.

Monitoring is done for all recordings using the best speakers you can, to show all the faults in the rehearsal stage, with the operator sitting centrally. If it is not possible to set up the equipment away from the site of the recording, it probably will not be convenient to use speakers, and in these cases earphones could be used, although they can be a little misleading. Slight cross-connection (i.e., Bauer circuitry—see *Hi-fi News*, April 1965, page 1021) helps considerably. If you possess a machine with separate record and replay heads, remember to check the tape itself every now and then, and listen for any faults such as over-recording, intermodulation—in fact the normal precautions of a mono recording.

There is at the moment a slight mystique around stereo recording, and perhaps this short article may help to dispel it somewhat ; it is no more difficult with two channels than it is with one, and often it is easier. The realism which can be obtained from live tape recording in stereo considerably outweighs the extra costs involved—so why not make your next machine a stereo model?

equipment reviews



REVOX 736 STEREO

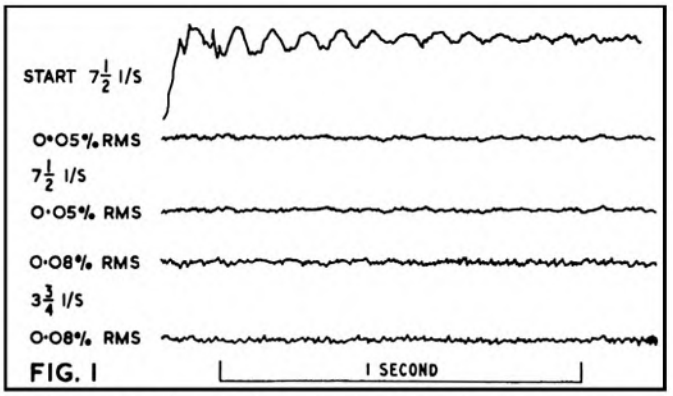


FIG. 1

MANUFACTURER'S SPECIFICATION: Speed constancy: less than 0.3% variation from norm. **Speeds:** 3¾ and 7½ i/s, pole switching capstan motor, direct drive. Motor may be switched off if the recorder is used as an amplifier. **Wow and flutter:** below ±0.1% at 7½ i/s. **Rewind time:** 80 seconds for 2,400ft. **Spool capacity:** 10½in. **Frequency response:** 40 c/s - 15 Kc/s at 7½ i/s +2—3dB. 40 c/s - 12 Kc/s at 3¾ i/s. **Equalisation:** 70μS at 7½ i/s, 140μS at 3¾ i/s (CCIR). **Signal to noise ratio:** better than 52dB at peak recording level. **Overall dynamic range:** 55dB at 7½ i/s, 53dB at 3¾ i/s. **Crosstalk:** mono 55dB, stereo 53dB. **Bias:** 70 Kc/s, push-pull oscillator. **Inputs per channel:** microphone 1 Meg. 3mV, radio 1 Meg. 50mV, diode 47K 50mV adjustable. **Outputs:** Two cathode follower outputs 0.6V, 1 loudspeaker output 5 ohms, 6W. Push-pull power amplifier, internal speaker may be switched off. **Tube complement:** 4 ECC81, 1 ECC82, 5 ECC83, 2 ECL86, 3 diodes, 3 selenium rectifiers. **Weight:** 65lb. **Price:** £130-4s. **Distributor: C. E. Hammond & Co. Ltd., 90 High Street, Eton, Windsor.**

THE *736* differs from the *E36*, which was reviewed in August 1962, in minor differences in styling and cabinet work, the substitution of two VU-meters for the single magic-eye record level indicator and the provision of a tape tension switch to cope with the large 10½in. NAB spools without giving excessive tension on the smaller domestic reels. Internally, the casting which carries the motor, capstan, flywheel and pressure roller has been strengthened to minimise vibration and to ensure accurate alignment at all times. The module system of wiring, where all the components for a given stage are grouped around the valve holder, is retained, together with DC heating of all the early amplifier stages.

The internal speaker and power amplifier may be switched to monitor either or both tape replay amplifiers, or the incoming signal on either channel. All forms of duoplay and multiplay (i.e., cross recording from one channel to the other) are possible, and on mono, two input signals may be mixed and recorded simultaneously. The only tone control provided is a bass lift on the power amplifier which is used to compensate for the falling low frequency response of the monitor speaker-cabinet combination.

The speeds were exact at both 3¾ and 7½ i/s, as would be expected from the direct capstan drive from the large *Papst* hysteresis multipole motor.

The rubber disc which couples the motor shaft to the flywheel is rather soft and there is a damped oscillation at about 10 c/s which persists for about one second when the motor is switched on, see top trace **fig. 1.** This mass-compliance resonance can be shock-excited by touching the tape as it leaves the supply reel or by bad spooling which may cause the tape to touch the reel flanges occasionally.

When the tape is running steadily, however, the wow and flutter are remarkably low as can be seen from the other pen traces of **fig. 1,** which show r.m.s. readings of 0.05% at 7½ i/s and 0.08% at 3¾ i/s.

The playback equalisation was measured by playing 70 and 140 μS test-tapes at 7½ and 3¾ i/s respectively and measuring the outputs at the cathode-follower line sockets (**fig. 2**). The responses are to the desired characteristic within ±1dB at 7½ i/s and ±2dB at 3¾ i/s.

System noise with no tape running was 45dB below test-tape level, and consisted of almost equal proportions of valve hiss and 50 c/s hum.

RECORD/PLAY RESPONSE

The overall record/play responses of **fig. 3** were obtained by feeding oscillator tones into the radio input sockets and measuring the levels at the line output sockets a fraction of a second later. This instantaneous monitoring facility makes the job of a reviewer remarkably easy, as the slightest deviation from a level response, or the onset of waveform distortion, can be detected instantly. These curves are remarkable for the complete absence of peaks and dips caused by head contour effects and for the exact matching of the top and bottom tracks which can not be shown on the curves as the deviations are within the line thickness.

Test-tape level was recorded at a VU-meter reading of —6dB, and waveform distortion was just evident at 14dB above test-tape level, well off the meter scale. It is standard practice to set professional VU-meters 6dB above constant tone level to permit accurate registration of signal peaks.

Peak recording level was erased on the machine to give 52dB unweighted signal/noise ratio. Weighting the response to match the ear's response at low listening levels gave a dynamic range of 58dB.

(*continued overleaf*)

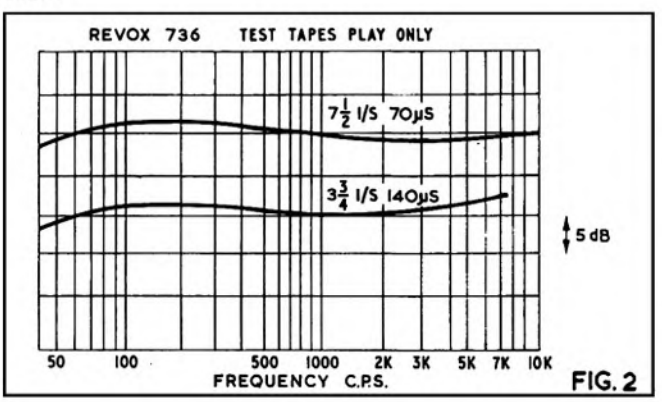


FIG. 2

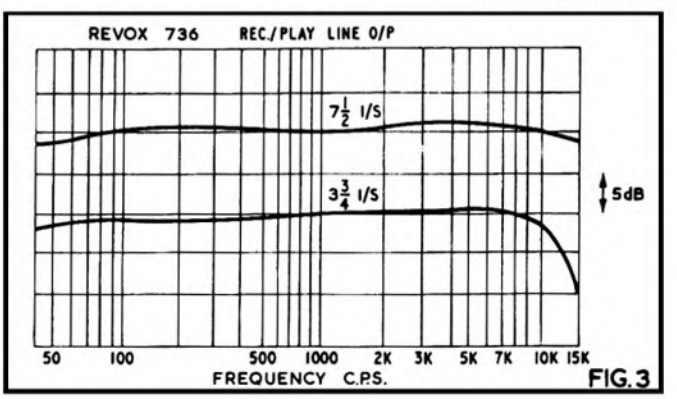


FIG. 3

Twenty-five one-third-octave bands of filtered white noise were recorded at 7½ i/s and the sound level measured on the speaker axis at the extreme settings of the low frequency tone control to give the responses shown in **fig. 4.** Apart from the slight dip at 2 Kc/s, the corrected response is remarkably level from 150 c/s to 10 Kc/s. There is little point in trying to equalise the extreme bass response in a speaker of this size, as harmonic distortion increases sharply if the power input is increased further. The response shown is more than adequate for judging recording quality and balance, and for full stereo monitoring, or normal home listening, wide-range speakers and power amplifiers are essential.

UN-BYPASSED CATHODE

At first sight the valve circuits seem to be completely orthodox, but closer inspection shows that almost every stage has an un-bypassed cathode to linearise the valve characteristic, and that each pair of triodes has overall negative feedback to reduce distortion, noise and hum, and to reduce the effect of circuit capacitances by reducing the output impedance and input capacity of each pair.

Each record amplifier has no less than five triode stages, not counting the push-pull erase and bias oscillator or the cathode-follower buffer stages between these amplifiers and the VU-meters. No resonant circuits are used for pre-emphasis equalisation ; instead, simple passive R-C networks are used between stages to eliminate as far as possible any transient distortion of the signal on the way to the record head.

The play amplifiers consist of three triodes, two amplifiers and a cathode-follower, with overall frequency selective negative feedback to give the desired playback time-constants for the two speeds. The heads are tuned at each speed to cancel the gap and iron losses and to improve signal/noise ratio at high frequencies.

The power amplifier consists of a straightforward triode amplifier, phase-splitter and push-pull pair, with the bass-ride tone control in the feedback loop.

COMMENT

This is a machine with all the hallmarks of its professional pedigree. It is heavy and robust and built to last a lifetime. Controls are laid out in logical fashion with all play controls on the left and all record controls on the right. The coaxial controls save a lot of space as the knobs control all variable functions, while illuminated engraved skirts govern the switching facilities. Each knob or skirt operates ganged controls which act on both channels simultaneously. All tape control is by solenoid, so that the keys are feather light and can be extended for remote control at any distance.

Personally, I do not like the plastic cabinet, and the least said about the plastic lid and securing catches the better! This recorder is worthy of a dignified teak or dark wood cabinet more in keeping with its professional technical specification, and I understand from Mr. Hammond that both this and the flywheel damping are under consideration for the final step to virtual perfection.

Finally, I feel I should remind you that, unlike most of the stereo recorders reviewed recently, the 736 only contains *one* speaker and power amplifier.

A. Tutchings.

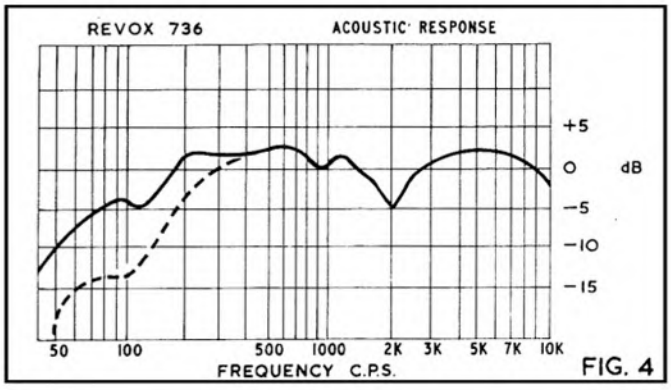


FIG. 4

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 **OCTOBER 1965** issue must reach these offices by **20th AUGUST** addressed to: The Advertisement Manager, Tape Recorder, Link House, Dingwall Avenue, Croydon, Surrey.

SITUATIONS VACANT

Technician or Senior Technician required to operate, maintain, develop and construct radio and film equipment. Applicants should hold H.N.C. or equivalent qualification and must be able to work with students: experience of broadcasting or film work an advantage. Salary ranges £600-£675; £725-£840; £840-£1,040 per annum, according to age, qualifications and experience. Supplement for recognised qualifications. Applications, giving full personal details including previous posts and also the names of two referees, should be sent to The Professor of Drama, The University, Bristol 8, within two weeks of the appearance of this advertisement.

FOR SALE

Ferrograph. 4A/Stereo. Immaculate condition, mechanically perfect, recently checked by Ferrograph. Reslo ribbon microphone to match, if required. Price £55. Audix, transistorised pre-amplifier, with inputs for 2 mics, Radio and Gram, As new £5. Bruce, 4 Loxley Road, Stratford-on-Avon, Warwickshire. Phone 2336/3766.

Vortexion WVA, semi-professional recorder. Immaculate condition and performance. Grampian mike, tape—£65 lot o.n.o. Parish, 49 Nuneaton Road, Bulkington, Nuneaton.

Complete copies of Tape Recorder in Binders. Vol. 1, 2, & 3. Offers over £6? Box No. 384 (London).

Walter Mains/Battery Transistorised Portable clean but needs speed and record position repair £4. Scott, 4 Laverock Road, Blyth.

WANTED

Wanted Vortexion Recorder (WVB) series 4 in good condition. Reply Norton, 5 Healing Road, Stallingborough, Lincolnshire.

Commercial outlet for simple battery transistor Wow and Flutter meter design. Box No. 383 (Herts.).

Mado Robin fan wants pictures, records, articles, programmes, etc. What else have you? Parylak, Texaco, New York, N.Y. 10017.

Old Jazz records (78 rpm) any condition, any quantity, will pay cash and collect. Box No. 385 (London).

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.

Highest cash prices offered for good quality Tape Recorders and Hi-Fi. See our ad. page 348 this issue. R.E.W., 266 Upper Tooting Road, London, S.W.17.

TRADE

Lafayette "International" Tape. Polyester : 7in. 2400ft. 22/6 ; 5½in. 1800ft. 19/- ; 7in. 1200ft. 14/- ; 7in. 1800ft. 19/- ; 7in. 1200ft. 12/-. Acetate : 7in. 1800ft. 14/9 ; 5in. 900ft. 10/6 ; 5in. 600ft. 8/- Refund guarantee. 'Bib' Tape Splicer 14/11. We also have a full range of message Tapes and Triple Play Tapes all at lowest ever prices. P. & P. 2/- per order. S.A.E. list. Leda Tapes, 30 Baker Street, W.1.

A Unique Buy! Recording tape, top brand. 7in. 2400ft. D.P. 25/-, 5½in. 1200ft. 19/6, P. & P. 1/6 per spool. Bargains in all sizes. S.a.e. for list. We repair, buy and sell recorders. E. C. Kingsley & Co. Ltd., 132 Tottenham Court Road, London, W.1. EUSton 6500.

Speedy and Expert Tape Recorder and Hi-Fi repairs by England's leading Hi-Fi Specialists. Telesonic Ltd., 92 Tottenham Court Road, London, W.1. MUS 8177.

Learn While You Sleep. Learn languages, memorise speeches and sales presentations, absorb business statistics or the highway code while asleep with Learnasleep Equipment. Details from: Sleep Learning Supplies (Dept. T.R.), 245 Capworth Street, Leyton, E.10.

— YOUR TAPE DEALER —

Leicestershire

LEICESTER
ALL YOUR HI FI REQUIREMENTS
Speakers by : H.M.V. QUAD LEAK ROGERS TANNOY MORDAUNT LOWTHER W.B. WHARFEDALE GOODMANS
Tape : FERROGRAPH REFLECTOGRAPH GRUNDIG SIMON BRENELL
Record Department : ALL LABELS-PARASTAT SERVICE
LEICESTER CO-OPERATIVE SOCIETY LIMITED, High Street, Leicester. Tel. 20431

Northamptonshire

PETERBOROUGH, NORTHANTS *Tel :* 5643/5644
CAMPKINS RECORD SHOP
RECORD TAPE AND HI-FI EQUIPMENT SPECIALISTS
NEW ADDRESS **15 LONG CAUSEWAY** LARGE STOCKS
(IN CITY CENTRE)

Oxfordshire

WESTWOOD'S *of* **OXFORD**
46 GEORGE STREET
PHONE: 47783

Staffordshire

WOLVERHAMPTON
WARNERS for TANDBERG
AUDIO DEPARTMENT, CHAPEL ASH,
Tel. Wolv. 26581
WE ARE "The World's Finest Tape Recorder"
SPECIALISTS
SALES AND SERVICE

Surrey

FARNHAM, SURREY
The finest selection of Tape Recorders, Hi-Fi Equipment and quality Radiograms in the Provinces is awaiting you at:—
LLOYD & KEYWORTH LTD
26-27 Downing Street, Farnham, Surrey. *Telephone:* 5534
Comparative Demonstrations, Large stock of Cabinets and Pre-Recorded Tapes.

CROYDON'S TAPE RECORDER CENTRE
All leading makes in stock, Hi-Fi equipment, cabinets, etc.
Service agents for AKAI Tape Recorders
SPALDING ELECTRICAL LTD.,
352/354, Lower Addiscombe Road, CROYDON
ADDiscombe 1231/2040

Sussex

WORTHING, SUSSEX
Stocking Ferrograph, Revox, Sony, Tandberg, Truvox, Philips, EMI, Luxor, etc., on fully comparative Demonstrations
BOWERS & WILKINS LTD.
1 Becket Bldgs., Littlehampton Road, Worthing 5142

NEW PREMISES
NEW PREMISES
NEW PREMISES 132 montague street telephone 2585
CRAY
CRAY OF WORTHING LTD

— YOUR TAPE DEALER —

Warwickshire

For tape recorder service in the Birmingham area

L. BISHOP LTD.

1708 Bristol Road South, Rednal, Birmingham

Telephone : RUBery 2709

GRUNDIG SPECIALISTS

COVENTRY & DISTRICT CO-OPERATIVE SOCIETY LTD.

HIGH FIDELITY SOUND EQUIPMENT TASTEFULLY DISPLAYED FOR YOUR "BROWSE AROUND" ENJOYMENT

All leading makes : Amplifiers, Control Equipment, Loud-speakers, Cabinets, Tuners, Microphones, Tape Recorders and Ancillary Items in stock or quickly obtainable.

Coventry & District Co-operative Society Ltd., High Fidelity Sound Section, Electrical Dept., First Floor, Central Premises, Corporation Street, Coventry. Tel. Coventry 24031-10 lines

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AUDIO & TAPE SALES & SERVICE HIG. 4182

COLIN G. TURNER M.I.P.R.E.

QUAD. LEAK. ROGERS. TANDBERG. TRUVOX. BRENELL

All makes in stock and on demonstration

39 YORK ROAD, KINGS HEATH, BIRMINGHAM 14

Wiltshire

SOUTHERN ENGLAND

HI-FI AND RECORD CENTRES

J. F. SUTTON

SALISBURY — 18 QUEENS STREET

SOUTHAMPTON — 421 SHIRLEY ROAD

Yorkshire

TAPE RECORDER CENTRE (HALIFAX)

Stock all the best Tape Recorders; Hi-Fi Equipment; Tape; L-P Records, etc.

DEMONSTRATIONS DAILY BY EXPERT STAFF

2 years FREE SERVICE ON NEW RECORDERS over £35

30 King Cross Street, Halifax. 'phone 66832

— TAPE TO DISC SERVICES —

Members of the Association of Professional Recording Studios who can be relied on to give satisfaction

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MJB RECORDING & TRANSCRIPTION SERVICE

specialise in the production of microgroove records from Professional and Amateur recordings (Acetate copies ; Mono and Stereo pressings). Extended playing times achieved by controlled cutting techniques. Studio, Mobile, "Off the Air" and all recording services. Detailed booklet available.

7 HIGH STREET, MAIDENHEAD (Tel: 25630)

TAPE RECORDERS - AUDIO EQUIPMENT - DISC CUTTING STD & LP FROM TAPE - STUDIO FACILITIES - HIRE SERVICE - SALES - EXCHANGES

MAGNEGRAPH

1 Hanway Place, London, W.1. *Tel. : LAN 2156*

STUDIO Republic

Church Farm, Pinner, Middx.
Tel: Field End 5555

FOR ALL AUDIO SERVICES

tapes · discs · p.a.
studio · dubbing · mobile

CLASSIFIED ADVERTISEMENTS — TRADE *continued*

"Gevaert" New boxed recording tapes 600ft., 5¾in. spools at 9/- each or 6 for 50/-. "Grundig" 2-Transistor pre-amplifiers suitable for boosting microphones and tape head monitoring—listed at 4½ gns—offered new and boxed at 57/6 each. Lee Electronics, 400 Edgware Road, Paddington 5521.

Tempotapes—Music 3¾ i.p.s. and Castle copyright free sound effects 45r.p.m. discs. Wide selection of titles. 6d. stamp for catalogues to: Recorded Tuition Ltd., 174 Maybank Road, South Woodford, London, E.18.

American 4 Track Stereo Tapes covering most famous labels at realistic prices. Why pay more? Imported directly by us, saving distributors profits. Vast selection at 75/- each—send S.A.E. for free lists or call at London showrooms Teletape of Marble Arch, 33 Edgware Road, W.2.

Apply to the Sleep-Learning Association for free booklet on Tapes Subjects, Method, best equipment to use for sleep-learning. Also for details of residential sleep-learning facilities available in London and Cheltenham Spa. 14 Belsize Crescent, London, N.W.3. Tel. SWI 6160.

New World famous recording tapes, Polyester base and fully guaranteed. 5in. 600ft. 7/-, 5¾in. 900ft. 9/6, 7in. 1200ft. 12/-, 5in. 900ft. 9/-, 5¾in. 1200ft. 12/6 7in. 1800ft. 13/6, p/p 1/- per spool. Starman-Tapes (T.R.), 421 Staines Road, Bedfont, Middx.

STUDIO FACILITIES

John Hassell Recordings. Tape to Disc. Latest high level microgroove cutting system. Competitive prices. Studio and Mobile Services, 21 Nassau Road, London, S.W.13. RIVerside 7150.

Rapid Recording Service. Records made from your own tapes. (48 hour service). Master Discs and pressings. Recording Studio—Demo Discs. Mobile Recordings, any distances. Brochure from 21 Bishops Close, E.17.

Ilford Sound Recording Service. Tape to disc—pressings—studio recordings—weddings, school choirs, etc. S.a.e. for list. 445 High Street North, Manor Park, London, E.12. Phone : GRA 5107 or evenings CRE 8947.

Scotland

Edinburgh's TAPE RECORDER specialist

Ferrograph—Grundig—Telefunken—Philips, etc.
W. G. Graham, Assoc. Brit. I.R.E.

Tape to Disc Recording Service

Agent for The Famous Heathkits.

Hi-Fi Corner

1 Haddington Place, EDINBURGH.

Phone WAV 7901

ADVERTISERS' INDEX

buzz along to the

Do it yourself Exhibition

Olympia 3-18 Sept

It's a honey! See all the new ways to do-it-yourself and save-on-cash. Question the experts on the Do it yourself Magazine Stand. Go everywhere, miss nothing —especially the native craft work from many countries. Hundreds of D.I.Y. demonstrations—see the latest equipment and materials—come soon!

OLYMPIA Empire Hall, 10 am to 9.30 pm

Admission: Adults 3/- Children 1/6

13th International Handicrafts and Do it yourself Exhibition. Sponsored by Do it yourself Magazine

YOU SAID IT! (played it, sang it!) NATIONAL HAVE IT TAPED SUPERBLY!

Just say the word – and it starts! You stop, and the recording stops, too! The **National RQ-150** is the first completely automatic **Voice-operated** portable tape recorder in the world.

And this is only the beginning—the incomparably versatile RQ-150 also provides automatic slide and film synchronisation, automatic threading and remote control. If you really want to spread the word, there's a Public Address System that permits accurate monitoring through a built-in loudspeaker while recording. All this and *immaculate* reproduction—for precisely 44 gns!

SPECIFICATION

Power Source:	**6 unit cells (U.2.), 9 V.**
Output:	**500mW (700mW max.)**
Transistors:	**9 Transistors, 1 Thermistor, 1 Diode.**
Tape Speed:	**3¾ i.p.s., 1⅞ i.p.s.**
Frequency Response:	**100-7,000 c/s at 3¾ i.p.s., 100-4,000 c/s at 1⅞ i.p.s.**
Recording Level Indicator:	**VU meter.**
Speaker:	**3½" Permanent Dynamic Speaker.**
Dimensions:	**3¼" x 9" x 12½".**
Weight:	**5 lb. 14½ oz.**
Accessories:	**Dynamic microphone with remote control switch; 5" recording tape (600 ft.); 5" empty reel; radio cord; leather case for accessories; hand belt; splicing tape; sensing tape; plug for slide sync.; magnetic earphone.**


RQ-303

Also from NATIONAL:

RQ-303, Mains, 2 track, single speed, 15 gns.

RQ-115, Battery*, 2 track, 2 speed, 35 gns.

RQ-116, Battery*, 4 track, 2 speed, 39 gns.

RS-753, Mains, Full stereo, 4 track, 2 speed, 76 gns.

**With optional mains adaptor available*


RQ-115 & RQ-116

National

TAPE IT EASY—

with **NATIONAL,** naturally!

UME 5-7658-100