NOVEMBER 1966 TWO SHILLINGS

tape recorder

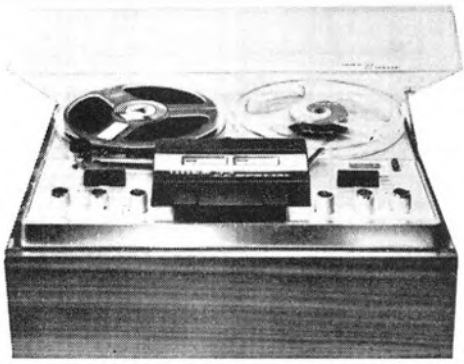
PERSONAL BIAS — BUILDING A MICROPHONE BOOSTER — THE AWKWARD CUSTOMER
DATA PROCESSING WITH THE MAGNETIC TAPE — UHER 4000L REVIEW AND FIELD TRIAL

UHER

a range of tape recorders to satisfy every amateur and professional enthusiast

4000 REPORT L

A battery portable that offers you virtually every facility of a mains-operated recorder—with many exceptional new features. Four tape speeds provide an infinite variety of recordings. Price (incl. microphone and tape) 103 GNS.

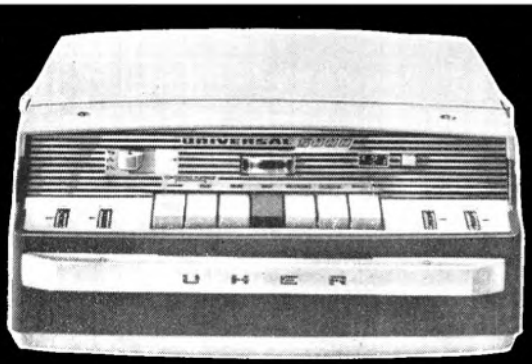


22/24 HI-FI SPECIAL

In many ways quite unique, this recorder meets the most exacting demands of a home sound studio. The Hi-Fi Recorder with a Test Certificate and Original Frequency Response Curve sheet for Hi-Fi systems. Price: 129 GNS.

724 L STEREO

A new, four track, all mains recorder priced at only 75 gns—and specially designed to meet the demand for an instrument particularly easy to understand and to operate.



UNIVERSAL **5000**

An ideal dictation machine and recorder ensemble for professional and business use. Three tape speeds, exceptional handling comfort and high tonal quality. Price: 95 GNS.

784 ROYAL STEREO

One of the most versatile recorders in the world with a fascinating range of recording possibilities. A high-quality stereophonic model featuring a simple knob control with eleven different functions. Four track Price: 129 GNS.

AUDIO FAIR * Special Showroom Exhibition at 205 Gt. Portland St.

During the period of the AUDIO FAIR at HOTEL RUSSELL – April 14th and 15th we shall be featuring a special display of UHER TAPE RECORDERS, to which you are cordially invited. Our showrooms are easily reached — just one minute from Gt. Portland Street Underground station (Circle and Metropolitan lines).

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As Britain's largest tape recorder specialists we claim to have an unrivalled selection of the most up to date recorders on display in Gt. Britain. The most experienced staff with expert knowledge. ideal demonstration conditions with every recorder ready for immediate demonstration and comparison. The finest FREE AFTER SALES SERVICING facilities available. The largest, most centrally situated and accessible showrooms in London devoted exclusively to tape recorders. Exaggerated claims ? Don't take our word for it, put our claims to the test and visit whichever of our showrooms is most convenient to you. You won't be disappointed and it's ten to one that if you are interested in buying a tape recorder you'll become one more of our many thousands of satisfied customers.

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SONY TC260

BRENELL Mk. 5M

UHER 4000L

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To all our customers residing outside the Greater London Area we offer a unique Free Travel facility. For full details by return, write to our Head Office: 191 Plashet Road, London E.13.

SONY TC260 A brilliant new 4 track stereo model. Separate record and playback volume controls. Bass and treble controls. V.U. meters. Automatic tape stops. 7" Tape. 2 speeds. Superb Hi-fi quality. Complete incl. 2 dynamic microphones, fantastic value at **97 gns.**

TRUVOX R104 A first class quality mono tape recorder. All transistorised amplifier. Freq. 30-17,000. 3 speeds. 7" Tapes. V.U. Meter. Mixing facilities. Auto tape stops. Locking pause control. 4 Watts. 3 Heads. Before and after record monitoring facilities, etc. **79 gns.**

UHER 4000L A superb 2 track all transistorised battery/mains portable. Unbelievable performance. Freq. 40-20,000. 1 Watt output, 4 Speeds. 5" tapes. Ultra lightweight only 6 lbs. Capable of recording to the highest standards and used extensively by professionals. **103 gns.**

SPECIAL OFFERS!

ELIZABETHAN LZ 507	Brand new 35 gns.
GRUNDIG TK30	As new 32 gns.
SONY 777 Professional Recorder	85 gns.
AKAI M69	As new 35 gns.

FERROGRAPH 632 A complete stereo record/replay preamplifier unit with inbuilt monitoring amplifier included. For the perfectionist who is only content with the finest possible performance. 3 speeds. 3 Heads. 4 Pre-amplifiers. Auto tape stops. Mixing. V.U. Meter etc. **126 gns.**

SONY TC250A The finest value for money. 4 track stereo tape record/replay preamplifier unit. Incorporates the latest Sony tape deck. 2 V.U. meters. 7" tapes. 2 speeds. Separate record/playback controls for each channel. For the budget-conscious Hi-fi enthusiast. **57 gns.**

BRENELL Mk 5M The most comprehensive and finest mono recorder made by this famous British company. 3 heads, 4 speeds. Up to 10½" tapes. Bass, treble controls. Mixing. Before and after record comparison facilities. V.U. Meters. 6 watts output. Separate record/replay amplifiers. **93 gns.**

AKAI M8 Japan's finest. Complete Stereo. 4 speeds. Unique Akai Cross Field recording. Freq. 30-25,000. 2 V.U Meters. 10 watts output. Auto tape stops. Bass, treble controls. 4 tracks. 7" Tapes, etc. Fantastic Hi-fi performance. **136 gns.**

GRUNDIG TK6 A handsome high quality battery/mains portable by the world famous company. 2 Tracks. 2 Speeds. Freq. 50-13,000. 4½" Tapes. Meter for recording and battery level. Includes superb dynamic microphone. A portable recorder with big machine performance and quality. **69 gns.**

REVOX 736 The stereo tape recorder that sells by reputation alone. One of Switzerland's finest products. Full professional record/replay facilities. 4 Preamplifiers. 3 Heads. 2 V.U. Meters Track to track facilities. Freq. 30-18,000. For the perfectionist. **127 gns.**

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PHILIPS 3549 Inc. accs.	As new 39 gns.
COSSOR CR1607 Stereo	As new 39 gns.
FERROGRAPH 4AN	Perfect order 42 gns.

VORTEXION CBL. A superb complete stereo record/replay recorder, employs the latest Wright & Weaire 3 speed tape deck. 3 Heads. Two 4 watt amplifiers. Mixing. Before and after record/replay facilities. A recorder for those wishing to obtain professional results. **£172**

WYNDSOR VANGUARD

The newest model to the famous WYNDSOR stable. 3 Heads. Before and after record/replay facilities. 3 Speeds. 4 Tracks. 7" Tapes. Freq. 40-15,000. 6 watts output. Detachable 8" Hi-fi speaker unit giving superb reproduction. A wonderful value for money recorder at **59gns.**

B & O 2000 The most comprehensive fully transistorised stereo recorder available. Its facilities are too numerous to list. Available in 2 or 4 track, suitcase or table model versions. A recorder for those wishing to purchase the finest available. **119 gns.**

VIDEOTAPE DEMONSTRATIONS

We are demonstrating at our **82 High Holborn, W.C.1 Showroom,** during the period **October 18th to 27th** the fantastic PHILIPS **VIDEOTAPE TELEVISION CONSOLE.** Call into our showrooms and see this fascinating and superb equipment recording television programmes direct off the air or live Video Recordings made with the camera. Don't miss this exciting opportunity for seeing the development of the future now ! *(Domestic Videotape recorder for under £350 available January* **1967.)**

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242/4 PENTONVILLE ROAD, N.1 (3 minutes from King's Cross Station)	**TERminus 8200**
228 BISHOPSGATE, E.C.2 (1 minute Liverpool Street Station)	**BIShopsgate 2609**
36 LEWISHAM HIGH STREET, S.E.13 (1 minute Lewisham Station)	**LEE Green 2399**
2 MARYLAND STATION, STRATFORD, E.15 (adj't Maryland Station)	**MARyland 5879**
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BISHOPSGATE:
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KING'S CROSS, STRATFORD, LEWISHAM, EAST HAM:
Monday to Saturday 9 a.m. to 6 p.m. Halfday Thursday.

NUSOUND TAPE RECORDER CENTRES

Tandberg model 9 the world's finest Monaural Tape Recorder

A new facia in the finest Scandinavian design tradition plus Tandberg precision audio-engineering now combine to make the Tandberg Model 923 the monarch of portable, monaural tape recorders.

The Tandberg Model 923, 2 track, 3 speed ($7\frac{1}{2}$ ips, $3\frac{3}{4}$ ips, $1\frac{7}{8}$ ips) machine includes a formidable built-in speaker and amp system of the highest quality which provide exacting performance standards without any auxiliary equipment.

Superlative sound, functional simplicity, clean design, the classic look of teak combine to make the Tandberg Model 923 the ultimate in the field of portable, monaural tape recorders Price: 69 GNS.

Model 8 (2 speed version) available from 54 GNS.

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Tandberg

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TR4

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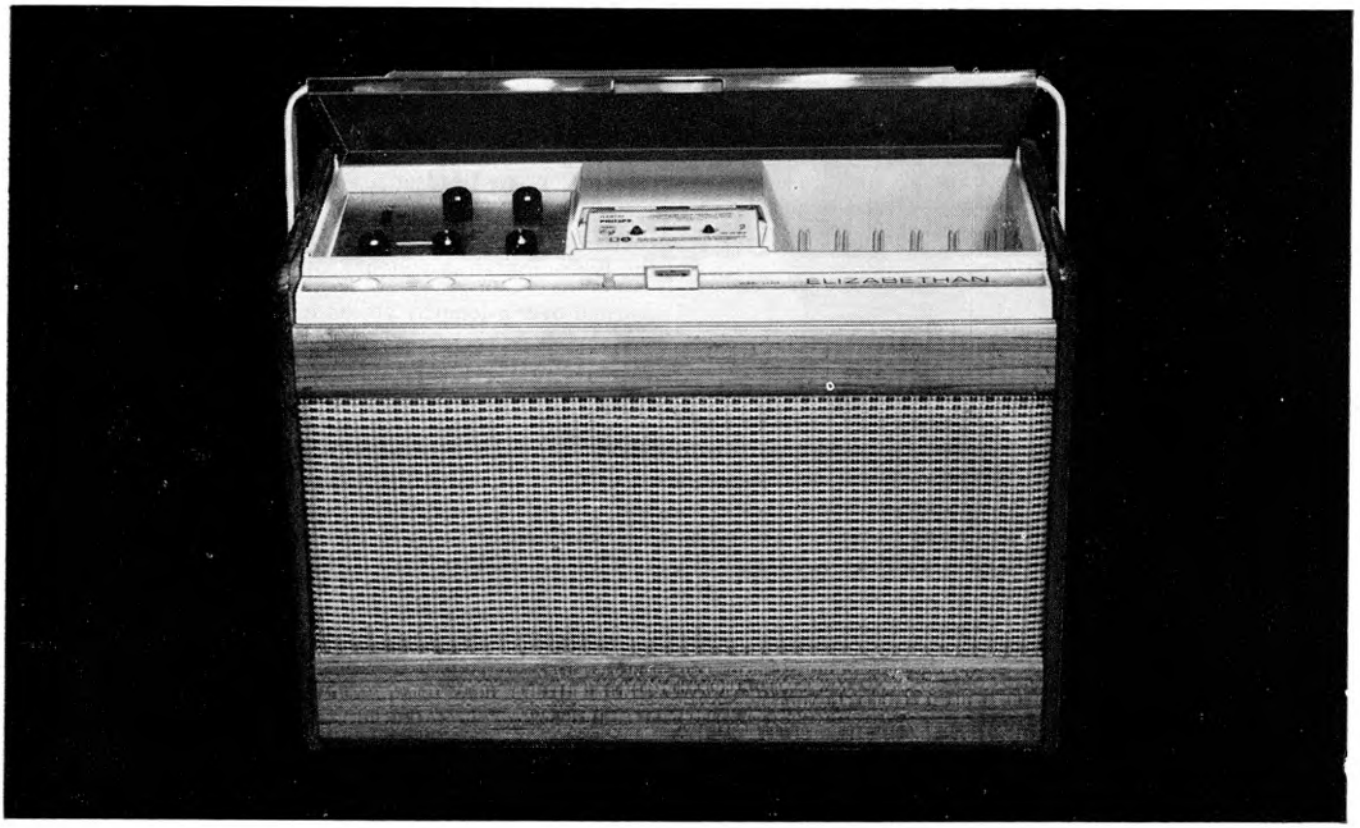

NEVER in the history of tape recorders a machine that looks and sounds like this!

Tall and handsome, cassette loaded and with a wonderful depth of sound (it has a *10 inch round Hi Fidelity speaker*). And *only* the fabulous new Elizabethan LZ 612 allows you to slip a 90-minute programme from the top pocket of your jacket—or your handbag—and be listening to it at over 5 watts output, literally in the next second. No wonder this unique machine was the sensation of the Radio Show. Just study its advanced features . . . but better still, go to your Elizabethan dealer . . . hear it . . . and judge for yourself!

- *Completely portable, mains/battery and car supply operated.*
- *Furniture style solid teak acoustic cabinet.*
- *Specially developed 10 inch round Hi Fidelity speaker.*
- *Separate bass and treble controls.*
- *Full mixing facilities via independently controlled inputs.*
- *Straight through amplifier monitoring providing 'listen while you record'.*
- *Separate mic, radio and gram inputs.*
- *Record/battery level indicator meter.*
- *90 minutes per cassette playing time.*
- *5½ watts output* ■ *Supplied complete with microphone, tape cassette and leads.* **LZ 612 45gns.**

the Sound alone tells you it's

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SEE AND HEAR THESE OTHER ELIZABETHAN MODELS, TOO!

LZ 9102T 27 gns
Compact portable battery operated cassette loaded tape recorder weighing only 3 lb.

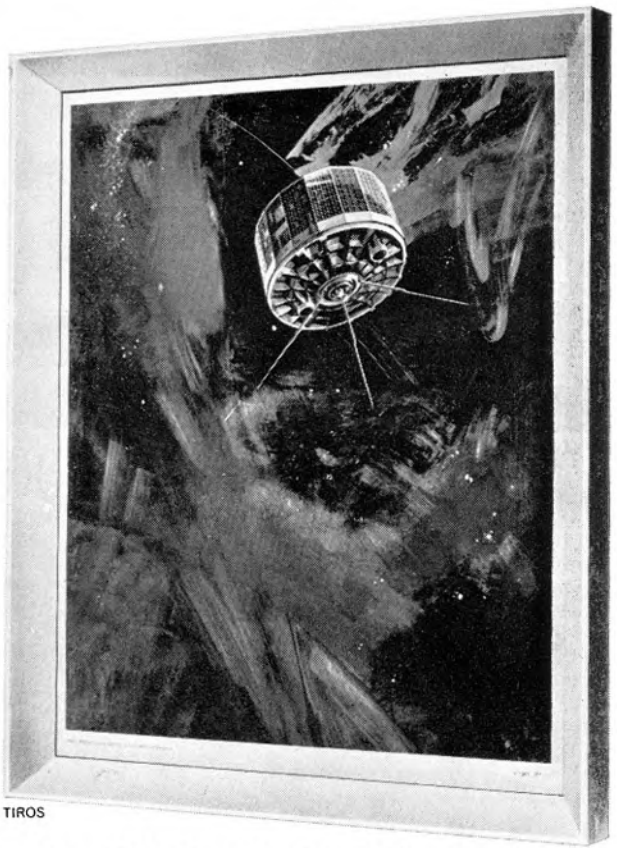
LZ 32 (twin track) 32 gns
LZ 34 (four track) 34 gns
Brilliant 3-speed mains operated 2 and 4 track recorders.

LZ 102 49 gns
Fully transistorised 4 track 3-speed mains operated recorder with outstanding performance.

LZ 711 75 gns
Complete portable mains operated stereophonic tape recording system for the creation of professional quality tapes.

These authentic, framed space pictures. Yours for only 9/6

(Each worth 19/6 at least!)



TIROS

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Actual size of all pictures 16¾" x 14¾"

3M Company commissioned these beautiful coloured prints of Tiros, Mariner and Polaris from Oleg Stravrowsky, internationally famous painter. Each one is authentic in every detail, each one could be yours for a mere 9/6 and the tartan tab from a reel of 'SCOTCH' Magnetic Tape.

Framed in white painted wood in contemporary style, either individually or as a set, they make fascinating and educational decoration for a study, a boy's bedroom or, because the colours and designs are so good, for your living room.

The research that leads the way in space

3M Company research has provided communications systems for much of the space programme. The same research developed 'SCOTCH' Magnetic Tape with Superlife, used by tape enthusiasts all over the world. The most stringent precautions and meticulous standards are essential for all equipment used in space — the same standards are applied to the recording equipment sold to you.

You can get your Tartan Tab from any reel of 'SCOTCH' Magnetic Tape, 4" size or over.

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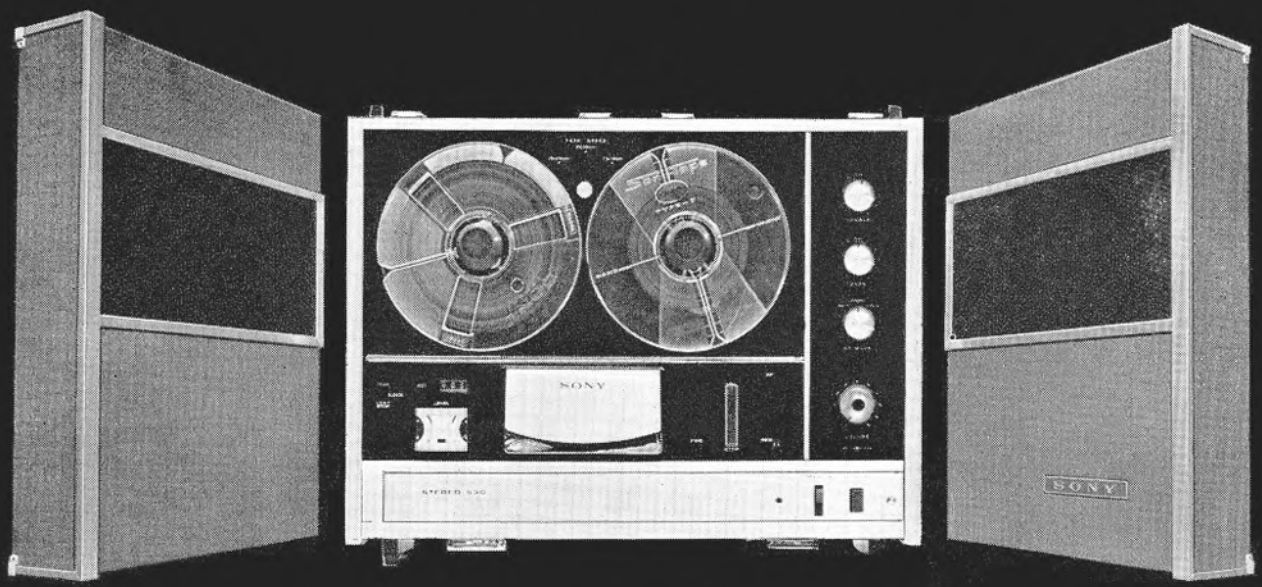

...Quadradial Sound

MODEL TC530—FEATURES ■ 4-track stereophonic and monophonic recording and playback ■ Quadradial (4-way) speaker system ■ High precision all silicon solid state circuit ■ Vertical or horizontal operation ■ "Retractamatic" pinch roller for easiest tape threading ■ 3-speed, full 7" reel capacity ■ Tape position indicator ■ Instantaneous pause control ■ Two illuminated, calibrated VU meters ■ Automatic "Sentinel" tape stop ■ Stereo headset jack. Price 120 Gns.

SPECIFICATIONS:

Power requirements:	100–125V and 220–240V AC. 50/60 c/s 65 watts.
Tape speed:	7½ ips., 3¾ ips. and 1⅞ ips. instantaneous switching.
Reels:	7" diameter or smaller.
Recording system:	4-track stereophonic or monophonic.
Frequency response:	30–20,000 cps at 7½ ips. (±3dB 50–15,000 cps. at 7½ ips.) 30–13,000 cps. at 3¾ ips. 30–10,000 cps. at 1⅞ ips.
Wow and flutter:	Less than 0.17% at 7½ ips. Less than 0.3% at 3¾ ips. Less than 0.4% at 1⅞ ips.
Power output:	5W R.M.S. per channel.
Signal-to-noise ratio:	Better than 48 dB (at peak record level).
Harmonic distortion:	Less than 3% at 0 dB line output.
Level indication:	Calibrated VU meter x 2
Tone controls:	Separate controls for bass and treble.
Inputs:	Low impedance microphone inputs: transistorised (will accommodate any microphone from 250 ohm to 1K ohm impedance).
Inputs (cont.):	High impedance Sensitivity—72 dB (0.19mV) 100k ohms) Auxiliary: Sensitivity—22 dB (0.06V).
Outputs:	Line outputs: 0 dB (0.775V), load impedance 100k ohms. Speaker outputs: 2 x 8 ohm. Binaural monitor output: will accommodate stereo headset Model DR-3C (10k ohm impedance).
Dimensions:	19 11/16" wide x 9 15/16" high x 15 7/16" deep.
Weight:	41 lbs. 10 ozs.
Accessories:	Stereo recorded 5" tape, 7" reel. Two SONY dynamic microphones (F-96). Integrated record replay connector type RK-46 60c/s Motor pulley, Reel cap, Head cleaning ribbon, Splicing Tape.

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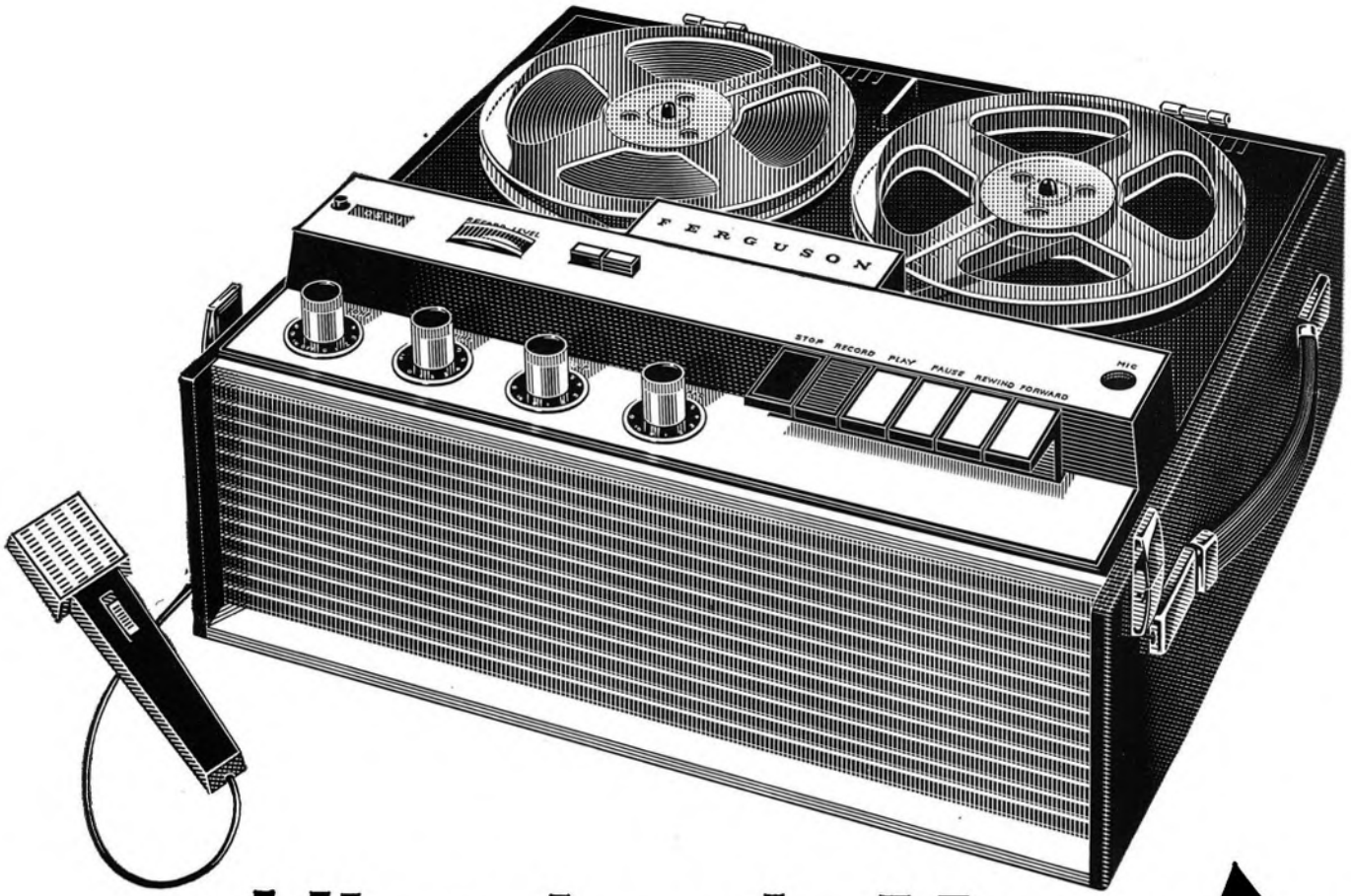

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GREAT ENTERTAINMENT VALUE

Just look at the big-price features on this new low-cost Ferguson Model 3214 tape-recorder: three speeds, four tracks, 7″ self-threading spools and up to 17 hours playing time per reel of double-play tape (8½ hours on the tape supplied). This is the recorder with the real professional touch: mixing facilities, two-way tape inching, double-track replay for special effects pause key, remote control microphone, and interlocking keys to prevent accidental erasure. The output is 3 watts feeding into a 7″ x 4″ speaker with a frequency response of 40 c/s to 18 Kc/s at 7½ i.p.s.; 40 c/s to 14 Kc/s at 3¾ i.p.s.; and 40 c/s to 7 Kc/s at 1⅞ i.p.s. Leathercloth covered wood cabinet with silver-trim panels. Beautifully designed and beautifully finished. With 1200 ft of free long-play tape, remote control microphone, and connecting leads.

Great, great value. Great entertainment, too.

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Ferrograph MODEL 631

If you are determined to be satisfied with nothing but the best—if you want a Tape Recorder which will record with unequalled fidelity, play back to a superb standard of reproduction—there is no substitute for the incomparable Ferrograph 631. Offering exceptionally clean, elegant styling, superb performance and an advanced specification, the 631 is supported by a comprehensive range of accessories, which includes tape, carrying case, microphone, plugs, endless loop cassette, etc ; as well as the Wearite De-fluxer, an indispensable accessory for all makes of recorders, preventing hiss and protecting tape from cumulative noise.

Wherever you are, you can enjoy the "pride-of-ownership" which comes with the possession of this magnificent equipment by using the fast, friendly and experienced R.E.W. Mail Order Service.

We carry large stocks of the Model 631 together with other models, both mono and stereo, in the Ferrograph Series 6 range. You can order your Ferrograph from us with complete confidence and with comprehensive after-sales service. All models available on R.E.W. credit terms, for minimum deposit and 8 monthly payments, or on H.P. Terms, over 12 months, one third deposit, INTEREST FREE.

Ferrograph Series 6

Model 631	(Mono)	**95 gns**
Model 632	(¼ track Stereo)	**126 gns**
Model 633	(2 track mono-Hi-Fi)	**120 gns**
Model 631H	Mono & Stereo Models with tape speeds of 3¾, 7½, 15 i.p.s.	**100 gns**
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Model 634	(¼ track Stereo)	**132 gns**

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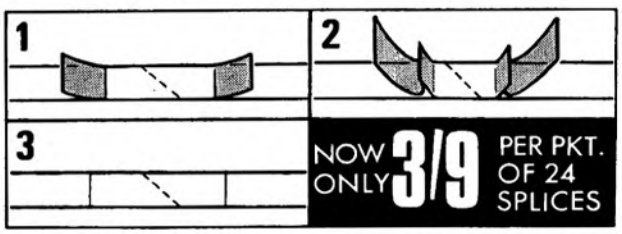

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the big sounds of '66 on tape from EMI

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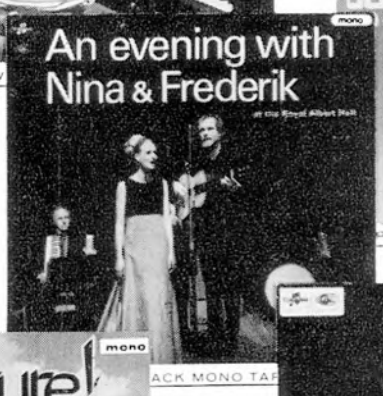

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TRUVOX D93-2 ¼-track	£36 15 0
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A must for the tape enthusiast. Four channels allow recording from a wide variety of sources, e.g., dynamic and crystal microphones, tuners, record players. Kit £11 14 6
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STEREO CONTROL UNIT, USC-1	£19 10 0	£26 10 0
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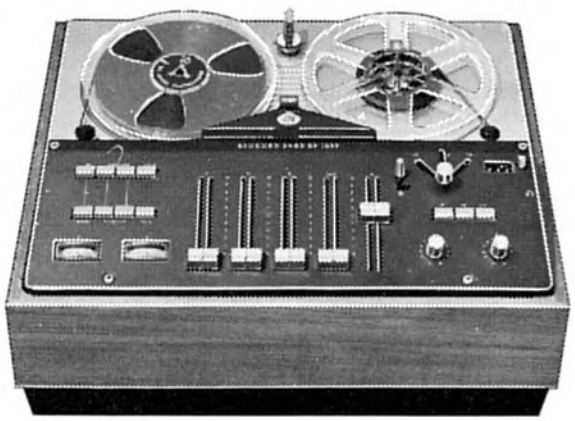

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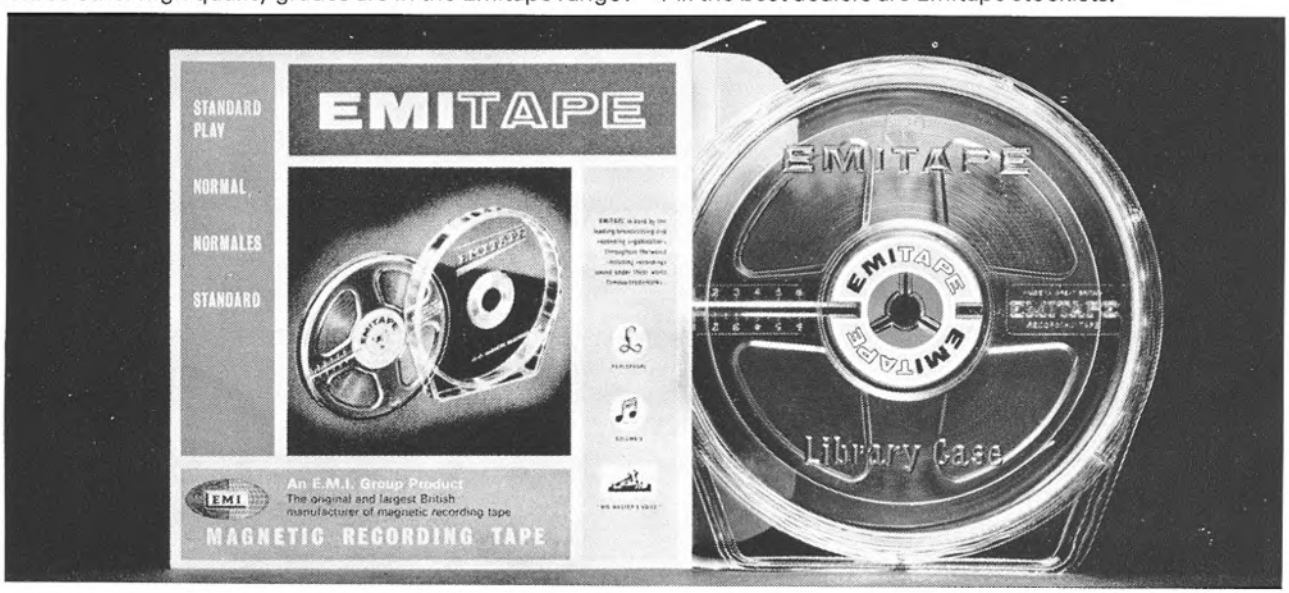

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NOVEMBER 1966 VOLUME 8 NUMBER 10

INCORPORATING
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COVER PICTURE

The quantity of magnetic tape employed in audio recording is but a drop in the ocean, compared with that consumed by the data-recording industry. Quality, too, is much higher, and the *Computer Tape Certification Unit* shown on our cover is an example of the sophisticated equipment now being used to check manufacturing tolerances. A microscope in the centre of the mechanism permits detailed examination of the tape surface. The unit is installed at the *C.E.I.R. Computer Centre*, Newman Street, W.1.

SUBSCRIPTION RATES

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

INCONSISTENCY OR CONSISTENT shoddiness. Which of these two evils is most feared by those engaged in mass production? Put another way, when a tape recorder, motor car, soap powder or vacuum cleaner is praised, reservedly recommended, criticised or slammed, how representative of its brethren is the item under examination? Only rarely does a recorder break down under test, entailing submission of a new version, but when it does, then comes the opportunity to gauge the degree of B between A and C.

Rather more frequent is the situation where a recorder under test, or immediately after test, is used alongside another machine of identical design. No names, but here are some recent experiences: A medium-price Japanese mains/battery portable on the one hand exhibits severe rattling—probably a loose motor bearing—but has a tolerably low wow level. On the other hand is a model of the same species; no rattle here, but a fairly high level of wow.

On the bench are two mains recorders—nominally different models but actually employing almost identical decks. Both employ slip-on capstan sleeves to attain a higher speed. To be more precise, one features a push-on sleeve, while the other has a fall-on version. Dare we try a swop? Dare we even organise a capstan-exchanging conference of dissatisfied deck-owners?

Two more battery portables: very expensive British models, excellent in almost every respect. The recorder dangling from our left shoulder has a pretty good signal-to-noise ratio (but with just a touch of motor hash), in the region one expects at the price, provided all unused input channels are turned well down. That on the right shoulder is simply superb—background hiss is almost inaudible and no trace is to be found of motor interference. In a few days, the model on the right is going to break down completely. Troubles in the power supply circuit.

We are offered the use of a small European battery portable, adulated, a year or two ago, for its lack of motor crackle. Were we lucky before, or are we the unfortunate bearers of an inferior model now? Certainly this crackling model deserves no praise.

If inconsistency is as rife in the mechanical side of the audio industry as in the motor car industry, then this would help to explain why some individuals strongly approve of certain designs while others have nothing to recount but bitter experience. We are beginning to suspect that even the sturdiest machines in the £100-plus category are prone to appreciable performance variation between models.

Certainly the situation is nowhere near as bad with us as in the motor industry. Intending car purchasers who have endeavoured to plumb the opinion of friends and 'authorities' towards one vehicle or another will know what we mean. A total equilibrium of ideas is found, in which "The *Rolls* is probably better value than a *Mini*, but the clock ticks rather loudly."

A few months ago, in this column, we made a similar complaint. The problem then under discussion was *wear*. We hoped, at the time, that a practical method would be found of determining whether the superb performance of West European tape recorders really did depend on the precise position of pre-set screws and bent pins. The results of such an experiment, undertaken upon the *Uher 4000L* battery portable, are published on page 433 of this issue—and they reach a surprising conclusion. Critics of belt-drives, miniature high-speed motors and fragile-seeming mechanisms may find themselves having second thoughts, as we did, when digesting the fact that twelve weeks hard use did not detract from, *but actually improved*, the mechanical performance.

Judging from Dr. Noble's account on page 414, the ideal reviewer might be a computer with a hammer. In the meantime, however . . .

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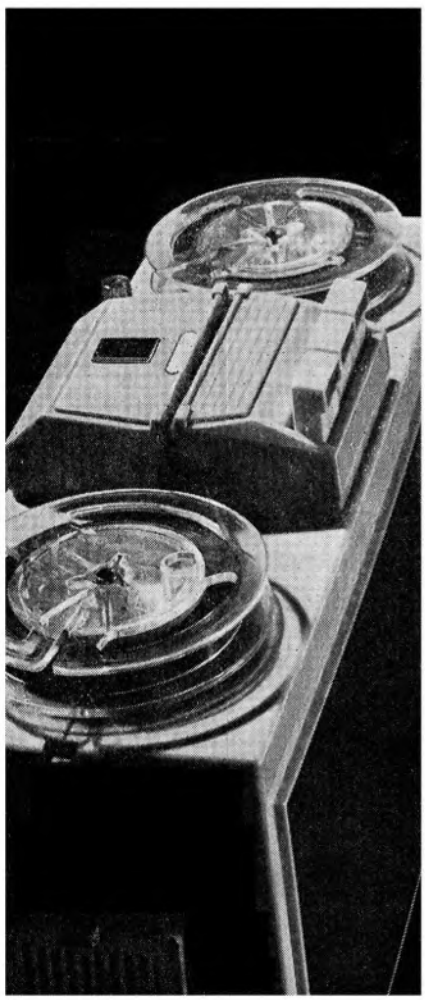

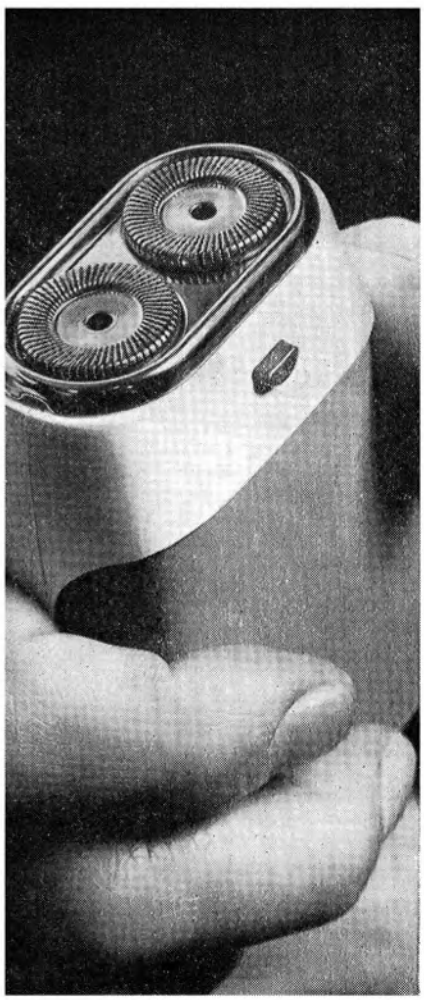

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WORLD OF TAPE

TAPE CONTEST JUDGING

ENTRIES for the tenth *British Amateur Tape Recording Contest* were judged on September 15th, at Mullard House in London. The judges (shown in the picture below, left-to-right front then left-to-right second row) were Douglas Brown, Donald Aldous, Timothy Eckersley, John Crabbe, Alan Freeman, Eric Robinson and John Gilbert. Behind Mr. Freeman is John Bradley, the Contest's Hon. Secretary, with observing visitors and committee members at the rear, Chairman C. Rex-Hassan at back-left, and Mullard technicians—operating the replay equipment—visible through the control room window.

Members of the BATRC committee had already 'vetted' the entries, leaving the judges some sixteen tapes from which to pick winners and runners up in the three main categories, and also the 'tape of the year'.

In the 'novices' section the first prize (Scotch Trophy, £10 and £15-worth of tape, from the 3M Co.) went to K. McKenzie of Sunderland for *Grandfather's Chronoclasm*, a one-man integration of various musical strands. Second prize (Agfa Cup and £10-worth of tape) was awarded to C. Blair, also of Sunderland for *Dreams of Northumbria*, a 'folk song' type arrangement of verses sung by a girl against a small instrumental background. Third prize in this section (Acos Cup) went to E. Fitzgerald of Hawick for *Trains*, a stereo recording of various railway sounds.

Of the 'advanced amateurs', P. Griffin of High Wycombe was placed first (Philips Shield, £10 and £15-worth of tape) for *Breeze and I*, another one-man-several-instruments musical effort. Next came J. Shuttleworth—of *Stereo International* fame—with *Negro Spirituals* for second prize (Kodak Shield and £10-worth of tape); this was a straight stereo recording of extremely high technical quality. Third in this group was W. P. Copinger of Kilmarnock with *Saraband and Finale* (Irish Trophy, from Elstone), a stereo recording of some music by Corelli played by an amateur string group.

Recordings from 'groups' were led by the Oxford University T.R. Society with *The Making of a Mass* (first prize: Amphlett Shield from FBTRC, £10 and £15-worth of tape). This again was in stereo, being an attempt to catch some of the atmosphere of a live recording session of choral music by John Taverner. Next came *Tutti* from the South Devon T.R. Club (BASF Shield and £10-worth of tape), a stereophonic presentation of *Baa Baa Black Sheep* with trumpet fanfares and organ—perhaps taking off Dohnanyi's similar musical semi-joke. Third group was St. Peters R.C. Secondary School of Aberdeen (Mastertape Trophy), who offered *The Bus Run*, a children's adventure in a cellar.

Tape of the Year was judged to be *Excerpt from Macbeth* by A. Brown of Mitcham, who will receive the Emitape Challenge Cup and a prize of £100. Originally first in the 'advanced amateurs' section, but promoted to pre-eminence after all the tapes had been heard, this Shakesperian episode was compiled by Mr. Brown with the assistance of his own voice in various guises and sundry sound-effects. The voice effects for witches and others were cunningly contrived by use of non-standard capstans for speeds, without using the more normal extremity of doubled tape velocity. The general effect was very entertaining.

In addition to the various awards mentioned above, the Tape of the Year winner and winners of first prizes in the three sections will be given a free trip to London to collect their prizes at a special ceremony on November 4th.

VAN DER MOLEN VR7

NOTING our use of the term "upward facing speaker" in last month's *New Products* description of the *VR7* tape recorder, *Van Der Molen* have pointed out to us that their machine is designed specifically for vertical use and will not function effectively with the deck in a horizontal position. They add that the recorder features a unique balance mechanism to permit wear-free and wow-free operation when used vertically.

BATTING TO MUSIC?

THERE is no truth in the rumour, which we are trying to start, that David Holford (left) spent quiet moments during his test match century listening to *Musicassettes* on a *Philips EL3301* portable tape recorder. No, the cricketer is, in fact, being interviewed by another member of the West Indies Team, Peter Lashley, for his feelings on scoring 100 runs. The three musicassettes in the foreground provided background music for the tourists between games.

CHEAPER DRY-SPLICING

LENNARD Developments are now marketing their Dry-Splice tape editing accessory at a reduced price. Packets of 24 splices now retail at 3s. 9d., the original price having been 4s. 11d.

AUDIO DIARY '67

PROMPTED by the success of the 1966 *Audio Diary*, a second, slightly larger, version has been produced for 1967. An extra eight pages of audio data, improved presentation and printing, tear-off page corners and a coloured London Underground map are featured in the diary, which is now available at 7s. 6d. including postage from **Link House Publications Ltd., Dingwall Avenue, Croydon, Surrey.**

A veritable bookshelf of audio facts and figures has been condensed into 64 pages preceding the diary section, including data on track dimensions, tape equalisation curves, a spool-size/tape length/playing time table, FM aerial construction, impedance matching and equipment interconnection, loudspeaker cross-overs, bass horn design data and common circuit symbols.

NEXT MONTH

TO BE PUBLISHED on Saturday, 15th October, the November issue of *Tape Recorder* will contain the first of a short series of articles entitled *No Need to Think*. Under this heading, William Henry is to describe techniques of automatic recording gain control. A. D. Marsh will describe a professional studio installation built around a *Robinson Studio Mixer* and Alec Tutchings will review the *Tandberg Series 8*.

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B & O—the quality angle in pickups

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DP0225

A MICROPHONE BOOSTER

BY R. F. SPRIGGS

A simple high to low impedance matching circuit

MOST enthusiasts will no doubt be occupied at the moment with the job of playing back their recordings made during the summer months and editing them into some sort of order. Last year whilst I was engaged in this work I became aware that on some recordings, particularly of bird-song, it would have been advantageous to have had a higher sensitivity on the microphone channel of my portable recorder. The obvious answer was to use a microphone preamplifier of some sort, so I set to work building various devices. After many different circuits had been tried I decided that the main trouble was the noise which every circuit giving the required gain introduced, thus defeating the purpose of the unit.

DIFFERENT APPROACH

A different approach to the problem was then made. The microphones which I use with my portable recorder are of the continental variety, with both high and low impedance connections appearing at a DIN plug. The battery recorder has a low impedance input of 2K and did not use the transformer in the microphone. The output voltage of the microphone at the high impedance connection is greater than that at the low impedance connection, in proportion to the turns ratio of the transformer built into the microphone. If this higher voltage could be used instead of the voltage at the low impedance connection, there would be no need to provide any extra gain in the tape recorder. The high impedance connection on this type of microphone is almost always 50K. All that is needed is a simple emitter-follower circuit to raise the input impedance of the recorder to this level.

MULTIPLYING THE GAIN

The input impedance of an emitter-follower is found by multiplying the gain of the transistor by the emitter resistance. In the final circuit, shown in **fig. 1**, the emitter resistance consists of a 10K in parallel with the input impedance of the following recorder ; in my case the latter is 2K. This works out at 1.7K. The transistor specified has a gain of at least 40 times, so the input impedance of the emitter-follower will be in the region of 70K, which is quite adequate for our purpose. As the extra gain is not always required, the on-off switch is arranged to connect the microphone normally when the unit is switched off.

The unit is built in an *Eddystone* die-cast box *Type 896*. This provides a substantial case for the unit, with space for the battery as well as completely screening the assembly The holes in the box should be drilled first as shown in **fig. 2.** The holes for the switch should be cut using the actual switch as a pattern, as different makes vary in size considerably. The components can be mounted on a piece of group board before being bolted into the case A spacer such as a nut will be needed behind the board to prevent the contacts on the board touching the metal case.

The circuit is so simple that no difficulty should be experienced in wiring it up When the wiring is completed a piece of foam rubber can be stuck on the inside of the lid to hold the battery in place A short length of cotton can be tied round the output lead and some convenient point to take the strain off the output connections should the lead be pulled.

The unit can then be tested by connecting it to the recorder and a microphone. With the unit switched off the recorder should function as normal. When switched on an increase in sensitivity will be apparent if all is well.

(*continued on page 413*)

FIG. 1

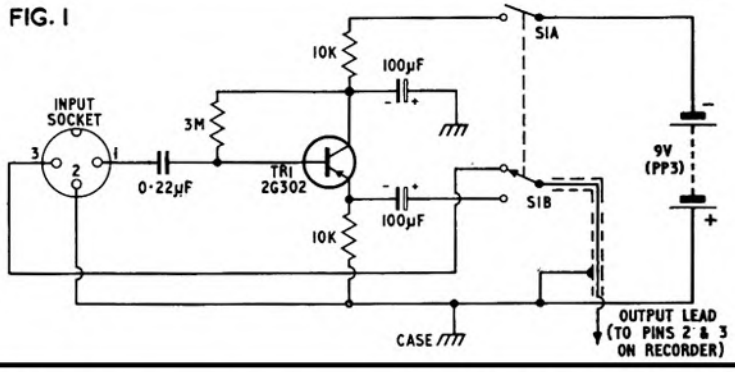
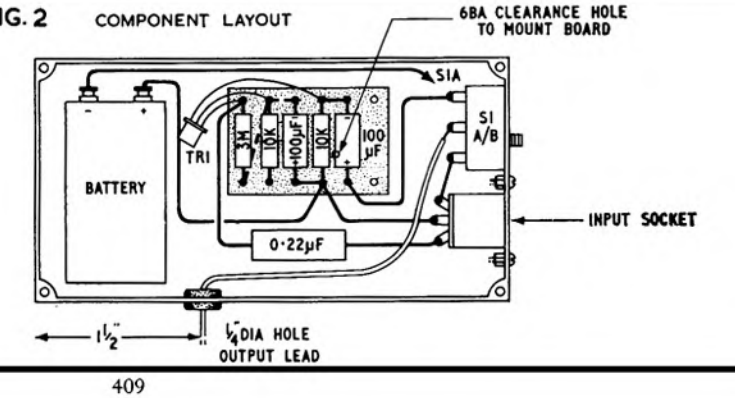


FIG. 2 COMPONENT LAYOUT



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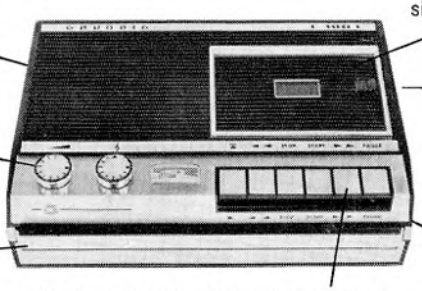

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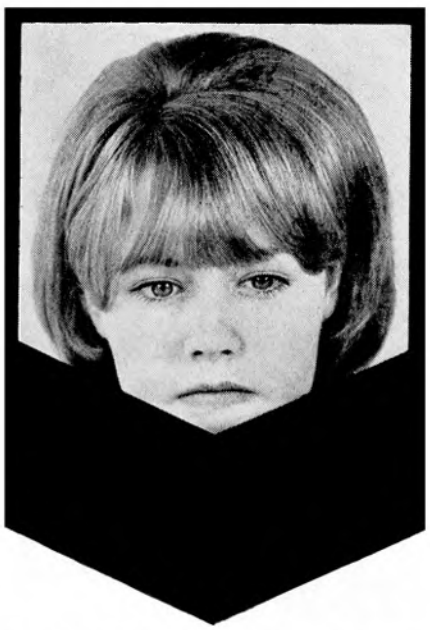

SOUND AND CINE

SCREEN TESTS AND REHEARSALS

BY ANTHONY WIGENS

WHILE the search goes on for the male lead to act in my film, I have screen-tested the leading lady. When I played back the tape I was satisfied she is right for the part—which is a load off my mind.

With post-synchronising it is always feasible to have one person act the part and someone else dub their voice. Now I have this consoling thought in case the boy in the film just cannot speak lines convincingly—but if the wild recordings, made on location, are possibly to be edited into sync with the film I must either use the natural voices of both actors, or use studio sound and dub both. You cannot mix natural and studio sound like that, and anyway it would have to be a tape-editing job. So I am hoping to find an all-talking, all-acting lad for the film.

The title is *The Country Lovers*, a nicely ambiguous phrase to describe the story of a boy-and-girl who are vandals—but the sarcasm may be lost on my audiences! Certainly Kay thought its meaning would be quite unambiguous to her parents, and declined to show mother the plastic bound script I had given her to study.

Study is perhaps not quite the right word. Deliberately, I handed her the script on the day of the screen test. I wanted her to read it, but not to become so familiar with it that early mistakes became stuck and difficult to correct.

There are only two characters in the story, for a script reading or rehearsal of any part of it. In the absence of a boy to test, and bearing in mind that Kay had virtually no acting experience, I decided to tackle the boy's part myself, in private!

"If I make a complete fool of myself," says I "at least nobody but us is going to know about it!" I think the decision reassured her, too. So we took a script apiece and retired to a seat at the bottom of the garden with my *Philips* battery portable.

We had been there less than ten minutes when the thick pall of pollen that hung on the air precipitated a violent attack of my hay fever, and between sneezes I made a mental note to take anti-hystamine before location recording sessions!

There is a two-page passage in the script of straightforward dialogue, which carries the narrative forward logically. Later in the script some sound effects and silent visual passages are necessary to convey the full sense; we therefore ignored this latter section and worked on the beginning. Our first stab at it was simply a read-through. We were both feeling our way into the roles. It went fine. I had some reservations about a few of Kay's lines, and thought the emphasis she gave on them was wrong, but I said nothing.

We read the passage through again, giving a little more character to the voices, beginning to act a little. Then we turned back to the beginning of the script again and I pushed the record button on the Philips.

The reading finished, I rewound the tape and played it back. It gave a good foretaste of what 'natural' recording is going to do to the soundtrack if we achieve it. The atmosphere of the spinney was tremendous. Bird song, of which I had not been conscious while we recorded, came piping through insistently. But the real kick I got from that first tape was the immediate realisation that Kay's voice was just right for the part. While we had been reading, sitting there woodenly without any actions to match the dialogue, it sounded rather artificial. But hearing the playback, half closing my eyes and visualising related action projected on a screen, it sounded real—even if there was room for improvement.

I did not re-wind after the playback. I thought it might be encouraging to keep some early rehearsal tapes for comparison, providing we improved as we went along. So we read the passage again, after I had told Kay to intensify her efforts a bit, and give it some realism. To encourage her I started to read more loudly, instead of talking quietly. Ours is a big garden and the spinney at the bottom of the hill proved a good sound-absorbing amphitheatre for us. Kay responded well, and the mood was good. I promised I would start to be ultra-critical of her performance now that we were getting warmed up, and this second tape came in for a keen appraisal.

The main point I made was that a mood of anger, which is established early in the film, was dissipated too soon, and conversation between the two became mundane instead of being spiky and aggressive as the theme demanded.

When we made the third recording, we had begun to enjoy ourselves. Working in privacy had been a good ruse, particularly as we were in the same boat when it came to acting experience. Like fellow conspirators, we had each acquired boldness from the other. Our third effort was excellent, and I felt greatly encouraged.

Now we moved indoors where I had the mains recorder (*Philips EL3534*) set up, together with lights, tripod and movie camera, for the screen test proper.

The room was fairly small and I had a tight shot of Kay's head in the viewfinder, even at the wide-angle end of the zoom. Inevitably she had to move her head as she looked down at the script, and then looked up again to say her lines, and I found I had to keep my eye to the viewfinder to follow her. This made it difficult for me to say *my* lines, although having written them I suppose I should have memorised them by then! However, I managed to split time three ways and look at my script, declaim lines, and squint through the viewfinder in turn. I made one tape of Kay and myself first of all, then had her run through her part once again while I filmed her.

Fortunately I had checked the camera before the session. My usual movie camera, an old *Eumig* electric, had daylight film stock in it. The *Ilford Elmo 8 CZ* had *Kodachrome II Type A*, and was therefore the logical choice for this indoor, tungsten-lit, screen test. But when I pressed the battery check button, nothing happened. And when I turned the control to single shot (to avoid possible film waste) again there was no response on operation. I found the battery container awash with acid, and corrosion just setting in around the terminals. I had the leaky batteries out and the container sluiced out with water in a few minutes, and luckily I had a spare set of batteries with which to equip the camera. But the lesson is a valid one: check equipment beforehand. (*And use leakproof batteries*—Ed.)

The 8 CZ was the original choice of camera for this film, but now I am not so sure. For months I have had a *Delrama* wide screen attachment on order. The *Widescreen Association* have really given a big boost to *Cinema-Scope* style filming, and having seen a demonstration I thought *The Country Lovers* with its countryside backgrounds and big fire climax would look good on the wide screen.

But Delramas, the cheapest of the 2:1 'squeeze' adaptors, are in short supply and not being made any more. I was expecting my cheque back rather than the lens, when to my glee it arrived. The slight snag is that it can't be used with a zoom lens. So I shall test it on the Eumig, and decide from the results which camera and screen size to adopt for the film.

Playing through the tapes of the screen test alone, later on, I was pleased to find that all the dialogue had been easy to say. Further on in the script there is a long speech for the boy, that in contrast seems unrealistic, and probably just about unspeakable. This will need to be re-written. Of the section we tackled, only two words proved a problem. They were "thank you". The girl says them sarcastically, after the boy says "you're not bad looking", and I wrote them confidently, feeling that with a heavy emphasis on the second word the sarcasm could be stressed easily.

But Kay seemed to find it impossible to give this emphasis without a corresponding emphasis to the word "thank", and after she

(*continued on page 413*)

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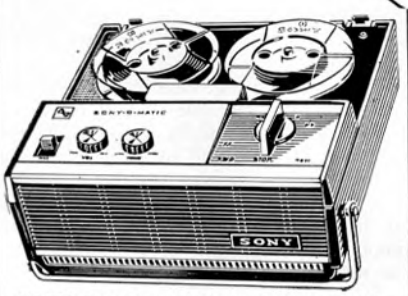

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I kept away from the crowds in my search for a subject.

For only then could the soft sounds of nature thrust through my limited dynamic range.

summer in the country

A DISTORTED RECORD BY ANSCOMB

Interference from nearby traffic upset a tight recording schedule.

And, try as I might, not to upset the locals . . .

A MICROPHONE BOOSTER CONTINUED

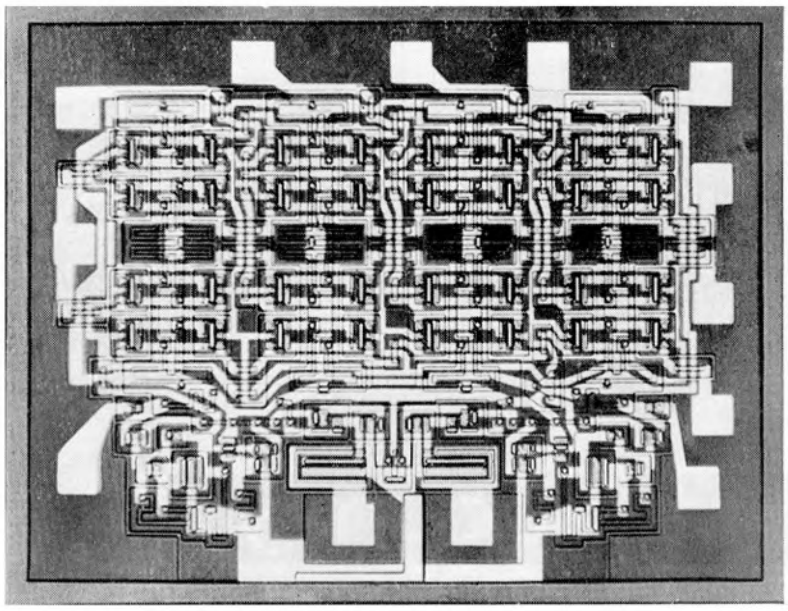
The increase in output voltage available is equal to the turns ratio of the microphone transformer. With low and high impedances of 200 ohms and 50K respectively, the turns ratio is just over 15:1 (square root of the impedance ratio). This means that by using the high impedance connection we obtain 15 times the voltage at the low impedance connection. Before someone writes in to say that we have had something for nothing, I should add that the current at the high impedance connection will only be one fifteenth of that at the low impedance connection. We are only interested in a voltage to drive the recorder. By consulting the *Audio Diary* we find that a voltage change of fifteen times is equal to about 24dB. As an emitter-follower has a gain of less than one, the actual gain will be about 20dB. If the specified transistor (*Texas 2G302* or *Mullard AC107*) is used, no trouble will be experienced with noise.

Many makes of microphone use this type of connection, including those by *Telefunken*, *Grundig*, *Philips*, *A.K.G.* and *Beyer*. It must be emphasised that only recorders which have a low input impedance can be used with this unit. If you have such a recorder but not one of the microphones mentioned, a high impedance microphone can be used through the unit but it will not be possible to switch over when the unit is switched off. The unit has been in use for about six months and has enabled me to obtain recordings that would not previously have been feasible.

The most difficult part of this exercise has been trying to decide what to call the article. By calling it a microphone booster I am running the risk of having thousands of irate readers writing in to tell me that an emitter-follower has no gain so it is impossible to boost a signal with it ; but if I call the article "An impedance matching unit enabling a high impedance microphone to be used with a low input impedance recorder" no one would bother to read the article let alone build the thing . . .

SOUND AND CINE CONTINUED

had tried several times I found that I could no longer 'hear' the correct pronounciation in my mind's ear, as it were. Like a word which becomes a jumble of letters when you stare at it overlong, I could make no rational judgement about our "thank *you*", and my own attempts to say it as I wanted Kay to say it proved feeble and unconvincing to my ears and presumably to hers too! We left it, rather unsatisfactorily, that we would both keep our ears attuned to this use of "thank you" with heavy sarcasm, and make a mental note of the way it is stressed. Already this seems nonsensical, and no doubt once the obsession with the phrase has subsided, it will come sidling back into my mind, quite simply and unequivocally, pronounced "thank-*you*" just the way you know it should be. Try saying it to yourself Is that right? Say it again Already you are not quite sure . . . The most trivial problems in sound filming can look enormous!



BY RICHARD NOBLE

MAGNETIC MEMORY

AN INTRODUCTION TO THE USE OF MAGNETIC TAPE IN DATA PROCESSING

DATA processing is a rather impressive sounding expression, and computers are generally presented to the public in such a way as to achieve maximum astonishment at their miraculous powers. Now, without wishing to detract in any way from the brilliant and often original work of the designers of these machines I must try to take away some of the magic and make the essential operation of data processing easy to understand. For without this the whole business of data recording on magnetic tape will seem pointless and obscure. In any case, as a seven day wonder, the computer's days are numbered, for there is a new generation of machines being born in the laboratories now with altogether more startling and miraculous powers. These are the infants from which will grow the true thinking robots, beside which the current computers' powers will pale into insignificance. And some of these machines (the early ones at least) will be using magnetic recording techniques hitherto undreamt of.

But to return to the present, let us look at data processing in terms of a simple but well-known analogy. This is the chain of events which the average businessman sets in motion when he wishes to write a letter. It can introduce and give meaning to all the words used in data processing. Although it may be a fancy name, sending a letter to someone is a form of data communication and, in business, the operations which precede it are undoubtably data processing.

First of all, the businessman, having set his thoughts in order, will dictate his letter into a dictation machine. Here we introduce the first word—*coding*. His thoughts (the data to be communicated in this case) are abstract things and cannot be grasped and given to another person. So in the absence of the ideal communication channel of telepathy, they must be 'coded' into a more tangible form of transmission. The first step in the coding is a series of hoots, honks, buzzes and clicks known as speech. And make no mistake, it is a code : if the businessman in question is a native of Tibet, it is pretty improbable that you or I will break his code very easily. Which brings us to the next important point, that there is no unique method of coding information ; there are in fact an infinite variety of ways of doing it and I suspect that we have barely scratched the surface in this field. But if this is borne in mind later, the codes used to process information by electronic machines need not seem so very strange. It is all a matter of which code is convenient.

The next stage in our chain consists of the same information coded into a series of magnetisation directions in the coating of a reel of magnetic tape. This is the first time information is in a tangible form ; it can be picked up and carried away. In fact it will be.

Now let us complicate the story a little by supposing that the office typewriter has broken down and that the secretary is going to type the letter on her portable at home, but unfortunately she cannot take the dictation machine with her. So she promptly sits down and replays the tape, making the data revert back to the 'speech code' and while listening to it, she codes it into yet another form known as the 'shorthand code', once more tangible and transportable. Having taken it home she converts it into what may be its final form, a written code of words and characters. Here is another point to analyse : most thoughts are represented by characters strung together to make words, the words being put together in groups which can be used to represent the information content of the thoughts. But do not restrict the idea of characters to the printed symbols you see on the page ; the other forms of code have their characters too. In the 'speech code', they are usually called syllables, and the 'shorthand code' has its own symbols to represent these syllables. And if you think that the 'tape code' still lacks a character structure, you obviously have never played that amusing game of editing syllables out of a pompous speech with a pair of scissors.

The last stages in our data processing are called *error detection* and *error correction* and they are performed next morning by the secretary and her boss, before the final coded version is put in Her Majesty's mail. When the letter is finally received, it is read and the information is transferred to another man's thoughts. This is a long-winded and complicated process when looked at in this light, but it does not seem strange, because it is familiar. What the computers do is often no more complicated—only unfamiliar.

There is one other factor, underlying all the processes described so far, which is of very great importance, but is usually taken for granted. This is the fact that various forms which the message takes in its travels all contain more than just the bare statement quoted once ; if you like they contain the message quoted many times. *To und-rst-nd h-w this work- j-st studi thi- s-entense.* I will say that again. *To undrastand -ow this werks just st-dy this centense.* It has been badly mutilated twice, but I think most English-speaking people would agree that it remains intelligible. This illustrates two things, the first being that a badly mutilated data recording does not of necessity lead to any error in the information recorded ; the second is that the secret of success lies in the fact that the coded form contains the really basic message in many different disguises, any one of which is good enough to guarantee correct interpretation. The computer engineer has a name for this effect too and this is another word for our new vocabulary ; he calls it *redundancy* for the fairly obvious reason that it works by virtue of the use of superfluous or redundant characters. The point about the English-speaking people should not be taken too lightly either ; a foreigner might not easily understand the mutilated sentences quoted above for the simple reason that he is not familiar with the redundancies or redundant code of the English language. This suggests that redundancy is not of itself sufficient for successful data recording ; we must also make use of some kind

MAGNETIC MEMORY

AN INTRODUCTION TO THE USE OF MAGNETIC TAPE IN DATA PROCESSING

of reading mechanism that can take advantage of the redundancy, something that 'knows the code'.

The idea of data processing should not by now seem quite so formidable, and we can turn to see just how magnetic tape can be used in detail.

The first and most familiar method is what is called direct recording ; this is, in fact, exactly the same method as is used to record sound in the conventional audio recorder. High frequency bias is used and the only significant difference is that in data recording it is often necessary to record faithfully much higher frequencies than those required for sound reproduction. To make this possible, much higher tape speeds are used, sometimes as great as 150 inches per second and, more startling perhaps, the bias frequencies used can exceed 1Mc/s. This is not a frequency many people would associate with tape recording, for it lies somewhere in the middle of the medium waveband on the average radio set.

The direct recording technique can be used to record, and store for future reference, waveforms as diverse as earthquake vibrations in the ground, shock waveforms from explosive charges, and turbulence frequencies in the water streaming past the hull of a ship. However, there is one major disadvantage from which it suffers, and that is amplitude inaccuracy. Errors of at least $\pm$ 10% can be expected and this is much too large for many applications. Another disadvantage is that it is not possible to record and replay very low frequencies and DC components using this method. However, when interest is centred mainly on frequencies rather than amplitudes, the accuracy is good, since frequency is only affected by wow and flutter and this can be held as low as 0.05% in a well-designed tape transport. The reason for this 200-to-1 difference in accuracy is a simple physical one : while it is difficult to control the exact thickness of a layer of paint being spread on a thin (and by no means uniform) sheet of plastic, it is relatively easy to make close tolerance capstans and flywheels rotate with very uniform speeds.

An important conclusion to be drawn from this is that 'codes' which represent information by the amplitude of a recorded signal are not very good, while those that do it by frequency can be literally hundreds of times better. This has led to the widespread use of a code called *frequency modulation* in which the amplitude of an incoming signal is represented by a frequency recorded on tape. Fortunately, the conversion of a fluctuating frequency signal to a varying amplitude signal is one that can be made fairly simple and very accurately, so this is a code conversion that is inherently good ; very little information is lost in the process. Since we care only about frequency, any amount of amplitude distortion can be tolerated on the replayed signal and no attempt is made to obtain a linear amplitude characteristic from the tape.

No high frequency bias is used and the signal is hammered as hard as possible on to the tape, so as to obtain as large a replay signal as possible. The tape is thoroughly over-recorded so as to saturate the magnetic material in alternate directions with the peaks of the recording signal. This is known as *salvation recording* and has the advantage of automatic erasing properties since the very powerful recording completely destroys any previous tape signals. Apart from the improved accuracy, frequency modulation overcomes the difficulty of recording low frequency and DC signals, since it is possible to vary a frequency very slowly or even hold it constant, which corresponds of course to fixed or slowly changing amplitude in the incoming information. To the hi-fi enthusiast the specification of an FM recorder must sound like a dream ; just imagine—a frequency response flat to within 0.1dB from DC to 20 K/cs, distortion below 0.5% and none of the modulation noise associated with biased recorders. There is only one snag : the tape speed would have to be around 60 i/s.

So now we have two ways of putting data on magnetic tape ; there are many others which fall into the so-called *analogue recording* class, but only one other deserves special mention at this point, largely because of the misunderstanding which seems to exist about it. This is the *pulse width modulation* system ; in this system, the incoming signal is made to alter the width of a pulse which is recorded on tape, the width being exactly proportioned to the incoming amplitude. This system has recently come into prominence because of the transistor pulse width modulation amplifiers which have become available.

At least one commercial kit has been sold for the construction of such devices, and a number of articles on the design of these amplifiers have suggested that a tape recorder can be interposed between the input and output of such a system and used to store the PWM signals directly. Although this is, in a sense, strictly true, it is very misleading and I am sure that any one who has tried has met with very disappointing results, if he has had any at all. The truth is that it works only if the tape speed is very high or, alternatively, if you only attempt to record very low frequencies at normal tape speeds. The difficulty arises out of the pulse width distortion introduced by the tape itself. If you try to record a very short pulse, what you end up with on tape is a much larger, round-shouldered one ; so if, say a 50 Kc/s variable width pulse is recorded on tape, all that is replayed (if anything at all) is a 50 Kc/s sine-wave. In other words, the variable width that went in has been completely eliminated from what comes out, and the output is what might be described as completely informationless. In fact all we have succeeded in producing is a very effective information filter. Such systems have been used, however, and if a 250 c/s pulse is modulated at up to about 25 c/s using a tape speed of about 15 i/s, reasonable results are obtained. The exercise seems rather pointless, however, in comparison with what can be obtained at lower speeds by other methods.

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BOOK REVIEWS

THE LAW AND YOUR TAPE RECORDER. By Andrew Phelan. 30 pages, 11 line illustrations. Price 3s. 6d. Published by *Print and Press Services Ltd.*, 7 Tudor Street, London, E.C.4.

THE aim of the author, who is a Barrister-at-Law, has been to compress into some 20 pages all the salient facts about the law in connection with a tape recorder which the average user needs to know—leaving aside the specialist in any particular field.

Clearly, copyright is one of the most important aspects, and also the most complex. The author makes it clear that, without permission, it is an infringement of copyright to put somebody's poem on tape, or to get hold of a tape of the poem and perform it in public.

The author also makes the point (which is fully appreciated) that, irrespective of the material used, copyright is conferred on every television and sound broadcast put out by the BBC and ITV, and that it vests in them. Permission must be obtained before making any record of a broadcast, other than for private purposes.

Following this, the book explains that permission is needed from the owners of the copyright in musical and literary material and also the permission of performers taking part in a broadcast. Gramophone records are covered by separate copyright.

It is perhaps a pity that, having given the problems facing anyone wishing to make a recording of, say, a gramophone record on a BBC programme (other than for private purposes), the author does not explain how one should set about obtaining the necessary permission. Although the introduction refers to the *Mechanical Copyright Protection Society Ltd.* (without giving its function, which is the control of the right to copy music), no mention is made of the *Performing Rights Society Ltd.* or *Phonographic Performances Ltd.* and the need to obtain permission from them so far as public performance is concerned. This is a pity, because the result is that the complete picture, for someone who knows nothing about copyright, or from whom it is necessary to obtain permission, is not given.

A point is made in connection with lectures to the effect that when a lecture is given to a limited audience, it is on the tacit understanding that, while the public can take the fullest note for personal use, they cannot utilise it afterwards for the purpose of publishing the lecture for profit.

There is a warning about defamation of character—to the effect that, although everybody may be happy about what is said at a particular gathering, they may not want it repeated elsewhere afterwards, so as to be made an object of ridicule to people whom they may not even know.

Other points mentioned in this booklet are the right of someone to privacy and the fact that even a microphone can cause trespass on somebody else's land without their permission. Mention, too, is made of the 1361 Justices of the Peace Act which created an offence called 'eavesdropping'. One chapter is devoted to the use of tape recording, as evidence, in court.

All in all, having read this booklet, one may feel that a tape recorder is a most dangerous weapon. But everybody should know what is involved—for it is no excuse to plead ignorance of the law. J.G.

PRACTICAL TAPE RECORDING by Percival J. Guy. 82 pages, 45 line illustrations. Price 7s. 6d. Published by *Norman Price (Publishers) Ltd.*, 150 Ossulston Street, London, N.W.1.

"THIS handbook," says the Acknowledgment on page 9, "is based in part upon a set of professional training discs entitled *An ABC of Radio Production*, prepared by the BBC Staff Training Department and Transcription Service for the staff of broadcasting organisations in Commonwealth countries". If it's good enough for them . . .! And Mr. Guy's book certainly is good enough for the beginner to learn from, or for the amateur wishing to brush up on forgotten facts.

What I like particularly about this book is its down-to-earth approach to subjects which might easily become dry if not treated with care. Basic acoustics, for example, are covered in a concise and interesting manner, with practical suggestions for treating a reverberant home studio. A tape indexing system, an electronic mixer, a spring reverberation unit made with two headphones and an electric fire element, even a rifle microphone, all are illustrated in sufficient detail for the enthusiastic constructor to work from. Stereo microphone technique is described in a short chapter while *musique concrete* and radiophonics receive similar treatment, together with an illustration of the Guy system for recording backwards, by lacing tape round the capstan in an S form, which has worked on none of the three-motor machines I have tried. Nevertheless, these absorbing parts of the recording activity receives far too little space in the average handbook.

Production of sound-effects, editing, copying, mixing, are all subjected to treatment at just the right level to embrace both non-technical and technically informed readers.

Practical Tape Recording is a natural complement to Mr. Guy's earlier book *How to Get the Best Out of Your Tape Recorder* and should prove just as popular.—D.K.

YOUR BOOK OF TAPE RECORDING. By Ken Peters. 92 pages, 33 line and 4 plate illustrations. Price 12s. 6d. Published by *Faber & Faber*, 24 Russell Square, London, W.C.1.

THE book is divided into an introduction and fourteen chapters, and takes the reader through a brief history of recording to using a modern domestic recorder, ending with a view of the future in tape recording and electronics. The book is aimed at the young recorder-owner with little or no experience of using a tape machine and is intended to show the reader the possibilities of recording as a creative hobby and the recorder as a useful piece of equipment in the home. The book must therefore be reviewed with the needs of the young owner in mind.

Broadly speaking, the chapters on the history of recording and on the tape recorder itself are interesting background material, although I must criticise the rather misleading diagrams on track systems and widths which suggest there is no difference in width between two- and four-track systems : this is not the first book to have this fault. There could also be some confusion, on first reading, with the next section on stereo.

The chapters on practical recording, editing, etc., seem reasonable, but I would rather the topics had been dealt with in greater detail instead of going on to more and more improbable uses of the tape recorder, tape games, etc., many of which do not seem to require a recorder at all. Mr. Peters suggests using the recorder for background effects for younger brothers' or sisters' games—I would be very surprised if any child took kindly to the intrusion of an adult or teenage brother into such games with an element such as the recorder that is beyond the control of their own imagination. The section on 'Making Music' is another which might well have been left out as having little to do with recording music that is of any value, though it does mention self-accompaniment.

The chapter on accessories is too superficial, as it gives little beyond a bare idea of some of the accessories available or that can be made. The one do-it-yourself item, a microphone stand, looks very unsafe ! There is also a chapter on turning a room into a studio, for the lucky few who have a large empty room in which to stick egg boxes on the walls, and whose parents are agreeable to enthusiastic amateur attempts at acoustic treatment.

The last two chapters should never have got past the publishers. The half-page entitled 'Millionaires Only' deals with upper-price domestic hi-fi equipment and domestic video recording in an uninformative few paragraphs. The final chapter, on possible future developments in recording and electronics, is a pure flight of fancy—or should one say nightmare ? I can see no point or grounds for any of the fantasies here, which make a very weak ending to the book and would put many people off right away if they looked at this chapter first and thought the rest of the book as ludicrous. There are some places in the book where schoolboy essay writers might well feel that they recognise the signs of 'padding'.

The price of the book is not high, it is attractively bound with a hard laminated cover, and it does contain some useful and interesting material for the young newcomer to recording ; some of it would not be read more than once, much of it rarely when the proud owner is familiar with his machine and with recording as a hobby ; but the book would probably be a useful addition to the machine's instruction booklet for a young person using a recorder for the first time, and before progressing to magazines concerned with recording.

Out of interest I loaned the book for a few days to a young friend who has not had his machine very long, to find out his reactions. On the whole he enjoyed the book and found some of it useful, but, as I suspected, was put off by the irrelevant sections that I have mentioned, and by the childish or 'talking down' tone of parts of the book. He would have liked the book with his recorder, but was doubtful whether he would buy it now. Fair comment, I think. J.H.F.

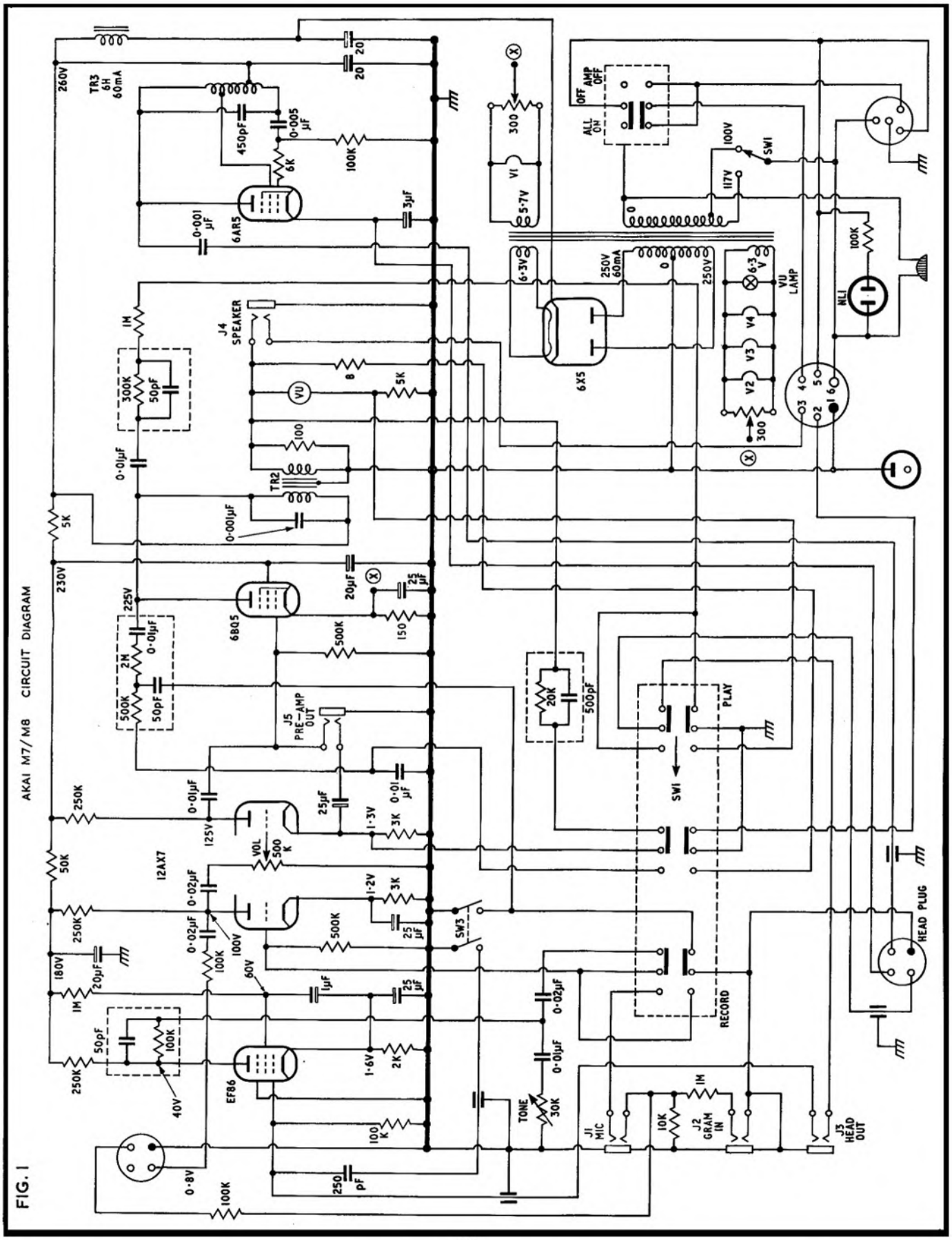
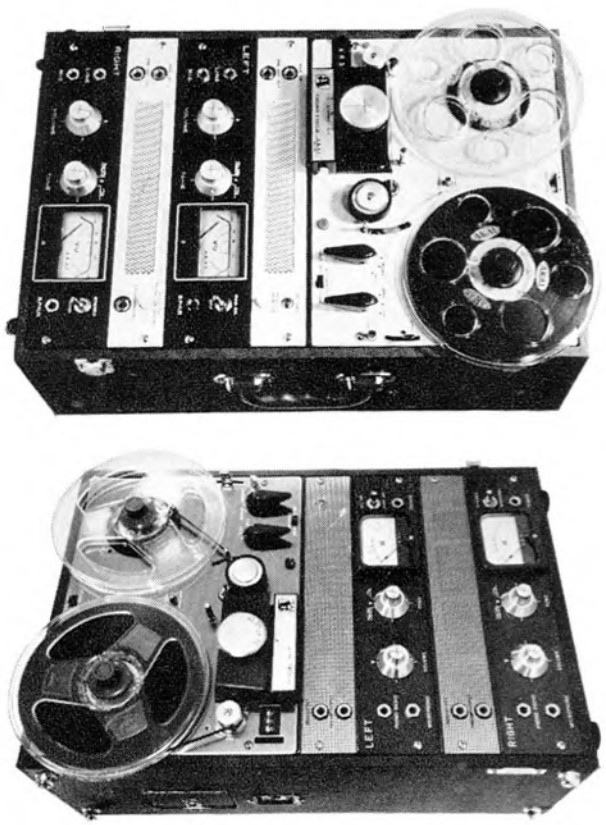


FIG. 1

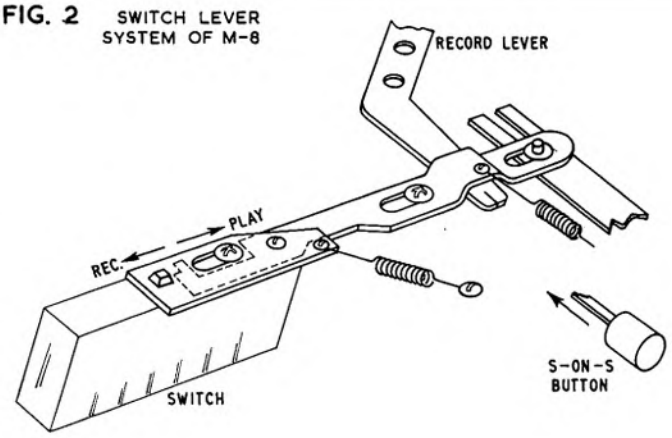
BY H. W. HELLYER

TAPE RECORDER service



NUMBER 59/AKAI M7 AND M8

FIG. 2 SWITCH LEVER SYSTEM OF M-8



THIS should have been an easy article to write—mainly because publication of the complete circuit of either of these stereo machines would have taken up all the available space. However, the Editor insists upon his pound of flesh, so the diagram shown on the adjoining page is a neat solution, suggested by a colleague who spent half-an-hour wondering why the plug-leads would not reach their matching sockets when re-assembling a similar machine. In other words, it is one complete channel of the *Akai M-7*, minus the selector switching and head-wiring.

The *M-8* is basically the same, except for some switching changes introduced to accommodate the two loudspeakers and the stereo playback. The major addition is a 'sound on sound' switch, which is simply a mechanical linkage that neutralises the movement of the record switch of the lower (right-hand) amplifier when the s.o.s. button is pressed. **Fig. 2** shows the method. The long lever from the deck actuates the record/play switch of both amplifiers, pressing the button to slide the switch against the pull of the spring. Normal position is at Play. When the s.o.s. button is pressed, the link lever pivots and the key at the end allows the switch of the right-hand amplifier to move.

Other differences include a loudspeaker isolation switch on the M-8, which inserts 30-ohm resistors across the output, in addition to the existing 8-ohm protection resistors that are fitted for both switching 'open' protection and to isolate the extension loudspeaker jacks. A stereo headphone jack also provides a monitoring facility, with 100-ohm resistors in each line of the three-pole outlet fitted to the M-8.

Another purely mechanical difference is the use of a brake band at the take-up spool in place of the rubber stop, although the same type of pivot arm is used. But some adjustment is now provided, and this is a modification worth making to avoid slight spillage, especially if a doubtful spool is used. The outer bracket of the brakeband has a slot which gives a small amount of variation in binding action. A final difference is the omission of the three-position on/off switch, which gave a deck-only facility on the M-7. Peter Turner please note !

There are a few features worthy of note in this circuit. Beginning at the front end . . . the three jacks are, J1—Microphone input, J2—pick-up input and J3—head output ; 1 mV from a fully modulated tape is available at this output. The preamp output, another jack socket just beneath the head output on the front panel, is actually an 800mV output at a rated 10K impedance at 1 Kc/s, with a switching 3-pole jack socket that allows the signal feed to be shunted when the plug is inserted.

(*continued on page 421*)

This is necessary, as the pre amp output comes after the volume control and the M-7 has no muting switch.

Note that the first stage has its own heater winding and hum-bucking resistor. Note also, as a further precaution against hum, that the tapping on each of the hum-bucking resistors is taken to the cathode of the output valve.

The next point to observe is that the tone control, although apparently a complicated feedback network, simply resolves to a modified top-cut type, slightly compensated for a flattened bass response, when the circuit is redrawn to omit the switching. Concentric with the tone control is the equalisation switch, which is shown on the circuit as SW3. This is open for $7\frac{1}{2}$ and $3\frac{3}{4}$ i/s and closed for $1\frac{7}{8}$ i/s. If the record/play switch is traced through, remembering that bottom left pin of the head plug is the record play head connection, we see that S3 comes into action mainly during record, when the feedback loop over V3 is modified and the 50pF capacitor is shunted to chassis from the middle of the unbalanced network, improving the response.

This brings us to the output stage, whence, rather strangely, the take-off point for the signal to the head is taken. Quite a heavy filter circuit is included in series with the head feed, not complicated by the need for a bias shunt, happily, when the crossfield system is employed. The recording level indicator is a VU-meter, actually registering output directly across the speaker circuit, with a series 5K resistor during play to prevent damping (and needle flicker), shorted during record.

Having mentioned cross-field bias—but without getting drawn into an argument about its merits balanced against cost—we had better say a few words about the way Akai apply their pet device. The technique is to energise a subsidiary head with the bias voltage, mechanically placing this third head against the back of the tape, opposite the recording head. Flux from the bias head is induced in the recording head winding and the interaction between direct and induced flux is said to cancel the flux leakage which ordinarily affects the high frequency response. You must have seen the advertisements !

In practice, there are a few factors to note. The head itself is faced with linen, thus acting as a pressure pad, and it is sprung against the back of the tape. When the record switch is neutralised, the head lifts away. The switch action puts a 3μF capacitor in the cathode of the oscillator ; the charge effect allows this stage to 'die away' gradually, and the decremental output partially demagnetises the recording head. The oscillator is common to both channels and again has the advantage with this system that no buffering is needed to prevent interaction, beating, or other undesirable effects that beset stereo designs. Although there is one small point about which I am not clear—what happens on the M-8 when sound on sound allows the right channel to revert to play ? Is not bias still picked up via the crossfield head with its common winding ? We know it is 65 Kc/s and strictly for the bats, but it will be interesting to note what effects we can get when using the system to record broadcast stereo, with its barely supersonic pilot tone. Any Akai owners in the Wrotham/Dover areas care to experiment ?

Before leaving the subject of bias, note that the correct recording bias for each head is stamped on the mounting bracket of the head assembly. It may be anywhere between 130 and 230V AC, measured with a good valve-voltmeter, and should be measured between the deck side of the trimmer (100pF variable, on the deck itself) and chassis. First, check that the erase head is receiving more than 170V bias, then adjust the trimmer for correct feed to the auxiliary head.

Much of the mechanical detail of the deck assembly was discussed, and some of it illustrated, in the two articles (*Akai 345* and

(*continued on page 432*)

READERS' PROBLEMS

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

AN IMPOSSIBLE SYMPTOM?

Dear Sir, I wonder if you could help me with a small problem. I own a *Brenell Mk. 4* recorder which refuses to create any sound other than occasional buzzes, these being heard only when the chassis is touched. I have checked various amplifier components and found them to be in order.

Running a tape through the machine results in a very low replay signal which has been traced to the *erase* head. The replay head and adjacent connections have been checked, but to no avail. I have been unable to obtain a service diagram for the Mk. 4 from Brenell and would greatly appreciate any help you can give.

Yours faithfully, **A.H., Torquay.**

The phenomenon you describe on your Brenell Mk. 4 might seem an impossible symptom, but can in fact occur when the oscillator coil is, as in this case, in series with the primary winding of the output transformer and the erase head shunt-fed, parallel-coupled.

The trouble could be practically anywhere between head and output stage, but the reference to 'buzzes' points to the input stage. On this model, by far the most likely cause is the grid switching of the EF86. There are several inputs, both switched and with safety shorting at the sockets, as you have probably noted. Later models use a 0.05μF coupling capacitor to the 10M grid load and this point should be checked. In any case, simple signal tracing provides a clue.

Although there is no circuit of the Mk. 4 available, circuits of both the Mk. 5 and Three-Star, which more-or-less bridged the gap, can be found in H. W. Hellyer's Tape Recorder Servicing Manual, published by George Newnes.

BIAS AND RESPONSE

Dear Sir, Could you please answer the following questions : (a) How do you obtain an overall record/replay response curve for a tape recorder ? (b) How do you determine the 'correct' bias for any combination and tape and recorder ?

Yours faithfully, **J.E.H., Ellesmere Port.**

First connect the signal generator to the line input of the recorder, using the voltmeter to monitor the input level, and record a series of spot frequencies, setting each test-tone to a constant input level. We suggest a 1 Kc/s reference frequency, followed by 10, 7.5, 5, 3 and 2 Kc/s, 500, 250, 120, 60 and 40 c/s. Input level should be set so that, with the recorder gain control set to about half way, the record level indicator is at about one quarter of full deflection, i.e., the test-tones should be well below peak recording level so that no overload occurs at high frequencies due to pre-emphasis.

Next, the machine should be set to playback, and the voltmeter connected to the line or loudspeaker output, whichever response is desired, with the levels of each tone noted with the gain control at a fixed setting.

If the voltmeter has a dB scale, then the 1 Kc/s reference tone should be set to 0dB and the other levels plotted relative to this reading. If not, the meter should be set to mid-scale and the output voltages noted for each tone. The ratios of these readings relative to the 1 Kc/s reference level can be converted into dB's by using a conversion table, or a graph such as that on pages 7 and 9 of the 1966 Audio Diary.

To find the optimum bias for a given tape, record a 500 c/s tone at a series of bias settings and select the one which gives maximum playback level. If the tape speed and equalisation are such that the bias can be increased to drop the output by 0.5 to 1dB, then this should be done in the interests of lowest distortion, intermodulation and best signal-to-noise ratio. On many domestic recorders, however, bias must be decreased to drop the output level by 0.5 to 1dB to obtain the specified frequency response at low tape speeds. If this reduction of bias is carried too far, there is a risk of dropout and HF intermodulation.

Finally, the oscilloscope should be used to examine the recorded 500 c/s tone at peak recording level, as indicated by the meter or magic eye. The waveform should be free of any visible distortion at this level. If the waveform is distorted with near-optimum bias, the record level indicator should be set to full deflection where the distortion just starts to become visible (about 5%). Do not neglect the possibility of record amplifier overload at high recording levels, also try another tape . many of the cheap tapes are manufacturer's rejects which will not accept full recording level due to low remanence or low sensitivity, which allows the record amplifier to overload before the tape is fully recorded.

(*continued on page 432*)

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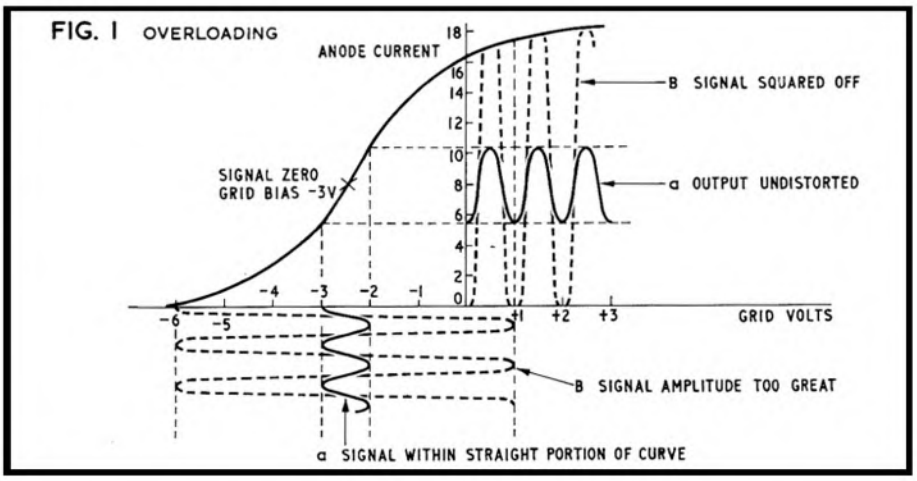
PART SEVEN

DISTORTION

C N G MATTHEWS



MAGNETIC SOUND RECORDING

WE have seen that it is possible to convert a wave into a series of magnets carried on a flexible tape, and we have briefly examined the process by which these magnets can be used to set up an alternating current which eventually may be used to reproduce the original sound-wave at any desired amplitude within the range of the equipment. Your own tape recorder may provide you with evidence that both recording and reproduction can be carried out to something approaching perfection (!). But the excellent performance of modern tape recorders is not achieved without a great deal of careful planning.

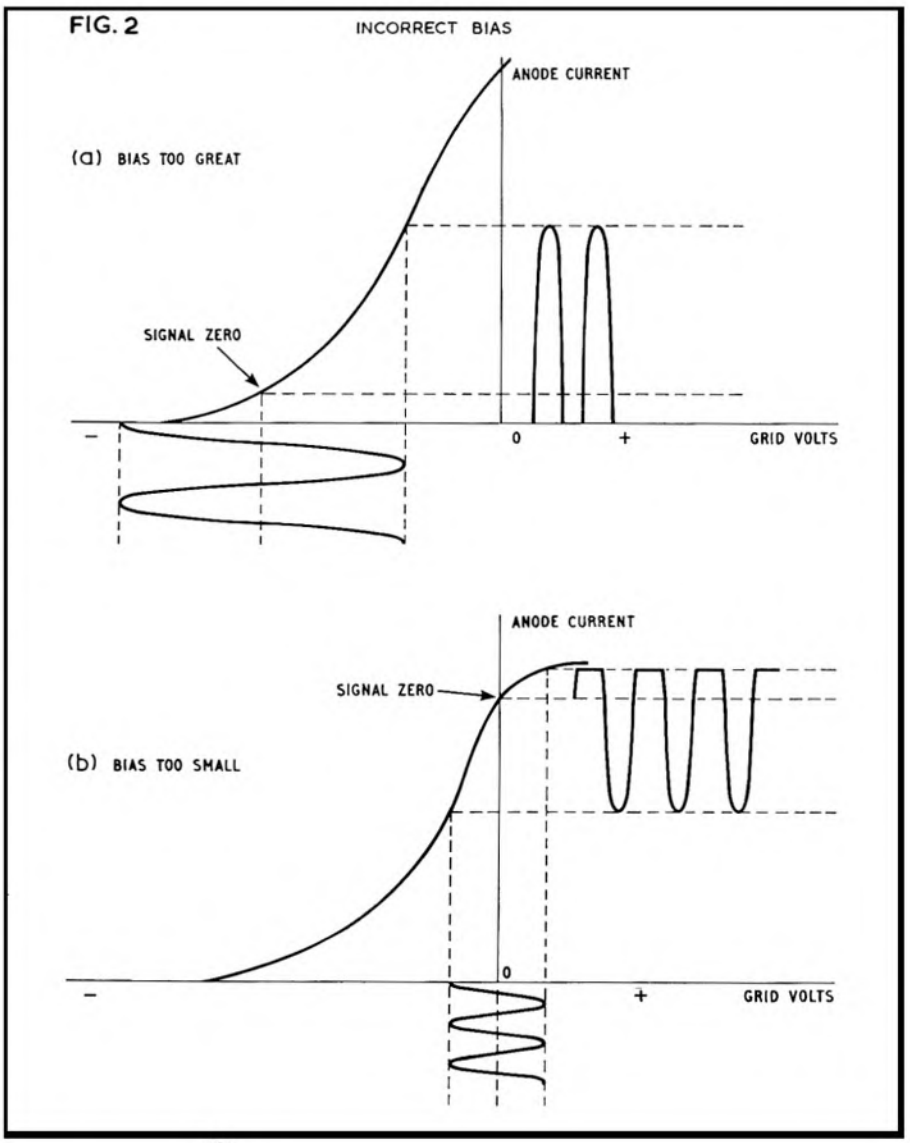
As we already know, the very nature of magnetic materials and electrical behaviour introduces variations in performance with both frequency and amplitude. The frequency variations, which are most serious, are cancelled out by incorporating equalising circuits into the amplifiers. But all the equalising circuits in the world will not prevent a loss of sound quality unless the actual *waveform* of the signal is passed on unchanged in shape from stage to stage of the recorder.

A change in waveform shape is called *distortion*. The greater the change, the greater the distortion and the more serious the loss in the sound quality. To reproduce even a single sine-wave without any distortion is difficult in the extreme, but in a tape recorder we are handling a constantly changing mixture of sine-waves of varying amplitudes and frequencies. Under these circumstances some distortion is inevitable, though in a modern recorder it is so slight that the most critical of listeners can find no real cause for complaint.

This month we will be considering the more common types of distortion. Usually, if we know what causes a fault in performance we know how to put it right.

If your recorder is in good working order, but distorts on some of the louder passages, the most probable cause is *overloading*. This merely means that you are trying to put more into the machine than it can handle. Look at **fig 1,** which is a curve showing the relationship

(*continued on page 425*)



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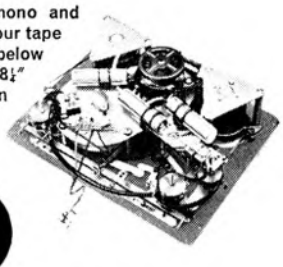

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between input voltage and output current of a valve amplifier.

The first thing to notice is that the curve is reasonably straight over a large part of its length. But at top and bottom it turns over to the horizontal. Note too that grid *voltage* is shown horizontally and anode current vertically. In normal valve amplifiers the input is applied to the grid and the output is taken from the anode. All we need to know about valves is that a small change in grid voltage produces a relatively large change in anode current. The corresponding change in voltage developed across a resistor connected in series with the anode is much greater than the change in grid voltage which produced it.

So if we apply a voltage sine-wave to the grid, it will appear amplified at the anode as shown by the *full* line. Provided we limit signal changes in grid voltage to the straight part of the curve, equal changes in grid voltage will produce proportionally equal changes in anode voltage and the waveform will be amplified without distortion. But suppose we increase the signal amplitude so that it extends on to the curved portions of the graph. Then the peaks of the signal will not be amplified as much as the centre part of the waveform. This, of course, means that the shape will be changed and distortion will be introduced as shown by the *dotted* line.

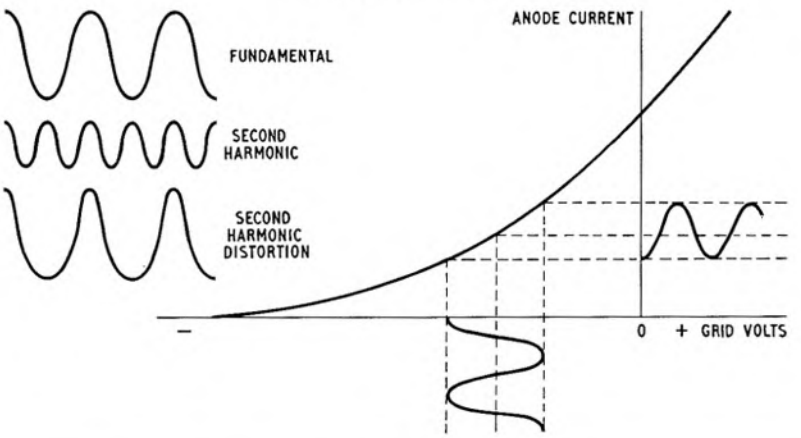
A similar form of distortion, which occurs only on half of the waveform, appears when the grid bias is not correct. You will observe that in **fig. 1** the sine-wave input swings about a fixed negative voltage, not about zero. This fixed voltage is the grid bias, which is added to the input to bring zero of the sine-wave on to the straight portion of the graph. If the grid bias is too high, signal zero will move down the curve. If it is too low, signal zero will move upwards. Either condition will introduce distortion which becomes more serious as the signal amplitude is increased. **Fig. 2(a)** and **2(b)** show the effect.

Transistors can introduce distortion for the same reasons, with a few additional complications of their own. Perhaps at a later date we can discuss remedies, but this article is not about servicing. However, if you are having marginal troubles with distortion on a machine you are servicing, you could do worse than pay very careful attention to bias levels.

Intermodulation is another form of distortion which can be caused by incorrect biasing. When two signals at different frequencies are fed into an amplifier which is not working on the straight part of its curve, the signals tend to produce two extra signals at their sum and difference frequencies. For example, if two notes at frequencies of 200 c/s and 300 c/s were fed into an amplifier, extra notes at frequencies of 100 c/s and 500 c/s would be produced. An amplifier in this condition would be liable to convert a musical chord into a mere jangle of noise.

Naturally, intermodulation is more serious at high signal amplitudes, because these drive the amplifier further into the curves of its characteristic. In fact, this type of distortion can be produced by overloading even when the amplifier is correctly biased.

FIG. 3 HARMONIC DISTORTION



Harmonic and amplitude distortion are two more forms of distortion which are produced by curvature of the amplifier characteristic. Even the 'straight' portions of most amplifier characteristics have a certain amount of curvature. The pentode valve is a particularly bad offender in this respect.

The result is that different parts of the input signal are amplified by different amounts. **Fig. 3** shows the effect. Here the characteristic has a progressively increasing slope which, although it does not 'square off negative half-cycles as shown in **fig. 2,** causes them to be amplified to a lesser extent than the positive half-cycles. The waveform produced is comparable to one made up from a fundamental and its second harmonic. Harmonics of other magnitudes are also generated by any amplifier with a curved input characteristic, but the second harmonic often tends to predominate.

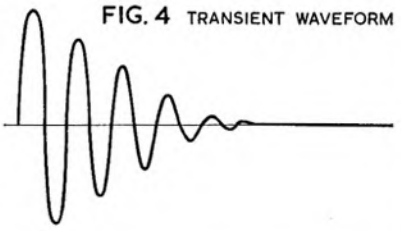
One of the advantages of using a push-pull pentode or beam-tetrode output stage is that it cancels-out the second harmonic distortion normally generated by a single valve of this type. Transistors handling large signals have roughly the same kind of input characteristic—for different physical reasons of course. So in good quality equipment we usually find transistors working in push-pull at the higher signal levels.

Any circuit which generates harmonic must also introduce amplitude distortion when it is handling a normal sound signal. This consists of a mixture of sine-waves at different amplitudes. Naturally the larger sine-waves will be amplified out of proportion and harmonic distortion will be introduced into the bargain.

The use of *negative feedback* is one means by which these and other forms of distortion are countered. Part of the output is fed back to the input in such a way that it tends to cut down the gain of the circuit. An increased output means that the feedback is increased so that the amplification is further reduced. Thus, any part of a signal which tends to be over-amplified automatically cuts down the amount by which it is amplified. Consequently, with negative feedback at the right level, any form of distortion caused by unequal amplification can be largely eliminated.

Frequency distortion has nothing to do with the curvature of valve or transistor characteristics It occurs when different frequencies are amplified by different amounts, partly because

FIG. 4 TRANSIENT WAVEFORM



of the tape head characteristics, partly because some of the components used in amplifiers behave differently when the frequency changes. This distortion, which is also known as attenuation distortion, is countered by equalization and negative feedback.

Now to *transient distortion*. **Fig. 4** shows a transient waveform. It starts at a high amplitude, then dies rapidly away to zero. Examples encountered in tape recording are the sounds of all percussion instruments, the piano, and many sound effects such as footsteps, closing doors, gunshots, etc. All of these are difficult to reproduce at really first-class quality. This is because the transient has both a mechanical and an electrical shock effect on the equipment. They can produce rattling at the onset of a loud note and sometimes prolong it beyond its original duration.

Transient distortion is perhaps the most difficult of all to combat. Nevertheless, it is to all intents eliminated from good modern tape recorders by a combination of negative feedback and damping. Damping is adding resistance to a circuit. By consuming the excess energy of the circuit, this helps to prevent it from prolonging itself unduly. Negative feedback reduces the amplification at high amplitudes, thus eliminating the shock effect at the start of a transient.

Wow and flutter are two kinds of distortion which have nothing at all to do with the electronics of the recorder. Both of them are caused by defects in the drive or tape transport mechanism.

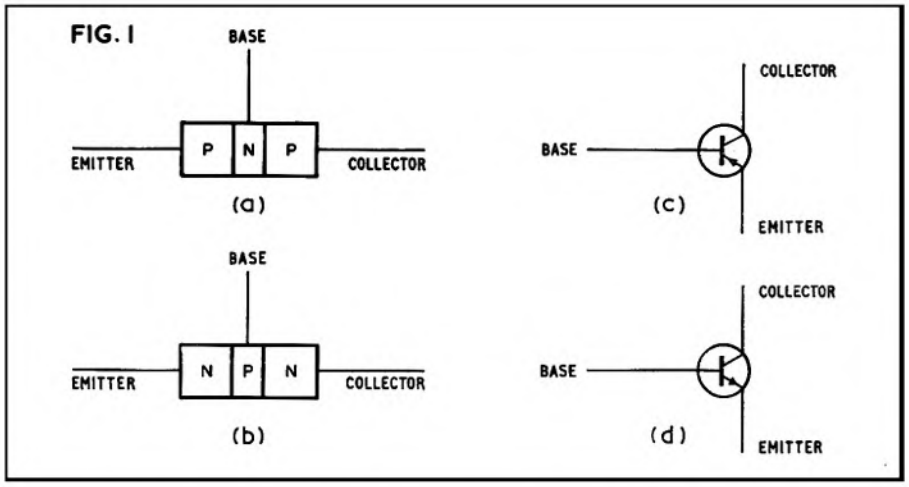
Wow is described exactly by its name. It is a variation in the pitch of sustained notes caused by slow changes in tape speed. Flutter is another name which fits the fault precisely.

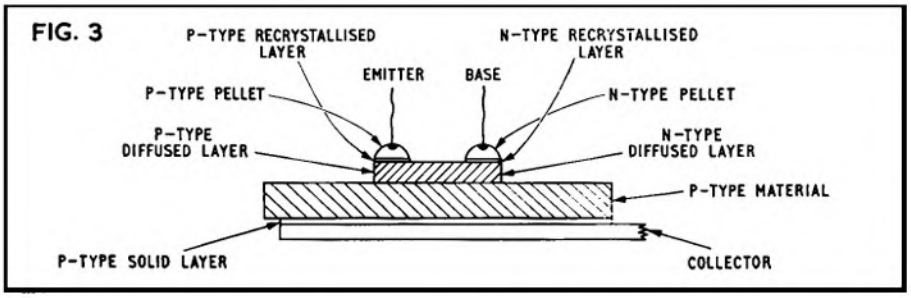
(continued on page 432)

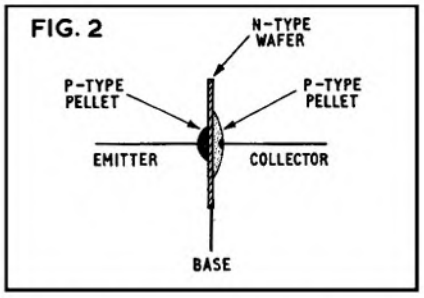
battery powered tape recorders

BY MICHAEL GORDON

PART 12 THE BIRTH OF A TRANSISTOR







LAST month we examined the semiconductor junction and discovered how it acts as a rectifier. Effects similar to those described also arise when the 'junction' is formed of a semiconductor and a metal, such as the metal of the cat's-whisker of the old-style crystal detector (used in early crystal sets) or of the 'point-contact diode'.

Diffusion, in fact, can occur between two metals in which the mobile electrons differ in make-up. Of course, the mobile carriers of a specially processed semiconductor differ substantially in type and quantity from those of an ordinary conductor. This, as we have seen, is how the non-linear or rectifier action takes place—i.e., diffusion of the carriers at the junction.

The ordinary transistor used in tape recorders, for instance, embodies two junctions, derived from three semiconducting materials so that one is common to both junctions. Basically, the three semiconductors are arranged to merge into the form of a sandwich, with the two outside layers sandwiching the inner layer, which is called the *base* electrode.

This conception is illustrated in **fig. 1**, where it is also seen that the two outside layers are called the *emitter* and *collector*. The base material is very thin in a practical transistor, and the basic design and scale of dimensions of the electrodes shown in **fig. 1** differ considerably from reality. Nevertheless, the sandwich conception helps to describe the workings of a transistor.

The two outer layers of semiconducting material are of the same type, but opposite to the type used for the inner or base layer. If the inner layer is made of *n*-type semiconductor and the two outside layers of *p*-type, the device is called a *p-n-p* transistor, for obvious reasons. Conversely, an *n-p-n* transistor is composed of an inner *p*-type material with the outers of *n*-type. Both *p-n-p* and *n-p-n* transistors are used in tape recorders, while the basic crystal is either germanium (mostly with *p-n-p* make-up) or silicon (many of these being of the *n-p-n* configuration).

Fig. 1 shows the sandwich conception of *p-n-p* and *n-p-n* transistors at (a) and (b) respectively, while the symbols at (c) and (d) correspond to *p-n-p* and *n-p-n* transistors. It is important to note that the only difference between the two symbols is the direction of the arrow on the emitter part of the symbol. This points towards the thick-line base for *p-n-p* and away from the base for *n-p-n*. The importance of this will be appreciated later when we deal with transistor circuits.

INSTRUCTIVE GLIMPSE

At this stage it will be instructive to have a glimpse at the manufacturing processes of some transistors so that we do not become too bogged down with the elementary 'sandwich' make-up. One of the latest techniques involves the use of 'alloy-junction' processing. With a *p-n-p* transistor, for instance, a very thin slice of crystal is processed with *n*-type additive, and on each side of this is placed a small pellet of *p*-type additive.

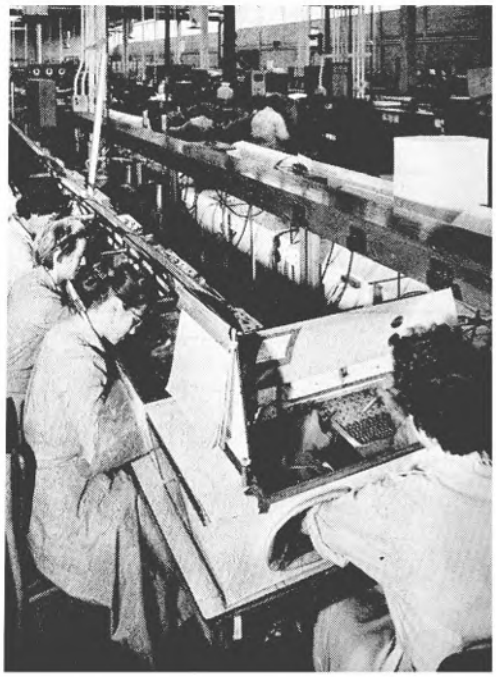
The process now involves encouraging the *p*-type pellets to melt and to dissolve some of the crystals from the *n*-type slice or wafer. This is accomplished by heating the assembly in a hydrogen atmosphere. After the *p*-type pellet to *n*-type wafer integration is completed, the heat is removed and the molten crystals commence to solidify and in so doing a *p*-type crystal forms on each side of the *n*-type wafer. The unions so achieved exhibit distinct regions of *p*-, *n*- and *p*-type effect throughout the assembly, with defined *p-n-p* junctions.

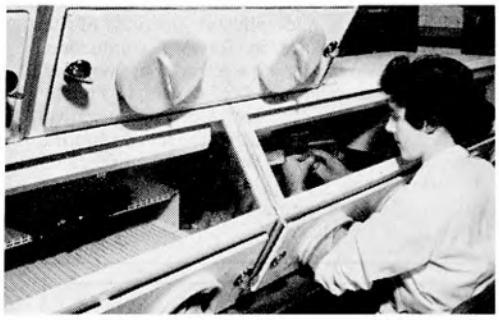
FINALLY SEALED

The wire lead-outs from the elements are soldered to the outside pellets and to the inner crystal wafer, while surface contamination is deleted by an etching process. After this, the electrodes are treated with a moistureproof grease and finally sealed into a metal or (the latest idea) a plastic housing.

It is necessary for the virgin crystal to be of a very high order of purity, and this is achieved by the drawing of an ingot of the material slowly through a tube round which is placed an RF heating coil. This melts the material in the region of the RF field and the impurities are effectively 'swept' to the end of the ingot, after which they are cut off.

The impurities remaining after this so-called *zone refining* process are less than one part in ten-thousand-million!





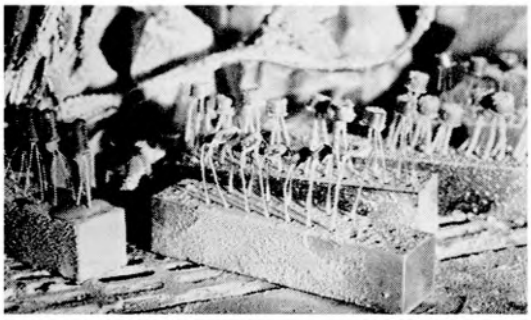


Fig. 4 (upper left): Germanium power transistor assembly line.

Fig. 5 (lower left): Preliminary transistor tests.

Fig. 6 (above): Audio transistor etching machine.

Fig. 7 (immediate left): Transistors undergoing low-temperature tests at *Mullard* factory.

The purified ingot is used to grow the crystals used by semiconductor devices by the insertion of a crystal 'seed' into it while it is retained in a molten state by RF heating. The seed then grows and takes on the same purified make-up as its parent ingot. **Fig. 2** shows a simple alloy-junction transistor in cross-section, but not to scale.

BASE WAFER

There are other manufacturing processes in current use, of course, and for transistors with a high switching rate, desirable for certain audio and VHF applications, the base wafer of the alloy-junction process is too thick. This slows down the current carrier transition and impairs the high-frequency performance.

This problem is resolved by the use of a so-called alloy-*diffused* process, resulting in the style of a transistor shown in **fig. 3.** The width of the base section is considerably reduced and the holes are caused to accelerate towards the collector by arranging for the base layer to be carefully graded in terms of *p*- and *n*-type additives in such a way that there results an accelerating or 'drift' field between the emitter and collector junctions.

The grading effect is achieved by the addition of both *p*- and *n*-type materials to the emitter pellet and then heating by RF current for a controlled period of time. This technique has the effect of reducing the time taken for the current carriers to move from the emitter to the collector when the transistor is in circuit, a factor highly necessary for good HF performance.

Fig. 4 shows a section of the automatic assembly line for the production of germanium power transistors at a *Mullard* factory, while the need for avoiding contamination is highlighted in **fig. 5,** which shows an operator performing preliminary tests on un-encapsulated transistors in sealed and dust-free 'boxes'. **Fig. 6** shows operators loading an audio transistor etching machine, while a group of finished transistors undergoing low-temperature environmental tests is shown in **fig. 7.**

So much, then, for the construction of transistors, now let us see how they work. Two fundamental features of a transistor are the two junctions, that between emitter and base called the *emitter junction* and that between the collector and base called the *collector junction.* These junctions operate in exactly the same manner as the diode junction considered last month.

FORWARD OR REVERSE

This means, then, that both the collector junction and the emitter junction can be biased either for forward or reverse conduction, relative to the common base. Most important however, is the polarity of biasing to achieve these conductions, since they differ between *n-p-n* and *p-n-p* transistors. This becomes extremely important when we consider transistors actually energised in circuit. Here incorrect polarity can impair the efficiency or completely ruin a transistor.

From the basic DC point of view, then, a transistor can be looked upon as a pair of junction diodes connected in series, as shown in **fig. 9.** In the real thing, of course, one electrode is common to both junctions—this being the base electrode. Actually, the *p-n-p* transistor symbol was derived from the symbol of a pair of series-connected diodes. **Fig. 1 (c),** for instance, shows the base as a thick line which is representative of the two connected cathodes in **fig. 8.** The emitter in **fig. 1 (c)** is arrowed the same as the anode of the left-hand diode in **fig. 8.** The collector part of the transistor symbol cannot be arrowed as well, of course, as then it would be impossible to distinguish between the emitter and collector. The collector in all transistor symbols, therefore, is not arrowed, but it can be assumed that from the DC aspect it is arrowed. That is, the *forward direction* of conventional current flow is from both collector and emitter into the base. If necessary, check with last month's article to see why this is so.

If **fig. 8** is representative of a *p-n-p* transistor, it follows that **fig. 9** is representative of an *n-p-n* transistor. Here the anodes of the two diodes are made common, meaning that in an *n-p-n* transistor the *forward direction* of conventional current flow is from the base into the collector and emitter. So far, so good.

Let it be clearly understood that while two series-connected diodes can be used to illustrate the DC aspects of the transistor junctions, such

(*continued overleaf*)

battery powered tape recorders

FIG. 8

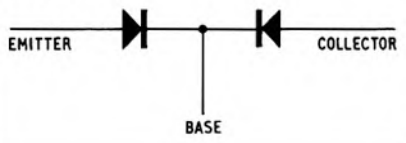


FIG. 9

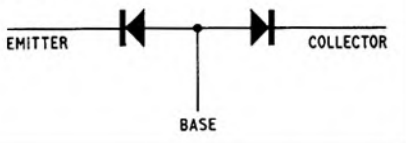


FIG. 10

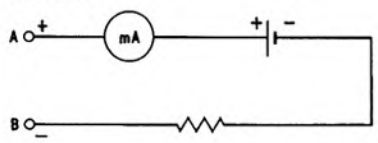
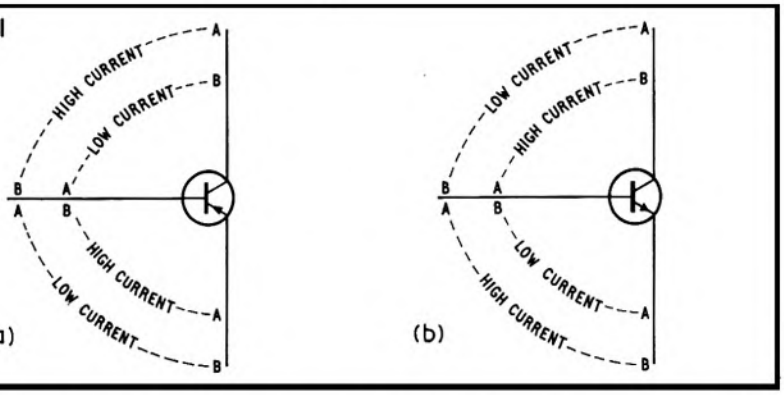


FIG. 11

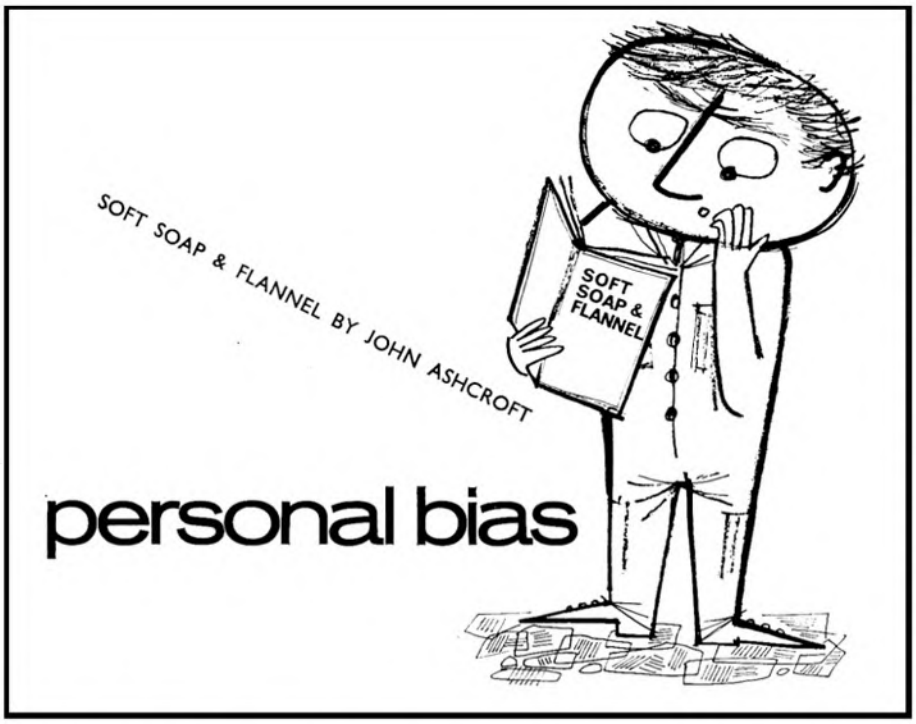


a partnership of diodes cannot ever create the transistor action, the reason for which we shall see later.

To conclude this article, let us study the transistor solely in terms of DC conduction across the junctions. Let us suppose that we have a milliammeter, a battery and series resistor arranged as shown in **fig. 10,** with the resistor value adjusted so that when leads A and B are connected together the milliammeter deflects to about full-scale (this, incidentally, represents the basic 'ohm-meter'). Note particularly that terminal A is positive with respect to terminal B owing to the way round the battery is connected.

Fig. 11 shows a *p-n-p* transistor at (a) and an *n-p-n* transistor at (b), upon which the current conditions between the emitter and collector junctions have been determined by connecting the circuit at **fig. 10.** A study of this will show that the emitter and collector junctions of the *p-n-p* transistor are in forward conduction when the corresponding electrodes are positive with respect to base and, of course, in reverse conduction when the electrodes are negative with respect to base, and that the reverse applies to the *n-p-n* transistor, as would be expected.

We are now getting very close to the transistor effect, but we must leave the study of this until next month.



UNLIKE Philip Radford, I know nowt about bird-recording. Actually, I know nowt about recording owt, but this column will continue until some spoilsport calls my bluff. Anyway, Mr. Radford's '*Hazards of Bird-Recording* the other month did remind me of my first serious attempt, which was quite memorable.

A feathered swarm was scavenging below my window. They fled squawking in all directions as I poked my head out (mind you, so do the neighbours) so I sprinkled some crumbs and crusts on the flowerbed to entice them back ; it usually works.

I lowered the mike to daffodil height, trapped the lead by closing the window on it, and began recording when the birds came back to gobble. Now this veteran *Tandberg* had no loudspeaker monitoring, and I didn't plug in the headphones ; but the flickering of the magic eye suggested that I was getting excellent results.

Then the eye threw a billious green fit and remained closed. I halved the gain in vain; not until the control approached minimum did the eye begin to behave. I made a drastic mistake—putting the headphones on *before* plugging them into the output. My eardrums cringed, and it was hours before the top of my head stopped rattling. I clawed myself free, squeezed one side of my face against the cold windowpane, extended an eyestalk and squinted balefully downwards.

Two birds were swinging upside down on the end of the microphone lead. One was tearing in frenzied hunger at the tasty sponge-rubber on the back of the mike ; the other had been pecking the grille and its beak had jammed in one of the tiny holes. Its struggles to free itself made the whole caboodle flail like a drunken pendulum, bouncing against the wall, while an audience of its feathered fellows danced up and down on the breadcrusts among the daffodils and shrieked advice.

The mike was hauled up and freedom presented to the pop-eyed brute, though nearly at the cost of a finger. The recording suggested the violent demolition of six nissen huts inside an aircraft hangar. I entered it years later for the BBC Wild Life contest, but the judges rejected it outright. Being ignorant, they'd obviously never even heard of the *Lesser Crested Sponge Gobbler* and the *Great Chromium Grille Pecker*.

The number of ribbon mikes wrecked by beat-groups in Merseyside in late years must be astronomical. One local dealer used to have a chap repairing them on a fulltime basis, if legend be true ; and next week a repaired mike would inevitably be back, shredded by the close-up wet bellow of some sweating hairy creature of indeterminate sex.

Among the equipment in a second-hand shop window—sold by a disillusioned gang whose collective jangling and braying hadn't been bad enough to bring quick fame and fortune—was a ribbon mike, one of our most highly-reputed native products (hand-carved with tribal totems, mate) going for a third of normal price.

I checked it cautiously (I'd been caught there before by one which, after repair, cost more than a new one). This one needed a new ribbon, lead, and jack-plug ; but even allowing a pessimistic estimate it seemed worth it.

Not having a suitable ribbon in stock, my dealer sent the entire microphone to its maker. That was Tuesday, 22nd February. On March 7th I learned that the makers promised to return it "in a week or two." On Tuesday, 12th April, I wrote asking what they'd done with it. Monday, 18th April, brought an apologetic reply explaining that illness had caused staff shortages and I'd appreciate that such important work could not be trusted to unskilled temporary staff (Letter IIIB, page 389, 1966 edition of the *Soft Soap and Flannel Handbook*). But I would no doubt be delighted to learn that the microphone was repaired and despatched on the day following receipt of my letter.

Meanwhile I'd asked the importers of a superb foreign recorder if they could overhaul a seven year old model. "Not just now," they said. "We're short-staffed through illness (look out, it's catching !) and might take five weeks on the job, so we suggest using the machine if possible meanwhile and we'll let you know when to whip it in to us." Fair enough ; they let me know ; the dealer whipped it in.

After seven weeks the dealer wrote inquiring after its health ; a fortnight later, having (a) had no reply whatsoever, and (b) got fed up of Ashcroft lurking in his shop and frightening potential customers, he wrote again and still got no reply.

In the eleventh week it came to pass that I wrote direct most liverishly, and soon came an ominous note asking me to phone (across country) the importer's service manager. He proved friendly, helpful, refreshingly candid and apologetic—and, in fairness, much of the delay had arisen while contacting the overseas factory for advice and spares.

He convinced me that a full-scale record and replay overhaul would cost more than the machine's age and state justified ; since it was used almost entirely for replay while dubbing, we agreed to have it brought up to scratch for this purpose—which he did, very well and very swiftly.

At the same time, by agreement on the phone, I sent back a newer machine for replacement heads and a spring-clean generally ; it came back in a week, and would light up and amplify beautifully, but was mechanically inert. No motor response. I peered within but saw nothing obviously wrong ; unfortunately a Bank Holiday was just starting, and it was four clear days before I could get the machine to the dealer and ask his advice.

One of his staff (with 20 x 20 vision) eventually spotted what my bleary eyes would never have seen : a microswitch contact that was *just* missing. It must have been jogged out of alignment in transit, since the machine was returned with the fast-wind function engaged and its lack of effect could scarcely have been missed at the workshop. Mind you, the £20-plus bill included carriage and insurance . . .

Now I'm the lucky sort who gets food-poisoning from a sip of distilled water, and would surely find hideous flutter and wow at 30 i/s on a *Studer* if I bought one. At one time my long-suffering dealer looked positively radiant with relief every time I entered his premises *not* carrying something he'd sold me the week before. For the dealer I have sympathy and gratitude ; also for the service staff at this importer's workshop who have done excellent work for me over the years. But, judging by my own and colleagues' experiences, there's a general theme of delay and disappointment.

My dealer once suffered a harangue from a bloke whose fairly new battery portable had "gone all dead" (it turned out that the owner had removed the batteries and forgotten to put them back). And workshop managers can tell hairy stories of "faulty machines" that have been filled with treacle by babies, or had 245V pumped down the microphone input.

As a long-nosed, beady-eyed snooper behind me has just remarked . . . "Tcha !"

audio diary 67

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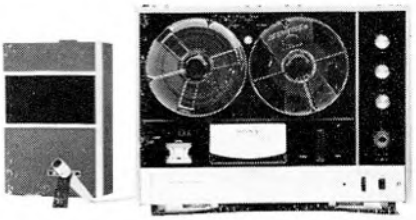


SONY AUDIO AND VIDEO RECORDERS

NOW being marketed by *Sony* are three new audio recorders and a low-price video model. The *CV2000* transistorised video recorder is the cheapest helical-scan unit ever to be sold in this country. Half-inch tape is transported at 7½ i/s past a twin-head rotating drum, the heads being positioned 180° apart. Only one of the two heads is employed for recording, the 'blind' head being left to scan the unwanted half-frame. The recorded information thus comprises 25 pre-interlace (every other line) frames, each frame being scanned twice on replay to prevent visible 'flicker'. Sound and sync tracks are recorded conventionally near the tape edges. Price of the recorder, complete with monitor/receiver, tape, microphone and connecting leads, is £368 11s. Camera, lens and tripod are available at an extra £131 5s.

The *TC 530* stereo tape recorder comes complete with detachable lid-mounted speakers, twin microphones and, to achieve a third speed (7½ i/s), spare capstan and pinch-wheel. Transistor amplifiers provide an output of 5W RMS per channel and feature separate bass and treble controls. A crossover arrangement feeds middle and high frequencies to the satellite speakers, bass and lower-mid frequencies being left to speakers in the main cabinet. The recorder costs £126.

For owners of separate amplifiers and speakers, the *TC 350* tape unit offers ¼-track stereo recording and off-tape monitoring facilities. Speeds of 7½ and 3¾ i/s are obtained by means of a slip-on capstan, frequency response at the faster speed being quoted as 50 c/s-15 Kc/s±3dB.

Price, including twin dynamic microphones and 7in. tape, is £78 15s.

Retailing at £61 19s., the *TC 800* battery portable operates at 3¾ and 1⅞ i/s and features a built-in mains adapter. Spool capacity is 5in. and gain control may be switched from automatic to manual. A three-digit position indicator and VU-meter are incorporated.

Distributor: Sony U.K. Sales Division, Mercia Road, Gloucester.

ROBUK STATESMAN

THE cheapest, if not the only, British tape recorder to feature a $\frac{15}{16}$ i/s tape speed is the *Statesman*, lately introduced by *Robuk*. In addition, the ¼-track recorder operates at 7½, 3¾ and 1⅞ i/s with a frequency response, at the fastest speed, of 60 c/s-14 Kc/s±3dB. Press-tab mode selectors and a spool rotation counter are incorporated, recording level being displayed by magic-eye. Superimposition and pause facilities are provided on the £30 9s. ½-track model and, in addition, parallel tracking on the £33 12s. ¼-track version.

Manufacturer: Robuk Electrical Industries Ltd., 559-561 Holloway Road, London N.19.

RADIONETTE MULTICORDER

A TAPE recorder of intriguing appearance is the *Radionette Multicorder*, a Swedish battery portable with built-in take-up spool. The machine accepts standard ¼in. tape on spools of up to 5in. diameter. Speeds are 3¾ and 1⅞ i/s, the tape being reversed at the end of each reel. Wow and flutter of the ¼-track Multicorder is 0.2% at 3¾ i/s and the price is £51 9s.

Distributor: Denham and Morley Ltd., Denmore House, 173/175 Cleveland Street, London W.1.

ELIZABETHAN CASSETTE RECORDERS

TWO recorders designed around the *Philips* cassette have been introduced under the *Elizabethan* label. The *LZ.9102T* is of similar appearance to the *Stella* battery portable and retails at the same price, namely £28 7s. Of original design, the *LZ.612* incorporates a 10in. speaker and has storage space for six cassettes. Output power from this battery portable is 5½W and the price is £47 5s.

Available in ½-track (£24 3s.) and ¼-track (£26 5s.) versions, the new *Elite* is based on the 3¾ i/s. *BSR TD2* deck.

Manufacturer: Elizabethan Electronics Ltd., Crow Lane, Romford, Essex.

TAPE RECORDER SERVICE CONTINUED

Akai M-7) which appeared in the January and February 1966 issues of *Tape Recorder*. It is not possible to add much to what has been said, although time has shown that a few of the points raised regarding switching, contacts, and mechanical complication were not without validity. To remain with the electronics, we should stress that troubles in and around the oscillator circuit can cause some bother. The oscillator circuit was given in the February article, and is also in our complete circuit of **fig. 1.** It looks too simple to be true, and in the *M-8* is no more complicated, except that a neon lamp, in series with a 300K resistor, is fitted across the head feed line, i.e. on the outer side of the 0.001μF blocking capacitor. We have not had any worry with the neon as yet, but it is quite possible that breakdown here may rob the bias, even damp the oscillator completely. More likely is the favourite component in these circuits, the 0.005 μF feedback capacitor from the tank-coil to the grid-leak. Incomplete erasure is the first symptom as this capacitor develops a leak, then distorted recording and finally no erasure at all.

A good 500V DC working paper capacitor is recommended if replacement is necessary.

A freak bias waveform is sometimes caused by filter camping, especially if the 50 pF section of the constant current circuit fails, or if the 1M resistor goes high, which can happen if the 0.01 μF coupling from the anode of the output valve breaks down. Again, if the blocking capacitor of the oscillator circuit breaks down, an effective DC charge is placed across the bias trimmer and noisy recordings will result.

A common cause of noise, in this as in many other circuits, is a poor anode load resistor in an early stage, (250K in the first two stages) and a damaged or poorly connected grid resistor. The 100K of the EF86 is a prime suspect. We should have liked to see a little common 'audio practice' in this section of the circuit, with separate stage decoupling so that the EF86 and the first half of the 12AX7 do not share the HT line. But we must not expect too much, even for nearly £140.

What we *should* expect is a less error-laden service manual. The engineering fraternity have many laughs from manuals with imported machines—then a twinge of conscience, wondering whether our own exporters are any better with their translations. But circuits are universal, and there is no excuse for a drawing that does not show electrolytic capacitors by their accepted symbol, and omits an important bridge line to the head socket, or shows jack and head switch contacts in a way that is not immediately understandable. Fortunately, the M-8 diagram is better, although the specification gives a head output figure and omits the line input, whereas the actual contact of J3 is arranged so that insertion of the plug isolates the deck and applies a signal to the input stage for straight-through amplification when switched to play. In the notes, J2 and J3 are transposed. In the servicing notes, R25, R26 should read R23, R24; on line 6 of page 24, R24, R23, C25, C26 should read C24, C23, R28, R29 . . . and so on.

READERS' PROBLEMS CONTINUED

A NOISY MOTOR

Dear Sir, I would be grateful for any helpful suggestions you can give me regarding a noisy motor on my *Fidelity Major*. I have consulted a dealer with no success and also written to the manufacturers, who advised me to fit a washer on the motor mountings. This I have done, but to no effect.

Yours faithfully, **K.B., Sheffield 2.**

The noisy motor of the Fidelity Major (BSR deck) is sometimes the result of overtight mounting, as the makers more or less implied. When they say fit a washer, they really mean slacken the spring mounting, and in this respect, three rubber grommets which sit in holes in the deck can be insufficient. Sometimes the answer is an additional fibre washer, topped by a brass shim, beneath the circlip of each mounting. In other cases, the whole motor can be altered slightly in position by a washer between the laminations and the support pillar of each mounting.

The spindle mounting, fan collar and bush should be checked for loose mounting, and you should ensure that the clamping screws, particularly the lone, isolated one of the motor laminations, are quite tight.

Temporarily hold off the idler wheel. If noisy, make sure that the central screw is quite clear of any rotating part, such as the bush. Check the cleanness of the spindle and apply a single drop of oil—keeping the oil well away from the rubber tyre. Finally, make sure that the idler runs correctly in respect to motor pulley position when switching on. If the motor is not evenly set, there is a tendency for the idler to edge on the capstan steps, causing rumble.

MAGNETIC SOUND RECORDING CONT.

Rapid variations in tape speed cause the output to produce a fluttering sound.

If your recorder is giving this kind of trouble, it pays to be sure you have not caused it yourself before blaming the instrument. One very common cause is a clumsy tape splice, which can cause the tape to come off a spool unevenly. Some owners, by what can only be described as a brilliant effort of clumsiness, have been known to jam a spool over a spindle so that it is not horizontal. Try this for yourself and you may decide it is impossible, but we all manage to achieve the impossible at times without even realising we have done it. You can introduce flutter by leaving the tension on your capstan and pinch wheel over night. This will produce a flat on the rubber which you can remove only by changing the roller.

Other causes are faulty or dirty motors, bent spools or spindles, dirty tape heads, and almost any mechanical defect which can arise out of unfair use or insufficient maintenance. But modern instruments are so well constructed that if you treat yours fairly you are unlikely to be troubled.

So much for distortion. Next month we will make an attempt on the rather complicated topic of equalization.

equipment reviews

THE original *Uher 4000 Report* was reviewed in September 1962 when we had some slight trouble with intermittent governer action and rather high erase and bias noise.

The new *Uher 4000 Report L* was the subject of a novel experiment in reviewing, where the machine was first sent to me for standard tests and then returned to David Kirk for field tests. After considerable use the recorder was again subjected to laboratory measurement to see if any appreciable deterioration of performance could be detected. It can be said straight away that wow, flutter and frequency response tests gave almost identical results and that very extended usage would probably be needed to show any measurable change in performance.

The motor control system alone uses no less than eight transistors, three diodes and a voltage reference zener-diode. Each of the three windings on the motor is fed through a pair of transistors, so that the three-segment 'commutator' makes and breaks only very small base currents of emitter-follower transistors.

The unswitched windings deliver back-EMF voltages proportional to the speed of the motor which are rectified by the diodes, compared with the reference voltage of the zener, and used to control the current to the switched winding. Not only is the speed control very delicate, but radiated motor noise is almost negligible as there is no governer to handle intermittent splashes of heavy current, and the commutator current is measured in micro-amps rather than fractions of an amp.

With the meter needle within the red segment of the scale, the tape speeds were within 1% of the specified speeds at all parts of the 5in. reel. With one cell removed, to simulate low battery voltage and with the needle well down into the white, the speed was about 2% low, but the wow and flutter remained low, indicating that the mean speed was still well controlled. **Fig. 1** shows my high speed pen recordings or fluttergrams at the three higher speeds. The duplicated 3¾ i/s traces are 'before' and 'after' the field-trial.

Standard frequency test-tapes, with recorded time constants of 70, 140 and 240μS were played to measure the play-only response of the recorder to line output. All responses (**fig. 2**) are within 2dB limits up to the highest frequencies on the test-tapes, with a falling response below 100 c/s amounting to about 7dB at 40 c/s.

The record/play responses of **fig. 3** are within the same limits, with extension of the high note response to 15 Kc/s at the two higher speeds, and perfectly adequate responses to 6 Kc/s and 3 Kc/s at the two lower speeds.

The 3¾ i/s record/play responses were checked after the field-trial and found to be so nearly identical to the original responses that it was not thought worth replotting them.

System noise, with no tape passing the heads, was 42dB below test-tape level and seemed to be mainly very faint transistor hiss. It was difficult to pick out any noise from the motor. Recorded noise at the two higher tape speeds was 40dB below test-tape level, indicating good bias and erase oscillator waveform.

Peak recording tests at 500 c/s showed that a level 12dB above test-tape level could be recorded without distortion, and that distortion at a level 14dB above test-tape level was just visible on the CRO at an estimated 5%.

The VU-meter was well damped and full modulation was obtained with the needle just kicking to 0dB on peaks. Steady tone tests showed that test-tape level was recorded at —10dB meter reading and that the top of the red sector corresponded to tape overload (plus 14dB on test-tape).

Unweighted signal-to-noise ratio (14dB above test-tape to 40dB below test-tape) is 54dB, which agrees closely with the specified figure of 55dB.

At the two lower speeds high frequency overload and lower recording level limited the dynamic range to about 40dB.

The acoustic response of the internal speaker was measured by playing a 7½ i/s white-noise test-tape containing 25 one third octave bands of filtered white-noise and measuring the sound output on the speaker axis with a calibrated microphone to give the response of **fig. 4.**

(continued overleaf)

UHER 4000L

MANUFACTURER'S SPECIFICATION. Twin-track battery portable recorder. **Tape Speeds:** 7½, 3¾ 1⅞ i/s and $1\frac{15}{16}$ i/s. **Frequency Range** (respective): 40 c/s - 20 Kc/s, 40 c/s - 17 Kc/s, 40 c/s - 10Kc/s, 40 c/s - 4.5 Kc/s. **Signal-to-Noise Ratio:** 55dB. **Wow and Flutter:** ±0.15% at 7½ i/s. **Output Power:** 1W. **Power Supplies:** Five torch cells or Z211 rechargable battery. Z114 power unit/battery charger available. **Price:** £108. **Distributor: Bosch Ltd., 205 Great Portland Street, London, W.1.**

FIG. 1 UHER 4000L WOW AND FLUTTER

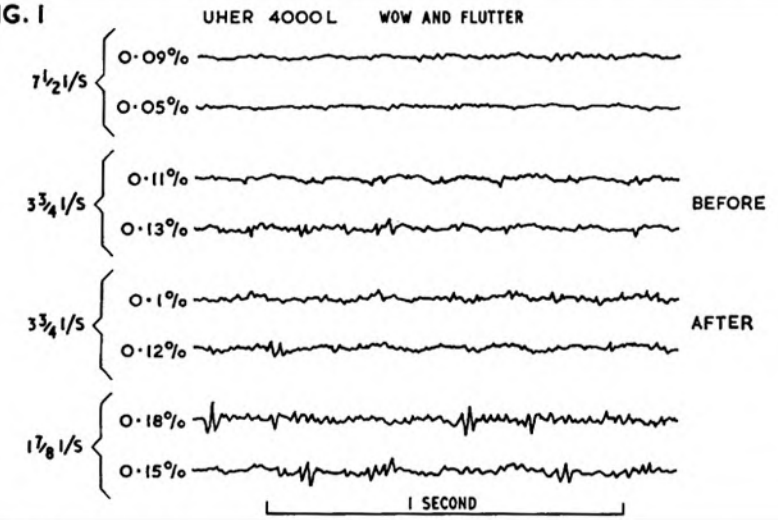
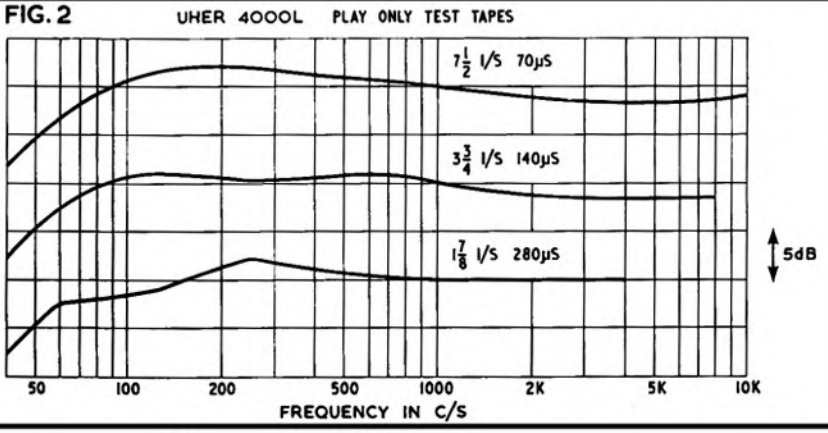


FIG. 2 UHER 4000L PLAY ONLY TEST TAPES



The expected fall in low note response due to the small volume of the recorder case occurred at 400 c/s, with a reasonably level response to 8 Kc/s. No box coloration was evident.

Microphone recordings showed surprisingly little quality change as the tape speed was reduced from $7\frac{1}{2}$ i/s down to the lowest speed of 15/16 i/s despite the two octave cut in high note response indicated by the record-play responses of **fig. 3.** White-noise measurement of the microphone response showed why: **fig. 5** reveals a sharp fall in high note response above 3.5 Kc/s !

The *Speech/Music* switch on the microphone cuts the low-note response as shown by the dotted curve of **fig. 5.**

The rather high price of £108 for a portable recorder can only be justified if it is to be used for semi-professional recording. For this class of work the microphone should be replaced by a wider range directional type which would do full justice to the wide response and excellent signal to-noise-ratio at the two higher tape speeds. Tape handling is very gentle and, if really long playing time is required, some of the new high-potency oxide triple and quadruple play tapes could be used.

I can see no real use for the $1\frac{7}{8}$ i/s and $\frac{15}{16}$ i/s tape speeds on this class of machine—there are a number of recorders in the £25 price range that cover this field adequately—and a simple two-speed drive might eliminate the only real complaint I have against this particular model; this is the rather fiddling speed-change gate lever which has to be set to zero after use to disengage the motor from the flywheel *and to switch off the motor.* I constantly found myself switching off by pressing the main stop key, and then putting the recorder away with the motor still buzzing. I think we should at least expect the current to the motor to be broken by the stop key, even if leaving the thing 'in gear' caused later flutter trouble.

Technically, I can not fault this machine. Mechanical noise is very low; wow and flutter are good at the two professional speeds; frequency responses are close to the standard recording characteristics, and signal-to-noise ratio and speed constancy are excellent under all conditions. **A. Tutchings.**

FIELD TRIAL

FOR some twelve weeks I have been experimenting with two battery recorders. One was the *Uher 4000L* and the other—of similar price and specification—so well-known that it seems hardly necessary to mention the name. The predecessors of both machines have, for some years, been used by broadcasting organisations throughout the world, the BBC relying on them for *Radio Newsreel* and *Today* spot interviews. These experiments were aimed at identifying the better machine.

The criticism most commonly angled at sophisticated miniature recorders of the 4000L breed is that of mechanical deterioration. At first glance, the mechanism of this particular recorder does indeed seem intricate and fragile But is it really so dependent on fine adjustment? There seemed only one way to reach a con-

FIG. 3 UHER 4000L RECORD-PLAY

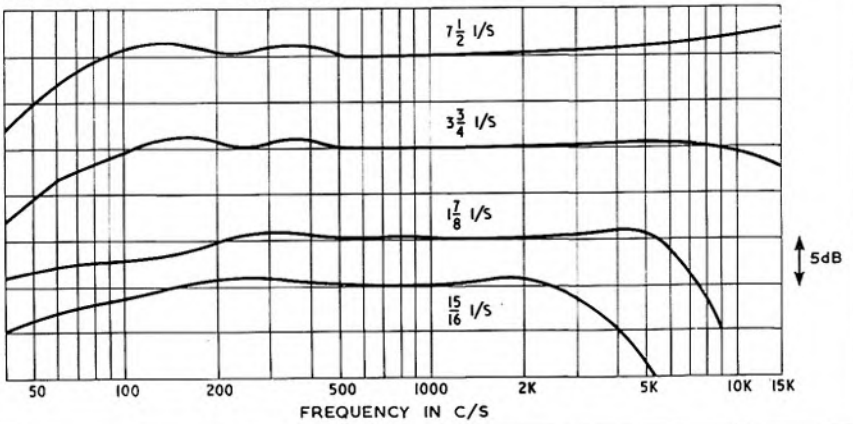


FIG. 4 UHER 4000L ACOUSTIC RESPONSE

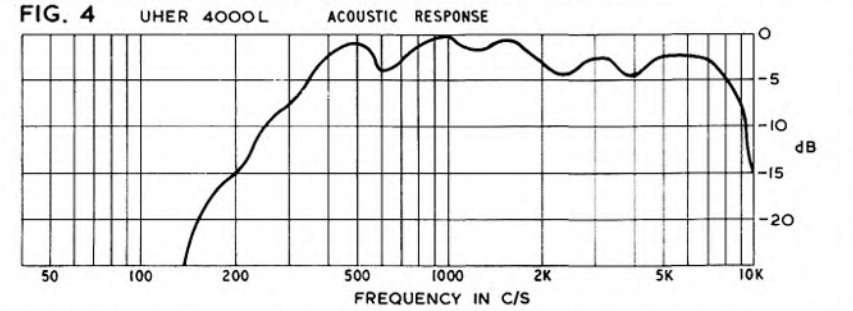
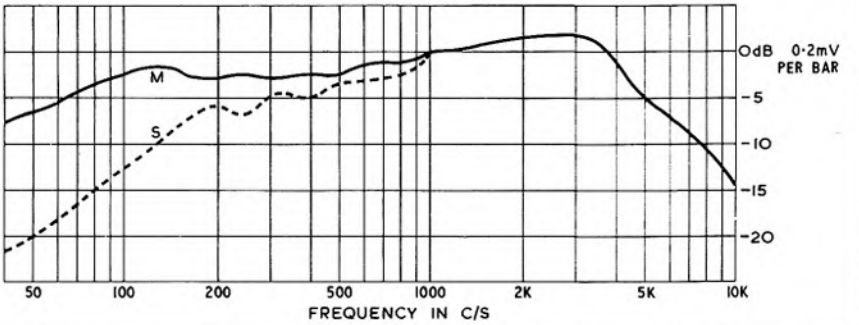


FIG. 5 UHER 4000L MICROPHONE RESPONSE



clusion. Alec Tutchings should measure the mechanical and electronic performance of a brand new model, it would then be subjected to 'an average hammering', and then measured again. At the time of writing I have seen neither set of measurements, and will therefore take care not to tread on my own toes !

Switched to 15/16 i/s, the 4000L commenced its hammering as an audio notebook at the 1966 *Audio Fair*. Its task was performed admirably, even though microphone and recorder were held in the same hand. Not being fond of 'bugging', I endeavoured to inform friendly exhibitors that they were being 'canned'. No-one objected, but the slight tendancy of certain individuals towards tongue-paralysis caused me to terminate this labour-saving activity. (The affliction was later cured in several instances, I should add, by a dose of alcohol at our own exhibition room !)

Shortly after the Fair, the machine was connected to an FM tuner and the resultant tapes reproduced through external audio equipment. The results were astounding. No falling off of upper or lower frequency scales was audible, wow and flutter (at 7½ i/s) were totally inaudible, and the signal-to-noise ratio was comparable with the best domestic mains machines. Particularly noticeable was the complete lack of radiated interference from the motor to the tuner. The 4000L, of course, has an electronic motor speed control in place of a governor. This fact must contribute to the very low general background noise level.

No difficulty was experienced in connecting the recorder to external equipment, a three-way switch on the front panel selecting input sensitivity for microphone, diode and gram.

With a single exception, all controls were found easy to operate. To the left of the three-way rotary switch was the recording gain control, followed by playback treble and volume controls. The latter, when tugged, acted as a speaker cut-out switch, whilst pulling the tone control turned on a lamp to illuminate the

(*continued on page* 437)

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7″	1200′	16/-	10/-
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4″	450′	6/-	5/-
5″	900′	11/6	9/-
5¾″	1200′	16/-	10/6
7″	1800′	23/-	14/-
Double Play			
3″	400′	6/-	4/-
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meter. This may seem like a gimmick, though on one occasion it proved invaluable. Switching on the lamp whilst recording, however, imparted an audible click to the tape. Finally, the recording gain control : when pulled against a spring, this connected the VU-meter to show battery voltage.

To the left of the meter was a tiny three-digit revolution counter. This was found to be unusually accurate and, being of the instant-reset type, was frequently used. Metal press-tabs on top of the recorder governed, from left to right, rewind, start, pause, stop, record and fast-forward. The record button locks in position to permit setting of the modulation level and is cancelled by the start switch to provide playback, or may be held down and interlocked with that switch for recording. The pause control was unusual, being pushed down to stop the tape and pulled up again to restart it. Care must be taken to pull this tab right up, or the most awful wow results.

I understand that a Japanese manufacturer 'borrowed' the internal design of the earlier *Uher 4000S* (they also borrowed the speed instability and motor interference). If this is true, then that company was wise to re-arrange the tape-speed selector, which was found a most troublesome feature of the 4000S and 4000L. This selector functioned as an on/off switch, battery power being disconnected while the selector was set at neutral. Pushing the control (inwards and downwards) into one of the four vertical slots, started the drive-motor. Only then could the recording level be set. My main complaint, however, is that this made it easy for the 4000L to be accidentally left running. Half-way through the field-trial, I did indeed return from an afternoon outing to find that the motor (though not the spools) had been running for more than two hours. During that period, the batteries had given up. This is an indirect compliment to the very low running noise. From a distance of some three to four feet, the recorder is almost inaudible.

An interesting aspect of the speed control, and one that must be unique, is a 'tamper-proof' lock. All but the earliest versions of the 4000L display a vertical mark on the selector-knob. When the knob is in the horizontal neutral slot, it may be twisted at a right-angle. The recorder cannot then be switched on.

The recorder performed equally well in horizontal and vertical positions, though wow was substantially increased when recordings were made vertically while walking. Since one would hardly tape an orchestra in this situation, this is no fundamental drawback, though one must try and follow the rule of not moving the machine around the axis of the capstan. Despite the light high-speed flywheel, which has good damping qualities for its weight, the tape-transport is fairly sensitive to lateral movement. This applies to almost all other recorders, mains and battery, and implies advantage to machines designed for horizontal operation only (such as the *Philips EL3586* and the 'un-named model' referred to earlier).

Detailed comparison of the Uher and its obvious competitor revealed that, despite the speed selector, the 4000L was by far the easier to operate. A-B comparison of the two machines, dubbed with a single stretch of orchestral music and monitored through a hi-fi system, revealed a remarkable similarity in frequency response, though the Uher had just a slightly better signal-to-noise ratio. To aid comparison, the passages were replayed through separate channels of a stereo amplifier in almost exact synchronisation. I was surprised by the length of time that they remained in sync. Several minutes passed before speed deviations rendered the two machines totally out of step a far cry from the few seconds of an average pair of domestic recorders.

Both machines feature remote pause controls, the Uher incorporating a solenoid stop device actuated from a switch on the microphone. This device was used on several occasions, circumventing the need for subsequent splicing of shuffling noises created in positioning the microphone. I believe this is the only battery portable actually being marketed in Britain with solenoid pause control.

The recording level meter was very well behaved (the term 'sensitive' seems incorrect in view of the uncontrolled sensitivity of certain cheaper portables) and is calibrated in decibels.

Battery life, with intermittent use of *Ever Ready HPU2* cells, was in the order of very approximately five hours. A mains unit is available for the 4000L and, since the recorder has considerable potential as a high-quality dubbing machine, this would be a good buy.

A major difference between the Uher and 'the other machine' is the absence, in the former case, of separate-head off-tape monitoring. Like solenoid pause control, this is a useful feature, but can be reasonably omitted if one is confident in the tape being used, in one's ability to thread without tangling in the head-channel, and in the condition of the batteries. As Alec Tutchings put it when reviewing a three-head portable some five years ago, "Any effort to monitor one's own voice on headphones will quickly lead to a nervous breakdown ; the slight time delay between record and play is guaranteed to turn the most hardened commentator into a gibbering idiot within a very few sentences".

Getting at 'the works' was a straight forward affair, as was the replacement of used batteries, and gaining access for servicing presented no problems. The actual task of servicing, however, should not be left in the hands of the high-street electrical ironmonger. We received just two complaints about *Bosch* servicing arrangements in recent years, both during the week that they were transferring to computer administration. Nothing before and, it is pleasing to add, nothing since. There need be no pre-purchase fears on this account.

One last point. A reel of cheap (ex-computer ?) tape caused considerable speed instability during a dubbing session. This occurred towards the end of the reel and could only have been due to interplay between supply-spool tension and slight variation in tape width. The 4000L, like the Japanese equivalent of its predecessor, seems particularly sensitive to tape width, rendering 'cheap' tape a false economy.

In conclusion, if Alec Tutchings can prove no high rate of performance deterioration (subjective impressions revealed no noticeable increase in wow throughout the twelve weeks), I would rate the Uher 4000L as being superior to all existing portables of lower price and, taking into account the Law of Diminishing Returns, a very good buy. **D. K. Kirk.**

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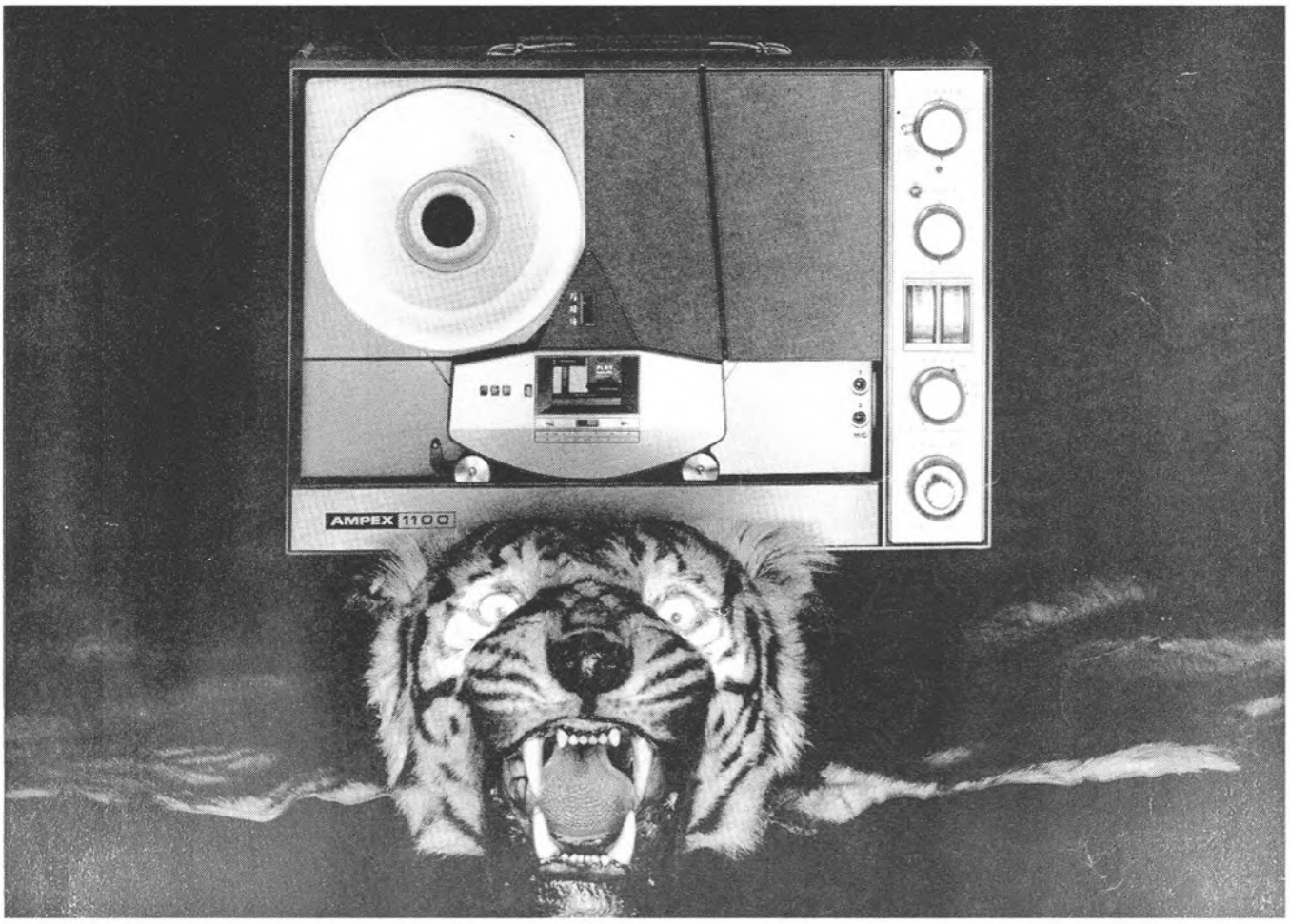

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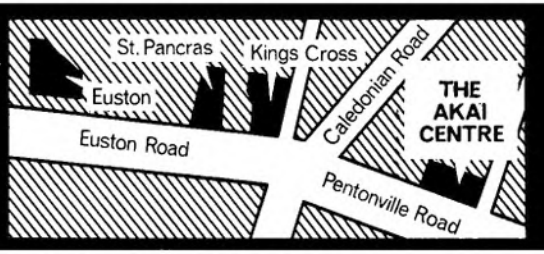

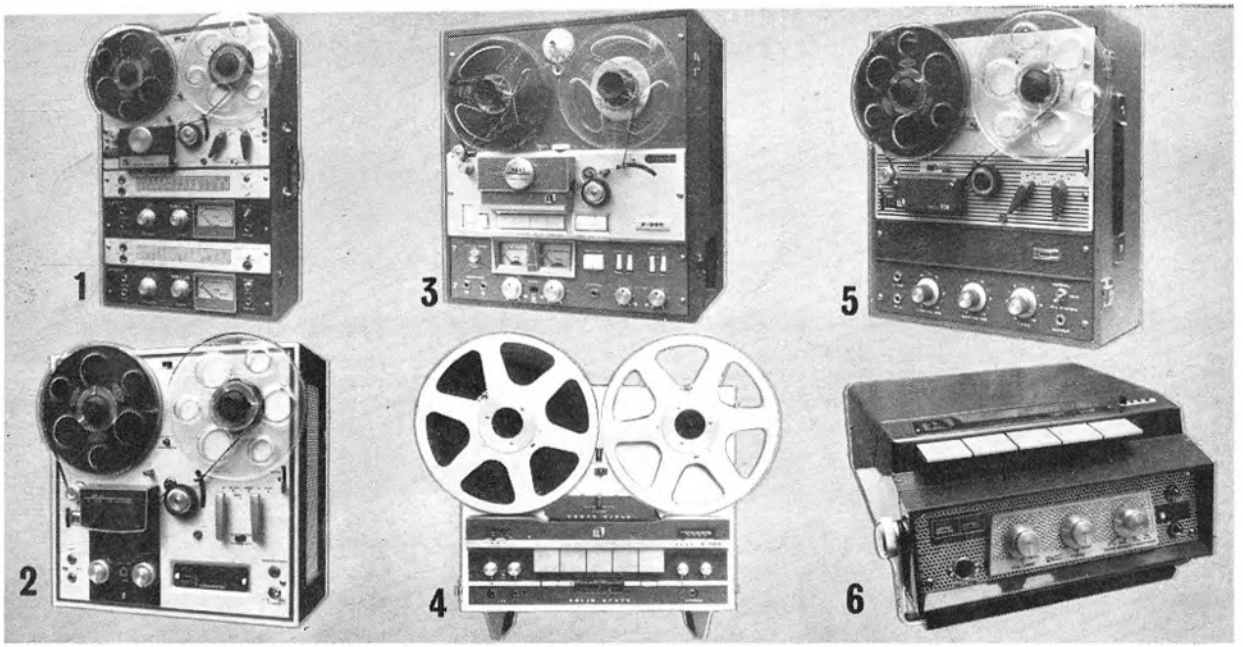

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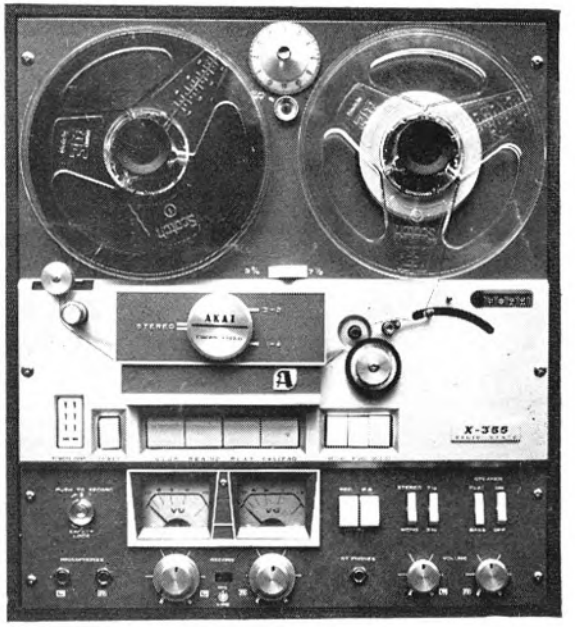

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