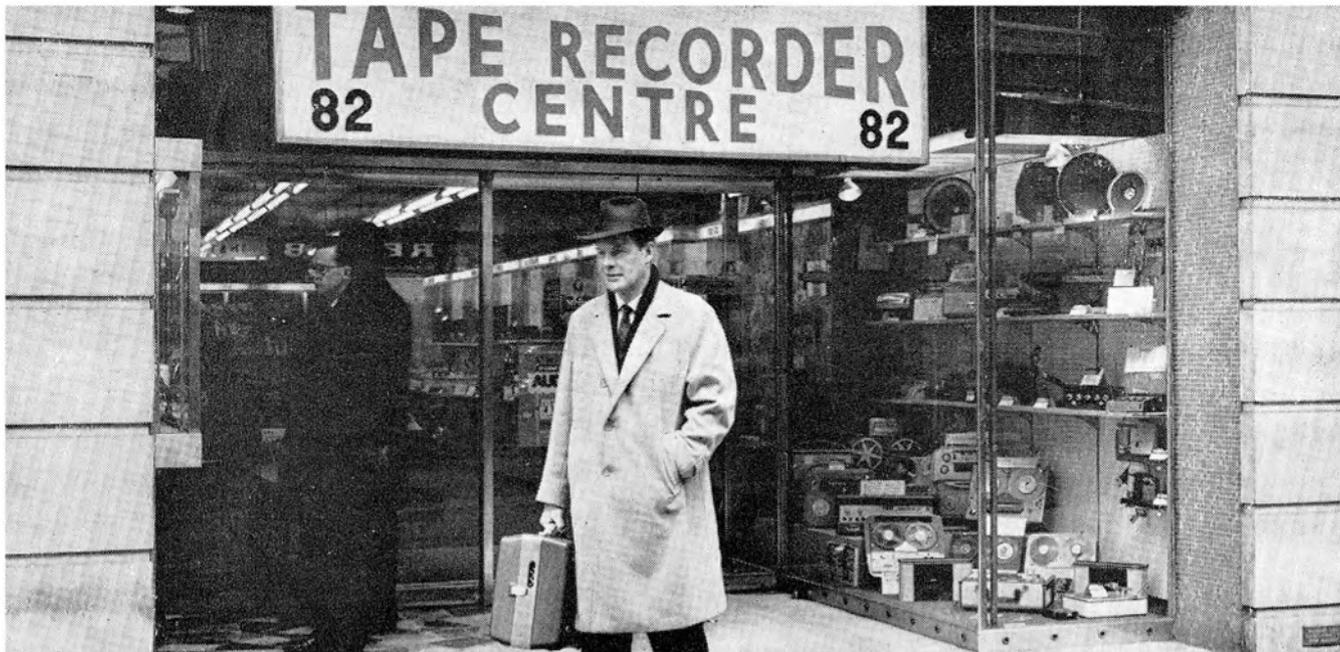


# tape recorder



**SLEEP LEARNING - ESTABLISHED TECHNIQUE OR ELABORATE FRAUD?  
TRANSISTOR CRYSTAL MICROPHONE PREAMPLIFIER — EMI L4 FIELD TEST**



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# —and it is

## SPECIFICATION MODEL TC260 — 97 GNS.

Power requirement	110/125 V — 220/240 V, 50/60 cps		
Tape speed	7½" and 3¾" per sec		
Reel size	7" or smaller		
Recording system	4-track stereophonic and monophonic	Output	High impedance auxiliary inputs
Frequency response	30-18,000 cps at 7½ ips (19 cm/s) (50-15,000 cps at 7½ ips ± 3db) 30-13,000 cps at 3¾ ips		Sensitivity —16 db (0.12 v) (2)
Signal-to-noise ratio	Better than 50 db (at peak recording level)		Low impedance line outputs (2)
Flutter and wow	Less than 0.19% at 7½ ips Less than 0.25% at 3¾ ips		Output level 0 db (0.775 v)
Erase head	In-line (stacked) quarter track, EF18-2902H	Operating position	External Speaker jacks (8 ohms) (2)
Record/Playback head	In-line (stacked) quarter track, PP30-4202	Speaker	Integrated Record/Playback Connector (1)
Level indication	Two VU meters (calibrated to 0 VU at 12 db below saturation of tape)	Power output	Binaural monitor output (1)
Tone control	Two separate controls for bass and treble	Transistor	Output level 0 db (0.775 v)
Input	Low impedance microphone inputs — transistorised (will accommodate any microphone from 250 ohm to 1 K ohm impedance) Sensitivity —68 db (0.3 mv) (2)	Weight	Either horizontal or vertical
		Dimensions	4 x 8" dynamic (2)
		Accessories	5 watts (x2)
			2SB381 (x6), 2SB382 (x2), 2SB383 (x2)
			2SC297 (x1), 2SC298 (x4), 2SD64 (x6)
			Approx. 34 lbs. 3 ozs.
			21 ⅝" (W) x 15 ⅞" (D) x 7 ⅞" (H)
			5" stereo recorded tape
			Empty 7" reel
			Microphone Model F-96 (2)

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NAME.....

ADDRESS.....

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# 99

## Emitape 99—the long play tape formulated for 4-track recorders

Emitape 99 has been created by E.M.I., the original and largest British manufacturers of magnetic recording tape, in co-operation with I.C.I. who have produced a special 'Melinex' film base material for this new production.

Emitape 99 has greater strength—perfect tracking at all speeds—and outstanding hi-fi performance has been achieved by the most up-to-date coating techniques.

Three other high quality grades are in the Emitape range:

**Standard Play 88** for use at professional tape speeds ; **Double Play 100** for more recording time ; **Triple Play 300** for maximum playing time on battery portables.

*Emitape is supplied in a free transparent two-piece library case originally designed for computer tapes. It gives compact dust-free storage and easy indexing.*

Emitape is used nine times out of ten by the B.B.C. All the best dealers are Emitape stockists.



# EMITAPE

THE MOST ADVANCED MAGNETIC RECORDING TAPE IN THE WORLD



AN E.M.I. GROUP PRODUCT  
E.M.I. TAPE LIMITED,  
HAYES, MIDDLESEX

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# tape recorder

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FEBRUARY 1967 VOLUME 9 NUMBER 2

INCORPORATING  
SOUND AND CINE

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JOHN CRABBE

## DEPUTY EDITOR

DAVID KIRK

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## COVER PICTURE

Owners of BSR TD10-decked recorders may notice certain oddities about the mechanism on this month's cover. The pause/motor-off control and anti-tape-fouling ribs are unique to the *Eltra 1001*, production of which is described on page 72.

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## SUBSCRIPTION RATES

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

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TWO topics occupy the Editorial pen this month—commercial tape records and British tape recorders. Tapes first: who buys them, and why? Will the 1½ i/s music-cassette ever push the LP gramophone record off the market? Does a £37 cassette player (or £28 for a battery model) make a more satisfying noise than a £20 disc reproducer?

We have yet to hear a record company claim that 3¾ i/s tape records are equal, in terms of quality, to their disc counterparts, though such statements have been made regarding the new 1½ i/s copies. And we have yet to see a tape record introduced before its disc equivalent.

The obvious potential customer for 3¾ i/s tape records is the domestic-recorder owner who possesses no disc player. Most of those in possession of a gramophone are unlikely, we feel, to buy anything other than the disc version of a recording. This consideration may or may not be based on quality; it will be decided, in most cases, by the fact that a disc may be dubbed more easily for personal use and for the benefit of acquaintances.

Philips are at present industriously trying to popularise their cassette system. Whether the recently introduced pre-recorded *Musiccassette* is designed to boost the sales of their cassette recorders or vice versa we do not know, but the aforementioned argument still applies. Even for those fortunate enough to own the useful little *EL3301*, we cannot regard it as a progressive move to become tolerant of the limitations of 1½ i/s for domestic music reproduction when a gramophone at the same price will give vastly superior results. Of course, one could always by-pass the output stage and speaker, try hard to believe that the carefully shaped recorded tape response is giving *real* bass and treble, and play the cassette through the gramophone amplifier. But at 2 gns. a time there is some element of deterrence.

The news that *DC International* commercially recorded cassettes are not, after all, to be marketed in Britain may be interpreted by some as a victory for Philips. Could it be, however, that one group of manufacturers has concluded that the cassette record is a dead duck?

There is rarely any controversy over British recorder manufacturers these days. Could it be that they are all sitting back quietly bemoaning the effects of The Squeeze? We were of that opinion until, shortly before Christmas, a British-made recorder was delivered for review. The recorder was unusually interesting in being an original design throughout. Though of intriguing appearance and construction, there were some features that equalled the shoddiness of the worst very low price products from the Far East. Wood-screws in metal, pressure pads that were fouled permanently away from the heads by the leads connected to the superimposition button, a wrongly soldered 'trick' button that erased only when held in the 'superimpose' position, two lid catches that fell away from the cabinet the first time the lid

was closed, and an instruction booklet that might itself have been inexpertly translated from Japanese.

We have probably all been advised, in the past, to place pieces of cardboard between tape and erase-head to achieve a form of superimposition. The instruction booklet contained an interesting new slant upon the employment of cardboard. To use the recorder as a straight-through amplifier, we read, the operator should cut a thin cardboard wedge, which may be jammed into the record-interlock slot. This must rank as the ultimate in unsophistication. Surely a rusty nail of suitable dimensions could have been offered as an optional extra?

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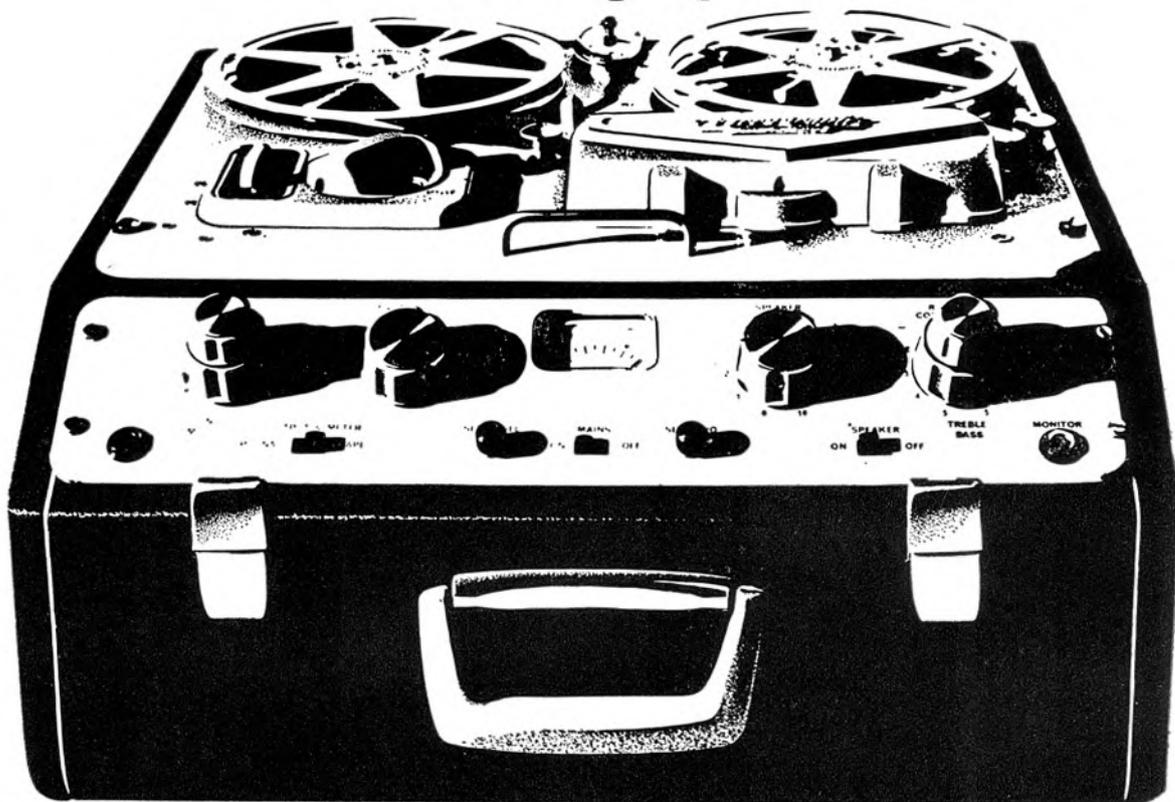
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**British**  
 (only 2% of imported material)  
**strong**  
 (many a 15-year-old still in daily service)  
**silent**  
 (background – where silence is needed)  
 That's the incomparable  
**Ferrograph**



Apart from that imported 2% (mainly plywood) and some superbly engineered components from other British sources, most Ferrograph components are made in our South Shields factory. Exemplary quality control at every stage ensures that not only are the black sheep rejected, but also any in doubtful shades of grey. The result is an instrument of impressive excellence; impressive in its recording fidelity and its reliability through year after year of exacting use. The Ferrograph is for professionals and the serious amateurs of sound—hardly for those who would buy a Tape Recorder with little more thought than a packet of cigarettes. You will be pleased when you move up into the Ferrograph class.

*Ferrograph models: 631 95 gns · 631H 100 gns · 633 120 gns  
 633H 125 gns · 632 126 gns · 632H 132 gns · 634 132 gns  
 All models can be supplied with teak sides if required.*

Interested? Then complete and post this coupon to:  
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- Please send me the FREE illustrated Ferrograph leaflet.
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- Mono  Stereo (Tick items required).

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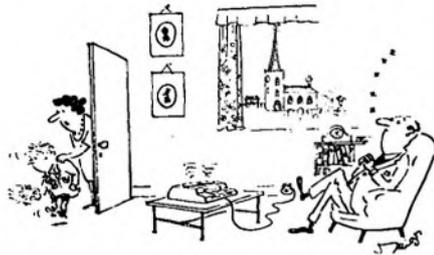
TR7

**Ferrograph**  
 THE INCOMPARABLE TAPE RECORDER

TWO YEARLY PUBLICATIONS

TWO audio publications—the *Audio Diary* and *Audio Annual*—have been produced by the publishers of *Tape Recorder* and *Hi-Fi News*. The diary, 1967 edition of which has been available for the past few months, contains many facts and figures of use to the sound recording enthusiast. Among the subjects covered in the 64-page reference section are tape equalisation, track positions, and playing time, VHF/FM aerials, sound wavelength and frequency, equipment matching, stereo loudspeaker placing, crossovers and dynamic range. These are incorporated in addition to a conventional two pages per week diary and colour Underground map. Price of the *Audio Diary* is 7s. 6d. post free, from *Tape Recorder*, Link House, Dingwall Avenue, Croydon CR9 2TA.

Also available from that address, from mid-February, will be the 1967 *Audio Annual*, price 6s. including postage. David Robinson contributes an article describing a noise reduction system intended for use with professional tape recorders and currently employed by certain gramophone record manufacturers. Stanley Kelly will examine *Transducers* while James Moir considers the sound qualities of ancient Greek Theatres in *Ancient Acoustics*. For those who missed the relevant issues of *Tape Recorder*, reviews will be reprinted of the *Akai X-355*, *Uher 4000L*, *Sony TC3574*, *Tandberg 84*, *Ampex 863*, *Korting MT 3624*, *Akai X-4*, and *Truvox PD104*.



"Don't disturb your father while he's playing his sermon."

RADIO SHOW CANCELLED

THE 1967 Earls Court Radio Show appears to be following the same pattern as that traversed in 1966, having now been cancelled after an announcement that both trade and public would be admitted. *Rex-Hassan Associates Ltd.* (responsible for the *Hotel Russell Audio Fair*) have announced, however, plans to organise an international radio show, to be held in London from Wednesday 6th to Sunday 10th September. The venue has yet to be decided.

PHILIPS ABANDON RPM

A POLICY of price recommendation is now being adopted by *Philips Electrical Ltd.* The announcement followed a withdrawal of the *British Radio Equipment Manufacturers' Association* application for exemption from the *Resale Prices Act*. Current list prices for Philips tape recorders, magnetic tape, television and audio equipment may now be adopted or undercut according to the inclination of individual retailers.

# WORLD OF TAPE

MOTOROLA INTRODUCE  
EIGHT-TRACK  
CAR PLAYER  
TO BRITAIN



AN eight-track stereo tape playback system, developed by *Motorola* for the *Ford Motor Company*, was demonstrated recently in London. The system was originally designed as an alternative to the car radio, but has been expanded, in the USA, to encompass the domestic audio market. Consequently, stereo players for the car and for the home are expected to be produced in Britain to sell in the £45-£70 price region, with or without integrated AM receivers.

*Stereo 8* endless cassettes are being recorded for *Motorola* by *RCA* at 3½ i/s on standard ½ in. tape. The eight tracks provide four stereo channels, a push-button selector altering the vertical position of the head face. Built into the tape transport is a switching mechanism that selects a fresh track at the end of each cassette cycle. Quality of the system, as demonstrated, was well up to background-music standards.

FERROTUTOR PRICE REARRANGEMENT

FOLLOWING requests from customers wishing to purchase alternative headphones to those previously supplied with the *Ferrotutor*, *Ferrograph* are now offering recorder and accessories separately. The recorder has been reduced £5 in price to £120 and the following headsets made available with boom microphone: *S. G. Brown 4C604/2* (£13 3s.), *Brown 4C705/2* with noise-excluding pads (£13 3s.), and *AKG 58* (£17 2s.).

RAY-O-VAC MOVE WEST

FROM the beginning of January, the head office of the *Ray-O-Vac International Corporation* will be located at Westminster House, 97 St. Mary Street, Cardiff. Telephone number is Cardiff 42137. The *Ray-O-Vac* offices in London and Treorchy, Glamorgan, have been closed, though manufacture of batteries and ancillary products will continue at Treorchy.

NEW LIGHT ON TV RECORDING?

THE use of a gas laser in place of an electron beam for television scanning was proved practicable at a recent demonstration by *Zenith* in Chicago. Signals from a conventional television receiver were fed to optical modulation equipment which, in turn, guided

the laser beam on to a projected 2ft. 3in. x 3ft. picture. Light generated by the laser is passed through an ultrasonic intensity modulator, beam brightness corresponding directly to the ultrasonic wave strength. Horizontal deflection is similarly achieved ultrasonically, the modulated beam passing through a de-ionised-water-filled tank containing four piezoelectric transducers. Vertical deflection, when the system was demonstrated, was by means of a 60Hz (US field frequency) mechanical vibrator. This was said to be entirely satisfactory, though an ultrasonic vertical deflector had been employed experimentally. Next step, perhaps, is a laser system that will burn the pictures on to moving plastic tape?

ELECTRONIQUES HOBBIES MANUAL

PRICES and details of eleven thousand items are given in the 608-page illustrated manual prepared by *Electroniques*. The *STC*-owned company is entering the technical hobbies mail-order field in an ambitious manner, supplying listed products by post and through certain retailers. The catalogue costs 10s. 6d. and is available from *Electroniques*, Edinburgh Way, Harlow, Essex.

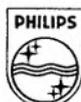
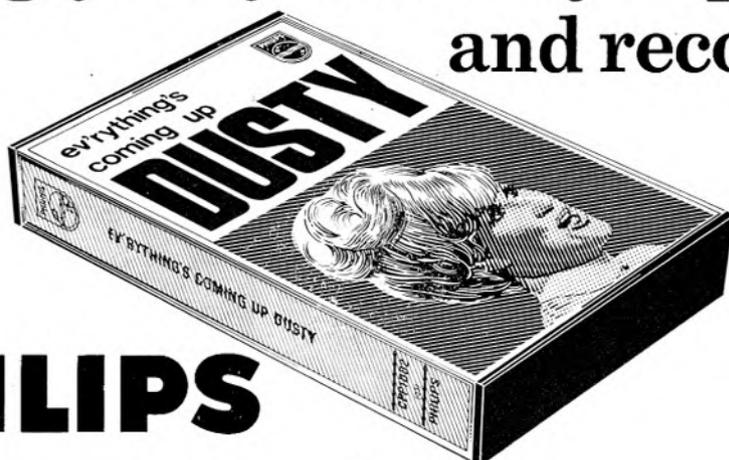
BATTERY PORTABLE WITH A DIFFERENCE

REMARKABLE feature of the latest *Sony* battery tape recorder is its ability to record moving television pictures. The new model, not yet being marketed in Britain, is designed for use with the *TCV2000* domestic video recorder, and has no internal playback facilities. Recording is on ½ in. tape at 7½ i/s, a 5in. spool capacity giving up to 30 minutes continuous running. The unit weighs a little over 9 lb. and measures 12½ x 5½ x 4½ in. No price has yet been announced.

NEXT MONTH

TUESDAY 14TH FEBRUARY is publication date of the *March Tape Recorder*. The first of a short series describing construction of a high-quality transistor mixer will be contributed by John Fisher. A. J. Lowe will describe the construction of a "rotator"—designed to ensure absolute freedom from background noise when employed with a bulk eraser. Alec Tutchings will review the *Eltra 1001*

# Excitingly easy new way to play music and record sound!

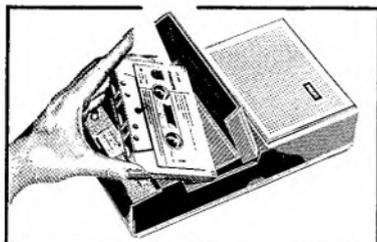


## PHILIPS

# Cassette Recorders

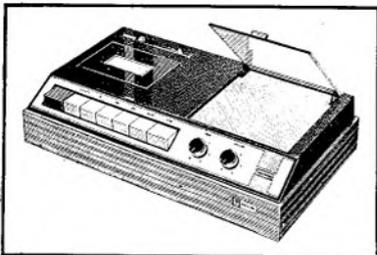
Sometimes you need a music player. Sometimes you need a recorder. Get a Philips Cassette Recorder and you have both—for the price of one! For instant recording or playback, snap in Compact Cassettes. For your choice of music—instantly—snap in Musicassettes. Nothing's simpler or more exciting. All models come with demonstration Cassette, library rack, microphone with stand, direct recording/playback lead.

**Compact Cassettes: C60 (plays 60 mins) 19/6: C90 (plays 90 mins) 27/6  
Musicassettes (famous recordings) 40/-**



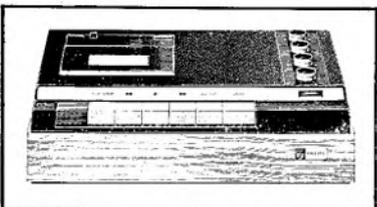
### Battery Portable Model EL3301T 27 gns

Plays and records anywhere, travels in a handy carrying case, has simple controls, plays Musicassettes in mono. Complete with Compact Cassette and remote stop/start control on microphone. Can even be mounted in a car, using Mounting Unit Type EL3794: £12.10.0.



### Mains/Mono Model EL3310 35 gns

Automatic Recording Control regulates recording level for you. 'Sound Mirror' reflects sound towards you. Push-button cassette ejector for rapid cassette changing. Plays Musicassettes in mono. Slim, teak-finished cabinet.



### Mains/stereo Model EL3312 48 gns

Plays Musicassettes in stereo—makes lifelike stereo recordings too. Variable tone and stereo balance controls. Push-button cassette ejector. Teak-finish cabinet. Supplied complete with moving-coil stereo microphone. Speakers, recommended type GL559, optional extras: 10 gns. (+ 3/1 P.T. surcharge) each.



## PHILIPS—the friend of the family

Philips Electrical Limited, Century House, Shaftesbury Avenue, London, W.C.2.

**D**ICTAPHONES apart, the *EMI L4* is the only battery sound recorder now being manufactured in this country. Eleven years ago, its remote ancestor—the *L2*—was one of the few portables available in the world. Like the *Wearite* tape deck, this machine is almost as old as the tape recording hobby itself.

Mechanically, the *L2* and *L4* are loosely related. Electronically, however, there is little similarity. The family tree runs rather as follows: Valves were employed throughout the *L2* tape amplifier until 1960, when the *L2/TA* appeared. This was mechanically identical to the original *L2*, but was fully transistorised. Minor improvements in 1961 led to the *RE321*, again mechanically almost identical, which continued until the appearance of the *L4* in 1965.

Although of similar dimensions to the *RE321*, the *L4* embodies a substantial face-lift and many extra facilities, plus a substantially better performance specification. Whereas the *RE321* lacked facilities for tape erasure, fast rewind and mixing, the *L4* is in all respects complete. A  $3\frac{1}{2}$  i/s tape speed has been added, but is really only for emergency use, since equalisation is to  $7\frac{1}{2}$  i/s. Despite the increased flexibility, the basic *L4* is some £4 cheaper than its predecessor.

Though there has been no major concession to popular styling, the current *EMI* embodies several up-to-date design features. Radial head mounting, for example, is employed to hold the tape against the heads, overcoming the disadvantages of pressure pads and pins. The pinch-wheel is of hard *Neoprene*, claimed to remain free from permanent deformation if the remote motor cutout is used. A sprung guide by the feed-spool turntable ensures even back-tension throughout the reel. Rechargeable batteries are available as standard accessories (at extra cost) and are attached to the power input in such a way that the connection of incorrect polarity is impossible. A three-position input bass filter is incorporated on the two microphone channels, and may be positioned to select zero, -5 or -10 graduations. These are evidently dB figures, though no reference could be found in the manufacturer's literature regarding the frequency at which these figures apply. Suffice to say that the filter proved a great asset on several unfavourable locations, to reduce wind rumble and traffic noise.

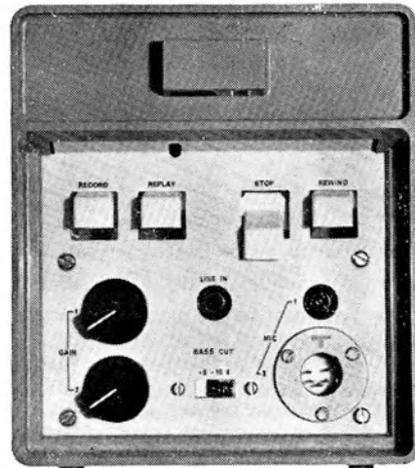
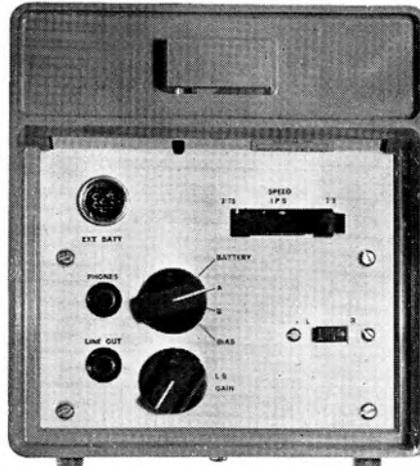
Before discussing the recorder's performance subjectively, a description of its mechanical layout and controls might be worthwhile. Whereas the *RE321* was encased in wood, the *L4* is housed in a metal cabinet, supported at the sides by a pair of plastic mouldings. The complete assembly—nameplates, metal 'belly' and mouldings—is extremely rigid. A clip-on *Plexiglass* lid protects the upper deck components, while retaining the facility of keeping a visual check on the meter and spools. Slots in the side mouldings are provided, through which a shoulder-strap may be threaded, with or without the accessory waterproof carrying-case. I have yet to find a portable that went into its case without a struggle, and the *L4* is no exception!

Mechanical controls are situated on the right-hand side of the machine and comprise four plastic press-tabs. From left to right,

## FIELD TRIALS OF BATTERY PORTABLES No17



# EMI L4



BY DAVID KIRK

these are **RECORD** (interlocking with the adjacent **REPLAY** tab), **STOP** and **REWIND**. These controls had a pleasing feel about them, being light and positive in action. The **STOP** tab left one in some slight doubt, however, since this could be locked right down as in the photograph below, or left on a plane with the other tabs.

It took me some weeks to become fully accustomed to the positions of these tabs, during which time an element of vagueness existed whenever—as normally occurred—one used the controls without looking at them. It is near-impossible to see which tab one is pressing when using the machine from the shoulder in its waterproof case. My most frequent error was to press the rewind tab at the end of a recording, when I wished merely to halt the tape. Possibly some knurling, or alteration in shape, of the **STOP** and **RECORD** buttons would make finger-tip recognition easier for unfamiliar users.

Similarly, the microphone mixers should be regarded as pre-set controls when working in the field. Even when using a single microphone, it was difficult to vary the tape modulation level while recording. The two microphone gain controls are located opposite the input sockets, *Mic.1* being a balanced tip, ring and sleeve jack, while *Mic. 2* is a five-pin *Cannon XLR-5-14*. No external control is incorporated for the line input, and individual external attenuation would sometimes be required if one were to dub into the *L4* from other equipment. Although the designers were obviously fearful of over-cluttering the side panels, some immediately accessible line potentiometer would have been useful, even if only a pre-set of the type incorporated in some *Tandberg* recorders.

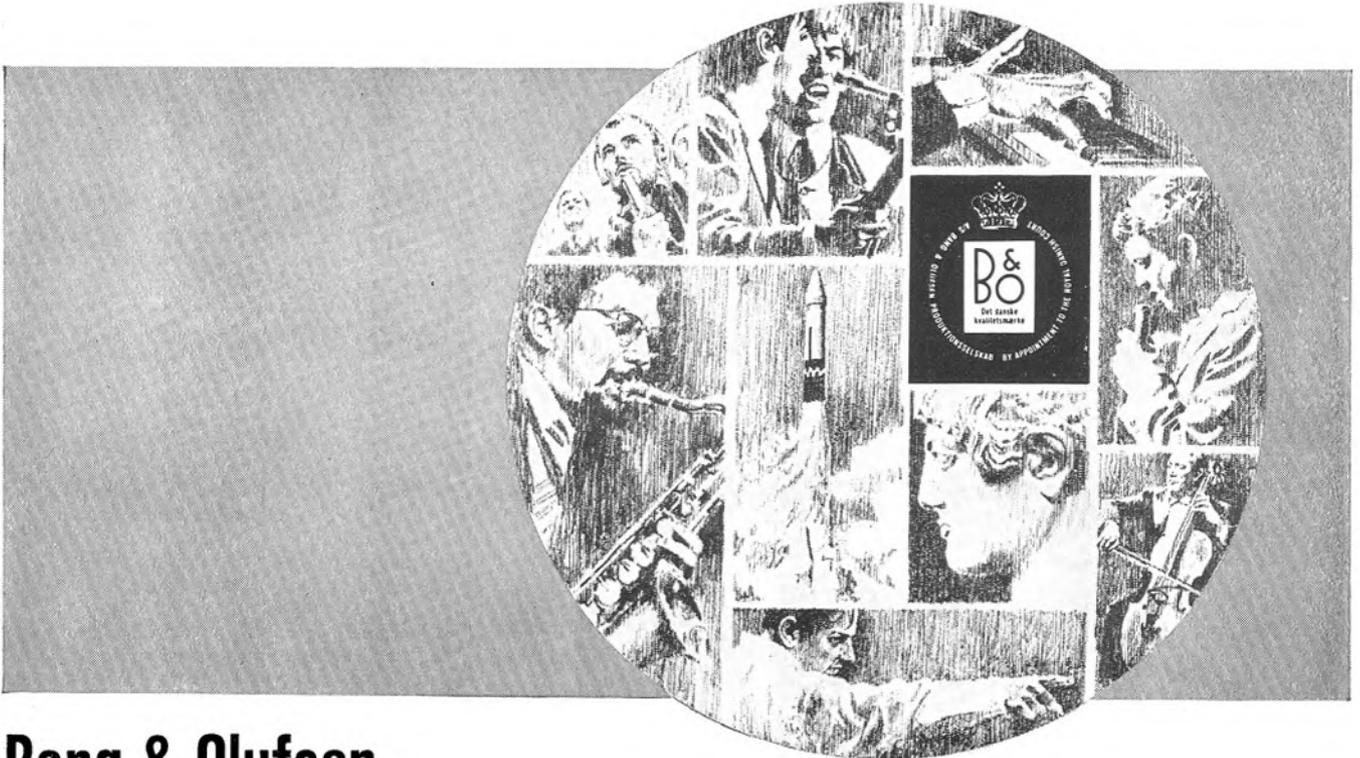
A gain control on the left-hand side of the cabinet governs the output of a low-power monitor amplifier, which feeds a small built-in speaker. This speaker is automatically disconnected on insertion of a jack at the headphone socket. The monitor amplifier may be switched to a tapping in the recording amplifier to indicate the signal that should be going on to the tape, or to the replay head to show what really *has* gone on. This latter 'off-tape monitoring' facility warns the operator if, for example, the tape has snapped or been wrongly threaded (inside-out, perhaps). It is a worthwhile feature, but should be exercised with care. One cannot conduct an interview or speech sensibly when every word is being fed to the ear a quarter of a second later. Nor can one guard quite so effectively against sudden overload. (Where is the Hoyle-inspired genius who can develop facilities to monitor sound *before* it is generated!)

From the above it will be gathered that the **VU**-meter registers the signal being monitored, and is not wired permanently to the recording amplifier. The meter also shows audio signal level on replay.

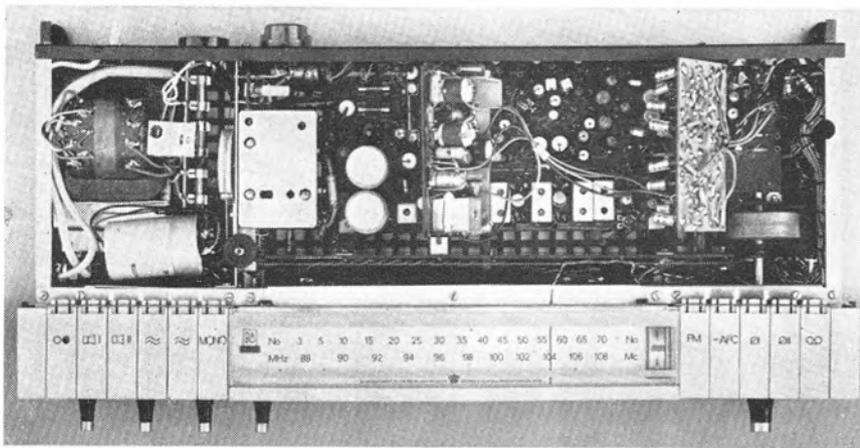
Other settings on the 'live/taped' switch connect the meter to read battery voltage and bias current. Bias can only be measured during recording, since only then does the oscillator function; not a self-evident fact, since at least one semi-professional recorder has its oscillator in circuit during playback.

The two most important features of a battery tape recorder, to my mind, are wow and flutter

(continues on page 71 f)



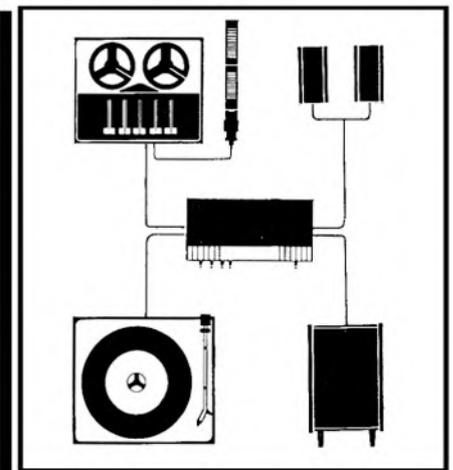
## Bang & Olufsen— for those who consider design and quality before price



This is what you would see under the elegant case of a Beomaster 1000K F.M. Tuner Amplifier. Solid state circuitry throughout, separate and hinged component panels, stereo decoder already fitted, and components of the highest quality and closest tolerance.

Notice too the positive piano key mode selectors, which require only finger-tip pressure to operate, the long tuner scale for easier and more accurate station finding, fly wheel balanced tuning drive and large radicator type tuning indicator. This must be the most sophisticated high fidelity tuner amplifier available at such a modest price.

**Technicalities.** *Tuner unit:* 88-108 Mc/s with switchable A.F.C. Sensitivity 2  $\mu$ v for 26 dB signal/noise ratio. Aerial 75 to 240 ohms. Stereo transmission channel separation > 34 dB. *Amplifier section:* Power output 2 x 15w R.M.S. Less than 1% distortion. *2 Gram inputs:* Crystal 250 mV, magnetic 7 mV for full rated output. *Tape Recorder:* Input 20 mV for full rated output. *Outputs:* 2 x 3/5 ohms in duplicate and switched. *Frequency response:* 30 c/s to 20 kcs  $\pm$  3 dB. *Bass Control:* +10 dB to -14 dB/80 c/s. *Treble Control:*  $\pm$  12 dB/10 kcs. Price: 80 Gns.



Bang & Olufsen's design theme continues throughout the whole range. For further information on Tape Recorders, Loudspeakers, Turntable units and accessories see your local B & O Dealer now or write for his name and our illustrated catalogue to:

**Bang & Olufsen**  
U.K. Sales Division,  
Eastbrook Road, Gloucester.  
Telephone: Gloucester 21591

# OUR READERS WRITE . . .

## . . . about plonks, plops and pops

From : H. E. Owens, 82 North Road, Highgate, London, N.6.

DEAR SIR, The 'plonk' syndrome (December *Readers' Problems*) afflicted my recorder even after modifications to prevent sudden application of bias and the recording of spikes from the deck switching.

With this machine, clicks, or more precisely a double 'plop', always occurred on recordings that had been interrupted and re-started by the pause control.

The cause was hum in the recording amplifier, too weak to be noticeable on normal replay; but when recorded at low speed as the tape accelerated from rest, it would play back as a tone beginning at a few hundred Hertz and sweeping rapidly down to 50Hz. This registered subjectively as a 'plop'.

Attention to input circuits removed hum from the record head and cut the double 'plop' to a single 'pop'. Complete cure came by isolating the erase head (with a  $1\mu\text{F}$  series capacitor) from 50Hz induced into the oscillator coil by the adjacent capstan motor.

*Yours faithfully,*

## . . . about Philips servicing

From : P. Hold, 'Angorfa', 25 Linthorpe Road, Buckley, Flintshire.

DEAR SIR, Apropos your December Editorial and the item in your *World of Tape* section about *Amalgamated Electrical Services Ltd.*, I would like to comment as follows. I have been, and still am, the owner of quite a number of electrical appliances, including tape recorders, manufactured by the *Philips* organisation. To me as a seafarer and sometime country resident, one of the main factors in my choice of such equipment is what I like to call the 'reliability factor'. If the need for servicing should occur, it has to be speedy,

efficient and easily available. Over the past eighteen years I have had to avail myself of the services of the above-mentioned company on only three occasions; twice this was achieved by post and on one occasion I was able to call personally. My requirements were handled with the minimum of delay; the repairs or replacements functioned completely satisfactorily, and on the occasion of the personal visit, to repair a car-radio damaged when my vehicle was stolen, I was treated with all too rare courtesy and no charge was made!

I have long wished to show my appreciation, and your remarks, together with reading of the all-too-frequent unfortunate experiences of many other people with other companies, spurred me to write to you in this vein. I can honestly and sincerely state that Philips are indeed a Friend of this Family.

*Yours faithfully,*

## . . . about lubrication

From : K. Holford, 30 Sandcross Lane, Reigate, Surrey.

DEAR SIR, I recently read the article on *Lubrication* by William Henry (May 1966).

The theory put forward, that contact lubricants lower contact resistance by their electrical conduction, is often versed, but as yet unjustified. Certainly not by the 400M per  $\text{cm}^2$  quoted for *Electrolube*.

The active area of a pair of small contacts is probably not more than one square mm. Other parts of the contact surrounding this area, even though they are only .01mm. apart, are much too far apart to matter, as will be seen in a moment—and the surface irregularities are of this order.

What is a reasonable contact resistance? Let us take 100 ohms and, although this is very high, it will be seen that the liquid film is no help.

How close are contacts when the liquid between is 100 ohms? Answer:  $2.5 \times 10^{-7}$  cm. or  $\frac{1}{20000}$  times the wavelength of light!

Even if heating lowers resistivity by 20,000 times, we still need contacts flat to a wavelength! Thus the figure  $400 \times 10^4$  can be dismissed as irrelevant.

An alternative theory is that a liquid film keeps oxygen away. Ordinary thin machine oil also seems very effective. *Yours faithfully,*

## . . . about PTFE

From : J. W. Barney, Esq., 65 Fontmell Road, Broadstone, Dorset.

DEAR SIR, Referring back to the August 1965 issue in which you advocated the use of Polytetrafluoroethane (PTFE) as a cure for tape squeaks, I would like to add the following comments:

The PTFE sleeve works well and I have overcome the problem of mounting it on the deck of my *Grundig* by employing the automatic stop pin as a support—though this prevents that mechanism from working, of course. Readers may find, as I have done, that the squeak disappears when the sleeve is used, and that about a dozen fast winds before actually recording on to a new tape seems to effect a permanent cure.

*Yours faithfully,*

## . . . about sockets abundant

From : C. C. Kindred, Stone Farm, Great Glemham, Saxmundham, Suffolk.

DEAR SIR, My tuner has outputs via coaxial sockets. The preamplifier takes Phono plugs, the main amplifier Octal. One tape machine, a *Uher*, has three different DIN sockets, plus a flat-pin and rod speaker output. The *Ampex* machine uses phono and GPO Jack plugs, and now to cap the lot my second-hand mixer has five sockets which take jack plugs of slightly less than GPO dimensions. This has become ridiculous. If motor and tractor tyre manufacturers can all conform to a standard air-valve, surely hi- and low-fi equipment manufacturers could make do with one, two, or even three sizes of socket.

*Yours faithfully,*

## EMI L4 FIELD TRIAL CONTINUED

and signal-to-noise ratio. Speed fluctuation only proved troublesome when the accumulator began to collapse, and it was found that very little warning was given at the end of a charge. A  $7\frac{1}{2}$  i/s recording of a Southend Airport *Carvair*, when reproduced, sounded more like a rocket than an aeroplane, the speed having fallen suddenly to some 4 i/s when the tape was made. The meter fell quickly enough as the tape speed dropped.

The recorded background noise on the L4 was very low indeed, and it is hard to believe that a centrifugally-operated governor has been in operation when recording from a line source and replaying through an external amplifier.

There are some reservations, however. A great deal of motor hash was present in the monitor amplifier; it was quite audible on the internal speaker and made headphone monitoring very difficult indeed. But this hash did *not* appear so strongly on the tape.

A small degree did break into the recording amplifier, nevertheless, when the microphone gain controls were turned upwards. For serious microphone work, therefore, one should either use an external mixer, feeding into the line socket, or have the L4 modified. I understand that EMI have overcome the crackle problem, and can certainly confirm that another L4 that I have handled was very much quieter. At the risk of causing confusion, perhaps I can explain that the quiet model was the first L4 submitted for test. It was returned after developing an apparently unconnected electrical fault.

The replacement L4 has been used for some months without displaying any similar fault and has showed no signs at all of mechanical deterioration. Since the mechanism is solidly constructed, and the heads exceptionally easy to clean, the L4 should have a lengthy useful life. The same cannot be said, however, of the rechargeable battery supplied with the machine. These are German *Sonnenschein* accumulators. This brand was supplied, some two years ago, with a Japanese portable, and

the sample in question functioned for many months before its charge became too short to be of practical use. Both accumulators supplied with the L4's, however, gave up completely after only a few weeks, despite being carefully stored at more-or-less full charge. The claimed lifetime of three hours continuous recording per charge was certainly never met in practice. A conventional battery pack, designed for U7 cells, is available as an accessory. Specified life, for this, is 30 minutes.

To put these critical points into perspective, for we are dealing with a machine costing well over £100, perhaps I can convey my reaction to the overall quality of the L4 by saying, simply, that it is one of the three portables I should most like to own. Provided that EMI continue their policy of keeping up with the times, and develop an electronically-controlled drive system to bring wow and flutter into line with European standards while removing the last trace of motor noise, then the descendants of the L2 will retain their position as being among the finest battery recorders in the world.

# telesonic



offer  
the  
**ELTRA**  
nation wide  
on 7 days approval

Our vast experience in nationwide selling enables us to offer today's best value and most reliable tape recorder. The Eltra 1001 High Fidelity Tape Recorder featuring 3 speeds ( $7\frac{1}{2}$ ,  $3\frac{3}{4}$ ,  $1\frac{7}{8}$ ), 7" reel capacity, two-track recording, 2-channel mixer amplifier with monitoring facility, individual bass and treble controls, power output better than 6 watts, frequency response 50-18,000 Hz  $\pm$  3dB at  $7\frac{1}{2}$  i.p.s., signal to noise ratio better than 54dB at  $7\frac{1}{2}$  i.p.s. Tasteful Scandinavian styling with unique carrying handle.

Send 49 gns. and you can enjoy the Eltra in your own home on 7 days approval with full refund guarantee.

H.P. Terms arranged : send the full price and when you decide to keep the Eltra we will refund two-thirds and you can then repay this over 12 months to suit your budget.

### TWO 1200ft. TAPES FREE

Yes! Two 1,200ft. tapes value £3.10.0 given free to all customers who decide to keep the Eltra (this special free tape offer expires February 28th, 1967).

To telesonic Ltd., 92 Tottenham Court Road, London, W.1.  
I enclose 49 gns. ; please send me the Eltra 1001 on 7 days approval.

Name .....

Address .....



## A Winner

The DP4 microphone is another winner—by performance alone it has achieved world wide acclaim. It is used regularly by P.A. engineers, broadcasting and television companies, film studios, etc., as well as by many professional and amateur tape recordists. Its winning qualities have been designed and produced by Grampian—specialists for over thirty years in the field of sound equipment. We shall be pleased to send you full technical details of the DP4 and other microphones, together with descriptions of various accessories.

Specially designed to use with the DP4, in order to cut down wind noise is the Wind-shield — as illustrated here.



There is also the "Grampian" Parabolic Reflector. Where it is not possible to place a microphone close to the source of sound such as when making recordings of bird songs, weddings, car and train noises etc. the Parabolic Reflector has been proved over and over again to be of enormous value.



Grampian Reproducers Ltd.,  
Hanworth Trading Estate, Feltham, Middlesex.

\* Member of the Oxford University Institute of Experimental Psychology.

THE possibility of sleep-learning has a powerful fascination for the indolent and the overworked alike. Can we really, as has been claimed, achieve "92%—100% retentivity" during the lost hours of our lives? Can we emulate the American Post Office worker who "memorised the names of 16,000 streets in his sleep", or Art Linkletter, who "mastered sufficient Mandarin Chinese after only ten nights of study to enable him to converse freely in this language with the Vice-Consul of China during a television interview"?

Sleep-learning, or *hypnopaedia* as its proponents name it, is widely depicted both as new and as unquestionably demonstrated. It is neither.

No learning whatsoever was found of material presented during sleep, whether or not the items were repeated many times, and only very slight and inefficient learning was found during drowsiness.

More recent experiments have been reported from Eastern Europe, and the Czechoslovakian and Russian experimenters, together with Mr. Geoffrey Stocker, President of the *British Sleep Learning Association*, emphasise the necessity of a 'conditioning' or 'induction' procedure, which was lacking in the Simon and Emmons experiments. The conditioning procedure is said to awaken a 'vigilant centre' in the sleeping brain and thereby permit the assimilation of material that otherwise would not be admitted.

In Czechoslovakia hypnopaedic broadcasts were made weekly for ten weeks by a provincial broadcasting station and it was initially claimed

taken the drugs not only with a control group who have not taken the drugs but also with a group who *think* that they have been given the drug but in fact have been given a harmless placebo. In some psychopharmacological experiments the placebo group have shown 40% of the effect shown by those who actually had taken the drug.

In an analogous experiment on sleep-learning one group of subjects would be told that the material to be learnt would be played to them during sleep, whereas, in fact, no words, or better still, a different set of words, would be played to them. It might be found that their day-time learning was as rapid as that of those students to whom the correct words had been played during the night.

Such an experiment, together with the proper monitoring of the EEG to ensure subjects were not awakening, seems never to have been reported in the Western scientific literature. Consequently there is no proof that sleep learning can occur at all. Dr. Ian Oswald, one of Britain's leading medical research workers in the field of sleep and now Professor of Psychological Medicine at the University of Western Australia, has recently expressed his complete scepticism.

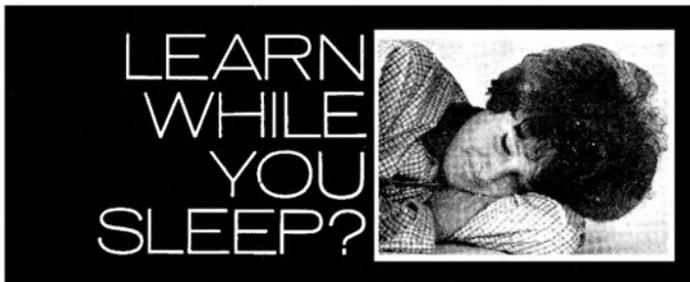
Can more primitive forms of learning occur during sleep? Krasnogorski, a pupil of the great Russian physiologist Pavlov, reported in 1931 his failure to establish a conditioned salivatory reflex in a sleeping dog. Dr. D. G. McDonald of the US Navy Neuropsychiatric Research Unit has recently been unsuccessful in trying to condition, during even very light sleep, the physiological responses of man to electric shock.

Even if there were any conclusive evidence for the occurrence of sleep-learning, prospective students might consider two further points:

First, even the most optimistic Russian reports admit that all people are not equally capable of sleep-learning; consequently it might be foolish to buy expensive equipment without prior experiment. The basic equipment (in addition to a tape recorder), time switch, pillow speaker, endless cassette and induction tape, will cost fourteen guineas or more, and each instruction tape another three or five guineas. At least one of the English companies selling sleep-learning equipment has a hiring system, and it might be wise initially to take advantage of this service.

Secondly, it would be surprising if there were not an excellent reason why, in the course of evolution, the brain has come to inhibit sensory input during sleep, and consequently it might be extremely unwise to employ artificial means to break this resistance. There is a growing belief among neurophysiologists that dreaming serves an important function, possibly equivalent to the 'programme clearance' of a computer. Everyone normally dreams several times each night: a sleep-learning tape might well interfere with the normal cycle of sleep, and, since different individuals show different patterns of sleep, it is impossible for the home-user to ensure that the tape is not playing during those periods of rhombencephalic or paradoxical sleep during which dreaming occurs.

Limited sleep-learning *may* be possible and it *may* be innocuous, but it may be nothing more than an expensive humbug.



### SOME CRITICAL COMMENTS

By JOHN MOLLON\*

Experiments on the learning of material such as the Morse Code during sleep were conducted by the American military authorities during both First and Second World Wars, and again during the fifties: all were inconclusive. By the late forties, however, manufacturers of recording equipment in the United States had already realised the considerable commercial possibilities of 'sleep-learning' and a wide, and costly, range of equipment was soon offered to a gullible public. Whatever the evidence now, it is quite certain that at that time there was no experimental evidence whatsoever for the efficacy, or even the occurrence, of hypnopaedia.

A few experimental results, some positive, most negative, appeared in the scientific literature of the early fifties, but some experiments lacked control groups and in none of them was sufficient care taken to ensure that the subjects did not wake up while the tape was being played to them. Then in 1956 Charles Simon and William Emmons, two American scientists working for the *Rand Corporation* in collaboration with the USAF, published details of a particularly careful and thorough series of experiments in which the subject's *electroencephalogram* was monitored throughout the night. The electroencephalogram, or EEG (see illustration), is a recording from electrodes placed on the subject's scalp and may be employed to determine his state of sleep.

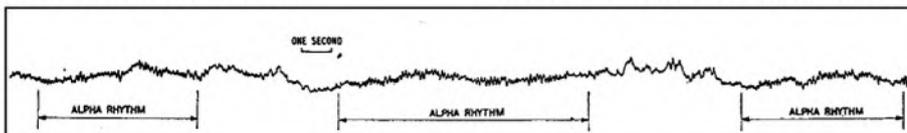
Segment of EEG recorded from electrodes placed on the scalp over the occipital cortex, illustrating the 8-13 Hz 'alpha rhythm'. Simon and Emmons took absence of alpha rhythm as evidence of sleep. By courtesy of T. R. Watts.

that students acquired sufficient English for basic conversation.

Research on sleep-learning in the USSR is particularly associated with the name of Professor Bliznitchenko. In Bliznitchenko's experiments, however, as in most other recent reports, sleep-learning was combined with day-time study and it is consequently impossible to determine whether repetition of the material during sleep is having any effect. In the Czechoslovakian experiment the nocturnal broadcasts were preceded by *five hours* of day-time teaching and the students were required to perform additional homework. Nor was there any control to ensure that they did not awaken during the night. Dr. V. Fried, lecturer in English at the Charles University of Prague, has been reported (*New Scientist*, 24th February 1966) as considering that the daytime broadcasts in themselves were sufficient to account fully for the students' progress.

Even if students combining nocturnal learning with daytime study do appear to learn more rapidly than students performing only the same amount of daytime study, this is no evidence at all for sleep-learning. The sleep-learning subjects may learn faster only because they have been persuaded that they will.

It is for this reason that experimental psychologists have an extreme distrust of classroom research into educational methods. Experiments on new educational techniques are invariably successful simply because teachers and pupils alike are better motivated. In medical research into the effects of drugs it is customary to compare the subjects who have



**T**HE Optacord 408 is one of a number of machines imported from West Germany by *Highgate Acoustics Ltd.* It is by no means chosen for this month's contribution as the best of the range, but in response to frantic queries from those who have been fortunate enough to pick them up cheaply on the second-hand market, and as an example of one type of circuitry which we have so far not had the chance of describing.

A field-trial of this model appeared in the April 1966 issue of *Tape Recorder*. In this brief operational write-up, David Kirk included the statement: "the 408 is no machine for the home serviceman." His advice is not without validity, for in this model as with all the Optacord range, *Loewe Opta* have compressed quite a lot of mechanical gubbins in a confined space. In addition, the electrical system is a mass of interconnected wiring, with relevant bits appearing in the most unexpected places. Patience is the keyword when tackling the 408.

And tackle it we must, for a dealer is likely to turn up his nose at a request for service, or quote a charge that is meant to be a deterrent. The importers are not so keen on

supply, if this is around 220V, the output from the power supply unit should also be around 6V. This is measured across C27 (see Fig. 1), taking in the control circuit of Tr8 and the zener diode in its base. This assembly is to the right, viewing the base of the machine with the battery compartment towards you. Actually, the motor control circuit is so efficient that changes in voltage from  $4\frac{1}{2}$  to  $7\frac{1}{2}$ V have been noted with little effect on speed. The stroboscopic markings on the upper rim of the flywheel, visible when the plastic head cover is removed, are used for factory checking, but our best method is with a test-tape and audio generator. Long-term tests, as with measured tape, etc., are not much help with this kind of adjustment.

#### WORKSHOP METHOD

The method used in our workshop, which may seem crude, is to play a 3kHz test-tape through while listening to the 3kHz tone from the audio generator fed to our bench monitor. The discrepancy in speed is immediately apparent, and as the speed approaches correct running, the beat note effect becomes very obvious. (Mr. Tutchings

be adjusted by movement in its cradle, relative to the two rim facings (flywheel and LH turntable) on which its pulleys bear. To check the current consumption, first unsolder the connection to the right-hand of the five tags on the motor panel mentioned above—still with the machine in the inverted position, battery compartment (rear) towards you. Insert a milliammeter capable of reading between 100 and, say, 500 mA. Exact range, of course, depends on the meter, but always err on the high side initially when taking current readings, to avoid the risk of wrapping the pointer around its stop!

Refer now to fig. 2, accepting my apologies for its surrealistic appearance. Slacken nut B and move the motor axially until a current reading of between 170 and 190mA is noted. This is a minimum reading, and is for the play or rewind function without tape. The pulley contacting the L spool rim must be firmly pushing, and to get this exactly right, move the motor around on its centre-point (pivot about A) before retightening B.

Next, to get the tape speed right, loosen the screw A, taking care not to disturb the other movements of the motor, and shift the

TAPE RECORDER SERVICE NO. 62 BY H. W. HELLYER

## LOEWE OPTA 408



having them back for repair, even from their accredited agents. Moreover, to judge from our own trade experiences, they have no service engineers of their own, but have to farm the work out—with the resultant increase in costs. I may be wrong, and shall surely be sat upon heavily (as usual) if I am.

#### VARIOUS MODES

Perhaps the most important single measurement in the servicing of the 408 is the motor current consumption in the various operational modes. This gives the first clue to the fault source if the trouble is mechanical—and it usually is. The battery is a total of 6V, from four cells, with the mains plug inserted in its interior socket to complete the negative circuit. When operated from the main

will probably have a seizure to read of this bludgeon method, but we find it swift and effective for bench work to normal limits.)

Speed of the motor of the 408 is determined by regulation of the switching pulses, and without an oscilloscope there is not much chance of checking whether these are indeed zeroing completely, as they should. But, on the other hand, the only parts of this circuit likely to give any trouble are the 5 $\mu$ F electrolytic, C36 and the little diode Gir 2. Both these are on the sub-panel between the battery compartment and the motor itself.

Current consumption of the motor, with a 6V supply, should be as follows: With tape—fast forward, 480mA; rewind 500mA. Without tape—play, 180mA; fast forward, 350mA; rewind, 200mA. Motor speed can

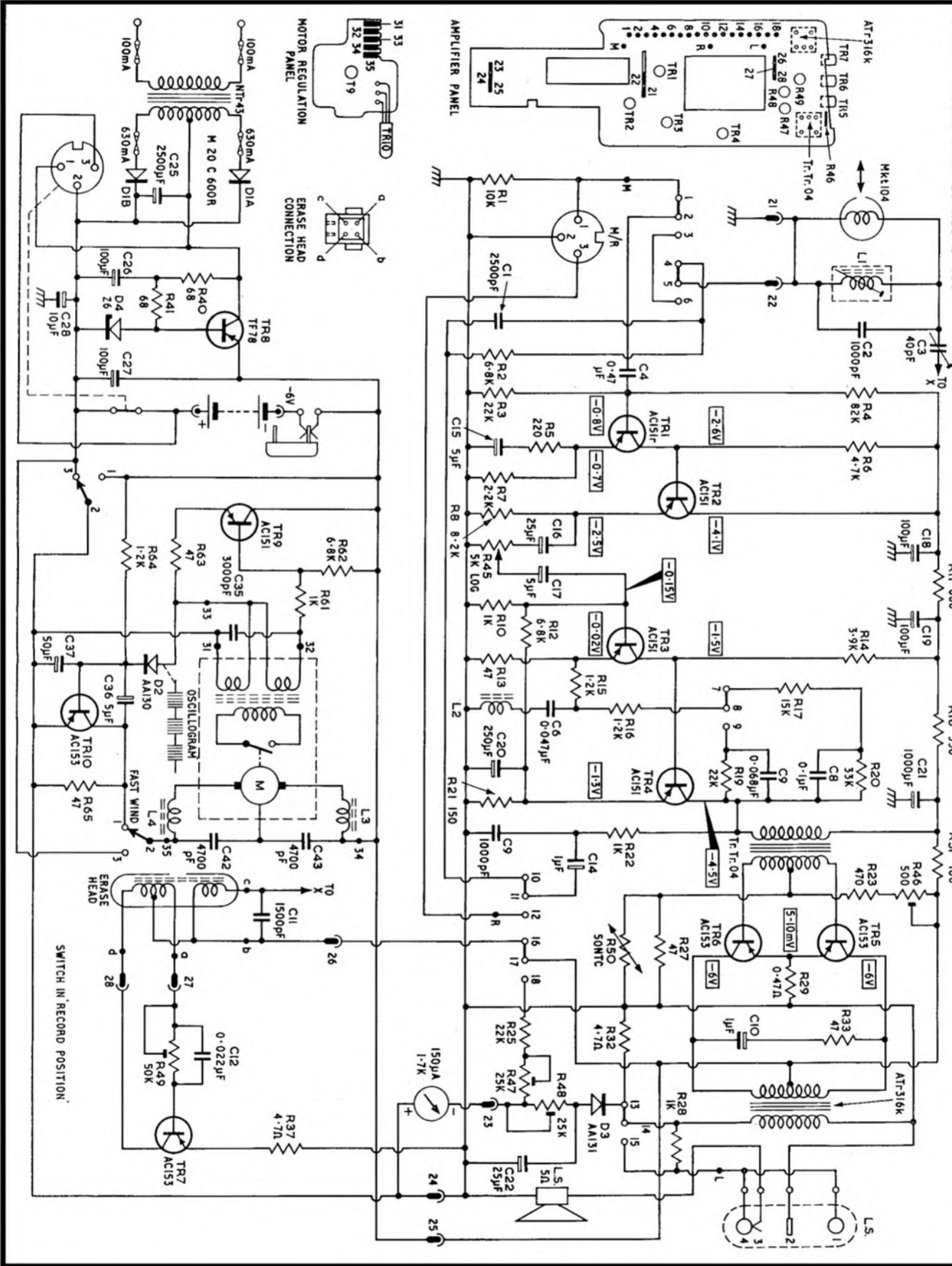
motor on its bearing to give precedence towards either the flywheel or the spool carrier. Moving the motor towards the flywheel increases the speed. A little thought shows that as the pulley approaches the capstan it has to push along a shorter path for each revolution of the flywheel relative to the constant revs of the motor.

#### SIGN OF SKIDDING

To check that the pressures are correct, switch to play and stop the flywheel by hand—this should stop the motor. If it does not, and if there is the least sign of skidding, beware! The outcome is usually an uneven facing on the flywheel rim and either a knock or a wow. Switching to rewind and halting

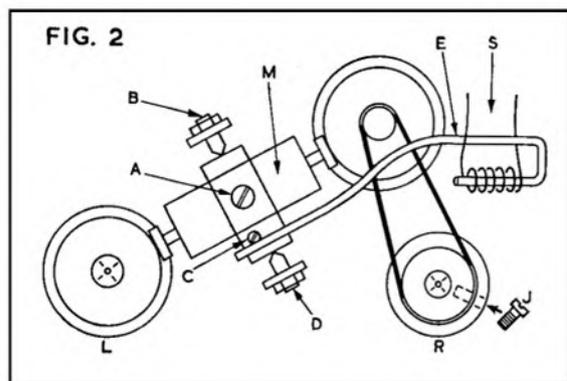
(continued on page 62)

FIG. 1 LOEWE OPTA OPTACORD 408



## TAPE RECORDER

### SERVICE CONTINUED



the left turntable by hand should similarly stop the motor instantly.

If there is still too much thrust after the above adjustments are made, we must check that the motor is being correctly positioned by the action of the selector mechanism—and here is the bugbear. The large hooked rod E is connected to the motor housing at one end and rests, supported by its spring S, just behind the selector keys. It is absolutely vital that this spring does not foul any other part of the mechanism, and if there is any need to adjust it, take the utmost care not to overdo any bending or twisting, for the complete driving operation of the machine depends on the rocking action imparted to rod E by the opposing torsions of the ends of this coiled spring. The chap who dreamt up this system should have had a medal. It is even more delicate than the *Luxor's* hairpin springs, though it looks quite a solid piece of ironmongery.

The screw D in fig. 2 is slackened slightly, and the hooked rod E can be moved in relation to the motor so that there is about a half-millimetre clearance between each motor pulley and its relevant driven surface when the mechanism is in the neutral position. The nut D can be used as a fine height control, in conjunction with the last adjustment, taking care when retightening not to disturb the overall positioning. This is really the secret of L-O adjustments; patience and careful relocking.

Brakes are simple rim types, actuated by a cranked rod which passes under rod E, its control key end hooked into a grommet and the outer end pulling the brakes on when the stop key is depressed. As the brake lever is pivoted at the left side, there is a tendency for the reservoir spool to brake slightly ahead of the other, but care should be taken not to overdo this, or spillage will occur when stopping from fast rewind.

The right-hand turntable is driven by a clutch mechanism, with the lower drum coupled to the flywheel by a triangular section belt. There has been no tendency for this belt to stretch, which is just as well, for replacement entails some sleight of hand. The torque is also adjustable, this time by a fine screw through an aperture in the side of the

upper section of the drum, shown dotted at J in fig. 2. Only a very small movement is needed here—slacken off too much and you will be faced with the unpleasant task of dismantling to refit the fine-threaded screw. A quarter turn anti-clockwise to reduce snatch or a similar amount clockwise to ensure smooth pull-away with a full spool on the left and the leader threaded and turned on by hand to the right, should be quite enough—unless the gremlins have got at this point also.

There should be little need to outline azimuth adjustment and pinch-roller pressure adjustments, as these screws are quite obvious, and their action plain to see. But there is an additional adjustment affecting the pressure arm movement, and this is underneath. Just beneath the spring S (view with machine inverted as in fig. 2) there is a rod and an adjustable conical roller. The position of this latter is very important for the inward throw of the pressure arm. As the flywheel spindle is quite fine, over-tensioning will tend to make the tape run up or down—a fault which can also occur when take-up spools snatch too fiercely.

Other factors affecting tape transport are the left-hand guide and the auxiliary pressure pad that contacts the erase head. Watch out for trapped particles of oxide in the former, especially in the angle between upright face and top, and also for hardening of the latter.

A final mechanical point to look out for is the action of the record/play switch, which has a lever coupling from the interlocked keys, and whose action is easily affected by slackness in the fixing of the circuit board. If the machine has been dismantled, there may be a chance of cables having been trapped beneath this lever; the small harness from the volume control runs under here, and as the action at the switch end is a kind of angled key, small variations at the bottom are quite enough to throw out the switching travel at the top. Again, fast winding is effected by putting the motor directly across the supply, open-circuiting the control from Tr10, and this is done by a microswitch, mounted near the volume control, and actuated by a pad on the arm which is controlled by yet another rod. Before making mechanical adjustment

to regain fast wind, if this is the fault condition, make sure this microswitch is changing over and the motor receiving its supply.

The oscillator, Tr7, provides 80V, measured at the bias trimmer (oscillator side) at a frequency of 55kHz. A valve-voltmeter is needed for this measurement, although some indication will be obtained with a fairly good AC meter, if this is all that is available, and the adjustment resistor for oscillator amplitude, R49, is to be found right at the opposite end of the board from the volume control, near Tr7, which is the upper of the three transistors at this end. The bias adjustment capacitor, C3, is on the upper board, with the head mounting assembly, and is simply adjusted for best output and minimum distortion when recording—which is, of course, a compromise.

Near R49 are other variable resistors, the two nearest the loudspeaker being used to control the meter reading. The lower, R48, adjusts for correct recording level indication, the needle being set to lie on the red/black division when a reading of 1V RMS is obtained at the collector of Tr4 with an input signal at 1kHz. The upper of this pair, R47, adjusts for battery state indication, the needle lying in the same position when there is 5V between the motor drive terminals on playback.

The other variable resistor, towards the top of the same end of the board, is R46, used to set the collector current of the push-pull output stage by regulating the base voltage. With no signal, check that there is between 5 and 10mV across the common-emitter resistor R29 and adjust R46 for balance. This is easy with an oscilloscope and a 1kHz input, when the adjustment can be made by scoping the two sections of the output transformer. But an aural test can be made by slightly varying R46 and making a series of tests with increasing input until overload conditions are reached, when the position giving least distortion will be the correct setting.

L1, the coil on the head panel, is a trap to eliminate interference from the oscillator, and should not be touched. With the gain control at full volume and no input, the signal measured at Tr4 collector should be less than 300mV. Combined with the correct bias setting and correct battery voltage and motor regulation, the signal-to-noise ratio should then be 42dB for a dynamic range of 46dB.

There may be some confusion over the input loading, as with many other transistorised machines. David Kirk noted that "recordings made through the high level socket suggested that the 408 was less suited to music than speech". This was probably due to a misunderstanding, as the single socket is an input/output device, permitting no mixing of microphone and radio signals. (*My turn to be sat on!*—D.K.) The terminal 3 is an output terminal—although it is a fact that a strong signal between pins 2 and 3 will produce a recording, via the capacitive coupling across the socket. The way to feed a radio or gram input to the machine is via a splitter attenuator of about 10 to 15k in series with pin 1 and 100 ohms across the input, between pins 1 and 2. This knocks a 20mV signal down to the required 2mV. A greater signal will need greater series attenuation, with perhaps a small shunt to restore any lost treble.



EAST PERU RECENTLY entered the tape recorder market with their *All-Purpose 101* model, which can be purchased in this country from any reputable profiteer. Bought in Britain, it costs £24, but orders may be sent direct to Peru, accompanied by a postal order for £22 18s., or 6lb. of salt, eight boxes of safety matches, an assortment of beads and/or three rods of best fissionable material. As the name implies, this model will do everything you expect of a tape recorder—namely make reasonable quality sound recordings. For the other 100 tasks, a few optional extras are required. These cost a mere £310 7s. 0½d. or, if buying direct, one reasonably sturdy female. To see if it was worth the price, the following tests were carried out:



The hair-cutting attachments proved a trifle bulky for their purpose, but were found well-suited to general field work. Do not fall into the trap of switching from **PLAY** to **FAST-FORWARD**, however, since although the resultant 80 mph operating speed made short work of the grass, it was positively distressing to be entangled in the cutters when the brakes were applied.



In the kitchen, the recorder was extremely useful. Some care was needed in using the knife sharpener, as it cut the pinch wheel into ribbons. My chemically-activated servo-assisted vertical-styled integrated domestic assistant—Mrs. Anscumb—found the mechanism invaluable but considered the tape heads a superfluity.



The wood-turning attachment was not entirely satisfactory, due to a certain lack of rotary torque. Our handywoman made good use of it, however, in turning the finishing touches for multi-storey wedding cakes. This left a nasty taste in the mouth.



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Taking into consideration the price of the attachments, the present economic situation in Peru, profits from the sale of wedding cakes, an editorial fee for mowing the Link House car-park, and the otherwise high cost of a new engine for our *Mini*, we find the recorder well worth reviewing.

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101

A REVIEW BY ANSCUMB

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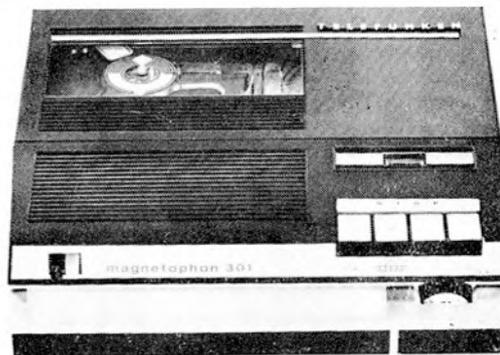
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# MAGNETIC SOUND RECORDING

PART NINE USING A TAPE RECORDER BY C. N. G. MATTHEWS



SO far in this series we have been mainly concerned with the internal economy of tape recorders. Although this kind of knowledge is important if you wish to get the best out of your machine, we should remember that the main reason for your buying a recorder was to use it, rather than study it. Now, what can you use it for?

The answer to that question is: pretty well anything within reason, certainly more than for casual recordings of radio programmes or conversations. It can be used for dramatic productions, for self-instruction, not only in music or singing but in languages and all manner of subjects, and it is an invaluable tool for the writer. Then there is the fascinating and at times fantastically difficult hobby of recording bird songs and animal noises.

These are just a few of the uses to which your tape recorder can be put. There is certainly no excuse for playing about with it for a few weeks and then relegating it to a cupboard for most of the year. Because this fate overtakes so many of the tape recorders that are given as Christmas presents, now is the time to dedicate an article to those readers who have been given their first tape recorder and are wondering what to do about it after having their first encounter with that disconcerting entity, the microphone.

Now a microphone is an excellent device for curing talkativeness. All the ideas that were bubbling up in your mind seem to evaporate as soon as you come within yards of it. It is not quite so terrifying as a live audience or a class of students determined to ferret out the weak points of a new lecturer, but just to speak into a microphone is far more difficult than you would imagine if you have never tried it.

## PRIVATE ATTEMPT

It pays, therefore, to make your first attempts in private. Then you can correct your mistakes while you gain competence in controlling the machine. In this way you will develop your histrionic and your recording ability simultaneously.

Let us assume that your first tape recorder is gleaming before you in all the awesome perfection of newness. It could be of any type, but we will say that it is a transistorised portable with push-button controls and not

too complicated in design or fantastically expensive. The *Telefunken 301* is typical of many recorders that come under this heading. This particular recorder has a frequency range of 40Hz to 14kHz, a playing time of up to three hours on one tape, and operates from a mains unit or batteries. Many makers produce comparable models, all of which are ideal for beginners because they virtually operate themselves. The loudspeakers in tape recorders of this class are adequate for checking your work, but they are on the small side. To do a good recording justice a larger, external loudspeaker is usually preferable. This is no problem, because most recorders have sockets which enable you to make immediate connection to an external loudspeaker, another amplifier, or the gramophone pickup socket on your radio receiver. The loudspeaker is always the weakest link in a sound-reproducing chain, so, however you go about it, remember that the best tape recorder in the world will not give first-class sound unless you provide it with a first-class speaker to work into.

## THOROUGHLY ACQUAINTED

But for the time being you will not be unduly concerned with the finer points of sound quality. Your first task is to become thoroughly acquainted with the machine, and the best way to go about this is to read to it. What to read? Well, why not its instruction manual? By adopting this approach you will not only build up confidence in handling the controls, but you will become thoroughly familiar with all the advice given by the manufacturer.

Whatever the make of your machine, it will have some or all of the following: Record control, replay control, rewind control, forward wind control, instantaneous stop, tone control, pause control, tape speed control, track selector, recording level control, recording level indicator, tape position indicator, on/off switch.

Quite possibly there will be other controls, but these are enough to keep your mind occupied at first. If there are others, set them to the positions recommended by the maker and forget about them. The word 'control' may mean switch, knob or push-button, according to the make of your recorder.

To make your first recording, sit comfortably at a table—which should carry nothing but the microphone and the manual from which you are reading. Use a thick tablecloth or, better still, a sheet of foam rubber to reduce sound reflections from the table. Your beautiful new tape recorder should be consigned to a chair beside you. If it is too close to the microphone and the volume control is up you may get 'feedback'—a ringing at the end of each syllable or even a howl.

Plug in the microphone and put it on the table so that it is about 18in. from your lips. Set the tone or equalizer control to the position recommended for speech and the recording level control to mid-range. You will, of course, have already laced up the tape in accordance with the manufacturer's instructions. Now zero the tape position indicator, press the RECORD button and begin to read *into* the microphone, not over it or under it or to one side of it. Above all, avoid the common beginner's mistake of holding the script in front of you and trying to read *into* it. Treat the microphone as a person to whom you are talking and all will be well.

While you are reading, keep an eye on the recording level indicator. With the microphone on the table and the recorder on a chair beside you, this is not so easy as it may sound. Very probably you will have to carry out a little repositioning before you can manage it. Still reading directly into the microphone, adjust the recording level control until the meter just fails to reach the overload mark or the magic-eye just fails to close during the loudest passages of your voice. When you are satisfied that the recording level is correctly adjusted, press the INSTANTANEOUS STOP button.

## BIRD'S-NEST OF TAPE

This stop button is an important control because it does exactly what its name implies—stops the tape dead in its tracks. On some recorders, if you switched off during record or replay the spools would continue to rotate for a little while and you would create a bird's-nest of spilled tape. So if yours has a separate ON/OFF switch, always press the stop button before switching off.

Having adjusted the recording level control,  
(continued on page 75)

To a practising audio engineer, one question that crops up with predictable regularity is: how can one match a crystal microphone to a transistor amplifier or the microphone input of a transistor tape recorder? Attempts to do this are described, and it is quite obvious from the results that there is severe frequency distortion, a heavy loss of bass and a preponderance of 'top'. The short and not-so-sweet answer is that if one has the highest fidelity as the ultimate aim, then it just cannot be done with 100% satisfaction.

The two devices are greatly incompatible. One, the microphone, is a voltage generator of high source impedance, and a very high terminating load resistance is always essential if optimum performance is to be realised. The transistor, on the other hand, is a current amplifier and to achieve optimum performance in terms of gain and signal-to-noise ratio, the input must see a low source impedance.

To put this into figures, taking the microphone first, most crystal microphones are the electrical equivalent of a capacitor with a value in the region of 1000pF. Connected to a

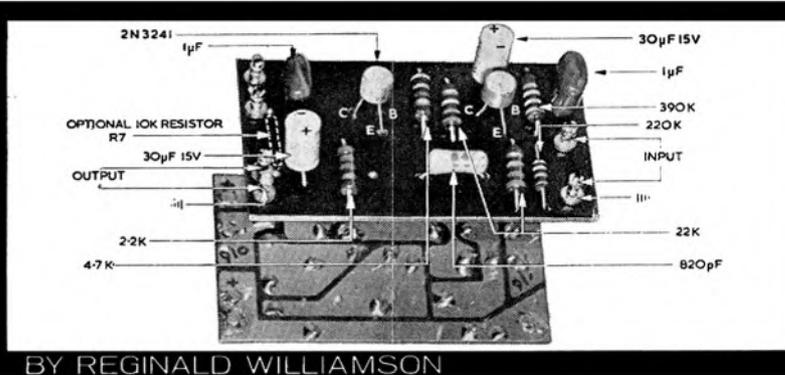
typical valve stage with a grid resistor R shunting the input, the combination appears as a voltage divider (fig. 1a). Readers with a knowledge of AC theory will know that the AC resistance, or more correctly the reactance, of a capacitor is inversely proportional to frequency; so to find the generator impedance of the microphone we have to do a little arithmetic. As a fair approximation, the reactance of a capacitor in megohms is 159,000 divided by frequency-times-capacitance (the latter in pico-farads, abbreviated to pF). Our particular microphone has a capacitance of 1000pF, and so at 40Hz, which we will regard as the lowest frequency of interest, the reactance is 4M—or near enough, anyway. Since the inductive and resistive components are negligible, we can regard this value as the generator impedance of the microphone.

At 40Hz, the signal across the terminating resistor has dropped by 3dB, and continues to fall below this frequency by 6dB per octave. Above this frequency, the linearity of the response will cease to be dependant upon the terminating conditions. If the grid resistor

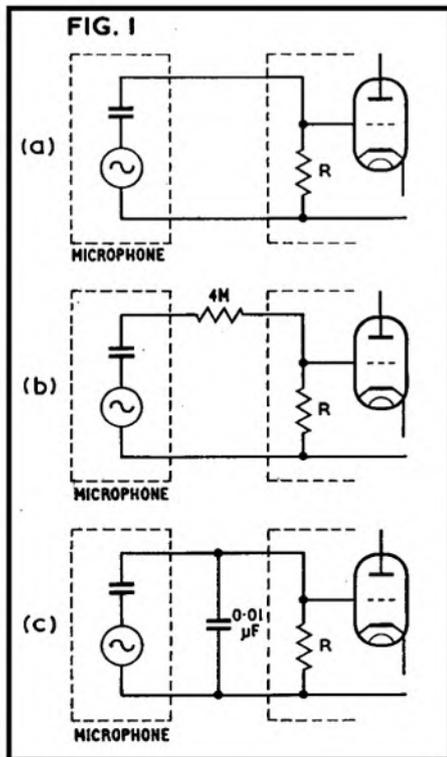
commonly used configuration is that described as a *grounded emitter*, which might have a typical input resistance of a few thousand ohms—we will say, for the sake of explanation, 4K. Using our little formula again, we find the turnover point is in the supersonic region of 40kHz! Clearly, the sound reproduction from such a set-up would be very odd.

Hear we come to the crux of the problem, of bringing together these two seemingly incompatible devices. One must again remind the reader that for a complete answer to the problem, we must wait a little longer for the new semiconductors—the field-effect and MOS transistors. But this does not mean that for medium-fi applications a compromise solution is not possible. It is entirely practicable, by means of some fairly sophisticated feedback techniques, to match a crystal microphone to a transistor stage, and whilst the principal defect will be a signal-to-noise ratio less than that possible with a valve input stage, the frequency response can be preserved down to 40Hz or better. So all-wirg for this drawback—a minor one in many instances—the ultimate

# A Transistor Preamplifier for Crystal Microphones



BY REGINALD WILLIAMSON

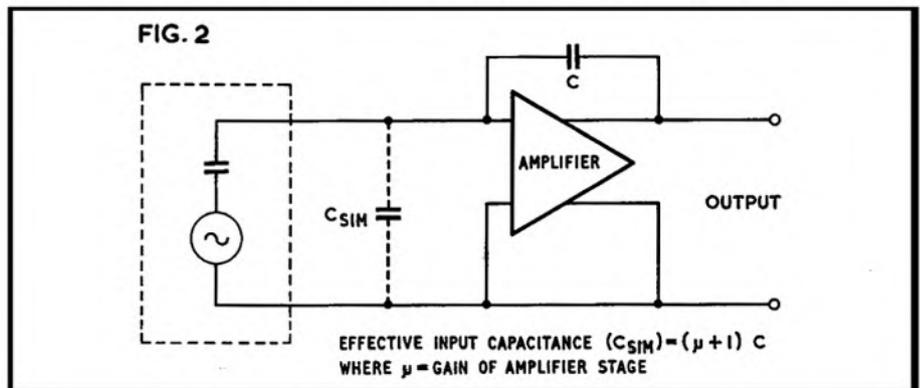


were appreciably lower in value, the point in the frequency scale at which the response would *turn-over* would be much higher (e.g. a value of 400K would result in a turnover of -3dB at 400Hz) and the sound reproduced by the microphone would be distinctly thin and lacking in bass. So it can be seen from this explanation that, to achieve a linear response from a crystal microphone fed into a valve stage, the grid resistor or the load seen by the microphone should be a value in the Megohm region—in fact, values of 2.5M are quite common.

Now, let us examine the same condition with a typical *transistor* input stage. The most

fidelity will be dependent upon the microphone used.

Now, how can we do this? Go back to the valve input stage again. Suppose, for example, the input resistance was 400K and it was inherent in the design of the tape recorder and that, therefore, nothing could be done about it. There are two solutions to this problem. We could connect a resistor in series with the input to raise the total value to 4M (fig. 1b). Matching conditions are thus satisfied and the response is preserved down to 40Hz—at the expense of a considerable loss of signal in the series resistor. But a superior way, often overlooked, is to lower the source impedance



of the microphone artificially, by shunting it with a fixed capacitor—and in our example, a value of  $0.1\mu\text{F}$  will do nicely (fig. 1c). Now the total capacitance 'seen' by the input is ten times as high and  $400\text{K}$  is optimum, with the response maintained down to  $40\text{Hz}$ . This method has one great advantage: the signal-to-noise ratio is more easily preserved, since the combination is actually less susceptible to hum pick-up.

We are now coming to the approach we can adopt in matching the microphone to even lower input resistances, such as a transistor input stage. But first, we must mention the technique usually employed. It is certainly possible by using the grounded-collector configuration to simulate input resistances in the order of a few million ohms and so doing, to satisfy the termination requirements of the microphone. But the conditions for the best signal/noise ratio are far from optimum, since the transistor sees a very high source impedance over most of the audio band and simply amplifies its own noise—usually equal to a substantial fraction of the minute signal

dilemma, and in essence this is a method of simulating the shunt capacitor without using the very high value needed with the low input resistance of the transistor stage, a method frequently overlooked by contributors on this topic and first employed in a practical design by A. R. Bailey in *Wireless World*, October 1963.

A grounded-emitter stage is used, with a very high degree of parallel negative feedback from the collector to the base of the transistor. If the feedback is via a resistor, then the simulated input resistance is, very roughly, the value of that resistor divided by the gain of the stage and in parallel with the input resistance before feedback was applied. Now, this is a gross over-simplification of the principle involved and for those who wish for a more accurate explanation there are a number of excellent textbooks on feedback analysis. This sketchy description is only intended as an introduction to the final recommended circuit.

To continue—if our feedback 'resistor' is altered to a purely reactive component, we now have a *Miller* feedback amplifier. Assum-

signal current is fed into the base of the transistor where it is needed. The outcome is a considerable improvement in the signal-to-noise ratio and, whilst not ideal, is substantially superior to any other method. The noise generated is 'weighted'—that is, is progressively reduced in direct proportion to frequency. The maximum noise level is at the very low frequency end and, subjectively, of much less nuisance value; by suitable choice of transistor it can be kept to quite a low figure.

And so, to a practical design (fig. 3). We know that transistors generate the least noise for low values of emitter current ( $I_e$ ) and it so happens that the input resistance is related to the emitter current, to the approximate formula  $\frac{25 \times \text{beta}}{I_e}$

$I_e$

In practice, using a silicon-planar type, run at a few microamps, an input resistance of  $10\text{-}15\text{K}$  is about as high a value as can be attained, since the beta of any transistor also falls with low values of  $I_e$ . To obtain the maximum overall gain a high value of collector load is used and its effective value increased

# A Transistor Preamplifier for Crystal Microphones

current from the microphone. On the other hand, we could use one of the two techniques mentioned earlier with the valve input stage, that of shunting the microphone with a large capacitor or inserting a large series resistor. In both cases, however, the insertion loss introduced (or the amount of signal that has to be thrown away to achieve correct matching) is quite prohibitive.

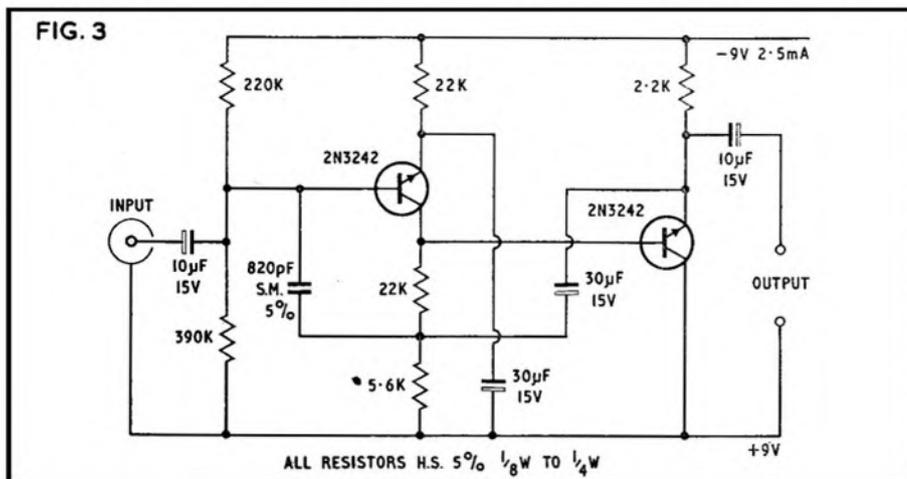
Fortunately, there is a way out of this

ing the feedback element is a capacitor, the input resistance is shunted by a capacitive reactance, the value of which is that of the feedback capacitor multiplied by the gain of the stage (fig. 2). So here we have a novel method of simulating the high shunt capacitor needed, but with the vital difference that whereas, before, the high shunt capacitor played a passive role in the circuit and resulted in a high insertion loss, a greater amount of

even more by the technique of 'bootstrapping'; the result is a total voltage gain in excess of 500 times. This closely integrated circuit includes an emitter-follower output stage with its attendant low output impedance.

Whilst the final circuit has virtually no-voltage gain due to nearly 100% feedback, it still has high overall power gain and one can connect it via quite a long cable to another transistor input (with gain) or even a suitable step-up transformer without degradation of the signal-to-noise ratio. With this design any crystal microphone will give satisfactory reproduction down to  $40\text{Hz}$  at least, with the high output microphones giving the best signal-to-noise ratio. It might be added that this preamp design can be used equally well not only with crystal pickups that rely on high input impedance operation to achieve self equalisation of the record curve, but with low impedance microphones, e.g. ribbon, moving-coil, etc., up to  $1\text{K}$  output impedance. In the latter instance no alteration to the circuit is required and the full gain of 500 times is available.

*Note. Printed circuit boards and components for the transistor preamplifier are available from Walsall Timing Developments Ltd., 98½ Lichfield Street, Walsall, Staffs. Cost of the board is 3s. 6d. (plus 1s. U.K. postage). Details of component prices will be advised to customers individually.*

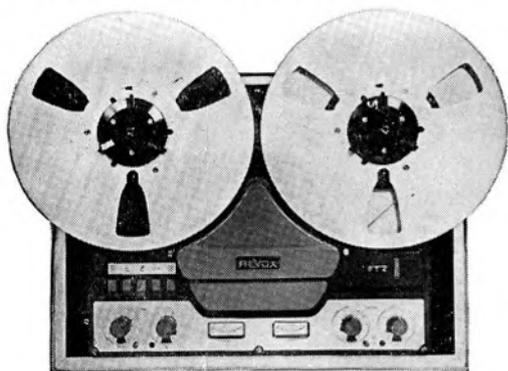


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IN the majority of battery models the first transistor stage is followed by the 'volume control' which, in the recording position, doubles as recording level control. This means that on playback all the available head signal can be applied to the input of the transistor, the required level being set *after* amplification, at the output of the first stage. The playback noise performance is optimised by this technique, especially if the head is matched to the input for the best signal-to-noise ratio.

The same principle is adopted so far as the low-level microphone signal is concerned, when the machine is switched for recording. The microphone signal is pretty well the lowest level signal that will ever be applied for recording, so the plan of the designer is to get as much of this signal as possible into the first transistor. When this is achieved, the recording signal-to-noise ratio is optimised.

The input impedance of a transistor in the common-emitter mode is low-to-medium impedance, as we have already seen. This allows the direct connection of a low-to-medium impedance microphone. However, it is possible to increase the input impedance somewhat by applying local negative feedback to the first stage, making it possible then to use a medium-to-high impedance microphone, still having the noise performance requirement in mind.

The same idea is applied to the head on playback, and in some machines the feedback is changed between the two actions (recording and playback) to secure the best noise per-

formance on both. The designer may also attempt to get the best noise specification by adjusting the local feedback relative to a known source impedance (i.e., the impedance across the terminals of the microphone or head). This he can do so far as the head is concerned and also so far as the microphone supplied with the machine is concerned; but trouble with noise can occur should the user decide to abandon the microphone supplied with the machine in favour of one of better specifications and/or more suitable polar response. Two things can happen when this is done. One, the better microphone may not deliver sufficient signal to give a practical signal-to-noise ratio and two, the source impedance may differ from that for which the first stage has been optimised. In both cases the 'hiss' recorded on the tape would be abnormally high. The trouble would also be noticed by the need for a somewhat more advanced setting of recording level to obtain 'full modulation' indications on the level meter.

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Many enthusiasts using battery-powered transistor models are having trouble with these problems right now. Past articles in

this magazine have indicated how microphones may be matched to recorders for the best results and how their signals can be 'boosted' by low-level transistor amplifiers. Unfortunately, many enthusiasts trying out these ideas have been pestered with noise, and while there has been a signal increase the value of this has been countered by an almost equal increase in noise signal. At this stage, therefore, a brief look at the signal-to-noise ratio problem would not be amiss.

Any electrical conductor has, developed across it, a 'noise signal' owing to the random movement of current carriers therein. This noise signal is in addition to any audio signal, which causes the current carriers to move in a controlled manner. Thus, if we have a source impedance across which a signal voltage is developed there is also a noise signal developed across the impedance. Noise signals also occur across transistor junctions, resistors and other components of an amplifier stage, the net result of which is a significant noise signal along with the real signal across the output load of the amplifier. One way of looking at signal-to-noise ratio, therefore, is in terms of the ratio of the real signal voltage to noise-signal voltage at this point in the system. Clearly, the ratio could be improved (less noise effect) by arranging for the amplifier to deliver an increase in real signal voltage without increasing the noise signal voltage. Simply increasing the gain of the stage would not help much here, for the noise as well as the real signal would arise, and the ratio would

be little changed. Applying a greater level of signal to the input of the amplifier is one way out of the problem, but this can only be done (a) if there is sufficient level of source signal, (b) if the source is matched to the amplifier for maximum signal transfer, and (c) if the amplifier can deliver the extra signal amplitude without running too non-linear (i.e., without clipping, overloading or running up too much distortion). (a) and (c) produce most troubles from the design aspect, while (b) can cause most problems so far as the enthusiast is concerned.

Another way out of the problem, of course, is arranging for the amplifier to deliver a decrease in noise signal without substantially changing (or, if anything, increasing) the level of the real signal. This is easier said than done, and early transistors were a real headache noise-wise. Some of the latest, cheap battery-powered transistor models still fail to give a good noise performance—and a few are singularly bad.

Before going on to see why this is so, we should have some basic idea of how the noise signal at the output stage is translated into terms of 'equivalent noise signal' at the

input. Let us suppose that the noise signal at the output load is 1mV and that the stage has a nominal gain of 40dB (100 times voltage), then we can say that the equivalent noise voltage that would have to be present across the input source is 1mV/100, which is 10 $\mu$ V. This, of course, is *not* noise which is actually present across the source. It cannot be, because it takes into account the noise of the amplifier stage as well. It is just the *equivalent* noise signal—nothing more.

However, since its value is fixed by the noise performance of the stage—in terms of type of transistor, resistors, design and so forth—knowing it makes it possible to glean some idea of the signal-to-noise ratio without a lot of trouble. Say, for instance, the input signal is 100 $\mu$ V (0.1mV), then the signal-to-noise ratio would only be 10:1 (or 20dB)—based on an equivalent noise signal of 10 $\mu$ V.

It can be demonstrated that the noise present when the signal-to-noise ratio is less than 46dB (200 times voltage) can actually be heard—the typical noise 'hiss', the 'car tyre on a smooth, wet road noise', for instance. It can barely be heard at 46dB because this is the threshold value or ratio, but as the ratio falls below 46dB (200:1) the noise becomes progressively more troublesome.

In the 20dB example just given, the noise would be really bad, but with the input signal rising to 1mV (from 0.1mV) the ratio would improve to 40dB, just about tolerable. Here, then, lies the reason for all the problems that beset our bird-song recording friends. Ambient noise probably accounts for a

microphone signal little more than 10 $\mu$ V under these recording conditions, so to get an electronic noise-free replay at such a low recording level would demand an overall signal-to-noise ratio in the order of 46dB, as we have seen, and this represents the incredibly small equivalent noise signal of 0.05 $\mu$ V—some hopes! When the birds start singing the microphone signal could rise to 100 $\mu$ V, but even then the equivalent noise signal would have to be about half a microvolt to obtain a noise-free rendering . . . poor bird-song recordists! In practice, though, they often get more microphone signal by employing microphone reflectors. It is a pity that manufacturers of audio equipment do not give an equivalent noise specification. It would be useful for low-level workers.

Noise signal is also dependent on temperature and bandwidth, and it does not take long to get really wrapped up in noise problems. A decibel equivalent in noise power is also employed by some workers and in some specifications. But we have said sufficient about this for the present.

Fig. 1 shows the first two stages in the (continued on page 71)

## BATTERY POWERED TAPE RECORDERS PART 15 SOME EARLY STAGES

BY  
MICHAEL  
GORDON

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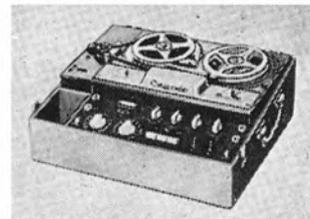
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*Sanyo MR200* battery model. Tr1 is the first transistor in circuit which receives the head signal in the playback condition and the 'radio' or microphone signal in the recording condition the input at the base being accommodated by switch S1. In spite of the complexity around the emitter circuit, the transistor is in common-emitter mode. The 2.2K resistor is the ordinary emitter resistor, bypassed by the 30µF electrolytic.

The extra 390-ohm resistor in the emitter circuit applies negative feedback, and this is aided by the 10µF electrolytic to the base potential-divider system. This network adjusts the input impedance of Tr1 to a value most suitable for the head and microphone matching. The emitter current of this transistor is also adjusted for a low value to help with the noise problem. This is because a reduced emitter current can—under certain conditions—result in a smaller equivalent noise signal. The designer has to take into account the maximum output required from the stage

when setting the emitter current from the noise aspect. Too low an emitter current could cause clipping or a bad rise in distortion towards peaks of head or microphone signal. The emitter current is thus to some extent a compromise value in this stage.

The output of Tr1 is developed across the element of the 'volume' control VR1, and the required level is tapped off by the slider for application to the base of Tr2, which is also in common-emitter mode. Coupling is through a 5µF electrolytic, such capacitors being common as couplers in transistor circuits owing to the relatively low input and output impedances involved. If ordinary 0.1µF couplers were used—as in valve circuits—the rising reactance of the capacitor at low frequencies, in conjunction with the input impedance of the coupled stage, would produce a potential-divider effect with consequent bass attenuation. The larger value of electrolytic capacitors keeps the coupling reactance low, even at low frequencies.

The unbypassed 200-ohm resistor in Tr2 emitter gives sufficient negative feedback to lift Tr2 input impedance to a value that represents a fair match to Tr1 collector. Noise is not such a problem in the second

stage, since the input signal is of a far greater level than that at the first stage; but even so, it is desirable to keep the first two stages, at least, as low noise as possible. More will be said about this next month when we look at silicon transistors in the first stages.

It will be seen in fig. 1 that the 'radio' and microphone outputs are similar to the arrangement given in fig. 4 last month.

Now the output of Tr2 usually feeds to a third stage which, in the recording condition, acts as recording output; or the set-up as shown in fig. 2 may be adopted. This, in fact, represents the remainder of the audio stages of the *Sanyo MR200*.

DRIVER TRANSISTOR

In the playback condition shown, the amplified head signal from Tr2 is fed to the base of Tr3 which acts as a driver transistor to the push-pull pair, Tr4 and Tr5, via the coupling transformer IPT. These transistors are loaded at their collectors across the output transformer OPT, and the top secondary winding feeds the loudspeaker and/or the 'monitor jack'. The output pair are biased for class-B by the potential-divider between the power supply tapped in at the centre of IPT secondary. It will be seen that the bottom arm of this divider consists of a 68-ohm resistor in parallel with a thermistor. This gives temperature stabilisation, for should the ambient temperature tend to rise, the resulting tendency for the current in Tr4 and Tr5 collectors to rise is neutralised by the thermistor reducing in resistance, an effect that reduces the base current and consequently the collector current of the output transistors. This technique is used in many battery portables.

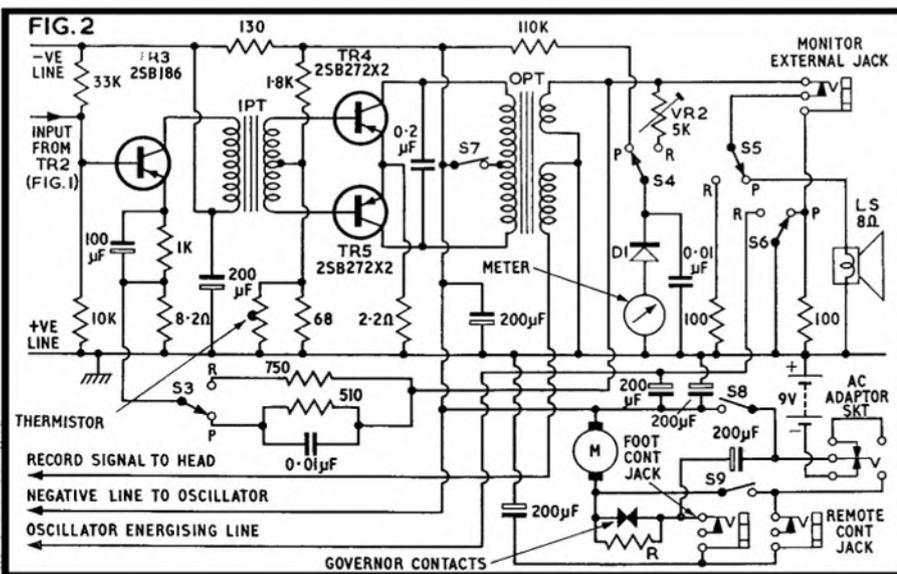
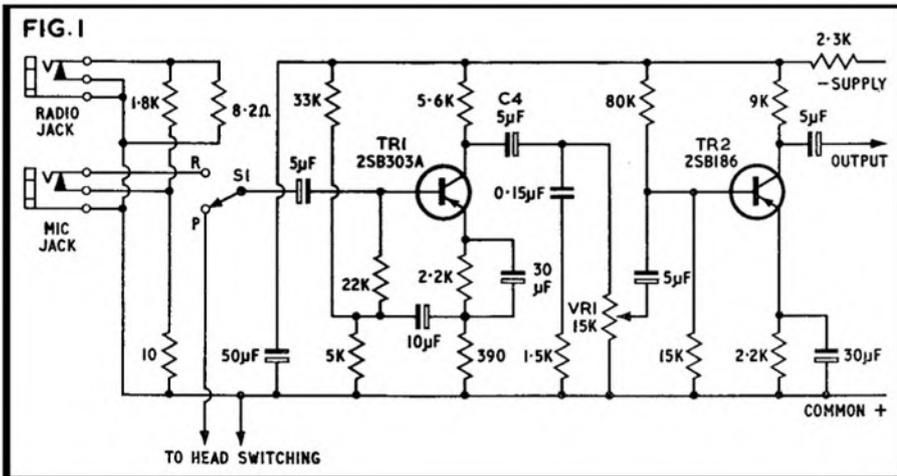
S3 applies frequency-selective negative feedback to Tr3 emitter from OPT for response correction or equalisation. The parallel RC network in the feedback path gives rising feedback with increasing frequency, thereby reducing the output with increasing frequency, the requirement for equalisation.

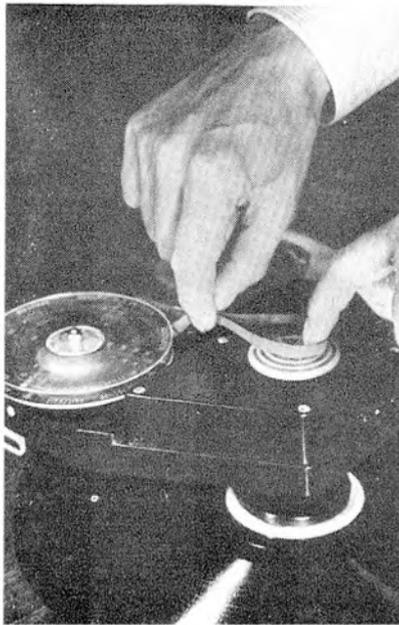
S4 switches the meter to the main negative supply line, via the diode D1, in forward conduction under this condition, thereby reading the battery or supply voltage. S5 switches the speaker and 'monitor' circuits, while S6 switches the HF oscillator, it being disconnected from supply positive in the 'play' position.

NON-FREQUENCY-SELECTIVE

In the recording condition S3 changes the feedback to non-frequency-selective, via the 750-ohm resistor in the loop, S4 applies the meter and rectifier to the signal across OPT top-winding secondary, while S5 removes the speaker and applies a 100-ohm load to the transformer, while at the same time energising the HF oscillator. At the other end of the circuit (not shown) the head is switched from playback to recording, and the head signal is picked up from the bottom-winding secondary of OPT. This is rather an unusual arrangement, since the push-pull playback output stage is used to provide the recording current.

This is, though, one of the problems of battery-powered recorders—obtaining a sufficiently high recording head current with (continued on page 75)





BY DAVID KIRK

# ONE HUNDRED 1001's

THE birth-place of magnetic sound recording, if it can be narrowed down to any one country, must surely be Denmark. For it was here, in the industrious land on and around Jutland, that Valdemar Poulsen created the *Telegraphone* wire recorder.

One of the highlights of a recent visit to Denmark was to indulge in the twice-reflected glory of meeting someone who had himself met Poulsen! The individual in question was Mr. O. E. Grue, technical manager at the *Eltra* factory in Copenhagen.

Our visit to the factory commenced with an account of the company's history and early products. *Eltra* were formed in 1935 from the Danish agency for (American) *Magnavox* products. From the beginning they produced radio receivers and loudspeakers, introducing their first tape recorder in 1950. The recorder bore some resemblance, in operating principles, to the later British *Gramdeck*—employing a gramophone turntable to drive the tape. No erase head was built into the unit, but a large permanent magnet was supplied with each model. This magnet was put to ingenious use to provide bulk erasing facilities on what was then a DC mains supply. It was clipped to the left-hand spool turntable, which was then rotated in the fast-rewind mode. The whirling magnet thus created an alternating magnetic field in which tapes could be speedily and effectively erased.

A few years later, *Eltra* introduced a complete domestic recorder which gained considerable popularity in Denmark but failed to reach the shores or stores of England.

Finally, and comparatively recently, came the *Model 1001*. Whereas mechanical components of the previous machines—decks, heads, motors, etc.—had been constructed almost entirely by *Eltra*, the 1001 is based on a British deck, the popular *BSR TD10*. This

is incorporated, with some minor modifications to extend versatility, in a neat wooden cabinet alongside European electronics and a Danish loudspeaker. The resultant combination is certainly one of the most attractive TD10-based recorders we have seen—a view supported by a well-known British manufacturer who has copied the external design almost to the last visible nut and bolt.

*Eltra* were evidently flattered that their design should be imitated, not by the Japanese, but by an English company, and took great delight in comparing to us the 1001 with its 'rival'—the latter imported specifically for demonstration purposes! Though superficially similar, the British machine proved far inferior to the 1001 in performance and finish. Even more laughable than the audio quality, however, was the thin cardboard covering that served to 'protect' the base and rear of the cabinet on the British recorder. This flimsy construction now bordered on the ridiculous—the cardboard having been severely warped by heat from the valves and motor.

*Eltra* do not conform to the 'if you can't see it, it doesn't matter' theory, so faithfully followed by the British manufacturer. The fascia on the 1001 is solid metal, not silver-painted plastic. The bass tone control (along with the treble) performs its allotted task, and does not act as an alternative—and unnecessary—volume control. The magic-eye is damped for slow-return peak-reading—not simply a vague shuddering shadow. The handle (which can be slid out of sight into the cabinet) holds firm when the machine is held upright; it does not sag pathetically.

There is a moral here somewhere, which the managing director of *X Ltd.* may endeavour to conceal by claiming that his machine is some £20 cheaper than the 1001. So it is in Britain, where the copy sells at around £30.

But in Switzerland, to which country both *X* and *Eltra* export, the price difference is only a matter of shillings.

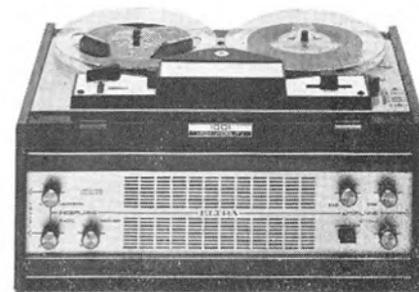
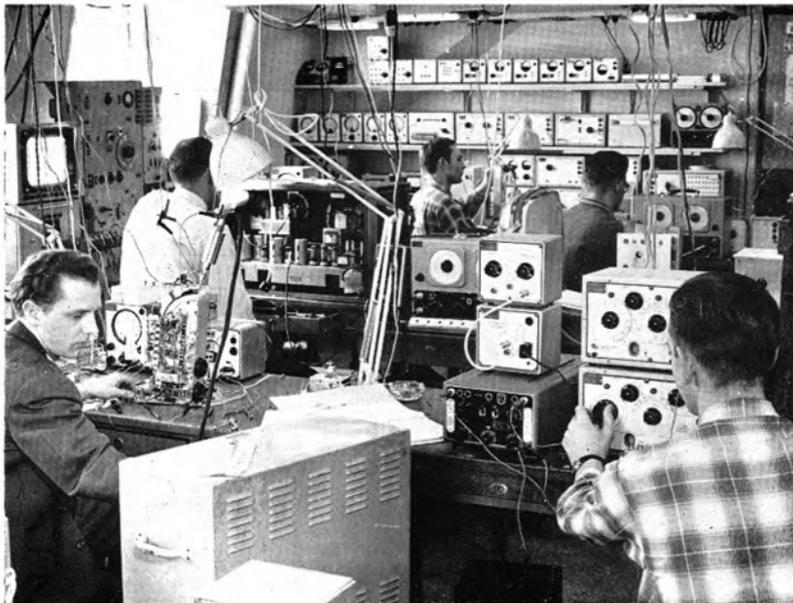
The 1001 recorders have at least one outstanding feature. They are probably the only tape machines in the world that come into existence beneath a row of living-room lamps. Mr. Grue personally dislikes the cold glare of neon and has installed circular lampshades above each seat on the production lines.

In terms of performance and value, a recorder stands or falls on its transport mechanism. After literally combing the world for a robust and versatile low-price deck, *Eltra* decided on the TD10. This offered speeds of  $7\frac{1}{2}$ ,  $3\frac{1}{2}$  and  $1\frac{1}{2}$  i/s, 7 in. spool capacity, simple and sturdy construction, and low wow and flutter. All TD10 decks entering the factory are checked for wow and flutter. Those not coming up to standard are packed and returned to BSR.

On acceptance, each desk is stripped of its cover plate and a few components added. *Eltra* have discovered that the TD10 can be modified very easily to give pause facilities. A spring-loaded lever is inserted to the right of the three-way mode selector, which retracts the pinch-wheel when pulled to mid-position, switching the motor off when pulled right back.

An additional modification permits the record lever to be mechanically engaged while the modulation level is adjusted. Alternatively, by switching off the deck motor, the recorder may be employed as an amplifier. Pushing the mode selector to PLAY automatically disengages the record lever, unless the latter is supported with a thumb.

When the components have been added, a deck-plate is fitted. This is not the plate supplied by BSR, but incorporates several additional features—including a path for the



**Far left and second left:** Early gramophone-driven Eltra showing bulk-erasing magnet and tape path. **Third left:** A high point is reached in 1001 production figures and the 30,000th model is presented to one of the assembly staff. **Immediate left:** Eltra development department; much of the test equipment is designed and built in the factory.

## A DAY IN THE LIFE OF ELTRA

pause lever. Most predominant are the raised ribs, which are designed to prevent tape being jammed beneath the spools.

Next step, for the deck, is its attachment to the amplifier and power-supply chassis. The two assemblies are produced entirely by Eltra in identical aluminium frames. Now more the exception than the rule, hand-wiring is preferred, here, to printed circuitry, for reasons of easier servicing and greater production flexibility. The two basic sub-chassis are identical, but one contains the record and replay amplifiers while the other houses the mains power pack and oscillator.

A third sub-chassis is assembled elsewhere on the production line to take the forward-facing loudspeaker, amplifier potentiometers and switches. The entire 6W push-pull power amplifier is built on a single  $\frac{1}{2} \times \frac{1}{4}$  in. metal rod, complete with triode and double-pentode.

A metal shield is fitted round the TD10 induction motor to prevent magnetic fields being radiated into the surrounding circuitry. The shield is positioned at the optimum distance from the motor to 'short circuit' the hum field without unduly reducing motor torque. As a further precaution, the input amplifier is screened.

Thoroughly testing a hundred recorders per day is no less formidable a task than assembling them. Eltra have approached this problem so efficiently that the test equipment can be, and is, operated by staff with practically no knowledge of tape recording or electronics. One girl, indeed, has checked more than 12,000 machines without, it appears, the slightest theoretical knowledge of what she was doing.

The secret of Eltra test procedure can be outlined in a single word—comparison. Each of the three test benches is equipped

with a known good machine. On completion, every 1001 is placed on one of the benches alongside an 'ideal model'. Both are connected to a rack of test gear, individual instruments being selected by a rotating switch. Each position on this switch is indicated by a numeral, and in the event of a fault being discovered, the relevant digit is marked on the recorder, which then passes to the trouble-shooter.

The examination begins with head alignment—already nominally undertaken by BSR. 1kHz and 10kHz tones are replayed from a test-tape to an oscilloscope, the record/play head being adjusted for maximum output voltage—displayed as maximum vertical deflection.

Distortion, up to 3rd harmonic at 1kHz, is measured by means of a sweep frequency generator. From the operator's point of view, a recorder is up to 'spec' when identical patterns are displayed on the two halves of a slow-scan double-beam oscilloscope. Mains consumption of each machine is checked after ten-minutes running as a general indication that motor and components have no obvious faults. Cathode-follower AC voltmeters are employed in preference to normal valve voltmeters, the latter having been found inaccurate over long periods. The meters are used to check bias level.

A final listening test is performed before the machine is packed, each recorder being connected to an Eltra radio. Here, the two record cards part company with the machine they have accompanied round the factory. The cards, containing serial number, performance figures and miscellaneous notes, are filed for possible future reference.

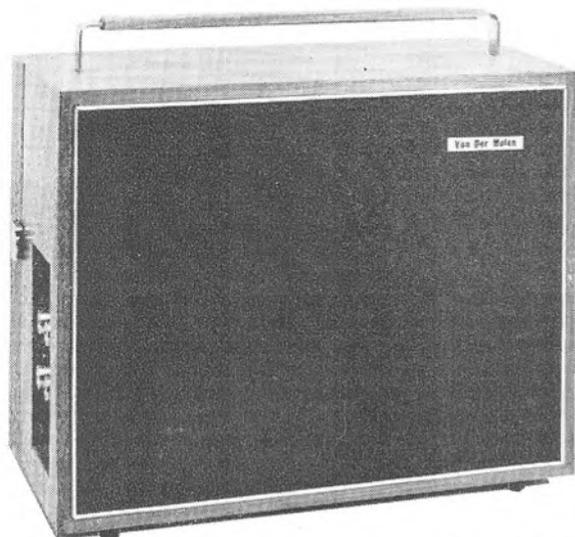
The next step for the Eltra 1001 may simply be to a nearby Copenhagen retailer; it may be across a few miles of water to Sweden, or

all the way to Iceland, Greenland, Austria, Finland, or even—despite *Messrs. X*—England.

In addition to producing tape recorders, Eltra manufacture television receivers, and I shall long remember the eerie blue glow at one end of the production line, where dozens of sets undergoing adjustment beamed reproductions of the Danish test-card.

The Danish audio industry is a lively one. When stereo broadcasting was introduced on a permanent basis in the U.K. last year, British manufacturers complained loud and long about the lack of advance warning. With two notable exceptions they were totally unprepared to market stereo radios or decoders. Compare this with the Danish attitude. They have not complained about lack of warning; they have been making and marketing stereo receivers for years—even though they have no stereo broadcasting service. In his own defence, the British manufacturer may complain that the Danes spend much of their energy exporting to the Continent. Of course they do. But perhaps our own audio industry can now explain why it, too, did not develop stereo radio equipment years ago for the Continental market.

If the Danes are a hard-working nation, they are also one of the most sociable. After touring the Eltra factory, an informal journey through the central area of Copenhagen was arranged—the itinerary being sufficiently pre-determined to show that all the audio dealers in that part of the world had Eltra products on prominent display! A visit to one of the largest Copenhagen audio retailers proved a great eye-opener. The range of products displayed was much the same as in London's *Imhofs* or *Largs*, with one or two additional Continental brands. We stood encircled in  
(continued on page 75)



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# THINKING SMALL

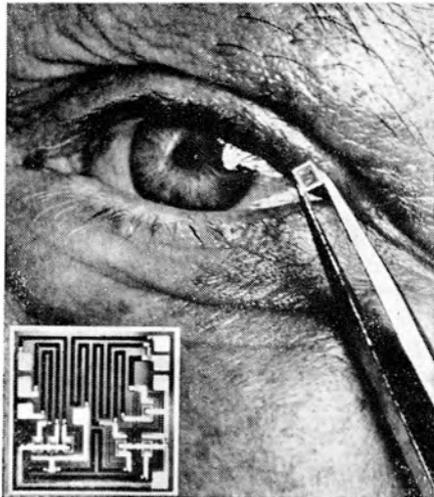
BY H. W. HELLYER

**H**AVE you spotted those articles in the radio, television, audio and electronics magazines, that take a prophetic look at the trends in technique?

Quite apart from the videotape promises, the whizz-bang head systems that will give us ninety-nine tracks on an eighth-inch tape and need a computer to synchronise the playback, and the tape itself, so thin and delicate that we shall have to hold our breath while editing, there is another significant promise.

This is the micro-module. A bank of components all squashed up together in an indestructible block. The idea is not so new; inspired by defence needs, rapid replacement of circuit parts rather than normal fault-finding, the system has an attraction for the mass-producer of entertainment equipment by virtue of a reduction in labour cost at the factory. Material cost can only be kept low by ruthless standardisation—which will make Recorder X even more like Recorder Z in the future. Makers will design around modular construction, and styling will be the only sign of individuality.

This is a pessimistic view for the enthusiast, and a position that I do not think will be



Telefunken photograph

attained, at least within the present decade. Nevertheless, there is already a disturbing tendency to 'build small' even where no apparent advantage seems to be gained. Followers of David Kirk's Field Trials of Battery Portables will know what I mean.

In a recent issue of *Electronics Weekly* there appeared a comment on the 5W amplifier developed by *Westinghouse Molecular Electron-*

*ics Division*, shown at a conference at Boston (USA, of course, not Lincs.). This midget had sixteen transistors, four zener diodes and three biasing diodes, with associated components, and is made in a stud package only  $\frac{3}{8} \times \frac{3}{8}$  in.

While you digest that bit of information, I'll add the comment of *Janus* " . . . instead of falling over the hi-fi, I guess the next trouble will be finding it".

For the complacent who mutter that this is all airy-fairy prophesy, I would simply open up the back of one of the several radiogramophones that graced the stands at the last Radio Show. Long, shapely enclosures they were, of sapele mahogany, walnut, or last year's 'in' wood—teak, but the amplifier occupied a lonely corner and one needed a strong light to find it.

My argument is that far too many designers seem to be building small just for the sake of the trend. When smallness is also flimsiness, this is an electronic crime. The essence of the micro-module is its robust compactness. You can kick them about the floor—and will probably feel like doing so when you have to pay for the complete package for the sake of a sixpenny component that has failed. If these are mounted on wafer-thin panels with tiny press joints, harnessed by wires that grow ever more brittle and thin, when there is enough room in the cabinet to hold a football match, I reckon we, as purchasers, are being sold a pup—and a pretty small pup at that!

## ONE HUNDRED 1001's CONTINUED

tape recorders of Japanese, German, Danish, Dutch, Swiss, Norwegian and British origin. Yes, there was one British recorder—a domestic *Thorn* of obsolete design. So far as we could gather, this was the only British-made product in stock—with the exception of a considerable number of tape and gramophone records. With Mr. Jensen of *Eltra* translating, we enquired whether *Ferroglyph* machines were ever sold. We half-expected a negative reply but were still shocked by the answer: the dealer had not even heard of the brand!

Perhaps I shall discover, one day, whether the staff of *Eltra* and of *Peerless* (another factory visited), Copenhagen retailers, and hotel employees, are an exceptionally good-natured minority. Possibly I shall find, as I now suspect, that friendliness is a national trait in Denmark. Either way, this particular visitor found Denmark to incorporate all the finer points of English life, plus illuminated pedestrian crossings, minus the British National Humbug.

## MAGNETIC SOUND RECORDING CONTINUED

note the new reading on the tape position indicator, press **RECORD** and start to read again from the beginning of the manual. Speak normally, without either shouting at the microphone or whispering confidentially into it. Tape speed is not very important for this exercise because any speed on a modern recorder will give reasonable reproduction of speech.

When you are tired of reading, press **STOP**

again. Then press the **REWIND** button. The tape will begin to whizz backwards at an alarming rate, but this is normal. Without the fast rewind you would waste an enormous amount of time. For instance, if you had been recording for thirty minutes you would have to run the tape back for half an hour at normal speed before you could listen to the recording. The fast-forward wind serves a similar purpose. If you wanted to play back a section of recording somewhere near the middle of a 7in. spool of triple play tape and could wind only at the normal record or replay speed, you might have to wait more than an hour for a listening period of a few minutes.

While the tape is winding back, watch the tape position indicator and press **STOP** as soon as it goes just beyond the zero. Then press **REPLAY** and, perhaps for the first time, you will hear your own voice as it really sounds.

Some adjustment of the volume control—which is often the same knob as the recording level control—may be necessary, but there is nothing complicated about replaying a tape. What will surprise you is the tone of your voice. It will certainly be higher-pitched and possibly less pleasant than you had imagined. You may hear a strong accent and quite a few 'Ers' and 'Ums' and hesitations. We rarely notice these imperfections while we are speaking, but on a recording they are painfully obvious.

Here, then, is one use for a tape recorder. If you care to devote half an hour a day to reading and listening, correcting your mistakes as you go, your diction will improve out of all recognition within weeks. When you are satisfied that you can read properly, try giving a talk. This is much more difficult, but with perseverance you will acquire a fluency and a

command of the spoken word that will serve you in good stead wherever you go.

Recording your own voice is among the more difficult of tape recording operations, because you have to concentrate on what you are saying as intently as upon controlling the machine. Once you can fulfil this dual role successfully, the whole field of tape recording is open to you.

## BATTERY TAPE RECORDERS CONTINUED

'constant-current' characteristics. This is achieved in valve models simply by feeding the head current through a high value resistor, but it cannot be done on transistor models where the supply voltage is limited. It is possible, however, when a higher transistor voltage can be obtained from the mains supply. More will be said about this in a future article.

It will also be seen that the meter signal is obtained from the top winding of **OPT**, while the head is powered from the bottom winding. The signal, of course, is proportional in both windings and the required deflection—for full recording level—can be adjusted by the series preset **VR2**.

The circuit section separate from the main circuit is mainly concerned with the connection of a remote control system, switching an operation from a mains adaptor. When the mains adaptor is connected the battery supply is automatically disconnected, while the 'foot-control' and 'remote control' circuit operates the drive motor, as the circuit shows. The centrifugal governor switches in and out the resistor **R** for speed control, as was investigated in early articles of this series.



state, quite unequivocally, that this will never give as good results—as good hi-fi results, that is—as when normal control of recording is provided. There is, inevitably, some bass attenuation. But as the circuit is primarily intended for speech recording, interviewing and suchlike operations, this apparent drawback may prove all to the good.

The six-position rotary switch normally feeds the microphone preamplifier to the main amplifier and uses the circuit given at fig. 3 for recording-level meter indication, but in the topmost position of the switch this feed to the main amplifier is bypassed, and the signal is applied to the OC306 transistor, which is controlled by the base bias derived from the control circuit of the OC72, receiving its triggering signal from the output transformer. The stabilised signal is then tapped off from the junction of the two 0.1μF capacitors across the OC306 and applied to the main amplifier. In effect, this is a simple balancing circuit, taking the place of the microphone level control.

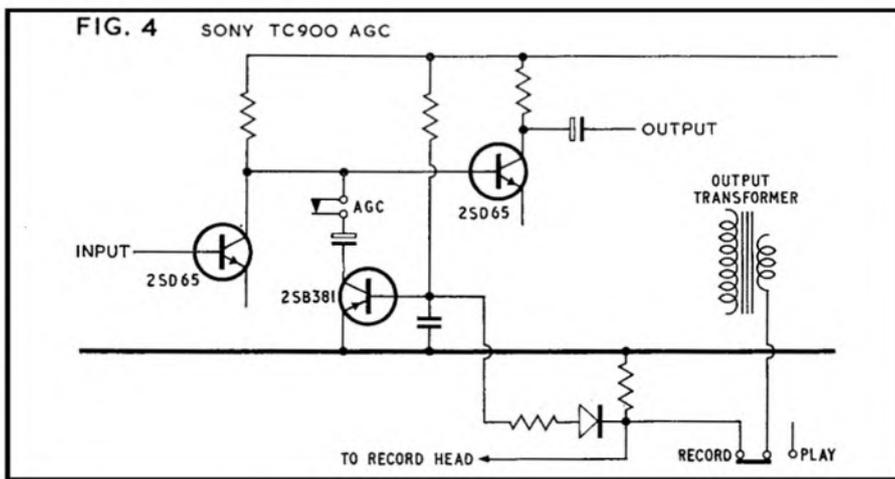
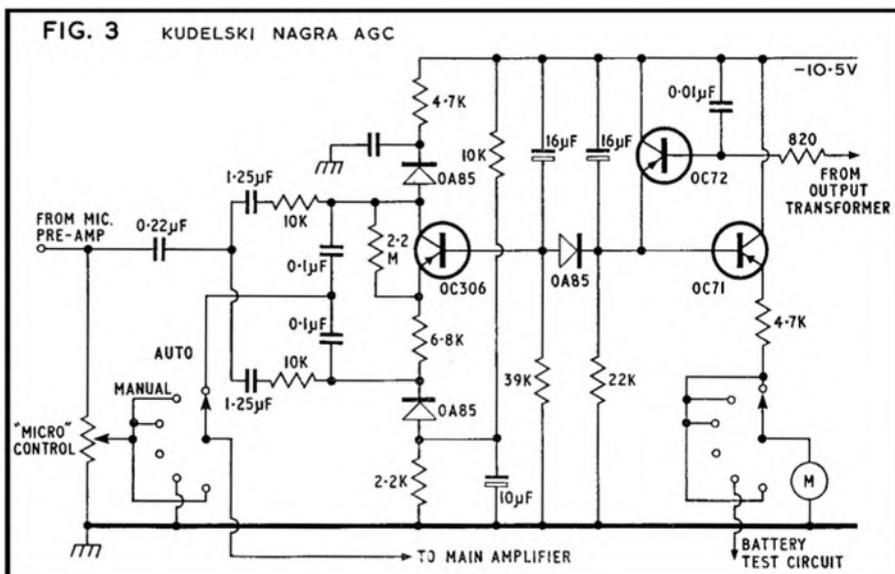
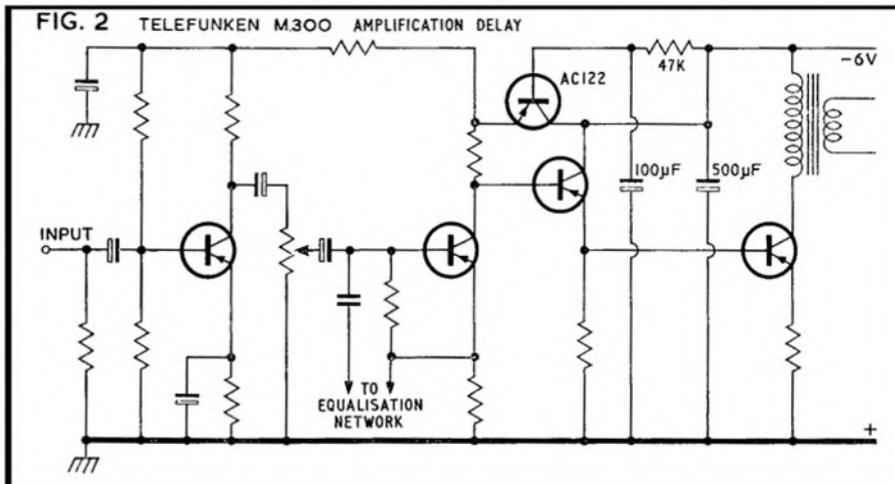
The Sony TC900, which is a transistorised tape recorder, also uses an automatic control circuit, with a selector switch which it unashamedly calls AGC. Fig. 4 shows the basic circuit, which again turns up as a transistor switched in to regulate the base bias of the main amplifier when record is selected. The interesting part about this circuit is the essential simplicity. Part of the signal fed to the recording head is tapped off, rectified and, via the time-constant of the 50μF and 20k components, used to regulate the base bias of the 2SB381 transistor. This transistor has its collector voltage held by the charge on the 30μF capacitor, which is connected by the AGC switch to regulate the base bias of the main amplifier when record is selected. The effect of this is to control the gain of this pair of n-p-n transistors according to the signal level above a threshold determined by the working voltages of the p-n-p shunt transistor.

Another Sony circuit, this time a valved popular, the TC3574, is shown in its rudimentary form in fig. 5. One winding of the output transformer is coupled back to the grid of the preamp stage via a 27K resistor and the grid leak, 1.5M resistor; but this is not a simple matter of direct feedback. The other end of this winding provides a signal for the anode of a triode (whose anode and grid are connected for diode operation).

The cathode of this pseudo-diode is taken to the cathode of the output valve. This gives a positive bias and determines the level at which the diode will conduct. When the output is such that this level is more than 15V the diode conducts and the resulting current around the loop formed by the transformer winding and the charge capacitor C19 puts a negative bias, via the 27K resistor, on the grid of the preamp stage, reducing the gain. When the signal level falls, the diode ceases to conduct and the bias dies away gradually as the charge falls. Note again that the circuit has a long time-constant, with C19 and R24, then C4 and R32 providing a good delay.

In addition to this AGC circuit is a control device of some interest. This consists of a silicon varistor across the microphone input circuit, switched in during record. The characteristic of a varistor, shown inset, is

(continued overleaf)





# SOUND AND CINE

IF AT FIRST YOU DON'T SUCCEED □ BY ANTHONY WIGENS

HAVING spent hours trying to record one ten-second take for the *Country Lovers* film, one thing is sure: we all know what we are trying to do. As Jess chalked Scene 64 Take 9 on the clapper board (as used by the BBC, price £3 10s. from *Samuelson Film Service Ltd., 303-305 Cricklewood, Broadway, Edgware Road, London, N.W.2.*) I said, "It's a good thing doing this line first, because nothing will ever seem as difficult afterwards. It's good psychology getting a hard scene out of the way first."

I know exactly what I said, because I left the tape recorder running for practically the whole shooting session. Not intentionally. One of the problems of trying to tackle a number of tasks simultaneously is that you only remember the vital chores. Imperative to turn the tape recorder on before marking the scene with the clapper board. Not imperative to turn it off. So I tended to stop the camera, and launch into directional criticism of the acting, while the recorder ran on (there goes another set of five *U II's*!).

One advantage of leaving the recorder running half the session is that I have a record of off-the-cuff observations on what we were

doing. I can also go through and count just how many of the 'wild track' dialogue recordings would be usable as they stand. I find that of the nine takes, only three were unmarred by extraneous noise, and on these you could detect the running of the *Elmo TLA* camera as a faint whistling noise. We then went on to shoot a cut-away close-up, and both takes of this shot were marred by car sounds.

The script calls for Kay and Jess to be alone miles from anywhere in the country, and the line was, "Hey, it's naughty boys who play with fire". ("I'll probably be saying that in my sleep tonight", grumbled Kay at one point!) We were working by a country road, at the edge of a field of barley. It was after work, on a weekday, so we had the rush-hour traffic to contend with. Even out in the country, traffic builds up at this time. It's going to be another compelling reason for post sync sound, I can see . . .

The actual interruptions to the sound track, on a total of eleven takes, worked out this way: cars 4, motor-cycle 1, aeroplane 1, actress 2. The actress interruptions raised an interesting and typical problem. On the first

occasion Kay never even got her line out, she just giggled. The second time she said, "Oops, that wasn't any good either."

True, she had cause to giggle. I said earlier that this was one of the most difficult shots in the whole script. The camera starts running on a patch of barley, and then Kay rolls through it into sight, sits up and straightens herself out, and then says her line. I visualised it as graphic and entertaining. I now see it as a nightmare drain on film stock resources (I used up two minutes of colour stock on the nine takes.) It turned out to be very difficult to roll with any control over direction, and Kay seldom appeared in the right place. I filmed her feet more often than her face.

This led to difficulty in placing the mike (suspended from a light stand with boom extension) and when we did get a good pick-up of sound on the dialogue, we also captured straw rustling so loudly it sounded like the big blaze that comes later in the film!

However, by putting together the best of different shots I think I will be all right.

The ever-running tape caught my instructions to Kay on this point. "If anything goes wrong" I said to her, "it's not up to you to decide that you can do better, it's up to me. What may be a fluffed line to you may be perfectly acceptable to me—and it may be fine for the film. So go on with the scene until I say 'cut'. If I think you have fluffed it, I shan't waste any film on it, I'll cut it. But don't you think "Oh, that was bad." Carry on acting until I say 'cut'."

There was more on the tape that was interesting to anyone doing location sound filming. There's a muffled curse from me, followed by an instruction to Kay to move a little bit. "The mike boom is throwing a shadow across your face" I said. I wonder if any of the other takes were marred that way?

The ground was wet. Kay got muddy knees and stockings. I had deliberately picked clothes from her wardrobe which would be easy to clean, but I began to worry a bit about continuity if ground conditions were going to make her look dishevelled in some shots, when subsequent filming of following scenes revealed her immaculate again. It's a point to watch. One advantage of taking production stills to illustrate this series is that it gives me an accessible check on the appearance of both my actors.

On this occasion Jess wasn't being filmed, but he came along to clap the new clapper board and hump gear. He turned out to have another use, not planned for.

The timing of the line Kay had to say was awkward. It was important that it was spoken leisurely, yet she found it difficult to judge the timing, and without any guidance, spoke too early. With a director and a cameraman at work, the former would be free to provide timing if necessary. But I was so involved with keeping Kay in frame that I was in no position to judge.

Then Jess, too, commented on Kay's timing, and I realised he was very conscious of this point. So I let him cue her. He also provided the point towards which she was talking, which helped make the situation more realistic for her. At this rate we'll end up with Jess as director as well as actor!



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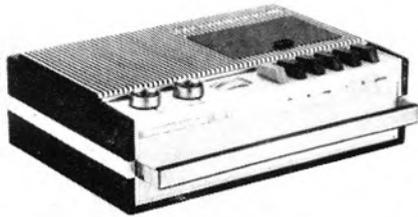
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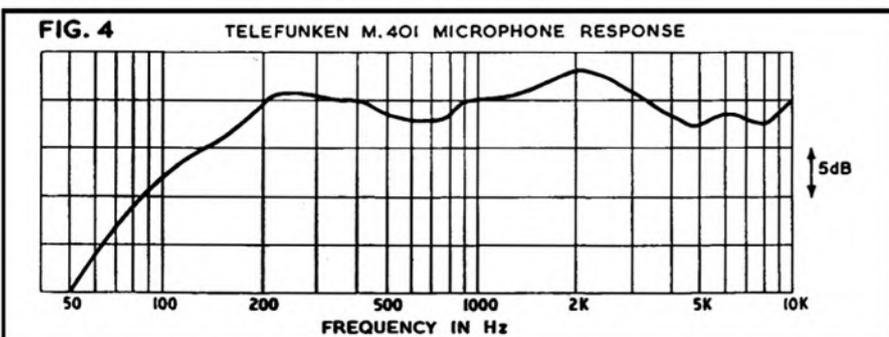
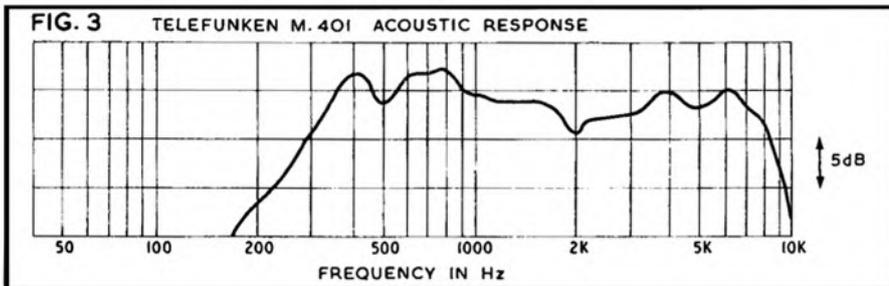
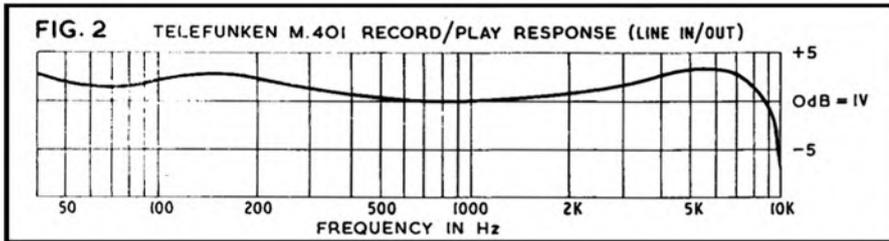
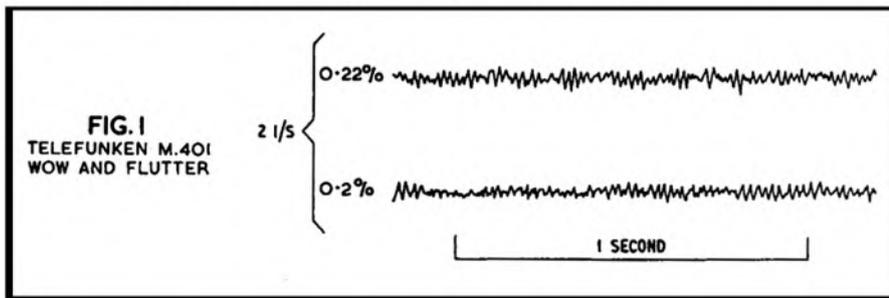
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# equipment reviews



**TELEFUNKEN  
M.401  
CASSETTE  
PORTABLE**

**MANUFACTURER'S SPECIFICATION.** Twin-track transistor battery recorder employing DC International system for mono recording and play-back. **Tape Speed:** 2 i/s. **Playing Time:** 45 minutes per track (DC90) or 60 minutes per track (DC120). **Frequency Range:** 40Hz-8kHz. **Signal-to-Noise Ratio:** 45dB. **Output Power:** 2W. **Level Indicator:** Meter. **Input:** 0.25-20mV at 5K. **Output:** 600mV at 15K. **Dimensions:** 11½ x 8 x 3½in. **Weight:** 7½ lb. **Price:** £48 6s. **Distributor:** AEG (G.B.) Ltd., Lonsdale Chambers, 27 Chancery Lane, London, W.C.2.



**P**RACTICAL operating tests and subjective impressions of performance were covered by battery recorder Field-Trial No. 15 which appeared in the October '66 issue of this magazine. I am glad to report that my more objective technical tests confirm this excellent report in every respect.

Like the *Uher 4000L*, the *Magnetophon 401* uses a complex multi-transistor motor control circuit to set the speed to fine limits and to reduce radiated motor noise to the lowest possible level. Transistors are used to switch current to the three main motor windings in correct sequence with a high frequency 'inductive commutator' providing the switching signal. An HF oscillator powers a ferrite-cored coil within the motor housing which induces a voltage into each coil in turn as the armature rotates. These high frequency voltages are rectified to bias the main control transistors on as required. At the same time the back-EMF of the unswitched coils, which is proportional to motor speed, is rectified and compared with the voltage across a zener voltage reference diode. The difference or error voltage controls the HF oscillator output so that the switching transistors are on for longer or shorter times to compensate exactly for the speed change. As all motor control currents are turned on or off relatively slowly, there are no inductive surges or sparking to create audio or radio interference.

The fluttergram of fig. 1 shows that wow is negligible, but that a high frequency flutter at motor rotation frequency is evident at 50Hz (3,000 r.p.m.). It is well known that the ear is not sensitive to such flutter, the subjective impression being of only a slight roughness on a sustained pure tone.

Due to the cassette loading, it was not possible to measure the play-only response or to relate peak recording level to standard test-tape level. Overload tests at 500Hz showed that waveform distortion was just visible at full scale on the record level indicator.

Test-tones were recorded 12dB below peak recording level at about quarter meter scale and playback to line output gave the very satisfactory response of fig. 2 which is level within 4dB limits to 9kHz. Remember the tape speed is only 2 i/s!

System noise with no cassette inserted, but with motor running, was 45dB below peak recording level. Recording tests with the gain control at zero showed bias and erase noise to be 43dB below peak recording level.

Erasing peak 500Hz tone gave various playback levels ranging from 43dB below peak to only 30dB below peak. This proved to be due to slight movement of the cassette when the stop button was depressed. With the cassette properly 'bedded down' consistent erasing to the 43dB limit was always obtained.

Next, a series of one-third-octave bands of filtered white-noise were recorded and the sound output measured on the speaker axis on each band during playback to give the acoustic response of fig. 3. This again is reasonably level within 5-6dB limits over the range 400Hz

(continued on page 83)

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to 8.5kHz and accounts for the pleasant if rather 'small' tone from this remarkable little recorder. The microphone response was also measured in a white-noise sound-field to give the response of fig. 4. This is more than adequate for recordings to be played on the 401 internal speaker and perfectly satisfactory for speech and background effects when played through line output to a wider range amplifier/speaker combination.

Apart from the motor control circuits discussed above, the record-playback circuits are straightforward. On record, the first four transistors amplify the microphone or attenuated line input to about 1V RMS, with feedback over the second and third stages to give sharp pre-emphasis of the higher frequencies for recording. One half of the push-pull output pair is switched to act as the erase and bias oscillator, and the other half feeds the record

level meter. On play, the output transistors revert to their normal role, and the feedback over the second and third stages is modified to give bass boost for playback equalisation.

**COMMENT**

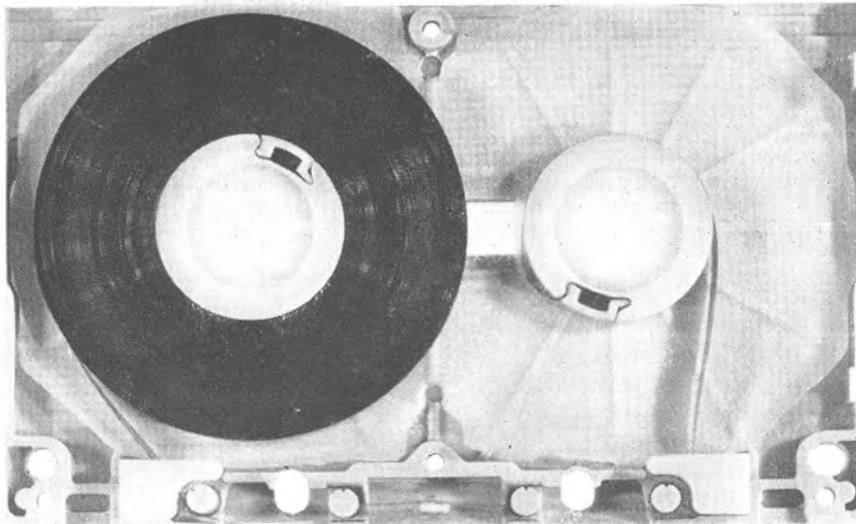
As a self-contained, simple-to-operate, very portable recorder, I give the Magnetophon 401 full marks. I would like to see the stop key disassociated from the cassette lifter and an extension loudspeaker output provided so that a good speaker or wide-range headset could be connected when necessary.

I have tried to put myself in the place of a prospective customer for this type of recorder and find great difficulty in visualising how it might be used. Would I be content to use one cassette only, continually erasing old recordings to make room for new ones? Would I need a number of cassettes, and how would the price compare with open reels, per hour of playing time? Would I use the recorder to collect 'sound pictures' with the idea of dubbing selected excerpts on to a static recorder?

The possibilities are endless and I can only repeat that the technical performance of the 401 is beyond reproach; it is up to you, the customer, to decide how it should be used.

A. Tutchings

**Below:** Life-size reproductions of an opened DC International cassette (employed on the M.401) and its rival (bottom), the Philips design.



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## 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.

### FAULTY TAKE-UP ON A TELEFUNKEN 104

Dear Sir, My *Telefunken 104* tape recorder has been functioning well for about a year, but recently has developed a fault which involves the take-up turntable.

When the machine is switched to the fast forward position, the turntable squeaks and rotates slowly. At first this fault occurred only when a spool was located on the turntable but now takes place even without the spool.

Moreover, and this may perhaps be due to this trouble, I have noticed that occasionally there has been clear indication of speed variation on playback. I would be glad of your advice.

Yours faithfully, R.B., St. Venera, Malta.  
The trouble is almost certainly due to the take-up belt, which in this machine is of flat fabric, tensioned by a roller on a pivot arm. The belt tends to become 'polished' on its surface and to bind on the plastic drum.

The take-up drum itself is of a thin plastic construction, and dryness at the bearing point can cause it to overheat and 'grip' the spindle, giving the snatch-and-slacken tendency which leads to irregular running. A clean-up and touch of light grease here will help. Check also the belt roller, both for free movement from the pivot point of the arm and for freedom at the roller spindle. Dismantle, clean and assemble with the aid of one drop of oil—surplus wiped off with the cotton wool before resuming running.

The machine also has a tendency for the top motor bearing to dry out and over-heat—a drop of light oil here may help, though this is not the prime cause of your trouble. Make sure the slide lever for fast-wind is free at the front and easily releases when you press the stop key.

### INDOCTRINATED BY AMPEX

Dear Sir, Entirely due to your report on the *Ampex 863* tape recorder, I decided to buy one and am fairly pleased with it. I am worried though, by the fact that, when switched to the record position, Radio Prague is heard very clearly from the monitor speakers. At first I was rather amused by this and often listened because the reception was so clear, but during a recent exercise of self-criticism I became aware of the serious danger of this fault. I have, since May, given up the *Daily Telegraph* in favour of the *Guardian* and have twice bought copies of the *Morning Star*! Can you advise?  
Yours faithfully, C.C.K., Saxmundham, Suffolk.

We are sorry to hear about your tape recorder, which appears to have been subversively indoctrinated! Now if it had been receiving Radio Caroline...

Joking apart, the reception of radio programmes when switched to record generally denotes that the input is unloaded, and this provides a very good detector circuit, the actual frequency of the signal detected depending on the circuit constants, stray capacitance of the wiring, etc., and the level dependent on siting and the efficiency of the amplifiers. With the Ampex 863 you have a superlative amplifier, and the sensitivity tells against you! However, you can prove this easily. Insert a shorted jack to the input socket and note whether the signal disappears. If it does, then you need have no worries, as the connection of external source for recording—microphone, gram or tuner, will balance the input loading and the circuits will not act as a radio detector.

If, however, you are getting this effect with the inputs loaded but no signal source (a microphone connected, a gramophone connected but not playing, a radio untuned or turned to minimum gain), then you really do have trouble and must call upon your agents for an under-guarantee check.

I think you will find this is only a phenomenon caused by the above conditions and nothing to be worried about. Incidentally, if at any time the just wind belt breaks, the drive belt for Stella 458/9 models is an exact fit!

#### HUM ON A TANDBERG

Dear Sir, I have a Tandberg 74 which has developed a mains hum. This increases in loudness when the volume controls are turned up but is not audible during recording. If Valve 1 and/or Valve 2 is removed, the hum disappears from the respective channel. I wonder if you can give me any idea of its cause?

Yours faithfully, C.P.M., Stamford, Lincs. The fault in your Tandberg evidently has a common cause, since the hum is present on both channels, and as it disappears when the pre-amplifier is removed we must suspect either the smoothing of this section of the HT circuit or the heater line.

The heater has a fixed humdinger, consisting of two 50-ohm wirewound resistors, the junction tapped to chassis. Replace these with a 100-ohm wire-wound potentiometer, tapping the slider to chassis, and adjust for minimum hum.

Test each channel individually and clean all switch contacts. An aerosol switch-cleaner such as the new Multicore 2-AX may be of advantage here, but remember to allow time for the volatile 'carrier' to evaporate before switching on, even though these solvents are reputed to be harmless with arcing contacts. Ordinary switch-cleaner tends to linger and can give noise symptoms on 'early' switch positions, I have found. A camel-hair brush and carbon tetrachloride is a good cleaning agent, so long as the usual precautions are taken (i.e. ensure adequate ventilation and do not inhale the fumes). Clean the V1 and V2 valve pins with a knife blade, and clean the sockets, working the valves up and down several times in their bases when re-inserting. Excuse these obvious hints, but experience has proved them to be common causes of many 'teasers'.

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

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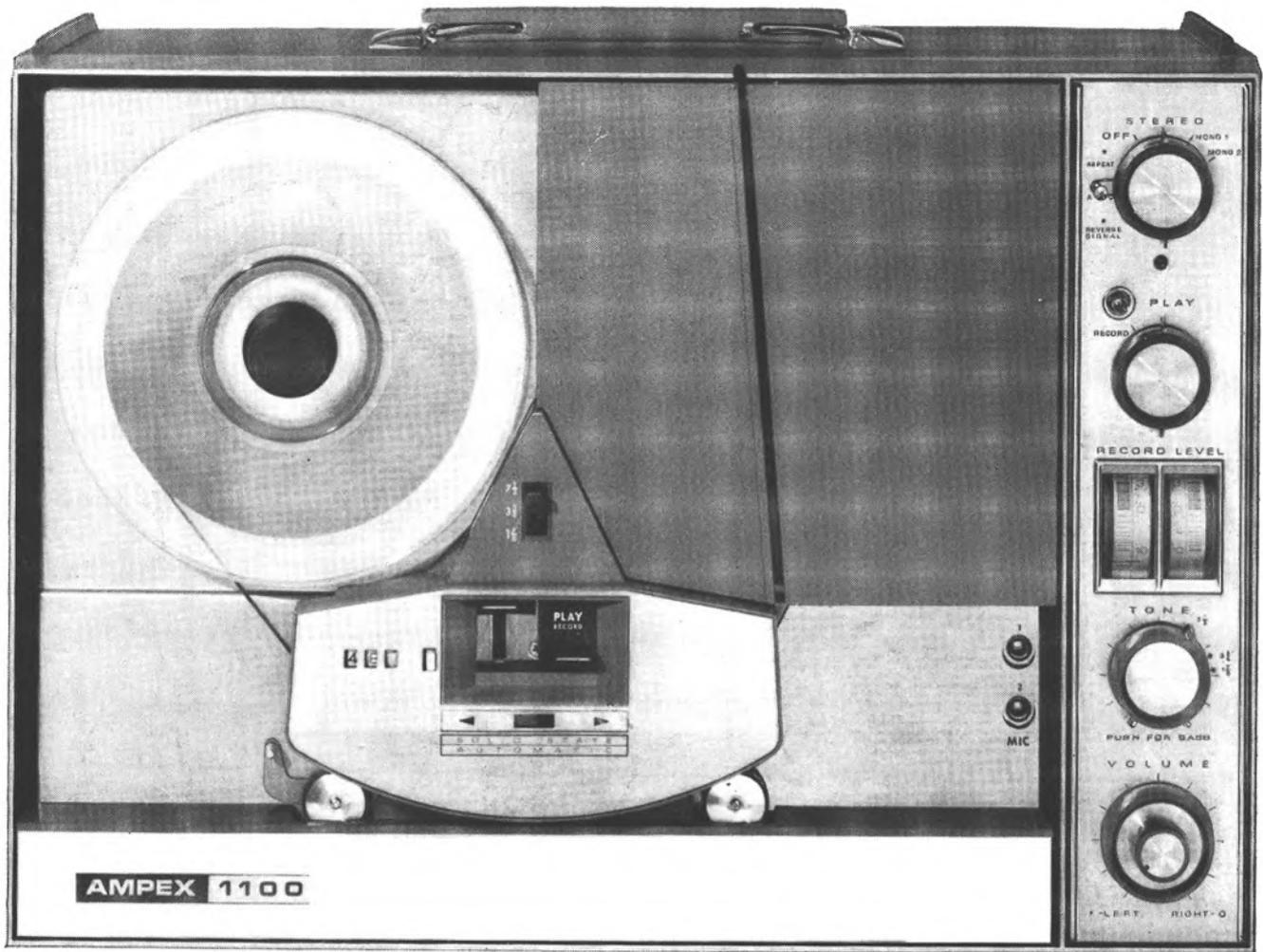
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