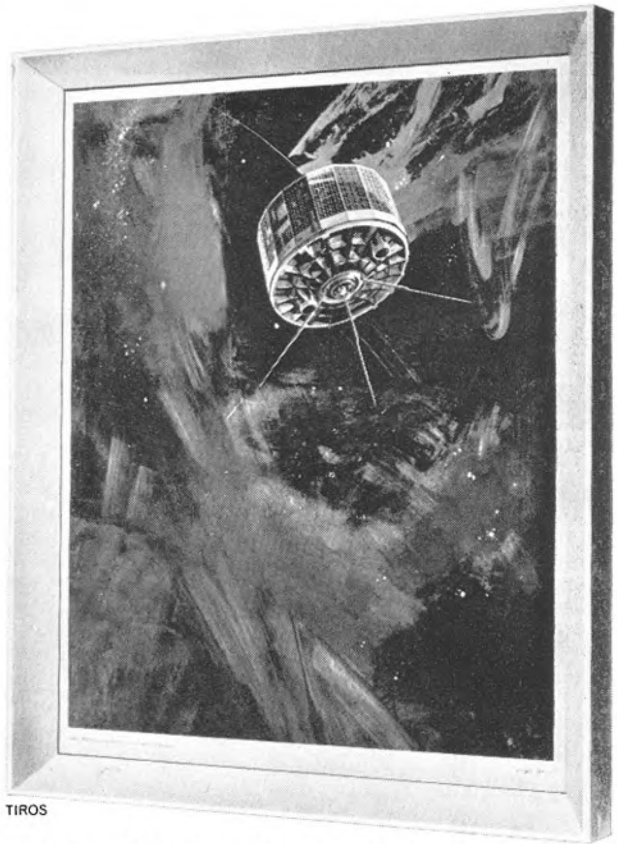
OCTOBER 1966 TWO SHILLINGS

tape recorder

SONY TC3574 REVIEW — SURVEY OF STEREO TAPE RECORDERS
RECORDING FM STEREO BROADCASTS — TELEFUNKEN M401 FIELD TRIAL

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

(Each worth 19/6 at least!)



TIROS

MARINER

POLARIS

Actual size of all pictures 16¾" x 14¼"

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

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

The research that leads the way in space

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

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Scotch

MAGNETIC TAPE

first with the new ideas

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Please send me—tick which

Tiros ☐ Mariner ☐ Polaris ☐

I enclose ...... tabs—one for each and cheque/P.O. for ....

(9/6 each)

NAME ....

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ADDRESS ....

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STICK YOUR TARTAN TABS HERE

Offer closes 31st Jan. 1967

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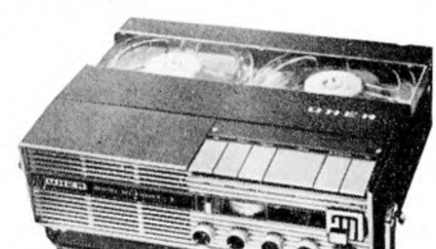
TELEFUNKEN 300

TRUVOX R104



UHER 4000L

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AKAI 355 The world's finest and most comprehensive recorder. Unique Akai Cross Field record head. Completely automatic track reversal and replay. 20 watts output. All transistorised amplifier. V.U. Meters. Freq. 40-21,000. Has to be heard to be believed. **239 gns.**

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

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B & O STEREOMASTER.	Brand new, few, 89 gns.
PHILIPS 3534 Stereo, inc. mic.	As new, 55 gns.
AKAI M69 inc. mic.	As new, 39 gns.
TRUVOX R64, inc. mic.	18 gns.

AKAI X4 Completely fully transistorised stereo battery/mains portable. Superb performance. 3 Speeds. 5" Tapes. V.U. Meters. 4 Tracks. Operates from rechargeable batteries or mains, unit optional extra. Has own power amplifiers. Freq. 40-20,000. Excluding microphones. **99 gns.**

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VORTEXION WVB One of the most tried and tested models available. This latest model has the new Wright & Weaire 3 Speed deck. 3 Motors. 3 Heads. Separate record/replay amplifiers. Before and after record monitoring facilities. 4 Watts. Variable bias. 8¼" tapes, etc. **£115.10.0**

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

TELEFUNKEN 300 A remarkable battery/mains portable tape recorder. Available in both 2 or 4 track models. Extremely portable and a delight to use. Easy to operate push buttons and controls. High quality dynamic microphone incl. Freq. 40-14,000. Wonderful quality. **49 gns.**

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

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

SPECIAL OFFERS!

FI-CORD 202A	Brand new, few only 39 gns.
SIEMENS 12 Stereo	As new 39 gns.
GRUNDIG TK60 Stereo	Perfect order 49 gns.
TELEFUNKEN 85KL	Perfect order 39 gns.

AMPEX 1100 The latest fully automatic 4 track stereo recorder by this world famous company. No tape threading, no turning over of tapes, no track changing. All done fully automatically. Separate V.U. meters. 2 Drive capstans. 4 Heads, etc. The most advanced design available. **150 gns.**

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

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

BRENELL Mk 5 III A well proven mono recorder basically unchanged but highly developed over many years. 4 Speeds. 4 Watts. 2 Tracks. 8¼" Tapes. Superimposing facilities. Monitoring. 3 Motors. An extremely well made and thoroughly reliable design of high performance. **74 gns.**

82 HIGH HOLBORN, W.C.1 (1 minute Holborn Underground)	**CHAncery 7401**
242/4 PENTONVILLE ROAD, N.1 (3 minutes from King's Cross Station)	**TERminus 8200**
228 BISHOPSGATE, E.C.2 (1 minute Liverpool Street Station)	**BIShopsgate 2609**
36 LEWISHAM HIGH STREET, S.E.13 (1 minute Lewisham Station)	**LEE Green 2399**
2 MARYLAND STATION, STRATFORD, E.15 (adj't Maryland Station)	**MARyland 5879**
205 HIGH STREET NORTH, E.6 (opposite East Ham Station)	**GRAngewood 6543**

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Incontestably the best value for money

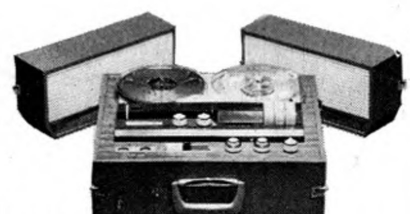
The Elizabethan LZ32, a brilliant three speed, twin track recorder. Combines consummate reliability and accuracy with the unerring attention to detail for which Elizabethan are so famous. Wonderful value at 32 gns. . . . indeed the LZ32 is hailed as producing sound equal to some tape recorders costing three times as much.

Just check these exciting features:

Light-weight (24 lbs) with rugged construction
A special 10" elliptical speaker for superb tonal quality
Separate bass and treble controls for complete flexibility
And if you want four tracks there's the LZ34, available at 34 gns.

Of course, there's no limit to the versatility of the Elizabethan range. For the avid enthusiast who can afford to pay a little more there's the LZ102, a fully transistorised 4-track 3-speed mains operated recorder, at 49 gns. Or the magnificent LZ711, a complete stereophonic tape recording system with facilities for sound on sound and sound with sound, at 75 gns. *Prices quoted are recommended.*

LZ102



LZ711

The Sound alone tells you it's

elizabethan

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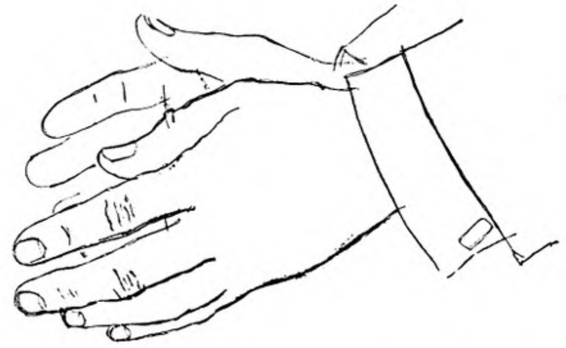
you've got to hand it to them



hand what to whom? The Grampian DP4 microphone to its users and to Grampian. This outstandingly light-weight mike has achieved world-wide success both with amateurs and professionals in public speaking, recording and broadcasting studios. This medium-priced all-rounder is remarkably reliable and sensitive to a wide range of sounds—uniform frequency response to all sounds between 50-15,000 c/s. The DP4 complete with connectors and 18 ft. screened lead:—low impedance model £8. 5. 0., medium and high impedance model £9. 5. 0. A complete range of stands, swivel-holders, reflectors and other accessories is available.

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	Deposit £	s.	d.	12 Monthly Payments £	s.	d.	Cash Price Gns.
4-TRACK STEREO/MONO							
Sony TC200	25	4	0	4	4	0	72
Akai 1700	27	13	0	4	12	2	79
Philips EL3534 ...	32	4	0	5	7	4	92
Tandberg 74	32	11	0	5	8	6	93
Tandberg Series 12 ...	36	15	0	6	2	6	105
Sony TC500A... ...	36	15	0	6	2	6	105
Beocord 2000K ...	47	5	0	7	17	6	135
Beocord 2000T De Luxe	48	13	0	8	2	2	139
Akai M8	51	2	0	8	10	4	146
Akai X300	66	10	0	11	1	8	190
MAINS 2-TRACK							
Ferguson 3220 ...	8	15	0	1	9	2	25
Fidelity Playmatic 2 ...	9	16	0	1	12	8	28
Grundig TK120 ...	10	6	6	1	14	5	29½
Grundig TK14L ...	12	5	0	2	0	10	35
Truvox 42	16	9	0	2	14	0	47
Tandberg 823... ...	18	18	0	3	3	0	54
Tandberg 92	24	3	0	4	0	6	69
Brenell 5/3	25	18	0	4	6	4	74
Brenell 5/3 (Meter) ...	27	13	0	4	12	2	79
Truvox R102	31	3	0	5	3	10	89
Brenell 5/3 'M' ...	32	11	0	5	8	6	93
Ferrograph 631 ...	33	5	0	5	10	10	95
STEREO TAPE UNITS							
Sony TC250A... ...	20	13	0	3	8	10	59
Truvox PD104 ...	36	15	0	6	2	6	105
Beocord 1500... ...	36	15	0	6	2	6	105
Ferrograph 634 ...	46	4	0	7	14	0	132

MAINS 4-TRACK	Deposit £	s.	d.	12 Monthly Payments £	s.	d.	Cash Price Gns.
Fidelity Playmaster ...	8	15	0	1	9	2	25
Fidelity Playmatic 4 ...	10	17	0	1	16	2	31
Ferguson 3218 ...	11	18	0	1	19	8	34
Ferguson 3222 ...	12	5	0	2	0	10	35
Philips EL3558 ...	14	14	0	2	9	0	42
Grundig TK17L ...	15	1	0	2	10	2	43
Truvox 44	16	9	0	2	14	10	47
Grundig TK400 ...	16	9	0	2	14	10	47
Wyndsor Vanguard ...	20	13	0	3	8	10	59
Philips EL3556 ...	21	14	0	3	12	4	62
Truvox R104	31	3	0	5	3	10	89

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Philips EL3301 ...	9	2	0	1	10	4	26
Philips EL3586 ...	9	2	0	1	10	4	26
Sony TC900 Bat/Mns	11	4	0	1	17	4	32
Sanyo MR110 Bat/Mns	12	12	0	2	2	0	36
Grundig C100 ...	15	15	0	2	12	6	45
Telefunken 300 ...	17	3	0	2	17	2	49
Telefunken 301 4-T ...	18	18	0	3	3	0	54
Akai X-4 Stereo ...	34	13	0	5	15	6	99
Uher 4000L	36	1	0	6	0	2	103

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Stereosuperb

TC250A Tape deck completes your system

FEATURES ■ Long life, solid state, all transistor circuit ■ Single lever control for all tape functions ■ Smooth and wide frequency response ■ Automatic end of tape switch, tape index counter ■ 57 Gns.

SPECIFICATIONS:

Power requirement	100, 110, 117, 125, 220 or 240 V. 40 watts, 50/60 cps.	Input	Low impedance microphone inputs – Transistorised (will accommodate any Microphone from 250 ohm–1 K ohm impedance) Sensitivity – 72 db (0.2 mv) High impedance auxiliary inputs Sensitivity – 12 db (0.2 v)
Tape speed	Instantaneous selection, 7½ and 3¾ ips. (19 and 9.5 cm/s).		
Frequency response	30–18,000 cps at 7½ ips. ± 3 db 50–15,000 cps at 7½ ips. 30–13,000 cps at 3¾ ips.		
Signal-to-noise ratio	Better than 50 db		
Flutter and wow	Less than 0.19% at 19 cm/s Less than 0.25% at 9.5 cm/s	Output	Low impedance line outputs Auxiliary Record/Playback connector
Harmonic distortion	1% at 0 db line output.		
Erase head	In-line (stacked) quarter track, EF17–2902H	Transistors	2SD64 (x6), 2SB382 (x2), 2SB383 (x2)
Record/Playback head	In-line (stacked) quarter track, PP30–420	Weight	Approx. 16.9 lbs.
Bias frequency	Approx. 55Kc	Dimensions	14.2 (W) x 6.3 (H) x 11.4 in (D) (360 x 158 x 287 mm)
Level indication	Two VU meters (calibrated to O VU at 12 db below saturation of tape)	Accessories	Connecting leads. Head cleaning ribbon. 60 c/s pinch wheel capstan

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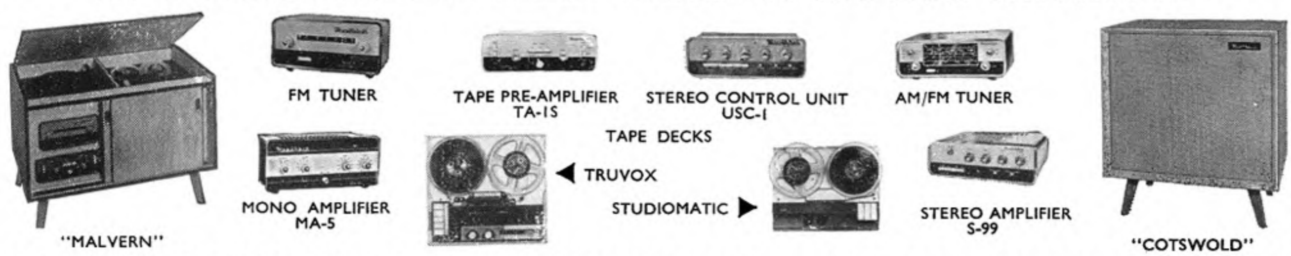

A wide range of models for the Tape and Hi-Fi Enthusiast

	Kit	Assembled
MONO TAPE PRE-AMPLIFIER, TA-1M ...	£19 10 0	£28 18 0
STEREO TAPE PRE-AMPLIFIER, TA-1S ...	£25 10 0	£35 18 0

TAPE DECKS

TRUVOX D93-2 ½-track	£36 15 0
,, D93-4 ¼-track	£36 15 0
MAGNAVOX '363' ½-track	£13 10 0

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A must for the tape enthusiast. Four channels allow recording from a wide variety of sources, e.g., dynamic and crystal microphones, tuners, record players. **Kit £11 14 6**
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9 + 9W STEREO AMPLIFIER S-99	£28 9 6	£38 9 6
3 + 3W ,, AMPLIFIER S-33H ...	£15 17 6	£21 7 6
3 + 3W ,, AMPLIFIER S-33	£13 7 6	£18 18 0
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10W POWER AMPLIFIER, MA-12	£11 18 0	£15 18 0
50W ,, AMPLIFIER, MA-50	£19 18 0	£27 18 0
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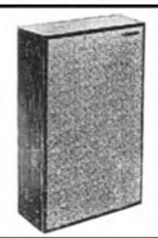

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,, AT-60 ,, Deram	£17 16 1
,, SP-25 ,, GC8	£13 10 8
,, SP-25 ,, R105	£16 4 8
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,, ,, CONNOISSEUR, 2-speed	£17 2 11

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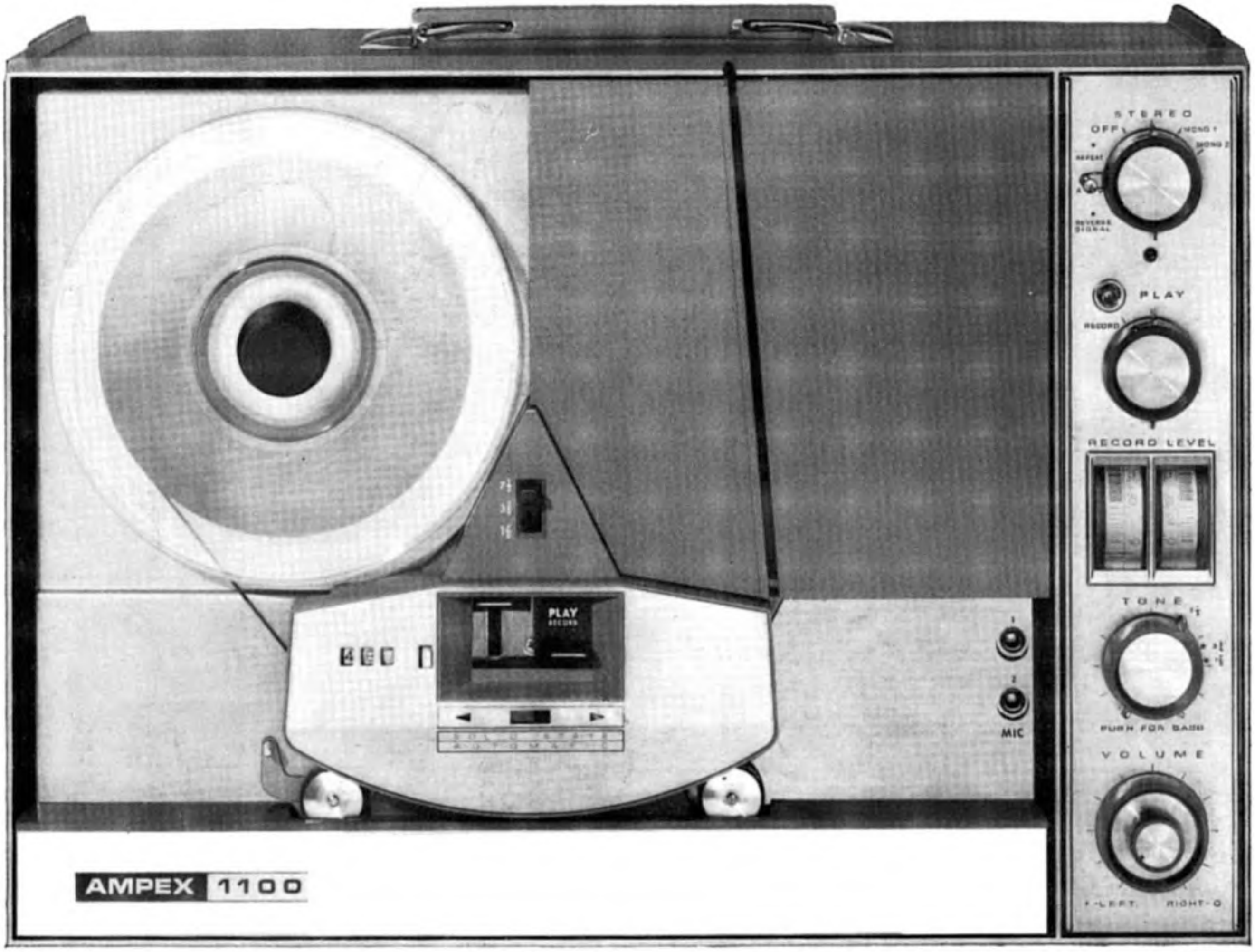

There's something special about the new Ampex 1100

Listen

It's sound. Pure sound. The reproduction you'd expect from the world's leading makers of recording equipment. Just play the Ampex 1100 up against any other recorder in the same price range, and listen to the difference. Ampex 1100 variants are available as a deck version with pre-amplifiers (1153), as a portable deck with pre-amplifiers and power amplifiers (1163) or in a walnut cabinet (1165-3). Ampex 1100 has an automatic reverse (plays unattended for 9 hours) □ automatic tape threading □ 3 speeds □ accurate VU meters □ interlocked tape controls □ precise dual capstan drive □ life-long Ampex deep-cut heads and solid state electronics □ No head-wearing pressure pads are used in *any* Ampex recorder. Full warranty—of course. If you want something extra from a tape recorder, you'll find it in Ampex.

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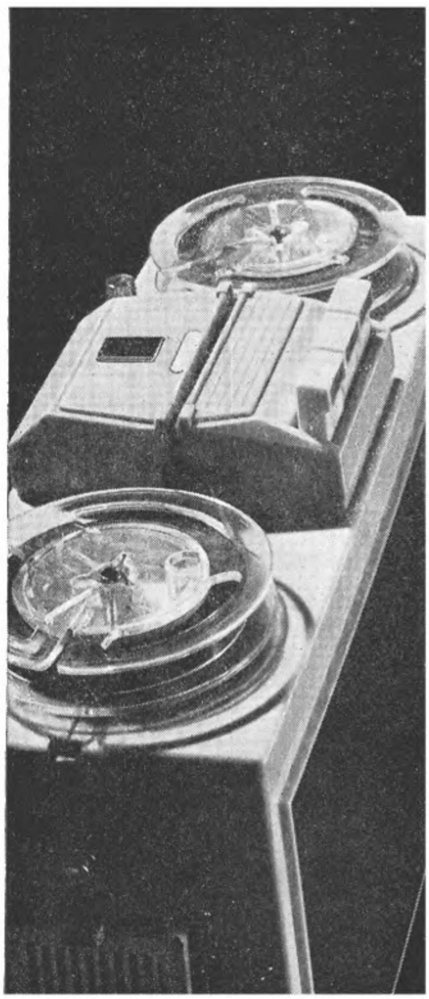

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tape recorder

OCTOBER 1966 VOLUME 8 NUMBER 9

INCORPORATING SOUND AND CINE

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COVER PICTURE

Every picture tells a story—it just happens that this story is more subtle than most. Our interpretation is that *Telefunken*, proud of their new *M204E*, are commenting slyly that someone on that globe is incapable of manufacturing anything so attractive. The antique English rocking-chair brings home just who that 'someone' is. But why should such a functional and solid chair be improved? The chair is reliable, sturdy, and does not deteriorate rapidly with age. Another of the chair's pleasing features is that it will not, unlike the precarious Balance of Payments situation, tip us on the floor. However, perhaps we are erecting an Aunt Sally, as *AEG* were, after all, the first organisation to produce a tape recorder in the modern sense, and maybe they are still on top of the world.

SUBSCRIPTION RATES

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

CASSETTES AND TAPE RECORDS have sometimes provoked black thoughts on the future of our hobby, and phrases like "the death of splicing" or "mere uncreative listening" have been bandied in our pages. Now, the announcement of *Musicassettes* (see page 359) brings us into the groove once again. The groove is indeed a good starting point, as pre-recorded music tapes have been battling away for a stake in the gramophone market for many years. In some respects tape records have achieved a modest success, and many tape machine owners without disc playing equipment have found this type of record useful.

Although we have reservations regarding any threat to sabotage the tape recording hobby by techniques or uses which discourage creativity, we feel that active recordists can also be listeners, without a guilty conscience, provided everyone accepts the tape recorder as a multi-purpose instrument. For this reason we join other magazines in publishing occasional reviews of tape records alongside constructional articles. (Such reviews unfortunately held over this month due to lack of space.)

Similarly, although the cassette idea has raised a few editorial eyebrows, we recognise the extreme operational simplicity of these new machines. As David Kirk remarks in the course of his field-trial on page 379, cassette machines will not oust reel-to-reel spooling—ideally, they should be complementary.

But now a fresh hybrid has arisen: the cassette machine produced specially for playing music tapes, with tape records specifically intended for playing on such machines. Unfortunately the background to this development is not a desire to satisfy a genuine demand or to provide new goods and services for their own sake, but to win a battle. *Philips* on the one hand and the *DC International* group (*Telefunken*, *Grundig*, *Loewe Opta* and *Uher*) on the other, have produced competing cassette systems, and in the desperate attempt to make 'ours' more acceptable to the public than 'theirs', the facilities of a music recording organisation have been brought in.

Perhaps Tweedledum will beat Tweedledee, but let it be quite clear that this is the object of the exercise. No confidences are being betrayed here, as at recent press conferences it was made perfectly clear to all present that the whole venture was a piece of naked commercial power politics.

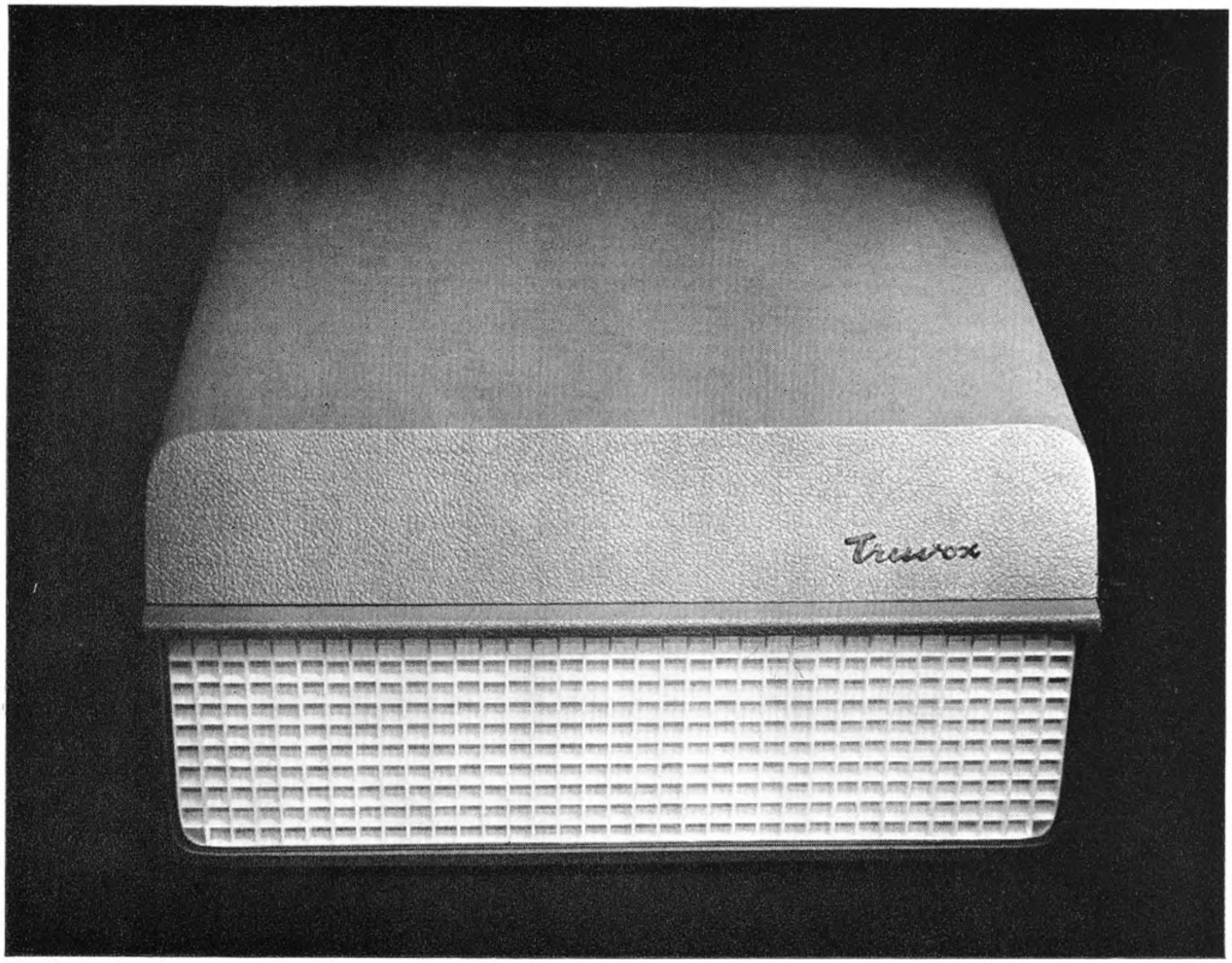
On the other hand, we must admit a slight preference for the Philips cassette, and on balance we would like to see it win this battle which should have been so unnecessary. Apart from other considerations, and even taking into account the non-standard tape width in both systems, the *DCI* choice of 2 i/s as the speed is quite simply irresponsible. Why in heaven's name introduce yet another tape speed only $6\frac{2}{3}$% (just over one semitone) faster than an existing and widely used standard? However, let battle rage and may the best man win.

A side issue, not new but underlined by the Musicassette development, is the price of tape recorded music. In the past, tape has in nearly every case been more expensive than disc for a given quantity of music: costs of material and the multiple copying processes have made this inevitable. Narrower tape and a speed of $1\frac{7}{8}$ i/s will certainly lower the former, while larger scale production may help to spread the capital costs for the latter. Also, confining the catalogues to the type of material used—in the main—for background music, should nullify some of the supposed advantages of discs. Despite this, the new cassette records cost £2 each for the direct equivalent of existing discs, some of which sell at 33s. We do not know which is more silly, a pricing system offering *reissues* of records at higher than original prices, or that semitone speed difference. Still, as we said, it's a case of Dum and Dee.

FEATURE ARTICLES

REGULAR ITEMS

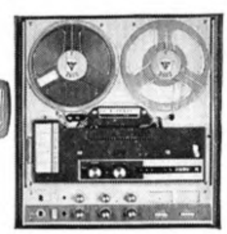
EQUIPMENT REVIEWS



What's in it for you?...

Call it 'the PSP Factor'. It stands for the ideal balancing of Performance, Styling and Price you get only from Truvox. Truvox build this quality into everything they make. You'll recognise it instantly in the all-transistor, all-British Recorders and Tape Units illustrated right. A spec. will give you only the cold clear facts. The moment of truth comes when your Truvox stockist demonstrates it. Then 'the PSP Factor' really comes alive. Only Truvox build this 'PSP Factor' into everything they make.

Tape Recorders (Monaural)
Two-track 76 gns.
Four-track 79 gns.



Stereo Tape Units
Half-track 93 gns.
Quarter-track 89 gns.

TECHNICAL SPECIFICATIONS, RECORDERS & TAPE UNITS

Reel size:	Up to 7"
Tape Speeds:	$7\frac{1}{2}$", $3\frac{3}{4}$" & $1\frac{7}{8}$" p.s. constant within $\pm 1\%$
Drive:	3 motors, separate capstan motor, heavy flywheel, drive disengaged in OFF position.
Brakes:	Mechanical compensated.
Winding Time:	60 sec. for 1200′
Frequency response:	30—17,000 c.p.s. $\pm$ 2db, at $7\frac{1}{2}$" p.s. (19 cm) 40—10,000 c.p.s. $\pm$ 2db, at $3\frac{3}{4}$" p.s. (9.5 cm) 60—8,000 c.p.s. $\pm$ 3db, at $1\frac{7}{8}$" p.s. (4.75 cm)
Amplifier distortion: (Recorder only)	.35 of 1% at 5 watts.
Hum:	better than 45db
Signal to noise:	better than 50db
Inputs:	(1) Microphone 1mV at 50K ohms. (2) Radio/P.U. 50mV at 100K ohms.
Output (Recorder only):	5 watts, into 15Ω load.
Output to ext. amp:	Emitter follower, across 100 ohms, output Voltage variable up to IV.
Record Characteristics to the new European standards	70 µS at $7\frac{1}{2}$" p.s. 140 µS $3\frac{3}{4}$" p.s.
Wow & Flutter:	$7\frac{1}{2}$" p.s. better than .1% $3\frac{3}{4}$" p.s. better than .15% $1\frac{7}{8}$" p.s. better than .25%
Oscillator frequency:	90Kcs.
Dimensions and weight R102/104:	16" x $17\frac{3}{4}$" x $8\frac{1}{2}$" Wt 34 lbs
Dimensions and weight PD102/104:	16" x $16\frac{3}{8}$" x 8" Wt 28 lbs

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WORLD OF TAPE

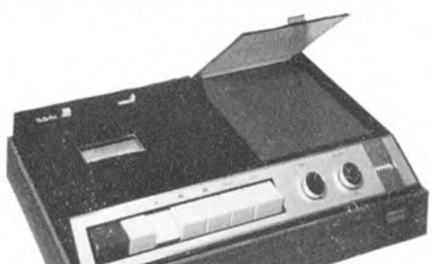
LISTEN TO THIS SPEC'

NEW thinking at *Garrard* has resulted in a taped recorded 'audio catalogue', aimed at blind audio enthusiasts. Available to registered blind individuals from the *Tape Circle*, 32 Paton House, Stockwell Road, London S.W.9, the recording comprises a 3,000 word description of Garrard turntables and record-playing mechanisms. Part of the tape is also devoted to details of the company's activities, accessories and spares. Complete technical specifications, design features and prices are stated for each unit.

The Tape Circle is a postal service catering for the supply of tape recorded material to the blind. Their programme includes fiction and general interest items, extracts from magazines and newspapers.

UHER INTRODUCE LANGUAGE LABORATORY

DISTRIBUTION of *Uher* language-teaching systems is now under way at the *Bosch Ltd.* showroom, 205 Great Portland Street, London W.1. Heart of the 'laboratory' is the *Universal 5000*, a domestic tape recorder with additional features for high-quality dictation. Each booth incorporates a *5000* and is connected to a central control panel. This panel enables the instructor to communicate with pupils, individually or as a class, and permits relay of pre-taped lessons from a *784* twin-channel recorder. The latter machine may also be synchronised with a slide projector.



PHILIPS INTRODUCE 'MUSICASSETTES'

ENCOURAGED by the success of the *EL3301* battery tape recorder, Philips are now marketing two new mains-powered cassette machines. Although of unusual appearance, the most original feature of the stereo *EL3312* is its method of tracking. Four tracks are squeezed on to the $\frac{1}{8}$in. tape, each pair of stereo tracks being adjacent rather than, as is the convention, interlaced. This system has a strong disadvantage in terms of cross-talk between adjacent tracks, but Philips make no claim regarding its suitability as a $\frac{1}{4}$-track mono recorder. A point in favour of this tracking technique is that $\frac{1}{2}$-track mono and $\frac{1}{4}$-track stereo cartridge recorders are rendered compatible. Styling of the *EL3512* is similar to that of the *EL3310* illustrated. The EL3310 retails at £36 15s. and has $\frac{1}{2}$-track mono facilities only.

For the three cassette designs, Philips have also introduced, and are now marketing, commercially recorded *Musicassettes*. Available through distributors of Philips records, these are all being dubbed in stereo for either single channel or double channel reproduction —depending on the equipment used. All are recorded at $1\frac{7}{8}$ i/s and cost £2 each.

A SOUND REVIEW

THREE *Reslo* microphones are reviewed on the latest 'recorded magazine' to be produced by *Stereo International*. Commentary by John Shuttleworth links a series of live music recordings, demonstrating overall quality, while other passages compare the pickup pattern of each model on voice recordings made in noisy surroundings. Copies are available to non-members for 17s. 6d. (including cost of 5in. tape and postage) from **Stereo International, 33 Grove Park Road, London, S.E.9.**

Q-CORDS WITHOUT ACCESSORIES

Q-CORD battery tape recorders are now being offered without accessories, at a correspondingly reduced price of £28 7s. The *R.119K* and *203* are available at this price (with $4\frac{1}{4}$in. spool and patch-cord) or at £33 12s. with all accessories. In both cases, recorders will be covered by a six months guarantee covering cost of labour and parts. **Distributor: C. Braddock Ltd., 266 Waterloo Road, Blackpool, Lancashire.**

GRUNDIG RANGE SELECTED FOR DESIGN CENTRE

FOUR Grundig tape recorders in the *Luxus* range have been selected by the Council of Industrial Design for display at the Haymarket Design Centre. Machines concerned are the *TK14L*, *17L*, *18L* and *23L*. Styling of the *TK6* battery portable has been altered and the new Model *TK6L* raised in price by £4 4s. to £80 17s.

NEXT YEAR OF HI-FI

NOW available from *Imhofs* is the 1966-67 edition of their catalogue *This Year of Hi-Fi*. Whereas past editions have been published at the beginning of each year, a switch to late summer has enabled equipment introduced at the *Audio Fair* to be included. Fifty-six pages of data and illustration are devoted to a selection of currently available audio and tape equipment. A separate price list is supplied with the catalogue, which is obtainable free of charge from **Imhofs (Retail) Ltd., 112-116 New Oxford Street, London W.C.1.**

SOLDERING EXPLAINED

MULTICORE Solders are now producing a leaflet entitled *Hints on Soldering*, which combines sales literature with practical advice to inexperienced circuit-builders. The leaflet is aimed at the handyman and non-technical reader, and is being distributed to the public through the retail trade.

MULLARD SERVICING

THE service department of *Mullard Ltd.* was recently moved from 294 Purley Way, Croydon, to premises at Mitcham. Personal enquiries, letters and parcels should be directed to **Mullard Ltd., Service Department, P.O. Box 142, New Road, Mitcham Junction, Surrey.**

DANCE TO THE BRENELL

"A DISCOTHQUE is a restaurant that cannot afford a band." Whether or not they conform to this view, the folk of Piccadilly apparently derive pleasure from dining and dancing to the 200W output of a Wharfedale amplifier bank, connected to a $10\frac{1}{2}$in. capacity *Brenell* tape recorder and a pair of *Thorens* turntables. Four of the amplifiers feed a total of 17 loudspeakers, the fifth amplifier acting as a standby in case of failure on any one channel. Careful arrangement of the speakers permits high volume sound to be reproduced over the dance floor, while a comfortably low level is obtained in the dining vicinity. The Brenell-Wharfedale-Thorens trio are employed at *Sibylla's* of 9 Swallow Street, the installation being by *3D Sound Ltd.*

FISH RECORDING

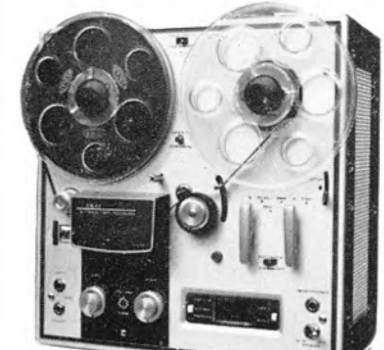
MAGNETIC tape is currently being utilised at the White Fish Authority's Hull Industrial Development Unit, to design an accurate fish detector. The one that got away this time, may next time be caught by *Scotch* tape. Research into fish detection has been undertaken for several years by the WFA and has centred around the use of echo-sounding equipment. A library of recordings has been built up, comprising echoes from many species of fish, made in varying weather conditions and at different depths. An instrumentation tape recorder, operating on three channels at 60 i/s, gathers the signals from prototype narrow-beam echo-sounders that have been fitted to three new fishing vessels. The sounder transmits signals at a minimum frequency of 30 Kc/s vertically downwards from the vessel to some 300 fathoms. An area of sixty feet along the sea-bed, and eight feet above it, is scanned by the signal arc. Outcome of present work is hoped to be a horizontal sounder, enabling the location of fish up to a mile in front, or to the side, of the boat.

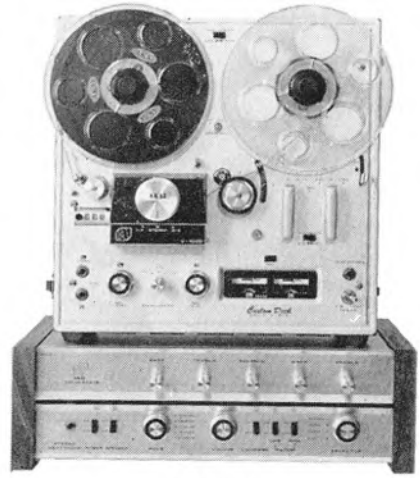
NEXT MONTH

PUBLISHED ON Friday 14th October, the November issue will feature one of the most comprehensive reviews ever given to a battery tape recorder. The *Uher 4000L* will be tested before and after a twelve week field trial, to assess the rate of performance deterioration. Service data and a circuit diagram of the *Akai M8* will be given by H. W. Hellyer, while Richard Noble describes the application of magnetic tape in data processing.

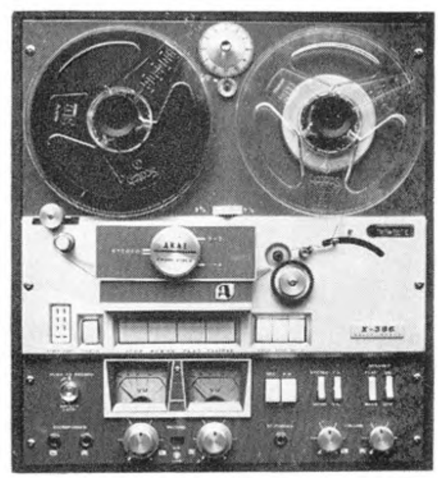
STEREO TAPE RECORDERS

A COMPREHENSIVE SURVEY OF CURRENT EQUIPMENT


Akai 1700


Akai X-100D


Akai X-4


Akai X-355


Akai M8


Akai X-300

Ampex 800

IF there is one field in which we are not marching solidly backwards it is stereo radio broadcasting. Advocated by *Wireless World* in the 1930's, stereo transmissions were recently introduced on an apparently permanent basis, using the *Zenith-G.E.* pilot-tone multiplex system. Although no assurance has been given by the BBC that this system is their final choice, manufacturers and importers are hurriedly preparing to supply stereo FM tuners, and decoders with which to convert existing mono tuners. (A survey of stereo tuners and decoders is included in the September *Hi-Fi News*, currently on sale.)

How does this affect us? Many tape recorders are understood to be incapable of making 'whistle-free' copies of pilot-tone transmissions, whether dubbed in mono from a mono tuner, or in stereo. The whistle is generated by beating between the recording bias signal and 19 Kc/s pilot-tone. It is difficult to say, at present, whether all recorders, other than those specifically adapted, will be prone to 'whistling', though our own experiments seem to indicate that, for one reason or another, some recorders will accept multiplex broadcasts without trouble.

The techniques of modifying existing recorders to prevent beating are described by John Earl on page 366 of this issue. One way of overcoming the need for such modification, unless you already possess a stereo recorder unsuitable for multiplex broadcasts, is to buy a model with a very high bias frequency (such as the Truvox PD100) or with a built-in filter (in the pattern of the Tandberg Series 12). We have made a point, therefore, of mentioning the suitability of machines for FM stereo under the FEATURES heading. Manufacturers have been consulted in all cases regarding this particular entry, and any omission of the feature indicates that the model would probably require adaptation. Any recorder can, of course, be used successfully with the *Revox* Multiplex Filter, now being marketed at £12 (see *New Products*, page 381).

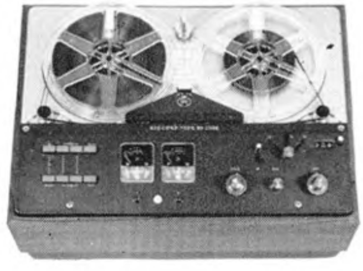
Following the pattern of the September 1965 survey, we are publishing the manufacturer's claimed frequency response (or range) only for a 7½ i/s tape speed. This should simplify comparison of specifications. Only exceptions to this procedure are machines which do not feature that speed.

Where no output is quoted, and 'output from preamplifiers' is given as a feature, the recorder may be taken as being a tape unit—namely a complete recorder minus replay power amplifiers and speakers.

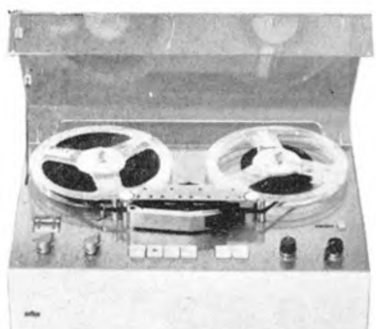
Strictly professional stereo recorders (over (£400) have been excluded from the survey, due to the detail and variety of design modifications available to individual purchasers.

Ampex 1100

Beocord 1500 De-Luxe



EMI TR52/2CT



Braun TG60

Beocord 2000L De-Luxe

Elizabethan LZ711

AKAI M8. SPEEDS: 15, 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.15% RMS. FREQUENCY RESPONSE: 30 c/s-25 Kc/s ±3dB. OUTPUT POWER: 6W x 2. SPEAKERS: Two 4in. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two VU. MICROPHONES: Two moving-coil. WEIGHT: 47lb. DIMENSIONS: 20 x 13 x 9in. FEATURES: Cross-field bias, interchangeable capstans, FM multiplex recording. PRICE: £153 6s. **DISTRIBUTOR: Pullin Photographic Ltd., 11 Aintree Road, Perivale, Greenford, Middlesex.**
● **Review:** March 1966.

AKAI 1700. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.18% RMS. FREQUENCY RANGE: 40 c/s-18 Kc/s. OUTPUT POWER: 5W x 2. SPEAKERS: Two 5 x 7in. SPOOL CAPACITY: 7in. TRACKS: Two or four. LEVEL INDICATOR: VU. WEIGHT: 33lb. DIMENSIONS: 13¼ x 13¼ x 9in. FEATURES: Interchangeable capstans (15 i/s accessory available), FM multiplex recording. PRICE: £82 19s. **DISTRIBUTOR: See above.**

AKAI X-4. SPEEDS: 7½, 3¾, 1⅞ and $\frac{15}{16}$ i/s. WOW AND FLUTTER: 0.16% RMS. FREQUENCY RESPONSE: 40 c/s-20 Kc/s ±3dB. OUTPUT POWER: 2W x 2. SPEAKER: 5in. elliptical. SPOOL CAPACITY: 5in. LEVEL INDICATORS: Two meters. MICROPHONES: Two moving coil. WEIGHT: 12lb. DIMENSIONS: 10 x 9½ x 4in. FEATURES: Cross-field bias. Powered by rechargeable nickel-cadmium battery. Mains unit and charger supplied. Battery life is six hours per charge. PRICE: £137 11s. **DISTRIBUTOR: See above.**
● **Review:** March 1966.

AKAI X-100D. TAPE SPEEDS: 15, 7½, 3¾, 1⅞ and $\frac{15}{16}$ i/s. WOW AND FLUTTER: 0.15% RMS. FREQUENCY RESPONSE: 30 c/s-25 Kc/s ±3dB. SPOOL CAPACITY: 7in. WEIGHT: 30lb. DIMENSIONS: 13¼ x 13¼ x 9in. FEATURES: Output from preamplifiers. Cross-field bias. FM multiplex recording. PRICE: £103 19s. **DISTRIBUTOR: See above.**

AKAI X-300. TAPE SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: 0.05% RMS. FREQUENCY RESPONSE: 30 c/s-24 Kc/s ±3dB. OUTPUT POWER: 20W x 2. SPEAKERS: Two 6 x 4in. SPOOL CAPACITY: 10½in. LEVEL INDICATORS: Two VU-meters. WEIGHT: 47lb. DIMENSIONS: 13¼ x 16 x 9in. FEATURES: Cross-field bias, FM multiplex recording. Transistorised amplifier. 15 i/s capstan available. PRICE: £199 10s. **DISTRIBUTOR: See above.**

AKAI X-355. TAPE SPEEDS: 7½ and 3¾ i/s (15 i/s capstan supplied). WOW AND FLUTTER: 0.08% RMS. FREQUENCY RESPONSE: 30 c/s-24 Kc/s ±3dB. OUTPUT POWER: 20W per channel. SPEAKERS: Two 6½in. SPOOL CAPACITY: 7in. (10½in. extension arms available). TRACKS: Four. LEVEL INDICATORS: Two VU-meters. WEIGHT: 62lb. DIMENSIONS: 17½ x 16 x 12in. FEATURES: Cross-field bias. Bi-directional solenoid-control transport. FM multiplex recording. Sound on sound, automatic replay, automatic rewind. Separate record and replay heads. PRICE: £250 19s. **DISTRIBUTOR: See above.**
● **Review:** September 1966.

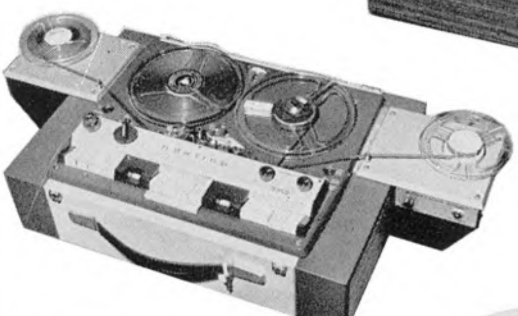
AMPEX 863. TAPE SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RESPONSE: 50 c/s-15 Kc/s ±4dB. OUTPUT POWER: 6W RMS x 2. SPOOL CAPACITY: 7in. TRACKS: Four. MICROPHONES: Two moving-coil. LEVEL INDICATORS: Two VU-meters. WEIGHT: 37lb. DIMENSIONS: 19 x 13½ x 7½in. FEATURES: Output from preamplifier and power amplifier. Twin capstan, solenoid-controlled transport. Automatic tape reversal. Variable replay equalisation. PRICE: £127 10s. **MANUFACTURER: Ampex Ltd., Acre Road, Reading, Berkshire.**
● **Review:** February 1966. (*continued on page* 363)

Ferrograph 632H

Korting MT3623

Grundig TK340

Tandberg Series 6



Korting MT3624

Luxor MP424

Telefunken M204E

AMPEX 1153. Transistorised version of *Model 863*. FEATURES: Automatic reverse/playback, automatic threading. Output from preamplifiers. WEIGHT: 27lb. PRICE: £149 10s. Other specificational details as above.

AMPEX 1163. OUTPUT POWER: 6W RMS x 2. WEIGHT: 39lb. PRICE: £159 10s. Other specificational details as *Model 1153*.

AMPEX 2100. FEATURES: Automatic reverse/record/playback. Four heads. Mono mixing. **(Available in November)**

BANG AND OLUFSEN BEOCORD 2000T DE-LUXE. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.02% p-p. FREQUENCY RESPONSE: 40 c/s-16 Kc/s ±2dB. OUTPUT POWER: 8w x 2. SPEAKERS: Two, mounted in detachable lids. SPOOL CAPACITY: 7in. TRACKS: Two-track record, two-and four-track replay, through separate heads. LEVEL INDICATORS: Two VU-meters. DIMENSIONS: 9¾ x 17¾ x 13½in. FEATURES: Four-channel mixing with twin slide faders. Echo. Straight-through amplification. Inter-track recording. Multiplex stereo recording. PRICE: £145 19s. **DISTRIBUTOR: Bang and Olufsen U.K. Sales Division, Mercia Road, Gloucester.**

● **Review:** June 1965.

BANG AND OLUFSEN BEOCORD 2000L, DE-LUXE. Teak plinth housing. No speakers. PRICE: £141 15s. Other specificational details as *Model 2000T*.

BANG AND OLUFSEN 1500 DE-LUXE. PRICE: £110 5s. Output from preamplifiers. Rotary gain controls. Other specificational details as *Model 2000T*.

BRAUN TG60. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: 0.1% R.M.S. FREQUENCY RESPONSE: 20 c/s-16 Kc/s to DIN standard. SPOOL CAPACITY: 7in. TRACKS: Two. LEVEL INDICATORS: Two VU-meters. DIMENSIONS: 16¾ x 11½ x 7in. FEATURES: Output from preamplifiers. Separate record/play heads, transistor tape amplifier, solenoid tape transport. Three *Papst* motors. PRICE: £308. **DISTRIBUTOR: Fi-Cord International, Charlwoods Road, East Grinstead, Sussex.**

BRENELL STB2/5/2. SPEEDS: 15, 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.1%. FREQUENCY RESPONSE: 40 c/s-15 Kc/s ±2dB. SPOOL CAPACITY: 8¼in. TRACKS: Two-track record, two- and four-track replay, through separate heads. LEVEL INDICATORS: Two PPM. WEIGHT: 48lb. DIMENSIONS: 19½ x 17½ x 9½in. FEATURES: Interchangeable capstans. Variable bias. Output from preamplifiers. PRICE: £120. **MANUFACTURER: Brenell Engineering Ltd., 231-235 Liverpool Road, London, N.1.**

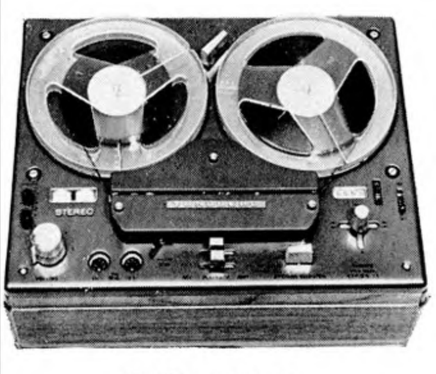
BRENELL STB1/510/2. SPOOL CAPACITY: 10½in. NAB. PRICE: £140. Other specificational details as *Model STB2/5/2*

EMI TR52/2CT. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: 0.25%. FREQUENCY RESPONSE: 50 c/s-10 Kc/s ±2dB. SPEAKER: Single monitor. SPOOL CAPACITY: 8¼in. TRACKS: Two. LEVEL INDICATOR: VU-meter. WEIGHT: 80lb. DIMENSIONS: 20 x 17½ x 13½in. FEATURES: Output from preamplifiers at +6dm. PRICE: £150. **MANUFACTURER: EMI Electronics Ltd., Hayes, Middlesex.**

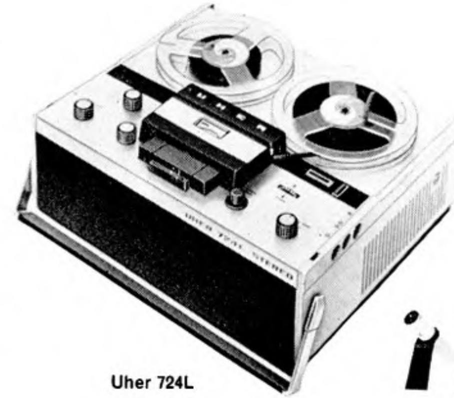
● **Review:** May 1960.

ELIZABETHAN LZ711. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RANGE: 60 c/s-14 Kc/s. OUTPUT POWER: 3W x 2. SPEAKERS: Two 8 x 5in. detachable. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. MICROPHONES: Two crystal. WEIGHT: 40lb. DIMENSIONS: 25 x 16 x 9in. FEATURES: Magnavox Studiomatic tape deck. PRICE: £78 15s. **MANUFACTURER: Elizabethan Electronics Ltd., Crow Lane, Romford, Essex.**

(*continued on page 365*)



Tandberg Series 12



Uher 724L

Sony TC260

FERROGRAPH 632. SPEEDS: 7½, 3¾ and 1⅞ i/s. FREQUENCY RESPONSE: 30 c/s-15 Kc/s ±3dB. SPOOL CAPACITY: 8¼in. TRACKS: Two. LEVEL INDICATORS: One PPM. WEIGHT: 48lb. DIMENSIONS: 18½ x 17¾ x 9⅝in. FEATURES: Separate record and replay heads. Output from preamplifiers. Monitor amplifier. Solenoid stop mechanism. Bias and erase links. PRICE: £132 6s. **MANUFACTURER: Ferrograph Co. Ltd., 84 Blackfriars Road, London, S.E.1.**

FERROGRAPH 632H. SPEEDS: 15, 7½ and 3¾ i/s. PRICE: £138 12s. Other specificational details as *Model 632H*.

FERROGRAPH 634. Quarter-track version of *Model 632*. PRICE: £138 12s.

GRUNDIG TK340. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: ±0.1%. FREQUENCY RANGE: 40 c/s-18 Kc/s. OUTPUT POWER: 8W x 2. SPEAKERS: Two 6 x 4in. side-facing. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATOR: Magic-eye. WEIGHT: 37lb. DIMENSIONS: 21 x 8½ x 16in. FEATURES: FM Multiplex recording. Separate record/play heads. PRICE: £152 5s. **MANUFACTURER: Grundig Ltd., Newlands Park, Sydenham, London, S.E.26.**

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

KORTING MT3624. SPEEDS: 7½, 3¾ and 1⅞ i/s. OUTPUT POWER: 3W x 2. SPEAKERS: Two 7in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two magic-eyes. WEIGHT: 35lb. DIMENSIONS: 20¾ x 14 x 8in. FEATURES: Separate record/play heads. Clip-on spool turntables for mono dubbing and preamplifier for stereo dubbing available as extras. Variable echo delay from sliding replay head. PRICE: £102 18s. **DISTRIBUTOR: See above.**

● **Review:** May 1966.

LUXOR MP423. SPEEDS: 7½, 3¾ and 1⅞ i/s. OUTPUT POWER: 2W x 2. SPEAKERS: Two 7in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two magic-eyes. WEIGHT: 24lb. DIMENSIONS: 14 x 11½ x 6¾in. FEATURES: Mounted in teak plinth. PRICE: £77 14s. **DISTRIBUTOR: Britimpex Ltd., 16-22 Great Russell Street, London, W.C.1.**

LUXOR MP424. Portable carrying case. WEIGHT: 28½lb. PRICE: £80 17s. Other specificational details as *Model MP423*.

LUXOR MP463. SPEEDS: 3¾ and 1⅞ i/s. PRICE: £82 19s. Other specificational details as *Model MP423*.

LUXOR MP464. SPEEDS: 3¾ and 1⅞ i/s. PRICE: £85 1s. Other specificational details as *Model MP424*.

NATIONAL RQ753. SPEEDS: 7½, 3¾ and 1⅞ i/s. SPEAKERS: 6½in. elliptical and 6in. circular. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Meters. WEIGHT: 28lb. DIMENSIONS: 14 x 13½ x 9½in. PRICE: £84. **DISTRIBUTOR: United Africa Mechanical and Electrical Co. Ltd., United Africa House, Blackfriars Road, London, S.E.1.**

PHILIPS EL3555. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER (at 3¾ i/s): 0.6%. FREQUENCY RESPONSE: 40 c/s-8 Kc/s ±3dB. OUTPUT POWER: 2.5W x 2. SPEAKERS: 7 x 5in. (cabinet), 4in. (detachable lid). SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATOR: Magic-eye. MICROPHONE: Stereo cardioid moving-coil. WEIGHT: 28lb. DIMENSIONS: 17¾ x 13½ x 8½in. PRICE: £78 15s. **MANUFACTURER: Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.**

PHILIPS EL3312. SPEED: 1⅞ i/s. WOW AND FLUTTER: 0.6% p-p. FREQUENCY RESPONSE: 60 c/s-10 Kc/s ±3dB. OUTPUT POWER: 1.8W x 2. TRACKS: Four (stereo), two (mono). LEVEL INDICATOR: Meter. MICROPHONE: Stereo moving coil. FEATURES: Cassette loading. Adjacent-track stereo. PRICE: £50 8s. **MANUFACTURER: See above.**

REVOX 736. SPEEDS: 7½ and 3¾ i/s (15 and 7½ i/s version available at £163 13s.). WOW AND FLUTTER: ±0.01%. FREQUENCY RESPONSE: 30 c/s-18 Kc/s ±2dB. OUTPUT POWER: 6W (single-channel monitor). SPEAKER: 8in. SPOOL CAPACITY: 10½in. TRACKS: Two or four. LEVEL INDICATORS: Two VU-meters. WEIGHT: 45lb. DIMENSIONS: 18 x 13 x 11in. FEATURES: Separate record/play heads. Solenoid switching. Phototransistor auto-stop. Multiplex filter available to suit 736 and other recorders, price £12. Remote control and slide synchroniser available. PRICE: £131 5s. (chassis only), £133 7s. with cabinet. **DISTRIBUTOR: C. E. Hammond Ltd., 90 High Street, Eton, Windsor, Berkshire.**

● **Review:** September 1965.

SABA TK230S. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RANGE: 40 c/s-20 Kc/s. OUTPUT POWER: 5W x 2. SPEAKERS: Two 6½in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATOR: Magic-eye. WEIGHT: 30lb. DIMENSIONS: 16½ x 14 x 7½in. PRICE: £98 14s. **DISTRIBUTOR: Saba Electronics Ltd., Eden Grove, Holloway, London, N.7.**

● **Review:** December 1964.

SANYO MR909. SPEEDS: 7½ and 3¾ i/s. OUTPUT POWER: 2½W x 2. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. MICROPHONES: Two moving-coil. WEIGHT: 20lb. FEATURES: Mixing, sub-miniature jack sockets. Detachable lid loudspeakers. PRICE: £75 12s. **DISTRIBUTOR: Sanyo Sales and Service, 23 Savage Gardens, London, E.C.3.**

SONY TC250A. SPEEDS: 7½ and 3¾ i/s. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. FEATURES: Outlet from preamplifiers. Transistorised. PRICE: £59 17s. **DISTRIBUTOR: Sony U.K. Sales Division, Mercia Road, Gloucester.**

SONY TC260. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: 0.19%. FREQUENCY RANGE: 30 c/s-18 Kc/s. OUTPUT POWER: 5W x 2. SPEAKERS: Two side-facing 4 x 8in. SPOOL CAPACITY: 7in. LEVEL INDICATORS: Two meters. WEIGHT: 34lb. DIMENSIONS: 21½ x 16 x 8in. FEATURES: Transistor tape amplifier. PRICE: £101 17s. **DISTRIBUTOR: See above.**

TANDBERG 6. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.1%. FREQUENCY RANGE: 30 c/s-20 Kc/s. SPOOL CAPACITY: 7in. TRACKS: Two or four. LEVEL INDICATORS: Two magic-eyes. WEIGHT: 25lb. DIMENSIONS: 16 x 12 x 6in. FEATURES: Output from preamplifiers. Separate record/play heads. PRICE: £115 10s. **DISTRIBUTOR: Elstone Electronics Ltd., 81 Kirkstall Road, Leeds 3.**

● **Review:** February 1961 (½-track), April 1962 (¼-track).

TANDBERG 12. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RESPONSE: 40 c/s-16 Kc/s ±2dB. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two magic-eyes. OUTPUT POWER: 10W x 2. WEIGHT: 23lb. DIMENSIONS: 15½ x 11¾ x 7in. FEATURES: Straight-through amplification. Multiplex filter. PRICE: £110 5s. **DISTRIBUTOR: See above.**

(*continued on page 382*)

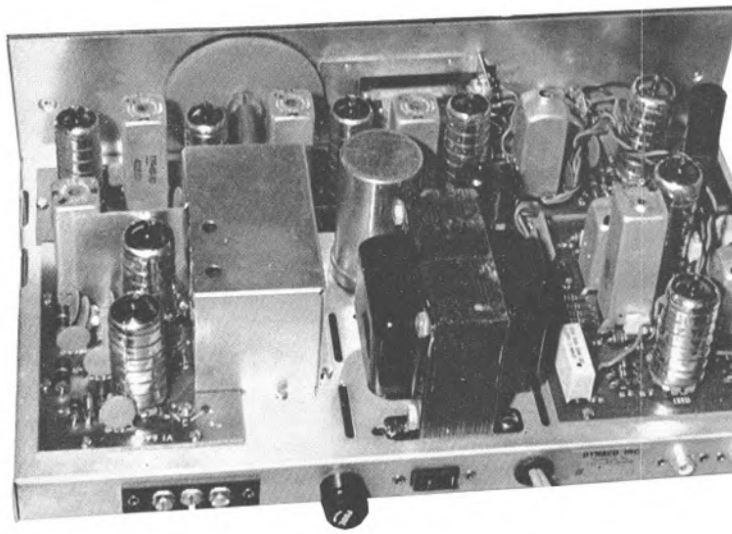
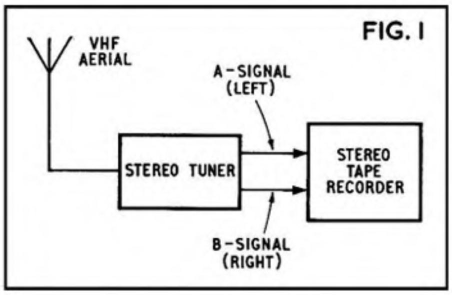


Fig. 2 (immediate right): Interior view of a *Dynaco* stereo tuner

Fig. 3 (upper right): *Fisher* decoder connected to *Rogers* switched tuner

Fig. 4 (lower right): *Truvox FM*100, wired for stereo reception



MULTIPLEX COMPLEXITY

HAVING regained our breath following the BBC's announcement of its plans to put into immediate effect a substantial development in stereo sound transmissions, many of us will now be exploring the possibilities of taping these new programmes. This, indeed, is quite feasible and promises many exciting hours of experiment.

From the technical point of view, there are one or two things that we should know about stereo broadcasting and one or two problems that we may come up against in the early days of our experiments in this new medium. These are explained in this article ; but before diving in at the deep end, let us get used to the environment.

The stereo signals contain all the information required by an ordinary mono tuner to give a correctly balanced mono output. In addition, however, they contain the stereo information. This information is totally discarded by the mono tuner, but the stereo tuner is designed to accept it and to deliver an output on two channels in the usual stereo manner.

All stereo tuners are ordinary mono tuners up to and including the FM detector (discriminator), though their IF amplifier and FM detector design may be somewhat more exacting than that of the inexpensive mono-only tuner. This is to ensure that none of the stereo information is lost in the signal's passage through to the detector.

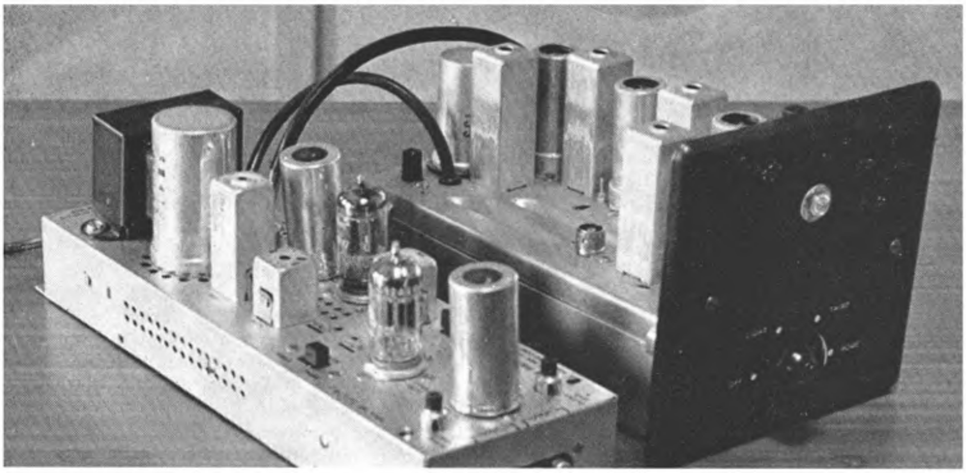
True stereo tuners have, following the detector, a special circuit arrangement called a *decoder*. This processes the stereo information and passes the audio signals in the left and right-hand channels to the appropriate outlets, each channel sometimes passing through an audio amplifier stage to provide a signal of fair level for application to the right- and left-hand inputs of the stereo amplifier or tape recorder. The basic idea is shown in **fig. 1.**

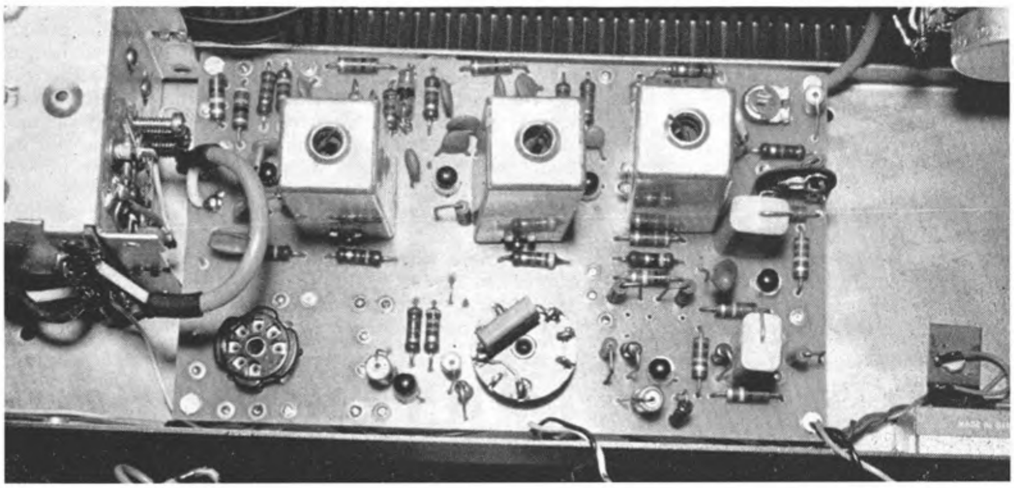
Of recent years it has been the practice of tuner makers to concentrate on the production of mono tuners with wiring to a rear socket, or with an internal termination and fitment, for the connection of a separate stereo decoder for use at a time such as now. Few manufacturers, though, finalised detailed developments on decoders to the stage of assembly and marketing, for the general policy in this respect has been geared to the evolution of stereo broadcasting in this country, and this has not been very startling. The sudden announcement of the big stereo project by the BBC has, therefore, taken many people by surprise, including the manufacturers. This means that we may have to wait a month or so for a decoder to fit our wired-for-stereo mono tuner. Glad to report, anyway, that the tuner boys are now working flat out to produce their decoders !

Enthusiasts with true stereo tuners or with mono tuners plus matching decoders will be able to commence operations right away. Indeed, many have already been taping the BBC's experimental stereo programmes, so quite a bit is already known about the problems.

Fig. 2 shows the inside of a true stereo tuner by the American *Dynaco* company. The decoding section is located wholly on the printed circuit board on the right of the chassis (as looking from the rear in the photograph). This has three valves in addition to those in the tuner sections proper. The right and left-hand signals are fed to the two photo sockets adjacent to the decoding section.

A separate decoder (by *Fisher*, but not currently available in the U.K.) is shown connected to a *Rogers* switched FM tuner in **fig. 3.** Incidentally, it will be seen that the





A GUIDE TO WHISTLE-FREE RADIO RECORDING

BY JOHN EARL

Rogers tuner is not one of recent vintage, yet it performed quite well with the decoder on the BBC's stereo test programmes, even at 50 miles from Wrotham !

This implies that it is possible to connect a stereo decoder to almost any FM tuner. This is, in fact, true, with the proviso that the partnering tuner has to be *of good design* and *in accurate alignment* to secure the best of the stereo signal. We cannot, in this article, detail the ways and means of connecting decoders to mono tuners, but readers will find some more information on this in the September issue of our sister magazine *Hi-Fi News*.

Some tuners are fitted with a single AF stage, to serve as a buffer and amplifier between the detector and the amplifier or tape recorder input, and in some cases this can be used as the right or left channel amplifier, a second one being needed, of course, for the other channel. Decoders sometimes have a pair of such amplifiers, for the two channels, unless they are designed specifically for a particular tuner.

An exclusive photograph of the inside of the *Truvox FM100* wired-for-stereo mono tuner is given in fig. 4. This is fully transistorised, the valveholder in the front left-hand corner of the printed circuit board is wired to accommodate a plug-in transistorised stereo decoder. This decoder carries an audio amplifier/buffer for one of the stereo channels ; the matching amplifier/buffer for the other channel is already embodied in the mono section of the tuner. This tuner has right- and left-hand audio output sockets at the rear and a stereo transmission lamp-type indicator.

A domestic stereo-by-radio tape recording scene is given in fig. 5. Here the Fisher decoder is coupled to a *Heathkit* tuner, the stereo output to the tape recorder being via a Heathkit amplifier. Very pleasing results were obtained from this set-up at 50-odd miles from the Wrotham station, with BBC Beckly (the near-Oxford FM booster) pumping in a 10mV non-stereo signal in competition with the weakish Wrotham signal (stereo) on a close frequency ! This speaks highly for the selectivity and the stereo performance of the Heathkit tuner.

So much, then, for the general picture ; now let us get a bird's-eye picture of the transmission/reception techniques.

The *Zenith-GE* system of stereo broadcasting is employed by the BBC. This is the American system partnered by *Zenith* radio and the American *General Electric Company*, approved by the American FCC in June 1962 and recommended by working parties of the European Broadcasting Union for use on this side of the Atlantic, but with two fundamental differences : one that a pre-emphasis of 50μS be used instead of the American 75μS, and two, that a "storecasting' channel *not* be used. (In America, the stereo radio channel carries an extra multiplexed channel on a sub-carrier of 67 Kc/s to provide background music for shops and stores.)

Any stereo system uses two microphones or more, initially to provide two signals, the *left-hand* signal called the *A-signal* and the *right-hand* signal called the *B-signal*. The integration of the A and B signals gives the mono signals, while the difference between the A and B signals gives the stereo information. Thus, A+B is called the *M signal* (M for mono), while A-B is called the *S signal* (S for stereo). The M and S signals are obtained at the transmitter by a device called a *matrix*, to which both channel signals (i.e., the A and B signals) are fed.

A matrix in the decoder at the tuner does the

(continued overleaf)

opposite thing. It accepts both the M and S signals, and by their correct addition and subtraction produces isolated A and B signals, which are fed to separate audio channels and speakers for eventual stereo reproduction.

Fig. 6 shows a block diagram of the system at the transmitting end. The A and B signals are fed to the matrix through the 50µS pre-emphasis filter. The resulting M signal is fed to the transmitter through a delay network, while the S signal goes to a double-sideband AM modulator where it modulates a 38 KC/s sub-carrier.

Ordinary upper and lower sidebands of the S signal are thus created, but for various technical reasons the original 38 Kc/s sub-carrier is not transmitted. It is suppressed so that only the sideband signals of the S signal are transmitted, and these go via a further delay network. The transmitter also receives a 19 Kc/s pilot carrier signal to facilitate decoding at the tuner.

These three signals—the M signal, the side-bands of the S signal and the 19 Kc/s pilot carrier signal—represent the modulation signals for the FM transmitter They all, in fact, simultaneously modulate the VHF carrier.

If this VHF signal is tuned in by an ordinary mono tuner, the pilot carrier and the upper and lower sidebands of the S signal are all theoretically attenuated due to the response of the tuner's de-emphasis filter. These signals fail to affect the mono tuner, but the M signal, which contains all the normal mono information, passes through the tuner in exactly the same way as any other mono signal. The mono tuner thus gives a normal output in spite of the aerial signal carrying stereo information. The system is thus compatible.

Fig. 7 shows how the mono, pilot and stereo signals are spaced in frequency from each other. This shows that the mono signal still carries information up to some 15 Kc/s (under ideal transmitting and land-line conditions).

Fig. 8 gives a block diagram of the tuner's decoder. Here Filter 1 selects the M signal and directs it to the matrix. The S signal is not so easily handled because it consists only of upper and lower S sidebands, devoid of a carrier. Before it can be processed, therefore, the carrier has to be re-inserted. This is where the pilot carrier sent from the transmitter comes in. This carrier is tuned in by Filter 3, then amplified and finally frequency doubled, making it 38 Kc/s, the frequency of the missing carrier.

This synthesised sub-carrier is applied along with the upper and lower sidebands of the S signal (the latter via Filter 2) to the synchronous detector, the output of which represents the audio rendering of the S signal. This, along with the M signal, is applied to the matrix which translates back to the original A and B signals.

The reason why the 38 Kc/s sub-carrier is suppressed at the transmitter and then re-inserted again at the tuner's decoder is basically to do with transmitter power.

The deviation of the main carrier can be extended up to 90% due separately to the M signal and the S sidebands. This leaves 10% deviation for the low-level pilot carrier (assuming 100% modulation overall). However, if the 38 Kc/s sub-carrier were retained, the requirement would be greater than 10% deviation, thereby cutting down the deviation (i.e., modulation percentage) that could be given to the M and S signals.

The range of a VHF FM transmitter of given ERP modulated for stereo is less than when modulated for mono only. This is because the effective power is divided between the two stereo channels. The suppressed-carrier stereo system decreases the effective power per channel relative to mono by about 10%. On a stereo transmission, therefore, we can expect a slight worsening of the signal-to-noise ratio with respect to mono, but this is insignificant in most areas, excepting, possibly, those in the deep fringe. However, the importance of a good aerial system is emphasised.

It was stated above that the M and S signals *each* can modulate the carrier up to 90%. This does not mean a total modulation of 180% (the impossible), plus 10% for the pilot carrier. In practice, a rise in modulation depth on, say, the M signal corresponds to a fall on the S signal.

The requirements in practice, therefore, are for a tuner with decoder (separate or integrated) and a stereo tape recorder. That is, one with a pair of recording channels and a pair of play-

MULTIPLEX COMPLEXITY

Fig. 5: *Fisher* decoder coupled to a *Heathkit FM-4U* tuner.

FIG. 6 MODIFIED ZENITH-GE TRANSMITTING SYSTEM

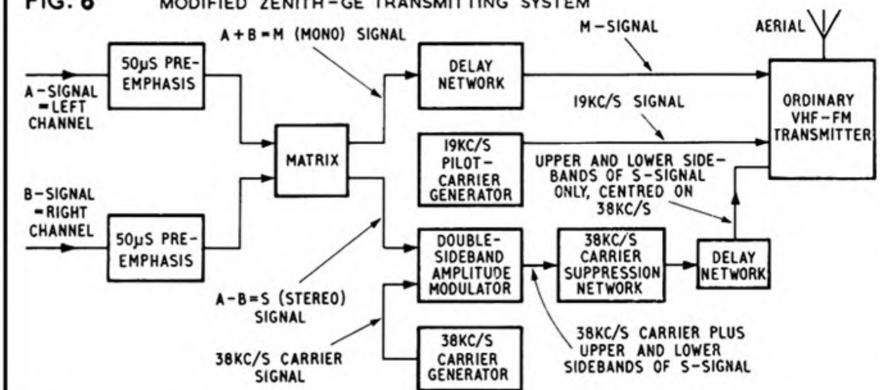


FIG. 7 FREQUENCY DISPOSITION OF TRANSMITTED SIGNALS

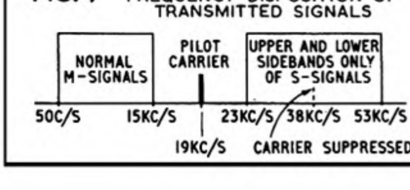
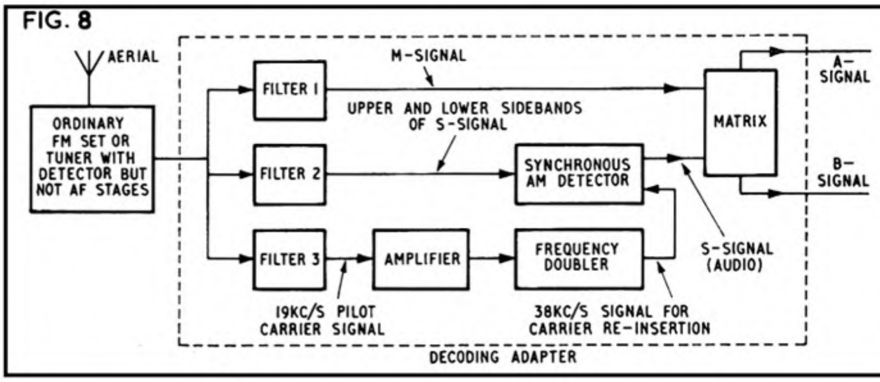


FIG. 8



back channels that can be worked for left and right channels together. Recording then simply resolves to the recording simultaneously of two tracks on the tape (quarter or half, whatever the case may be). This is not a great deal more difficult than recording just a single mono track, apart from securing the correct stereo channel balance in the first place. It is expected that the BBC will eventually put over co-channel balancing signals or tones.

A block diagram of a complete radio stereo reproducing system is given in **fig. 9**. This one, of course, does not take into account recording.

We have seen that the stereo decoder accommodates two fairly strong continuous wave signals, the pilot carrier signal at 19 Kc/s and the doubling of this, giving the sub-carrier at 38 Kc/s. Many stereo decoders and stereo tuners, combined, deliver quite hefty lumps of these signals along with the A and B signals. This is of little consequence when the tuner is to drive into a stereo amplifier.

However, when the decoder or stereo tuner is to be used for making stereo tape records of radio programmes, these 19 and 38 Kc/s signals can play havoc with the results by marring the recording with whistles. The whistles result from the 19 and 38 Kc/s signals beating with the signal produced by the tape recorder's bias and erase oscillator. Of course, neither the bias signal nor the 19 and 38 Kc/s signals are within the audible range by themselves, but when they 'beat' or heterodyne together a difference-frequency signal is produced which might well be within the audio spectrum and which then gets recorded along with the programme signals on the tape.

There are also harmonics produced of the fundamental frequency signals and these can beat with the fundamental or harmonics of the recorder's HF oscillator. A study of the simple decoder circuit in **fig. 10** will reveal why such signals (and harmonics) are likely to be present at the A and B outlets.

V1A of this circuit amplifies the signal from the tuner's detector, while V1B forms a basic frequency-doubler. This triode section receives the amplified 19 Kc/s signals and tunes them by L1. The valve here (V1B) is arranged to deliver a strong second harmonic at its anode, which it tunes by T1 to 38 Kc/s. Thus a signal relatively strong in harmonics is applied to the matrix consisting of two diodes, which are non-linear devices, exaggerating the production of further harmonics. Clearly, then, one can understand why the outputs deliver not only the wanted audio but also unwanted 19 and 38 Kc/s signals and their harmonics.

Some decoders have rejectors tuned to the offending frequencies at the matrix A and B outputs, these feeding into AF amplifiers, as mentioned earlier. Also, some tape recorders have rejectors incorporated in their 'radio' input circuits, but the existing state of the art reveals that very few recorders have such rejectors and that a high proportion of stereo tuners and decoders deliver unwanted carrier signals at their outlets.

There are various processes concerned with the beating of these signals with the recorder's HF oscillator, including overloading and resulting non-linear operation and, of course, the very nature of the recording process at the tape itself (which is singularly non-linear).

The complete solution, therefore, is to employ low-pass filters in the A and B circuits from the tuner/decoder to the A and B inputs on the tape recorder. That is, one such filter in each circuit.

This is all very well, but a problem arises due to the closeness of the 19 Kc/s pilot carrier signal to the upper audio passband of the tuner. If we put a reasonably practical filter in circuit, optimised, say, at 19 Kc/s (for maximum rejection), we find that we tend to attenuate wanted audio signals around the 12 Kc/s mark. This trouble can be reduced a little by disconnecting the de-emphasis circuits in the decoder's A and B channels, letting the initial attenuation of the external filter serve to de-emphasise as well as reject.

The author, in common with other workers in the field, has been investigating filter circuitry for this application, having in mind complexity, insertion loss, economics and so forth. Of course, it is possible to produce and develop a filter that will take out of the spectrum signals of almost any frequency without affecting the audio passband of the tuner/decoder—but one has to be practical !

It seems that the 19 Kc/s signal produces quite a bit of trouble, and that if this is attenuated by 30dB or so, the whistle problem is often solved (not always, though!). The conventional pi section filter using an inductance and two capacitors in low-pass configuration yields an attenuation rate of about 20dB/octave. Thus, if the critical frequency (fc) is arranged to occur at about 10 Kc/s the response is approaching −20dB at 19 Kc/s. This is not always sufficient,

(continued overleaf)

FIG. 9

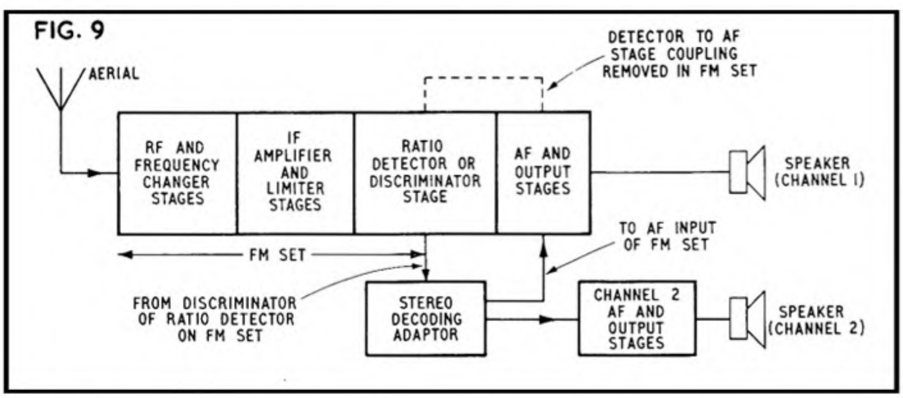


FIG. 11

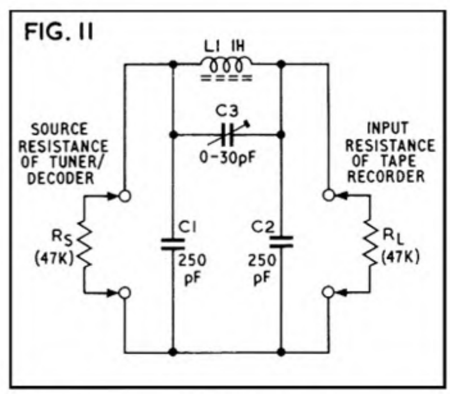


FIG. 10 PRACTICAL DECODER CIRCUIT

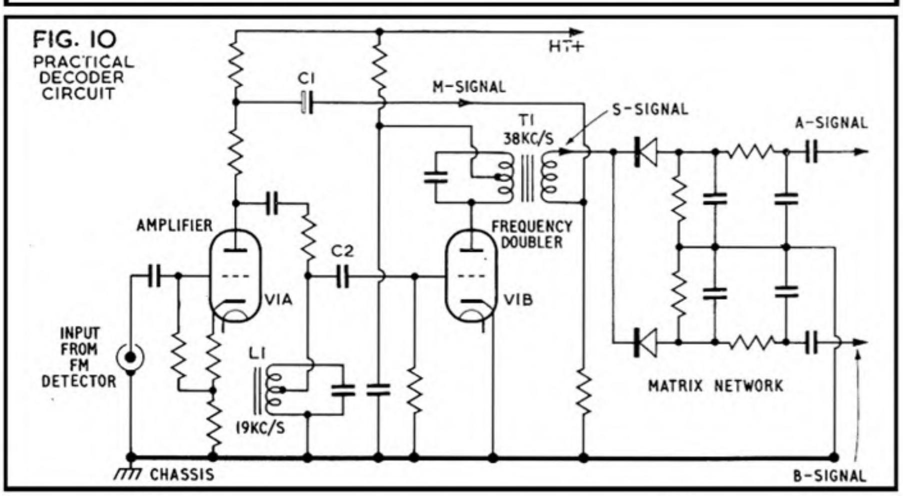
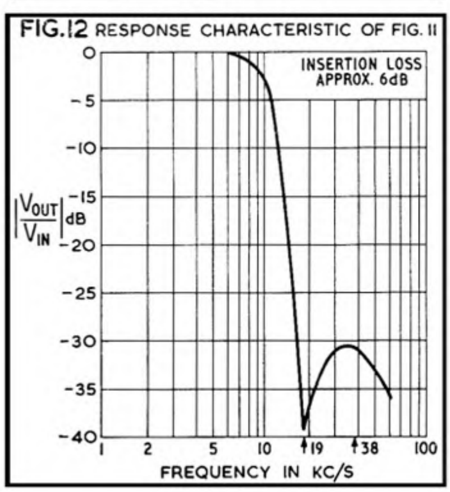


FIG. 12 RESPONSE CHARACTERISTIC OF FIG. 11



though adequate with such a filter at 38 Kc/s.

If the filter is arranged as a shunt-derived pi section (i.e., with a capacitor in parallel with the inductance) a rejection approaching −40dB is possible at the frequency of maximum attenuation which, in this instance, can be made 19 Kc/s. Unfortunately, however, if the value of the capacitor across the inductor is much larger than about one-tenth of the value of the other two capacitors in the filter, the attenuation starts to drop at frequencies above 19 Kc/s, giving only a relatively small attenuation at 38 Kc/s.

Nevertheless, it is possible to keep the 19 Kc/s attenuation at around 38dB and the 38 Kc/s attenuation still about 30dB (see **fig. 12**) by tuning the inductance with a small value capacitor, as shown in **fig. 11.** This filter is designed for input and output impedances of about 47K, but small alterations either way should not matter much.

The 1 Henry choke can either be purchased or made. It should have a ferrite core, and if wound at home about 1,100 turns of 40 SWG enamelled-covered wire should give the inductance when wound carefully on a *Mullard Ferroxcube Type LA7* core, or equivalent. The capacitor C3 is a small concentric trimmer (*Radiospares*) and this should be adjusted for maximum 19 Kc/s rejection.

This, and the other filters about to be described, should be built in a solidly made metal box with two sections, one for the A channel filter and the other for the B channel filter. The two sections, of course, should be shielded to avoid crosstalk.

DIN or phono sockets should be used for the ins and outs and screened cable should be used for connecting to tuner/decoder and amplifier/tape recorder.

Fig. 13 gives a parallel-T (twin-T) resistor-capacitor filter. This sort of filter has a remarkable attenuation at one particular frequency, as shown in **fig. 14,** which is, in fact, the plotted response of the **fig. 13** circuit. The attenuation at 19 Kc/s is approaching −40dB, but at 38 Kc/s it is little more than 10dB, which may be sufficient in some cases. One disadvantage of this filter, though, is the relatively slow rate of attenuation at the roll-on. 10 Kc/s is, unfortunately, down by about 8dB, but this may be tolerable if the tuner/decoder de-emphasis is disconnected. The T resistor is made variable as a means of shifting the rejection frequency a little one way or the other, for maximum rejection of whistle.

GREAT ADVANTAGE

Fig. 15 shows a circuit of the same kind of filter arranged for maximum rejection at 38 Kc/s. The plotted response of this one is given in **fig. 16.** It will be seen here that the 19 Kc/s signal is only 10dB down (and whether this will be sufficient will depend on the circumstances), while the 38 Kc/s signal is approaching −40dB (adequate for pretty well all cases). The great advantage, however, is that the audio signal proper is only about 3dB down at 10 Kc/s.

Incidentally, the parallel-T circuits have an insertion loss of between 10 and 12dB, meaning that by passing the signal through them the amplifier or recorder will receive only about one-third (−10dB) or one-quarter (−12dB) of the signal delivered by the A and B channels

FIG. 13 19KC/S PARALLEL-T FILTER

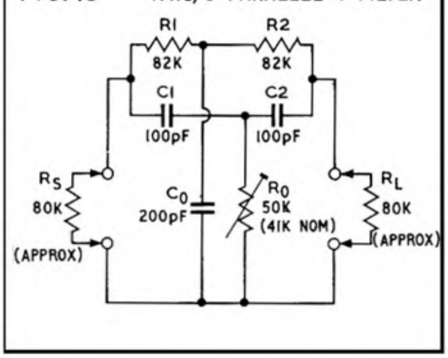


FIG. 15 38KC/S PARALLEL-T FILTER

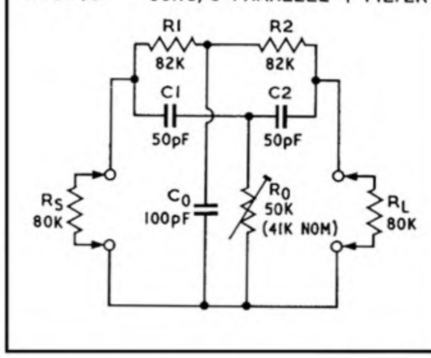


FIG. 14 RESPONSE CHARACTERISTIC OF FIG. 13

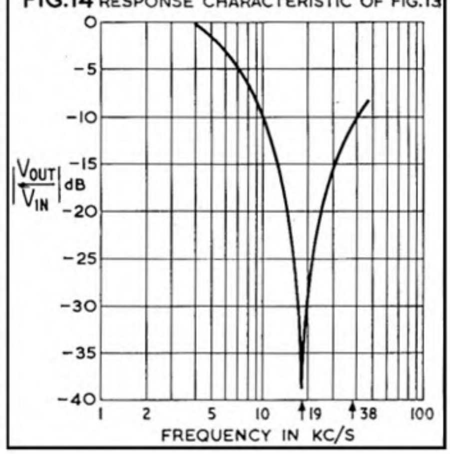
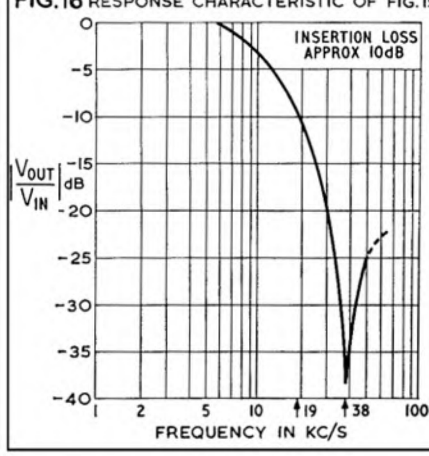


FIG. 16 RESPONSE CHARACTERISTIC OF FIG. 15



MULTIPLEX COMPLEXITY

of the stereo tuner or decoder. Usually, though, the signal level will be sufficient to accommodate this loss.

The shunt-derived pi section filter and the ordinary low-pass pi section filter yield an insertion loss of only about 6dB, so that about a half of the tuner/decoder signal will be available for the amplifier or tape recorder.

Since writing the main body of this article, Mr. Uden—FM correspondent of *Hi-Fi News* —has passed on information concerning filters with which he has experimented for removing the 20 Kc/s supervisory signal which accompanies the modulation of some of the FM Light and Third transmissions. Mr. Uden points out that the 20 Kc/s control signal is likely to be used at more stations as time goes on, but at the present does not exist on Home programmes.

The circuit in **fig. 17** was found satisfactory with a *Philips* recorder which suffered whistles from the 20 Kc/s signal when recording mono, while that in **fig. 18** is a development later used with *Tandberg* machines which responded insufficiently with the **fig. 17** circuit.

There seems to be no reason why the circuits should not be modified to the extent of 1 Kc/s to extract the 19 Kc/s stereo pilot carrier between the stereo tuner and tape recorder. In fact, it is possible that the trimmers

FIG. 17

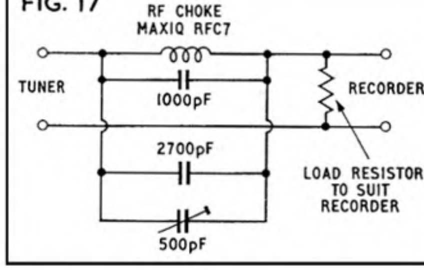
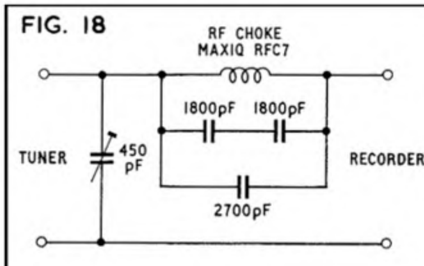


FIG. 18



(*continued on page* 385)

NUMBER 58 PHILIPS EXTRAS BY H. W. HELLYER

tape recorder service

READERS of *Tape Recorder* will be well aware that the purchase of a basic machine is not the end of the matter. Once the bug bites, we find ourselves needing all kinds of additional oddments to widen the scope of our equipment. Special leads, attenuators, matching pads, spare microphones, headsets, loudspeakers, pre-amplifiers, mixers, mains units, remote controls and slide or cine attachments are among the growing catalogue of extras that an enterprising dealer can provide. There are now firms devoting their energies wholly to the production of accessories.

Unfortunately, a number of readers have complained that information about some extras has proved hard to come by. We all know the sort of shop that is happy to sell us all we need—provided we can point it out on the shelf and hand over the needful shekels. This is rather like supermarket dealing, and about as technical. Another dealer will take a little more trouble, even to the extent of ordering the spare parts for us, if we will quote the correct makers' designation or give him the magic part-number. The trouble arises when the part-number is not known and the designation that we would apply is a foreign language to the often unhelpful manufacturer.

The tape recorder specialist will make the effort to interpret our wishes and satisfy our wants—not an easy task, as we are not always very sure of our own minds. But there comes a time when the reader needs a little information before he trots along to the emporium clutching his hard-earned pelf in a grubby hand, and this is where *Tape Recorder* can offer some sort of service. Which brings us to this month's contribution.

A very large number of *Philips*, *Stella* and *Cossor* tape recorders in the *EL3541* and *EL3542* categories have been sold. The basic machine lends itself to adaptation, and later marks, such as the Philips models with suffix *K*, Cossor models suffix */04* and Stella */03* onwards, will have been modified to take a stereo preamplifier. Where this is not done, the amount of work needed to carry out the modification is quite small—and certainly worth doing one's-self rather than traipsing around the town to find a retailer willing to undertake it. Several correspondents have raised this point and sparked off the present article. (It is emphasised by Messrs. Philips that work should be done on under-guarantee machines by Philips dealers—but this is hardly likely to apply to the range under discussion.)

The earlier models, with a stereo socket that either had pin 3 of the DIN 3-pin socket open, or connected to the return side of the erase head, and employed a superimposition switch that disconnected the feed to the erase heads, is the one that primarily concerns us. To modify it for stereo use, we need to adapt the track switch for parallel playback and add a couple of components that will give us the required voltage to power the external pre-amplifier unit.

This involves removing the connections from the superimpose switch and connecting the free ends together, insulating them and laying them out of the way. The 4.3K resistor, if fitted, can be disconnected and removed. It is worth keeping in the spares box, being a close-tolerance type. After this, we can use the superimpose switch as a parallel-track switch, as long as we remember to use the 'make' contacts in the right sense when the button is pressed. One contact is taken to the track switch end of the 56K resistor whose other end goes to pin 1 of the stereo socket. The other goes to contact 29 on the change-over switch. This item, denoted SW2, is the one on the ECL82 board of the 3541/15B range, the rearmost switch on the 3541 range, and the inner of the two parallel switches on the 3542 range. See **fig. 1.** The wiring diagram, simplified from that issued by the makers, is shown at **fig. 2.**

This puts both sections of the record/play head in parallel during playback. To use as a stereo playback machine, the track switch must be in the Track 1 position, and the parallel effect button left open (i.e., if we connect the superimpose button accordingly). Then the recorder's internal amplifier will reproduce the left-hand channel of a pre-recorded tape, and the external amplifier the right-hand channel.

We now have the signal at pin 1 of the stereo socket, via the 56K resistor. Before moving on to the power supply for the preamp, one small job is needed. The 470-ohm resistor fitted in the head return lead of the earlier

(continued on page 375)

FIG. 1

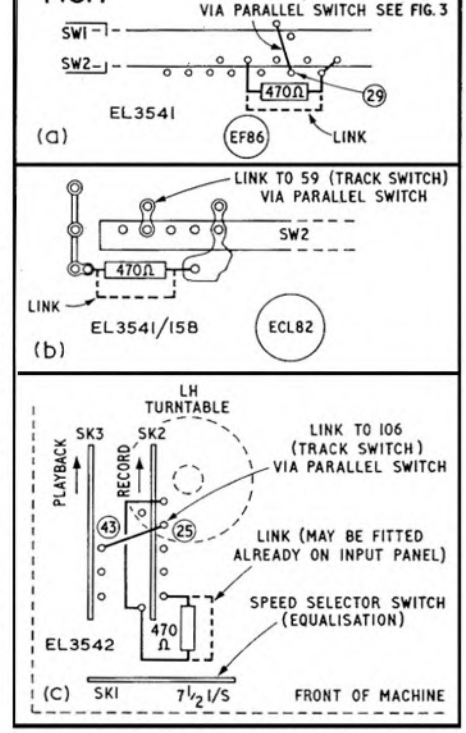


FIG. 2

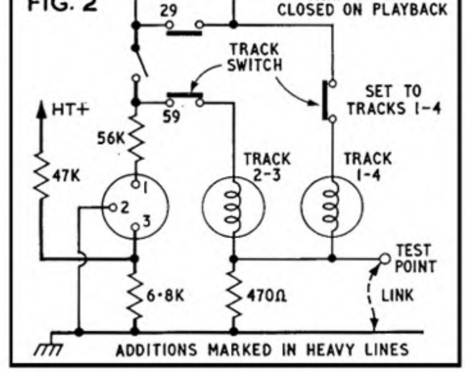
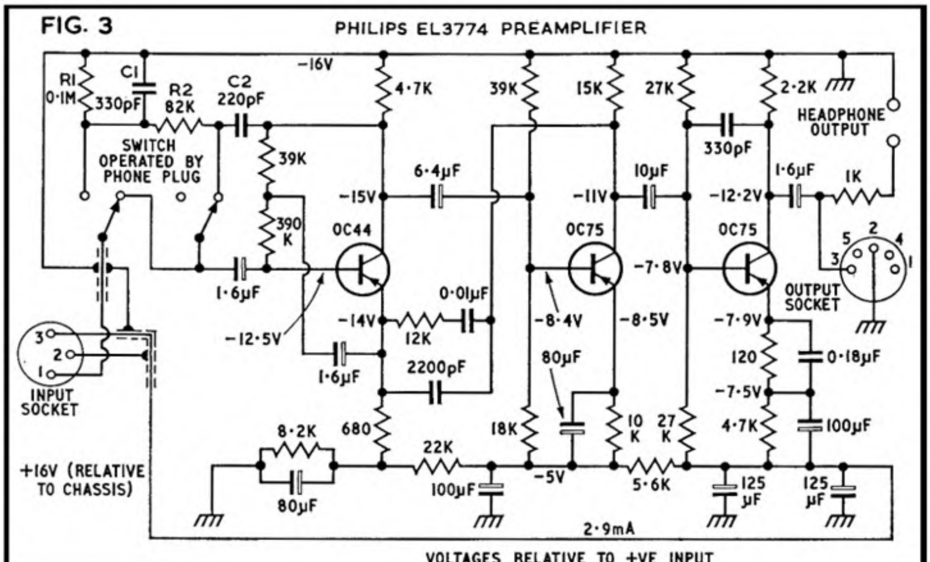
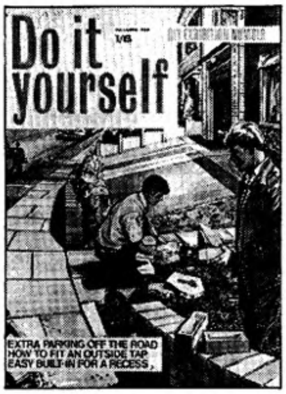


FIG. 3 PHILIPS EL3774 PREAMPLIFIER





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MAGNETIC SOUND RECORDING

PART 6 THE PROCESS OF REPRODUCTION

BY C. N. G. MATTHEWS

LAST month we saw how the main problems of getting an undistorted signal on to tape are solved. Now we must consider the process of converting the magnetic recording back into an audio-frequency alternating current. This brings difficulties of its own, which we can begin to investigate by considering the recording itself.

A tape on which a signal has been recorded is, in effect, a series of flexible magnets, each with its own field. Their physical length will depend both on the frequency of the signal and the tape speed at which the recording was made. **Fig. 1,** which is drawn well out of scale, shows how the magnetism ties in with the original sound wave.

We can calculate this length quite easily. Suppose for example that a pure tone of 1 Kc/s was recorded at a tape speed of $7\frac{1}{2}$ i/s. As we can see from the figure, each cycle produces a pair of magnets of opposite polarity. This of course is due to the reversal of current during each cycle. So the length of a single magnet will be $\frac{7.5}{2000}$ or 0.00375in. Putting the figure into words, each magnet has a length of just under four thousandths of an inch—not a great deal to play with.

Higher frequencies and lower tape speeds produce even shorter magnets. If the recording we have been considering had been made at a tape speed of $1\frac{7}{8}$ i/s there would have been four times as many magnets to the inch, giving a length of less than one thousandth of an inch. Increasing the frequency to 10 Kc/s would cut down the length to less than a ten-thousandth of an inch. As we shall see later, the shortness of the recorded magnets is a major limiting factor to high frequency reproduction.

To reproduce the signal we draw the magnetised tape past the reproducing head. This is similar to the recording head, including the gaps, but it is not supplied with an alternating signal current. Instead, it produces the current.

When one of the recorded magnets is opposite the gap we get the effect shown in **fig. 2(a).** In spite of the gaps, the overall reluctance of the soft iron core is much lower than that of the surrounding air, so the magnetic field is concentrated in this easier path. In other words, the core becomes a magnet whose strength and polarity are determined by the strength and polarity of the tape magnetism.

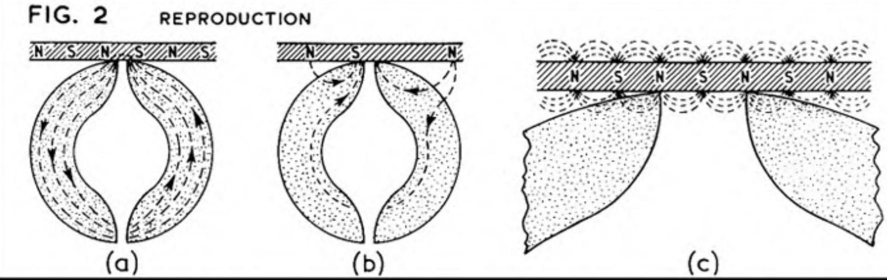
Ideally, each line of force from the tape magnet passes through the core and so threads the coils wound on it. Under these circumstances each line of force links with each turn of the coils. A basic law of electricity is that whenever this *flux linkage* changes, an EMF is induced. The magnitude of this induced EMF is governed by the rate at which the flux linkage changes. Basically, the two are directly proportional, but in tape recording we must take other factors into consideration.

In our reproducing head the flux linkage is constantly changing because the tape magnetism is a function of the air pressure variations due to the original sound wave. So provided the tape speed is the same as that at which the original recording was made, the induced EMF follows the amplitude variations of the sound picked up by microphone. We can feed it to an amplifier which drives a loudspeaker.

This would be a very straightforward process if we were dealing with a 1 Kc/s note only, but in practice our sound signal is a constantly varying mixture of sine-waves at different frequencies and amplitudes. Consequently, the tape magnets differ in both strength and length and we run into complications caused by the relationship between magnet length and gap width. We only get the ideal situation shown in **fig. 2(a)** when the two are more or less equal.

Our first snag is encountered when we attempt to reproduce low notes. If a 1 Kc/s note recorded at $7\frac{1}{2}$ i/s produces magnets just under four *thousandths* of an inch in length, then without stretching our mathematics too far we can deduce that the magnets produced by recording 100 c/s at the same speed will be a little less than four *hundredths* of an inch long. The gap in the tape head is very narrow, and consequently at 100 c/s the magnets are considerably longer than the gap, giving us the situation illustrated in **fig. 2(b).** Here the ends of the magnet are so far apart compared with the gap width that only part of the field threads the core. As a result, the flux linkage is weaker and the induced EMF is lower. To make matters worse, the longer the magnets, the slower the change of flux linkage. These two factors combine to give a serious loss of volume at low frequencies. The reproducing amplifier must include circuits to compensate for this.

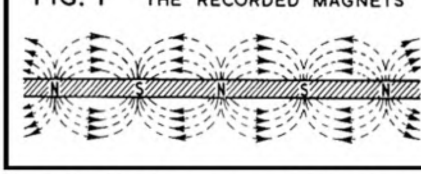
FIG. 2 REPRODUCTION



Once the low frequency loss has been overcome, we run into another difficulty. The reproducing head has a *rising frequency characteristic of 6dB per octave*. Perhaps this piece of engineering jargon should be translated before we go any further. The decibel is a logarithmic unit of comparison which was described in the first article of this series, so we need not go into details. But a 6dB rise in voltage means that the voltage is doubled. The octave is of course a musical interval. For our purposes we can say that when we raise the pitch of a note by one octave the frequency is doubled.

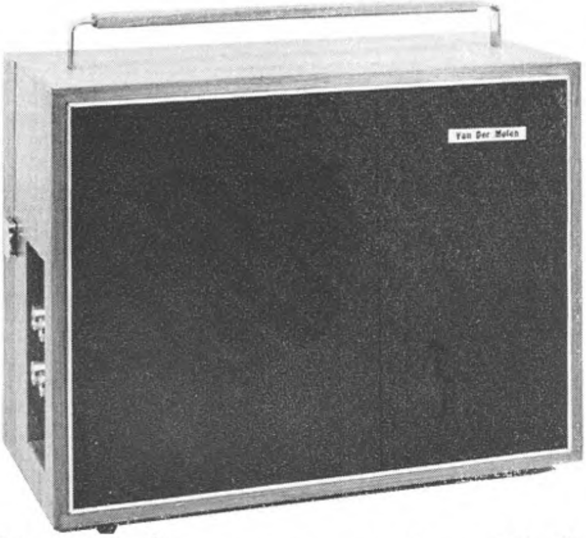
The effect of this rising frequency characteristic could be to destroy completely the quality of reproduction. Suppose for example that we recorded notes of 1 Kc/s and 2 Kc/s at equal strengths. On reproduction the voltage produced by the 2 Kc/s note will be twice as great as that resulting from the 1 Kc/s note. Again, then, we are in difficulties. Not only will the high notes be reproduced at strengths out of all proportion to the low notes, but the overtones will be accentuated with respect to their fundamentals. Now we have to modify the reproducing amplifier again. As well as the boost for the bass, we must incorporate a falling frequency characteristic of 6dB per octave so that this compensates for the rising characteristic of the reproducing head.

FIG. 1 THE RECORDED MAGNETS



As we approach the upper end of the frequency range, the relationship between magnet length and gap width again comes into play, giving us the condition illustrated in **fig. 2(c).** Here the tape space occupied by one complete cycle of signal is equal to the width of the gap, which is now bridged by two magnets of opposite polarity. Since the magnetic fields threading the core are equal and opposite, the total magnetic effect is nil. With no flux linkage to change there can be

(continued on page 375)



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no induced EMF. Consequently, no sound is produced. The frequency at which this effect occurs is called the *extinction frequency* and the effect itself is called the *gap effect*.

Now we come to one of the major reasons why higher tape speeds give better reproduction. For a tape speed of $7\frac{1}{2}$ i/s the extinction frequency on a domestic recorder is something between 11 and 12 Kc/s. Although this would not be acceptable to a professional or a hi-fi enthusiast, it will nevertheless give excellent reproduction of both music and singing. But if we halve the tape speed we halve the magnet length and so reduce the extinction frequency to something under 6 Kc/s, which of course is nowhere near so good. At a tape speed of $1\frac{7}{8}$ i/s the extinction frequency will be even lower: less than 3 Kc/s. This is useless for music, but it is adequate for recording speech and has the advantage of giving a long recording run. (As a point of interest, this article was dictated into a tape recorder running at $1\frac{7}{8}$ i/s. The quality of sound was more than good enough for typing. To the writer, a domestic tape recorder fitted with a foot control is on the whole more useful than a dictaphone. This is because a single reel of tape can accommodate a complete book, which can be revised and improved far more rapidly than by slaving over a hot typewriter.)

To make up for all the deficiencies of the reproducing process we must use equalising circuitry to give the reproducing amplifier a frequency characteristic something like that shown in **fig. 3(a)**. This is an inverted image of the output frequency characteristic of the reproducing head, shown in **fig. 3(b)**.

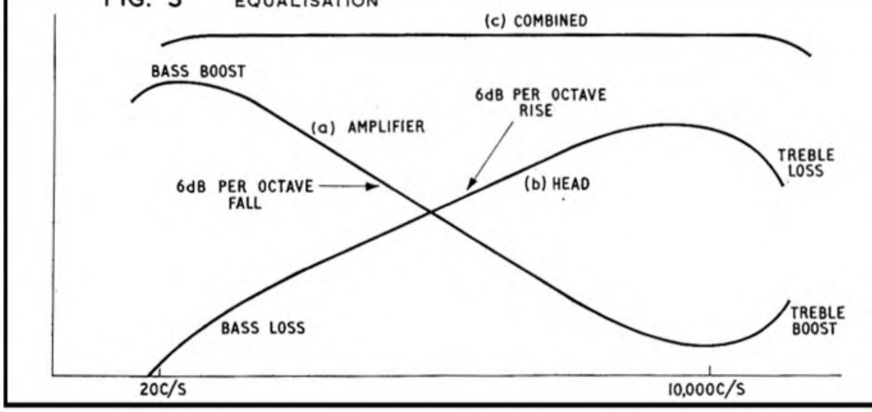
At the low frequency end we must give the amplifier characteristic a 'bump' to compensate for the loss caused by the excessively long magnets produced when bass notes are recorded. Then we must introduce a falling frequency characteristic of 6dB per octave to make up for the rising rate of change of flux linkage as the recorded frequency increases. Then, at frequencies at which the recorded wavelength begins to approach gap width, a treble boost must be incorporated. At extinction frequency, output falls off completely and all the treble boosts in the world will not bring it back again.

So the combined responses of the reproducing head and a properly equalised amplifier give us a curve of the shape shown in **fig. 3(c)**. This is substantially a straight, horizontal line, falling off at the upper and lower frequency limits.

Having persuaded the reproducing head and amplifier to give a satisfactory audio frequency output, we must still convert the alternating current into a sound wave. Here we come up against what is usually the weakest link in any audio chain—the loudspeaker. Particularly with miniature, battery-operated recorders, we can hardly hope for high-quality sound from the internal loudspeaker. There simply is not room to incorporate a speaker which is man enough for the job. For really good sound it is essential to use an external device driven by the external output socket on the recorder.

We shall be discussing loudspeakers in detail later, but for the time being here is something that seems to occur to remarkably few amateurs. If you have a reasonably good radio receiver—most enthusiasts have—why not use this as the output device for your tape recorder? Simply make up a screened lead, the shorter the better, with plugs to fit the EXTERNAL OUTPUT socket of the recorder and the PICK-UP socket on the receiver. By taking advantage of the larger loudspeaker and compensated amplifier in the receiver you can improve the quality of your sound without running into extra expense.

FIG. 3 EQUALISATION



models must be shorted out and the best place to do this is across the resistor itself. Do not be tempted to take the easy way out and solder the earthy side of the head connections to the mounting plate, or a tag under a mounting bolt. This is simply asking for hum. Follow the general rule: earth at the amplifier end where screened connections are used. This resistor is mounted on or by the point on the changeover switch where we are connecting our new parallel effect switch, and is shown in **fig. 1.** Links are already fitted in later models. The link is removed only for electronic testing.

Power for the preamp is taken to pin 3 of the stereo socket and gives a 16V positive supply, on load. With no preamplifier connected, and using a 10K-per-volt DC meter, we are likely to get a reading more like 35V. Not to panic—it is quite correct; the load will bring it down. The voltage is derived from a potential divider consisting of a 47K and a 6.8K resistor in series, across the HT tapping taken from the junction. **Fig. 2** shows the method. Amplifier current consumption is only about 3mA.

On some models, pin 3 of the stereo socket is connected to the erase head and track switch, but all we need do is disconnect at the socket and tape this lead aside. It must be remembered that the notes given here are practical jottings—the manufacturers tell us to fit tag strips for the voltage splitter components, and even give mounting hole dimensions and other such details in their service information.

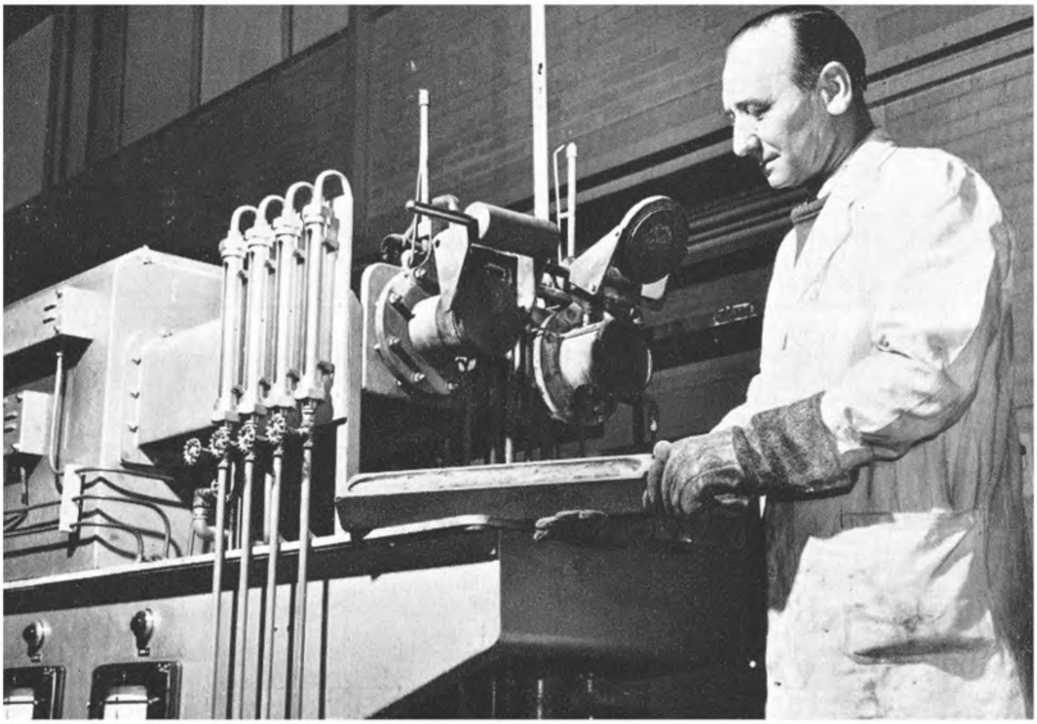
Whatever method of mounting the two resistors our readers choose to follow, it must be pointed out that the connection is taken to full HT positive, and the convenient point is the cathode, pin 3 of the EZ80 rectifier. A poor connection, loose, bare wire, flopping components and you will have at the very least a blown fuse. Be warned! We have had several of these models with blown rectifiers and burned-out transformers following an HT short, where the fuse stood up to the surge of current for a fraction longer than desirable. The actual fuse is a link on the mains transformer (so you can stop searching, Joe!) and should be replaced with suitably rated wire, or a glass fuse of no more than 1.5A, surge type, soldered across the tag points.

The circuit of the amplifier is given at **fig. 3.** The input sensitivity is 5mV and the three-transistor circuit gives about 1V across 2K at the DIN 5-pin output or 200mV at the 2-pin output (banana plug connectors) for headphone monitoring. This output is also available for re-connection to the microphone input of the tape recorder for copying and mixing. Note that this is done while recording tracks 1 or 4, and the material on the inner tracks is mixed with the outer track recording. This is not full multiplay, although a bit of adroit dubbing gives the same result. For the full facility, one must turn to the later, EL3787 amplifier, used with the EL3549A, 1604A, 1605A, ST458A and 459A ranges of Philips, Cossor and Stella machines.

The correct method of connection to the pickup input of a radio set is via a series resistor, chosen to give as near an impedance match as possible, This will depend on the loading, and a direct connection via a short screened lead can be tried initially. But the connection of the preamp to the microphone input of the tape recorder needs an attenuating pad of 1.2K in series, followed by a 33-ohm resistor across the low impedance input, pins 1 and 2, of the microphone socket. The lead EL3948/09, which should have been supplied with the amplifier, has this attenuator fitted in the DIN plug.

Note that one of the 2-pole pins actuates a small switch which inserts C1, R2, C2, a 4.5Kc/s filter to attenuate high frequencies when recording on the outer tracks. This is to minimise leakage effects of the bias voltage from the magnetic coupling between upper and lower windings of the record/play head. When working on the amplifier, make sure this switch is acting correctly. And, finally, be sure to replace the case screws, two of which are important return path clamps for the screening.

BATTERY POWERED TAPE RECORDERS



PART ELEVEN THE SEMICONDUCTOR

BY MICHAEL GORDON

Fig. 1: A tray of germanium after removal from a *Mullard* reducing furnace.

TO date in this series we have studied almost everything connected with the battery powering of tape recorders, with the exception of complete recorders which are designed specifically for battery operation. Subsequent articles in this series, therefore, will consider such recorders in some detail; but since the true battery-powered model of recent vintage is wholly transistorised, we shall first devote a little time to studying the basic principles of the transistor, without which the new generation of recorders would never have evolved

Most readers will be aware that transistors are rapidly ousting the thermionic valve in almost all areas of electronics. They are much more efficient and robust than valves and are absolutely ideal for light-weight, portable equipment.

They differ from valves in that they have no heater to produce electrons and no vacuum in which the electrons of valves operate. Instead, controlled current conduction is achieved in a pure crystal. This pure crystal can be likened to the vacuum of a valve in which the *current carriers* are provided by the addition of certain impurities to the crystal.

The current carriers in a valve are exclusively the electrons which are emitted into the vacuum by the heated cathode and then attracted to the positively-charged anode via the control grid and, in multi-electrode valves, other grids.

At this juncture it is important to remember that the controlled flow of electrons through a vacuum, through a crystal or, indeed, through any conductor or semiconductor constitutes a flow of electric current. Thus, the flow of electrons in a valve from the heated cathode to the positively-charged anode can be looked upon as a flow of electric current. The electron flow, of course, is from cathode to anode, while the *conventional current flow* is from anode to cathode. That is, from positive to negative. The heated cathode produces a large quantity of electrons, but rarely are all these used at any one time to produce anode current. The flow of electrons through the vacuum is controlled by the control grid which has a negative potential (or bias) applied to it. Thus, depending upon how negative the grid is made, the quantity of electrons flowing through the control grid—and constituting the anode current—is varied. If the control grid is not made negative at all, most of the cathode electrons arrive at the anode, but if it is made very negative, virtually no electrons at all get through it and there is no (or very little) anode current.

These things happen because the electron is a diminutive, negatively-charged body. It is thus attracted very much by the positively-charged anode and repelled by a negatively-charged control grid on the basis that like charges repel and unlike charges attract.

Clearly, then, the control grid can be considered as an 'electronic tap', capable of turning up or down the electron flow and hence the anode current. So much for the valve, but what of the transistor?

A transistor has no vacuum, neither does it have a cathode, anode or grid. It does, however, rely partly on negative current carriers (electrons) for its operation; but it makes use of so-called *positive current carriers* (termed *holes* in semiconductor parlance) as well.

As already mentioned, instead of these current carriers working in a vacuum, they work within the structure of a crystalline material composed essentially of germanium or silicon. Pure germanium and silicon are perfect insulators (containing no normal current carriers), but pure crystal—like the absolute vacuum—is impossible to attain. Nevertheless, the germanium and silicon of semiconductors are processed to a very high degree of purity.

The manufacture of germanium transistors, for instance, starts with germanium dioxide powder which is reduced to germanium by heating in an atmosphere of hydrogen gas, after which the germanium is fused into a bar and purified by an RF heating process. **Fig. 1** shows a tray of germanium powder after removal from the reducing furnace at Mullard's semiconductor factory.

We have seen that a perfect insulator is no good in itself for electrical conduction, so when a crystal is purified certain impurities are purposely added to give the crystal a *semi-conducting* characteristic. A semiconductor is a material which is neither a perfect conductor nor a perfect insulator, and the term semiconductor is often used to describe any device of the *solid-state* (as distinct from thermionic) diode and transistor families.

Depending on the nature of the added impurity, the processed crystal is caused essentially to pass an electric current either by reason of negative current carriers, which are electrons, or positive current carriers, which are the *holes* mentioned earlier.

The term *hole* is adopted because a piece of crystal processed to conduct by holes operates by virtue of the fact that the impurity addition has created an electron deficiency. This means that the material has more spaces for electrons than there are electrons to fill them. These spaces represent the so-called holes.

At this stage it should be understood that the impurity additive releases into the crystalline structure *free* or *mobile* current carriers, and that these are perfectly free to move at random or to be moved by electric charges without the crystal material being in any way affected. Remember that the 'pure' crystal is representative of the vacuum of a thermionic valve.

One impurity additive is arsenic. When a small, controlled trace of this material is integrated into the crystalline structure, its atoms merge in such a manner with the atoms of the crystal proper that there becomes a *surplus* of electrons. These are the mobile electrons (i.e., negative current carriers), and they are free to move around the crystal in a random manner, just like the free electrons in any other conductor or semiconductor.

Now, semiconductor material with an electron surplus is called *n-type*, the *n* denoting negative carriers. Such material can be represented diagramatically as in **fig. 2(a).** Here is shown just one positive current carrier or hole to signify the impossibility of achieving the perfect in practice. A hole in n-type material is called a *minority carrier*.

By the integration of a different kind of impurity, aluminium, for example, the resulting mobile electrons are fewer than the available spaces (holes) which they could occupy. The effect is that as the electrons of neighbouring atoms move around the crystal from hole to hole, they leave unoccupied holes behind them. Thus, if the electrons move in one direction from hole to hole, the holes themselves appear to move in the opposite direction.

To understand *exactly* how the electrons and holes are created in the virgin crystal material, we should need to make a close study of the structure of solids in terms of atoms, molecules, bonding, crystal lattices and so forth. While such study is instructive, it would divert too far from the title of this series of articles. In any event, detailed atomic study is not essential for a practical understanding of the working of transistors and their applications in tape recorders.

A semiconductor in which holes predominate is called p-type, *p* for positive, and is shown diagramatically in **fig. 2(b).** Here the minority carrier is the electron.

The atomic impurities added to the virgin crystal material are called *acceptors* and *donors* for *p* and *n* characteristics respectively.

It should be observed that the effective electrical charge of a hole is exactly equal in magnitude, though opposite in sign, to the charge of an electron, and that there exists a mutual attraction between holes and electrons. A process upon which the operation of a semiconducting device is based is called *recombination.* This happens when an electron fills a hole, after which neither the hole nor the electron can further contribute towards the conduction of electric current.

The basic solid-state device is the diode or rectifier, and we must get some idea as to how this works before we can go on to transistors. In any case, battery-powered tape recorders generally contain several 'crystal diodes', as they are often called.

Such a device is composed of integrated *p* and *n*-type semiconductors, in the form of a *p-n* (or *n-p*) junction. Now, when two opposing types of semiconductor are brought together in this manner to form a junction, a so-called *potential barrier* is created.

The effect is that some of the electrons from the *n*-type material diffuse across the junction and neutralise some of the holes in the *p*-type material. This means that the junction is left with an electron deficiency on the *n*-type side, giving this side a positive charge. Conversely, some of the holes from the *p*-type material diffuse across the junction and neutralise some of the electrons in the *n*-type material, thereby giving the *p*-type side a negative charge. These two charges—positive on the *n*-type side and negative on the *p*-type side of the junction—form the potential barrier, as shown in **fig. 3.**

It should be understood that the potential barrier is formed during the actual processing of the *p-n* junction, and that this so-called barrier exists only inside the device, at the junction, and it cannot be measured in terms of a voltage by connecting a voltmeter across the two leadout wires of a diode.

Now let us see the effect of connecting, say, a battery across a junction diode. When battery positive is connected to the *p*-type side of the diode and negative to the *n*-type, the external potential is in opposition to the potential of the junction barrier. The potential of the barrier is thus neutralised when the external potential equals the barrier potential, and only a very small potential (i.e., voltage) is needed to do that.

However, when the external potential exceeds that of the barrier, electrons from the *n*-type material flow into the *p*-type, and holes from the *p*-type flow into the *n*-type, giving rise to an unrestricted interchange of positive and negative current carriers, as shown in **fig. 4.**

With an external supply connected this way round in polarity, therefore, an easy path for electric conduction is established, and the junction diode is said to be biased for *forward conduction.* The conventional current flow is then from battery positive, through the *p*-type and *n*-type material and back to battery negative.

(continued overleaf)

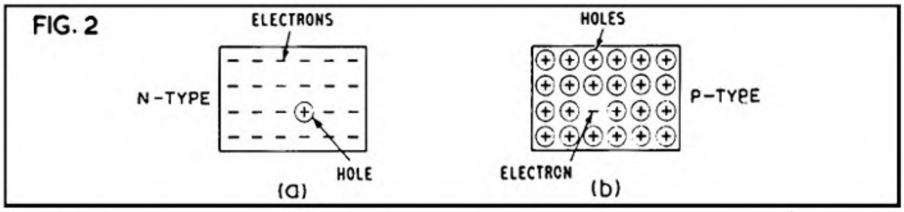


FIG. 2

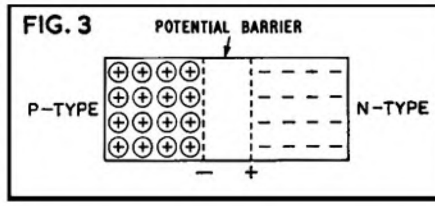


FIG. 3

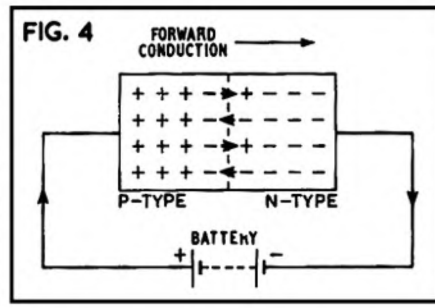


FIG. 4

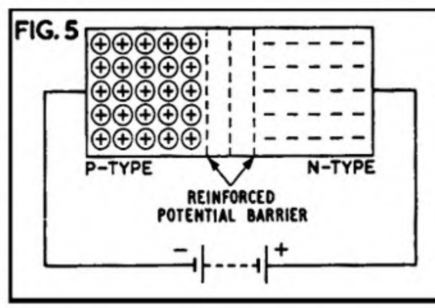


FIG. 5

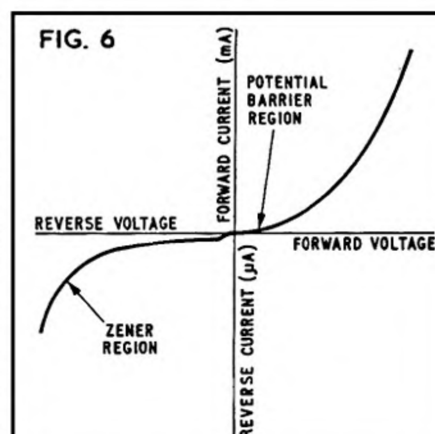


FIG. 6

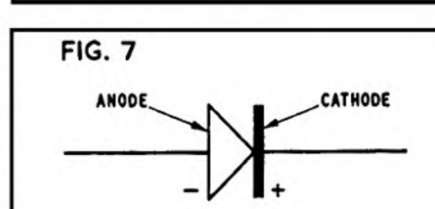


FIG. 7

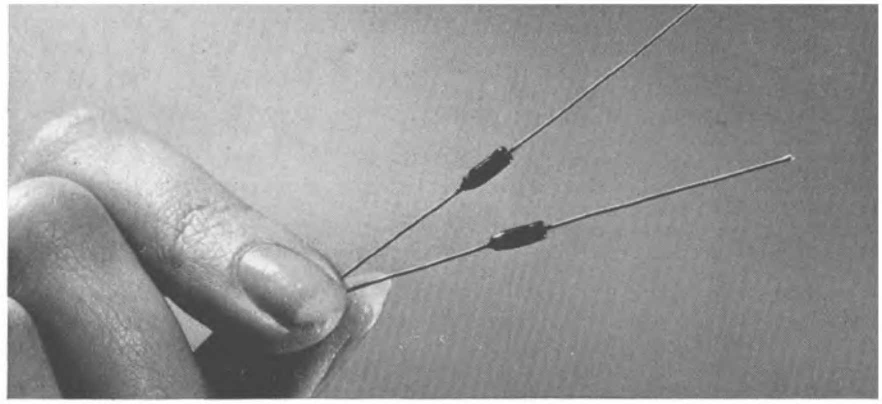
BATTERY POWERED TAPE RECORDERS

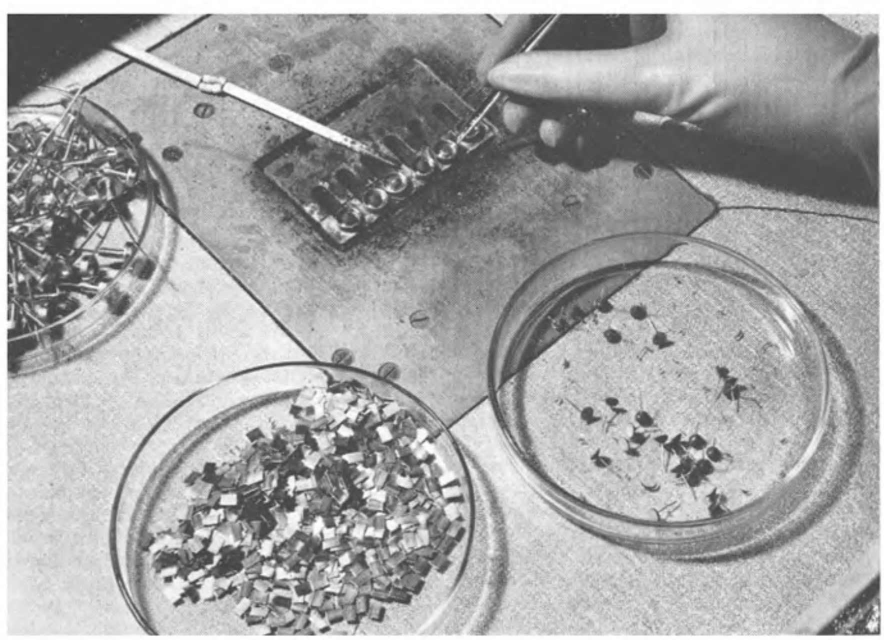
CONTINUED

Fig. 8 (top right): *Simet M* silicon diodes

Fig. 9 (middle right): Lapping of *Mullard* silicon slices

Fig. 10 (bottom right): Crystal assemblies being soldered to base





When the external polarity is reversed, the potential barrier, instead of being neutralised and eventually destroyed (temporarily of course), is reinforced. This is because the external potential adds to the potential of the barrier, as shown in **fig. 5.**

Under this condition, known as *reverse biasing*, normal conduction through the diode junction is impossible, but there is a very small conduction, called *reverse conduction*, due to the minority carriers. The current through the diode under this condition is called *leakage current*. The leakage current tends to increase as the temperature of the junction is increased, and the leakage can also be influenced by light falling on the junction.

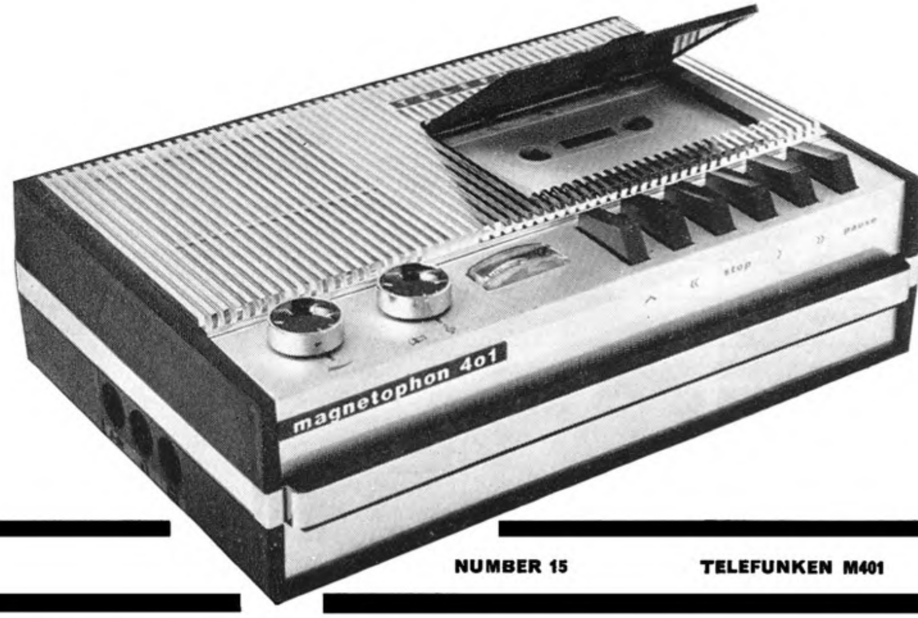
When the reverse biasing potential is increased beyond a certain point (well outside the value required for ordinary diode working), the current swiftly rises considerably above normal leakage value. This is called the *Zener* or *breakdown* voltage, which has already been considered in the articles dealing with voltage regulation. **Fig. 6** gives the forward and reverse characteristics of a junction diode, illustrating graphically the aspects already expounded.

We can now understand why a junction diode (or crystal diode) acts as a rectifier. That is, allowing current to pass unrestricted in one direction, while virtually cutting off current flow (within the diode's rating) in the opposite direction.

The diode symbol is given in **fig. 7,** the triangular element being the 'anode' and the thick line the 'cathode'. The anode is usually coded black or with a negative sign, while the cathode is coded red or with a plus (positive) sign. The triangular element (or narrow head) signifies the direction of conventional current flow through the diode in the forward direction.

Fig. 8 shows how small silicon diodes can be made. This is the *Simet M-series*. **Figs. 9** and **10** show stages in the manufacture of the Mullard BY100 silicon power diode. **Fig. 9** depicts the lapping of silicon crystal slices, in which process the untreated sides of the silicon slices are ground with fine abrasive to remove any deposited phosphorus, while **fig. 10** shows the use of a jig to solder the crystal assemblies (in the dish on the right) to their bases (in the dish on the left). The dish in the centre of the picture contains wafers of solder.

With this introduction to semiconductor techniques, we shall be able to start next month with an examination of the transistor itself.



FIELD TRIALS OF BATTERY PORTABLES

NUMBER 15 TELEFUNKEN M401

BY DAVID KIRK

WHEN field-testing the *Philips EL3300*, some two years ago, I took pains to withhold my views on the subject of cassettes. Perhaps I hoped that, good as the little machine was, the cassette was more a played-out gimmick than a promising new development. If I did, then the sales figures proved me completely wrong.

While the EL3300 caused me to tolerate cassettes, the *Telefunken M401* has really won me over to the conviction—not that they will ultimately oust reel-to-reel spooling—but that both systems can fulfil a role in modern society. The cassette recorder certainly does not lend itself so well to creative recording as does the multi-speed spool machine, but compensates for this with an increased capacity to supply passive entertainment. I am starting, however, where I should end.

The M401 is the first of a series of recorders to be marketed in this country by *Telefunken*, *Uher* and *Grundig*, based on the *DC International* cassette, developed in collaboration between the three companies. Also standardised is the 2 i/s tape speed. I suspect, having seen the Grundig *C100* (*New Products*), that the manufacturers are also pooling their skills in the tape recorder design field, merely modifying the cabinet and controls to suit their respective techniques of styling. This is certainly nothing to complain about.

All controls are positioned on a chrome panel, the mechanical press-tabs being within reach of the fingers holding the handle. The recorder can thus be held and operated with one hand, once gain has been adjusted.

The handle itself is of plastic and metal, arranged to slide against the chrome facia when not in use.

Six press-tabs to the right of the level meter govern record, rewind, stop/eject, play, fast-forward and pause respectively. The record control contrasts in red against the remaining black tabs and interlocks with the play button to achieve the recording mode. Continuous pressure on the record tab alone sets the motor in motion and switches on the amplifier, to allow pre-adjustment of modulation level. Alternatively, the pause tab may be locked down and the record/play tabs switched into action. The tape will not then move until the pause button is released. Unlike the others, this control is of the press-on, press-off type. Fast-forward and rewind controls are a little unusual in having no locking facility ; the tabs must be pressed for the entire period of winding. This becomes uncomfortable if more than half the reel is rewound. (Please note the distinction in terminology, incidentally ; the term 'reel' is being used to define wound tape, a 'spool' being the flanged spindle on which the reel may be stored.)

Two rotary controls govern record/replay gain and tone, the latter varying treble level and incorporating a speaker switch. The speaker itself faces upwards through a chrome grille.

Batteries are housed in a plastic cradle, this being completely detachable from the body of the recorder. Insertion and removal of cells presented no difficulty.

The DC International cassette is an obvious rival to the Philips design, so it seems worthwhile comparing the two. As can be observed from the illustration overleaf the DCI is rather larger than the Philips, but otherwise of very similar construction. Both incorporate tape of some ¼in. width, wound with the coating facing outwards. Erase and record/play heads scan the bottom half of the tape, which is driven from left to right.

An odd effect, which can only have been due to pack-slip within the cartridge, showed itself as an occasional loss of treble. The recorder would perform happily for a period and then become suddenly muffled. A more-or-less temporary cure could be effected by stopping and restarting the tape-transport.

The DCI design is a little more tricky to dismantle than the Philips, but, by virtue of its size, is probably a little stronger. On one occasion, the DCI cassette was dropped on to a carpeted floor, causing one reel turntable to jam between upper and lower cassette mouldings. However, light finger pressure on the hub quickly freed it.

Inserting the cassette into the recorder was a simple procedure. Removal would be near-impossible, though, were the stop-switch not arranged to push up the front edge. This switch is cleverly interlocked to prevent the cassette jumping up whenever a mode is cancelled. A detachable lid was supplied, which may be clipped over the cassette to make the machine look even less like a tape recorder. Occasionally, the cassette would try to jump out, only to jam against the lid. When this occurred, it was necessary to remove the lid and press the cassette home before the machine could again be operated.

The lid on the recorder tested tended to vibrate on certain types of music. If I owned this machine, therefore, I would probably 'lose' that attachment.

The quality of recorded speech and music was very good, considering the 2 i/s tape speed. Despite this low speed and the narrow track width, dropout on no occasion proved troublesome, and background hiss only became audible with the treble control at its upper limit. Feeding the M401 through external amplifiers and speakers gave even more astounding results. Never have I heard such fine quality at so low a tape speed. The manufacturer's claim to achieve 8 Kc/s seemed to be fully borne out.

Wow and flutter gave no trouble throughout the period of field-trial, and the M401 was found to be particularly resistant to speed fluctuation when twisted or shaken. Most portable recorders are subject to violent changes in tape speed when twisted about the flywheel axis. In the case of machines having light high-speed flywheels, the main source of wow tends to be the spools, which snatch the tape as they violently re-assert their tension. In the M401 we have no spools, so even this effect was hardly noticeable.

(continued overleaf)

This freedom from speed deviation must be due, in part, to the electronic motor control which takes the place of the conventional governor-switch. An additional advantage, and possibly the most important, is the complete freedom from electrical interference rendered by the absence of a governor. The motor control circuit, with its thirteen semiconductors, must be responsible for a sizable portion of the £48 price, but it is worth it.

On one occasion the recorder was employed in tape correspondence from a parked motor car, a combination of activities that provides the restfulness of a living-room armchair with the freshness of country air. (Once the windows had been closed to combat the noise of occasional passing cars, the 'country air' aspect was somewhat limited!) Many machines are too noisy to allow recording at close quarters in such quiet locations, but the Telefunken proved quite silent, apart from an acoustic whistle that sometimes mysteriously appeared. It was found that this could be eliminated by stopping the machine and pressing the play switch slowly into action.

When the resultant correspondence had been dubbed on to a conventional tape, I fell prey to the idea of using the M401, not to record, but to replay music in the car. Investigation showed the machine to be small enough to fit in the glove tray, so out came a tape of favourite music, on went thirty minutes of dubbed material, and in went the M401.

Although I quickly tired of hearing the same music over and over again, the recorder performed a worthwhile, though thoroughly uncreative, role of further enlivening the enjoyable activity of driving.

The recorder certainly does not lack volume, and gives a strong impression of having been designed as a unit, rather than a 'young sister' to a mains recorder or hi-fi system. The internal speaker gave a pleasing, untiring sound which lacked the 'boxiness' of so many plastic-cabinet recorders.

Externally, the M401 appears equally suited to horizontal and vertical operation, though one variation in performance was noted between these two positions. The tape ran slightly faster when the recorder was upright.

In concluding, I can find much to praise and little to criticise in the M401. Were it designed for spools, the recorder would be more bulky and the performance probably not as good. Indeed, there is really only one point to be made. What a pity Philips and the DCI group were unable to agree.

MANUFACTURER'S SPECIFICATION. Twin-track transistor battery recorder employing *DC International* cassettes. **Tape Speed:** 2 i/s. **Playing Time:** 45 minutes per track (DC90) or 60 minutes per track (DC120). **Frequency Range** 40c/s—8—Kc/s. **Signal-to-Noise Ratio:** 45dB. **Output Power:** 2W. **Level Indicator:** Meter. **Power Supply:** Six dry cells (mains unit and car battery adapter available). **Dimensions:** $11\frac{1}{2} \times 8\frac{1}{8} \times 3\frac{3}{4}$in. Price: £48 6s. (including microphone). **Distributor: AEG (Great Britain) Ltd., Lonsdale Chambers, 27 Chancery Lane, London, W.C.2.**

NEW PRODUCTS NEW PRODUCTS NEW PRODUCTS

REVOX MULTIPLEX FILTER

THE problems of recording multiplex stereo broadcasts, discussed at length elsewhere in this issue, may be solved by a simple outlay of £12. This is the price of the multiplex filter now available from *C. E. Hammond Ltd.* Although intended for *Revox* stereo recorders, the unit may be used with almost any machine. Two inputs are provided on each channel, for tuner outputs of 5-200mV at 47K and 100mV-5V at 1M. A preamplifier is incorporated before the filter stage to achieve correct impedance at the filter input and to compensate for level losses. Each channel features a pair of silicon transistors. Frequency response is flat from 40 c/s to 14 Kc/s, falling sharply to —40dB at 19 Kc/s and 38 Kc/s. Signal-to-noise ratio is 55dB unweighted for 5mV-200mV input levels, 67dB for 20mV to 800mV input. Cross-talk rejection is 70dB, and distortion, at maximum input levels of 200mV and 5V respectively, is 1%. Output level to tape recorder is 25mV-1V at 47K. The unit requires 24V DC at 2mA, this being available from the remote-control socket of the Revox.

Distributor: C. E. Hammond Ltd., 90 High Street, Eton, Wyndsor Berkshire.

GRUNDIG DCI CASSETTE PORTABLE

NOW being marketed by *Grundig* is the *C100* battery tape recorder, designed to accept *DC System International* cassettes. The machine operates at 2 i/s and features an electronically stabilised motor driving the tape through contra-rotating flywheels. Finished in charcoal and silver, with dimensions of $11\frac{1}{2} \times 7\frac{1}{2} \times 3\frac{3}{4}$in., the C100 weighs $7\frac{3}{4}$lb. and has a total playing time of $1\frac{1}{2}$ hours using the *DC90* cassette supplied. The recorder retails at £41 9s. 6d.

Manufacturer: Grundig (G.B.) Ltd., Newlands Park, Sydenham, London S.E.26.

SANYO MAINS AND BATTERY RECORDERS

DESCRIBED as a portable mains recorder of advanced design, the *MR701 Brigadier* features automatic gain control, AC recording bias and DC erase. Six transistors and two diodes contribute to a frequency range of 100 c/s—8 Kc/s at $3\frac{3}{4}$ i/s, 100 c/s—4 Kc/s at $1\frac{7}{8}$ i/s. The recorder features $\frac{1}{2}$-track heads and supplies a maximum of 2.7W to the $6\frac{1}{4}$ x 3in. internal speaker. Dimensions are $12\frac{1}{2}$ x 10 x 6 in. and price is £40 19s.

Rather smaller is the *MR225* battery portable, a $\frac{1}{2}$-track machine operating at $1\frac{7}{8}$ i/s. Claimed frequency range is 200 c/s—3 Kc/s. Output power is 450mW and weight is 2lb. The recorder measures $6\frac{1}{4}$ x 6 x 2 in. and costs 16 gns.

Distributor: Sanyo Sales and Service, 23 Savage Gardens, London, E.C.3.

VAN DER MOLEN VR7

SPEEDS of $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i/s, transistor circuitry and an output power of 3.5W are features of the $\frac{1}{4}$-track *VR7* tape recorder, lately introduced by *Van Der Molen*. Styling of the machine is a little unusual, electronic controls being mounted in a recess on the right-hand side of the machine. These comprise track selector, gain, mixing, treble and bass. An 8in. upward-facing speaker is located to the left of the deck. Output sockets are incorporated for external amplifier or headset, and loudspeaker. Claimed wow and flutter of the press-tab-operated deck is quoted as 0.15% at $7\frac{1}{2}$, 0.25% at $3\frac{3}{4}$ and 0.35% at $1\frac{7}{8}$ i/s. Respective frequency responses are 60 c/s—15 Kc/s, 60 c/s—10 Kc/s and 60 c/s—4 Kc/s, ±3dB. Claimed signal-to-noise ratio is 40dB. Housed at the rear of the deck, between the spools, is a magic-eye recording level indicator. The machine is supplied with a crystal microphone to feed the 2mV 1M low-level input. High level (gram) input is 200mV at 1M.

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

CAROUSEL RADIOTAPE

ALL the advantages of a 'radiogram', minus the possibility of mechanical feedback, are provided by the *Carousel RT5*. Based on a BSR TD10 three-speed tape deck, the unit incorporates a complete record/reproducing amplifier and AM radio tuner and sells at £45 3s. Recordings may be made from external sources or the tuner, simultaneous direct monitoring being possible through the forward-facing 9 x 5in. loudspeaker. The teak veneer cabinet includes storage space for tapes. Also available without the tuner, at £35 14s., the RT5 may be used as a straight-through amplifier for disc reproduction.

Manufacturer: Stereosound Productions Ltd., Capital Works, 12/14 Wakefield Road, Brighouse, Yorkshire.

CROWN MAINS/BATTERY RECORDER

FOUR torch cells or AC mains may be employed to power the *CTR5450* tape recorder, manufactured by *Crown* and imported by the *Heddon-Smith Group*. Spool capacity is 5in. and the speeds are $3\frac{3}{4}$ and $1\frac{7}{8}$ i/s. Five transistors are contained within the $11\frac{1}{4} \times 9 \times 4\frac{1}{4}$in. cabinet, overall weight being 8lb. Retail price is £30 19s. 6d. Designed for batteries only, the *CTR3000* takes $3\frac{1}{4}$in. spools and operates at $3\frac{3}{4}$ and $1\frac{7}{8}$ i/s. Weight is 5lb. and dimensions are $8\frac{3}{4} \times 8\frac{1}{2} \times 3\frac{1}{2}$in. The recorder costs 19gns. and may be mains-powered from a separate adaptor, available at extra cost.

Distributor: Heddon Smith Group Ltd., Heddonia House, 7-9 William Road, London N.W.1.

MOOD MUSIC AND SOUND EFFECTS

TWO gramophone records of mood music and sound effects have lately been introduced by *CDC*, complementing the earlier *Custom Music for 8mm*. The discs, entitled *Cine Mood Music* and *Sound for a Picture Evening*, are being retailed by photographic dealers and record stores at £2 9s. All three are 12in. LP's, *Sound for a Picture Evening* being imported from the USA while the other two are made by *EMI*.

Distributor: Commercial Drug and Chemical Co. Ltd., 460 Holloway Road, London, N.7.

Grundig C.100

Sanyo MR701

Van Der Molen VR7

Carousel RT5

STEREO RECORDER SURVEY CONTINUED

TELEFUNKEN M203. SPEEDS: 3¾ and 1⅞ i/s. WOW AND FLUTTER (at 3¾ i/s): ±0.2%. FREQUENCY RANGE: 40 c/s-15 Kc/s. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATOR: Meter. OUTPUT POWER: 2.5W (single channel). SPEAKER: 5 x 3in. elliptical. FEATURES: Output from preamplifie.s. Multiplex stereo recording. WEIGHT: 21lb. DIMENSIONS: 15½ x 12¼ x 6⅝in. PRICE: £72 9s. **MANUFACTURER: AEG (Great Britain) Ltd., Lonsdale Chambers, 27 Chancery Lane, London, W.C.2.**

TELEFUNKEN M203 de Luxe. Decorative wood case. MICROPHONE: TD20 omnidirectional dynamic. PRICE: £81 18s. Other specificational details as *Model M203.*

TELEFUNKEN M204E. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: 0.15%. FREQUENCY RANGE: 40 c/s-18 Kc/s. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two meters. OUTPUT POWER: 6W x 2. SPEAKERS: Two side-facing. DIMENSIONS: 8¼ x 13¾ x 18½in. FEATURES: Metal-foil autostop. Illuminated level meters. PRICE: £111 6s. **MANUFACTURER: See above.**

TRUVOX PD102. SPEEDS: 7½, 3¾ and 1⅞ i/s. WOW AND FLUTTER: 0.1%. FREQUENCY RESPONSE: 30 c/s-17 Kc/s ±2dB. NOISE LEVEL: —50dB. SPOOL CAPACITY: 7in. TRACKS: Two. LEVEL INDICATORS: Two VU-meters. WEIGHT: 28lb. DIMENSIONS: 16 x 16½ x 8in. FEATURES: Separate record/play heads. Output from preamplifiers. FM multiplex recording. PRICE: £97 13s. **MANUFACTURER: Truvox Ltd., Neasden Lane, London, N.W.10.**

TRUVOX PD104. Quarter-track version of *Model PD102.* PRICE: £93 9s.
● Review: July 1966.

UHER 22. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: ±0.1%. FREQUENCY RANGE: 20 c/s-20 Kc/s. SPOOL CAPACITY: 7in. TRACKS: Two. LEVEL INDICATORS: Two meters. WEIGHT: 24lb. DIMENSIONS: 15 x 7 x 13in. FEATURES: Variable replay head azimuth. Separate record and play heads. Switchable CCIR/NAB equalisation. PRICE: £156 9s. **DISTRIBUTOR: Bosch Ltd., 205 Great Portland Street, London, W.1.**

UHER 24. Quarter-track version of *Model 22.*

UHER 724. SPEEDS: 7½ and 3¾ i/s. WOW AND FLUTTER: ±0.2%. FREQUENCY RANGE: 40 c/s-18 Kc/s. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATOR: Meter. WEIGHT: 20lb. DIMENSIONS: 15 x 7 x 14in. FEATURES: Solenoid foil-actuated autostop. Transistorised. PRICE: £79 15s. **DISTRIBUTOR: See above.**

UHER 784. SPEEDS: 7½, 3¾, 1⅞ and 15/16 i/s. WOW AND FLUTTER: ±0.15%. FREQUENCY RANGE: 50 c/s-20 Kc/s. NOISE LEVEL: —50dB. OUTPUT POWER: 2W x 2. SPEAKERS: Two 5in. elliptical. SPOOL CAPACITY: 7in. TRACKS: Four. LEVEL INDICATORS: Two VU-meteis. WEIGHT: 23½lb. DIMENSIONS: 15 x 14 x 7in. PRICE: £135 9s. **DISTRIBUTOR: See above.**

VORTEXION CBL. SPEEDS: 7½, 3¾ and 1⅞ i/s (15, 7½ and 3¾ i/s version available at £180). WOW AND FLUTTER: 0.16%. FREQUENCY RESPONSE: 40 c/s-15 Kc/s ±3dB. NOISE LEVEL: —50dB. OUTPUT POWER: 3½W x 2. SPEAKERS: One 7in. elliptical. SPOOL CAPACITY: 8¼in. TRACKS: Two. LEVEL INDICATORS: Two PPM. WEIGHT: 68lb. DIMENSIONS: 27½ x 15⅞ x 9in. FEATURES: Separate record/play heads, mixing. PRICE: £172. **MANUFACTURER: Vortexion Ltd., 257-263 The Broadway, Wimbledon, London, S.W.19.**

equipment reviews

SONY TC3574 AUTOMATIC

MANUFACTURER'S SPECIFICATION. Quarter-track mono tape recorder with automatic gain control. **Tape Speeds:** 7½, 3¾ and 1⅞ i/s. **Frequency Ranges** (respective): 40 c/s-15 Kc/s, 40 c/s-12 Kc/s, 40 c/s-6 Kc/s. **Wow and flutter:** 0.12% at 7½, 0.2% at 3¾ i/s. High impedance microphone and auxiliary inputs. **Outputs:** High impedance line and 8-ohm external speaker. **Output Power:** 2W. **Weight:** 22lb. **Dimensions** 15 x 8 x 12in. **Price:** £65 2s. **Distributor: Sony U.K. Sales Division, Debenhams Electrical and Radio Distribution Ltd., Mercia Road, Gloucester.**

LIKE most automatic level-setting recorders, the *Sony TC3574* uses valves—we do not have variable-mu transistors yet !

Three valve envelopes are used : a high gain variable-mu pentode first stage, and two triode-pentodes with the pentodes acting as the power amplifier and the triodes as control bias rectifier and bias and erase oscillator. The output stage is in circuit whilst recording and the loudspeaker can be left on for monitoring if desired. A medium-impedance winding on the output transformer provides a signal which is rectified to provide the control bias for the automatic gain control stage. An 8-ohm winding feeds internal and external speakers and the VU-meter circuit.

Panel controls are cut to the minimum by combining the functions of microphone gain, playback gain and mains on/off switch on one edge type control, and line input gain, tone control and auto-manual switch on an adjacent edge type control. Illuminated windows on the top panel show the function and level settings clearly.

Two novel features on the deck simplify tape loading. With the control lever in the neutral position, the pressure roller is moved both back *and down* so that the tape can be withdrawn from the supply reel and wrapped around the heads by placing it in the forward facing slot formed by the over-hanging head cover. The movement is continued to wrap the tape round the hub of the take-up reel where cunningly placed flat springs grip the edge of the tape. As the control lever is moved clockwise, the pressure pads and capstan roller return to their normal positions and the loose end of the tape is bent back and wound under the tape fed to the take-up reel by the capstan ; the complete loading sequence takes only a few seconds.

The long-term tape speed was checked by strobe tape and found to be within 1% limits at all parts of a 7in. spool.

The fluttergrams of **fig. 1** show short-term speed fluctuations over periods of one second. The integrated wow and flutter readings for a bandwidth of 200 c/s were 0.08%-0.09% at 7½ i/s, 0.1% at 3¾ i/s and 0.15%-0.17% at 1⅞ i/s. Only at the lowest speed was there a slight trace of 2 c/s wow, and this was not noticeable on normal programme material.

The tone control is continuously variable and it was set for the most level response on line output at each speed to give the play-only responses of **fig. 2.** The test-tape time constants and the tone control settings are given for each response.

Record-play responses were measured on 'Manual' from line input to line output to give the responses of **fig. 3.** It will be seen that the 7½ i/s and 3¾ i/s responses are satisfactory on both tests, but that the lowest speed responses lack high-note output due to insufficient pre- and post-equalisation.

System noise, with no tape passing the heads, was 33dB below test-tape level and consisted mainly of harmonics of the mains frequency. Erase and bias noise was only just appreciably noisier than bulk erased tape, indicating good oscillator waveform and adequate bias. Peak recording level on the manual setting showed

(*continued on page 385*)

FIG. 1
SONY TC3574
WOW AND FLUTTER

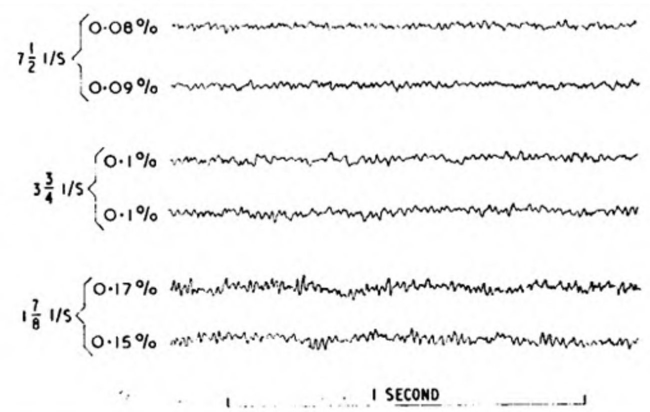


FIG. 2 SONY TC3574 PLAY—ONLY RESPONSE (TEST TAPE TO LINE OUTPUT)

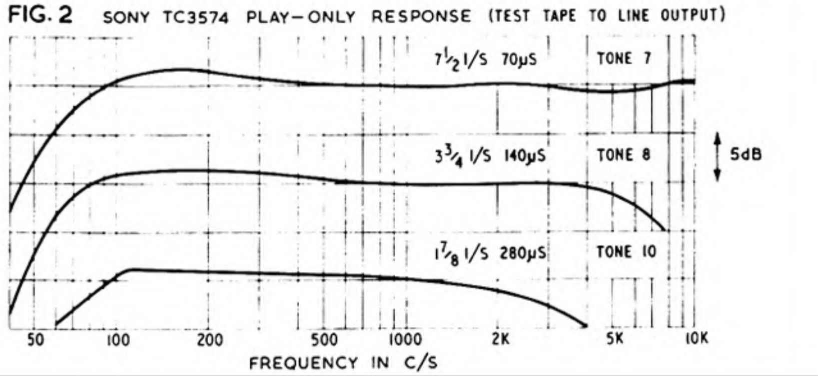
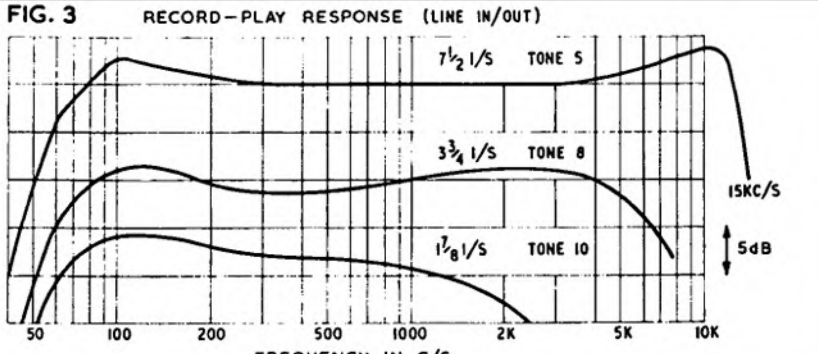


FIG. 3 RECORD—PLAY RESPONSE (LINE IN/OUT)



about 5% distortion at 12dB above test-tape level. This corresponded to the top of the red sector of the meter scale. Dynamic recording tests on 'manual' showed that the meter was insufficiently damped and tended to overswing, so that kicking into the red only occasionally resulted in under-recording.

The 'auto' setting used the dynamic range of the tape fully, with a recovery time of about 40 seconds after the application of a very loud input signal. The time-constant of the automatic gain control was fixed on this recorder. from the speaker. Voice quality on microphone recordings was excellent.

COMMENT

The simple tape threading and the automatic recording level control makes this a very suitable recorder for general family use.

During my listening tests I connected the line input to the speaker line of my high fidelity installation and started to record a well known pianist who intersperses light piano music with quiet announcements and loud

FIG. 4 SONY TC3574 ACOUSTIC RESPONSE

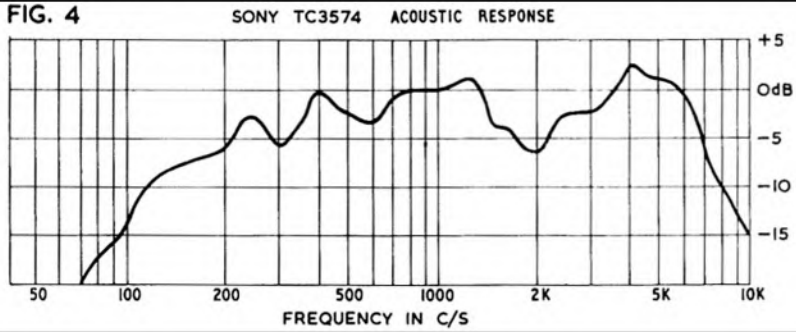
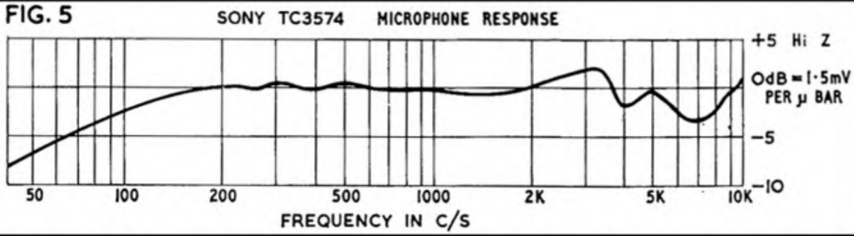


FIG. 5 SONY TC3574 MICROPHONE RESPONSE



The acoustic response sounded full and well balanced and this is confirmed by the response of **fig. 4** which was obtained by playing a 7½ i/s white-noise test-tape and measuring the sound output on the speaker axis with a calibrated microphone. The microphone supplied with the recorder was also measured in a white-noise sound-field to give the very satisfactory response of **fig. 5.** The response of the microphone is so nearly level that the curve of **fig. 4.** represents the 'air to air' overall response from sound input to the microphone to sound output passages with full orchestral support. During this sequence, some friends arrived and, without thinking, I turned the music down to quiet background level, and then up again when they moved to another room. I have listened to this recording several times and find it very difficult to decide where the level was changed, and in addition there is no sense of 'ironing out' the music to a constant level. I doubt if my own gain control manipulations with the aid of a good VU-meter or magic-eye would have done much better. **A. Tutchings.**

MULTIPLEX COMPLEXITY CONTINUED

on the circuits would range into this frequency. Worth trying, anyway.

These filter circuits do not cost much to make up and many enthusiasts enjoy experimenting, but it is sad to relate that rather a high fee is being asked for tailor-made filters for adding to recorders susceptible to supersonic modulation signals, such as the Tandberg.

From Mr. Uden's comments it seems that the recorder can be as much to blame as the tuner for the beat-frequency recording effects. We shall probably know the reason why in more detail as time progresses.

Clearly, at this stage of the stereo-recording-from-radio art we cannot know all the problems —let alone the answers—likely to occur. But as more information becomes available, so it will be published.

For instance, the question of the best filter to employ for specific cases may require some degree of experimentation for its answer. The best plan is to build one section of a filter and try it out on either the A or B channel (with the other channel disconnected). Once the whistle has been removed from one track (or, at least, greatly attenuated), the filter can then be duplicated for the other channel.

Even the BBC is up against some problems concerning the 20 Kc/s supervisory signals, which have been known already to cause a bit of trouble to recordists on mono programmes; hence Mr. Uden's efforts. Stereo-wise, however, they can upset tuners and decoders that incorporate circuits for the automatic detection of stereo transmissions. It seems, therefore, that stereo tuner and decoder makers may also have to take this 20 Kc/s signal into account. But this is another story . . .

CLASSIFIED ADVERTISEMENTS

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

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

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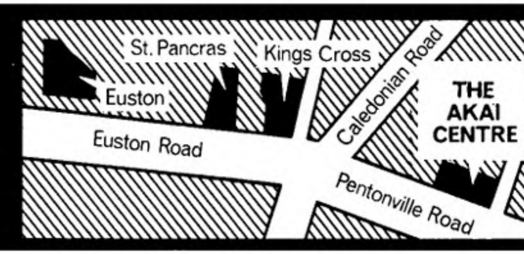
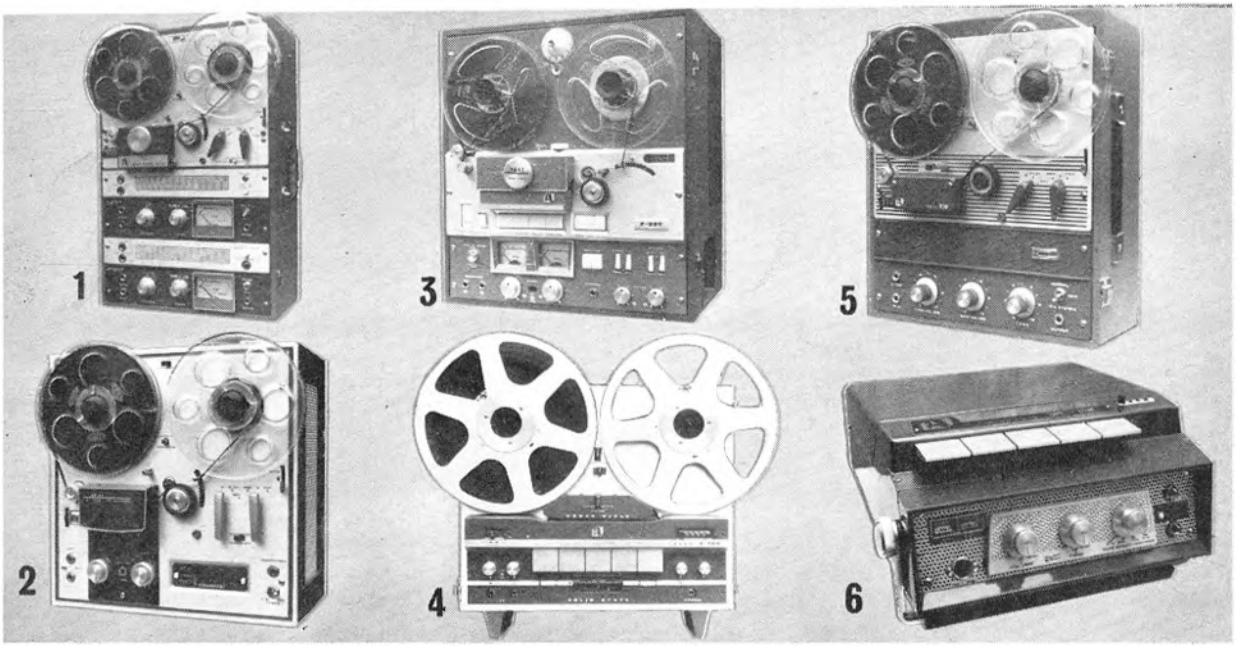
THE AKAI CENTRE





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A high quality 4-speed, 4-track stereo/mono recorder with Crossfield head. Vertical or horizontal operation. 4 hours stereo recording on 1200ft. standard tape. 2 stereo fill-in speakers. Sound-on-sound. 6 watts per channel. **136 gns.**

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4. AKAI X300
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5. AKAI 910
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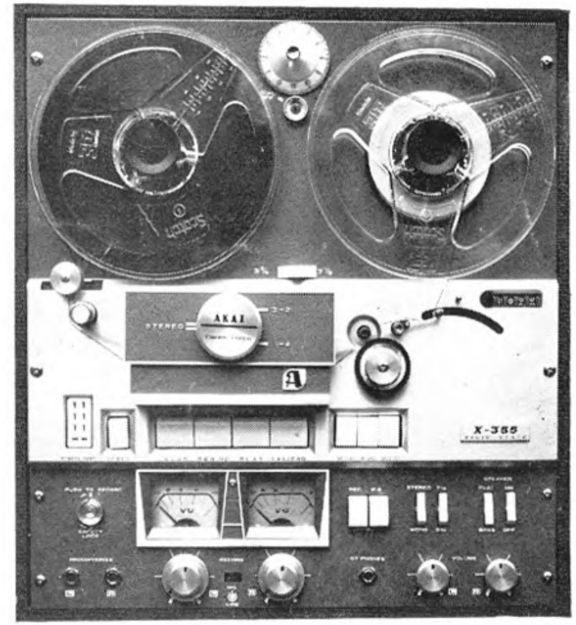
A fully transistorised stereo/mono, battery/mains portable recorder. 4 track; 4 speeds; Crossfield heads; superb low-speed frequency response. Mains-rechargeable battery. 5 in. reels. Weighs only 11.2 lbs. **131 gns.**



3. AKAI X355
A machine for the advanced amateur or professional, with 3 motors, 3 speeds, 4 heads (including Crossfield bias) and 20 watts per channel output. Fully solid state; push button solenoid operated controls, automatic reverse, repeat and shut-off functions. Built-in echo chamber effect. Full A.B. monitoring. Remote control facilities, etc., etc. **239 gns.**

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