FEBRUARY 1968 TWO SHILLINGS

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7" 1,800' ...	50/-	37/6
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10½" 4,200' Agfa only...	107/6	80/9

DOUBLE PLAY	APPROX. LIST PRICE	OUR PRICE
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3½" 400' Kodak only	17/-	12/9
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4½" 900' Agfa only...	35/6	26/8
5" 1,200'	42/-	31/6
5¾" 1,650' Kodak only	52/6	39/6
5¾" 1,800' Agfa only...	56/6	42/6
7" 2,400'	77/6	58/3
10" 4,600' Agfa only...	140/-	105/-

TRIPLE PLAY	APPROX. LIST PRICE	OUR PRICE
3" 450'	21/6	16/3
3½" 600' Kodak only	27/6	20/9
4" 900'	38/6	29/-
4½" 1,200' Agfa only...	47/6	35/9
5" 1,800'	65/6	49/3
5¾" 2,400'	90/-	67/6
7" 3,600'	115/-	86/3

STANDARD PLAY	APPROX. LIST PRICE	OUR PRICE
5" 600' } 5¾" 900' } 7" 1,200' } Kodak only	18/-	13/6
	24/6	18/6
	30/6	22/6
QUADRUPLE PLAY		
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	58/6	44/-

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5¾" 900'	28/-	22/6
7" 1,200'	35/-	28/-
LONG PLAY		
3" 210'	9/-	7/3
4" 450'	14/6	11/8
4½" 600' BASF	21/-	16/10
*5" 900'	28/-	22/6
*5¾" 1,200'	35/-	28/-
*7" 1,800'	50/-	40/-
8½" 2,400' } BASF	72/6	58/-
10" 3,600' } Only	95/-	76/-
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4½" 900' BASF	30/-	24/-
5" 1,200'	42/-	33/8
*5¾" 1,800'	55/6	44/6
*7" 2,400'	77/6	62/-
TRIPLE PLAY		
3" 450'	22/-	17/8
4" 900'	39/-	31/3
*4½" 1,200' BASF	49/-	39/3
5" 1,800'	66/-	52/10
5¾" 2,400' } BASF	90/-	72/-
7" 3,600' } Only	115/-	92/-

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SCOTCH

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5" 600'	20/6	16/4
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3" 300'	9/6	7/6
4" 450'	14/6	11/8
5" 900'	27/6	22/-
5¾" 1,200'	34/6	27/6
7" 1,800'	49/-	39/-
8½" 2,400'	72/6	58/-
STANDARD (ACETATE)		
5¾" 850'	24/6	19/6
7" 1,200'	30/-	24/-

DOUBLE PLAY	LIST PRICE	OUR PRICE
3" 400'	16/6	13/2
4" 600'	24/6	19/6
5" 1,200'	41/9	33/6
5¾" 1,800'	55/-	44/-
7" 2,400'	76/6	61/-
TRIPLE PLAY		
3" 600'	24/9	19/6
4" 900'	38/6	30/6
DYNARANGE (L/P)		
5" 900'	32/3	25/10
5¾" 1,200'	40/6	32/6
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A large purchase from TWO world renowned manufacturers enables us to make this unique half-price offer. Brand new, fully guaranteed, premium grade Polyester Base Tape with FULL LEADER and stop foil. In original maker's box and Polythene wrapped at these EXCEPTIONALLY LOW PRICES!

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900' on 4" reel GEVASONOR	39/-	24/6	72/-	140/-
2,400' on 5¾" reel ZONAL	90/-	55/6	165/-	324/-

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ILFORD TAPE NEAR HALF PRICE

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

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1,800' on 7" reel.	List price 50/-	32/6	95/-	180/-

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FERROGRAPH TAPE—20% OFF!

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		ONE	THREE	SIX
BN.7 1,200' on 7" reel (Dynarange).	List price 50/-	40/-	117/6	230/-
BN.8 1,800' on 8½" reel (Dynarange).	List price 71/-	57/-	168/-	330/-
BL.7 1,800' on 7" reel (Dynarange).	List price 70/-	56/-	165/-	324/-
BL.8 2,400' on 8½" reel (Dynarange).	List price 90/-	72/-	213/-	420/-

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Tape Head Demagnetiser, essential for any enthusiast! Ready for immediate use. Fully guaranteed. Worth 50/- ... ... **Only 27/6** P. & P. 2/-
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International Polyester Tape, 2,400' 7" reel (boxed) ... **Only 25/-** P. & P. 2/-
Bib Tape-Head Maintenance Kit ... ... **12/6** P. & P. 2/-
Colton Tape/Book Rack ... ... **22/6** P. & P. 2/-

20% OFF ALL GRUNDIG AND PHILIPS EQUIPMENT

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541-12	1150′ L/P 5¾″ reel	33/6	25/6	74/-	144/-
541-18	1800′ L/P 7″ reel	45/-	29/6	86/-	166/-
551-12	1200′ D/P 5″ reel	42/-	31/6	92/-	180/-
551-16	1650′ D/P 5¾″ reel	56/-	39/6	116/-	226/-
551-24	2400′ D/P 7″ reel	72/6	49/6	145/-	284/-

"600" SERIES PROFESSIONAL AUDIO TAPE (MYLAR BASE)

641-9	900′ L/P 5″ reel	30/6	23/-	66/6	127/6
641-18	1800′ L/P 7″ reel	52/6	39/6	116/-	226/-
651-12	1200′ D/P 5″ reel	46/-	34/6	101/-	197/-
651-24	2400′ D/P 7″ reel	80/-	60/-	177/-	348/-

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N.B. Other types and sizes available including the inexpensive "White Box" series.

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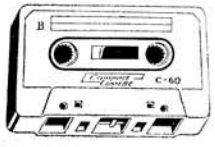

"MC 60"

Compact cassettes with 60 mins. playing time. Brand New and packed in normal plastic Library Box—available at this exceptional price.

Normally 17/6 **OUR PRICE 12/-**

3 for 35/-
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Standard Pattern to fit Philips, Stella, Elizabethan, Dansette, Sanyo, etc.

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A Special Offer of this famous Premium Grade Tape. Brand new, boxed with full leader, stop foil and "Polythene sealed". Multiples of three 4″ D/P 600′ size can be supplied in the BASF 3 compartment plastic library cassettes at no extra cost.

TYPE	DESCRIPTION	LIST PRICE	ONE	THREE	SIX
LGS26	600′ D/P 4″ reel	25/-	17/-	49/-	93/-
LGS26	1,200′ D/P 5″ reel	42/-	29/6	86/-	166/-
LGS26	1,800′ D/P 5¾″ reel	55/-	38/6	112/6	219/-
LGS26	2,400′ D/P 7″ reel	77/6	49/6	145/6	285/-
PES18	900′ T/P 4″ reel	39/-	27/6	80/-	154/-
PES18	1,200′ T/P 4½″ reel	49/-	34/6	101/-	196/-
PES18	1,800′ T/P 5″ reel	66/-	47/6	139/6	273/-
PES18	2,400′ T/P 5¾″ reel	90/-	63/-	186/-	365/-

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AGFA TAPE—HALF PRICE!

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

TYPE	DESCRIPTION	LIST PRICE	ONE	THREE	SIX
PE21	1,200′ S/P 7″ reel	35/-	19/6	55/6	105/-
	Also available at substantial reductions.				
PE31	1,200′ L/P 5¾″ reel	35/-	24/6	71/-	137/-
PE31	1,800′ L/P 7″ reel	50/-	32/6	95/-	180/-

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I enclose my remittance for Total £.....

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(Print Please)

February 1968

Upgrade your recordings to full professional standards

The EMI L4 is down in price!

The EMI L4 is the *professional* portable tape recorder used worldwide by Broadcast and Film Engineers. But you don't need to envy the professionals. With price reductions on all models, professional quality recordings become a practical reality for the enthusiast.

Here are a few of the advanced features:

■ Weighs only 10¾lb complete with re-chargeable batteries ■ Frequency response at 7.5″ p.s. ±2dB from 50 c/s to 12 Kc/s ■ Tape speeds 7½″ and 3¾″ p.s. ■ Signal to noise ratio better than 50 dB unweighted ■ Two microphone inputs with separate gain controls ■ Separate record and replay amplifiers.

NEW PRICES (including protective carrying case)

MODEL L4 A (½ track) **£120**

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Nu-Sound Limited, 82 High Holborn, WC2
242-244 Pentonville Road, N1
222 Bishopsgate, EC2
205 High Street, North, E6
36 Lewisham High Street, SE16
2 Maryland Station, E15

ABERDEEN James Henderson, 377 Union St.
BRISTOL Audio-Bristol, Park Street Avenue
CAMBRIDGE University Audio, 1-2 Peas Hill
CARDIFF Sound Film Services, 27 Charles St.
CARLISLE Misons, Citadel Row
GLASGOW James Kerr & Co, 435 Sauchiehall St.
LEEDS Beckett Film Services, 46-48 The Headrow
LEICESTER Midland Camera Co, 106 Granby St.
NORWICH Suttons Pianos, 16-18 Exchange St.
OXFORD Horns, 6 South Parade
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Buy the new, improved range of Emitape. It makes everything sound so real—it's unbelievable! Insist on it for your tape recorder and enjoy the difference. And don't forget the new C60 Compact Cassette—a whole hour of playing time (30 mins per side) and the new C90 Compact Cassette—an hour and a half playing time (45 minutes per side). Ideally matched for all Compact Cassette Recorders. Packs of 6 include free rack for library storage.

88 STANDARD PLAY	100 DOUBLE PLAY
99 LONG PLAY	300 TRIPLE PLAY

EMI TAPE LIMITED HAYES MIDDLESEX ENGLAND

tape recorder

FEBRUARY 1968 VOLUME 10 NUMBER 2

INCORPORATING
SOUND AND CINE

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COVER PICTURE

Our cover photograph, this month, depicts a late stage in the assembly of Akai M8 recorders. Anthony Eden describes the Akai factory on page 76.

SUBSCRIPTION RATES

Annual subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 36s. and 38s. respectively. Overseas subscriptions are 38s. 6d. (U.S.A. $4.60) for *Tape Recorder* and 38s. (U.S.A. $4.60) for *Hi-Fi News*, from Link House Publications Ltd., Dingwall Avenue, Croydon, CR9 2TA.

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

SHOULD WE KEEP the Monarchy? Hardly a relevant subject for this journal, readers may think, but tenuously related to the business of (painful word) 'Continentalisation'.

Although fondness for patriotic pomp and circumstance has been diluted by improvements in the standard of education and a gradual widening of mental horizons, the mock splendours surrounding our noble British past are still considered a profitable magnet for holidaymakers from overseas. Yet Britain has other oddities to attract the foreign visitor: in addition to its social peculiarities, it is determinedly *different* in as many respects as are practically possible.

It measures its distances in *inches*, of which there are 12 in a *foot*, of which there are three in a *yard*, of which there are . . . pause for thought . . . 1,760 in a *mile*. In Britain, water freezes at the nice round figure of 32 degrees, and boils at 212. The British people purchase their food in *ounces*, of which there are 16 to a *pound*—not to be confused with *poundal* or *Pound*—112 pounds being a *hundred-weight* (or eight *stones*), hundred-weights being, in turn, 20 to the *ton*.

The water surrounding our island of mathematicians is measured in *pints*, two of these giving a *quart*, of which four make a *gallon;* not forgetting the *fluid ounce*, a happy mixture of state and weight.

These lunatic standards cost the British people time (nothing to be done about that) and money—24 *half-pennies* to the *shilling*, two-and-a-half shillings to the *half-crown*, and so on.

With the Decimalisation (another painful word) of our currency only a few years away, and an impending national change to Metric standards generally, *Tape Recorder* has elected to play its small part by publishing metric equivalents of speeds and dimensions in future articles. Some compromise will be necessary when, for example, contributors employ such expressions as "a few inches", but we shall be as thorough as common-sense permits. In due course, when 38.1, 19.1 and 9.5 cm/s (15, $7\frac{1}{2}$ and $3\frac{3}{4}$ i/s) have become familiar to readers and contributors, we shall move further towards the goal of complete Metric standardisation.

In the meantime, there is news of progress in other directions. Two major British manufacturers are on the verge of announcing completely new semi-professional recorders, and both have assured us that the next Audio Fair will be well worth attending. From what we have seen of one and heard of the other, these may well prove to be the first of a long-awaited new generation—modern equipment, competently styled and capable of equalling, if not out-performing, Swiss, Scandinavian and German designs. Full solenoid mode selection, twin peak-programme meters, consistently low wobble, three heads, three speeds, and a price tag of under £120; all are promised by a comparatively small but well-known and respected British manufacturer for a high-quality stereo tape recorder. There are whispers, too of a British helical-scan domestic video recorder to compete with the Sony.

While writing in whispers of such encouraging developments, we regrettably have to mention a less pleasant one. Exactly five years ago a combination of increases in the cost of producing *The Tape Recorder* (as it then was) finally forced the publisher to boost our selling price from 1s. 6d. to its present 2s. Since 1963, as readers will need no reminding, prices in every field of commerce have continued to ascend. In that five-year period the wheel has turned full circle and we are now obliged to follow the path taken earlier by our sister *Hi-Fi News* in raising the cover charge to 2s. 6d., with effect from the March issue. Printing and paper costs have risen, but in recent issues the space devoted to editorial material has also risen, giving an average of four pages more per month. We therefore hope that readers will bear with us; we shall, as always, endeavour to provide the highest quality-to-cost ratio of any journal in the tape recording field.

We'd like you to hear our latest number

It's the TK145 de luxe. And it's quite a tape recorder

Grundig have built quality into every inch of this four-track machine. Recording level adjustment is fully automatic, by means of the unique Grundig 'Magic Ear.' This ingenious device acts with split-second precision, and retains natural loudness variations *without distortion.* And when you want it, manual operation is yours at the click of a switch!

The TK145 de luxe has a frequency response of up to 12,500 Hz, Wow and flutter below ±0.2%, and a signal to noise ratio of 48 dB. Result? Clean, crisp, *life-size* reproduction.

What's more, you can make synchronised recordings by using the Monitoring Amplifier MA2, and the Earphones type SE3, both available as extras.

There are connecting sockets for recording/playback, monitor headphones and switchable extension loudspeaker. There's even a press-button reset for the position indicator! And—to guarantee cool operation over long periods of playing and recording, the TK145 de luxe has the exclusive Grundig single-unit combination of motor and mains transformer.

The uncrushable steel chassis is elegant in teak finish, with Silver G-line grille. The TK145 de luxe comes with 1,200 ft. of tape and a high-quality dynamic microphone . . . all that for just 46 gns! Like to hear more? Then send off the coupon *today* for full details of all ten Grundig 2 and 4 track tape recorders ranging in price from under 33 gns. to 147 gns.

To: Grundig (G.B.) Ltd., Dept. TR4, London, S.E.26.

Please send me 'The Sound of Grundig' all-colour tape-recorder leaflet ☐ radio leaflet ☐ audio unit and stereogram leaflet ☐ *Tick which you require.*

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GRUNDIG

WORLD OF TAPE

TAPE RECORDER STATISTICS

TAPE recorder sales statistics are now being collated by the Ministry of Technology for the benefit of subscribing manufacturers and, although not particularly healthy, show that the relatively small number of British manufacturers are competing fairly successfully against a much larger number of overseas companies. Of 75,053 recorders delivered to retailers in the first quarter of 1967, 48,055 were imported while the remaining 26,998 were of British manufacture. In the second quarter, 45,713 units were imported against 27,670 home-produced models. Total values were £1,344,000 and £1,354,000 for the first and second quarters respectively. Since these figures include imported 'toy' recorders, however, the comparative values of imported and home-produced equipment are rather less depressing. Deliveries of British recorders in the first quarter were valued at £552,000, while the imported machines were £822,000. In the second quarter, the imbalance reduced to £570,000 (home-produced) against £784,000 (imported).

The latest figures available at the time of writing refer to August 1967, when 11,530 British recorders (worth £227,906), and 14,968 imported models (worth £239,166), were delivered.

NAGRA AGENCY RE-ESTABLISHED

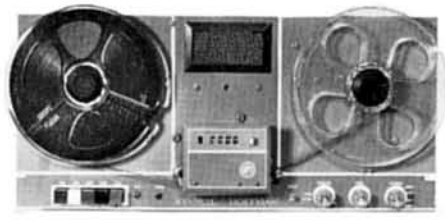
FOLLOWING the demise of *Livingston Laboratories*, distribution and servicing of *Kudelski* battery recording equipment has been taken up by *Hayden Laboratories Ltd.*, East House, Chiltern Avenue, Amersham, Buckinghamshire. Factory-trained staff are now undertaking servicing during and after the 12-month guarantee period.

MORE STUDIO CARTRIDGES

THE range of studio cartridge recorders produced for professional users by the Italian *Appel* company, described recently, now has a competitor in the shape of a *Plessey* unit. Developed in Australia, the *CT80* was inspired by the 'talking chair' equipment designed by the company for *Expo 67*. Rack, desk and flush-mounted versions of the player, with or without recording facilities, are now being produced for broadcasting and industrial communication applications. Of particular interest is the 'trip cue' facility, available with all models, with which a recorded cue tone may be employed to actuate a relay—starting a separate tape mechanism, projector, or activating warning lights. Each unit accepts endless-loop cartridges of 7, 5 or 3 in. (17.8, 12.7 or 7.6 cm.) width. Overall dimensions of the illustrated desk-top version are 7⅜ high x 12½ wide x 11½in. deep (18.7 x 31.8 x 29.3cm.).

GRUNDIG TO FORM ACCESSORY DIVISION

FOLLOWING a survey of consumer and industrial audio markets, *Grundig* (*Great Britain*) are forming a new division to meet an apparently large demand for audio accessories. According to the survey, an average of £10 is spent on each £40 tape recorder for additional loudspeakers, mixers, microphones and tape. Grundig plan to supply accessories for their own recorders and for those of competitive manufacture.



A NEW LOW ?

AN unusually versatile recording unit for studio, general audio, communications or industrial applications, has been developed in the USA by the *Stancil-Hoffman Corporation* of California. The *R.70* is a single-speed machine produced, to order, for operation at any standard speed between 7½ i/s (19.1 cm/s) and $\frac{15}{32}$ i/s (1.2 cm/s). Claimed wobble at the lowest speed is 0.5% RMS with 5% distortion at and below 1⅞ i/s (4.8 cm/s).

£50 VIDEO TAPE RECORDER

THE Japanese *Shiba Electric Company* are shortly to market in Japan a domestic video recorder for some £50. It will be in the form of a tape unit designed to record from and reproduce through a household television receiver. The price is said to include tape but no details are yet available regarding the recording system.

BALMAIN ON TAPE

'AUDIO Aspects of Magnetic Tape Performance' was the title of a lecture given by Graham Balmain, Quality Control Manager of *Mastertape* (*Magnetic*) *Ltd.* to the BKSTS on 29th November. The talk, which was illustrated with recorded examples, considered the limiting factors of magnetic tape with emphasis on background noise, distortion, modulation noise and dropout. The merits and demerits of using partial erasure to reduce print-through were also examined. Although print-through is of an alarming level on pulse and steady tone material, it is subjectively much less annoying on normal sound recordings.

NEXT MONTH

THE MARCH ISSUE of *Tape Recorder*, to be published on Wednesday, 14th February, will include a practical examination of sound mixer circuits by G. T. Rogers, advice by Philip Radford on recording sea birds, and a review of the *Grundig TK245*. Anthony Eden will describe a visit to the Japanese *Sony* company while, nearer home, H. W. Hellyer describes one English retailer's answer to the thorny problem of servicing.

LISTENING TO HOT AIR

RESEARCH into the acoustic properties of flames has proceeded in comparative obscurity since 1858, when John Leconte noted the effect of concert music on a gas flame. The most recent development, described in Vol. 216 of *Nature*, concerns the application of a welding torch or gas flame for music reproduction. W. R. Babcock, K. L. Baker and A. G. Cattaneo of the United Technology Centre, Sunnyvale, California, have achieved a "fine rendering" of Beethoven's Fifth Symphony from a Bunsen flame. Various methods of flame modulation have proved successful, the simplest comprising two DC-biased electrodes in an oxy-acetylene flame. The electrodes are connected through a transformer to an audio amplifier fed, in turn, from a tape recorder. The transformer achieves the high-voltage signal required to modulate the flame. John Leconte has been quoted as regarding "all jets as musically inclined". Perhaps tomorrow's *Concordes* will trail a pre-recorded sonic apologia behind their supersonic booms.

CARSTON TO HANDLE WHM METER

DISTRIBUTION of the *WHM Flutter-meter*, previously marketed direct by its manufacturer, is now being undertaken by *Carston Electronics Ltd., 71 Oakley Road, Chinnor, Oxfordshire*. The unit, which now sells at £51, is being extensively used by manufacturers, recording and film studios, and has been supplied to customers in Sweden, Cyprus, Germany and the USA.

BASTIN ON THE MOVE AGAIN

PETER Bastin, veteran producer of several successful BATRC tapes, has won the BBC North Region Tape Recording Competition *On the Move*. His contribution, a five-minute history of transport, followed the usual Bastin recipe of unlikely voice and sound effects supporting a particularly original rhyming commentary, with an equally lighthearted musical accompaniment. The tape was broadcast in full in Radio 4 on 20th December, along with a selection of extracts from among the 97 entries.

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3 **BEOVOX 3000.** Pressure chamber loudspeaker with separate bass, mid and high (x 2) frequency units. Variable attenuators to the mid and high frequency units. Provision for the connection of a separate high frequency diffuser unit (Beovox 2500). Maximum power handling capacity 50 watts music power, impedance 4 ohms. Solid Teak or Rosewood finish.

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5 **BEOGRAM 3000.** Transcription turntable unit fitted with the world famous B & O STL/15° tone arm, lowering device and a B & O SP7 stereo magnetic cartridge. Illuminated and magnified strobe. Mounted on solid Teak or Rosewood plinth and complete with plexiglass cover.

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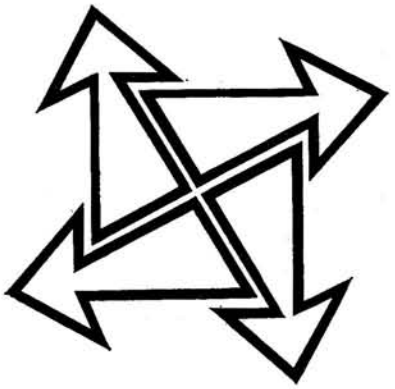


FOUR WAYS AHEAD

ERIC ROBJOHNS CONSIDERS THE VIRTUES OF FOUR-CHANNEL STEREO

READERS of *Hi-Fi, 2000 AD* in the October 1967 edition of *Hi-Fi News* may or may not agree with the idea of using the present-day four-track tape recording technique to provide a *four-channel* stereo system for the home. It is, however, a fact that such a system would have undoubted advantages over the relatively simple two-channel systems now in use; these advantages would benefit the hi-fi enthusiast and musician, and would more than nullify the disadvantages of increased cost and complexity that such systems would have. The four-channel system would be particularly advantageous in the cases of opera, musical shows, plays and recorded drama, oratorio and other religious works, and travel or feature programmes; but in the case of the straightforward symphony concert the advantages of this system would, perhaps, be less obvious. Today, this latter kind of programme material forms about 75-80% of the type of music enjoyed at home by hi-fi and tape recording enthusiasts, the balance being made up chiefly by popular music and opera. However, it is rather likely that the other kinds of material mentioned will be more in demand within the next decade or two, and therefore a four-channel stereo system would become advantageous.

This would only be practical with tape. Other programme sources, such as LP disc and VHF radio, could only provide a similar service at considerable expense and with appreciable technical complexities, such as the use of twin Multiplex transmitters in the case of VHF radio and twin stereo-grooves in the case of discs. With ¼-track tapes, however, a four-channel system would, at least in theory, be possible even today. A four-channel tape machine need not cost more than a third to a half as much again as a two-channel model of the same comparative quality; if such a machine incorporated its own power-amplifiers, the only extra equipment an average enthusiast would have to purchase would be a couple of extra loudspeakers of the same type as those already in use. The tape-recorder could then become the 'front-end' of the hi-fi system and could be provided with twin-channel inputs for disc and VHF tuner.

What are the chances of a four-channel tape system being adopted in the near future?

At first sight, there might seem to be a good chance. If the demand for recordings of the musical and dramatic types mentioned earlier increases, as I feel it will over the next decade or two, four-channel stereo could well become a reality.

It can be said that two-channel stereo has a 100% advantage over mono, and that three-channel stereo would give a further 50% improvement over two-channel stereo. The addition of a fourth channel would, however, only give a 25% improvement over three channels. Thus one need not go beyond four-channel stereo to secure an 'audible ultimate' in stereophonic sound recording and reproduction; although this ultimate would, in theory, require an infinite number of channels, in practice it would not be necessary to go beyond four (except in cinemas, where very wide-screen systems demand a greater number). Indeed, many people, perhaps even the majority of hi-fi enthusiasts, believe that two-channel stereo will prove to be the ultimate in stereo reproduction, at least in the home!

Present-day ¼-track commercial tapes are made by high-speed copying techniques, the twin-stereo copies being made from a 15 i/s (38.1 cm/s) four-channel twin-stereo master tape, using four-channel copying equipment. Master tapes are often recorded via a four-channel system, the four channels being later balanced and mixed to give a satisfactory two-channel output when the final disc or tape transfer is made. Similar methods would be involved in the manufacture of four-channel stereo tapes, the only difference being that the resulting four-channel product would play for only half the total time of a standard stereo tape at the same speed and for the same size of spool and type of tape. The cost of such four-channel recordings need be no higher than that of present-day stereo tape records.

The advent of domestic four-channel tape reproduction would undoubtedly help the tape medium to compete more successfully with the LP disc and VHF radio, and might make the tape medium the leading programme source for sound reproduction in the home. However, the adoption of a four-channel system would raise many problems, particularly for the recording studios. The microphone balance would, of course, have to be fully compatible with the standard two-channel balance so that a good performance would be obtained from the normal two-channel LP discs and pre-recorded tapes, which would have to be issued together with the main four-channel products. In fact, even if four-channel recordings were introduced, LP discs would still form the primary output for a good few years.

Two distinct types of four-channel stereo recordings could be made available, these being largely dependent on the kind of presentation which is required at home. The first type would be eminently suitable for such material as stage-plays, musical shows, opera, oratorio, symphonies and chamber music. For these, the loudspeaker arrangement in the listening-room would, superficially at any rate, resemble that of the stereophonic sound systems used in cinemas. Three channels—and three loudspeakers—would be used for the main 'body' of the recorded material, these emanating from in front of the listener as in normal practice today (**fig. 1**). The centre-channel loudspeaker would be placed directly in front of the listeners, and the two other loudspeakers would be placed at either side of the centre, as in normal stereo practice today The fourth channel would be used to highlight dramatic effects, and would not be in use all the time; the loudspeaker reproducing sound from this channel would be placed *behind* the listener.

Clearly, such an arrangement would need a fairly large room, and the listener would have to be seated a reasonable distance away from all the loudspeakers concerned. This would be basically a 'three-channel' system, with the provision of a fourth channel for special effects, such as applause, thunder, gunfire, or any special sounds relevant to the main recorded material, or perhaps even recorded ambience.

Such a system would possess advantages over the existing two-channel system in that the usable 'stereo listening area' would be wider, and the stereo images produced would suffer less from a 'hole in the middle'. It could happen, of course, that improvements in the normal two-channel system would nullify these advantages in the years to come; loudspeakers, in particular, may be developed that give a sharp central image and crisp stereo definition which does not depend on the listener's position in the room to anything like the same extent as it does today. Experimental electrostatic loudspeakers have already been developed which secure this condition and which tend to obviate any need for a centre channel.

The other kind of four-channel stereo recording, however, would not be so greatly influenced by such developments in loudspeaker design, this being a recording intended for reproduction via loudspeakers placed at each corner of the listening room, with the listener seated in the centre of the room so as either to face one loudspeaker (**fig. 2**) or to face the wall between two particular speakers (**fig. 3**). The effect in both cases would be to surround the listener to a greater or lesser extent with sound. Such an arrangement would be particularly suitable for recorded drama or travel and documentary

(*continued overleaf*)

GETTING THE EVIDENCE TAPED

BY LORNA GULSTON

NOWADAYS the Law, traditional stronghold of ancient routine, has really come to grips with the age of automation. Judges, who for centuries depended on their own notes and those of court shorthand-writers, now have the complete trial literally at their fingertips by the push of a button.

When tape recorders were first used for reporting court proceedings about ten years ago there were many snags. No machine then on the market could cope with all the demands that would have been made of it—long hard running, outsize tape-spools, perfectly intelligible reception of sound from anywhere in the court, and sturdy reliability. Several firms designed prototypes geared to these special needs and at last a cumbersome but acceptable mongrel was devised, fed from omni-directional microphones fixed at key points—on the judge's bench, witness box, counsel's table; dangling overhead like grapes on thick wire vines. It was weird but it worked.

Among the pioneers in the tape field was The Royal Courts of Justice in Belfast, Northern Ireland, where one of the first cases recorded turned out to be a marathon affair of nine double-track 1800 ft. tapes. There was no typist trained for this new kind of work, but a brave volunteer from the typing pool agreed to 'have a go'. Using an ordinary domestic *Grundig* recorder with foot-pedal stop/start/reverse control, she went into isolation in a little room specially cleared for her. It was a tough assignment. Part of the tapes were imperfectly recorded, so that she had to lay her ear against the machine to hear them, tormented by a deafening electronic hum. Local dialects and soft-voiced witnesses complicated the issue further, while coughs, sneezes, dropped books and shuffling feet threatened to wipe out whole phrases. When, after almost six months of dogged slogging, the weary typist tapped out the very last word, the transcript would have filled two average-length novels.

Gruelling though the job had been, the end-product was a remarkably faithful reproduction of pretty well every word spoken at the trial, banishing for ever disputes that the judge could not read his own writing or the shorthand-writer had muffled an outline.

More tapes were made and transcribed but it was still uphill work. Unfamiliar technical or medical terms had to be jotted down phonetically and checked later in reference books, while distortion, indistinctness or background noise was a perpetual problem. Mechanical failure, common in the early experimental machines, often could not be detected until playback revealed stretches of blank or faulty recording, when all that could be done was to fill up the gaps from the Judge's notebook.

Despite difficulties and delays, however, it soon became plain that tape-recording *worked*, and had come to stay.

By the 1960s equipment and techniques had made great strides forward. Today, courts are not bristling with obvious gadgets to frighten a mike-shy witness. Instead, tiny, highly-sensitive microphones on concealed wiring are scarcely noticeable against the woodwork of tables and benches, and halter microphones are under discussion.

The clumsy guinea-pig machines have been replaced by ¼-track *Truvox* models, carrying a 7 in. (18 cm.) spool at 1⅞ i/s (4.8 cm/s) with a monitoring device so that the operator can hear through his headphones what is actually registering on the tape.

The transcription model is a *Uher* from which the case is typed, phrase by phrase, straight on to wax stencils, with a carbon copy for the judge to check. To help her find her way about the transcript, the typist receives a proforma setting out the sequence of speakers—a far cry from the primitive days of luck, guesswork and knowledge of counsel's voices. Used in conjunction with the tape position indicator, any recorded item can quickly be pinpointed.

When the carbon copy of the finished transcript has been approved and signed by the judge, any number of trial reports can be duplicated off for solicitors or other interested parties. Meanwhile, transcribed tapes are erased and re-used.

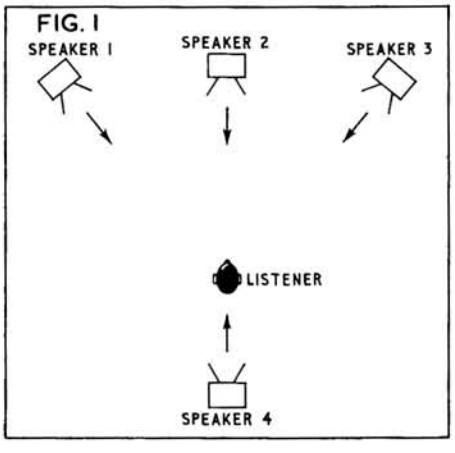
Now that the Court shorthand-writer is slipping into the shade, will automation extend its tentacles wider? With the rise in judges' salaries, will *they* eventually become an uneconomic proposition?

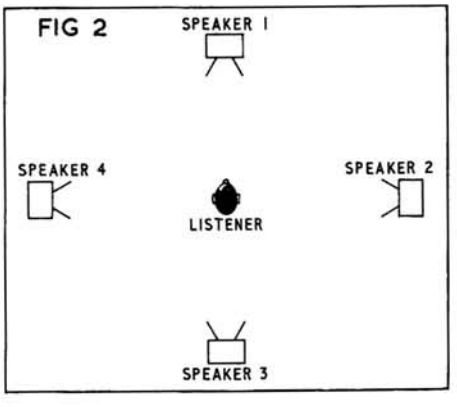
Who knows, we may even advance to a stage where judge and jury are replaced by a computer which digests the taped evidence played over to it, and pronounces a verdict of appeal-proof scientific justice in a tape-tongued, metallic whine!

FOUR WAYS AHEAD CONTINUED

programmes, in which the listener could be projected right into the centre of the 'action' taking place on the recording.

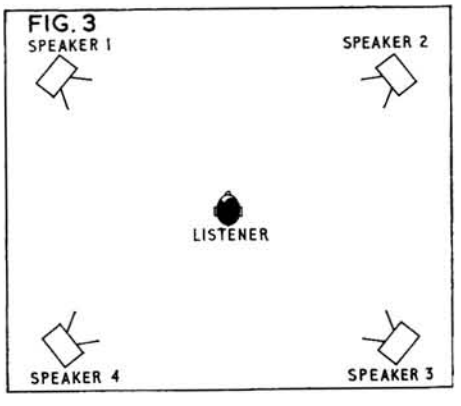
It is with this type of material and set-up that four-channel stereo will probably make its debut and which would make the best headway if it is ever introduced. Its disadvantage is that, like normal two-channel stereo, the optional





listening area would be small and, in addition, would be sited in the centre of the listening-room, which may be impracticable in many households. Many people may be aghast at the thought of being completely surrounded by sound, or may consider the system a 'gimmick' and not worth the extra expense it would involve, or both. However, this could form a very effective type of entertainment in the future, and would certainly involve a completely different concept of stereo recording at the studio.

Whether four-channel stereo is introduced depends on many factors, not the least of these being financial, and, of course, on the answer to the 64-dollar-question: *do we want it?* A minority of enthusiasts would probably say *yes*, and some would be undecided either way; but probably more than half would say that, for the present at any rate, they are content with the conventional two-channel stereo system as available from LP discs and VHF radio in addition to the relatively expensive tape records. (*continued on page 93*)



READERS' PROBLEMS

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

SYNCHRONISING WITH SLIDES

Dear Sir, I should like to know what apparatus would be required to synchronise my *Cossor 1602* ¼-track tape recorder with a remote-controlled slide projector.

Yours faithfully, **S.R.B , Wednesbury.**

The normal method of achieving full synchronisation between tape and slide projector is to record a sound pulse on the unused track of a ¼-track recorder, using the amplifier current to trip the relay within the projector. This requires a synchroniser of the type manufactured by Philips. The EL3769 is a three-transistor device, separately powered, using an impulse frequency of 700 Hz and ½ to 1½ seconds duration.

SUPPRESSING INTERFERENCE

Dear Sir, I would like to know if there is any means of suppressing switch clicks other than fitting suppressors to every switch in the house. Every click is faithfully recorded on my tape equipment and is quite audible when replayed. One of the worst offenders is the refrigerator, which is thermostatically controlled. *Yours faithfully*, **L.F.G , Keighley**

Interference suppression is only effectively carried out at the source. It may be possible to reduce its effect by ensuring that your tape recorder and associated equipment is properly earthed. If it is possible to run a separate heavy lead to a good earth, and not necessarily the 'third pin' of the mains system, this is the first test. Although mains earths conform to regulations (we hope) as regards safety, this does not mean that they are an effective return path for the RF and AF signals in which we are interested.

You can try the effect of a suppressor filter at the point of mains entry to the tape recorder. This can consist of a pair of paper capacitors—good quality types of 1,000 V working are recommended—from each pole of the mains to chassis (earth) and as near the point of entry as possible. Across the sections of the double-pole switch is as good a place as any.

The refrigerator is a real problem, and you must be careful not to upset the action of the thermostat, but a 0.1 μF capacitor in series with a 100-ohm resistor, across the actual switch contacts (i.e., at the connector block which you will usually find tucked away at the rear) will generally do the trick.

Lighting circuits are a different problem, for the interference is often radiated from what is in effect the good 'aerial' of the wiring, which encompasses the whole building. Again, you can try suppression at the switches, but this is a big job, and not to be recommended. We may point out that some types of switch are prone to sparking, having wiper blade contacts rather than the spring-loaded snap action of modern types.

If you try the foregoing, beginning with the earthing, some improvement should be effected.

REPLACING A METER

Dear Sir, I have a *Fidelity Playmaster Major 4* tape recorder. About a month ago I did a stupid thing and dropped a large screwdriver on the top plastic panel, whereupon the meter ceased to function. On enquiry at a tape recorder dealer in Bradford I was told that a replacement from Fidelity could cost up to £4. My pocket does not run to this much so I wonder if you could suggest a cheaper alternative. *Yours faithfully*, **G.T.T., Keighley.**

Bad luck! Having done our share of 'stupid things', we sympathise with you.

You can replace the meter of your Fidelity Playmaster with any suitable 0-1 mA f.s.d. meter, preferably one with a well-damped movement. This may cost you only a few shillings, but, if you want one with a fancy scale, or are willing to go to a good edge type, it could cost as much as £2 10s. The quote for £4 for repairs may have been realistic, knowing that a simple meter replacement is seldom the end of the affair, but if the local shop quoted this much for a replacement meter from Fidelity, they are giving you a bit of a ride.

You can regulate the overload level by altering the 50 K resistor from the anode of the ECL82 triode to limit the current. There is no great stringency about this.

Incidentally, a very attractive replacement for this meter, as well as being a good movement, is the Wessex 38320 type, scaled in decibels, as used in the Magnavox 840 tape recorder.

NO PAUSE ON A TK41

Dear Sir, I have a *Grundig TK.41* recorder which has developed two annoying faults. The pause control no longer halts the tape and the erase head seems to function only occasionally. I should be grateful for your advice as it is difficult to get Grundigs serviced in this area. *Yours faithfully*, **A.R.P.B., Slough.**

The two faults you describe may have a common origin, i.e., uneven tape transport which originates from irregular head gate pressure. This is really because of the design, deliberately finely sprung to allow inching, which is possible by judicious use of the fast-wind facility.

However, the result has been to allow tape 'creep' in neutral and erratic pause control action—with a possibility of snatching occasionally—the intermittent erasing you describe. The remedy I have found is a light tension spring (one of the Grundig valve-retainer springs is ideal for the purpose) between the cut-out in the angled bracket just in front of the pressure arm and the leaf bracket that takes the head pressure sling. If you look for the sort of square 'C' cut out and fit the spring to run forward from the front right edge of this to a point roughly between the heads, this should do the trick.

Check the pressure spring and make sure the flock is intact on its inner surface. I have had TK41, TK46 and TM45 recorders in with complaints of dropouts (and similar models with this long sling) and in many cases it is because enthusiastic head cleaning with methylated spirit or other substances has removed the flock from the tape, leaving a lovely clear plastic which looks nice but does not bear hard enough against the outer side of the tape.

Another trouble with these decks is poor fast-wind, and in this case it is usually the pivot of the bracket to the left side of the central sliding arm, on which the fast rewind wheel is mounted.

FAULTY WINDING ON AN EL3541/15K

Dear Sir, Would you please advise me as to the cause and cure of a fault which has developed on my *Philips EL3514/15K* recorder? The tape fast-winds loosely and very unevenly, more so on rewind than fast-forward. It is not too bad when taking-up during replay. I have a maintenance manual.

Yours faithfully, **B.W.K., Fareham.**

The Philips EL3541 has a drive arrangement, as you will note from your manual, which depends on the clutch action of both spools being derived from the common belt travel. On rewind, the balance between the spools is achieved by the weight of greater or less tape loading upon the gravity clutches.

First step is to ensure that the belt is not slack. The usual cause of this common fault is heat and age, and a slightly stretched belt should be changed. Check that, when running, the bracket bearing the belt pulley is at least 5mm. clear of the chassis edge. If the belt is in order, check the clutch disc facings, clean well with methylated spirit and also clean the felts on the underside of the carriers.

To remove the carriers, you need only push the brake lever back slightly, and they lift off. When removing the discs and replacing, check the nylon washers between the disc and spindle step. A little grease at this point helps. This lubrication assists the clutch action and thus the back-tension. Finally, check that the Vulcanan plugs in the drums are not worn to small flats. If they are, you will need to change them.

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STR-1 SPECIFICATION: Tape Speeds: 7½, 3¾ and 1⅞ ips. **Wow and Flutter:** Better than 0.15% rms on 7½ ips ; 0.25% rms on 3¾ ips. 0.35% rms on 1⅞" ips. **Tape Size:** ¼" wide, Long or Standard play. **Reel Size:** Standard, up to 7"/5¾" spools and tape supplied. **Digital Counter:** 3 digit counter with zero reset. **Heads:** ¼ track erase record and playback. **Microphone:** Moving coil hand microphone (mono) supplied. **Semi-Conductor complement:** 18 transistor, 1 silicon bridge rectifier. **Frequency Response:** 3dB, 40 c/s to 18 Kc/s at 7½ ips. 3dB, 40 c/s to 12 Kc/s at 3¾ ips. 3dB, 40 c/s to 7½ Kc/s at 1⅞ ips. **Signal to noise ratio (unweighted):** Better than 40dB. **Inputs per channel:** Microphone 0.35mV. Auxiliary 50mV. **Outputs per channel:** 4 watts rms into 15 ohms. 1 volt rms (1,000 ohm source). **Speakers:** Two, high efficiency 8" x 5" pm 15 ohms. **Power requirements:** 200-250V AC, 50 c/s, 60 watts. **Cabinet:** Materials, 9mm. plywood covered with two tone Rexine with chrome fittings. **Dimensions:** 19½" wide x 7⅞" high x 15½" deep.

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SRP-1 SPECIFICATION: Amplifier Frequency Response: 3dB, 50 c/s to 12 Kc/s. **Power Output per channel (rms rating):** 1.5 watts. **Music power output (total):** 4.5 watts. **Controls:** Volume, Balance, Tone. **Speakers:** 8" x 5" permanent magnet, 15 ohm. **Transistor and Diode Complement:** 2-BC108 ; 4-AC128 ; 2-AC176 ; 1 silicon diode. **Record Changer: Type:** Model UA 15 SS. **Controls:** Mode : Off, Manual on, Reject, Speed : 16, 33, 45 and 78 rpm. **Record Size:** 12" 10" and 7". **Cartridge:** Stereophonic crystal, LP and 78 turnover sapphire stylus. **General: Power requirements:** 220-250 volts, 50 c/s AC, 30 watts. **Dimensions,** overall, with separate speaker enclosure in place 27" wide x 14⅜" high x 7½" deep.

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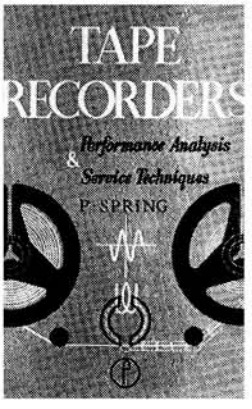
BOOK REVIEWS



TAPE RECORDERS
By P. Spring. 207 pages. 144 line illustrations, 27 half-tones. Price 42s. Published by *Focal Press Ltd.*, 31 Fitzroy Square, London, W.1.

TAPE recorder bibliography is pitifully small, despite the 'guides' and 'operating manuals' which the more ambitious manufacturers have seen fit to produce. Apart from the incomparable Spratt, McWilliams' book by the same publishers as the volume under review, and perhaps Westcott & Dubbe's book with an unmistakable transatlantic bias, there has been no authoritative volume on the subject for a decade. Those that have attempted the task have either fallen short on grounds of outdated information or wasted precious pages on fundamental theory of sound and magnetism before getting to the hard core of practice.

Mr. Spring does not make this mistake. He states in his introduction that the book is aimed at the engineer, or at least, those who already possess enough grasp of the basic laws to tackle the job of tape recorder maintenance. He asserts unequivocally that books written specifically for the amateur with some technical knowledge (a dangerous combination—his phrase, not mine!) are many, but those for the service technician are few. Certainly, he is well qualified to write such a book. Involved in magnetic recording for nearly 20 years, Paul Spring has spent much of his working life as Chief Engineer in London for the giant *Grundig* company. He is at present the Technical Director of *Grundig (Great Britain) Ltd.* Those who know him are aware that he is a convincing and erudite speaker on the subject of tape recording; his book does not disgrace him.

Although the author is 'tied' to a company, and preaches some of the philosophy that, right or wrong, his company has developed, he does not completely overlook the designs and methods of other people. Examples of *Philips*, *Ferrograph* and *Akai* circuits can be found at random. In all cases, he is concerned to illustrate a principle and uses, obviously, the source he knows best. Beginning with a nod towards theory, two chapters on sound and its measurement, short and to the point, he introduces magnetic recording properly in a very good third chapter. Chapter Four, on frequency compensation, overcomes the usual tedium of this subject by leading up to the standards and describing the way they are obtained and the reason they are needed, and finally illustrating their use by giving specimen feedback circuits and describing the functions of the vital components.

After a short chapter on Dropout, we come to the important part, Chapter Six, 'The Basic Mechanism'. Allied to Chapter Eight on mechanical tests and adjustments, this section should be obligatory reading for the service department. As, indeed, should the chapters on electrical tests and measurements. But succeeding chapters which deal with sockets and standards and with impedance matching could well have been expanded to cover the general field. This is where company philosophy falls down. Most of us who read *Tape Recorder* know that interconnection can be one of the biggest bugbears, and it is not always possible to link up disparate pieces of equipment with one of the (rather expensive) 'matching leads' that the large firms market specifically for their own range of products.

The chapter on 'Effects and Special Purpose Recordings' includes a description of the *Sona-Dia* method of projector synchronising that will interest many readers and the one dealing with automatic level adjustment is not unnecessarily involved. We were glad to note that Mr. Spring suppressed the temptation to use the copywriter's phrase, 'Magic Ear'.

Chapter 13 concerns brushless DC motors, and contains some interesting illustrations. We were glad to note the author's wry humour led him to comment: " . . . many potential users of battery-operated machines believe that simply because such instruments can run on ordinary torch batteries, they must therefore be far less expensive than more conventional recorders and at least as reliable." Service engineers may be permitted a sympathetic cheer, plus the observation that repairs to the little 'uns can often be more time consuming than on more conventional machines.

Chapter 14 has a look at crossfield bias, rather perfunctorily, and the next two pages are given to the subject of cassette recorders. Here again, much more space could have been devoted, and at least a few examples of cassettes shown and described. Like it or not, the cassette, and (St. Cecilia defend us) the cartridge, are going to be with us until someone invents a transportless recorder. Finally, a chapter which is a kind of summary of dimensions and values leads us to an appendix of tables and a useful index.

I like particularly the odd italicised phrase that sums up principal points, and the excellent subject layout. A well-organised, useful book that can be thoroughly recommended.

H.W.H.

FUN WITH TAPE. By Joachim G. Staab. 258 pages, 25 line illustrations. Price 21s. (paperback). Published by *Focal Press Ltd.*, 31 Fitzroy Square, London, W.1.

THE advent of a new book on tape recording is very welcome, although I found the title a little off-putting! I expected dubious suggestions of microphones hidden in table lamps, or vases of flowers, to trap the unwary visitor. A better translation of its German title might have been "Pleasure with Tape". In spite of other difficulties in translation, Mr. Staab's enthusiasm and obvious wide knowledge of tape recording comes through very well. In some 240 closely packed pages, he takes us through all the possibilities and potentialities of tape as a medium for self-expression. He starts with a basic description of the workings of a tape recorder and ends with the sub-title "The Future is already here", a reference to video tape recording.

The non-technical need have no fear since the book is written in a very straightforward style and there are no circuit diagrams to frustrate the uninitiated. It is, if anything, very light on illustrations, although the 2 dozen or so which are produced, are models of clarity.

UNUSUAL METHOD

The chapter on reportage, interview and conversation, suggests a rather unusual method of learning the basic question and answer technique. Mr. Staab recommends using an already recorded speech, perhaps a well-known politician. Having dubbed it on to tape and studied it closely, the game is to interpolate one's own questions, edit the answers and endeavour to end up with a believable interview. This is a new idea to me—but certainly it has its possibilities. At least one could choose an expert in oratory to practise upon!

Microphones are treated in a cursory manner in the early pages, and there is rather too much generalisation of the "there are, of course, expensive microphones and cheap ones" style. Later, under the Chapter on "Quality Musical Recording" we are given more detailed information on the different types and their use.

The author treats sound drama, and sound and vision, in far more detail and this is, perhaps, the best part of the book. It is well worth study by the amateur anxious to combine the best of sight and sound.

"Fun with Tape" is a rather generalised coverage of most aspects of sound recording on tape aimed at the reader who may need a stimulus to start him off upon some creative work.

J.B.

TAPE RECORDER SERVICING MECHANICS. By H. Schroder. 122 pages, 62 line illustrations. Price 21s. Published by *Iliffe Books Ltd.*, Dorset House, Stamford Street, London, S.E.1.

RESPONSIBLE works on tape recorder servicing are few and far between. Too often, they waste pages describing the way we should hook up the author's firm's products to join in the children's party games, or flounder around the deep waters of theory when they should be getting on with the job of describing repair methods, measurements and tests. Herr Schroder does not fall into this trap—at least, not in the early chapters.

He begins with 30 pages on the fundamentals of drive systems, clutches, belts, idlers, brakes, speed selection, tape tensioning and so on. Enough of the mechanical theory determining these factors is given to satisfy the average reader. In Chapter Two, we learn how

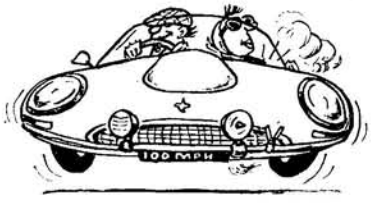
(continued overleaf)

music on the move

ANSCOMB IDENTIFIES SOME PRE-RECORDED CASSETTES

Country and Western Folk

Themes from the Ted Willis Show



Modern Jazz Quartet

Top Twenty

Eighteen Twelve

Pomp and Circumstance

The Best of the Popular Classics

to make some of these theories fit the facts with simple test equipment and a brief mention of maintenance is allowed.

By page 44 we are taking a look at the electrical operation of the tape recorder, and some of the basic features are discussed. Although we find a very neat drawing of track disposition, there is little regarding track dimensions and spacing, and no regard for cross-tracking effect, although stereo is given a perfunctory nod in the test sections. Moreover, in this chapter, the equalisation standards are hopelessly out of date, and the "new" standards discussed by the author relate to those of ten years ago. Present CCIR recording characteristics are 70, 140 and 280 μS for tape speeds of $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i/s (19.1, 9.5 and 4.8 cm/s) respectively. We cannot wholly blame this lapse on publishing delays, for the English Edition was edited by R. C. Glass, City University, London, and published this year.

Happily, other points are less topical and the section on the influence of HF bias is particularly good. Adequate graphs are given to illustrate the effect of bias on frequency response and distortion. Spacing and azimuth effect, and the little-mentioned face width effect are also covered in this section, which leads on to the record amplifier and brings us into the world of circuits.

NOT TYPICAL

Here we receive another disappointment. The given circuits are very paltry examples, and not very typical of modern design. The glaring omission is that of transistors. There is not a mention of semiconductor devices, and, just as in the earlier chapters on drive mechanisms, one would gain the impression that battery-operated machines had not been invented.

Such omissions are a pity when the material in the book is so well prepared and presented. This reader would have liked to see much more space given to mechanical systems, with some photographic illustration of typical methods—clutch and brake systems vary so widely that there is a wealth of subject matter. The electrical section could have then been reduced to the necessary Chapter Four on electrical measurements. Although, even here, it would be necessary to bring the facts about test tapes up to modern standards.

MERE PAGE

Chapter Five is insulting to the technical reader and quite inadequate for the layman. A mere page on repair hints, and some of those almost laughably inept (such as changing the playback head if treble response is down—with no mention of possible amplifier checks to prove where the fault originates) this is just not good enough for the rest of the book.

And yet it is not illogical to recommend this book. The publishers believe it will be a reference work for City & Guilds examinations. I would not care to go so far, but do contend that the student will gain useful knowledge without having to plough through masses of fundamental waffle, and the enthusiast should not begrudge a guinea to brush up his basic grasp of systems. **H.W.H.**

a survey surveyed

SOME PERSONAL VIEWS ON THE TAPE RECORDER DESIGN STUDY

BY PETER TURNER

YOU might call this article *More about the Beast*; and indeed many of the features which were demanded in a high-quality recorder in the recent survey were suggested in my original article about the Beast. Of course, the recommendations of the survey were arrived at by a purely statistical method of counting votes: they show what a majority of users want, and it is my purpose here to discuss the rationality of some of those wants.

First of all: are we designing a tape-recorder or a portable hi-fi system? I ask because one of the desiderata in the survey was the provision of twin 5W amplifiers. Why on earth should anybody want that? To begin with, such amplifiers would add considerably to the cost of the machine, whereas what we need is the money put to quality of *recording*. They would also add to the weight and bulk of what is presumably intended as a portable machine; and it seems to me that 5W output is quite insufficient for a good amplifier anyway: I should ask for at least 10W. Surely what we need in a recorder is firstly the facility for monitoring the signals through headphones, with variable control of volume, and then *one* amplifier of quality sufficient for run-of-the-mill mono purposes (like replaying speech tapes from correspondents) and for checking that there is indeed a signal on one or both tracks? The method adopted on *Revox* machines (prior to the latest) seems to me ideal. Anyone who is seriously concerned with sound quality (and why should one not so concerned bother with a machine of this type anyway?) will have to possess a high-fidelity amplifying system and loudspeakers, which will give a standard which cannot be provided by any inbuilt amplifiers and speakers and will cost as much and more than the machine we are designing.

The next point concerns meters. It is my experience that twin meters are extremely difficult to watch simultaneously, even when they are sensibly mounted very close to each other. Earlier this year I heard Mr. Dakin, of *Elstone* say at the National Federation of Gramophone Societies' conference at Hoddesdon that it is the intention of Tandberg to carry on as long as possible with the twin magic-eyes fitted to their machines. Now, these machines offer a standard of quality which places them amongst the very best; and magic-eyes (like those of the earlier Revox machines) are both convenient and sufficiently accurate. A *good* meter, with its associated electronics, is an expensive item; and I for one vastly prefer two good eyes to two of the piffling VU-meters which are so common at the moment. Most of them give only a vague indication of what is going on.

Granted that we are to have meters, is there need for more than one? I take leave to doubt it: I have found the method used by *Ferrograph* on my *422*, and by EMI on my *TR52/2*, perfectly adequate in practice: that is, one meter which can be switched from track to track. Let us be realistic about all this: we are going to use two microphones, the output of which is most unlikely to be equal, though it may be near enough in practice. We shall be fortunate, on most locations, if we can get more than a rough idea of balance and be able to set up exactly where we should like. The result will be rough-and-ready stereo, whether we like it or not; and the final balancing will be done in the amplifier on replay. Even a PPM, if we are lucky enough to get a real one, has to be learnt by experience, to see just how much overload, as indicated by the meter, can be tolerated in practice on a given machine with a given tape. I know that there has never yet been a recording session which I have attended during which the sound-level has not gone overboard at some point: even when one has sufficient control over the performers to be able to obtain trial runs, differences of level occur which are such that a setting obtained in the trial run proves too high on the hot run.

One solution to this problem which I like very much is that adopted by Daystrom on their new build-it-yourself stereo machine: an elegant circuit to the single meter ensures that the *higher* of the two incoming signals alone is indicated; and twin meters, in the hands of amateurs, will do no more than that. This particular machine is intended to be relatively inexpensive, and it has no separate monitoring-head; but our machine will have, and that, combined with a single meter of such design, would seem to me to be all we need.

We then come to the question of speeds. Assuming, as I do, that our machine is intended for the creative practitioner, I find it incredible that anyone should want $1\frac{7}{8}$ i/s (4.8 cm/s) let alone $\frac{15}{16}$ i/s (2.4 cm/s). I am aware that the latter speed is intended for recording conferences and the like, where only speech is envisaged and quality is secondary to length of run on one tape; but how often are these things done? A friend and I once recorded a whole conference, and we found it perfectly easy to have two machines side by side, and start up the second just before the first came to the end of a track, subsequently re-setting the first machine at leisure so as to be ready for the next period. For my part, if asked to choose I should prefer 15 and $7\frac{1}{2}$ i/s (38.1 and 19.1 cm/s) to $7\frac{1}{2}$ and $3\frac{3}{4}$ i/s (19.1. and 9.5 cm/s). I admit that I have no machine running at 15 i/s (38.1 cm/s) and that several of my jobs require $3\frac{3}{4}$ i/s (9.5 cm/s); but most of us have more than one machine (it is doubtful if advanced recording can be done without at least two) and the slower speed can be provided on the second. The difference in quality between 15 and $7\frac{1}{2}$ i/s (38.1 and 19.1 cm/s) *is audible*: it is rather like doing 60 in a Mini and 60 in an Aston Martin: a different experience altogether. Quality is improving steadily; but we proceed to negative the advances in tape and head development by using slower speeds, yet we profess to be concerned with quality!

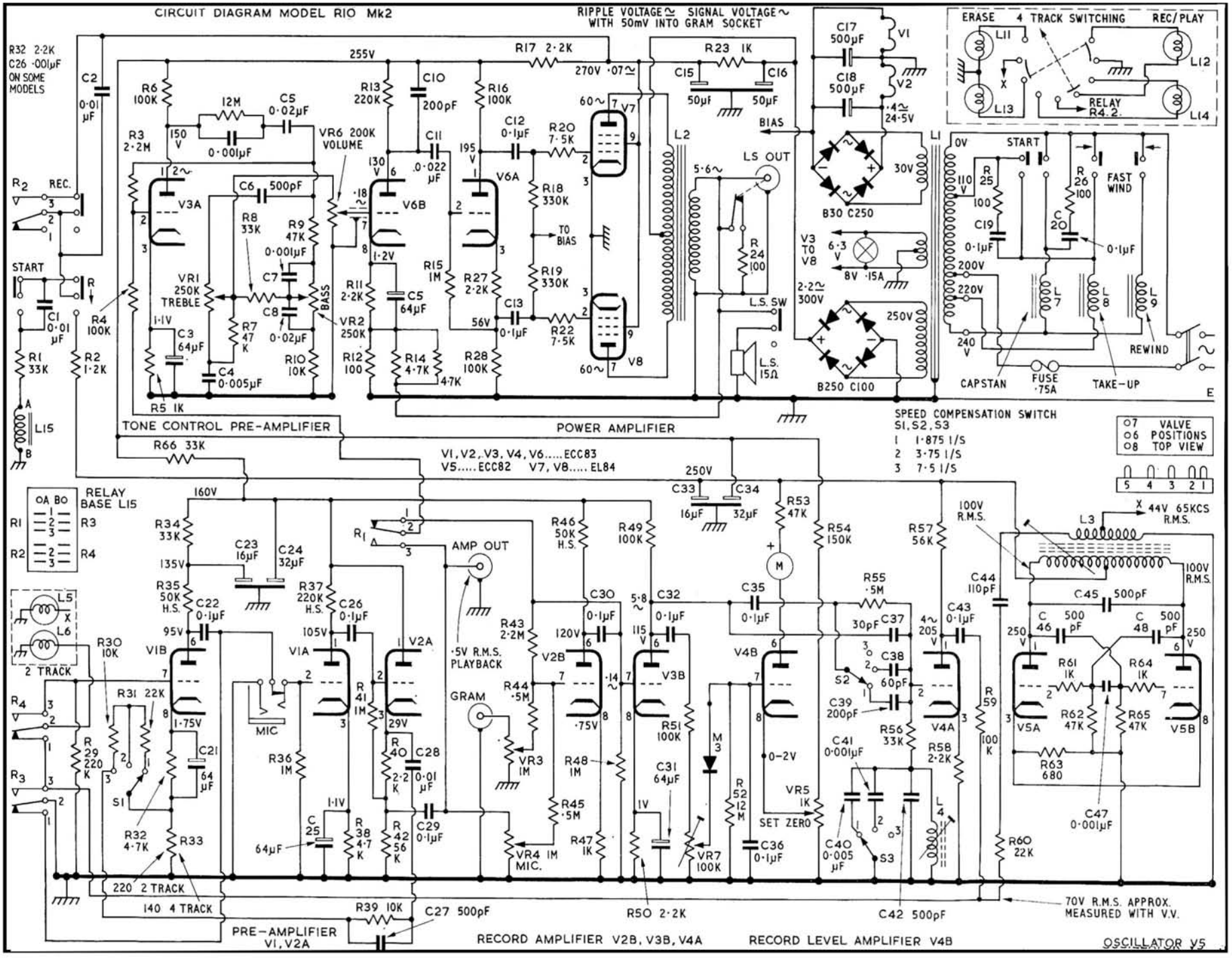
But the other need for higher speeds in creative recording comes from the need to *edit*. One has to experience editing a $7\frac{1}{2}$ i/s (19.1 cm/s) tape and one at $3\frac{3}{4}$ i/s (9.5 cm/s) to believe what a difference it makes; and I am ready to believe that a similar difference exists at 15 i/s (38.1 cm/s). Further: many final tapes, such as circulation copies of welfare programmes, have to be at slower speeds; and if quality and intelligibility are to be retained in the copies, then quality in the original is of the first importance. Once again, that means higher speeds.

While we are talking about editing, I was disappointed that the survey made no reference to the type of tape-path needed to make it easy. One of the major deficiencies of most recorders on offer at the moment in the amateur range is the intolerable clutter of pillars, pads and guides which make withdrawing the tape from the heads for editing a fiddling and exasperating chore. I often wonder how much time I waste disentangling the tape from this forest, and then re-threading it to get the tape moving again. We need a completely uncluttered tape path; and if pressure-pads are to be used at all, they must be designed to stand well off the tape when in the rest position: at present they tend to move only about a quarter of an inch. They catch at the tape both when removing it and re-threading it. Lacing the tape when first putting it on is a different matter: I am referring to the situation when one has both spools threaded and wishes to manipulate the tape in that position.

I was delighted to see that most people favoured the flat and low type of presentation rather than the high and thin: I *detest* upright recorders, and how anybody edits on such things I do not begin to know. It was also good to read that our machine will be designed for function and not for appearance. If it be so designed it will also look right; but that is another argument.

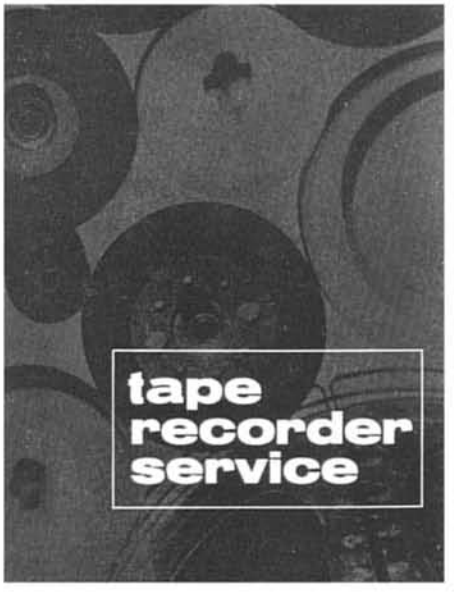
The winner of the competition (lucky hound!) would allow £150 for his stereo machine. Good: for that he should get a

(*continued on page 71*)


CIRCUIT DIAGRAM MODEL RIO Mk2
RIPPLE VOLTAGE ≃ SIGNAL VOLTAGE ≃
WITH 50mV INTO GRAM SOCKET
R32 2·2K
C26 ·001μF
ON SOME
MODELS
C2
0·01
μF
R2
REC.
START
R
C1
0·01
μF
R1
33K
R2
1·2K
A
B
L15
R4
100K
R6
100K
12M
C5
0·02μF
0·001μF
R3
2·2M
150
V
VR6 200K
VOLUME
255V
R13
220K
C10
200pF
C11
·0022
μF
R16
100K
R17 2·2K
270V ·07≃
C12
0·1μF
R20
7·5K
195
V
130
V
V6A
V6B
V3A
C6
500pF
R8
33K
R9
47K
0·001μF
C7
C8
0·02μF
VR1
250K
TREBLE
VR2
250K
BASS
R7
47
K
C3
64μF
C4
0·005μF
R5 1K
1·1V
1·2V
R11
2·2K
C5
64μF
R12
100
R14
4·7K
4·7K
R15
1M
R27
2·2K
C13
0·1μF
56V
R22
7·5K
R18
330K
TO
BIAS
R19
330K
R28
100K
V7
V8
60≃
R23 1K
C15
50μF
C16
50μF
BIAS
L2
5·6≃
LS OUT
R
24
100
L.S. SW
L.S.
15Ω
C17
500μF
C18
500μF
V1
V2
·4≃
24·5V
B30 C250
30V
V3
TO
V8
6·3
V
8V ·15A
2·2≃
300V
B250 C100
250V
L1
0V
110
V
200V
220V
240
V
START
R
25
100
C19
0·1μF
R
26
100
FAST
WIND
C
20
0·1μF
L
7
L
8
L
9
REWIND
CAPSTAN
FUSE
·75A
TAKE–UP
E
ERASE
4 TRACK SWITCHING
REC/PLAY
L11
L12
L13
L14
X
RELAY
R4.2.
SPEED COMPENSATION SWITCH
S1, S2, S3
1 1·875 I/S
2 3·75 I/S
3 7·5 I/S
07 VALVE
06 POSITIONS
08 TOP VIEW
5 4 3 2 1
TONE CONTROL PRE-AMPLIFIER
POWER AMPLIFIER
R66 33K
V1, V2, V3, V4, V6.....ECC83
V5.....ECC82 V7, V8.....EL84
250V
C33
16μF
C34
32μF
R53
47K
R54
150K
R57
56K
100V
R.M.S.
X
44V 65KCS
R.M.S.
L3
100V
R.M.S.
C44
110pF
C45
500pF
C
46
500
pF
C
48
500
pF
250
V
250
V
R61
1K
R64
1K
R62
47K
R65
47K
R63
680
V5A
V5B
C47
0·001μF
RELAY
BASE L15
OA BO
R1
R3
R2
R4
160V
R34
33K
135V
C23
16μF
C24
32μF
R35
50K
H.S.
C22
0·1μF
95V
R37
220K
H.S.
C26
0·1μF
105V
AMP OUT
·5V R.M.S.
PLAYBACK
R46
50K
H.S.
R49
100K
C30
0·1μF
120V
C32
0·1μF
115
V
C35
0·1μF
M
4≃
205
V
C43
0·1μF
R55
·5M
30pF
C37
C38
60pF
C39
200pF
R56
33K
R58
2·2K
R59
100
K
R60
22K
L5
X
L6
2 TRACK
R30
10K
R31 22K
R29
220
K
S1
R32
4·7K
R33
220 2 TRACK
140 4 TRACK
C21
64
μF
VIB
VIA
V2A
V2B
V3B
V4B
V4A
1·75V
·75V
29V
0–2V
MIC
R36
1M
R41
1M
R40
2·2
K
C28
0·01
μF
C29
0·1μF
R42
56
K
R38
4·7
K
C25
64μF
1·1V
GRAM
VR3
1M
R43
2·2M
R44
·5M
R48
1M
R45
·5M
R47
1K
VR4 1M
MIC.
R51
100K
C31
64μF
1V
R52
12
M
M3
VR5
1K
SET ZERO
VR7
100K
C36
0·1μF
C40
0·005
μF
C41
0·001μF
S2
S3
L4
R50 2·2K
C42 500pF
70V R.M.S. APPROX.
MEASURED WITH V.V.
R39 10K
C27 500pF
PRE–AMPLIFIER
V1, V2A
RECORD AMPLIFIER V2B, V3B, V4A
RECORD LEVEL AMPLIFIER V4B
OSCILLATOR V5

REPS R.10 MARKS II AND III

BY H. W. HELLYER



WE continue, in the third of our Reps articles, with the circuit of the 1964 model, which I shall call the 'late *Mark II*' of the *R. 10* series. As we can see, it has some very significant differences, some of which are worth studying by would-be constructors.

Chief among the changes is the addition of a winding to the mains transformer, a rectifier and low voltage DC supply. This is used to power the heaters of the preamplifier valves, to get low-noise conditions. And it is no gimmick, such a device really does work. When the machine is switched on and the gain turned up with no signal, you can put your ear to the loudspeaker grille at the left side and just hear it 'breathing', as with a good hi-fi amplifier. How many machines in the mid-price range will stand up to that sort of test?

In the circuit given, this DC heating of the two ECC83 preamplifiers (no pentodes here, you may note), seems to be the sole function of the extra circuit. But again we split marks and models: later versions took advantage of the available voltage at the junction between the two heaters to tap off approximately 12V bias to stabilise the circuit further by setting the working point of the pair of output valves. To do this, we remove the common cathode bias resistor and its de-coupling electrolytic capacitor, and strap the cathodes directly to chassis. Then we lift the lower ends of the 330 K resistors R18 and R19 from chassis and return them to the bias point.

No startling improvements are immediately noted from such changes. In the quest for high fidelity, small changes to circuits can be made, and the results measured separately and approved. What really matters is the cumulative effect of the numerous small changes. In the above case, if we record, using the original circuit, and manage to capture a particular balance of sound that would threaten intermodulation distortion, we would note an uncomfortable harshness on replay. Nothing too definite, just an obtrusive 'edge' to certain combinations of tones. This becomes very obvious on certain types of 'semi-pop', where the arts of the orchestra have been overlaid by the crafts of the studio. Take, for example, the Ray Coniff sound, which makes an excellent background furnishing for those places that will not allow us to pursue our pleasures in aural peace. By cleaning up the circuit, we can get rid of these 'edges' and roughnesses. Any improvement to an already good sound may make only a marginal difference, but when one lives with it for a while, becomes appreciated.

So, let us go on to the next minor points of improvement, which, I am informed, grew out of the DC heating and fixed bias philosophy.

TRIM BASS

First, the output stage feedback. If we are going to fix the bias of the EL84 push-pull pair, we must trim up the bass a little to regain our response. As I have already stated—stuck my neck out, one might almost say—the tone quality obtainable from this model, with its 10 W output from a 15 ohm loudspeaker, is quite remarkable. We have now improved the distortion figure slightly, at the expense of the lower end of the spectrum, so two small changes are made to preserve matters. These are the shunting of the feedback 4.7K resistor R14 with a 47K and the changing of the driver to split-phase coupler, C11, to 0.022μF.

A word of warning here—don't change that coupler unless the other alterations have been made. Further, when a machine that has been in use for a couple of years comes for service, it is a wise step to replace this coupler, with its appropriate value, using a good paper capacitor with adequate rating. There may be less than 100 V of DC across it, but for good transient response, it is vital that there shall be no leakage at this point.

NEVER GET OWT

We never get owt for nowt, and the high output power and wide response can cause us a bit of trouble if we mess around with loudspeaker coupling and switching. I must confess I have never had any trouble with the output transformer fitted to these machines, though the temptation to fit a more conventional heavy-duty output transformer has several times bothered me. Reps make sure of the loading by fitting a shunt resistor across the output. In the circuit given this is R24, a 100 ohms resistor, but in practice we may often find this to be 56 ohms, 1W or even less. When the loudspeaker push-button is depressed, this resistor takes the full output power and it can get overheated. In addition the output stage can try to turn itself inside out if we are so foolish as to leave microphone and gram controls fully open with no input, and then switch from inside to external loudspeaker, and as a form of safeguard against the peaks, a network of a high resistance in the order of some 10 M shunted by a 0.001μF capacitor (good polyester of paper) can be inserted between the anode or V3A and C5, shunted by the loudspeaker switch.

Astute and perceptive readers of *Tape Recorder* (*Aren't we all*?—**Ed.**) will have noted that the circuits so far described require that the Reps R10 Mark II shall have a different mains transformer to its preceding models.

This is further complicated by the omission, at one stage of the production run, of the 110 V motor supply, with the alternative use of the stabiliser brake we have already discussed. The result is that, when ordering a replacement mains transformer it is necessary to specify the mark and serial number or describe the circuit detail, or to employ the simple subterfuge of fitting the type shown here. All that is necessary, when fitting this to a model with no DC heating is to isolate the pair of green leads from the 30 V winding and the white 110 V lead that is normally taken to the 'choc-block' connector at the rear of the deck. Then the separate 6.3 V AC supply that is employed to power the heater of the first valve in previous Marks will not be available, but that is no great difficulty. All that is needed is a short pair of jumpers from the adjacent tags on the strip at the base of the main chassis. The single 6.3 V winding is quite adequate to supply the extra 300 mA.

There is one weak link in this circuit that deserves a special mention and this is the metal rectifier, a full-wave contact type, such as the *Siemens B250 C100*. These rectifiers are quite efficient, but when they do break down, for any number of odd reasons, they impose a heavy load across the mains transformer which protests by exuding wax and emitting the characteristic odour that sends the youngest apprentice running for the fire-bucket. One could possibly avert this tragedy at relatively low cost by adding an HT fuse. Although a 100 mA surge type would do the job nicely, I have seen one owner's neat solution of an 8V 0.15A dial bulb fitted in the HT return line electrically and taking the place of the indicator light on the front panel, physically. As this is the rating of the fitted bulb the amount of work in doing this modification is very small. (You can then boast that you have a *Ferrograph*-type indicator that comes on when the HT warms up—but don't confess that it isn't a neon!)

OTHER DIFFERENCES

Other differences from previous circuits which will be noted are minor ones, but of overall importance. By which I mean that it is not done to try to adapt one circuit to another by modifying. One of our customers insisted on our doing just this: he owned a Mark II and his son, who had been our sales ambassador by possessing an early Mark I, boasted that his was the better sound. Father nagged us constantly, and wrote to Reps as well, demanding, pleading, finally begging that we would rebuild his machine in the former fashion. From my experience of this experiment I can assure readers that the small differences are *all* important to preserve the distortion limits and recording level.

(*continued on page 71*)

What have the happiest Hi-Fi enthusiasts in common with the Fire, Police and Defence services...with theatrical producers and concert impressarios?

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Ferrographs are unique in their combination of reliability, rugged construction and *fidelity of recording* . . . not for the first exciting months of ownership, but for year after year of faultless performance. Even so, we do not claim perfection, although we do believe that we have come nearest of all to the ideal. And the vast majority of Ferrograph users agree.

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THE INCOMPARABLE TAPE RECORDER

As a result of which experiments we may pass on two simple tests. For overall distortion feed a signal in at the gram input and monitor this across a 15-ohm load resistor at the speaker output socket, with valve voltmeter and scope—or simply with the scope if you have an accurate graticule. A sine-wave input at 3 kHz can be pushed up to give 11 or 12 V across the 15-ohm resistor before any clipping is observed.

The other test, often necessary when an owner complains that his machine is 'slightly down', is to prove the record channel. If we link the two anodes of the push-pull oscillator, pins 1 and 6 of the ECC62, or more conveniently the coil connections, easily available, we can now measure the signal at the head in the absence of bias. Feed in a 1 kHz sine wave at 60 mV to the gram input and measure the signal voltage at the 0.1 μF capacitor in the head feed chain, i.e. C43 in the given circuit. There should be about 6 V reading for a fully modulated recording and the preset of the meter circuit should then be set for this indication. After removing the oscillator short-circuit and checking that the bias voltage is around 70 V at the head, that the readings at each anode balance, and that the waveform is symmetrical, we can make recordings at the same level and play them back, checking as previously for any waveform clipping or mis-shaping that may have occurred in the transfer. Quite often the 'slightly down' symptom will be a combination of small 'ageing factors'. In practice these, and minor distortion faults, are the most difficult to tackle. Give us the good old burn-out every time !

Next point that has been raised is the matching of a gramophone pick-up to the Reps. We have already mentioned that the input sensitivity is 60 mV and readers will probably be aware, or able to work out, that this is at a nominal high impedance. Actually, the specification gives 1 M, but as a crystal cartridge likes to see perhaps twice this impedance for adequate bass response, there may be difficulty in matching. If we insert resistance in the coupling we attenuate too much and it is a common drawback when trying to play a modern ceramic or one of the better crystal cartridges into a Reps, especially to employ the tape recorder as an amplifier to have to use the gram gain control at about position 8, which is too high in terms of noise figures, etc. This is even more noticeable if we have a stereo cartridge paralleled for mono playback or record. It can be an advantage to modify the characteristic and take advantage of the extra gain from the microphone input by using a network something like that of **fig. 2.**

My own view on this, admittedly not always popular with customers, is that an external preamplifier which is tailored to the source should be used, presenting the tape recorder with a level signal at nominal line input. This means a small unit, two or three transistors with equalisation to suit the crystal, ceramic or magnetic cartridges or other souce of signal. There would appear to be a market for such devices, ready-made, judging by the number of times we are called upon to modify commercial inputs to suit a user's particular circumstances. (And when I say particular, I do mean 'particular'.)

Soon after the first of this short section of three articles dealing with Reps machines appeared, one reader sent us a letter glowing with praise of the machine and glad we were giving tribute where due. Very heart-warming but slightly spoiled by the references to the *Mark III*, to which he had now graduated. He had one of the few which were fitted with the imported deck and mentioned what a great advantage it was to have an auto-stop and a lock-on pause control fitted, which the *Magnavox 363* lacks. Well, of course, our manufacturers are not so sleepy as that, whatever His Highness may think. Reps have fitted both these functions to the *M10*, which is the model number of the new machine, using a powerful solenoid for the autostop, actuated by the conventional method of short-circuiting an insulated right-hand tape guide and a simple mechanical trip for the existing pause control, converting it to a locking device. (DC supply for the autostop solenoid is from the 25.4V point of the low-voltage DC circuit.)

It was not my intention to discuss this later model but it may be worth mentioning that the circuit is essentially the same as that given with this article. Small differences are only those needed to allow for the record switching, which now depends on a micro-switch, operated by a tongue on the spindle of the record/play control. This micro-switch was one of the problems with the first few machines of this range, tending to jam on with the result that the machine stuck in the record mode, often too late to prevent erasure of some precious material ! The answer, quite simply, was to re-shape the tongue (all right, then, to bend it) so that at the moment of contact the pressure was at right angles to the pip of the microswitch. Like all good solutions, essentially simple. Owners of early Mark III or M10 models may care to remember that small point. **Fig. 3** shows the change necessary.

There is only one other small change and I leave readers to argue out its significance. This is the change of C26 to 0.001μF from the value of 0.01μF shown in my diagram. Now get out those slide rules and tell me why.

FIG. 2

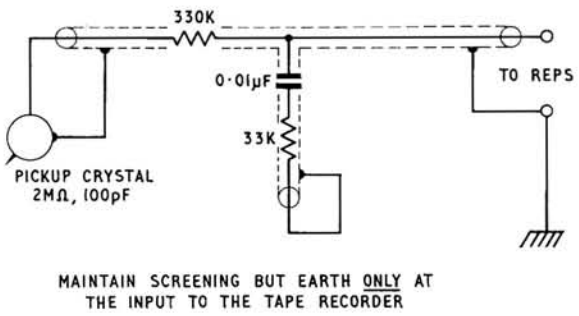
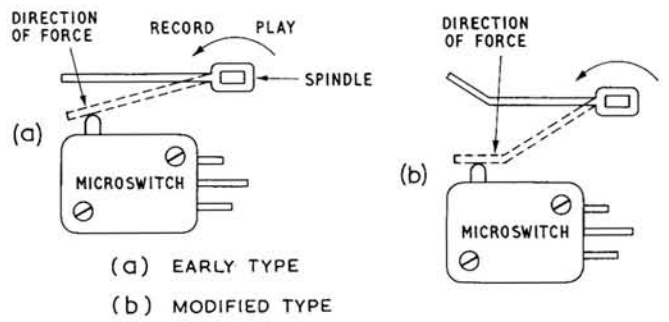


FIG. 3

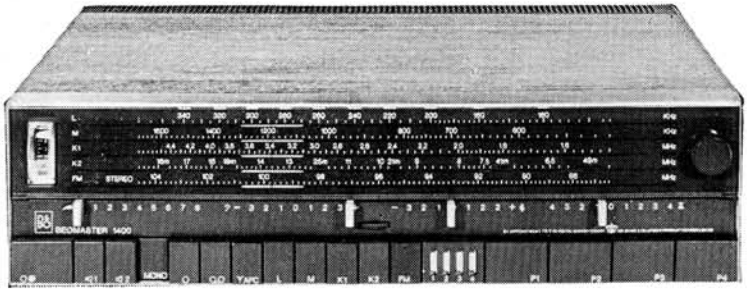


real one—though it is worth remembering that such a price is chicken-feed when compared with the professional range and is not really costly at all. Let us not forget that we are designing a machine which will give us a recording standard not so far below that obtainable on a machine costing more than ten times as much ; and all that money is not just profit to the maker ! The burden of my song is that our money should be devoted to one end alone : the provision of a machine which will give high quality recordings *and be suitable for the creative user*. If one is the type who seeks no more than the addition of tape facilities to his hi-fi system, then one's needs are quite different from those of one who will bundle the rig into a car or on to a bus and go out *recording*. I make bold to assert that the real fun in recording comes only to he (or she) who is not content to play recorded tapes and dub broadcasts. Perhaps above all, it will never come to one who never cuts a tape and possesses just one microphone through which to talk to his friends. By all means let each do as he wishes with his own machine ; but when we come to design a recorder, do let us do it for recording ; let us avoid all useless frills and gadgets and put our money into a practical machine.

I concluded my reading of the survey still feeling that The Beast would serve me better than the suggested design. That is natural, for the Beast was designed by me for me ! All the same, if and when it appears, the Survey Beast will be a very nice bit of equipment.

Bang & Olufsen - for those who consider design and quality before price.

From Bang & Olufsen - the Beomaster 1400 - a new sophisticated five waveband stereo radio receiver combined with a powerful stereo amplifier.



The Beomaster 1400 M. Also available – model 1400K with end speakers.

Completely modern in styling—this new Beomaster is available with or without built-in pressure chamber loudspeakers—making it either a complete table radio of the highest quality or the central unit in a quality audio reproduction system. Special features include 4 pre-set positions on the F.M. waveband, shortwave bandspread tuning, a built-in stereo decoder and high output combined with small physical size.

A brief specification is given below - but for full information see your nearest B & O dealer or write for full details.

TECHNICAL DATA

AMPLIFIER
33 Transistors.
16 Diodes.
Power output:
2 x 15 watts continuous.
2 x 20 watts music power.
Frequency response:
30-25000 c/s ± 1 dB.
Distortion:
< 1% at 40–12.5 kc/s.
Signal/noise separation:
> 50 dB.
Tone control range:
Bass: + 10 dB —16 dB at 40 c/s.
Treble: + 13 dB —16 dB at 10 kc/s.
Channel separation:
> 40 dB at 1 kc/s. > 30 dB at 12.5 kc/s.

STEREO DECODER
Channel separation:
> 35 dB at 1 kc/s.
> 26 dB at 10 kc/s.
Distortion:
< 0.5%.
Pilot and sub-carrier rest:
< 40 dB.
Frequency response:
50–15000 c/s ± 2 dB.

POWER SUPPLY
Voltage:
110–130–220–240 volts AC.
Mains frequency:
50–60 c/s.
Power consumption:
15–120 watts.

EXTERNAL CONNECTIONS
Inputs:
Gramophone, low ohms (47 KΩ)
Sensitivity: 4 MV/1000 c/s for full output.
Tape recorder (record + playback).
Sensitivity: 500KΩ–200mV/1000 c/s.
Speaker input: (e.g. TV sound) 4Ω.
FM aerial: 75Ω.
AM aerial.
Outputs:
2pairs of speakers, DIN sockets, 4Ω.
Tape recorder. Sensitivity: 82KΩ–100 mV/1000 c/s.

TUNING
Wave bands:
F.M. 87.5–104 mHz.
Long Wave 857–2040 m (350–147 kHz).
Medium Wave 188–578 m (1600–520 kHz).
Short Wave 1: 66.6 m–200 m (4500–1500 kHz).
Short Wave 2: with bandspread.
16 m–49 m (18–5.9 mHz).
CABINET
Model 1400 M:
16 5/16" x 4 7/16" x 9 1/8" without end loudspeakers
Model 1400 K.
29 5/16" x 4 7/16" x 9 1/8" with end loudspeakers
Available in teak or rosewood.

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London Showrooms: 70/71 Welbeck Street, London, W.1. Telephone: 01-486 2144.

PERSONAL BIAS

LOOKING TROUBLE IN THE PHASE BY JOHN ASHCROFT

THIS tale of woe features several characters—a transcription turntable, tape recorder, stereo microphone, headphones, amplifier, twin speakers and other odds and ends. All excellent items—until I began using them together !

To check the speaker-phasing I used that DGG test disc. It sounded awful. It includes an outer-space sound which should "commence between the loudspeakers and finish up in the room". Imagine my expression when it started out whirling around my left ear, ran round on the ceiling, dived between the loudspeakers, rolled itself into a tiny ball and vanished up the chimney with a triumphant echoing chortle.

I had been blaming room acoustics and standing-waves (whatever they are) for the uncertainty of stereo images ; but Ebenezer cackled and told me he had always known my speakers were out of phase. I switched the leads to one of them. Revelation ! Cleaner treble, deeper bass, less exaggerated channel separation, and a rock-solid middle.

Then the local church organist wanted a recording of the new organ. Owing to the arrangement, it is impossible for one person to get the full benefit of this lovely instrument. So we decided to mix two mikes and get a "better than real" effect. Then I thought : "Blow it, let's feed the mikes on to separate tracks and do a sort of stereo recording ; if it works, fair enough—if not, we'll keep the best track later."

FACING THE KEYBOARD

So I stood a moving-coil in the choirstalls facing the keyboard, and a ribbon in the nave facing the "swell" department, and filled 90 minutes of tape at 7½ i/s. Now, the microphones were nearly 36 ft. apart ; so obviously we had got a powerful left, a powerful right, and nothing in between.

The replay baffled us. We got a stunning wash of central sound, and only an occasional effect from the two extreme sides. But disillusionment soon set in ; the notes were jittery in space, and Ebenezer suggested that, since the speakers were now in phase (I was feeding the tape through the same amplifier), the mikes must have introduced a phase clash, which was hardly surprising in the conditions.

Grudgingly I switched one speaker's leads. The impact was terrific : better bass, glorious treble, and rock-solid images. So I reconciled myself to putting the speakers officially out-of-phase whenever I played those organ recordings.

Then I bought a reputable stereo mike and recorded discussions, traffic, school choirs and a Salvation Army carol concert. The results were disappointing. And it was months before Ebenezer plucked up the courage to tell me what I was beginning to suspect—all those tapes were out-of-phase. And, again, reversing the speaker phasing made a marvellous difference. So let me say that out-of-phase recordings are not always as obvious as you might think. And let me recap. We have an *AKG* mike, *Tandberg* recorder, *Goldring Lenco* turntable, *Goodmans Max-Amp* and *KEF* speakers. Plus a gremlin hell-bent on mischief whenever stereo is mentioned.

While Ebenezer uncorked the *Drambuie* I double-checked the connections from the mike to the recorder, the connections from the *Connoisseur* cartridge and from the amplifier to the speakers. Ebenezer suggested that the jack-socket on the Max-Amp offered an ideal check : we could use the headphones and build from there, assuming that this was correct—just in case we had been building up from the false premise of a wrongly wired cartridge, something I had not thought of.

So I plugged a pair of headphones into the Max-Amp and played the disc. That whooping sound from space is weird enough, let loose in the room. When it happened inside your head the effect is positively terrifying. But it was at least in phase. So we wired up the speakers to agree with this. So far, so good : cartridge, headphones and speakers OK. No trouble at all with the discs.

And now to tape. We tried separate moving-coils, separate ribbons and the AKG D77. All replayed out-of-phase. We tried reversing the leads in one section of the AKG, wiring the outer screening to the centre pin and so on : this produced an obviously in-phase recording, with obnoxious hum on the rewired channel, so we hastily altered it back.

STANDING WAVES

Another consultation around the Drambuie bottle produced a brainwave. Ebenezer said the whole trouble was due to room acoustics and standing-waves. This sounded (a) utterly implausible, (b) vaguely familiar ; but I was well oiled enough to stand the mike out on the lawn and walk round it giving a running commentary while the neighbours wondered if I were attempting to communicate with something that had landed in the night. (Tape me to your leader ?)

These recordings were clearer—but still out-of-phase.

"Let's find the simplest solution," said Ebenezer. "You never use the headphones with the amplifier. Why don't you phase the speakers for the tapes, then reconnect the cartridge so that discs are in agreement with *that* set-up ? We've a false premise somewhere ; I mean, supposing the headphones or the socket on the amplifier were wrongly wired ?"

I felt less than happy at his afterthought ; but the other idea seemed fine. So I got the tapes and discs in full agreement ; perfection was attained. "See ?" cried Ebenezer. "Everything in the stereo garden is lovely."

It was. But all hell broke loose in the mono garden.

STARTED MONO

We started with a mono disc. Whether we amplified both channels from the mono head, or pressed the mono selector on the amplifier, we obtained feeble bass, wandering treble and orchestras that leapt about the room whenever we blinked. Gone was that solid bouncing bundle of sound that formerly exploded from the fire between the speakers. The same horrible thing happened to mono tapes, and signals from the mono tuner. But if we put the speakers out-of-phase for stereo (that is, according to the new arrangement) the mono signals were quite gorgeous.

Mono discs, mono tapes and mono tuner programmes came out correctly at the amplifier's headphone socket. So I re-wired the cartridge on the stereo head to agree with this (that is, I restored the cartridge to its original arrangement). That left tape's up the creek. The Tandberg was apparently out-of-phase with the amplifier and speakers. But locating the trouble might not be easy. The culprit might be at the microphone input, anywhere in the 'works', or on the output sockets—or even at the tape input sockets Max-amp.

I thought of rewiring the links from the Tandberg to the Max-Amp. Ha! Not too easy with those infernal phono-plugs ! I can now either break the straight phono-to-phono cable with a jackplug and socket in between, wire one wrongly and see what happens, or introduce a phase-change switch into the speaker-leads.

But I think it's optimistic of anybody, even in this advanced year, to miss a phase-change switch off an amplifier. And, while I am still wondering where the culprit is actually lurking, I think I have realised just why many amateurs have dabbled in stereo and given it up as a bad job !

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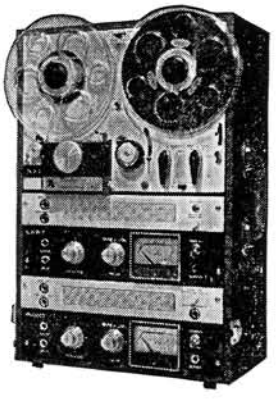

High quality 4-speed, 4-track stereo/mono recorder featuring Crossfield head. Frequency range 30-25,000 c.p.s. at 7½ i.p.s. Vertical or horizontal operation. 4 hours' stereo recording on 1200ft. standard tape. 2 stereo fill-in speakers. Sound-on-sound. 6 watts per channel. **Pre-devaluation List price 125 gns.** Few shop-soiled but immaculate and fully guaranteed at **108 gns. or on interest-free terms, £28.7.0 deposit and 12 monthly payments of £7.1.9.**

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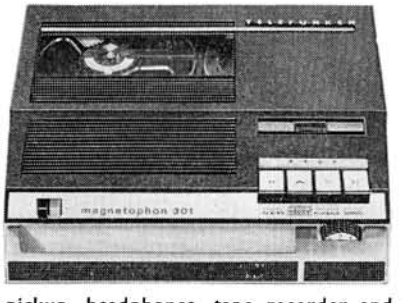
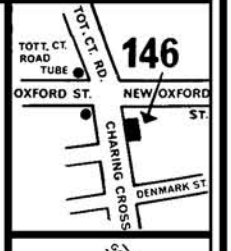
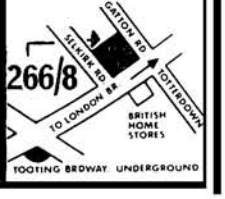
Telefunken 301



These are the machines which stand up to the hard life you expect from a portable and they're also the ones that really stand out from the rest for performance. Model 301: 5in. spool, four-track, 40-14,000 c/s, 3¾ i.p.s. Sockets for radio, microphone, pickup, headphones, tape recorder and additional loudspeaker. AC power supply/battery charger. Operates on five flashlight cells, car battery or rechargeable storage battery. **Save 6 gns. on pre-devaluation price of 54 gns. REW's price only 48 gns. or on interest free terms, 12 gns. deposit and 12 monthly payments of 3 gns. Model 302:** four-track, 3¾ and 1⅞ i.p.s. **Save 8 gns. on pre-devaluation price of 59 gns. REW's price only 51 gns. or on interest free terms £13.8.0 deposit and 12 monthly payments of £3.6.11.**

Please Note: these Telefunken machines are slightly shop-soiled but are in immaculate condition and fully guaranteed.





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tape reviews

CLASSICS BY GEORGE GOODALL
JAZZ AND FOLK BY TONY FARSKY
POPULAR BY BERNARD PLUMTREE

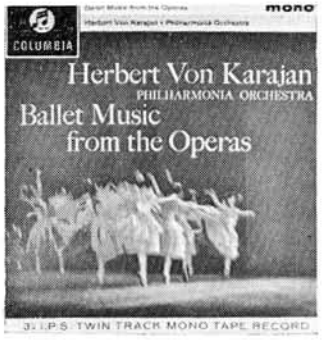
RAVEL/DEBUSSY/PROKOFIEV Bolero (Ravel), Prelude a l'Après-midi d'un Faune (Debussy), Love of Three Oranges Suite (Prokofiev). Hamburg Philharmonic Orchestra conducted by Pierre Dervaux. **World Record Club TT513.** 3¾ i/s twin-track mono. 29s. 6d.

A PROGRAMME OF FRENCH impressionists' music and music from a lively Russian opera sounds immediately attractive, but unfortunately this tape does not come up to expectations. To begin with, the recording quality is not of the best, having a harsh edge to it which needs severe filtering to make the sound reasonably acceptable. It is warm and full-bodied, however, in the lower register, so users of small machines may find it less objectionable. Debussy's *Prelude a l'Après-midi d'un Faune* comes off the best on all counts, in my view, but Track 1, which contains both the Ravel items, suffers from both unexciting performance and the previously mentioned recording defects.

The music from Prokofiev's opera *The Love of Three Oranges* receives a vivacious enough performance, but again the quality is edgy in tone. I'm afraid that, on the whole, I cannot regard this tape as being one of World Record Club's more rewarding issues. **G.G.**

BALLET MUSIC FROM THE OPERAS *Aida, Khovantschina, Prince Igor, La Gioconda* and *Tannhauser*. Philharmonia Orchestra conducted by Herbert von Karajan. **Columbia TA-33CX1774,** 3¾ i/s twin-track mono. 40s.

AS ONE WOULD EXPECT, this selection of ballet music from the operas—played by The Philharmonia Orchestra under Karajan—receives a vivid and precise performance throughout. All of the selections are well known items and need no introduction here.



It is perhaps in the Venusberg music from *Tannhäuser* that Karajan gives us the benefit of his interpretive skills, but in this item the music itself is more worthwhile anyway.

The quality of sound is acceptable enough. The review copy had some minor patches of drop-out and a rather high level of hiss. On the whole a pleasant issue that should be popular. **G.G.**

TCHAIKOVSKY/GRIEG/SIBELIUS Polonaise, Eugene Onegin Waltz (Tchaikovsky), Wedding Day at Trolhaugen, Homage March (Grieg), Finlandia, Valse Triste (Sibelius). Bamberg Symphony Orchestra and Berlin Symphony Orchestra. **World Record Club TT502.** 3¾ i/s twin-track mono. 29s. 6d.

NONE OF THE MUSIC on this tape is very profound and all of it is well known. Listening to a tape of this kind, one often finds oneself saying: "So that's where that tune comes from", as tunes known by ear rather than context are plentiful.

The Tchaikovsky and Grieg items on track one are brightly played by the Bamberg Symphony Orchestra, and perhaps over brightly recorded. Still, the woodwinds sound pleasantly close, especially in the Tchaikovsky *Polonaise*. The Berlin Symphony Orchestra items on track two are a little more warmly recorded, though the string tone is not perfectly clean throughout. Only wide-range speaker users need worry about this, however. *Finlandia* comes off well, with a sympathetic performance, and it may well be for this item that this tape will be purchased. **G.G.**

WALTZING IN VIENNA (Vol. 4) Vienna Volksoper Orchestra conducted by Josef Leo Gruber. **World Record Club TT468,** 3¾ i/s twin-track mono. 29s. 6d.

ANOTHER VOLUME OF waltzes from Vienna, played by the Vienna Volksoper Orchestra. Their conductor keeps them in strict enough tempo to dance to if you feel so inclined. Perhaps this is the main purpose of this issue? The recording quality is restricted in both dynamic and frequency range, but is free from other defects. This series is obviously directed at some specially interested market, but is not of general musical interest. **G.G.**

STRAVINSKY/BARTOK Firebird Suite and Fireworks (Stravinsky), Miraculous Mandarin Suite (Bartok). Royal Philharmonic Orchestra conducted by Fernando Previtali. **World Record Club TCM 77.** 3¾ i/s twin-track mono. 29s. 6d.

STRAVINSKY IS A COMPOSER who has taken to himself and made his own a great number of different styles. No sooner have we made ourselves familiar with a certain selection of his work, nodding our heads wisely and saying, "Ah, yes, we know Stravinsky", than we find that he is off on a completely different track, absorbing fresh principles and instituting new practices. So much so that we come back almost with relief to the Stravinsky works recorded on this tape. Here at least we are on well trodden ground: this is a Stravinsky we are all familiar with. The orchestral fantasy *Fireworks* is a very early work and it is interesting to note that the twenty-five year old Stravinsky still has the endearing habit of quoting other people's works, in this case Dukas' *Sorcerer's Apprentice*. With this work, and with the accompanying *Firebird Suite*, we get a glimpse of an impressionist Stravinsky, colourful and atmospheric, in marked contrast to the other work on this tape, Bartok's *Miraculous Mandarin*. In juxtaposition, the music of this suite seems to out-Stravinsky the previous items, its mood being feverish and macabre, akin to the *Rite of Spring*.

The Royal Philharmonic do more than justice to the music under the Italian conductor Fernando Previtali. The recording needs some filter to take the edge from it on wide-range gear, but this defect may pass unnoticed through internal speakers. For anyone wishing to savour the sweeter Stravinsky, and to have a bellyful of belligerent Bartok, this is a worthwhile issue. **G.G.**

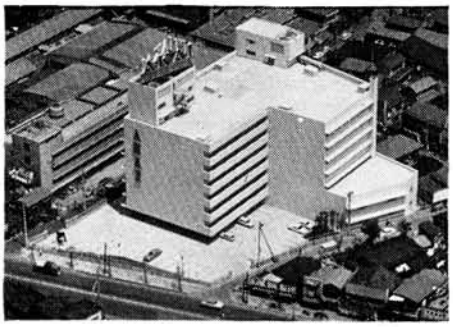
MENDELSSOHN/BRUCH *Violin Concerto in E Minor* (Mendelssohn) and *Violin Concerto No. 1 in G Minor* (Max Bruch). Julian Olevsky and Vienna State Opera Orchestra conducted by Julius Rudel. **World Record Club TT427.** 3¾ i/s twin-track mono. 29s. 6d.

THIS IS THE SORT of stuff we music lovers were brought up on; violin concertos always have strong appeal, and the pair presented on this tape have a fundamental position in the concert repertoire.

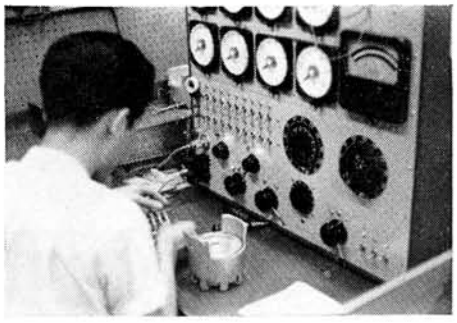
To take the Mendelssohn first, this receives a polished performance from Julian Olevsky. He is especially pleasing in the second movement, with a very lovely smooth flow of melody which holds attention throughout. Perhaps the scherzoesque sections of the last movement just fall short of the ideal fairy-like quality that one associates with Mendelssohn, but even so the performance is very satisfying. The violin is recorded with a close-up sound, but the tone sounds rather thin. In general the string tone on track one has a rather 'tizzy' quality, and this thinness may be a result of this characteristic. These are only slight defects, however, mentioned for the sake of the fastidious.

The violin tone sounds warmer in the Bruch concerto, but of course this concerto exploits some of the violin's warmer characteristics. This is a work more highly charged with emotion than the Mendelssohn, and I had the impression that Julian Olevsky was more deeply involved with the music in this performance. On the whole this is a pleasing issue that should prove popular. **G.G.**

View from the air of the Akai factory



Checking motor dynamic balance



Early stage in assembly of the X-4 battery recorder

A VISIT TO AKAI

ANTHONY EDEN CONTINUES HIS EXAMINATION OF THE JAPANESE AUDIO INDUSTRY

ON the outskirts of Tokyo, near Haneda Airport, is a company whose products are available in over one hundred countries—*Akai Electric*. Akai is quite small compared with the giant electrical companies of Japan, but in the specialised field of tape recording its name is amongst the best known.

Akai is a progressive and developing concern. Today it boasts a magnificent half million pound, seven storey building which has been constructed alongside overcrowded existing premises. Relationships between management and production floor are very good, wages are high and the whole atmosphere at the company is one of hard working enthusiasm coupled with genuine pride of workmanship. A very informal atmosphere existed and during my one day visit I was allowed to go freely anywhere in the factory, visiting and inspecting whatever production lines I wanted.

MOTOR ACCESSORIES

Akai Electric came into being in 1924, producing motors and electrical accessories for cars. They entered the tape recording field in 1953 when they marketed a tape recorder kit—the *A.T.1*. Since that time they have concentrated exclusively on the production of tape recorders and ancillary equipment and today about 90% of their products are exported. The president of the company, Mr. Saburo Akai, is the son of the founder.

In the older part of the factory the basic components for motors, chassis and tape-heads are made, and in the new factory alongside the old one, the recorders are assembled and tested. Motor parts undergo rigorous inspection and checking and only those parts which are within the tight tolerance limits go forward to the assembly shops. Those motors which do not meet the specification, about 10% of the total, are returned to the assembly floor for dynamic balancing. In the inspection room one piece of checking equipment is used. This monitors the correct winding of the coils, correct speed of rotation (errors here indicate excessive friction in the bearings) and dynamic balance. Any imbalance is marked up automatically on the rotor. Certain of these motors are duplicated on the various types of tape recorder to ease production. It is quite standard to find in the workshops in Japan where the highest precision is required, European tools and machinery being used. Akai are no exception and their grinders and lathes are of West European manufacture.

Before the electronics are assembled the individual components are carefully checked and tested. Akai do not manufacture their own semiconductors, valves or basic components, but buy them from one of the reliable giant manufacturers such as *Hitachi*. As each amplifier module is assembled, it is checked for overall performance, with particular emphasis on noise level.

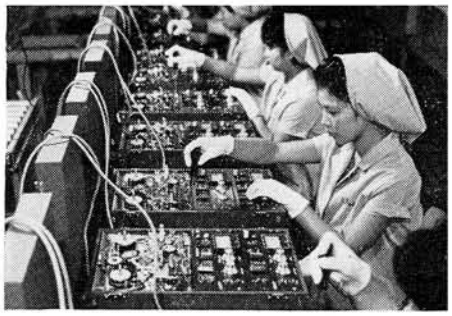
The final testing and checking of each tape is thorough and comprehensive.

TWO OR THREE DAYS

At the time of my visit to Akai, production was concentrated on the *M8*, the *X150D* (a successor to the *X100D*), and the *X4*. The M8 production was of particular interest to me and serves to illustrate Akai manufacturing techniques. Recorders are produced in batches, each batch usually occupying two or three days. This means that the girls working on the production lines must be trained to work on several different kinds of recorder. In many Japanese factories girls are only trained to work on one piece of assembly. While simpler from a training point of view, this is obviously not economic with a high quality product of which only relatively small numbers are required.

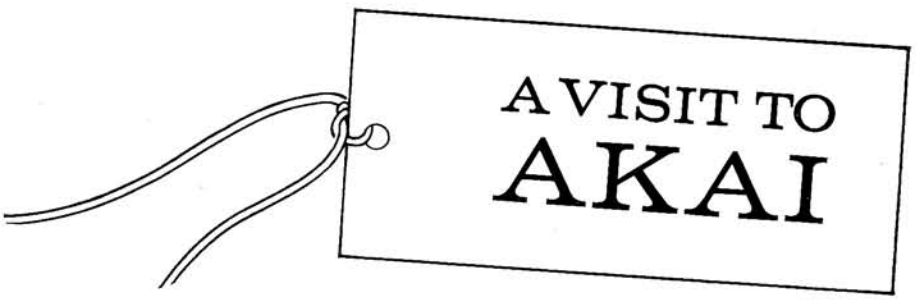
After a preliminary electrical checkover each machine is subjected to life testing. This

Final stages in assembling the Akai M8



Akai M8 passing-out tests

Mass copying of demonstration tapes on M8 recorders



ANTHONY EDEN CONTINUES HIS

EXAMINATION OF THE JAPANESE AUDIO INDUSTRY

initial checking gives an opportunity for faults to be located before final tests are made. After this, each machine is shock tested which involves dropping the machine about four inches on to a steel baseplate. This test brings to light any poor connections or loose mechanical fittings. The girl operating this shock testing equipment obviously enjoys her potentially destructive work, for at the same time she pulls at the knobs and selector switches, all at very high speed. After this the general mechanics of the deck are checked, particular emphasis being placed on correct setting and alignment of the tape transport mechanism. When necessary adjustment have been made, the wow and flutter of each machine is checked. The level registers as an RMS value on a wobble-meter, a pre-recorded tape being used to show the playback value of wow and flutter only.

COMPLETE CHECK

A complete electrical check is then performed to check treble boost, bias level and playback characteristics. A final check is made using a microphone to record speech, which is then played back and listened to critically. If all is well here, the machine is ready for packing.

In addition to the already comprehensive tests carried out on each machine, 10% of each batch are chosen at random and sent to a special test room. Again the tests are exhaustive, and if 2% of the batch fail, the whole batch is rejected and returned for complete rechecking and testing. On the M8 production I saw, 500 machines were being made for an American order. Fifty of these were then selected for close scrutiny and if only one machine failed these tests, the whole batch would be rejected. After such exhaustive tests the worthiness of every machine that leaves the Akai factory must be well assured.

A point well worth mentioning was the recording of the demonstration tape that Akai include with each M8 machine. A group of M8 tape recorders were set up and recorded their demonstration tapes from a master machine. This must surely illustrate the confidence that Akai have in using their own machines, for most companies make their demonstration tapes on sophisticated professional equipment.

There are three observations of particular note I should like to make concerning the production of Akai tape recorders after my visit to the factory. The first point is the extreme care taken in the production of the tape decks. The component parts are meticulously produced and my own impression of the people in the workshops was that of a highly skilled production team. I must confess that after watching these people at work it was disheartening to find a slip-on capstan sleeve—a rather unscientific approach to speed changing.

MANY USERS

The second point is that many users—in Britain at least—prefer really low hiss level to the alternative, offered by crossfield bias, of extended HF response.

The third point concerning Akai equipment is the trouble taken to test every tape recorder. Genuine care is taken to ensure that every tape recorder functions properly. While rigorous testing does not necessarily produce the ultimate in precision engineering, it does produce a uniform standard of production, and this is very important.

I shall long remember my visit to Akai for the hardworking enthusiasm of everyone in the company, and the happy atmosphere that existed there. The creation of such an atmosphere is one of the secrets of Akai's success.

David Lester: Q. A. Engineer

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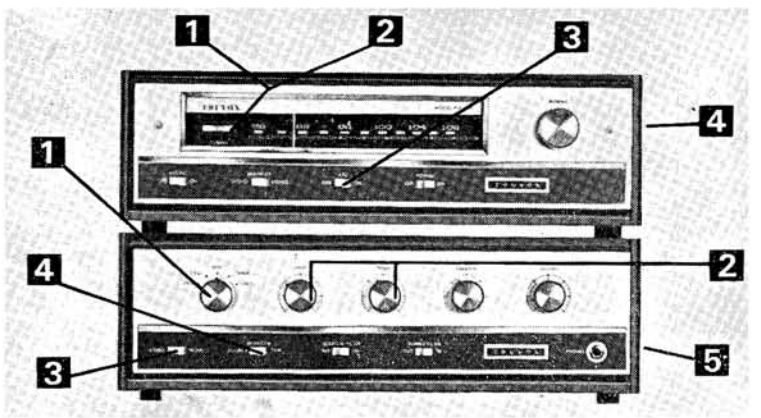

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WHAT'S WRONG WITH TAPE RECORDS ?

SOME CANARDS COLLECTED BY BERNARD PLUMTREE

FROM the day that the first spool of magnetic recording tape was sold as a deliberately pre-recorded item, to be played back in place of a disc and to be erased only in error or pique—from that day there has been talk of tape-recorded albums sooner or later supplanting disc.

Later we may see embossed tape or laser-optical methods outdating the pair of them. Meanwhile, for those who want to join in, here are a few pre-recorded pebbles frequently heard rattling against Goliath's twelve-inch shield.

(i) Tape by its constant speed avoids the quality loss of the innermost grooves on disc.

(ii) Stereo production and separation are more satisfactory from tape than with the multilateral hip-wiggling of the stylus and its couplings.

(iii) Artificial restrictions on playing-time, crowding of grooves and/or awkward turns in mid-symphony are avoided.

(iv) Your choice : frequent sapphire-replacement, the danger of a damaged diamond digging up your best disc—or siliconed tape sliding placidly past long-life heads (these may soon be glass-bonded-ferrite, changed by a simplified, positive plug-in whenever a General Election comes round). Your tape-machine, like a government, may be due for service anyway by then.

A quick word from the Opposition. Apart from troubles over recording characteristic (still bothering tape just as it used to beset disc), an odd feeling has been confided to me by one or two tape-album owners that records on that medium have an air of impermanence compared with discs — *because they are potentially erasable* ; whereas the stylus may damage a disc or blur its fidelity, it can never erase it. Psychology again putting its oar in ; a recordist friend of mine travels only on the top back seats of buses when bearing valuable tapes for fear of DC fields on the tube, unsuspected radios and speaker magnets under car shelves, scooter magnetos and the like !

No amount of technical reassurance (or blinding with science, as it is known in orchestral circles) re the tenacity of the induced magnetic pattern, unless deliberately and radically disturbed, has any success in uprooting an illogical 'semi-permanent' worry about tape records. Nor the point that a disc could in theory be warmed and re-pressed—nothing save death and taxes is truly permanent.

The fact that the worriers may also find tape difficult to lace up, or to keep it from ending up on the wrong spools after a party, may be a part of it ; moreover, they argue right back at you, thus :

(i) Disc-damage has a practical tape equivalent too. Repeated playings past magnetised heads and guides can 'wear away' (part-erase) the finer details, i.e. cause progressive replacement of high treble with hiss.

(ii) You are safe if you pay extra to have the record-stages immobilised, but in practice it is rare to meet machines thus emasculated ; even with an erase-link drawn it is easy enough to put clicks on the tape.

(iii) How often do the tape-catalogues prove short of the piece you want, by the artist or under the baton you prefer ?

(iv) Tape, like transistors, has not existed long enough for dogmatic statements about 'everlasting', while the disc process is in the prime of life with its groove (on cylinder) going on three-score-and-ten.

(v) What does the layman do when the tape snaps, or if the machine starts eating it ? Change to cassettes which may not fit your machine, nor match each other ?

Meanwhile, a number of unnecessary troubles persist on many pre-recorded albums ; my collected experience with seven recent stereo tape issues may surprise the readers as much as the writer.

Packaging promotes your product—so the American sales-experts say—but compared with disc-record sleeves the tape-boxes of albums now before me are rough in printing, colour and in accuracy of the listings in some cases. Labelled cardboard, not smooth surfaces, meet the eye and finger ; on opening, no inner transparent bag nor any leader on the record : it is just a raw end tacked down with a bit of splicing tape.

The spools carry a paper label with titles, code number and "This is Side One" (again there was an exception bearing only a batch number on a little white sticker). The tape contradicted the label in one case, as This was Not Side One ; the outward end was the start of Side Two. One of the snags of the medium shows here—turning-over to achieve a true start is bedevilled by the necessary rewind : a minute or so during which, as the poet says, one feels a proper nit or burke before the assembled companee.

Natural break here for a word of praise. The tapes are $7\frac{1}{2}$ i/s (19.1 cm/s) $\frac{1}{4}$-track, promising wobble-free sound of good quality with an adequate running-time. Things are further helped by special spools with wide-centre hubs ; the pull-off radius, thus the supply tension of the tape, changes minimally from start to finish. Perhaps some enterprising British firm will stock these soon at a price competitive with the usual small-centre type. The radius-effect when playing from the usual narrow-centred spool one has to hand can give a lowered pitch to music, slip-wobbles, and even a bit of stretching on the odd machine in the limiting-case of message-spool work.

Lace up and begin. Tell yourself, perhaps rightly, that economics absolutely forbid fitting leader to the pre-recorded album these days—though EMI have had individually-printed ones on their issues, trailers too, so it can be done. Comes now a gap of anything up to a minute before a pre-echo or two heralds the show, out of a silence that is only relative ; the Isle is full of noises, clicks, bumps, glissades of background hum as a tape gathers pace for the high-speed-dubbing. Commonly one gets also the upward glissade of deceleration plus the switch-off left over from the previous customer in the race ; for high-speed copying has become a veritable steeplechase to keep copies-per-hour to a maximum, so as to hold unit-cost.

On one example unique in my experience the usual early-warnings were followed by a loud gravelly rattle for some seconds, possible causes of which defeat me (unless they then had to stop to de-mag the capstan-spindle ?).

Dropout during play (some seems inevitable in the present state of the art) stems sometimes from quite esoteric troubles, e.g. trapping of air between tape and record-head at high speeds ; these give fairly evenly-spaced fade-outs by loss of intimate contact, especially at an edge, where the slightest wrinkling aggravates matters. Other drop-outs are simply tape-faults, perhaps accentuated by the impossibility of using a pressure-pad safely at speed when producing copies in bulk.

One particularly original 'drop-out' in a mouth-organ session was the disappearance of the tune until someone faded up the solo-microphone fast . . . some fourteen bars too late !

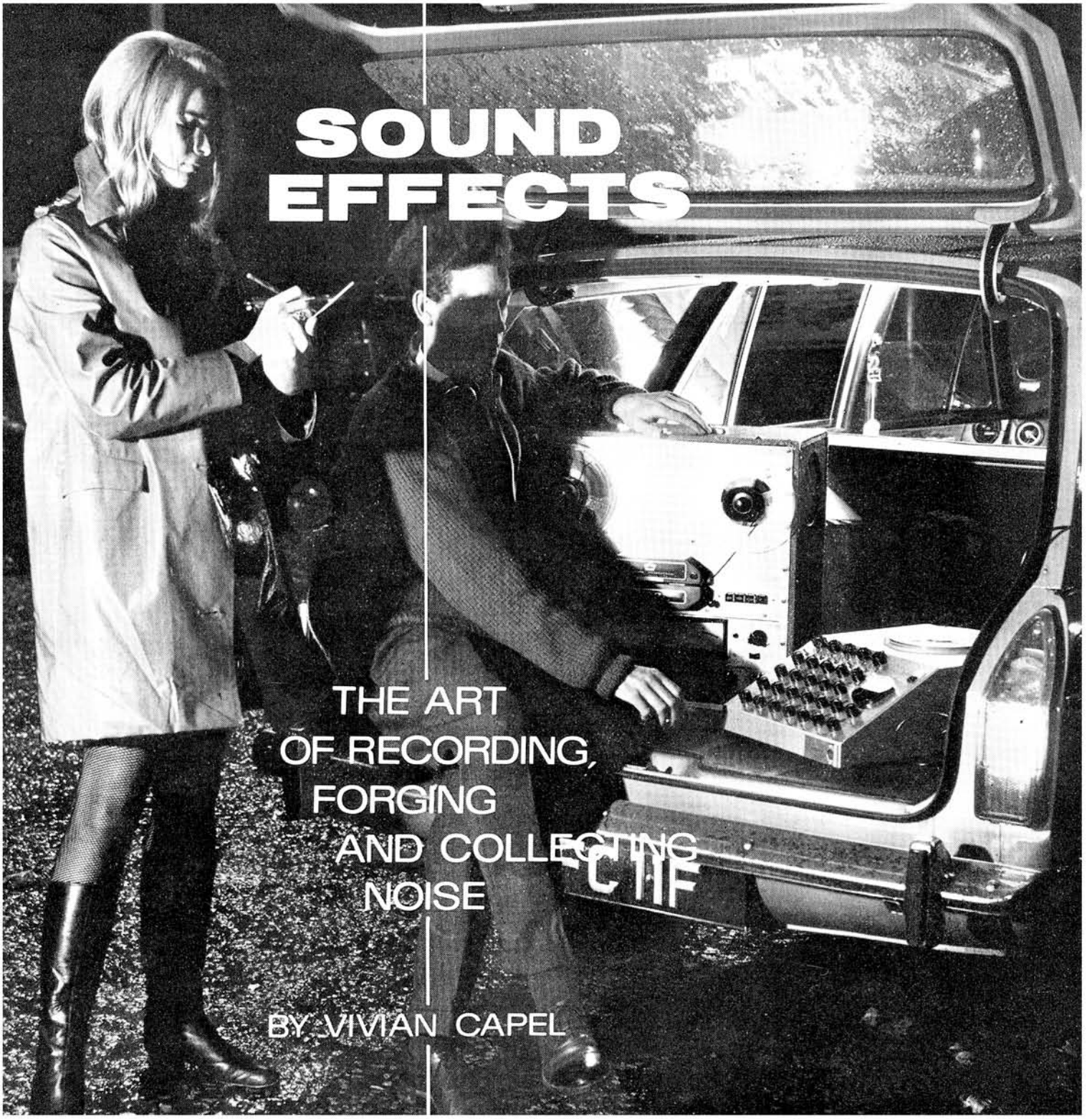
But it is surely not unreasonable to lay blame for discontinuities mostly at the door of rather cheap materials. The seven albums which provoked this article had been made on three different sorts of tape—one having the slightly springy hallmarks of old stock,

(*continued on page 83*)

SOUND EFFECTS

THE ART OF RECORDING, FORGING AND COLLECTING NOISE

BY VIVIAN CAPEL



Above: Crown International SX724 recorder and Feldon mixer being used, on a wet night near the Embankment, to produce stereo special-effects tapes.

MOST cine films, theatrical productions and taped dramas call for the use of sound-effects of one description or another. In some cases these may be artificially produced at the actual time of recording, but this can be rather inconvenient if the effects are complex. In addition, there are many effects which just cannot be produced artificially in the home. The answer is, of course, to have the effects pre-recorded and then to mix them in at the appropriate time and place.

It may be difficult to obtain particular effects at the time they are wanted and a production may be held up through lack of them. A solution to the problem is to prepare a tape of effects in advance, when no immediate use for them is foreseen, which can be continually expanded over a period, until quite a large collection is built up. Suitably labelled and indexed, these can then be drawn upon when required. A battery portable recorder will be essential, of course, as many of these recordings will be made out of doors or in places where a mains supply would not be available. The recordings can then be dubbed or spliced on to the effects reel later.

One question which may arise concerns the duration of individual effects. Some may be quite short and just last for the period of the actual event. Some examples are the sound of breaking glass, a tree being felled, an explosion. There obviously will be no timing problem with these, but matters are different where continuous sounds are involved, such as the sound of wind, storm, street sounds, the sea and such-like. There could be a tendency to record too much, occupying long stretches of tape, and fewer items could then be included. Generally about two minutes should be ample

for most effects. Should an occasion arise where a long stretch of a particular effect is required, then a special tape can be made from the effects tape, on which the particular effect is recorded over and over again for the desired period. Of course, more can be recorded initially, only the most suitable parts being selected for the effects reel.

The next consideration is how to find a particular effect when needed. The digital programme indicators included on many tape recorders are really not accurate enough for precise location of exact positions. Furthermore, one may change one's tape recorder, or perhaps need to replay an effect on a different machine, which would make any programme numbering useless. The only positive way is to mark the tape itself. Some colour-coded tape markers are available commercially, but those which the writer has tried have not proved very successful. Firstly, there were insufficient colours to mark a large number of tape positions, and secondly, they were rather thick, which could lead to uneven spooling and difficulties when passing the pressure pad in the recorder. White ink was tried on the back of the tape, but this did not prove very durable and could easily be rubbed off.

The best method that the writer has tried is a piece of white splicing tape fixed to the back of the recording tape. This marker should cover the whole width of the recording tape, though care should be taken not to overlap the edges. If the length of the marker is made about an inch then it can easily be seen as it passes during the fast-forward winding operation. Shorter lengths tend to pass unnoticed on machines with a rapid wind. These markers are then numbered to correspond with the index, and here a further difficulty is raised. Most forms of ink marking do not take very well on the smooth PVC surface and so can easily be obliterated. A simple answer to this is to scratch the number on the sticky side of the tape before fitting to the recording tape. This removes the white colouring, leaving the transparent base; then when applied to the recording tape, the brown colour will show through in the shape of the numeral. A steel point—not too sharp—should be used so that the tape will not be torn or punctured. The number must obviously be scratched backwards.

It may be thought convenient to arrange matters so that the marker occupies an easily recognised position, such as the first tape-guide at the start of the particular effect. The snag here again is that if a different machine is used at any time to replay the tape, the positioning will not be the same. Furthermore, if it is ever necessary to cut the tape in order to insert or perhaps take out any particular effect, it will not be known exactly where the actual recording starts. For these reasons it is possibly best to have the marker actually on the recording head at the start of the recording, thus enabling the recording to be used on any machine. It should not be necessary to mark the end of the recording, as it is better to note the duration of each particular effect in the index. This information can then be used when planning and scripting productions without the need to play effects through to see how they will fit for time. Watching a time-piece with a second-hand will in any case give a more accurate idea of how much sound-effect time is left, than is gained by watching for a finish marker.

In the case of continuous effects, it is better to fade them up at the beginning and out at the end when recording from the original tape, rather than leaving an abrupt start and finish. This will save fading up at the start when an actual production is being recorded and, should the effect run out before time, it will sound much better than an abrupt finish.

It would be tidier if all the recordings could be grouped and classified so that all of one kind were together. For example, one group could contain various types of bells, alarm bells, church bells, door bells and chimes, ice cream van bells and so on. The difficulty here is that some recordings that would qualify for inclusion in one particular section would be taken at different times. In the meantime, other sound-effects would have been added to the tape and duly numbered. Cutting the tape and making additions can be done, but this would throw the numbered sequence out. One way over this problem would be to add a lettered suffix A, B, C, D, etc., to each insertion. Generally, though, there is no great advantage in having the effects of one classification together, as rarely will they be needed on the same occasion. The easiest way is to keep adding each new effect as it is obtained, and to keep the index revised so that similar effects appear under the same heading with detailed description and the number on the tape where each can be located.

If a ½-track machine is used, when the reel is filled it can be turned over and the lower track used also. This could create some confusion with the labelling, as the labels for the first track extend over the whole width of the tape. An easy answer to this is to use a different colour for the lower tracks, yellow being one with sufficient contrast from the white labels of the upper track. When making lower track recordings it is as well to arrange matters so that the markers are not immediately adjacent to any of those of the upper tracks, as some confusion in identification could result when fast winding. If a ¼-track recorder is used, then it would be as well to use only the outer tracks and leave the inner ones blank. This will save further confusion and marking difficulties, and also will make the tape compatible for use on a ½-track machine if desired.

Now to some of the sources where good effects can be obtained. There are many easy ones to be obtained in and around one's own locality. Traffic sounds can be obtained merely by standing on the nearest main road and letting the battery recorder run for a few minutes (or if one does not wish to be too conspicuous, sit in a parked car with the window down). A car journey would make a realistic background for conversation in a tape drama, and can be easily obtained by letting the recorder run and driving the car round a couple of blocks. Further traffic noises could be: a car door slamming and the vehicle being driven away; a motor cycle starting up and moving off; a bus arriving and departing from a bus stop; and a heavy lorry starting and also labouring up a hill.

Various crowd noises can be obtained in a department store, at a sports meeting, and at swimming baths; in each case they will be quite different. Children at play can be recorded outside the local school playground. Many effects will need more patience, and will therefore be more rewarding when they are obtained. For example, a vigil at the end of the road housing the local fire station may be rewarded on Guy Fawkes Night by the sound of the fire engine at full speed with bells and sirens.

A trip into the countryside to the nearest farm could yield a variety of sounds. Cattle, poultry and other farm animals both separately and together could be recorded, milk churns clattering and farm equipment and machinery such as tractors and harvesters can also be obtained. A visit to a zoo could also yield a number of animal noises, but it would be better to choose a quiet time as animal sounds would be more useful without any human noises to accompany them.

When going on holiday, why not take the portable recorder instead of the more usual camera, which can make quite a few additions to the effects collection? Opportunities may arise for recording the sea on sand beaches, on pebble beaches, or dashing against rocks. Also, general beach noises could be added, fair-ground noises and those of motor-boats and other craft. Even a thunderstorm would not be so unwelcome if it yielded a good recording. With all these recordings several may have to be taken at various positions and distances from the source, and then the best selected for inclusion on the effects tape.

Another group of sound-effects are those produced by artificial means. Strangely enough, some of these artificial effects sound better and more realistic than the real thing! One possible reason for this is that they can be controlled, modified and re-recorded with the microphone in varying positions before the final one is eventually selected. Here are a few examples of some easily made ones:

Thunder can be produced by suspending a large sheet of thin metal and shaking it from one corner. Gentle shaking will give the effect of distant rumbles, but a sudden, violent start to the shaking followed by gentler ones will sound like a nearby peal followed by its echoes.

A quantity of dried peas rolled around on a metal sieve will give a good effect of torrential rain. This can be recorded on its own and also with accompanying thunder.

A good impression of waves breaking on a shingle shore can be obtained by putting some dried peas along with a few small pebbles in a fibre suitcase and rocking it back and forth.

The sound of rustling leaves and undergrowth can be obtained by gently crushing a ball of tissue paper in the hand, if done fairly smoothly with random rises and falls of intensity, the effect will be that of the wind rustling the leaves of trees; but if more vigorously and rythmically, the effect of footsteps through fallen leaves will be achieved. A sheet of cellophane treated in the same way will give the effect of a roaring fire.

Footfalls on other surfaces can be successfully imitated too. A small cloth bag filled with flour impacted rhythmically will give footfalls in snow, and a bunch of keys carefully shaken vertically will give the effect of footsteps on gravel, although care must be taken not to allow them to jangle against each other.

Footsteps on pavement are best achieved by recording the real thing, but the effect will be better if shoes with steel tips are worn, and also if the recording is made in a courtyard or narrow street. Sound reflection from the walls of nearby buildings will add reverberation and improve the effects. *(continued on page 83)*

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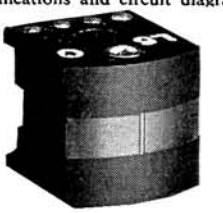

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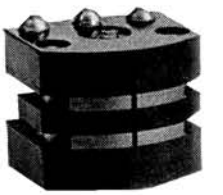

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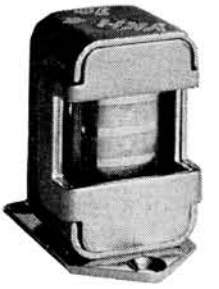

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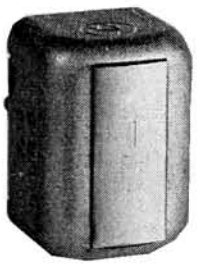

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SOUND EFFECTS
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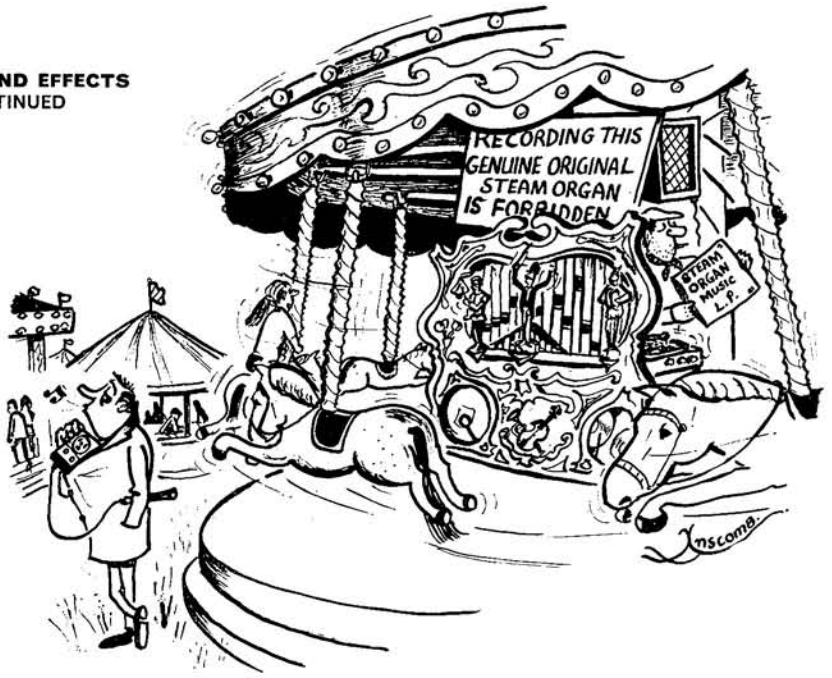

Quite a collection of footstep effects can be made as, in addition to the various surfaces, one can record walking and running steps, single and several simultaneously, and on the pavement, male and female footsteps. Then of course there can be numerous combinations such as a man and woman's footsteps together, running and walking, and also running and walking with additional combinations.

A breaking window is quite a useful sound to add to the collection. Dropping pieces of glass on to stone rarely sounds effective because the sound lacks the initial impact. The best way to do this one is to support a piece of (unwanted!) glass above a stone surface and then tap the centre with a hammer. The blow should not be too violent but just sufficient to break the glass, whereupon the sound of the impact and the glass vibrating will be obtained as well as the subsequent crashing on to the stonework. It goes without saying that extreme care should be taken when doing this one, and a sensible precaution would be to wear leather gloves and a pair of sunglasses.

The use of half coconut shells for hoof-beats is well known, but remember that when used on a padded surface the effect of hoof beats on grass or earth can be obtained. A foghorn or ship's siren can be imitated by blowing across the top of a bottle. The pitch of the resulting note can be varied by putting some water in the bottle; the more water the higher will be the note.

Some good effects can be obtained by recording and playing back at different speeds. A splashing tap played back at half the recording speed will sound like a waterfall or other large volume of moving water. The effect of a large generator or other piece of heavy machinery can be simulated by running a recording of a vacuum cleaner at half speed.

A yet further source of effects remains: radio and television drama productions. Effects are often heard which it would be difficult to obtain naturally or make artificially; the writer has one very good recorded effect of a car smash obtained from a radio play. Of course one does not know in advance what effects are going to be used, so the only thing to do is to record any likely looking production in the hope that a usable effect may be extracted later. A snag is that the effects are usually of short duration and often dialogue is superimposed over them; but often, enough is transmitted so that with a few repeats a recording of usable length can be made. Television films are often quite productive in this respect, because owing to their visual nature, there are usually much longer gaps in the dialogue than could be tolerated in the sound radio play; adventure and action films are usually the richest source of unusual sound-effects.

Having exploited these various sources, the result should be quite an extensive collection

(*continued on page 93*)

WHAT'S WRONG WITH TAPE RECORDS? CONTINUED

with several spots over caliper by 0.006 in. (0.015 cm.) width showing up near the end of another reel. Should such faults not have been trapped somewhere in the inspection, by the tape-makers if not by recording-operators? More than one of the tapes collected static-charges like a Wimshurst-machine, too.

Average levels put on to these tapes showed over 10 dB between the heaviest-recorded album and the softest one; bass-heavy to a point needing -3 (*Quad*) ranging down to deficiency in the low end calling for +2, while the treble differences between albums were, if anything, wider. A few gratuitous test-tones to establish the maker's record-characteristic are of course too much to expect, but what was easily checked on the too-abundant empty parts was that the three detectable grades liked three different bias settings for an optimum product.

Of course, running perhaps ten slave-machines from maybe only a single high-powered record-amplifier is not easy; bias frequency should be up to twenty-thousand times copying-speed in inches per second, which runs into the MegaHertz if a company let speed really go to their heads (ouch!). Bad bias alone could account for variable treble-content; what spurious resonances a long lead to the head of a distant machine might manage is anybody's guess.

While we have been chatting, the tape has reached the end of Side One, or Track A (box and spool are at variance—is there yet a standard term for tape-records?). In order to avoid another slice of silence, we naturally stop the tape as music ceases, free it from the head slot and carefully transpose spools. Maybe some do this to dodge another lacing-up from scratch, or have an expensive status-symbol which will reverse itself at the pre-set spot.

We now meet the second half of the album, perhaps several minutes into the programme, this having been much nearer to the inner end than the end of Track A's programme. Three of the seven albums had this fault. The final piece invariably concluded quite a few minutes before the end of the available tape, so there would have been room and to spare to move it all up until the turn-over point coincided—as had been done perfectly well on the other four albums.

A minor point: how many owners of machines with 5¾ in. (14.5 cm.) spool capacity are precluded from using the supplied 7 in. (18 cm.) spools? It is by no means a question of accommodating enough tape; LP tape is common enough on commercial recordings, and the amount supplied with each album would fit snugly on a 5¾ in. (14.5 cm.) spool with ample room for a wide hub.

A problem still unsolved is that of finding individual items on a tape. Discs are still more convenient in this respect, since one can 'drop the needle' wherever one wishes. Discs are also easier to handle and store, though cassettes may have the edge on them here. But the machine that will accept any cassette does not yet seem to exist.

The foregoing is fact—not a deliberate diatribe against any one manufacturer. All these troubles could have been explained away in the early days as teething tantrums—but these are no longer early days.

I recently broke the rule 'no peeping before December 25th' when I received a long-awaited orchestral tape as a Christmas present, purchased from a most reputable London dealer. The counter assistant was most helpful when I returned it, with a list of faults, and changed the recording without question. Perhaps he also had met some slight difficulties before!

Have not yet come across a case of accidental B-wind (oxide-outwards) but this happened to a screwdriver-happy friend of mine. His tape had a fold-over a little way in and, when first played, was reproduced backwards. Having twiddled every knob and lever to restore the missing sound, he unplugged the machine and up-ended it, then proceeded to . . . (slow fade to *Tell Me the Old, Old story*, montage National Anthem, and fade to black).

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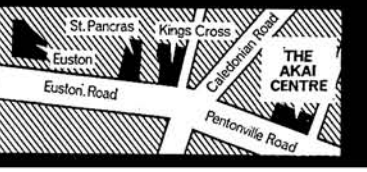

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CLOSED CIRCUIT

No 4 THE PRICE OF LEARNING

BY RICHARD GOLDING

IN the last few years, the *Marconi* company has supplied closed-circuit television equipment to more than thirty university and college units throughout this country. By 1971 it is estimated that over a million school children and students in London alone will be able to view transmissions derived from Marconi cameras and systems. This experience in planning, designing and installing educational CCTV equipment has resulted in the production of two standard packages, one for fixed installation and the other for mobile use.

St. Mary's College of Education, Twickenham, has been supplied with a typical two-camera package TV system. This provides facilities for televising lessons, lectures, news items and mini-drama productions for reception on monitors in the same building or other departments. One of the advantages of the Marconi package system is the accommodation of the control room equipment in prefabricated packages: a vision console, a sound console and, if required, a telecine bench. Connection is effected by preformed cables, the entire system being assembled and tested before it leaves the factory. This results in rapid, trouble-free installation on site and a reduction in time and expense. Two Marconi vidicon cameras, type *V322B*, fitted with manually-operated four-lens turrets and electronic viewfinders, and mounted on pan-and-tilt heads on castor-based tripods, feed video signals and talkback from the cameraman to the control room. The camera cables also connect the mains supply and synchronising pulses to the camera.

VISION MIXER

A six-channel vision mixer, with *mixing* (superimposing the beginning of one shot or scene on the tail of the other), *fading* (fading to a black screen) and *cutting* (changing instantaneously from one picture to the next) facilities, synchronising pulse generators and vision-and-pulse distribution amplifiers are included in the control equipment. Programme sound sources from microphones, telecine, disc or tape are fed through a selector panel to a multi-channel sound mixer. Two-way communication by means of headsets is provided between the producer, cameraman, telecine operator and the studio floor manager. The complete mains power requirements may be supplied from one 13 A source. Provision is made for extension of the system by the addition of video tape recorders and remote cameras. Four 14 in. (35 cm.) monitors allow any picture to be previewed before cutting. The planning and design of this system make it a useful, versatile and economical installation to meet a wide range of studio requirements.

The photograph shows the control room and part of the two-camera television studio at St. Mary's College. One of the two studio V322B cameras can be seen through the glass window separating the studio and the control room. These cameras are fully automatic in operation and can cater for a wide range of lighting conditions, without attention from the cameraman. A V322B is also visible on the left. In normal use, the on/off switch is the only electronic control that need be touched.

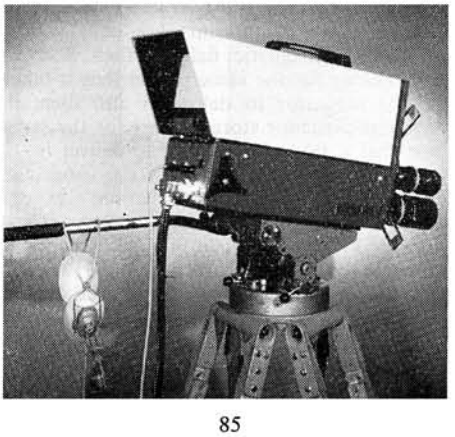
EDUCATIONAL NEEDS

The Marconi Mobile Television System for outside location work has been built into a 30 cwt. *Ford Transit* van. It was designed to meet the needs of educational establishments and incorporates three V322B vidicon cameras with viewfinders, two having four-lens turrets and one a zoom lens; three *Vinten* tripods with pan-and-tilt heads; and three 250 ft. lengths of terminated camera cable on drums. Racks in the rear half of the van accommodate all the electronic equipment including four 9 in. monitors, the distribution amplifiers and the synchronising pulse generator. A mounting platform in the forward part of the van accommodates the video tape recorder. This mobile system will supply signals to eight 23 in. display monitors. The addition of an extra vision distribution amplifier and sound distribution amplifier increases the output to feed eighteen monitors, and one more video amplifier increases this to accommodate twenty-eight. The lighting equipment that can be supplied comprises tungsten-iodide flood lamps, spot lamps and all necessary stands, brackets and cables.

Glasgow University was among the first in education to use a mobile CCTV unit. Although it was designed by Marconi, it is rather different from their standard package for it is a four camera unit and is built into a *Morris* mini-bus. It cost about £16,000.

The fourth camera is used for scanning captions and has also been employed on a boom to record surgical operations. The main use for this camera, however, is to

(*continued on page 94*)



ELEMENTS OF TAPE RECORDER CIRCUITS

PART 9—THE BIAS OSCILLATOR

BY G. T. ROGERS

IN Part One of this series it was mentioned that the bias oscillator had a twofold purpose. Firstly, it has to provide an erase current with a frequency of about 50kHz to the erase head, which removes unwanted signals from a tape before a new recording is made. Secondly, the bias oscillator has to supply a smaller bias current to the recording head. The bias current is fed along with the audio signal and this serves to increase the amount of signal recorded on the tape and at the same time reduces distortion to an acceptable level (for a more adequate discussion of the effect of bias and the process of erasure the reader is referred to Parts Three and Four of David Kirk's series, June and July 1965).

In the present article we shall begin by describing the underlying theory of oscillation, then explain the working of some practical circuits, and finally see how the oscillator is coupled to the erase and recording heads.

To understand how oscillators work we must consider a simple oscillatory circuit consisting of an inductor and capacitor arranged in parallel ; but for the moment let us remind ourselves what happens when a charged capacitor is discharged through a pure *resistance*. The current through the resistance is greatest at the instant the discharge begins and diminishes almost to zero at a rate which depends on the value of the C and R components in the circuit. The product of the resistance and capacitance is known as the *time-constant* (T) and is the time taken for the current to fall to 0.368 of its initial magnitude, **fig. 1a.**

When the pure resistance is replaced by an inductor or coil, the decay of current in the resulting tuned circuit is not as shown in **fig. 1a** but more like that in **fig. 1b.** Instead, oscillations of current are obtained, that is an alternating current (AC) flows in the circuit.

To explain this surprising result we must recall what we have said earlier about the inductance property of a coil. Now assuming that the coil has negligible resistance, when the capacitor begins to discharge the inductance of the coil opposes the current, and the discharge is slowed down. Eventually the electrical energy from the capacitor is transferred to the magnetic field around the coil. The inductance of the coil now causes the current to continue to flow in the same direction and the capacitor begins to charge up again, but with opposite polarity to its original charged condition. The energy is thu passed back to the capacitor. The oscillatory interchange of energy between the capacitor and the inductor continues in this fashion and an AC current flows in the circuit.

In practice, of course, a coil has some resistance, and because the energy of the system is gradually converted into heat the amplitude of the oscillation steadily diminishes to zero as shown in **fig. 1b.** These *damped* oscillations, as they are called, require an external supply of energy to maintain the oscillation and keep the AC peak value of the current constant. A close analogy to this is the case of a child on a swing, who keeps moving as the result of a systematic push from someone on the ground, and in practical oscillators, as we shall see in a minute, this systematic aid is provided by a valve circuit with which the tuned circuit is associated.

Earlier in this series it was explained that a coil and capacitor when used in an AC circuit have a resonant frequency, and in the parallel circuit the current is a minimum at this frequency. Now when a coil and capacitor are set into oscillation in the manner described above the frequency of the AC current produced is the same as this resonant frequency. Given by the formula $f = \frac{1}{2}\pi \sqrt{LC}$; it is therefore governed by the values of L and C for the inductance and capacitance respectively.

The larger the inductance of the coil, the longer its electromagnetic field takes to grow and fall. Similarly, the larger the capacitance, the longer it takes to discharge electrons from one plate to the other. At the oscillation or resonant frequency the charge and discharge rates of both components are equal. The coil's electromagnetic field is then able to store energy for the same period that it takes for the capacitor to deliver it and then, in turn, the capacitor stores energy for the same time that it takes for the coil to deliver it.

Let us now see how a triode valve can assist in maintaining oscillations in an inductor-capacitor oscillatory circuit. Consider the simple circuit for an oscillator shown in **fig. 2.** When such a circuit is switched on, a disturbance is set up in the tuned circuit, and from what has already been said an alternating *current* flows through the capacitor, which produces an alternating *voltage* across it. This voltage is then amplified by the valve and an alternating current is obtained at its anode and also in the coil (A) which is connected to the anode. Now if this coil is correctly wound and positioned relative to the other coil (B), some of the energy in coil A can be returned to the tuned circuit and compensate for the energy lost. With this circuit, then, the oscillations are undamped and continuous as long as the feedback of energy continues. The return of energy from coil A to coil B takes place by electromagnetic induction ; it is therefore the same as transfer of energy from the primary to the secondary coil of a transformer.

Moving on now to some practical examples, **fig. 3** shows the essential circuit of a Hartley oscillator which is used in many tape recorders. The oscillator employs *positive feedback* from the anode of the valve to the grid of the same valve.

The inductance L_1 is tuned to the correct frequency by the capacitor C_1. This, of course, is the oscillatory circuit and the alternating voltage developed across its capacitor is fed to the grid via the potentiometer R_1. This enables the grid driver voltage to be adjusted so that only the correct amount of feedback is used to maintain the oscillations, so that the overload point is not reached, thus avoiding harmonic distortion in the oscillator's output. Energy is supplied to the tuned circuit directly from the anode, which is maintained at the correct potential by tapping off HT from the coil L_1. The capacitor C_2 in the HT circuit enables the HT voltage to decay slowly when the oscillator is switched off. An important point, since it avoids any danger of permanent magnetisation of the recording head due to a sudden cut in the oscillator supply. As indicated, the energy for the erase and bias windings is taken from the secondary winding L_2, which is tightly coupled to L_1, the number of turns in L_2 enabling the correct voltage to be applied to the heads.

Another type of oscillator which is commonly used is the push-pull oscillator. This uses two triodes or two halves of a dual triode, and when one triode is in the positive half cycle of oscillation the other is in the negative half. This arrangement tends to reduce distortion in the oscillator's output and it is for this reason that the push-pull circuit is favoured both for professional and the better domestic tape recorders. Dis-

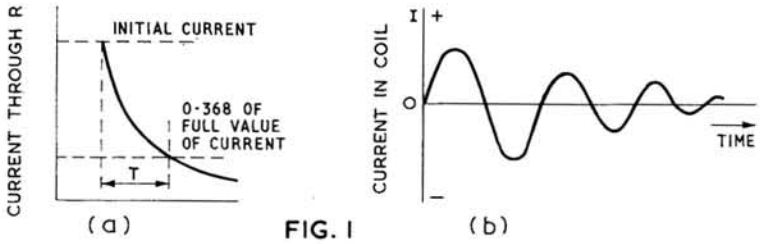


FIG. 1

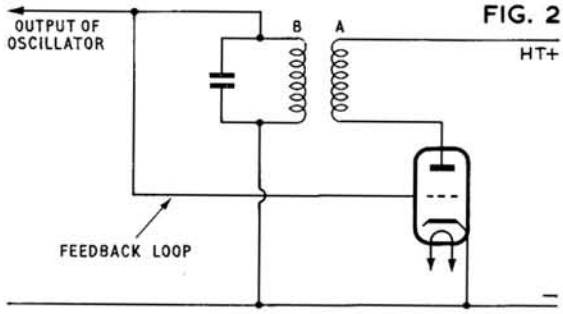


FIG. 2

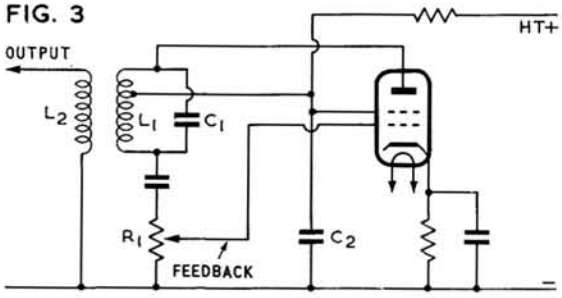


FIG. 3

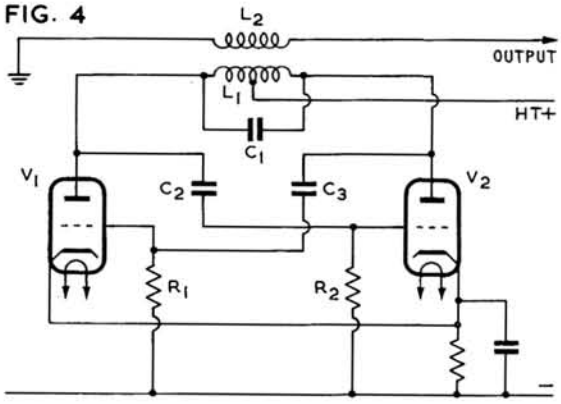


FIG. 4

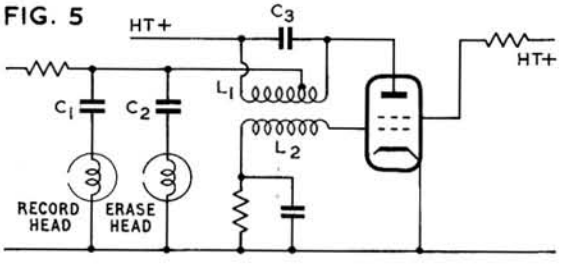


FIG. 5

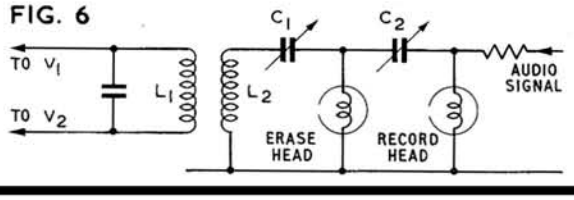


FIG. 6

tortion in the bias waveform shows up as noise. Moreover, the greater the demand upon the oscillator to provide enough current for adequate erasure, the greater the likelihood of distortion. The push-pull circuit therefore scores over most single-ended oscillators because of its lower distortion for the same output.

Fig. 4 shows a representative circuit, the resonant frequency being determined mainly by the resonant circuit L_1/C_1. Positive feedback, which maintains continuous oscillation, is from the anode of V_1 to the grid of V_2 through the capacitor C_2; and from the anode of V_2 to the grid of V_1 through the capacitor C_3. High tension is supplied to the anodes of the two triodes through the centre of the coil as shown.

Oscillations of the tuned circuit cause alternating voltages to be developed across the inductor and capacitors, which in turn cause alternating voltages of *opposite phase* to be applied to the grids of the two triodes.

Now before we see how this very efficient circuit works let us diverge for a minute and consider what happens when we vary the grid voltage of a triode valve. When this is made more positive electrons will be accelerated from the cathode to the anode and as a result the anode will become more negative. The reverse is true if we make the grid more negative. In this case the electron flow in the valve will be slowed, less electrons will reach the anode and this will become more positive.

Now back to **fig. 4.** When the grid of V_1 is positive-going at any given instant, the anode of this valve goes more negative. This, of course, does not mean that the actual voltage is negative but that the polarity of the AC waveform is going in the negative direction. The negative-going voltage at the anode of V_1 then is transferred to the grid of V_2 which in turn causes the anode of V_2 to go more positive. In short this means that the voltage fed from the plate of V_2 to the grid of V_1 is of the same polarity as the original signal on this grid and enhancement of the signal takes place. This is positive feedback. Similarly, positive feedback occurs at the grid of V_2 but the voltages on the grids of V_1 and V_2 are of opposite phase, and while one triode is working in the positive half cycle the other is in the negative half.

As stated earlier, positive feedback enables energy to be supplied in sympathy with the natural oscillation of the inductive and capacitive components of the circuit. This extra energy must be sufficient to maintain oscillation but at the same time it must be carefully controlled to prevent the valve being overloaded. In **fig. 4.** This is achieved by voltage divider action, the feedback capacitor of each triode forming a potential divider in conjunction with its respective bias resistor.

So far we have seen how the frequency of oscillation is determined by the capacitive and inductive components in a tuned circuit, and how the oscillation is maintained by an associated valve circuit. Another important condition of an oscillator, however, is that it must supply sufficient voltage to cause the required current to flow through the erase and record heads without overloading.

The voltage directly available at the oscillator

(*continued on page 96*)

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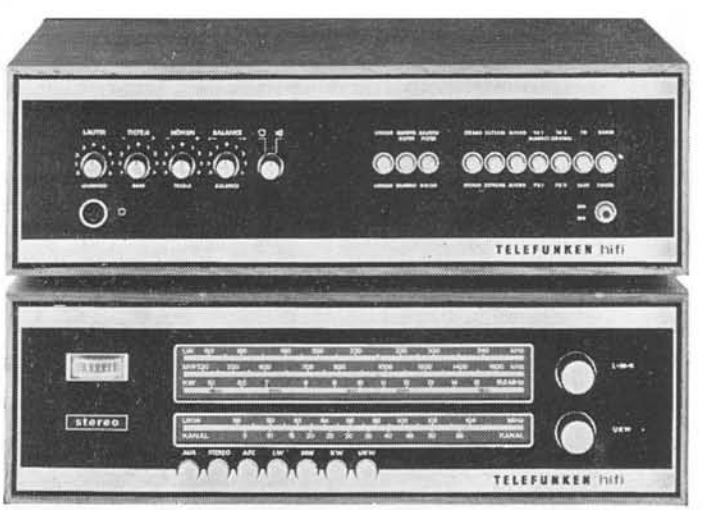


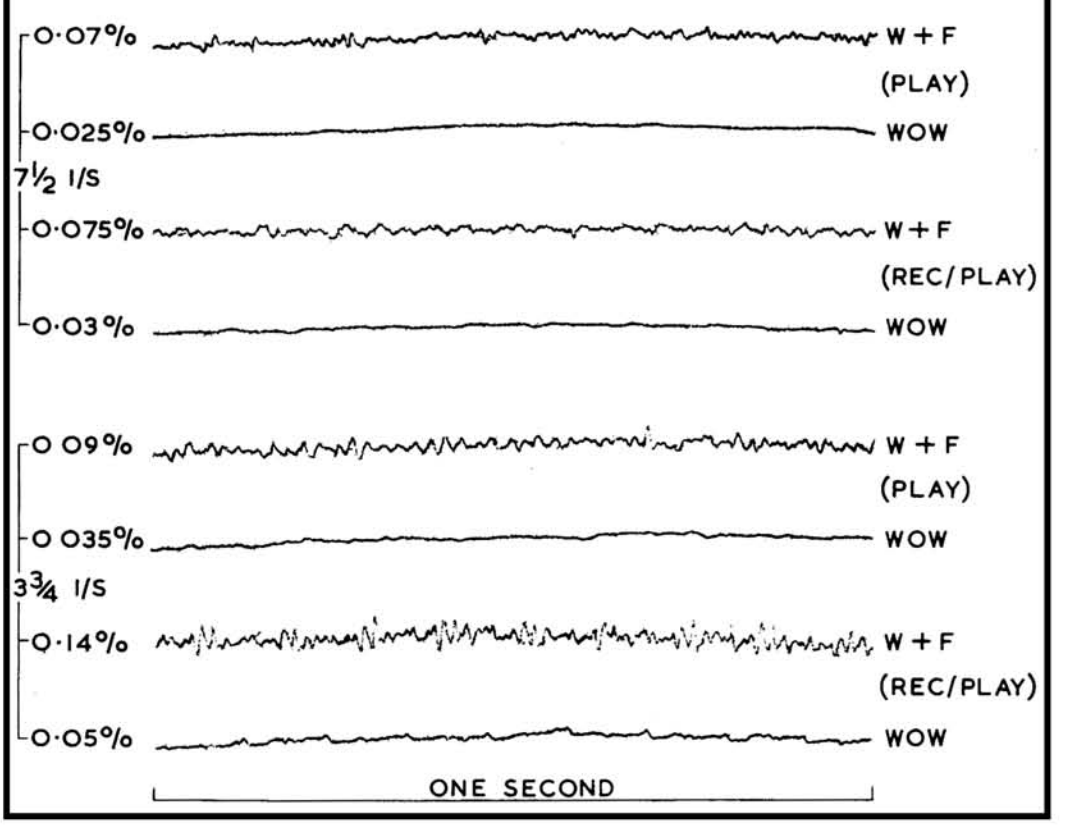
DUAL TG27 STEREO TAPE UNIT

MANUFACTURER'S SPECIFICATION. Quarter-track stereo tape unit. **Tape Speeds:** 7½ and 3¾ i/s (19.1 and 9.5 cm/s). **Wow and flutter:** ±0.1% weighted to DIN 45 507. **Signal-to-noise ratio:** 50 dB. **Inputs:** 0.3 mV at 2.7 K (*mic*) and 110 mV at 1 M (*gram*). **Output:** 0.5 V. **Frequency response:** 25 Hz — 16 kHz (19.1 cm/s) 30 Hz — 13.5 kHz (9.5 cm/s). **Price:** £61 19s. (£56 14s. in chassis form.) **Distributor: Dual Electronics Ltd., Radnor House, London Road, Norbury, London, S.W.16.**

ONE'S first impression of this unmounted deck is that of extreme lightness and possible fragility. Closer inspection, however, shows that although the plastic dress cover, for example, is very thin and light in weight, it is extremely tough and is adequately rigid when mounted on a board or cabinet. The deck plate also is of light gauge metal and relies to a certain extent on its mounting. The motor and flywheel, however, have plenty of weight in the right places—as will be seen later when we discuss speed stability.

This is a single-motor deck with the motor itself being moved right and left to drive the reel turntables directly for fast wind and rewind. Tape-operated servo brakes are fitted to each turntable so that the reels are stopped whenever the tape tension slackens. Wind and rewind are consequently relatively fast for a single-motor machine with no slack loops or over stressed tape on stopping. In the same way, during normal tape transport, constant tape tension is maintained and reel effects on the short-term speed stability are correspondingly reduced.

FIG. 1 DUAL TG27 WOW AND WOBBLE



Drive to the flywheel is by a well designed soft rubber belt with the speed change lever flipping the belt from one drive pulley to the other in a most satisfactory way.

A light-weight wire 'feeler' bears lightly on the tape and operates a very ingenious switch-off mechanism which uses some of the kinetic energy in the flywheel to release the pressure roller whenever the tape breaks or runs off the reel.

The record key can only be operated if the stop key is pressed at the same time. This leaves the amplifier in the record mode and the record level meter can be set to indicate proper recording level without the tape moving. The 'start' key sets the tape in motion when desired. Note that this procedure differs from that of most recorders, where the start and record keys have to be operated simultaneously. The circuits revert to the play condition whenever the stop or fast wind keys are pressed. It is in fact possible to switch directly from record to rewind without going through the 'stop' position.

Fast-forward wind of a 1,800 ft. EASF LP tape took 4 minutes 12 seconds, rewind of the same reel being 4 minutes 2 seconds.

The mains on/off switch is in an unusual position on the head dress cover.

The main function switch near the centre of the control panel has a central 'stereo' position where each channel records and plays stereo signals from microphone, radio or gramophone. The adjacent gain controls can be locked together so that the volume of the two channels can be varied simultaneously by operation of either control.

For mono operation the function switch is moved anti-clockwise for top or bottom channels. In this condition the two gain controls can be unlocked and used to mix two mono channels on to either track.

With the function switch turned clockwise, track-to-track transfer of recorded signals is possible with the addition of a further mono signal from microphone or disc.

A pause control and a button-reset rotation counter complete the control layout.

The counter is driven from the left-hand turntable, 12 turns giving a reading of 009.

The fluttergrams of **fig. 1** have once again been divided into play only (or once through) wobble and the usual cumulative record/play

(*continued on page 91*)

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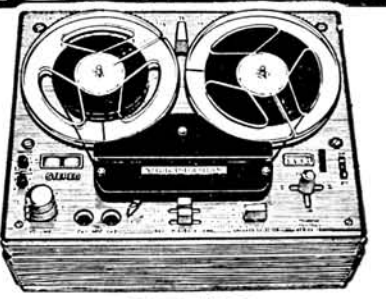

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Tandberg Series 12 ...	27 11 3	6 17 10	105
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Ferguson 3222 ...	9 3 9	2 6 0	35
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Grundig TK140 ...	10 2 2	2 10 7	38½
Philips EL4306 ...	11 0 6	2 15 2	42
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Tandberg 92	18 2 3	4 10 7	69
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wobble where the record and play wobbles may add or cancel from instant to instant. The upper traces at 7½ i/s (19.1 cm/s) show the play-only pen recordings from a virtually flutter-free test tape as 0.07% for the full bandwidth of 200 Hz and 0.025% for the wow measurement, where the bandwidth of the meter has been reduced to 10 Hz. Similar tests for combined record and play gave readings of 0.075% and 0.03% RMS. This shows that there is little build-up of either wow or flutter at 7½ i/s (19.1 cm/s) on this excellent tape transport mechanism.

At 3¾ i/s (9.5 cm/s) wide bandwidth wow and flutter from the test-tape was only 0.09% RMS, and the wow only on play was 0.035%. The combined record play wow and flutter (maximum reading) was 0.14% RMS and the record/play wow only was 0.05% RMS.

These readings are excellent by any standards, and all the more surprising when the extreme lightness and apparent simplicity of the deck are considered.

The responses of **fig. 2** from 70 and 140 μS test-tapes show that the playback equalisation is set to approximately 50 and 100 μS. The low frequency response is smooth and free of head contour effects. System noise with no tape passing the heads was only 30 dB below test-tape level and proved to be hum induced into the heads from the drive motor. As noted above, it is possible to move the motor slightly from side to side and this altered the hum level considerably. Hum-bucking coils are fitted in series with each head but any movement of these coils increased the hum showing that they had been set for best cancellation.

As the hum field from the motor contained multiple harmonics the audible effect was considerably worse than would be expected from the meter reading.

Record/play tests at 7½ i/s showed that peak recording level, with 5% third harmonic distortion at 500 Hz, was recorded with the record level meter needle just entering the red sector of the scale. This peak level was 13 dB above test-tape level. At 12 dB above test-tape level, 7½ i/s (19.1 cm/s) distortion figures were: 4.4% at 500 Hz, 3.8% at 1 kHz and 3.5% at 3kHz; and 5%, 4% and 4% at the same frequencies and level at 3¾ i/s.

FIG. 2 DUAL TG27 PLAY-ONLY RESPONSE (TEST-TAPE TO LINE OUT)

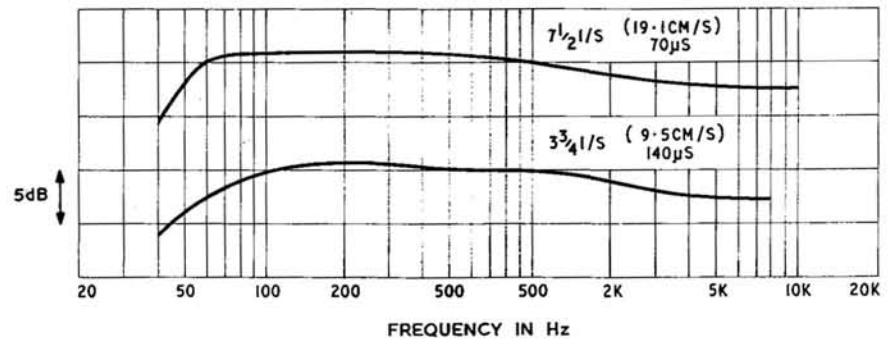
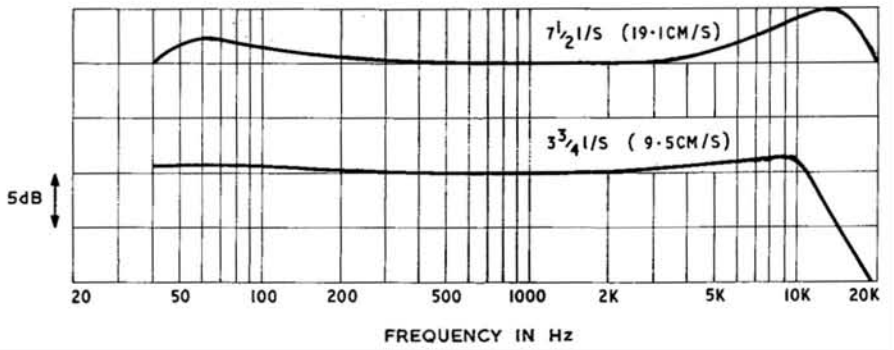


FIG. 3 DUAL TG27 RECORD/PLAY RESPONSE (GRAM INPUT TO MONITOR OUT)



The record/play responses at test-tape level are shown in **fig. 3**. It will be seen that a little bass lift has been used in the recording process together with adequate high note pre-emphasis to record a level response with the selected playback equalisation.

The electronic circuit design together with the mechanical design and originality of the deck are so good that it would be worth spending a few more pounds in reducing the hum field from the motor, or alternatively improving the magnetic shielding of the heads. I have never liked hum-bucking coils; they only seem to work properly on a pure 50Hz field and most induction motors send out a very distorted waveform with lots of high frequency harmonics which makes complete cancellation of the signal picked up on the heads a near impossibility.

A. Tutchings

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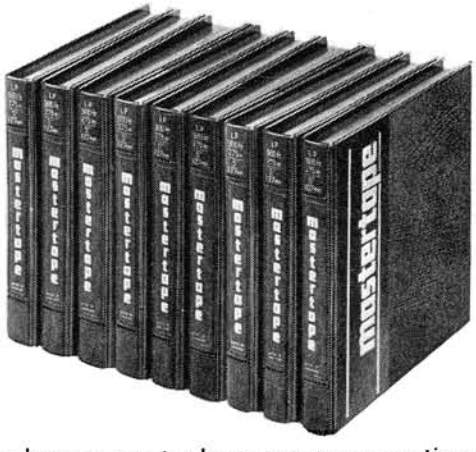

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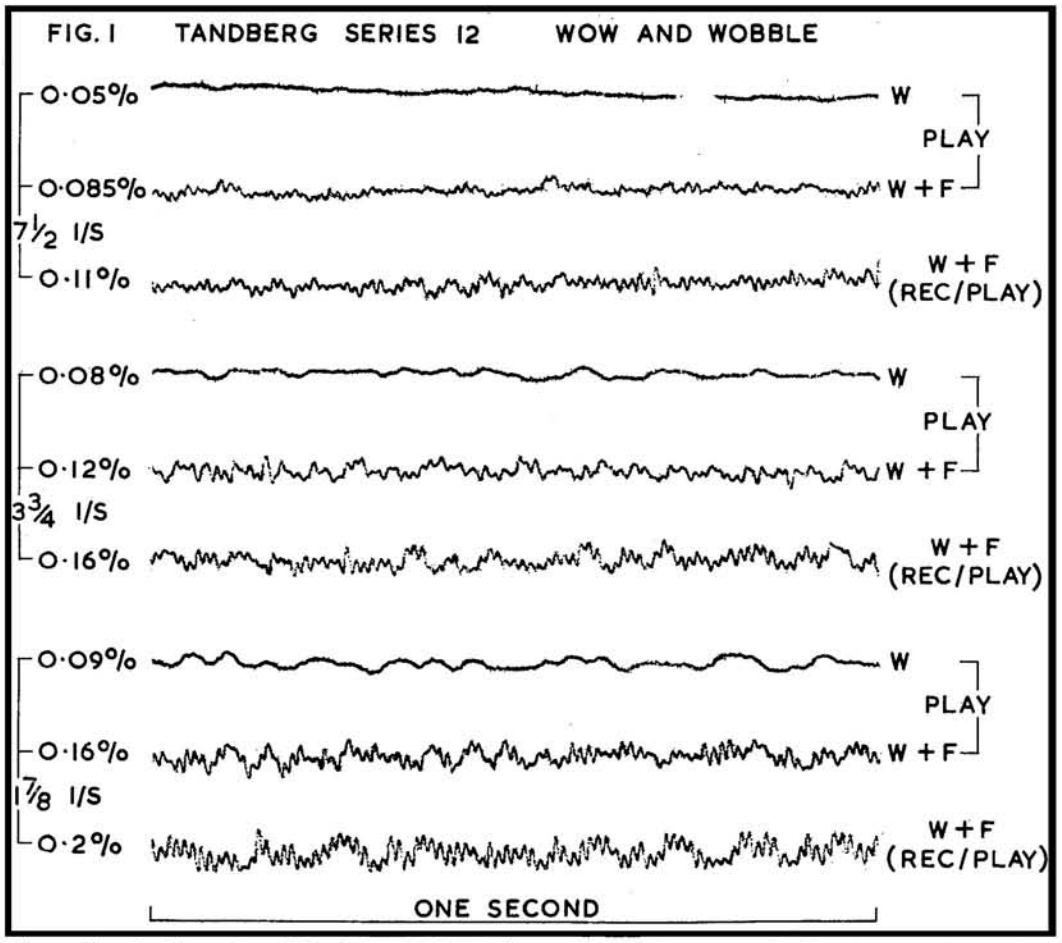
TANDBERG SERIES 12—POSTSCRIPT

THESE fluttergrams or pen recordings are the ones that went astray during the preparation of the review which appeared in the November issue.

One peculiarity of the original traces was a cyclical speed variation which occurred at about 10 Hz at all three tape speeds, but it was almost too much to expect that this would repeat itself several months after the original tests. Instead, the only cyclical speed variation common to all three speeds is a rather less obvious 20 Hz wobble. The offending idler wheel probably now has two flats on it instead of one!

David Kirk suggested that I left the pressure roller in contact with the capstan for 24 hours *after* my tests to simulate the conditions which might apply if the tape-operated auto-stop had switched the recorder off, leaving the roller and capstan in contact. This made no difference that I could detect; the wow and flutter readings were identical to those of the earlier tests and there was no audible bump from the roller or increased wow from the test-tape.



As mentioned in the original review, the top pair of traces for each speed were measured by playing a virtually wobble-free test-tape, so that the pen recordings show the play-only wobble of the machine under test. The lower traces are for record and play, where some components of the short-term speed variations may be in phase, and therefore adding, while other components may suffer momentary cancellation. **A. Tutchings**

THE FOUR WAYS AHEAD CONTINUED

Even if the four-channel system is adopted, however, the manufacture of two-channel recordings and normal stereo equipment will remain completely unaffected for at least a decade or so after its introduction; it may be that enthusiasts wishing to 'convert' to four-channel operation will be able to part-exchange their two-channel control-unit and amplifiers for the two extra loudspeakers required. It is almost certain that any four-channel tape machine placed on the market would have its own built-in power amplifiers, together with facilities for twin inputs from pickup and VHF tuner.

Any manufacturer who starts marketing four-channel tape recordings and equipment will be taking a bold step, but this would by no means be a greater step than that taken when stereo records were introduced barely 10 years ago, let alone that equally wide step of introducing the microgroove 33⅓ r.p.m. record. However, stereo VHF radio will forge ahead within the coming decade, and at present there seems to be no danger of stereo discs and conventional stereo audio equipment being outdated. These and other factors might mitigate against the adoption of a system such as I have described, which would involve a greater capital outlay on behalf of both manufacturer and consumer, perhaps without commensurate advantages being reaped by either or both parties. Only time will tell.

SOUND EFFECTS CONTINUED

of effects. Not only can these be used to add realism to a normal tape drama, but 'effects only' plays are possible if the collection is large and varied enough. In these, entire stories can be told by means of sound-effects alone, without a single word of dialogue or narration being heard.

An example of the beginning of such a voiceless play is given by the following sequence of effects: Several seconds of street sounds are heard, then the sound of a car drawing to a halt is superimposed followed by the footsteps of several men walking over a pavement. The street sounds continue for a few more seconds and then the sound of an alarm bell is heard. The footsteps are heard again, this time running, car doors are slammed and the car is driven off at high speed. Next, another car is heard with a siren sounding. The first car is faded up once more and then dies away to be followed by the clanking of level crossing gates and the sound of a train in the distance. Next the pursuing car is heard approaching, but stops with the squealing of brakes; the train gets louder and passes, taking a number of seconds to do so. The train fades out and there are a couple of seconds of silence and then we hear the sound of the first car again but this time with a background of farmyard sounds. It stops, the doors slam shut and then the sound of a barn door latch is heard followed by creaking hinges. The car is driven forward and stopped again and the sound of the barn door shutting. Then far away is heard the second car approaching with siren going, only to fade once more into the distance.

As the sound of the pursuing car dies slowly away the farmyard sounds continue in the background; then suddenly is heard the sound of a struggle inside the barn, muffled noises of things being knocked over, heavy breathing and the occasional tinkle of glass. Again the barn door is heard to creak and then follows running footsteps in undergrowth.

The continuation of the story can then be worked out and will of course depend upon available effects. Undoubtedly making a sound-effects tape has many interesting possibilities besides being an absorbing hobby in itself.

reproduce any transparencies, photographs, maps, diagrams and titles necessary to a programme. Full vision mixing is provided for the four cameras, with sound mixing for up to eight microphones and four high-level sources. Five monitors are mounted above the control desk in the van. The controls, incidentally, need no attention during the programme transmission.

The scanning caption camera and the videotape recorder enable a great range of visual material, including pre-recorded experiments and demonstrations, to be fed into any lecture room containing a suitable monitor. Added to this is a very useful sound feedback system which can be used for 'overflow' lecturing, allowing a student in a remote classroom to put a question to a lecturer speaking in another room.

£16,000 seems a great deal of money for a university to spend on one TV unit, but it does appear to have proved money well spent.

PITHEAD SERVICE

The National Coal Board have been in on this for over three years and now provides a pithead TV service for men either going on or off a shift. There are about five mobile units in action and the units try to visit two collieries each week, staying two days at each one. The programmes are usually mixtures of NCB film and live programmes involving local people. The live items are recorded on videotape and are mostly to do with safety or organisation. It is reported that live programmes, using well known members of the colliery as actors amid familiar surroundings, have an immediate impact on the men and have already shown the value of TV as a medium for safety information. The units are built to NCB requirements by *Systems Control Ltd.* of Southampton.

Of course, Marconi and Systems Control do not have the monopoly in providing CCTV systems. There are many other organisations all over the country that can provide and install a CCTV at almost a moment's notice. Just as there is a great variety of suppliers, so there is a wide divergence in price ranges. You can make up a mini CCTV system with two cameras, one monitor and a videotape recorder for a few hundred pounds ; on the other hand you can pay thousands of pounds for a camera alone. It depends on what you want and what you can afford. Most suppliers will happily make up a package to suit both your pocket and your requirements.

LEADING SUPPLIER

One of the leading suppliers of package CCTV is *Pye* and it is interesting to examine their range designed for educational television. Each scheme within the range can be expanded by the purchase of additional equipment, so, once having bought a cheaper priced package, you are not limited if you want to go on and expand the system. *Scheme B* comprises a *Teletutor* receiver which can be used for normal reception on its own and for CCTV pictures and sound. The scheme price is as follows :

25in. Receiver	£115	0	0
Tubular Trolley	10	0	0
Lynx Camera with 1in. f/1.9 lens	150	0	0
Tripod with Pan/Tilt Head ..	44	0	0
1000ft. Video Cable	26	2	6
	£345	2	6

Further up the scale we find *Scheme E.* This is a simple two camera Teletutor CCTV for lecturers.

25in. Receiver	£115	0	0
Tubular Trolley	10	0	0
Teletutor Viewfinder Camera with Zoom Lens (plus purchase tax)	672	6	8
Mobile Camera Stand with Pan/Tilt	95	0	0
Modified *Lynx* Camera complete with 1 in. f/1.9 lens, inc. junction box	210	0	0
Tripod with Pan/Tilt	44	0	0
Mobile Tripod Dolly	25	0	0
50ft. Camera Cables	67	0	0
Operator's Headsets	24	0	0
Four-Channel Mixing Unit ..	370	0	0
1000ft. Video Cable	27	0	0
8½in. Transistor Video Monitor	165	0	0
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Note here the price of the four channel mixing unit. If you require full control of mixing, fading and picture superimposition, with talkback to cameraman, picture quality control and acceptance of remote pictures, then you will have to pay around this price. There are, however, simple video bridge switches available on the market from £7 10s. upwards and I have details of twenty different models of this type which are supplied by *Visual Engineers Ltd.* of Aylesbury, Bucks. (This firm supplies a great variety of CCTV equipment and is responsible for marketing the Japanese *Ikegami* video tape recorder in the South and the Midlands.) With a Philips recorder a good system can be obtained for less than £3000; with a *Shibaden*—less than £2400, and you can go cheaper than the Shibaden. At the top of the Pye scale we find the *Scheme I* Educational Three Camera Outside Broadcast Van. This includes a Ford Transit, two Teletutor cameras and one Lynx camera as in Scheme E, one *Ampex VTR 7000* video recorder, four monitors, one vision mixing unit, and an audio mixing unit. The total price for the vehicle, fully equipped, tested and delivered to the customer's address is £9670 13s. 4d. This appears very reasonable considering that the van alone costs £3481 and the Ampex is £1375. *(The 4d. is presumably for the letter of complaint when it goes wrong?*—**Ed.**)

If you need a mobile CCTV for special occasions only then you can hire one. *Video Ltd.* of 2 Bath Road, Woking, Surrey, state that they can supply a three-channel O.B. van to cover any event in Britain at reasonable notice, and abroad by special arrangement. The equipment in the vans is self-contained and needs no external power supply. Video Ltd. also provide television studio facilities to broadcast standard.

output may be just right to drive the heads, but on the other hand it may be too much or too little. When the output is too small, transformer coupling is often used as shown in **fig. 3.** The secondary coil L_2 in this circuit steps up the output to the required amount.

Another single-ended oscillator is shown in **fig. 5,** where the secondary coil L_2 varies the grid voltage of the valve so that the current at the anode assists the natural oscillation of the tuned circuit (C_3—L_1). The correct output voltage for driving the heads is taken from a tap on the primary coil L_1, which has the effect of reducing the loading effects of the heads upon the oscillator. This tends to reduce distortion and enables the resonant circuit to be tuned more precisely to the correct frequency. Maximum loading is obtained when the output is taken directly from the anode, whereas if the other end of the oscillator coil were connected to the heads, the voltage applied would be zero.

The coupling capacitors C_1 and C_2, in conjunction with the head inductances, determines the amount of current flowing through the record and erase heads respectively. In particular, the value of the capacitance C_2 is sometimes chosen so that it resonates at the oscillation frequency with the inductance of the erase head with which it is in series. Under these conditions the series impedance of these components is a minimum and a relatively low voltage will cause adequate current to flow through the head. This is useful, since the erase head is fundamentally a high impedance device normally requiring a substantial voltage to cause sufficient current to flow.

Another method of coupling the oscillator to the heads, which has the advantage of isolating the heads from the oscillator circuit, is by means of a *tertiary* winding or third on the oscillator coil. This would be wound to supply the correct voltage to the heads.

In a push-pull oscillator, direct coupling of the record head to the oscillator coil L_1 (see **figs. 4** and **6**) is undesirable. Since the record head is unbalanced, one end of the winding being connected to earth, direct coupling would load down one triode but not the other and this would impair the important symmetry of the oscillator. This, of course, would defeat the object of the circuit which is to produce an output of exceptionally low distortion. Push-pull oscillators therefore nearly always use a secondary winding to couple the output to the heads. **Fig. 6** shows a typical coupling circuit for a push-pull oscillator, the record and erase heads being connected to the secondary coil L_2. C_1 is normally adjusted so that it resonates with the erase head winding at the oscillation frequency so that a minimum voltage can be used to drive the head as explained earlier. The bias current required for the record head is usually quite modest compared to the erase head current, but unfortunately the impedance of the record head is generally of a very high order. This means that a substantial driving voltage is still required for this head. In **fig. 6** this voltage is taken across the erase head winding itself. This is convenient, as although the voltage across the combined head and series capacitor C_1 is low, that across the head winding itself is much higher.

The capacitor C_2, being a variable component, enables the bias to be adjusted to suit the particular record head, the type of tape and the speed in use. The optimum setting of C_2 is of the utmost importance for it is the setting which gives the lowest distortion compatible with adequate high frequency response and a satisfactory signal-to-noise ratio. In professional equipment there is always some easily accessible means provided for varying the bias current, and also for measuring it, although in domestic equipment a variable control, if present, is generally hidden away inside the tape amplifier and intended for factory adjustment only.

With the erase head, the requirement for current is a different matter: so long as there is sufficient to saturate the head without overheating, full erasure within the limits of the head design will be achieved.

It will be recalled from Part 6 that simple input mixing can be incorporated into the early stages of the record amplifier and these circuits are adequate for mixing a high and low level signal. In the last article of this series next month we shall look at more complex circuits and explain some of the factors which have to be taken into account when two sound sources are mixed.

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