

NOVEMBER 1967 TWO SHILLINGS

tape

recorder

RECORDING IN
CZECHOSLOVAKIA

TANDBERG 12 REVIEW

CONSTRUCT A REMOTE
PAUSE CONTROL

CREATIVE TELEVISION
RECORDING

AMATEUR
CONTRIBUTIONS—DOES
THE BBC WANT TO KNOW?

HOW TO BECOME
AN ORCHESTRA



Top quality, high performance tape,
so sensibly priced —
plus free insurance for your tape recorder



and now you can get this superb tape splicer
for half price when you buy **'Synchronotape'**

It makes such sound sense when you buy SYNCHROTAPE — now more than ever. For not only do you get free insurance up to £25 for your recorder as protection against theft or fire, but each reel of SYNCHROTAPE that you buy, from 5" to 7", contains a special offer coupon towards the purchase of the superb Adastra 'Instant Cut & Trim' tape splicer for only 7/6. (usual price 15/-). *This Offer is restricted to the U.K. and Eire only.*

*... and yet another SYNCHROTAPE-PLUS feature!
Free booklet with unique Recording Log and Technical data now included in all Synchronotape packs from 4" upwards.

SIZE	STANDARD	LONG	DOUBLE	TRIPLE
BASE	P.V.C.		POLYESTER/P.V.C.	
2½"		200' - 5/9d.	300' - 8/9d.	
3"	150' - 4/9d.	225' - 6/3d.	300' - 8/9d.	450' - 13/9d.
4"		450' - 12/-	600' - 18/-	900' - 27/-
5"	600' - 15/-	900' - 18/6d.	1200' - 28/6d.	1800' - 45/-
5½"	900' - 18/6d.	1200' - 22/6d.	1800' - 36/-	2400' - 57/6d.
7"	1200' - 22/6d.	1800' - 28/6d.	2400' - 48/-	3600' - 75/-

COMPREHENSIVE TAPE-EDITING KIT WITH SPLICER — 29/6d.



How to get your Adastra Tape Splicer Send three of the splicer offer coupons with a postal order for 7/6d, together with your name and address on the order form supplied to: Adastra Electronics Limited. Within 14 days you will receive your tape splicer, postage free, and with full instructions for use.

'Synchronotape'
ADASTRA ELECTRONICS LIMITED

A range of 21 top quality, high performance tapes
167 Finchley Road, London, N.W.3 (Tel: MAI 8164,5)

LOOK SHARP! and hear the difference



SHARP Model RD504 Portable Tape Recorder

An all-transistor solid state Tape Recorder. For operation by batteries or AC mains, twin track, two speeds. Superb recording and reproduction. Plug in to the mains. It automatically changes from batteries to its built-in AC power unit. Remote control switch on microphone allows full flexibility in use. Dimensions: 12"x3 $\frac{3}{4}$ "x9 $\frac{1}{2}$ " Complete with dynamic microphone, recording lead, earphone, batteries (6 x sharp UM—1) 5" tape reel, empty spool.

Hearing's believing. Come and talk yourself into a SHARP vivid sound tape recorder.

SHARP



SALES & SERVICE,

16/18 WORSLEY ROAD, SWINTON, MANCHESTER. Tel: SW1 3232 (5 lines)

26GINS

for further details & colour leaflet contact
SHARP SALES & SERVICE
16/18 WORSLEY RD., SWINTON, MANCHESTER

NAME.....

ADDRESS.....

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.....

.....

T3



SONY research makes the difference

TC 200—the finest value in stereo tape recorders

FEATURES Complete 4 track stereo-
phonic and monophonic tape recording
system Compact and light weight 2 full
range balanced satellite speaker systems
 Public address Sound-on-sound
recording Variable tone control 2 VU
meters Instant stop, individual track
selection Transistorised pre-amplifier
 Individual level controls on each channel
 2 SONY F-96 dynamic microphones with
other accessories.

SPECIFICATIONS

Power requirements: 100, 110, 117, 125,
220, 240 volts 70 watts, 50/60 c/s

Tape speeds: Instantaneous selection 3½
ips or 7½ ips

Frequency response: 50-14,000 cps at
7½ ips ± 3dB 50-10,000 cps at 7½ ips

Signal-to-noise ratio: 46dB (perchannel)

Wow and flutter: Less than 0.19% at
7½ ips less than 0.25% at 3½ ips

Erase head: In-line quarter track
Record/playback head: In-line quarter
track

Bias frequency: Approx. 55 Kc/s
Level indication: Two Level Meters
Level controls: Individual Controls on
each channel for playback and record
Tone control: One Tone Control for treble
boost or roll-off operates both channels
simultaneously

Editing facilities: Instant Stop Lever,
Automatic Tape Lifters, Fast Forward and
Rewind, Manual Cueing and Digital Tape
Counter

Reels: 7" or smaller

Outputs 8 ohms Speaker outputs or high
impedance line outputs selectable by switch
(2) Integrated Record/Playback connector

Inputs: Low impedance Microphone in-
puts (2) High impedance Auxiliary inputs (2)

Power output: Max. 1.5 watts per channel

Tube complement: 6267 (2), 30MP23 (3)

Transistor: 2SD64 (2)

Diodes: 1T22G (2), 1S125 (1)

Weight: Approx. 27 lbs.

Dimensions: 15" W x 8½" H x 15½" D

Accessories:

Sony 5" Stereo demonstration tape
Sony 5" empty reel
Two F96L dynamic microphones
Connecting cord (2)
Sound-on-sound recording lead
Earphone
Pinch roller (1) Capstan (1) Pin plugs (2)
Recommended retail price **72 gns.**

Sony offer the finest range of
tape recorders from the battery
portable TC 900 to the studio
quality 777, together with a fully
comprehensive range of accessories.

For further details see your
Sony dealer or write to:

SONY U.K. DIVISION,
Eastbrook Road, Gloucester.

Tel: Gloucester 21591.

London Showroom,
70-71 Welbeck Street, London, W.1.

Tel: 01-486 2143

SONY®
RESEARCH MAKES THE DIFFERENCE

HEATHKIT offer wonderful value in their NEW! Stereo Portable Tape Recorder, STR-1

only £45/18/0 kit
FOR THIS SPECIFICATION

- ½ track stereo or mono record and playback at 7½, 3½ and 1½ ips.
- Sound-on-sound and sound-with-sound capabilities. ● Stereo record, stereo playback, mono record on either channel. ● 18 transistor circuit for cool, instant and dependable operation. ● Moving coil record level indicator. ● Digital counter with thumbwheel zero reset. ● Stereo microphone and auxiliary inputs and speaker/headphone outputs . . . front panel mounted for easy access. ● Push-button controls for operational modes. ● Built-in audio power amplifiers giving 4 watts rms per channel. ● Two high efficiency 8" x 5" speakers. ● Operates on 230V AC supply.

STR-1 SPECIFICATION : Tape Speeds : 7½, 3½ and 1½ ips. Wow and Flutter : Better than 0.15% rms on 7½ ips ; 0.25% rms on 3½ ips. 0.35% rms on 1½ ips. Tape Size : ½" wide, Long or Standard play. Reel Size : Standard, up to 7" / 5½" spools and tape supplied. Digital Counter : 3 digit counter with zero reset. Heads : ½ 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 3½ ips. 3dB, 40 c/s to 7½ kc/s at 1½ 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 7½" high x 15½" deep.



Send for full leaflet. Assembled prices on request.

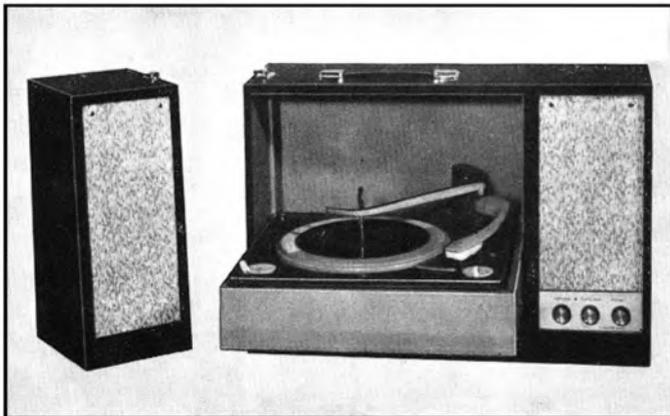
NEW! Stereo Portable Record Player, SRP-1

Only £27/15/0 Kit

Assembly can be arranged if required

- Automatic Playing of 16, 33, 45 and 78 rpm records. ● All transistor circuitry ensures cool instant operation. ● Dual sapphire stylus for LP's and 78's. ● Plays mono as well as stereo records. ● Compact, with easy-to-carry handle for suitcase portability. ● Detachable speaker enclosure for best stereo separation. ● Two 8" x 5" speakers. ● Operates on 220-250V AC supply.

The Heathkit Portable Stereo Record Player features an all-transistor amplifier for cool, instant operation ; gives a total high-power output of 3 watts rms . . . elegantly styled wooden cabinet with two-tone Rexine covering . . . record changer unit mounted on a swing-down platform ; folds up to make a compact case that's easy to carry from room to room or house to house . . . one speaker enclosure can be detached from the main cabinet to obtain the best stereo separation ; clips neatly to cabinet for ease of transportation . . . two high efficiency 8" x 5" speakers for crisp, bold sound . . . changer unit handles up to 6 records of mixed size . . . construction uses a printed circuit board for easy assembly.



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 14½" high x 7½" deep.

SRP-1A Amplifier Kit £13/2. SRP-1C Cabinet and Speakers £14/13.

Deferred Terms available on orders over £10 (UK only) Free Delivery U.K.

To DAYSTROM LTD., Dept. HT-11, Gloucester. Tel. Glos. 20217

Please send me FREE CATALOGUE (Yes/No)

Please send me model(s).....

.....

NAME

(Block Capitals)

ADDRESS.....

To DAYSTROM LTD., Dept. HT-11, Gloucester.

Please send FREE copy of Catalogue to my friend.

.....

NAME

ADDRESS

.....

Send for the



Latest
Colour
Catalogue
it's FREE

The largest selection of
Electronic Kit Models in
Britain—by Heathkit

WHEN IN LONDON visit the Heathkit Centre

233 Tottenham Court Road OPEN Mon.-Fri., 9 a.m.-5.30 p.m., Sat. 9 a.m.-1 p.m.

SAVE £££'s ON THESE SPECIAL PHILIPS OFFERS... ... from R.E.W.

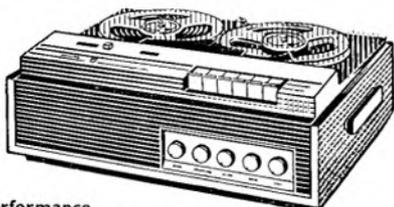
R.E.W.'s policy of offering the best in high-fidelity and tape at the lowest ever prices, only made possible by alert bulk buying in the audio market, continues once again this month with these superb machines from the Philips range. **Every model on Interest Free Terms and backed by R.E.W.'s full after sales facilities.**

SAVE 14 gns. Model EL3556
TAPE RECORDER

LIST PRICE 62 gns.

R.E.W.'s PRICE

48 GNS.



Own this luxury high performance machine, beautifully designed with an impressive array of technical features, and teak finished cabinet for that furniture look, plus!

- 4 tape speeds $\frac{1}{8}$, $1\frac{1}{8}$, $3\frac{3}{8}$, $7\frac{1}{2}$ i.p.s.
- 4 watts output from 7" x 5" loudspeaker.
- Mixing, monitoring and parallel track facilities.
- Complete with Moving Coil mike, 7" reel L.P. tape, spool and lead.

A machine you'll be proud to own and use and one which will give you years of reliable unique enjoyment. Interest free terms, £12 12s. deposit and 12 monthly payments of £3 3s. Carr. pkg. ins. 15/-. Brand new and fully guaranteed.

SAVE 5 GUINEAS!

Model EL3302 Philips latest Portable Cassette Recorder



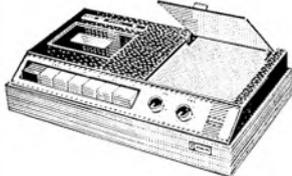
List Price
27 gns.

ONLY 22 GNS.

This new recorder from the compact Cassette range offers all the advantages of Instant Cassette Loading, with bigger, better performance than before! Wide freq. range, max playing time $1\frac{1}{2}$ hours. Interest free terms, £5 16s. deposit and 12 monthly payments of £1 8s. 10d. Carr. pkg. ins. 10/6.

SAVE 10 GNS.

Model EL3310 Home Cassette Recorder



List Price
35 gns.

ONLY 25 GNS.

High quality, slim line, 2-track Cassette mains recorder with wide freq. range. Tape speed $1\frac{1}{2}$ i.p.s. Housed in teak finished cabinet. Interest free terms, £6 15s. deposit and 12 monthly payments of £1 12s. 6d. Carr. pkg. ins. 15/-.

SAVE 9 GNS.

Model EL3312 Stereo Cassette Recorder
List Price 48 gns.

ONLY 39 GNS.



The ultimate in Stereo-Cassette recording, this 2-track machine offers a wide freq. range for superb performance. Interest free terms, £10 5s. deposit and 12 monthly payments of £2 11s. 2d. Carr. pkg. ins. 15/-. Also available for above (recommended type) Stereo speaker. List price 10 gns. **OUR PRICE only 8 gns. (2 req.).**

rew

R.E.W. (Earlsfield) Ltd., Dept. T.R.,
Headquarters, Showroom & Mail Order
266/8 Upper Tooting Road, London S.W.17.
Telephone 01-672 8267 or BAL 9175.
Open 9 a.m.-6 p.m. Weekdays.
Closed 1 p.m. Wed.
West End Showroom
122 Charing Cross Rd., Tel. 01-836 3365

Stereo Headphones FREE.



Akai will present a pair of their world-famous stereo headphones (value £5.19.6) to everyone buying any of the Akai range of Tape Recorders between October 1st and November 30th, 1967.

LISTEN

Matching impedance

8 ohms.

Maximum input

0.5 watts.

Response

25-13,000 Hz.

To get your free headphones complete the Akai guarantee card and post it to:-

**PULLIN PHOTOGRAPHIC,
11 AINTREE ROAD, PERIVALE, MIDDLESEX,**

who will post these Stereo Headphones to you. This offer is limited to the months of October and November 1967.

Sanyo puts you in the world class



Introducing: new handsome MR 801 tape deck/recorder.

- 4 tracks ● 3 speeds
- Sound with sound

Tape speeds

7- $\frac{1}{2}$ ips (19 cm/sec)
3- $\frac{3}{4}$ ips (9.5 cm/sec)
1- $\frac{1}{2}$ ips (4.8 cm/sec)

Wow and flutter

7- $\frac{1}{2}$ ips: 0.15% R.M.S.
3- $\frac{3}{4}$ ips: 0.20% R.M.S.
1- $\frac{1}{2}$ ips: 0.30% R.M.S.

Recording time

96 min at 7- $\frac{1}{2}$ ips
(stereo 7" 35 μ tape)

192 min at 3- $\frac{3}{4}$ ips
(stereo 7" 35 μ tape)
384 min at 1- $\frac{1}{2}$ ips
(stereo 7" 35 μ tape)

Input impedance

Microphone 50K ohm

Line in 200K ohm

Output impedance

Line out 2K ohm

Headphone 8 ohm or 10K ohm

Frequency response

7- $\frac{1}{2}$ ips 20-20,000 c/s
(\pm 3db 30-15,000 c/s)

3- $\frac{3}{4}$ ips 30-18,000 c/s
1- $\frac{1}{2}$ ips 30-8,000 c/s

Weight

18 lbs. (8.6 kg)

Accessories

Empty reel 7"
Patch cord x 2
Reel stopper x 2
Splicing tape
Dust cover

Price about 59 gns.

SANYO

RELIABILITY IS BUILT IN

See Sanyo at any authorised dealer. For further information write to: J. W. Cowley, Sales Manager, Electronic Equipment Division, Marubeni-Iida Co. Ltd., 164 Clapham Park Road, London, S.W.4.



The Tandberg Series 12 A hi-fi, fully transistorised stereo record & playback system

Features:

- *20 WATTS OUTPUT (10 watts per channel) makes additional Hi-Fi unnecessary.
- *BASS & TREBLE Tone Controls.
- *F.M. MULTIPLEX filters fitted (a *MUST* for recording Stereo Radio).
- *INTERNATIONAL CONNECTORS i.e. Phono and DIN and Standard Jack Sockets.
- *CENTRE CHANNEL OUTPUT.
- *PRE-AMP OUTPUTS.
- *LOW IMPEDANCE MIC INPUTS
- *PLUG-IN PRINTED CIRCUIT PANELS.
- *INTERNAL SPEAKERS.

Specification:

- Power requirements:* 220 Volts 50 c/s AC
- Power Consumption:* 58-100 Watts
- Recording System:* 4 or 2 track stereo
- Tape Speeds:* 7½ ips, 3½ ips, 1½ ips.
- Speed Tolerance:* Better than 1.5%
- Reels:* 7" Max.
- Internal Loudspeakers:* Two 7" x 4" Goodmans 2x3 Watts
- Frequency Response:*
- 7½ ips: 30-20,000 c/s (±2dB 40-16,000 c/s)
- 3½ ips: 40-12,000 c/s (±2dB 60-10,000 c/s)
- 1½ ips: 40-7,000 c/s (±2dB 80-5,000 c/s)
- Wow% R.M.S.:*
- 7½ ips: Better than .15%

- 3½ ips: Better than .2%
- 1½ ips: Better than .3%
- Signal/noise Ratio:*

- 4 track 55 dB
- 2 track 58 dB
- Distortion:*

- At max. recording level
- Recording Amp: 0.5%
- Playback Amp: 2 x 10 Watts 0.5%

Outputs:

- Power Amp. 10 Watts per channel, continuous power.
- Pre Amp: 5 K ohm/0.75V
- Centre Channel: 50 m1W (3.3V over 200 ohm)
- Input Impedance & Sensitivity (Max. Volume).*
- Mike: 2 x 200 ohm/0.15V
- 2 phono contacts per channel:
- High level: 1 M ohm/75mV.
- Low level: 0.1 M ohm/7.5mV.
- 2 x 5 pin DIN contact:
- High level (Phono)
- Low level (Radio)

Dimensions and Weight:

- Cabinet model: 15½" x 7½" x 11½" 23lbs.
- Case model: 15½" x 7½" x 12" 26.5lbs.
- Price:*
- Series 12, 2 track 105 Gns.
- Series 12, 4 track 105 Gns.

Please send me full details on the Tandberg

SERIES 12

Also full details on the Series

6 8 9
 tick as appropriate

Name

Address

Post to Dept. TR12
 Elstone Electronics Limited,
 Hereford House, North Court,
 off Vicar Lane, Leeds, 2.

THE BEST TAPE RECORDERS BY

Tandberg

IMMEDIATE DELIVERY!

K. J. ENTERPRISES

EVERYTHING AUDIO!

BRITAIN'S PREMIER MAIL-ORDER RECORDING TAPE SPECIALISTS

IMMEDIATE 24 HOUR SERVICE ON ADVERTISED LINES

FULL CASH REFUND GUARANTEED

SEND TODAY AND SAVE!

BRANDED TAPES OFFER!

Brand New, Fully Guaranteed, and in normal manufacturer's pack

25% OFF AGFA & KODAK

LONG PLAY		APPROX. LIST PRICE	OUR PRICE	DOUBLE PLAY		APPROX. LIST PRICE	OUR PRICE	TRIPLE PLAY		APPROX. LIST PRICE	OUR PRICE	STANDARD PLAY		APPROX. LIST PRICE	OUR PRICE
3"	210'	8/-	6/-	3"	300'	13/-	9/9	3"	450'	21/6	16/3	5"	600'	18/-	13/6
3½"	300'	11/-	8/3	3½"	400'	17/-	12/9	3½"	600'	27/6	20/9	5½"	900'	24/6	18/6
4"	450'	14/-	10/6	4"	600'	24/-	18/-	4"	900'	38/6	29/-	7"	1,200'	30/6	22/6
4½"	600'	22/6	17/-	4½"	900'	35/6	26/8	4½"	1,200'	47/6	35/9	QUADRUPLE PLAY			
5"	900'	28/-	21/-	5"	1,200'	42/-	31/6	5"	1,800'	65/6	49/3	3"	600'	33/6	25/3
5½"	1,200'	35/-	26/3	5½"	1,650'	52/6	39/6	5½"	2,400'	90/-	67/6	3"	800'	42/-	31/6
7"	1,800'	50/-	37/6	5½"	2,400'	56/6	42/6	7"	3,600'	115/-	86/3	4"	1,200'	58/6	44/-

Postage and Packing 2/-. ORDERS OVER £3 POST FREE.

20% OFF BASF — E.M.I. — GRUNDIG — PHILIPS — SCOTCH PHILIPS — BASF — E.M.I. SCOTCH

STANDARD PLAY		LIST PRICE	OUR PRICE	DOUBLE PLAY		LIST PRICE	OUR PRICE	STANDARD PLAY		LIST PRICE	OUR PRICE	DOUBLE PLAY		LIST PRICE	OUR PRICE
4"	300'	10/6	8/6	3"	300'	14/-	11/3	5"	600'	20/6	16/4	3"	400'	16/6	13/2
5"	600'	21/-	16/10	4"	600'	25/-	20/-	5½"	850'	27/6	22/-	4"	600'	24/6	19/6
5½"	900'	28/-	22/6	4½"	900'	30/-	24/8	7"	1,200'	35/-	28/-	5"	1,200'	41/9	33/6
7"	1,200'	35/-	28/-	5"	1,200'	42/-	33/8	LONG PLAY				5½"	1,800'	55/-	44/-
3"	210'	9/-	7/3	*5½"	1,800'	55/6	44/6	3"	300'	9/6	7/6	7"	2,400'	76/6	61/-
4"	450'	14/6	11/8	*7"	2,400'	77/6	62/-	4"	450'	14/6	11/8	TRIPLE PLAY			
4½"	600'	21/-	16/10	TRIPLE PLAY				4"	900'	27/6	22/-	3"	600'	24/9	19/6
*5"	900'	28/-	22/6	4"	900'	22/-	17/8	5"	1,200'	34/6	27/6	4"	900'	38/6	30/6
*5½"	1,200'	35/-	28/-	4"	1,200'	29/-	31/3	7"	1,800'	49/-	39/-	DYNARANGE (L/P)			
*7"	1,800'	50/-	40/-	*4½"	1,200'	49/-	39/3	8½"	2,400'	72/6	58/-	5"	900'	32/3	25/10
8½"	2,400'	72/6	58/-	5"	1,800'	46/-	52/10	STANDARD (ACETATE)				5½"	1,200'	40/6	32/6
10"	3,600'	95/-	76/-	5½"	2,400'	90/-	72/-	5½"	850'	24/6	19/6	7"	1,800'	57/6	46/-
C.60 Cassette	17/6	14/-		7"	3,600'	115/-	92/-	7"	1,200'	30/-	24/-	8½"	2,400'	83/6	66/10
C.90 Cassette	25/-	20/-		GRUNDIG TAPE AVAILABLE ONLY WHERE MARKED WITH ASTERISK				Postage and Packing 2/-. ORDERS OVER £3 POST FREE.							

PHONOBAND—Pre-recorded STEREO tapes from Sweden

Brilliantly recorded, ½-track stereo tapes superb quality Classical Jazz and Light Music at Tape speeds of 7½ i.p.s. (7" reels) and 3½ i.p.s. (5" reels). **PRICES FROM 49/6.**

Send for our Full Colour Catalogue and Price List.

TRIPLE PLAY TAPE — 50% OFF!

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!

	LIST PRICE	ONE	THREE	SIX
1,800' on 5" reel GEVASONOR	66/-	34/-	101/-	198/-
Also available at substantial reductions.				
450' on 3" reel GEVASONOR	22/-	14/-	40/6	78/-
600' on 3" reel GEVASONOR	27/6	17/6	51/-	99/-
900' on 4" reel GEVASONOR	39/-	24/6	72/-	140/-
2,400' on 5½" reel ZONAL	90/-	55/6	165/-	324/-

Post and Packing 2/-. ORDERS OVER £3 POST FREE.

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.

	ONE	THREE	SIX
900' on 5" reel. List price 28/-	16/6	48/-	90/-
1,800' on 7" reel. List price 50/-	32/6	95/-	180/-

Post and Packing 2/-. ORDERS OVER £3 POST FREE.

SCOTCH TAPE—HALF PRICE!

Brand new, top quality premium grade, POLYESTER BASE TAPE, double coated and made specially for the electronics industry. SCOTCH (150 D/C) Polyester L/P, 900' on 7" reel. **ONLY 15/6, P. & P. 2/-.** Three reels for 45/- post free; six reels for 84/-, post free. Boxed, add 1/- per reel. Can be supplied on 5½" reels at special request.

Don't forget our other ACCESSORY BARGAINS!
Tape Head Demagnetiser, essential for any enthusiast! Ready for immediate use. Fully guaranteed. Worth 50/- ... **Only 27/6 P. & P. 2/-**
Tape Splicer, fully auto., no razor blades. Worth 32/6 ... **Only 16/6 P. & P. 2/-**
International Polyester Tape, 2,400' 7" reel (boxed) ... **Only 25/- P. & P. 2/-**
Gevasonor 10" 3,600' L/P Polyester (boxed) ... **Only 64/- Post Free**
Gevasonor 8½" 2,400' L/P Polyester (boxed) ... **Only 48/6 P. & P. 2/-**
Gevasonor 3" 300' L/P Polyester (boxed) ... **6 for 37/6 P. & P. 2/-**

20% OFF ALL GRUNDIG & PHILIPS EQUIPMENT

SEND FOR LISTS OF OTHER TAPE AND HI-FI BARGAINS
K. J. ENTERPRISES, (Dept. TR), 17 THE BRIDGE, WEALDSTONE, MIDDLESEX (OPPOSITE HARROW & WEALDSTONE STATION) 01-427 0395 (CLOSED P.M. SAT.) REFUND GUARANTEE

FREE

Our New Illustrated catalogue sent entirely free on request. Britain's most specialized comprehensive range of recording tape and accessories. 20,000 reels always in stock with reductions ranging up to 50%.



This year only
 465 music enthusiasts
 will have their greatest wish
 fulfilled—the perfect
 High Fidelity system.
 The most thrilling system ever—
 and made by Bang and Olufsen.

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2 **BEOMASTER 5000.** Stereo F.M. Tuner with usable sensitivity of 1.5 μ V. Automatic Mono/stereo switching, 4 stage gang tuned R.F. section, 5 I.F. stages and A.F.C. Large radicator calibrated relative to signal strength. Cursor type tuning control with vernier adjustment. Variable muting and stereo levels. Aerial inputs for 75 ohm, 300 ohm and local. Identical in size and cabinet finish to match Beolab 5000. 85 gns

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. 45 gns.

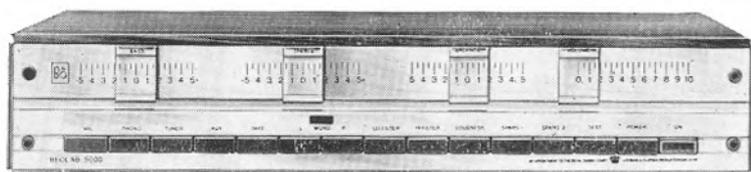
4 **BEOVOX 5000.** Pressure chamber loudspeaker with one bass two mid frequency and four high frequency units. Variable attenuators to mid and high frequency units. Provision for the connection of high frequency diffuser unit. Distortion at maximum power 2.2%. Maximum power handling 50 watts music power, impedance 4 ohms. Solid Teak or Rosewood finish, free standing on elegant stainless steel legs. 49 gns.

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. 69 gns.

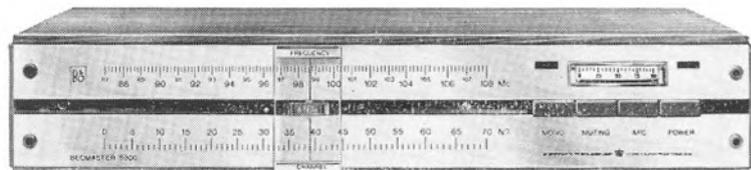
6 **BEOVOX 2500.** High frequency sound diffuser unit. Six loudspeakers mounted one to each face of a cube for the omnidirectional distribution of the high frequencies. Mounted on a stainless steel base or may be suspended. Power handling 50 watts music power over 2kHz. 42 gns. a pair.



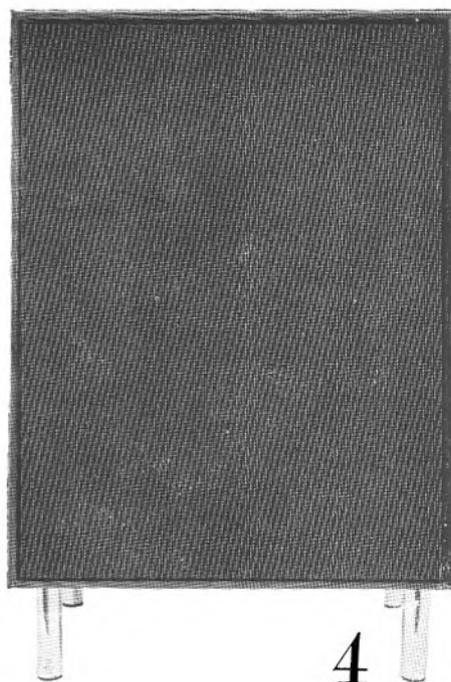
Bang & Olufsen



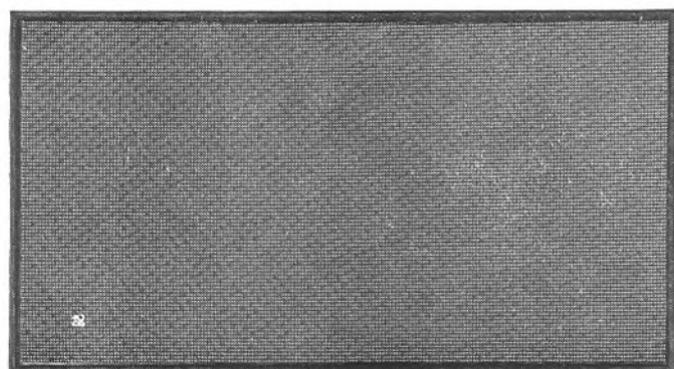
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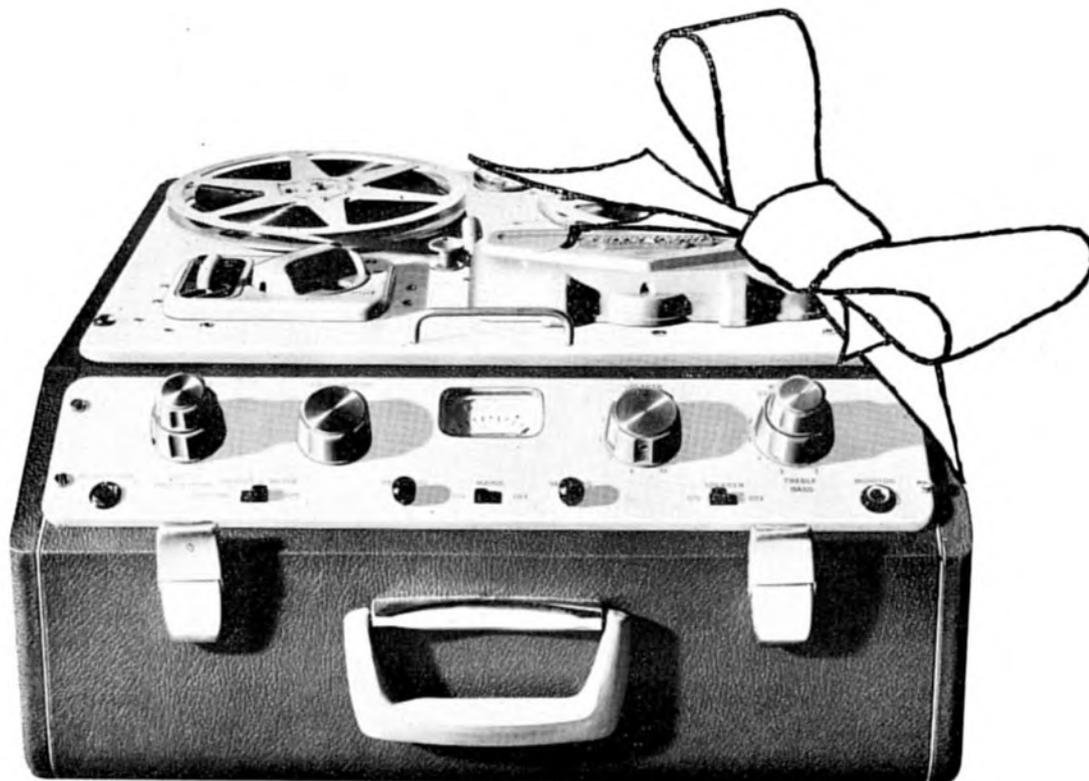
Bang & Olufsen gave their engineers complete freedom to develop the perfect high fidelity system. The Beolab system is the result. Beolab reflects the latest radio and electronic developments and practices made possible by using space age components and stringent production control.

B & O for those who consider design and quality before price

For detailed information see your B & O dealer or write to:
Bang & Olufsen United Kingdom Division,
Eastbrook Road, Gloucester. Telephone : Gloucester 21591.
London Showrooms :
70/71 Welbeck Street, W.1. Telephone : 01-486 2144.

Beolab Series





All I want for Christmas is a Ferrograph

You will probably have to be satisfied with a floral tie or a bottle of after-shave but, just in case you are in high favour with a rich uncle or aunt, or your wife's premium bond comes up, or you decide, if needs be, to give yourself a Ferrograph, here are a few details.

The Ferrograph is the tape recorder which, built to an original design has long enjoyed an outstanding reputation for reliability and fidelity of recording. Its high quality of performance is sustained over many years of use, and its construction is of a ruggedness consonant with expectation of long life. Even so, we do not claim perfection, although we believe that we have come nearest to the ideal. And the vast majority of Ferrograph users agree. They include the fire, police and defence services, concert impres-

sarios, theatrical producers, education authorities and many others whose demands are constant and exacting.

There are five models from 95 gns. to 132 gns.

Something more modest?

If your present won't run to a Ferrograph, or if you are looking for a gift for another enthusiast, how about a Wearite Defluxer? It depolarises all makes of head, prevents hiss and protects tapes from cumulative background noise. 60/- from all good Hi-Fi dealers.

For full details of Ferrograph models and the Wearite Defluxer, write to

**THE FERROGRAPH
COMPANY LIMITED**
84 Blackfriars Road, London S.E.1



tape recorder

NOVEMBER 1967 VOLUME 9 NUMBER 11

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COVER PICTURE

Our cover photograph comes, this month, from the *United Kingdom Atomic Energy Authority* and shows a tape recorder under examination at the *AWRE*, Aldermaston. The machine was developed by the *RAE*, Farnborough and was among the equipment orbited in the British satellite *Aerial 3*. In this role, it collected data for subsequent release to the ground.

SUBSCRIPTION RATES

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

SOME SEVEN YEARS AGO contributor Richard Golding commenced the *Sound and Cine* series, which achieved considerable popularity during its four-year run, being re-introduced later by another experienced film-maker but this time for a rather shorter period.

After a long absence from our pages, Richard has returned with another series as original and as promising as his first. *Closed Circuit* is believed to set a precedent for tape journals, in being the first regular series to show in practical terms how the new generation of video tape recorders may be used. Hitherto, mention of the VTR has been limited to technical description, mere passing reference being made to the all-important questions of splicing, mixing, monitoring and dubbing vision.

We have occasionally expressed the view that thermo-plastic techniques might ultimately remove the strictly magnetic element from tape recording, and the *ICI / CBS / CIBA / Thorn* announcement (see page 449) appears a step in this direction. Only a small step, however, for the £100 home video-tape system is capable of playback only. Even less promising—while appearing to use an electron beam technique, it apparently utilises a photographic medium and is thus no more re-usable than cine film, even if one could afford the obviously very elaborate recording equipment. However, unless nipped in the bud by further developments in the field of thermo-plastic recording, the Thorn EVR player seems likely, despite its limitations, to form the basis of a profitable new market in commercially recorded tapes. A self-threading mechanism is incorporated and will perhaps overcome the handling problems for which commercial sound tapes are sometimes criticised.

From the future of television we return to the present state of sound recording. On 17th September a BBC news reporter entered the Soviet Embassy in London with a battery tape machine hidden beneath his coat. Returning to Broadcasting House, he found his 'bugging' to have been marred within the Embassy by severe distortion. An extract from the distorted tape accompanied the 1 p.m. coverage of the Tkachenko affair. Forgetting the political issues, the Russians are apparently to be congratulated for their inventiveness in screening the building against secretive use of magnetic recorders. The question of interest to us is: What caused the distortion?

The BBC recording appeared to suffer from severe under-biasing or, possibly more to the point, extreme over-biasing. This suggests the feasibility of protecting a premises from 'espionage' with a powerful oscillator connected to an induction loop, which might tend to upset any recorder within the loop area by overloading the microphone input with an RF signal, or something of this nature. Scope here for experiment and room, even, for an 'anti-bug' accessory without which no executive

is complete! Meanwhile, any reader planning to bug the Soviet Embassy in the near future might try some careful screening around his microphone and place the recorder in a Mu-metal box (in case it is really magnetic bias at several megawatts!).

Having come this far into the field of 'anti-bugs', we would like to emphasise an editorial disapproval of fountain-pen microphones, attache-case recorders, and the rest of the paraphernalia available to the ultra-secretive. In particular, we do not propose to follow the recording enthusiast's magazine which recently surveyed a range of such equipment and recommended its use against the 'mike-shy'.

Our man in Tokyo has lately returned to England after a long and stimulating journey through Asia to the Far East. His discoveries will enliven our pages in the early months of 1968. The Japanese worker, we learn, appears content with a very much harder existence than his or her English opposite number. A graduate fresh from University can expect to earn, with Degree, just £30 per month. Tax is higher than in Britain and the cost of living double that of London. Such conditions make life under our economic 'squeeze' comparable to a rest-cure.

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WORLD OF TAPE

LIVINGSTON COLLAPSE

SMALL companies and agencies come and go, but the recent collapse of the Livingston Group has created a shock throughout the electronics industry. The group comprises several companies, including *Livingston Laboratories Ltd.*, *Livingston Components* and *Livingston Electronics*, all three of which are now in the hands of a receiver.

Livingston Laboratories attended to the business of importing and servicing a variety of electronic products, mainly of American manufacture. They were best known in the recording field for the Swiss *Nagra* battery recorder (see item below). One cause of the downfall is believed to be the limited credit offered by American companies compared with that extended to Livingston's British customers.

The group had lately embarked on an elaborate programme to develop its manufacturing activities, which fell victim to the economic squeeze. *Livingston Organs* has survived the liquidation, however, and will continue as a separate company to manufacture electronic musical instruments.

NAGRA SERVICING

CARSTON Electronics Ltd., whose managing director Ian Marshall handled *Nagra* sales at Livingston Laboratories until the latter's demise, is now undertaking service of *Kudelski* tape equipment. Manager of the servicing department is David Lane, who held a similar post with Livingston over the last nine years. Carston are currently agents for American *Crown* professional tape recorders.

It is not yet known who will obtain the *Kudelski* concession.

£100 VIDEO PLAYER

IMPERIAL Chemical Industries, *CIBA* and *CBS*, aided by the *Thorn Group* and a *CIBA* subsidiary—*Ilford Ltd.*—are pioneering a completely new audio-visual system which may achieve for television that which the gramophone record has managed in the realm of sound.

Essentially, the system involves producing a master electron-beam tape recording from cine film, magnetic video tape or television camera. This master is then dubbed at high speed on a "printer" (30 seconds for a 20-minute programme), the copies being sold in the form of 'closed-in' 7in. spools. Each cartridge will sell for about 7 gns. and will contain one 30-minute colour programme or two 30-minute monochrome programmes.

The *Thorn Group* are to manufacture prototype *EVR* (*Electronic Video Recording and Reproduction*) players, which will be similar in size to a domestic sound recorder, and these will be demonstrated early in 1968. The players are to be marketed in the spring of 1969 and will supply a 625-line UHF signal suitable for direct insertion to the aerial socket of a domestic television receiver. Cost of the player will be some £100.

An insight into the "electro-optical trans-

NEXT MONTH

CONSTRUCTION OF A transistor stereo tape replay amplifier—*The Pint Pot*—will be described by John Fisher in the December issue, published on November 14th. The amplifier incorporates all the features of a high-quality integrated unit, with tone and blend controls, filters, and equalisation for direct feeding from tape heads. Also in this issue, G. T. Rogers discusses the theory of equalisation. The *Aiwa TP1002* low-price stereo mains/battery recorder will be field-tested.

ducer" employed in the player is gained from the unit's ability to reproduce cine films in addition to the *EVR* cartridges. The film moves continuously at 5 i/s past the pick-up head, which is evidently a form of miniature camera. While this suggests a simplified pick-up tube scanning only in a vertical plane and relying on tape motion for lateral scanning, the claimed ability of the system to reproduce still frames and strip photographs tends to suggest otherwise. Monochrome vision is recorded in pictorial images corresponding to luminance, while, for colour programmes, each frame is accompanied by a twin carrying the chrominance.

Experimental electron-beam systems have been produced to use a clear-plastic erasable tape. The recording medium is probably a 'once-only' photographic film. *Ilford* will be manufacturing the first *EVR* tapes.

A PAIR OF BLOOMERS

THE attention of readers is drawn to page 411 of the article 'Inside *BASE*' in last month's issue, which displayed the slitting of ½in. computer tape and not 2in. tape as captioned.

PPM transformer T1 in fig. 3 of 'PPM or VU?' is available from *Transformer Equipment Ltd.* (Railway Place, Wimbledon, London, S.W.18.) at 25s., or from *Henry's Radio*—not *Gardners*, who make only T2 of fig. 4.

BATRC DEADLINE APPROACHES

DECEMBER 31st is the closing date for entries to the *British Amateur Tape Recording Contest*. Entry forms and rules are still obtainable from this office or *The Secretary, British Amateur Tape Recording Contest, 33 Fairlawnes, Maldon Road, Wallington, Surrey*, or may be found in the May issue of *Tape Recorder*. The competition is open to all amateur enthusiasts, groups and schools, and is divided into six categories—*Speech and Drama, Documentary, Music, Reportage, Technical Experiment and Schools*.

1968 AUDIO DIARY

THE third *Audio Diary*, for the year 1968, is now available for 7s. 6d. including postage from *Link House Publications Ltd., Dingwall Avenue, Croydon CR9 2TA*. Finished in dark green, the diary contains a substantial data section covering all aspects of sound recording and reproduction, electronics, acous-

tics and music. This section has been updated and expanded to include a dictionary of audio terms.

LEARNING BY DRUM

MAGNETIC drums are the heart of a new language-teaching system developed by the American *Data Recording Company* and imported by *International Tutor Machines*. The drum is initially employed to record a phrase spoken by instructor or student, being then repeated again and again to the student until mastered. Up to 32 phrases may be recorded on a single drum. Claimed advantages of the system over conventional laboratories are the absence of a need for tape rewinding and the facility for switching an entire class to the study of a single phrase. The instructor may monitor the efforts of individual students or over-ride their phrase selectors. *Isleworth Polytechnic, Middlesex*, have used the equipment with success in their department of business and professional studies.

TWO NEW VIDEO RECORDERS

TWO additions to the ever-expanding range of domestic video recorders have been announced by *Uher* and *Sony* and may possibly find their way on to the British market in 1968. Half-inch tape and a 7½ i/s speed are featured on the mains-powered *Uher*, with an anticipated price of £270—well below that of any previous European model.

The *Sony VC-2000* battery video recorder, first brief details of which appeared in our July issue, is now available in the USA. Selling in the £430 region, including camera and miniature viewfinder, the unit weighs 12 lb. including batteries and may be carried over the shoulder. It is equipped for recording only and intended for use with mains playback equipment. Also being introduced by *Sony* on the American market are a 7in. colour receiver, and a tiny 'pocket' set with a 1in. screen. In common with the battery *VTR*, these two receivers operate from batteries or direct from mains.

22 CHANNELS TO USA

THE most comprehensive and logical controls of any desk in production" is the claim made for a 22-channel mixing system by its manufacturer, *Sound Techniques Ltd.* The desk was produced for an American customer, *Sunset Sound Studios* of Hollywood, for use with an eight-channel tape recorder, and has a total of 10 output channels. Echo-send facilities and pre-fade listen, before and after an equaliser, are fitted to each input. Modular construction of the fully transistorised circuits is arranged to permit expansion of the installation if and when this is desired.



John Keene: recording engineer

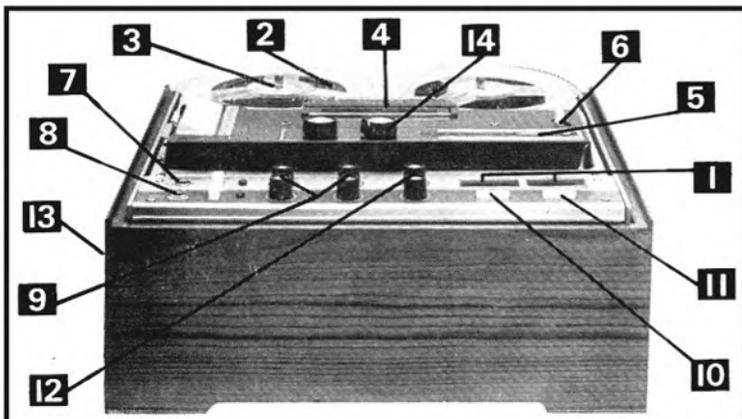
What buttons does he push at weekends?



John's an expert. A sound expert. And an enthusiast. So come the weekends, he's still up to his fingertips in buttons. On the Truvox PD 104 (four track). The *only* stereo tape unit for him. Like any good enthusiast he'll be delighted to tell you why. Button by button. Here goes. **1** Separate V.U. recording meters. **2** 7" spools. **3** Spool clamping. **4** Built-in splicing flap. **5** Push button reset 4 digit counter. **6** Cue and inching control. **7 8** Full independent control over each channel. **9** Mic/Radio/PU mixing. **10** Tape/Source A-B monitor switches. **11** Track to track transfer and mixing switches. **12** Fully variable output controls 0-1 volt. **13** Solid wood plinth finished in selected teak veneers. **14** 3 speeds.

And there are a few features without buttons that make the PD 104 John's choice. Like **Solid state all-silicon transistor circuitry/Emitter follower output/3-motor Truvox Tape Deck/Micro-switch deck operation/Vertical operation if required.**

With the Truvox PD 104 you might say John's got perfect sound reproduction all buttoned up. You'd be dead right. The Truvox PD 102 (two track) and PD 104 are priced at 105 gns.



THE TRUVOX SERIES 100



For full details of the Truvox Series 100 stereo tape units, tuner, amplifier and recorders, and all Truvox sound equipment, write for your free copy of 'Sound with depth and colour'.

Truvox Ltd. Hythe,
Southampton, Hants.
SO46ZH

your obedient servant

bits and gates

part 3: by H. W. Hellyer

WE can escape it no longer. Sooner or later we must grapple with figures if we are to expand this series of articles beyond what has been, in the first two offerings, a 'perfunctory butcher's' at the general subject of computers and the magnetic medium.

The hesitancy is understandable: except to those fortunate *Mensa* types who can work out the elapsed time and feet remaining of a triple play tape on a 10½ in. spool at 3½ i/s while the rest of us hum and haw over the calculator, figures tend to be frightening. But it is pointless to go on glibly talking about *bits* that the computers handle until we have discussed the rudiments of the binary system.

Bits of what? Not paper, not even punched tape, but simply *binary digits*, which is what that little word is an abbreviation for. We all know that a digit is a single figure, and can represent quantities of whatever we want it to, in the way that our digital spool counter tells, more or less how much tape we have used. The actual tape length we shall have to calculate: our digit may mean an inch, or several inches, or a fraction of an inch. All that matters is that the digits are on the same scale. (Actually, with the average tape position indicator, they are *not* on the same scale, but relate to the rotation of one or other spool carrier—but that is quite another matter.) The important point is that we are familiar with the word digit and agree on its meaning.

ON AND OFF

The binary digit, or 'bit' is either a 1 or a 0. For the computer, marvellous brain that it is, can think no further than 2. Indeed, the binary scale is based on the powers of two, the reason being that this can be signalled electronically very easily by a switching device that is in one of two states—either 'on' or 'off'. Our ordinary electric light is, in fact, a simple example of the binary system. It says 'yes' when there is current flowing, or 'no' when there is not. The secret of the computer is just its phenomenal speed in selecting and amassing these on-off switches to give the information we desire. The actual switches that do this work can take several forms, and we shall look at a few of them later.

First, let us consider the binary system, and the way it enables us to build up a code to represent any number by a combination of 1 and 0. And to do this we may find the best approach is to compare the binary system with our more familiar decimal system. This system, based on the number 10, uses ten digits, 0 to 9, as basic numerals. The total number we require is built up by showing these numerals against a power of ten. We use a kind of numerical shorthand when we say "five hundred and seventy six". We can

break this down as $500 + 70 + 6$. All our numbers are powers of ten (remembering that the unit $1 = 10^0$, $10 = 10^1$, $100 = 10^2$, etc.). Thus, our specimen number, 576 can be broken down to $(5 \times 10^2) + (7 \times 10^1) + (6 \times 10^0)$. It is a convention to omit the '1' when we mean ten to the power of one, but for the moment we shall keep it, to maintain our train of thought.

The current furore over decimal coinage has reminded us of our strong reliance on the decimal system, but, in practice, we could use other systems, based on different powers. A good mathematician could probably make out a plausible case for working out our housekeeping budget to the base of Napierian logarithms ($e = 2.718$). We probably feel more at home with the decimal system, and Briggsian logs (to the base of 10) because Providence blessed us with that number of frilly bits at our extremities.

CONVENIENT POWER

One of the alternative systems we can use is based on the 'power-of-two', hence the term *binary system*. This is convenient, for transistors (like inky office boys) find it hard to count farther than two and, as we have already said, a switching system that is either on or off is in one of two states. If we were to retain the decimal system and build ourselves a computer, for a number in the hundreds range, say the 576 we used before, we should need thirty such on or off switches, ten for each column. But with a binary system we need only ten digits and the computer 'word' comes out as 1001000000.

This is the point where some of our readers doff their hats to us and leave. That chain of digits looks so mysterious; but if we put our powers of two in tabular form, the problem resolves like a conjurer's string of flags. Once again, we start with 2^0 , which is 1. (A little thought will show us that *anything* to the power of nought is equal to one, just as anything to the power of one is simply itself—so that $2^1 = 2$.) To make the reading off a little easier, we compile the table with the highest powers to the left. As we needed ten digits, we start at 2^9 , but of course, the table could extend upwards indefinitely.

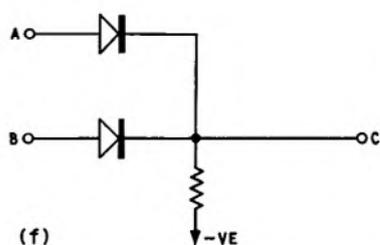
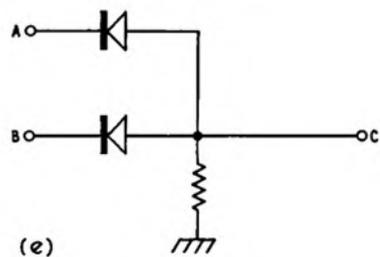
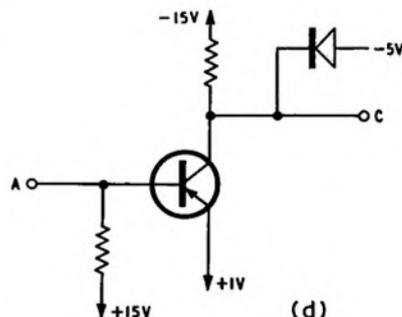
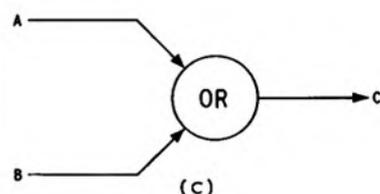
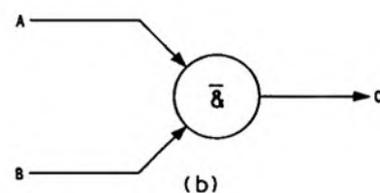
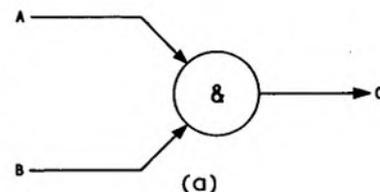
Powers:

2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	
Binary factor:	512	256	128	64	32	16	8	4	2	1
Binary number:	1	0	0	1	0	0	0	0	0	0

From the table we see that the binary number 1 indicates that we need the factor above it and the binary number 0 indicates that the switch is 'off' and we do not use the factor above it. So, to get 576 we added $2^9 + 2^6 = 512 + 64 = 576$.

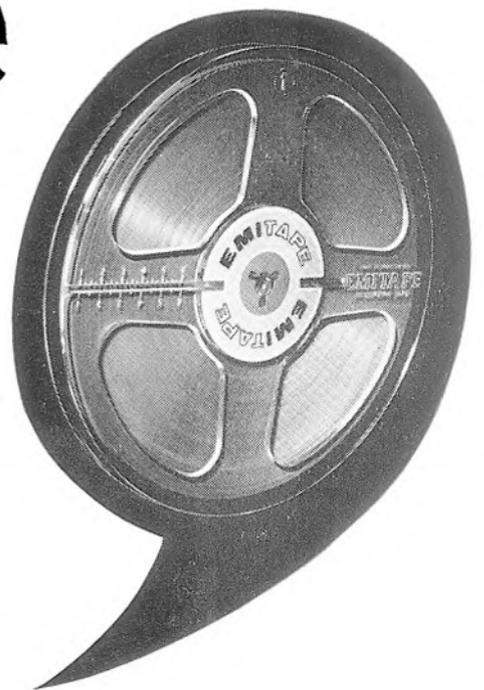
(continued on page 453)

FIG. 1





**safe
and
sound**



the case for keeping **EMITAPE**

There's a dust-proof library case with every reel of Emitape you buy. These are self-standing for compact storage and transparent for easy reference to index of recordings. This is just one advantage of the new, improved range of Emitape, designed to match all tape recorders. Enjoy its cleaner sound and consistent quality. *Insist* on Emitape every time and get the best results.

Don't buy any tape—buy **EMITAPE** 

AP3

It is interesting to note that the highest number we can decode from this table is twice the highest binary factor minus One, or 1,023. Supposing we had wanted to indicate the number 18 in binary notation; we need 16 plus 2, which is 10010. The switches for 16 and 2 are 'on' showing 1 and the switches for 8, 4 and 1 are 'off', showing 0. Taking another example, 722 becomes 1011010010 in binary notation, that is 512 plus 128 plus 64 plus 16 plus 2. A few minutes practising with the binary code will reassure doubters that deriving the quantity you want is easier than getting the right number on our 'modernised' telephone system.

While we are still in a figurative mood, so to speak, we may as well look at the next step toward understanding computer technology. The binary code, we have seen, is a form of mathematical shorthand which can be applied by electronic switches to give combinations of figures. Very fast switching, and some sophisticated circuitry, enables us to add, subtract, multiply, and, with a bit more difficulty, divide these chains of figures and make all sorts of rapid calculations. But before we go on to consider some of the circuits which make this possible, and the storage devices that retain the combinations until we are ready to use them—itsself a separate and fascinating subject—we must look at some of the control devices. The signals have to be fed to the place they are wanted, exactly when they are wanted, and logic circuits do this job.

Boolean algebra had its birth in 1847, when two mathematicians, deMorgan and Boole, demonstrated methods of handling logic in symbols. These used algebraic forms to symbolise logical propositions. Boiling it down to its essentials, we say that if the whole of the understood universe is unity, then the sum of anything and 'not-anything' equals unity—the *status quo* is maintained. In algebraic terms $1 = A + \bar{A}$. The bar over the top of a symbol denotes 'not' and we say 'not-A' or 'A-bar' for convenience. This demonstrates the simplest function, inversion. A switch is on or not-on.

AND ANOTHER

Another function is the AND function, where $C = A \text{ and } B$ and we used the dot thus $C = A \cdot B$ to denote 'and'. In electronic terms the AND gate gives an output C of 1 only when both A and B are 1 (in this context, it is worth remembering that '1' is 'on' and '0' is 'not-on').

The AND gate, shown symbolically in fig. 1(a), followed by an inverter, becomes a NAND element. In this configuration the output C is only a 0 when both inputs A and B are 1. If A is 1 and B is 0, if B is 1 and A is 0 or if both A and B are 0, C remains 1. Fig. 1(b) shows the symbol. Algebraically, we write the NAND form as $C = \overline{A \cdot B}$, i.e., C equals 'not-A and B'.

Next, we consider the OR function. This is where Boolean Algebra gets a bit confusing for we older folks who spent the precious hours firing ink pellets when we should have been attending to the maths master.

In the OR function, the plus sign is used to denote OR. $C = A + B$ means C will be '1' if either A or B becomes '1'. The symbolic form is shown in fig. 1(c). The negative form is the NOR unit, which is the inverse of the OR unit, i.e., C will be '0' when A or B become '1'.

To keep track of what becomes what and when we need to use a 'Truth table'. Taking the simplest form, the AND gate, we draw up a table as below:

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

From this we see that C is only one when both A and B are 1. More complicated truth tables can be drawn up for detailed functions, such as when there are several inputs and perhaps more than one output.

This all seems like a party game, and perhaps rather pointless, at this stage. But the whole point of the matter is that a transistor makes an excellent inverter and diodes are ideal elements for simple gates, so we can build up logic circuits and simplify our switching instructions by using this kind of 'logical shorthand'.

GOOD EXAMPLE

A typical inverter circuit is shown in fig. 1(d). This is a good example of a transistor's function in computer design and works as follows: with an input of 0V the transistor is held at cut-off by the bias applied from the positive 15V line. The collector rises to -15V in the absence of collector current, or, rather, it tends to rise, but the presence of the diode limits the output to -5V, so for 0V in we get -5V out. If we now apply a negative voltage to the input the transistor conducts. -5V in gives full conduction and the transistor bottoms. The emitter is at 1V and the drop across the transistor is 1V, so the collector reaches zero. So for -5V in we get 0V out. The circuit has inverted. The truth table for such a simple position is shown beside the diagram. The inverter is sometimes called a NOT gate, just to keep the nomenclature neat and tidy.

The AND gate is even more simple, as shown in fig. 1(e). When both A and B are 0V, current can flow. If either A or B separately rise to 5V current can still flow, but if both A and B rise to 5V there is no current path and the output B becomes 5V.

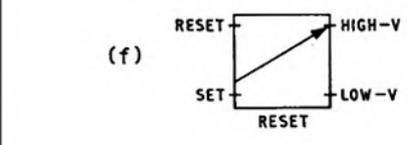
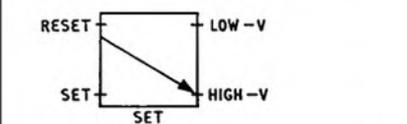
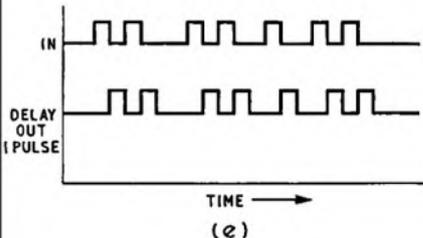
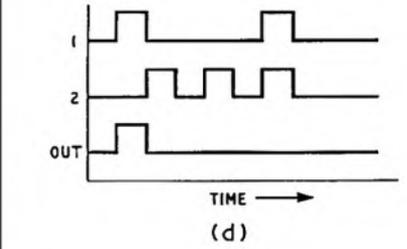
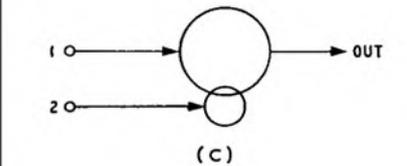
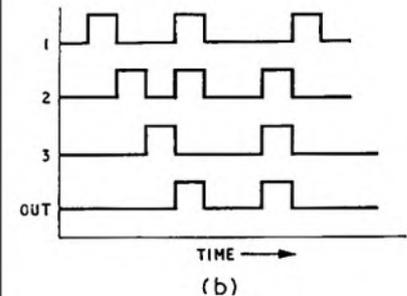
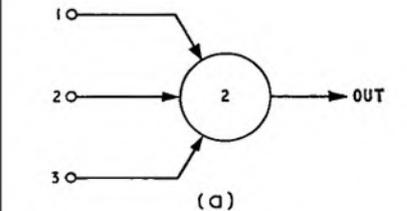
Similarly, the OR gate operates by allowing a current flow when A or B are at the same voltage as C but not when neither is at the same voltage—see fig. 1(f).

The gate concept is more easily grasped if we think in terms of pulses rather than applied voltages. There are four more we need to consider in computer technology before we move on to storage devices and come nearer to our brief of discussing the magnetic medium. These are (a) *threshold*, (b) *inhibit*, (c) *delay* and (d) *flip-flop*.

The 'threshold' gate has two or more inputs and one output. If pulses are received in from two or more inputs simultaneously, a pulse is given out. For a 2 threshold device, as shown in fig. 2(a), the pulse train diagram drawn with time as the horizontal axis makes

(continued on page 461)

FIG. 2



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The TK145 has a frequency response of up to 12,500 Hz, Wow and flutter below $\pm 0.2\%$, 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 loud-speaker. 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 has the exclusive Grundig single-unit combination of motor and mains transformer.

The uncrushable steel chassis is elegant in teak finish, with a charcoal and silver deck, and silver trim. The TK145 comes with 1,200 ft. of tape and a high-quality dynamic microphone . . . all that for just 47½ gns! Like to hear more? Then send off

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To: Grundig (G.B.) Ltd., Dept. TR1, London, S.E.26.

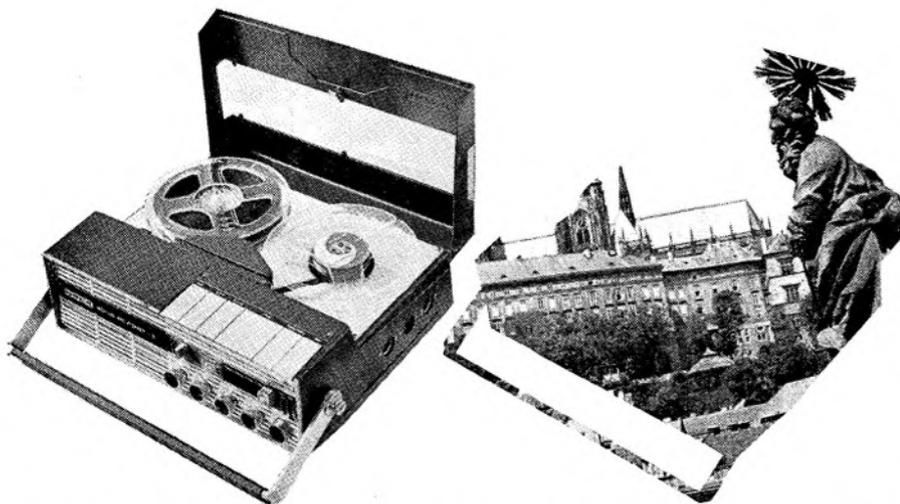
Please send me 'The Sound of Grundig' all-colour tape-recorder leaflet radio leaflet audio unit and stereogram leaflet *Tick which you require.*

NAME _____

ADDRESS _____

TR1

GRUNDIG



on location - in czechoslovakia

BY PHILIP TOWELL

THEY said it was sheer madness. Who would risk his liberty by taking a recorder behind the Iron Curtain? At best, I would have the machine and tapes confiscated. This article tells how perseverance can win through.

For some years I had been attracted by the idea of visiting the ancient capital of Czechoslovakia, and when I saw a tour to the Prague Spring Festival advertised, I felt this was the ideal opportunity to combine my musical interests with sight-seeing. As usual I wanted to take my stereo Uher portable with me, but when I mentioned this to *Gresham Tours*, they strongly advised me not to risk it. I then wrote to the Czech Embassy in London who quoted the relevant Customs regulations, not giving any opinion as to whether I was likely to forfeit the recorder. However, at this stage the original tour fell through due to lack of applicants, and I was offered a place with *Harold Ingham's* similar tour later in May. They were rather apprehensive about my proposal too, and the first glimmer of hope came from the Czech Tourist Office in Oxford Street. They told me that I could take a recorder, grand piano or even a fridge if I liked, provided it was declared on my visa to the Customs on entry and exit. At this stage I enlisted the help of my good friend, John Bradley, the *Federation of British Tape Recordists and Clubs* public relations officer, who contacted the Czech Embassy again, and then gave me a fullsomely worded and official-looking letter, which the Embassy kindly translated. Armed with these documents, I joined the Ingham tour at London Airport on May 21st.

On arrival in Prague by Ilyushin jet, we went through Customs and Currency Control, and were asked to declare on our visas any articles apart from the usual bona-fide traveller's items. As I put down a camera, transistor radio and recorder, I felt that perhaps I was being rather foolhardy, and would be locked away within hours. The

visa was stamped without a glance (I doubt if the young lady could understand it!) and I was in.

I shall never regret having taken a recorder with me, as on our very first morning's sight-seeing (a Sunday) we were led by our guide into the old city. The church bells were the first sound to go on tape and as we went into the lovely baroque church of St. James, the organ was being played. The Uher swung into operation, and we listened spellbound to a rehearsal by Prague's leading organist, Jiri Ropek. Though I had a plate fixed to the microphone with the one word *Soundhunters* on it (which was to attract much attention everywhere from the Czechs), an American lady came straight up to me and asked "Are you recording?" which, of course, went straight on to the tape. Such are the trials of using equipment apparently not known in the New World.

We had entered the church under the organ gallery and, looking back, I saw a full chamber orchestra assembling. After a few moments tuning up, they launched into a Handel Organ Concerto, which was (we discovered later) to be played during the interval in the Mass. After getting that taped no one afterwards queried why the Uher hardly left my side, and was always kept fully charged in my hotel room. It is the spontaneous moments like these which give one the greatest thrills and can always be recalled at home at the flick of a switch.

I remember vividly another lovely sunny day when we had gone out of Prague to Melnik, a small town where the Vltava and Elbe rivers join. Lunch was served in a hotel with the vineyard on the slopes below us, and I kept hearing singing in the distance. This so intrigued me that I went to investigate, and discovered a local wedding party in the next room. I began to get very fidgety, and someone suggested that I might get a drink if I went in. Eventually our guide came to my rescue. She was Lottie Kroutilova, surely

the most popular of all the *Cedok* guides, a charming Polish lady who had spent some years in Britain during the war. She asked the bride whether the young Englishman could record their songs. They were delighted, and I was able to tape several songs. One guest (slightly the worse for wear, I fear), seeing the *Soundhunter* sign, came right up to the mike and shouted his own pronunciation of "Soonder-hoon-ter" to my acute embarrassment but the amusement of the others. At least it broke the ice and they all listened enraptured to the playback—though I never did get that drink!

Language did not prove to be much of a problem, as most Czechs speak German, but after a moving excursion to Lidice I was careful to make certain they realised I wasn't German. Money for the British tourist is good, because we get an exchange rate of 45 crowns to the pound instead of twenty-five. We heard, too, that on the black market a pound note would fetch up to a hundred crowns, since the Czechs have to pay 125 for them if they are lucky enough to go abroad. Transistor radios (mainly Japanese) were much in evidence, but most of the recorders in the shops were made by the State concern, *Tesla*. I did see a *Philips* recorder in one window. Most of the tape being sold was the East German *Orwo*, but I found drop-out high even though it was marked "Specially for four-track". It was, however, half the price of the *Agfa* and *BASF* brands. *Supraphon* records (mono or stereo) were even cheaper than in Britain, selling at about fifteen shillings each, but without sleeve notes. Occasionally one could get East German records of the *Eterna* label, again ridiculously cheap compared with British prices. There were no real hi-fi shops as we know them, and in general the shops were drab, with inferior goods, except for their specialities like glass.

We were absolutely free to go where we liked, when we liked, even in the early hours of the morning. No one ever objected to my taking the recorder to concerts by such artists as Richter, Stern or the Czech Philharmonic. I even recorded large chunks of the centenary performance of Smetana's *Bartered Bride* in the National Theatre under Zdenek Kosler, by screwing the mike on to the seat back. At the State Song and Dance Ensemble we were in the front row, and I thought this a little exposed for recording, so I sent a message to the group's director asking for permission. Back came the reply that they had no objection at all, and if the gentleman was not in the best position, would he please find a better seat! In fact, one of our party took many close-up photographs at the same time.

So much of the former glory of Prague is still missing. Considerable renovation and reconstruction is taking place, with priority being given to the notable architectural beauties, such as the glorious Strahov Palace and its beautiful library, St. Vitus' Cathedral and, of course, the Aradany Castle, that imposing white edifice overlooking the majestic sweep of the Vltava, immortalised in Smetana's nationalistic music. Green parks abound and so few cars disturb pedestrians that sightseeing becomes a pleasure. The Historic Czechoslovakian capital, with its advantageous exchange rate for the tourist, is only ninety-five minutes flying-time from London.

"WOULD you like to do the sound for a Son-et-Lumiere at Taunton castle?" they said. With but a moment's thought, and little idea of what was to lie ahead, the neck was stuck out again.

This happened in January, and, as the production was not to be until the end of May, all was peaceful. An initial meeting of script-writer/producer John Wilkins, lighting technicians Ewart Evans and Leslie Morris—later to be so ably led by Master of the Spots and Floods—Ian Marfell, and the story unfolded. It was to be a combined amateur production. All the local drama, musical, opera and choral societies were to bury their assorted hatchets and join forces, co-opting as many 'odd bods' as possible to assist.

The plot was fiendishly clever—and ambitious. The production, although it was never proclaimed so, was hoped to be up to professional standards and was to include live acting in the form of mime to recorded narratives, using a cast of about seventy. Most of us had not experienced a Son-et-Lumiere presentation before, but this, as results proved, was no great disadvantage.

Meanwhile, back at the meeting . . . can you make a ghostly laugh echo round the courtyard? The sound of a squealing pig was to travel the whole length of the 100ft. castle frontage. Buildings demolishing, marching men to be heard where there were none, galloping horses, thunderstorm, tolling bell, gun battles, music, crowds, storm at sea, baby crying and voices for the dialogue—all these, and many others, the extended neck agreed to provide. It did, however, turn down the suggestion to create a realistic earthquake on the quite reasonable grounds that it had not the faintest idea what an earthquake sounded like.

The time for a more serious appraisal of the situation had arrived. First it was determined that each recording should be of the highest standard that could be achieved with the equipment to hand, both from the technical and aesthetic points of view. Next, after many hours scanning the script, it became obvious that at least three tape tracks would be required. The purchase of a "16-or-so track" machine was out of the question, and so a *Revox 736* was to be pressed into service, ably assisted by a *Telefunken* for the effects on the third track. The lighting boys would have to do it the hard way and not depend on the professional method of sound and light control from one machine.

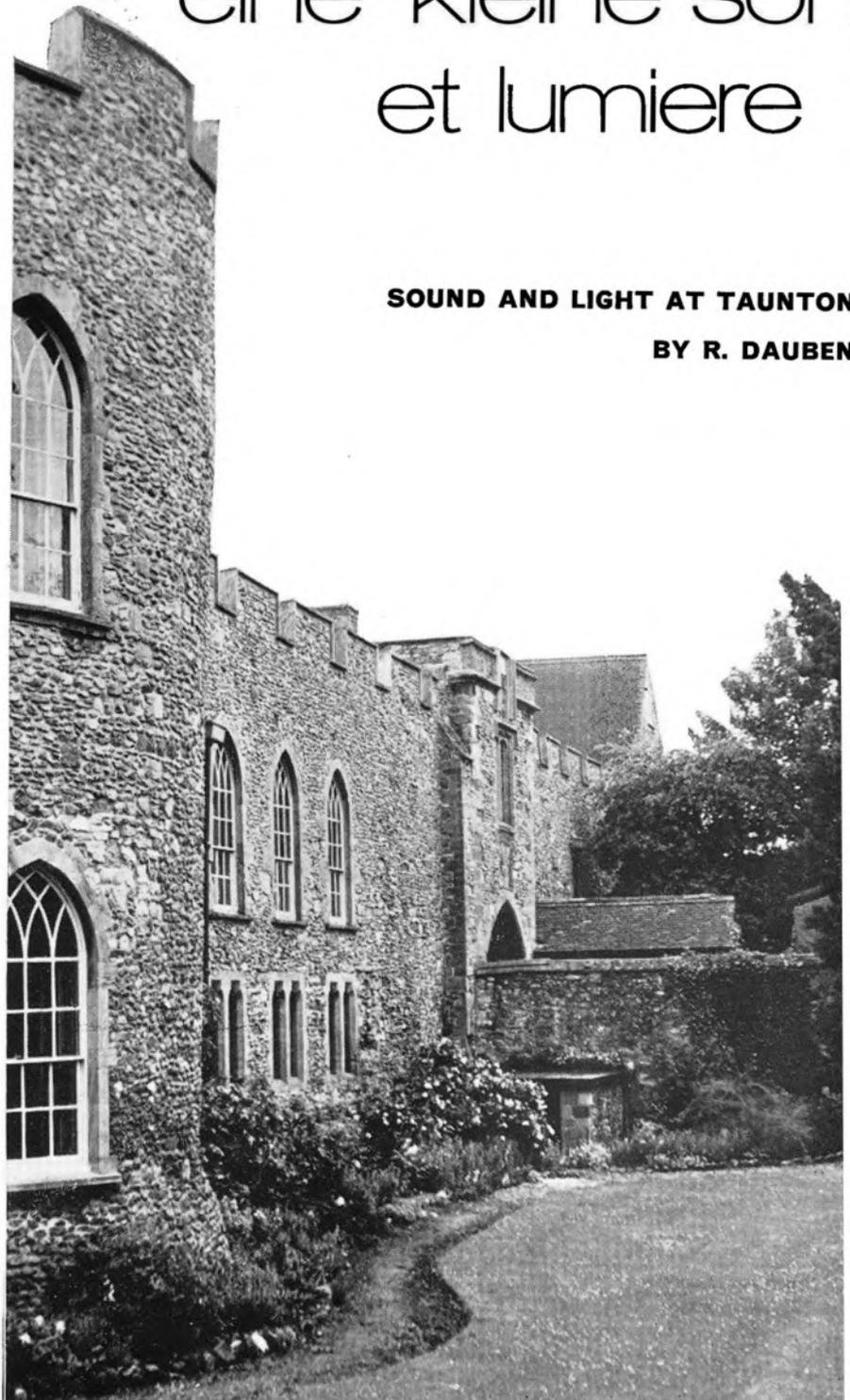
The script initially appeared to be a meaningless jumble of words adjacent to the names of various characters, spanning some twelve hundred years. It took a little time to get the feel of this, particularly as it was my first excursion into the world of drama. After de-jumbling the script, the first thing to send a shiver down my back was that some 140 recordings would be needed, many of them being simultaneous and required from separate sound sources—why couldn't I have been up in the Alps, or in Cleethorpes, or somewhere else when the call went out?

The castle layout called for three main sound sources, plus one lesser source in the entrance archway for effects, and so a search was made for the loudspeakers and amplifiers to be used. I had visions of great banks of *Quad Electrostatics*, but finally settled for

eine kleine son et lumiere

SOUND AND LIGHT AT TAUNTON

BY R. DAUBEN



three Philips 7ft. 50W and one 4ft. 20W, also Philips, line-source loudspeaker units, driven by four amplifiers of the same make ranging in power from 35W to 120W. Not quite what I had hoped for, but as results proved, reasonably satisfactory.

By now it was late March ("There's plenty of time") and so arrangements were made to start voice recording, but where? The recording room finally materialised on the top floor of a house owned by one of the participating dramatic organisations. Rather a bare, odd shaped, room, but one with possibilities. Drapes of velvet were hung making a room within a room, about 9ft. square with the ceiling of hessian and a carpeted floor. This was christened "The gypsies tent". On checking it seemed acceptably dead acoustically, that is, by noise excitation from within.

April arrived and a start was made on voice recording. Out came the Beyer omnidirectional microphone and, with the aid of a photographic lamp-stand, quite a useful boom type mount was fabricated. Right, we're ready to go. "Where's David Gent? (He is the narrator.) Ah, just sit here and read this so that the levels can be set". All is well so far, but what the devil is that? "David, are you tinkling anything in there?" No... the nearby church had decided that bell practice was to be tonight and so they rang for 15 minutes, with breaks of 15 to 20 minutes. We used the breaks. Despite this we got the narrator on tape in one evening.

Next session, Wednesday, 12th April, at 7.30, said the notice board. Once more, Revox, microphone, stand, cables, monitor speaker, etc., were carried up what seemed to be about 30 flights of stairs, all set up and ready to start again, only this time it was party night at the local youth club, meaning comings and goings of scooters with excellent transient response from their exhaust systems. Another start was made, most recordings being 'clean', but a few had to be made three or even four times in order to avoid Henry VII delivering a compassionate speech to an unseen, but acoustically prominent, group of scooterists.

The following Monday. Back again, this time for crowd scenes, all made in what is known as 'The workshop'. Happily, full of assorted scenery and other irregularly shaped objects which helped to break up wall reflections. The crowd scenes taped, now was the time to try for that ghostly echoing laugh. The Revox, in its versatility, allows for a form of artificial echo to be produced, this allied to the right voice—and that was another problem solved. Another session on Wednesday 19th April, and the remaining voices were taped.

PLANNING HAD HELPED

By now some 3,500ft. of BASF LP tape had been used—all on different reels. The early planning had helped, as all the speech had been recorded on the track required; all that remained was to sort it out, and get splicing.

A further meeting between the heads of departments and the Revox, and the recordings to be used were selected. Where to start? The narrator's tape seemed the most logical one to begin, so all clicks, er's, um's, sorry-I'll-do-that-again's (and bells!) were cut out, and the remains joined up. An

initial listen. For the first time a little order seemed to be emerging from a large amount of chaos. Next, the other voices were inserted in the correct places, Doomsday clerk, Geoffrey Chaucer, Perkin Warbeck, assorted Bishops, a lone king, Admiral Blake, Judge Jeffreys, and many others. All slotted into their respective spots with the aid of slicing tape.

Whilst the making of a documentary tape is quite straightforward, when this is used to synchronise with live acting, timing is all important. Stop watches came out at early rehearsals. Most movements were trouble-free, but such items as an antiquary leaving the castle, getting into his car and driving off, meant holding the tape—a mental note to arrange a remote control switch for the Revox. Another evening session of timing by John and the pattern emerged. Ten seconds here, 17 there, 35 seconds between words "clerk read the charges" and "John Denbury". In all about 30 timing sections initially required. The easiest way around this was found by using a 'tape measure', a length of dowel marked off in seconds by divisions at 7½ in. intervals, cut unrecorded tape to the time length required, and then splice this in at the right places. And so the tape grew, composed mainly of tape splices it seemed. In the interests of continuity two or three seconds were cropped off here and there, with the hope that the actors would be able to keep pace, which they did.

Sound effects next. Some quite simple, like horses, wind, thunderstorms and so on. Some 'pseudo stereo' was produced with the thunder, buildings collapsing and sea storm effects, by the simple expedient of having three quite different recordings of each of these and running them through three separate sound sources.

ENJOYABLE BATTLE

The gun battle for the siege of the castle was one of the most enjoyable effects to produce—there must be a built-in destructive element in some of us. An old recording carrying a royal salute was dusted off, track-to-track transfers, while feeding in the same original recording—altered by tone controls and filtering—finally produced an effect that would have helped the French to lose the battle of Agincourt, had it been on release at the time. It says a lot for the performance of the Revox that after about 20 track-to-track copies, the drop in fidelity (if this term can be applied to guns) was minimal.

The tape was now nearing completion and ways of inflicting it on the public ear were sought. Thus came into being the *Mark 1 Audience Confuser*. This was quite a simple mechanism, being basically a passive mixer unit with muting and signal switching facilities.

The sound requirements called for sound from any or all of the four loudspeakers, and mixtures thereof. To simplify things, the three tape tracks were coded yellow, green and blue and the amplifiers coded one, two, three and four. The decision was made to attempt click- and hum-free, high-impedance, signal switching, between the tape outputs and amplifier inputs, the amplifiers running at a constant gain setting.

Four three-way push-button assemblies, four 'push to changeover' switches, four moulded-track potentiometers, an assortment of high-

stability resistors, some sheet aluminium, coloured Sellotape strip Fablon, and so on, and a rather gaudy control box was fabricated. The push-button switches fed any of the three tape tracks to any of the four amplifiers through the switches for amplifier muting, and thence to the potentiometers for level control. The changeover switches fulfilled their purpose of amplifier muting by switching the amplifier input to chassis through a 50-ohm resistor; at the same time the opening signal feed contacts were bridged with 1M resistors. This idea worked surprisingly well, actually being click- and hum-free, an added benefit from the decision to use a passive mixer being that the insertion loss very nicely 'padded' down the fairly high output voltages of the recorders to a level much more acceptable to the amplifiers.

In order to monitor the signals going out to each loudspeaker, a rather crude method was employed. Each amplifier output was fed into a resistive potential divider, the reduced signal voltages then being resistively combined and fed to the input of a low power amplifier. This fed two monitor loudspeakers, one for light cueing, and the other for the 'ward-robeists', a further output feeding AKG headphones, for sound control. This method, while crude, was effective. A few more evenings of work on the tape and it was as ready as ever it would be—albeit about three weeks behind schedule.

CONNECTING UP

'Installation and Rehearsal Week' had arrived. The first evening was set aside for connecting everything up and making any adjustments. This went quite smoothly, and the time to switch on arrived—no, it didn't blow the fuses! A certain amount of the programme material was in stereo, thus necessitating the usual loudspeaker phasing precautions, a white noise tape having been prepared for this. Lots of walking and pondering. In some places the stereo effect was most pronounced, in others, one or other of the main loudspeakers took prominence. Still, the fact that we had any stereo at all was quite heartening, particularly as the seating layout was far from ideal from this point of view.

Stands had been put up to give seating for the audience, tiering at the back to give a better view of the 'battle area' and also to blank off the narrator's loudspeaker. A steel gantry enabled the loudspeaker to be raised some 6ft., thereby solving the problem.

Rehearsals started next evening. The time had come to see if the whole thing would work. "Select green 3, yellow 1, hold tape on remote..." It felt like a rocket launching. "All systems are go". Release the spring return remote tape switch and we are off on the very first run. A flurry of track switching, level balancing, making script notes determining not to do that particular part that way again, and it was all over. More than anything else I felt that a way had now been found to compress time. An hour had been reduced to about 10 minutes, or so it seemed. A talk with John: he seems fairly happy. "Can you bring this up a bit, fade that, change the clapping for Disraeli to this speaker", and so on. Home at about midnight and sit up in bed making alterations to the script coding. More

(continued on page 461)

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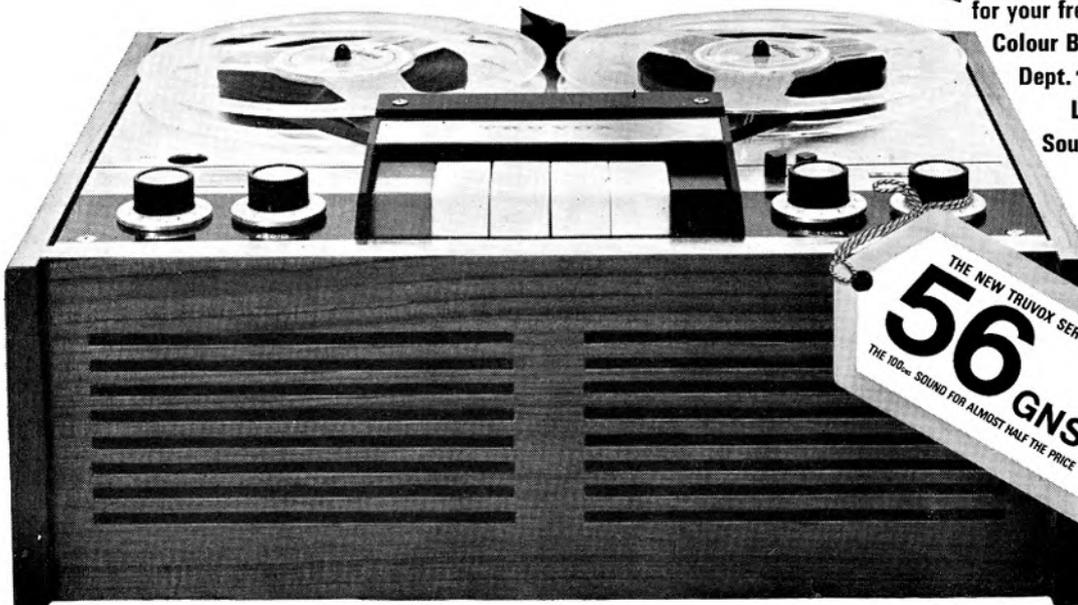
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READERS' PROBLEMS

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

FITTING $\frac{1}{4}$ -TRACK HEADS

Dear Sir, I have been thinking of converting my Ferguson 3200 tape recorder from $\frac{1}{2}$ -track to $\frac{1}{4}$ -track operation and I was wondering if you would be able to advise me:

(1) whether this is possible without drastically altering the existing wiring,

(2) whether the Ferguson $\frac{1}{4}$ -track heads as used on the model 3202 or later designs would be suitable,

(3) If the Ferguson heads are not suitable, could you recommend any heads that are?

Yours faithfully, I.P., London, E.11.

We only wish that all queries were so lucid and direct. To be equally direct, we could answer:

(1) Yes.

(2) Yes.

(3) No.

but that would hardly be fair, so allow us to go a little deeper.

The Ferguson 3202 is a development of the 3200, and the basic circuit need not be altered when converting to $\frac{1}{4}$ -track operation. It is advisable to use the 3202 head, as the circuit matches these pretty closely, except for the following changes: referring to the circuits published in our recent servicing articles; reduce C1 from 560 to 220pF, reduce C13 from 560 to 220pF, increase R14 to 220K (as it was on earlier models) and reduce C9 to 820pF.

Other alterations are to incorporate $\frac{1}{4}$ -track switching and the best bet is to follow the circuits as given. Note one very important alteration: this is to take the bias feed from the alternative tap on the secondary of the oscillator transformer, and to feed the erase head from the lower voltage tap. This is to allow for the change in inductance of the new head (which is, incidentally, much more efficient), and allows you to use the existing oscillator transformer.

We would not recommend alternative heads, which would probably need more extensive circuit changes.

FLUTTER AND LOW GAIN

Dear Sir, Can you please help me with two problems concerning my Philips EL3556.

First, when making recordings from the radio I now have to turn the gain control much further than I used to, to obtain a satisfactory signal. Consequently there is background noise. What is the cause of this? I have had the valves tested.

Secondly, some long recordings suffer from 'flutter' and I have to be very careful what tape I use. The machine is only 12 months old.

Yours faithfully, K.J.M., Southampton.
We would suggest your trouble is either a heavy oxide deposit at the record/play head, or wear at one or two possible points, causing the flutter effect, and poor tape-to-head contact.

If you have ensured that the head facing is clean, i.e., bright and shining, and wiped off with methylated spirit or one of the proprietary head cleaners, then look to the erase head and the plastic mount section at the left guide, where there is always a tendency for tape trapping when minute particles of oxide and dust get trapped in flanges.

A good method of getting these head channels clean—not an easy task without removing the top cover altogether—is to soak a ribbon in methylated spirit and draw this carefully through the tape path several times. The ribbon we use is actually a Sony tape cleaner supplied with their machines. But any linen or cotton ribbon or tape would do, such as a piece of binding tape, a name-tab length, or other such piece of plunder from your wife's workbox.

A WEARING BSR

Dear Sir, On the Fidelity Argyll tape recorder there is a metal disc underneath the plastic turntable which by means of a felt pad on the bottom of the turntable drives the take-up of the tape as you record. The metal disc revolves all the time the machine is switched on and the friction between the felt and the metal causes the metal surface to polish up, so when you record or play the tape slips.

I have tried roughening the metal surface with a wire brush, emery cloth, etc., but it only lasts for a few moments, and as soon as you rewind to the left (in the opposite direction to the disc) it becomes polished again and starts to slip, making it almost impossible to rewind to the left.

So can you tell me what else I can do to prevent this from happening.

Yours faithfully, W.M.S., Cannock.
The problem with the BSR TD2 deck, as used in the Fidelity Argyll, is the old one of wear. In your case, it appears the felt underpad, or ring, of the take-up spool carrier has hardened beyond any redemption. You should renew this ring, using soft felt.

Check also the centre boss of the lower drum, using a screwdriver shaft or something similar with the spool carrier removed, to act as a spindle. Note whether there is any tendency for the belt to give a sloppy radial play, or whether the belt has, in fact, become slack. On rewind, the tension is afforded by the spool carrier wiping on this drum which is, of course, revolving in the opposite direction; if, when rewinding, the belt action slows, it is too slack.

The final thing to check is the relative height of drum and carrier. Wear may have caused the centre bush to prise upwards, and then as the rewind action tends to make the spool 'aeroplane', it loses grip with the drum, despite the felt. A single packing washer between bush

and lower flange of drum can help, but you may need to bring the carrier down, if this can be done without affecting take-up, by adding a small washer under the deck, between bush and circlip.

INTERMITTENT BASS

Dear Sir, My Elizabethan Popular 400 has intermittently been fading down to a low bass on playback and will then suddenly click back to normal volume and tone. I suspect dirt on the play head, and following the instructions, cleaned it with methylated spirit. On close examination of the head, I noticed a green/yellow smear on it which the spirit wouldn't remove. The playback condition has not improved, so I seek your advice as to the trouble whether the smear has anything to do with it or not.

I should also like your advice on the importance of head demagnetism.

Yours faithfully, C.M.R., London, S.E.9.

The trouble with your Elizabethan Popular 400 would appear not to be at the head at all, if we interpret your remarks correctly. By "fading down to a low bass" we presume you mean a loss in volume, principally of the bass, and the fact that it 'clicks back' would indicate that you have an amplifier fault, most probably a high resistance joint at the wire ends of the 64 μ F electrolytic decoupling the cathode of the ECL86 pentode. It could, of course, be a leaky .047 μ F between the two sections of the ECC83, but this fault generally deteriorates and seldom reverts to normal once it develops. Equally likely with this machine, it could be a printed circuit fault caused by heat and movement, and you should check by tentative movement of the components when the fault condition obtains.

The coloured smear on the head facing may be the identifying paint mark that this firm sometimes uses in its inspection process and in this case you will find it well clear of the tape path. But if it is a mark across the gap, you will have to attack it once again with methylated or surgical spirit and a piece of linen wrapped around an orange stick to give a more positive wiping action. (continued on page 461)



"Shouldn't tell you this, Mabel, but . . ."

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READERS' PROBLEMS CONTINUED

In any case, this kind of trouble causes much more pronounced treble loss. Apropos this, demagnetisation is important to reduce the tape hiss and general noise level as much as possible. With an amplifier of this nature, at as high a gain as possible and very little feedback, any betterment of signal conditions at the input end, as is afforded by demagnetisation of the heads, is all to the good.

POOR ERASURE

Dear Sir, I have a Fidelity Playmaster $\frac{1}{2}$ -track (Model TR5) and am having trouble with the erase. When I erase, I can hear what I had on the tape before in the background. It cleans off if I erase three times. Could you please suggest the cause as I would like to put it right myself?

I would also like to know how to add superimposition; could you please advise me on how to do this.

Yours faithfully, D.J.W., Sedgley.

The most probable cause of poor erasure with your Fidelity Playmaster TR5, provided you have taken the obvious remedial steps of cleaning the head thoroughly and ensuring good pad pressure, is a faulty $4\mu\text{F}$ capacitor across the oscillator coil.

However, you should not overlook the possibility of a failing EL84 or even a poor cathode bypass capacitor. This component is quite important as it provides a low impedance path across the cathode bias resistor and can make severe losses evident if it ages or leaks.

Check the series $0.1\mu\text{F}$ capacitor to the erase head and also the $1\text{k}\Omega$ from the anode of the valve. There is quite a lot of heat around this

area of the machine and capacitors can dry out and develop high resistance leaks quite easily.

To add superimposition, insert a single-pole double-throw switch between the $0.1\mu\text{F}$ capacitor and the erase head, wiring to open-circuit the feed to the head and insert a 5K resistor. This should maintain your bias correctly to superimpose—but we must stress that you should get the erase circuit working well before doing this modification. The 5K resistor should be wired to take the place of the erase head during superimpose—do not leave the feed line open-circuited.

RELATIVE TAPE MERITS

Dear Sir, Apart from differences in playing time, what are the relative merits of 'Standard', 'Long Play' and 'Double Play' tapes?

What is the difference between PVC and tensilised polyester tapes?

Yours faithfully, G.W.S., St. Annen-on-Sea. Apart from the differences in tape length made possible by getting more of a thinner tape on a reel, there are several minor points that make one or other tape suitable for a particular machine. Standard tape is a good deal stiffer, will not sit so intimately against a head facing, and is thus less suitable for some machines. An example is the Tandberg 62, with its Bogen heads and no conventional pressure pad system. (One pad to the left engages the erase head guide plate only.) Standard tape, especially when new, can give slight differences of level, even to the extent of sounding fluttery. There are other machines which use these finely machined heads and which rely on tape travel for contact and which usually work better with double play tape. Signal-to-noise ratio is better and dropout less troublesome. On the other hand, a cheaper machine with a worn head and

a tight pressure pad system may give more trouble with thinner tape. Standard tape can catch in a fouled guide much more easily than DP, or LP.

Conversely, some portable machines, relying on quite light capstan pressures, tend to slip and wow when anything thinner than LP is used.

Tensilised tape is pre-stretched and not so prone to the edge-buckling curse which can be very troublesome on quarter-track machines—again worse on those that do not use the pressure pad system. Grundig, with their pressure sling device, are often happier with tensilised polyester.

Questions of matching for bias also arise—but that is another matter.

GRUNDIG TK23L—MECHANICAL NOISE

Dear Sir, I have a Grundig TK 23L which became mechanically noisy. I discovered quite considerable play on the bearing which holds the heavy flywheel, and extends to the tape, which is held on to this when playing by a roller. I have taken it back to the dealer, and it is quieter now, but the movement at the bearing is the same as before.

Yours faithfully, W.A.H., Wellingborough. It is quite normal for there to be a certain amount of play in the plastic rider which acts as top bearing of the flywheel spindle of the Grundig TK23L. This float is allowed for in the design, and should not produce mechanical noise.

Much more likely is the bottom bearing, where a ball is inset in the lower end of the spindle and rides on a flat plate. If the grease has dried the ball will have ground to a slight flat, which can cause wow and transport noise.

Other possibilities on this machine are the motor bearings and the fan, whose blades must be correctly aligned for quiet running.

EINE KLEINE SON ET LUMIERE CONTINUED

rehearsals next evening, and the next . . . Saturday, a breather. All rehearsals finished. The lighting boys have one or two problems to sort out but, from the way they coped with a recording that diverged from the hand-held scripts this would be easy for them.

Monday, 29th May, first night. On waking, this was the prime thought. I have never known a day drag the way this one did. Perhaps the time apparently missing during rehearsals was being given back! At 8.00 p.m. it is time to go and make sure all is still working. This completed, sit and wait. The atmosphere seems to be growing—so did the

clouds. Not more rain! At 9.45 we are due to start, but it is still a little too light, and the Mayor's party has not yet settled. 10.00. Help! We are off.

Once the main tape had started I felt that I had committed everybody—which I had. All went smoothly, however, though it was difficult to give the sound my full attention because of the impressive tableaux being presented by the actors and lighting. Halfway through to the battle scene: let us wind it up a bit and get the glass-fronted light and sound control box rattling; same with the thunder-storm, and the destructive sea storm. The finale, and it is all over. This time 65 minutes had compressed to five. The audience seem to have enjoyed it. The second evening was memorable because of the torrential rain—

and the stalwarts who sat out in it. Of about 250 audience at the start, only a handful left.

The week flits by and fortune smiles on us, providing warm sunny days and dry evenings. From Wednesday onwards we actually had queues waiting to stand and watch. At last, something to compete with the gogglebox. The press were quite kind. "A thumping success" and other comments, mostly favourable (I think!).

Things were a little quieter then. Spring had passed almost unseen, Summer had brought a few days in which to lay in the grass lazily reflecting. I could also settle again to the daily task of providing, installing and maintaining all shapes and sizes of audio equipment.

YOUR OBEDIENT SERVANT CONTINUED

the switching sequence clear—fig. 2(b).

The 'inhibit' gate allows a pulse out for a pulse in on the main line unless an inhibiting pulse arrives simultaneously on the second line, when there is no output. The pulse train is given below—figs. 2(c) and (d).

The delay line gives out an identical pulse train to that received, but at a specified number of pulse intervals delayed in time—fig. 2(e).

The 'flip-flop' is probably more familiar to us, and its many applications make us careless of its very strict function in logic circuits. It can be used in two ways, as a straight-forward switch, or as a memory or storage device for a single 'bit'. It represents 0 in the reset condition and 1 in the set condition. If we consider a flip-flop with a high- and low-volt output: when the device is switched on it is 'set', if the off button is pressed it 'resets', giving a high and low voltage output, that is peak of pulse and 'no pulse' output. In the reset condition pulses to the reset

input have no effect, but a pulse to the set input flips the switch and the output which was at high voltage becomes low voltage and vice versa.

We have skipped several functions and by-passed some quite important electronic building blocks (such as adders, registers and counters). These are too deep in the computer pool, however, since our dabble has been intended simply to lay the ground for a more detailed discussion of specialised magnetic devices; the latter will commence next month.

SINCE the articles 'Television on Tape' appeared in the August and September 1966 issues of *Tape Recorder*, the video tape recording scene has changed considerably. At that time, the choice of 'low price' television recorders was limited to the *Philips EL 3400* at around £1000 or one of the *Ampex HVR* series in the £2000 to £3000 category. Now, barely a year later, the price yardstick has fallen from thousands to hundreds of pounds, and the range of designs has greatly expanded.

The majority of these machines are helical-scan and it seems that manufacturers have plumped quite definitely for this system—at least for the present. The much discussed cross-field head has still to prove itself at the time of writing and thermo-plastic recording is still a thing of the future. A result of this decision in favour of helical-scan is that we are now in the happy position of having a choice in this country of almost a dozen different models. Among those actually in use in various CCTV systems are the *Sony Videocorder*, two *Loewe-Opta* models, two from *Ikegami* of Japan, two new *Philips* machines and three brand new *Ampex* models.

LEAST EXPENSIVE

Least expensive is the Sony. Price of the recorder and 9in. monitor is £368 11s. The camera and tripod run to another £131 5s. This comprises a complete (though limited) single channel CCTV at less than £500. The Videocorder used with its associated TV camera takes pictures and records sound, puts them on to tape, monitors them and plays them back again within seconds, or whenever required. It can tape TV programmes off the air. Recorded material is stored on tape which can be erased and used again. To make the system more versatile, a camera selector switch on the recorder permits use of two cameras with one recorder and monitor. So for £630 a two-channel CCTV can be provided; but with no facility for vision mixing. The single system, however, will satisfy most requirements of the small operator and meet many applications in business, science, medicine and engineering.

FAIRLY SMALL

The Videocorder is fairly small (18 x 16 x 11 in.) and fairly light in weight (41 lbs.). The helical-scan system (see diagram) consists of two quartz video heads mounted on a horizontal head-drum rotating against the moving direction of the $\frac{1}{2}$ in. wide tape for a full recording time of 60 mins. Fast-wind time is 7 minutes. The tape is slanted downwards by means of left and right tapered guides and by a difference in level between the supply and take-up reel tables (supply being at a higher level than take-up). Thus, heads on a horizontal plane in the head-drum and tape passing the plane at a downward angle results in a starter track.

The skip-scan system is used for record and playback. It has been found that video information varies little from one field or frame to the next, therefore it is possible to eliminate every other field and still achieve satisfactory picture quality. Of the two heads on the drum, one is used for recording while two are used for playback, which means that each field is scanned twice for playback. It

VIDEO CIRCUIT

PART I UNDERSTANDING AND USING HELICAL SCAN

works as follows: Video head A has record signal applied to it at all times. It makes a continuous 360° revolution around the head-drum; for 180° it scans the tape and for the other 180° it travels free of tape. During the scan one field of information is recorded on the tape and during the free travel period one field is eliminated. On playback both heads are used. Together they make a continuous 360° revolution, each scanning the previously recorded field once, first the A head and then the B head. The B head is set at a different angle and level with respect to the A head, allowing it to scan the same information to produce on the screen the appearance of a completely interlaced 405 line picture.

SIMPLE TO OPERATE

The controls of the Videocorder are simple to operate and include a three-position electro-mechanical selector for play, rewind and stop; a separate fast/forward control; a record button which can be used independently of the main tape transport control to enable the camera to be set-up accurately and monitored on the screen before commencing recording; and the recording source selector. The last is a two-way switch marked *TV* and *Camera* (the TV source can be used, of course, for a second camera channel). The 9 in. monitor is in every other respect a normal British TV standard 405 line VHF receiver with 13 channel coverage.

The television camera is light, small and, again, easy to operate, requiring connections only to the Videocorder and an AC source before placing its power toggle switch in the *POWER* position. If all adjustments are correct on the Videocorder a picture will appear on the monitor about 20 seconds after the camera has been switched on. The camera lens is a standard *f*/1.9 25mm. 'C' mount type, which means that there is a great variety of other lenses available for use, including zoom type. At the rear of the camera there is an adjustment marked 'Focus'. This does not operate the optical focus of the lens but concentrates the vidicon, or picture tube within the camera, to the camera lens. Normal focusing and opening and closing down the lens iris is performed by adjusting the lens rings as with a normal cine camera.

When operating the system it is found that normal domestic lighting is quite adequate, for even with the lens iris fully opened a fairly good though 'flat' picture is produced on the monitor screen. Of course, far better results are produced by adding spot lamps to model the subject.



Sony CV-2000 video tape recorder, price £368 11s.

'EDITING' AND 'CUTTING'

Quite a lot has been said lately about editing helical-scan recorded tapes, especially by cine enthusiasts with little experience of live television production, and it seems that some confusion has arisen between the two terms 'editing' and 'cutting'. Cutting one of these tapes, removing unwanted material and then rejoining it, is very easy; it is not at all easy, however, to edit.

By editing I mean the removal of superfluous frames, bad takes, flares and the tops and tails of good takes and then the reshaping of the good takes of the various camera angle positions (close-up, mid-shot, long-shot, etc.) into acceptable sequences within the story-line. This is established motion picture film practice and is essential to production.

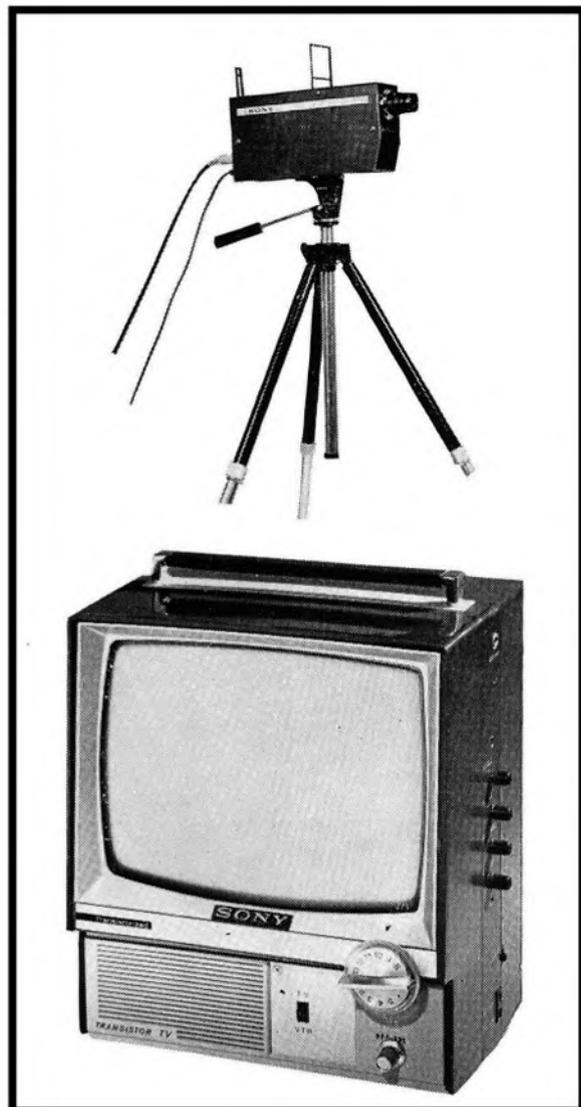
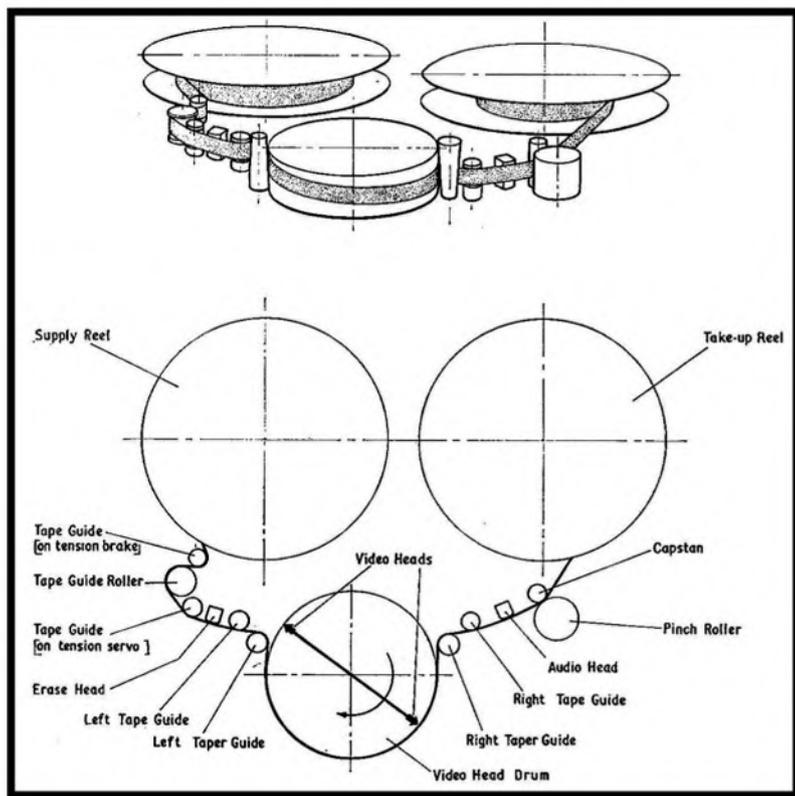
With VTR, the video information as recorded by helical-scan is current on a series of parallel diagonal tracks that extend almost all the way across the tape. According to the particular design of the head disc in the various models these can be anything from 8 to 16 inches in length. In addition, control and audio tracks are recorded longitudinally along the edges of the tape. Cutting to an exact frame is no simple matter, and on most machines is possible without producing an unpleasant picture roll lasting a couple of seconds.

If, however, cutting between scenes is desirable, the Videocorder may be inched manually, frame by frame, until the cutting point is found. The rotating head permits monitoring while inching and a still picture may be held for a short time. After marking

CLOSED CIRCUIT

PART I UNDERSTANDING AND USING HELICAL SCAN

Basic deck layout is visible in drawing.
Far right : Camera and tripod add £131 5s. to the cost of a complete closed-circuit television system. The monitor (lower right) is included in the price of the CV-2000



the tape with a grease pencil a transverse cut may be made and a normal tape splice completed. There will still be picture roll, but it will now last only a fraction of a second.

With normal CCTV recording practice even this may never be required, for live television is vastly different to motion picture production. A documentary or feature film production may be spread over days or weeks, the shooting takes place on different locations and in different studios, the picture and sound assembly being completed in the cutting rooms. CCTV production takes place at the one time in the one studio with all the editing taking place on the spot by cutting from one camera to another or by vision mixing from one camera to another. The programme material must be well rehearsed, of course, and timed to a degree so that once started the production moves off smoothly and goes on that way without a hitch, the various cameras or other channels being mixed in and out according

to the cues on the script. When the production ends and is finally faded out there should be no need for editing the resultant video recording.

If, however, the VTR is to be used as the heart of a portable film unit to capture necessary inserts to make up a programme, then cutting and rejoining are unavoidable unless there is another VTR at hand to which the material can be transferred electronically. The addition of extra equipment complicates the system, of course, and with the Videocorder defeats this machine's main assets—cheapness and portability.

COMPLETE OUTFIT

With the Sony, a complete outfit is provided for £500. It can be set up easily and then packed away as easily to be transported elsewhere for demonstration purposes. Operating the system needs no more practice than can be acquired by a few preliminary runs.

It records the TV signal adequately and plays back on to a small screen. It can be used quite efficiently as a small CCTV. Used as a portable film unit, however, by an operator with no real experience of film making, it can present problems.

Some of the problems of VTR can be completely unnecessary, however. The lighter side of this was emphasised for me the other day when I visited a College of Education to look over their Television Research and Training Unit. There among the array of gleaming Marconi TV cameras, spot lamps, caption machines and sound and vision mixers stood a brand new Peto Scott video tape recorder. I posed the question. "Editing! Good Grief, no!" said the pretty camera operator. "If we make a mistake, we just go back and start again".

It is not as simple as that really, and in a later issue I hope to expand a little on live CCTV production.

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PERSONAL BIAS

BY JOHN ASHCROFT



auntie

does she want to know?

AMATEUR recordists often accuse the BBC of not encouraging the hobby, and the fate of *Sound* makes her a sitting target for quite a few brickbats. "They don't want to know," is an oft-heard wail. "After all, if newspapers and magazines will print letters, photographs, cartoons or articles from talented readers, why can't broadcasting be equally open to the amateur?"

But think again. Publishers slap rejection slips on the bulk of amateur offerings because the work is sub-standard or needs more revision than a sub-editor has time to do . . . and having heard *some* entries for recording club contests I can well imagine the BBC vanishing under a deluge of audible ineptitude if they openly appealed for tapes from all and sundry seven days a week.

Don't get me wrong! Amateurs *can* produce professional calibre features and the BBC might be glad of them (as Keith Macklin stressed in our April issue); but many of the amateurs with the imagination and know-how are using equipment which—to full-track 15 i/s users—is on a par with 8mm. home cine in the eyes of a Hollywood producer.

Publishers seldom expect their readers to make allowances for amateur work which is amateurish (note the distinction); amateur or part-time writers have to compete on level terms with professionals. So we can hardly expect the BBC to broadcast programmes of sub-standard quality with the apologetic excuse that such work is, after all, produced by amateurs.

All right, I've heard of the lady who used a 1½ i/s cassette portable, dubbed the interview and sent the half-track 7½ i/s copy which was accepted and used . . . but I'll bet that the subject was interesting and that the BBC were fully aware of any technical limitations in the recording quality.

And some location interviews by BBC staff might be thrown out of any amateur contest judged solely on technical standards; I've heard samples, in topical magazine programmes, that were dimly reverberant or full of spiky sibilance; marred by motor noise, breeze-rumbles, peculiar crackles, or questionable microphone balance. When topicality has top priority, people get away with audio-murder—but of course the BBC would prefer subject interest *and* high-fidelity.

The BBC amateur tape-contests ('Summer,' and now 'On the Move') are a welcome sign.

But I'm annoyed by the specific exclusion of ¼-track recordings. In theory this stipulation says: entries are permitted using a 3½ i/s rusty rosy ruin of a prehistoric half-track machine, but *not* ones made on (say) a Tandberg 64 at 7½ i/s. Granted, a ¼-track entry could be dubbed on to a half-track machine and the dub could be submitted, but why should users of reputable ¼-track equipment suffer such an added handicap? Is it beyond the organisers' imagination to have ¼-track replay facilities at the judging sessions? I suspect that this stipulation stems from laziness rather than from purely technical quality considerations.

However, doors are opening, albeit slowly. But what prospects to clubs or individuals will be offered by the local BBC stations?

Immediately the door yawns wider. VHF implies far less deterioration between the original tape and what emerges from a listener's loudspeaker a few miles from the transmitter, so immaculate originals may not be so vital. (*Twisted logic!*—Ed.)

Compared with national broadcasts on medium-wave, the local VHF transmissions can start with lower quality yet still give better results. Significantly, the local stations will probably use 7½ i/s for most purposes . . . which, again, may lessen the gap between local professional and amateur. Also, they can use interviews with local characters which might not interest the national network listeners; so an amateur with local knowledge, contacts, awareness of unusual occupations and so on, might find himself in a promising situation.

John Bradley of the *Federation of British Tape Recordists and Clubs* has done some valuable stirring-up in this connection. He was agreeably surprised by the BBC reaction to his approaches—he was invited to come and talk matters over, meet the local station managers, tell them about amateur activities in their respective areas, and generally act as defending counsel before an interested and sympathetic jury.

On behalf of the Merseyside Tape Recording Society, I had previously contacted Mr. Michael Hancock, the manager of Radio Merseyside; but the Federation certainly strengthened this contact, and at the Liverpool Show Mr. Hancock put his cards squarely on the table during a lengthy and interesting discussion. And, to a large extent, his views are shared by other local station managers and by the BBC local radio planners.

He wants Radio Merseyside to develop its local flavour; contributions from amateurs will be welcomed and used, subject to two reasonable conditions—first, that the subject matter is interesting; second, that the recording quality and presentation are up to scratch. Ideally, contributions should be submitted in a ready-for-use state.

I suggested that his radio-car and full-time staff might be fully occupied on a major 'story' when something smaller, or a routine matter, came up . . . and was there any chance of local amateurs being contacted to help out in such instances, or even gather additional interview or actuality material from the bigger story? Ambitious, perhaps; but Mr. Hancock conceded that the idea did have possibilities.

First, though, amateurs must prove worthy of confidence. If they convince a local station manager that they *can* be relied upon to produce tidy interviews and well-recorded actuality, they could be accepted as useful people to know; any mess, let-down, or sheer chickening-out of a challenge, and they might become regarded as a pack of public nuisances.

(That last paragraph is merely my interpretation of the situation; it is *not* a quote from anybody. But it seems reasonable to me; and, while Mr. Hancock is an extremely pleasant and genial man, I'm sure that any old rubbish thrown at him by Merseyside amateurs will be—most politely—thrown right back!)

To stimulate interest, and assess amateurs' capabilities, Radio Merseyside (along with Radio Sheffield and Radio Stoke) is planning a tape-contest on a local theme—"The Mersey Sound", in this case. Full details will be thrashed out at a meeting between Mr. Hancock and members of the local club who will be helping in the organisation of the contest; meanwhile, I have suggested that entries might be eligible using any speed from 15 to 1½ i/s inclusive, and that ¼-track entries should be allowed—and, if necessary, dubbed into suitable broadcasting form if successful. Mr. Hancock accepted this idea, much to my delight—you'll have gathered that I have strong views on this topic.

Local radio can make or break the amateur movement generally. It could be the long-awaited thin end of the wedge. And, certainly, the ball has been well and truly belted back into the amateur's territory; so the amateurs must prove that the BBC has answered their prayer—and not called their bluff.



AN ORCHESTRA IN THE BASEMENT

SOME few weeks ago a 12in. gramophone record was deposited upon my desk by a member of our staff with the instruction: "Play it and see what you think". Judging from the cover, which was decorated in psychedelic squiggles of orange, green and pink, the disc appeared to be an album of light music and I responded by enquiring why my opinion was being sought. The contents of the disc, I was informed, had all been composed, performed and tape recorded by one man. "Ah!" I replied, "another Wout Steenhuis". "More or less, but there might be an article in it."

The "more or less" turned out to be unfair and, after hearing the record and meeting the performer, there did indeed seem to be scope for an article.

Mr. Barry Stoller (who works under the name 'Rhet' Stoller) is a gifted young musician who, twice in his 25 years, has passed through the barrier separating the amateur from the professional. From spare-time activities in guitar groups, he has become a full-time 'one-man-orchestra'. Of more direct interest to the tape recording fraternity, he has developed his equipment and his recording skills from an amateur *Vortexion/Truvox* operator to a 'one-man-studio'. The moral of this tale, epitomised in Mr. Stoller's first composition *Merry Country Overture*, is that artistic talent is dependent much more upon creative ability and imagination than upon the tools employed.

The climb from amateur to professional began in 1962, when the first composition was

recorded. An electric guitar was connected through a *Leak Varislope* preamplifier to a $\frac{1}{4}$ -track *Vortexion WVB*, a mono machine with the refinement of separate record and play heads but the grave disadvantage, as time was to show, of a $7\frac{1}{2}$ i/s maximum speed. Mr. Stoller does not improvise: the entire *Merry Country Overture*, like all the works to follow, was fully scored before recording commenced. The first component of the 'orchestra' was recorded, the tape then being placed on a *Truvox* deck and dubbed back through a *Heathkit* preamplifier to the *Vortexion*, where it was mixed with a second live performance on the electric guitar. Next, the combined recordings were placed on the *Truvox* and dubbed with yet another musical track; and so it continued—melody, chord and bass accompaniments being added one by one until the piece was complete.

There is another moral to *Merry Country Overture*, first track of the Rhet Stoller disc *Coronet EC101*: even with *Vortexion* equipment, repeated dubbing renders tape hiss a great problem. The benefit of his prompt move to 15 i/s machines is evident in the much reduced background noise on later tracks of the disc. In addition to the obvious advantages of lower wobble, lower treble distortion, and wider frequency response, the higher speed reduces the relative replay gain necessary at high frequencies, thus improving the signal to-noise ratio in relation to tape hiss. Two elementary tricks of the noise-reducing trade were quoted by Mr. Stoller: his own success at $7\frac{1}{2}$ i/s was due to recording



BY DAVID KIRK

at comparatively high levels, which tended to limit the scope of his compositions; and exaggerating the treble signals from the guitar—with the tone controls on the Vari-slope—before feeding into the Vortexion.

Quieter compositions were to follow, however, their tranquillity being reflected in their titles *Drifting Clouds*, *Summer Dream*, and so on.

Hence the move to *Brenells*, robust and economical recorders capable of professional quality, in the right hands, and optimised for 15 1/s operation. While moving upwards in this respect, there came the ignominy of moving down from bedroom to acoustically isolated basement, to meet the wishes of less musical neighbours! It was this basement studio in Stamford Hill to which I was conducted, a small neon-lit room containing equipment to the value of £3000 accumulated over the last five years.

The equipment is sensibly positioned around the performer's stool, as it must be when so many dexterities are required of one pair of hands. On the left of a bench are two Brenell *STB.2* stereo tape units, conventional models with $\frac{1}{2}$ -track and $\frac{1}{4}$ -track heads and an 8 $\frac{1}{2}$ in. spool capacity. Right of these is a *Binson* rotating-drum echo unit, positioned close to a *Grampian* (spring) reverberation unit. Between them, these devices can supply the lumpy echo of the Alps, the boom of a cathedral, or any combination of the two.

At the right-angled junction of the bench is a rack of controls providing two particularly important facilities—mixing and compression. Built to Mr. Stoller's specification by engineer Ted Wallace of Soho Street, this £200 system renders the balancing of individual recorded tracks much less of a problem than in the single-recorder-plus-deck days.

In front of the performer as he plays is the centre-piece of the studio, a seven-channel 10 $\frac{1}{2}$ in. NAB-spool recorder, again based on a Brenell deck, built to order by *Deimos*. Six heads are fitted to this machine: a pair of erase heads, two record and two playback heads. Each pair comprises a spaced four-segment and three-segment head, the segments being interlaced across the $\frac{1}{2}$ in. tape width to achieve the desired seven-track scanning. The unusual complexity of this system has resulted in the rather high cost of £1,000, though Mr. Stoller was keen to emphasise his favour towards the value of the *Deimos* construction.

Even equipment of this nature must be handled with great care to minimise the effects of noise. A bottle of meths stands by, not to extinguish the thirst of a temperamental artist(!) but to permit frequent cleaning of the Brenell heads.

In addition to an array of electronic equipment, the basement is equipped with four guitars—an acoustic folk model, two *Gibson* semi-acoustic guitars with tremolo arms, and a *Burns* solid bass. A squat *Vox* electronic organ rests against the wall in one corner, while a banjo, tambourine and other small percussion instruments are stored in another. The banjo is strung unconventionally to permit guitar fingering, a practice that might offend musical pedantics but which overcomes the need to train another set of nerve responses.

In some respects the most amazing musical instrument in the studio is a device which returns us to the realm of electronics: a completely electronic drumming unit. This £100 box extends the thinking put into a 'gunfire' effects circuit (developed by the BBC and employing modulated white-noise generators to achieve excitingly murderous ricochet sounds). It is awe-inspiring to hear a totally non-mechanical assembly of transistors and circuitry producing complex beats and percussive effects. One wonders whether an extension of such a circuit could be persuaded to sing! For all its apparent versatility, however, the electronic drummer has one defect—its beat is as perfect as that of a metronome. Although the tempo is infinitely variable within a certain (less than infinite) range, Mr. Stoller has experienced difficulty in dubbing drum effects over an existing track. No human musician, he explains, can keep a perfectly steady tempo, and all tend to vary their beat unconsciously while performing. This renders the machine somewhat out of step unless the percussion is recorded before the other tracks. Even then, it appears, it is both musically difficult and, in the long run, aurally monotonous, to work at an exactly steady tempo.

Arguments of this nature may suggest to the reader that Mr. Stoller's endeavours are at a more complex musical level than the general repetitive 'pop'. Certainly his repetitive-melody tracks have a more immediate appeal than his longer items, and I asked whether the musical intricacy of *Theme for Mid-June* and *January 12th Overture* compared with the simple but very attractive *Surf Rider* implied an attempt to carry the electric guitar towards the realm of the 'classics', from which this potentially sweet instrument has hitherto been withheld. He replied that he was continuously experimenting with new combinations of instruments, and new musical effects, but could not force his style in any one direction.

MORE DETAILS

The musician in me (a crude fellow, I regret) became ever more determined to make a serious attempt at combining a series of solo performances, and I requested more details of his recording methods. Recording an electric guitar is straightforward enough and a good pick-up will even feed straight into the high level input of a recorder, in this case the gram socket of a Brenell. This results in a smooth sound lacking 'bite' and needing the

treble lift mentioned earlier. It is possible to record through a microphone placed before a guitar speaker; alternatively, most of the amplifiers produced specifically for guitars have an output for external tape equipment—a fact of which I had not been aware.

The signal from the guitar is most conveniently monitored, together with that being supplied from the tape player (feeding in the earlier recordings), at the line output of the machine being used for recording. If separate record and play heads are in use, monitoring should not be 'off tape' since this results in an unpleasant time delay between instruments.

Where a microphone is used (Mr. Stoller possesses an *AKG C20* capacitor and *D12* dynamic), loudspeaker monitoring becomes impractical. A pair of *S.G. Brown* headphones are employed, in his case, to monitor the ingoing banjo, glockenspiel or percussion, to prevent earlier recordings from being re-taped with room coloration.

Mr. Edward Cox, a former trombone player, acts as publisher of the recordings, which are supplied to him on $\frac{1}{4}$ in. tape. He too has advice for recording engineers, based on painful past experience: they should all be trained to read a musical score. His comment needs no elaboration and, though it was directed at the professional recordist, is worth the consideration of serious amateurs. Mr. Cox believes that a great potential exists in the field of multi-track one-man musicianship and even prophesies the "end of the concert hall", though he will probably find few to agree with the latter contention. He also foresees the application of the technique in musical education and this suggestion certainly seems potentially worthwhile, particularly since the majority of modern schools are now equipped with the minimum two recorders needed.

Wout Steenhuis and Rhet Stoller may well be joined by other gifted 'one-man-orchestras' as time passes, and it is not, perhaps, a completely frivolous thought that such performers may even oust the groups of instrumentalists currently catering for one part of the music market.

From the vagaries of future musical trends to immediate plans of Mr. Stoller. The next step is a big one: from a seven-channel Brenell system to a fourteen channel *Ampex*, again with circuitry and cabinet by *Deimos*. Ever anxious to break the limitations imposed by noise, he has given serious consideration to the recently developed *Dolby* noise reduction system, and is perturbed only by a price tag of £700! A *Tannoy* loudspeaker will shortly supersede his twin-cone *Goodmans* monitor speaker. The white Polystyrene-tiled basement walls appear likely to burst at the seams, however, if his hopes for an *EMT Echo Plate* ever materialise, though there is room for expansion beneath his North London home.

Although the contents of his first disc are mono, my query "Going stereo?" was answered by an immediate "Of course".

"Of course", thought I, as I travelled home to try it for myself.

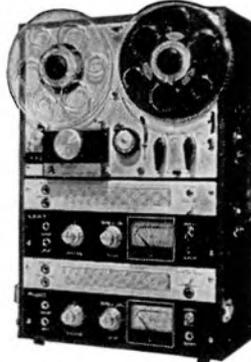
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ANOTHER group of *Sound* models which were widely copied (or, to be kinder, marketed) under different cover names, were the *A41A*, *A42*, *A43*, *A44* and *A46A* and *G* models. These were again based on the *BSR* single-speed and *Magnavox Studio*, three-speed decks.

Fig. 1 shows the general circuit of these models. It can be seen to be very much like the *A41/A46* circuit of last month's contribution, and, in fact, it is based on the same design. But there are some differences in detail and in layout; as these differences are the very points that appear to give most trouble, the circuit is worth repeating in full.

The series of circles in a line along the middle of this board are the anchor tags of a common earth return bus bar. In the *Studio* versions, this bar is attached to the deck switch unit by a stand-off bracket with small distance piece. When dismantling and re-assembling, it is quite important to get this bracket properly in place.

This board can flex quite easily during the inevitable tossing about it gets during service, and some of the lines of print are quite long. A hairline crack in one of the outer lines of print is fairly common, and as there is HT present on the remotest (and most vulnerable) line, an intermittent crackling and arcing is sometimes met.

Another weak point about this construction is the wafer switch, whose tags are soldered directly to the board. The action of removing the board for service needs care, as the flat blade of the switch spindle may tend to grip the rotor section of the switch, which is quite flimsy. Similarly, replacement of the board needs a gentle touch, first sliding the slot of the wafer on to the spindle, then holding firmly in place while the screws are inserted in their rubber grommets and tightened. Beware of the trap into which more than one serviceman has fallen; that is, to remove the board to the rather restricted length of its flyleads, then switch to record by turning the wafer inner rotor with a screwdriver blade—or by removing the board with the machine switched to record. The switch spindle always reverts to the play position when either *Studio* or *BSR* decks are neutralised, and if the board is pushed back hastily without checking the relative positions of spindle and rotor, the result will be a cracked inner section, or distorted contacts.

If the switch is *damaged*, don't waste time trying to bend and reset the contacts. There are, it is true, types of wafer switch which can be repaired in this way—this is not one of them. Poor contacts will lead to recurrent trouble, and some peculiar symptoms. One such that is baffling the first time it is met is the recorded whistle. Switching to Record kills the play signal and selects erasure, but when we replay that section of tape supposedly wiped clean, we discover a rising whistle on it! The trouble, which can happen to some other machines, such as the cheaper *Philips* with the cable-driven record switches, and the *Elizabethan* and *Elpico* which have similar switch arrangements to the *Sound*, is simply that the record/play switch is trying to select both functions at once.

In this case, changing the switch is the only real cure, once we have ensured that the spindle is indeed moving correctly through its

required arc of travel. Removing the switch calls for a spot of ruthless pruning. Do not potter about with a soldering iron: you are unlikely to salvage much of worth by careful unsoldering. It is better to cut the tags close to the switch and remove the carcass, then remove each amputated lug end individually. Better, not only because it is easier, but because you are less likely to damage the print by excessive heat. This print is not the most firmly bonded, and can be raised by careless soldering.

The next operation is to clean out the slots in the print board and make ready for the new switch. If the exact replacement is not available, it may be necessary to mount a six-pole two-way *Yaxley* type, and the slots will not be exact. Some fiddling is needed, and a solution is to mount the switch correctly relative to spindle (and the best way of doing this is to slide it on the spindle, push it along until it is near the board, then mark the fixing holes with a drop of light paint), use a pair of short distance pieces, and make short jumper wire connections from the board to the tags.

Incidentally, the cleaning out operation is made much easier if we employ an orange stick or match stick sharpened to the shape of the hole then melt and soak up the solder around it with the stick pushed into the hole, and left there until the operation is concluded, to keep the hole clear. As we are unlikely to have an aspirated soldering iron, the next best method of clearing molten solder is to use the capillary action of splayed wire or braid. A tail end of screening cable is allowed to 'wipe' the joint and the solder will tend to creep up the wire, which can be snipped off and discarded, presenting a continual new attraction for the solder—quicker to do than to explain!

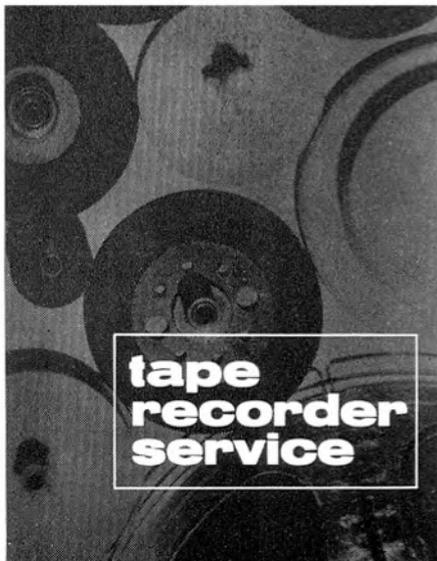
As for the circuit, this is very like **fig. 2** of last month, but there are some important variations. The second stage has a higher anode load and more cathode bias to suit the changed conditions. The feedback circuit is altered, and is more effective, the decoupling to the early stages being quite different. An EM87 magic-eye is used, which means that both the HT feed and the time constant components will be different from those that suit the EM84. It is hoped that those readers who ask for guidance regarding changes to their own machines—often unidentified—will take note of these quite simple circuits and adapt the particular parts of the design to their own ends. Nobody is going to sue you!

Other information that is sometimes sought refers to deck or head changes, and what circuit changes are needed to allow for these. If we use this type of circuit as a guide, we can follow the changes, noting the heads used in the *BSR* deck were *Bradmatic Mini-55* and in the *Studio* deck, *Marriott X/RPS/17* and *X/ES/17*. The components (with no values stated on the circuit diagram) are R25, R27 and C6. Differences are to allow for track and equalisation factors. In the *A41* and *A43*, R25 is 220 ohms; in the other two versions, 470 ohms. In the *A41A*, 220K is used for the R27 feedback resistor, the *A42* has 100K in this position, *A43* uses 47K and *A44* has 68K. C6 is omitted altogether on the *A43*

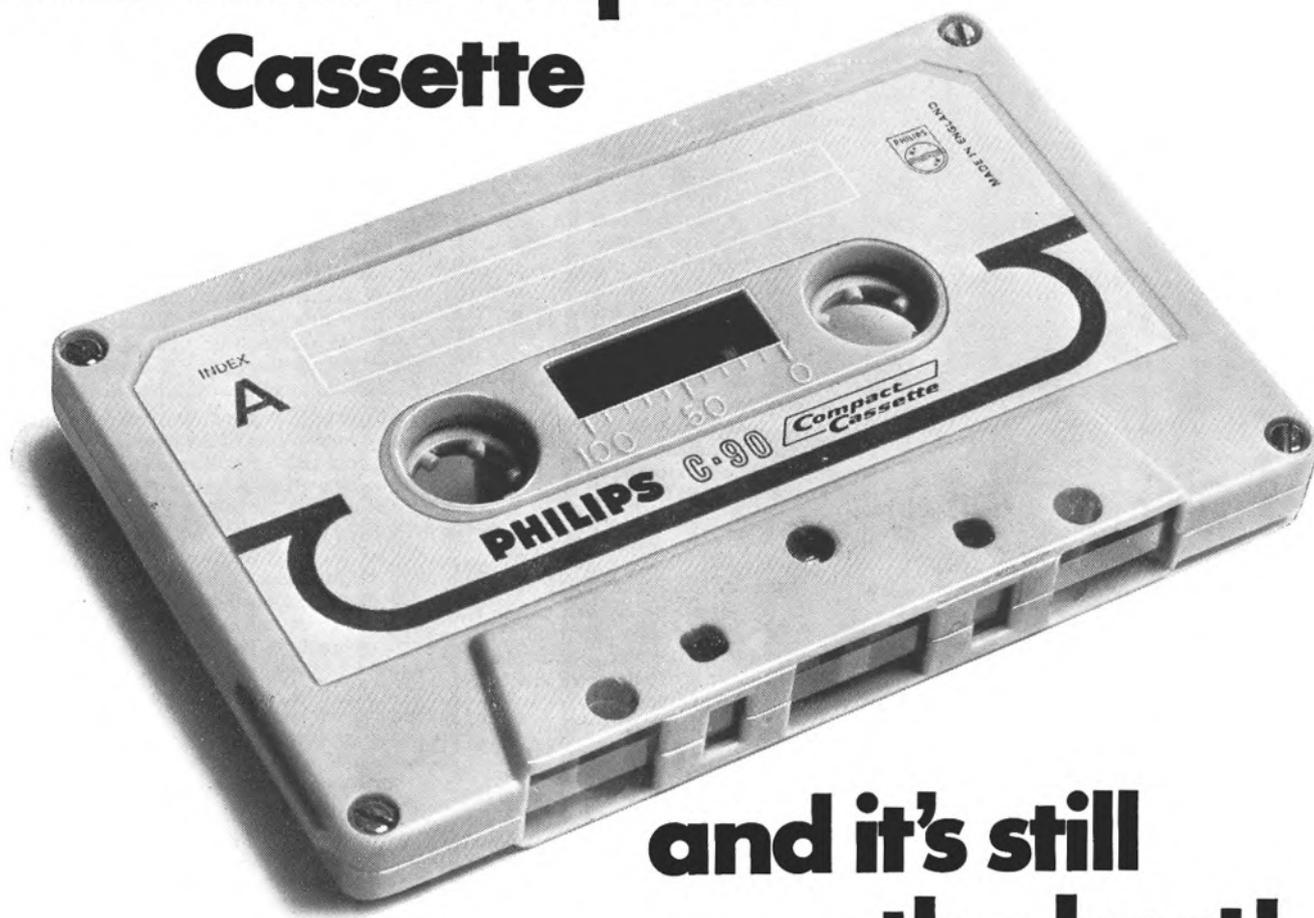
(continued on page 471)

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and A44 and the A41A uses a 100pF while the A42 has 47pF.

Referring again to the circuit diagram, and to anticipate the inevitable criticisms from those who demand redrawing to a 'house style', the suffix 'n' denotes nanofarad, one-thousandth of a microfarad, or a thousand picofarad, whichever you prefer. Its use certainly saves both cumbersome figures and the use of the decimal point that may get lost amid the tea-stains. Another method of saving the decimal point, used in one instance (R19) on this circuit, is to write the K of a resistor suffix between the figures, so that 1.8K becomes 1K8. Many Continental manufacturers use this method and it is wise to be ready for it on the odd occasion.

Fig. 2 is the circuit of the Elizabethan LZ29, which has also been used in a Civic styling, with the Studio deck and twin loudspeakers. This is quite a good machine without pretending to be hi-fi. Hum is much lower than on some other Civic models, and the recorded signal is much cleaner. Just how much of this is due to the push-pull oscillator, it would be difficult to say. A good waveform makes quite a difference, and the improvement of the signal-to-noise ratio makes all other recording/playback factors just that bit better. One gets a little more gain in each function before either hiss becomes troublesome or, at the other end, distortion sets in. As with many other improvements, the difference is hard to judge—but can be heard when absent!

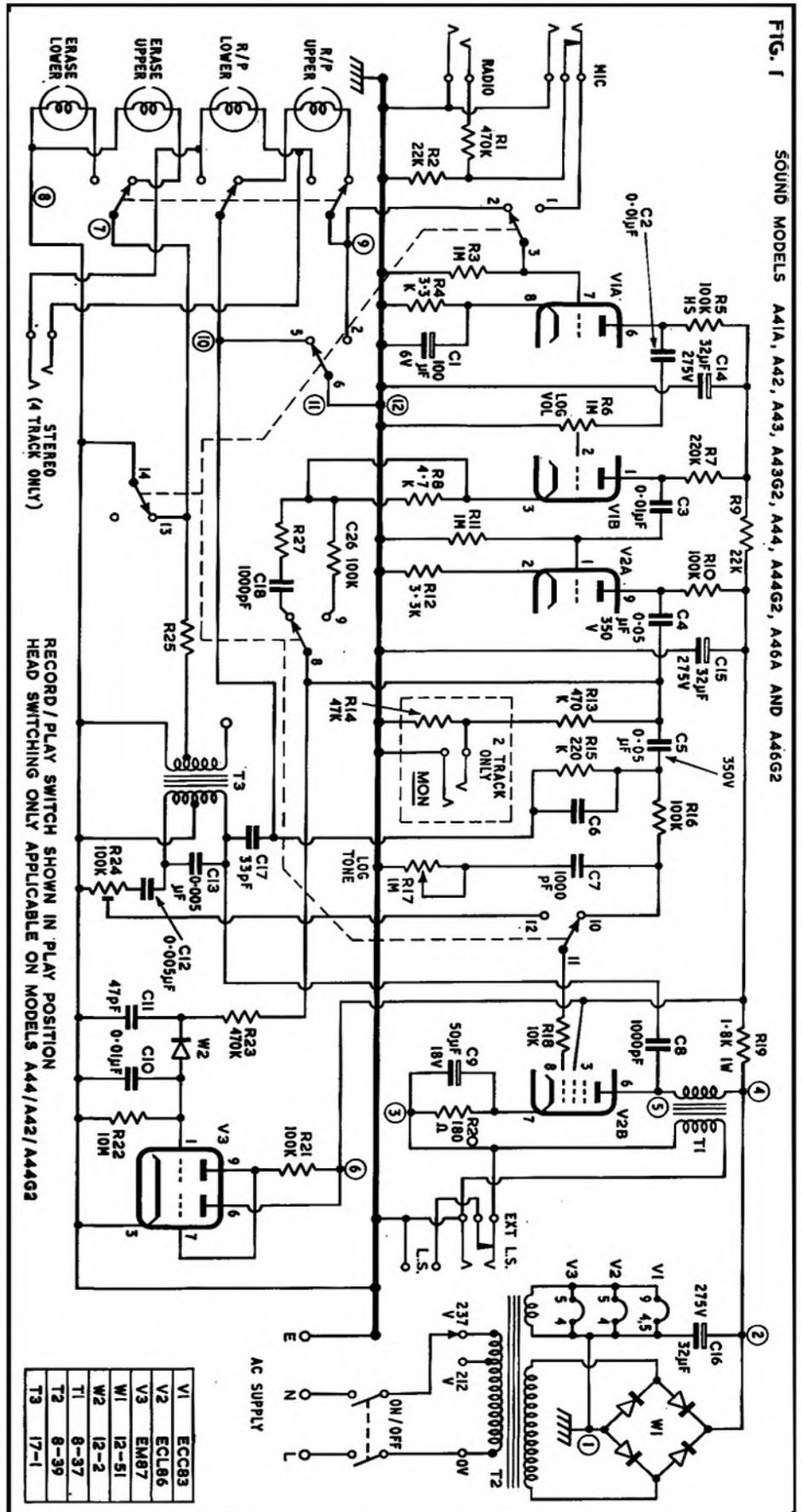
This oscillator is mounted on a small sub-panel, quite rigid and well-positioned. The coil is wound on a Mullard pot-core and none of the components is so critical as to cause trouble. Note one particular capacitor, C29, which is used to prevent the sudden cessation of oscillation when the machine is neutralised from record (a prevalent cause of head magnetisation, and that old bogey, hiss.) As HT is removed by the opening of the interlock switch, a charge remains on C29 and leaks away through the oscillator circuit, giving a decremental waveform, not the transient pulse that results from a transformer from which power is suddenly removed.

Although this circuit shows only one loudspeaker, in the Civic version there are two, rather awkwardly mounted under the edges of the deck support plate and side-facing. When the machine is assembled, there is a fair tone from a good pre-recorded tape, due to the boxiness which enhances the bass, and

(continued on page 473)



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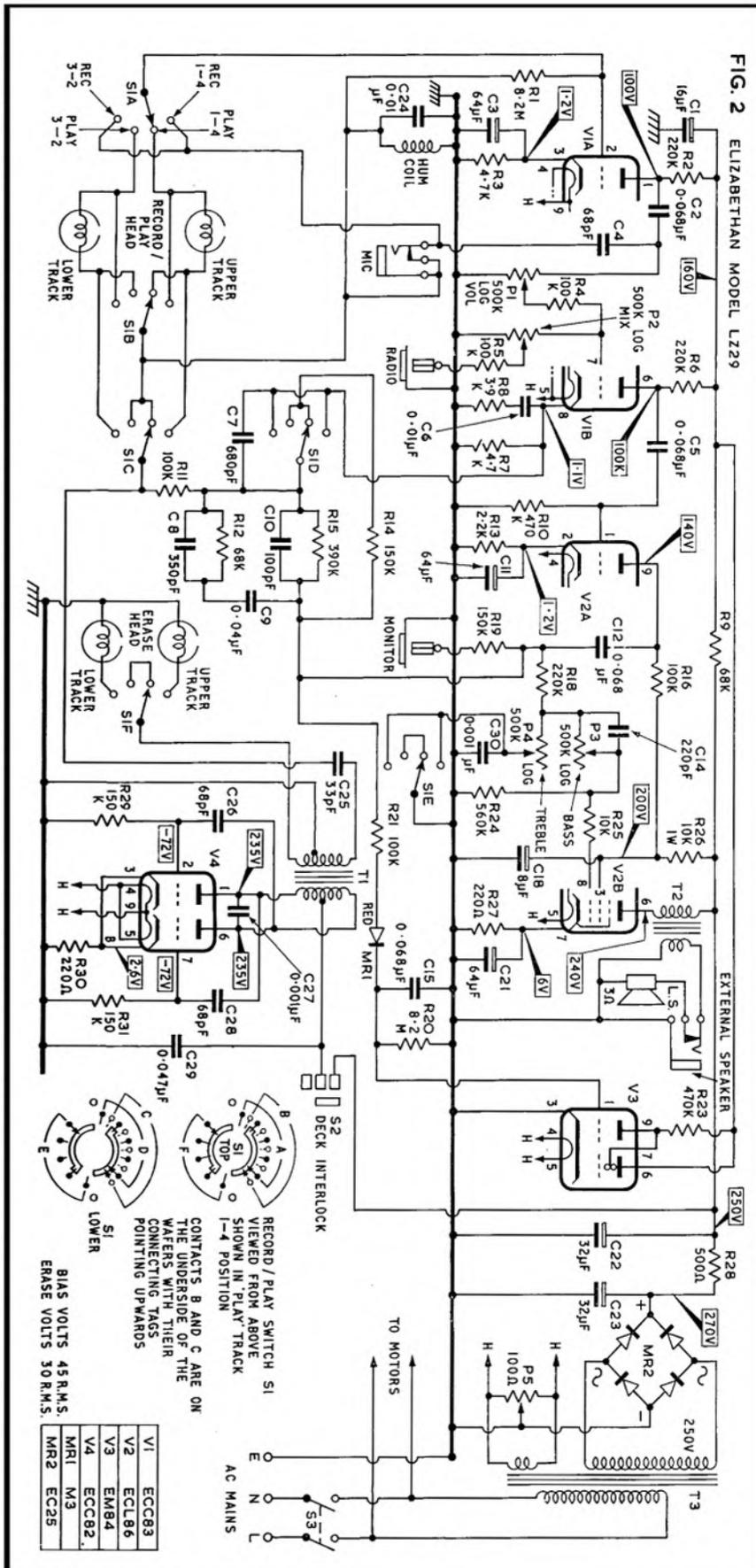
the treble tone control, which is quite effective. The bass tone control has less to do, but makes a measurable difference. If the machine is mounted diagonally in a room corner with the walls acting as forward throw baffles, remarkably good sound can be obtained by these control settings.

The use of a separate oscillator gives one more facility to this kind of machine, and that is a constant monitor during recording. The treble tone control operates as monitor level setting for this function, as with other Elizabethan models.

Input circuits are a constant source of trouble on the cheaper machines, and it is worth taking a second look at this one. Notice that the hum-bucking coil, with its tuning capacitor, forms the chassis return line for the recording head connections and also for the microphone input during record, via S1A. C4 provides feedback over the first stage and is not the series input feed. The signal arrives via S1A to the grid of V1A, whose leak resistor is also returned to the phantom earth line of the hum-bucking coil. A bit of trouble on the switch blades of the microphone socket can lead to all sorts of curious noises.

Radio input is fed to the grid of the second stage via its own mixing control, and with the main volume acting as microphone gain control during recording, a good balance can be obtained. The common mistake in design, of allowing the second stage to become overloaded, and an imbalance state to be set up quite unwittingly by a clumsy operator, is neatly avoided by inserting a 100K in series with the line to the grid of this triode.

The monitor socket on this model provides a line signal which is present during recording and replay, making the circuit suitable for coupling directly into a better quality amplifier. This, in conjunction with its own monitoring facility, quite widens the possibilities of use. Another point that can give more uses is the switch structure. Note that there is no so-called 'stereo' output on this model. This simply entails feeding the unused track of the replay head to a socket for powering an external amplifier, and is not always an easy facility to add to an existing machine, because of physical problems of head wiring and switch layout. On this model, another wafer can be added, and the switch linkages broken and crossed quite easily. To aid any experiments the existing switch layout is given in fig. 2.



ELEMENTS OF TAPE RECORDER CIRCUITS PART 6

LAST month we saw the elementary working of a triode valve and showed how this device can be used as a voltage amplifier. We also saw how voltage to be amplified is applied to the control grid whereas the amplified output appears between the anode and ground (or features anode and HT, which from the AC point of view is the same).

Let us start now by considering fig. 1, which is a typical input circuit for a record amplifier. The first amplifier stage V_1 in this circuit amplifies the low level, high impedance signal which is connected to Input 1. The value of R_1 determines the actual input impedance and R_2 , the cathode resistor, sets the valve at the correct bias for linear operation as we saw last month.

The output from the first stage is then fed to the next valve V_2 by the usual resistance/capacity coupling. Without the capacitor C_1 the grid of V_2 would have a high positive potential on account of the HT, supply and the valve would not work. In this method of coupling the capacitor has the effect of insulating the grid of V_2 from the DC anode voltage of V_1 but at the same time allows alternating signal current to flow through so that AC voltage is developed across the grid resistance R_3 .

done by means of the isolating resistors R_4 and R_5 . These are needed to prevent a virtual short-circuiting of one input when the control for the other is set at a minimum. The resistances R_4 and R_5 introduce the desired attenuation which is necessary for high input levels from radio tuner and crystal pickups. The impedance of input 2 is determined primarily by the value of R_4 .

The number of intermediate amplifier stages in the record amplifier depends on the requirements of the record head, although allowance must be made for loss in gain introduced by either filter or feedback frequency selective circuits. As we shall see next month, the record amplifier often incorporates a treble pre-emphasis current feedback circuit between the record head driver (last stage) and the head itself. Over most of the frequency range the gain of the record amplifier will therefore be reduced, the loss in gain being referred to as the *insertion loss*.

To ensure the best possible performance, the record amplifier should not contribute significantly to the total distortion, even on peaks. We have already seen how distortion can be produced by driving a valve into the non-linear portion of its characteristic curve, but there are other kinds of distortion which

INPUT MIXING AND THE PLAYBACK AMPLIFIER

BY G. T. ROGERS

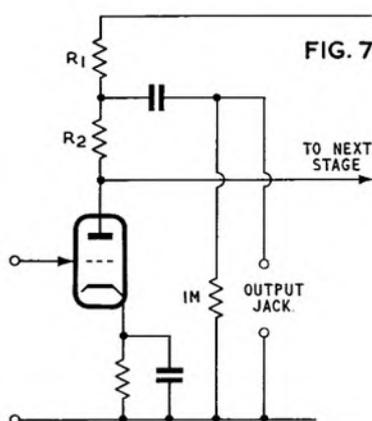
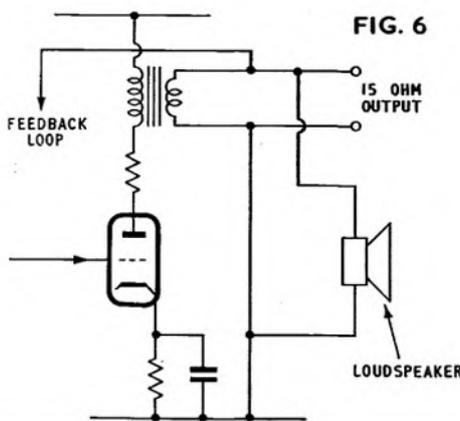
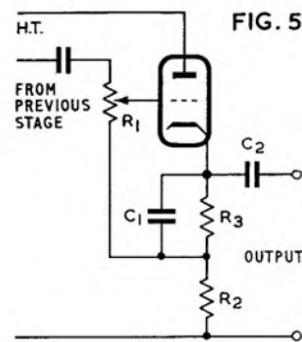
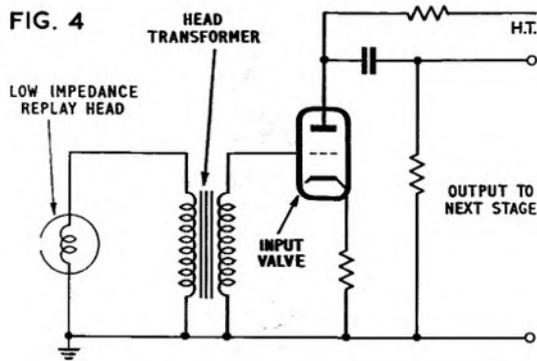
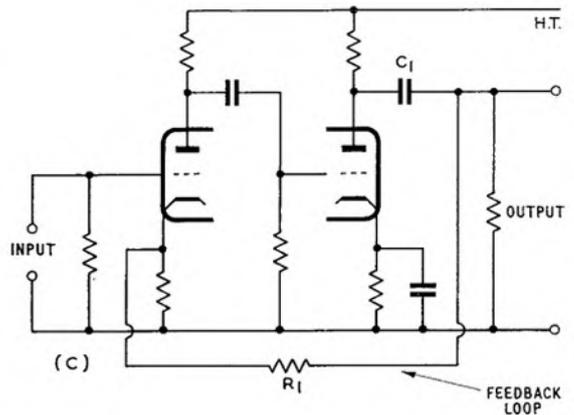
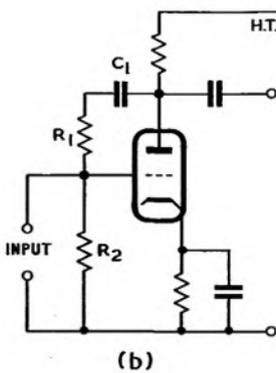
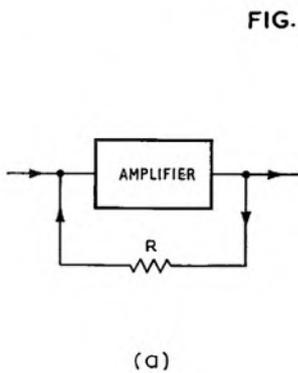
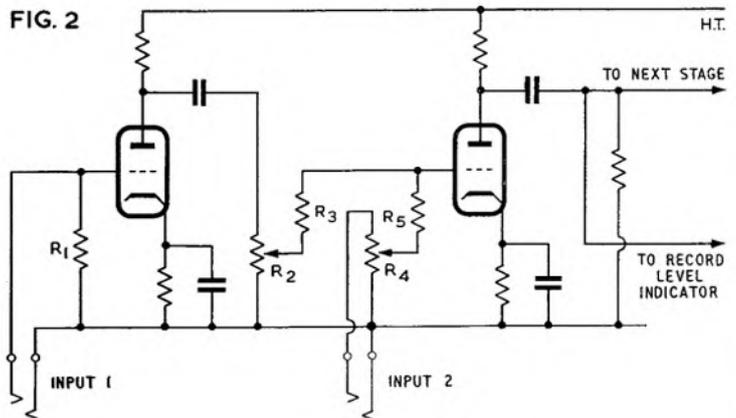
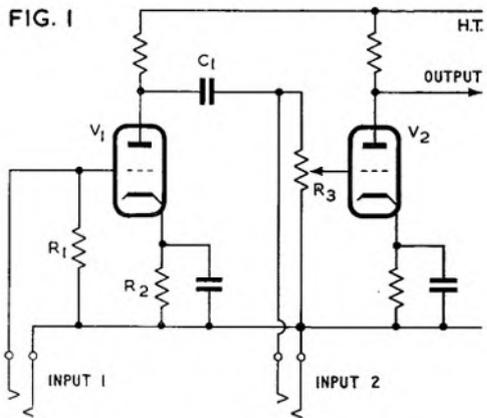
The components C_1 and R_3 act as an AC voltage divider to the output from V_1 and the value of C_1 must be sufficiently large so that its reactance at the low frequency end of the audio spectrum is small. This ensures that the fall-off of bass response due to valve coupling is kept to a minimum, and the grid/cathode circuit of V_2 obtains a level output from V_1 . Input 2, the high level one, is also fed into V_2 across the resistance R_5 and as shown this potentiometer functions as the recording level gain control for both inputs.

Circuits of the type illustrated in fig. 1 permit both high and low level signals to be recorded simultaneously, although independent mixing is not possible. When one gain control is provided this must be used to set the low levels, microphone, input and the level of the other channel must be set at its source. For independent mixing, the circuit must permit independent control of two or more input sources without interaction between them and without undue loss of signal in the process. Fig. 2 shows one way of mixing signals in the early stages of a record amplifier. Freedom from interaction between the two inputs demands some degree of isolation and this is

can occur in a tape recorder amplifier and these can become obtrusive if certain measures are not taken. Let us briefly mention two of these and see how *negative feedback* can help to eliminate them.

Firstly, in attenuation distortion the component frequencies of a signal are produced in incorrect comparative amplitude. (This is primarily due to the effects of (a) self demagnetisation, (b) decreased permeability of the tape with increase in frequency, (c) the gap effect, (d) imperfect contact between tape and heads and (e) eddy current and hysteresis losses). Secondly, rapidly decaying, highly damped, waveforms give rise to another form of distortion—transient distortion, because of the shock effect upon electrical and mechanical resonant circuits.

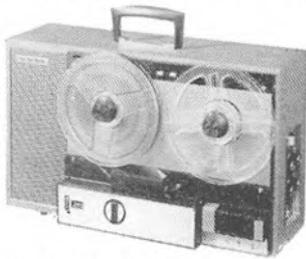
Both of these forms of distortion as well as various forms of non-linear distortion can be reduced by the use of negative feedback applied to either the early stages in a record amplifier or to the output stages of the playback amplifier. We shall have more to say about feedback next month, but for the moment let us understand the principle involved. (continued on page 477)



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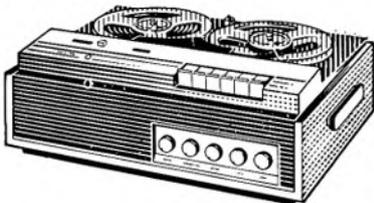
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ELEMENTS OF TAPE RECORDER CIRCUITS PART 6

A simple way of applying negative feedback (plate to grid) over a single stage is shown in fig. 3b. We have already seen that the signal at the anode of a valve is in opposite phase to that on the grid so it is only necessary to connect the anode to the grid via a suitable potential divider R_1 and R_2 . The capacitor C_1 ensures that the signal voltage and not the HT DC voltage is applied to the grid. Fig. 3c shows negative feedback (anode to cathode) applied over two amplifier stages. Here some of the output at the anode of V_2 is fed back to the cathode of V_1 , the amount of feedback being controlled by the resistor R_1 in the feedback loop. The capacitor serves the same function as in fig. 3b.

In addition to reducing distortion and hence improving the linearity of an amplifier, negative feedback can also stabilise gain which might otherwise vary with changes in valve characteristics, alteration of supply voltage, etc. Related to this is the effect of negative feedback on frequency response which is also flattened as the feedback is increased.

Before we leave the record amplifier let us just say a few words about the take-off point for the record level indicator. One way of connecting this is to a point in the record amplifier after the last stage before the record head, but a shunting capacitor must be used to prevent bias current from causing a misleading indication of the level. A take-off point at an earlier amplifier stage, as shown in fig. 2, has the advantage of greater protection from bias current and is particularly useful where accurately calibrated peak programme meters are employed.

FUNCTION TO AMPLIFY

The function of the playback amplifier is to amplify and equalise the signal from the replay head and produce an output which can either be fed to a loudspeaker or an external control unit. In order to obtain the maximum output voltage from the replay head it may employ high impedance windings suitable for direct connection to the input grid, though low impedance windings can be designed to work into a small step-up transformer built into the input of the playback amplifier, fig. 4. In this way the impedance of the replay head can be matched to the higher impedance of the control grid as explained last month.

Although, broadly speaking, the design of the amplifier will follow normal good audio engineering practice, certain aspects of such an amplifier are of particular importance in tape recorders. Among these are overall gain, hum and noise, distortion and frequency response. The number of additional stages of amplification in the playback amplifier depends on the type and magnitude of the output required, taking into consideration the small signal voltage (1-3 mV) from the replay head.

For negative feedback, a signal is tapped off from the output signal and applied to an earlier stage in the amplifier so that it is in opposite phase to the incoming signal at the control grid of that stage. The overall gain of the stages in the feedback loop is then reduced in proportion to the amount of feedback applied, and the *factor of overall distortion is similarly reduced*. Fig. 3a illustrates a simple feedback loop where the feedback and hence the gain of the amplifier depends on the resistance R .

As we have seen, the effective input of an amplifier valve is governed by the voltage between the control grid and the cathode. This means that the effective input can be reduced in one of two basic ways. Firstly, by applying to the grid a feedback voltage with a polarity *opposite* to the signal voltage on the grid and secondly, by applying to the *cathode* a feedback voltage with a polarity *the same* as that as the signal on the grid. Clearly, if the cathode voltage varies in the same direction as that on the grid then the voltage between them is reduced; fewer electrons will reach the anode and the overall output of the valve will be reduced, including any distortion that might be present.

ESSENTIAL POINTS

A full treatment of how hum and noise originates and how it is combated would require more space than is permitted in these articles, though there are some essential points which are worth going into here.

The replay head itself has an appreciable amount of inductance and is therefore susceptible to stray magnetic fields (from mains transformer, motors, etc.) which induce a corresponding hum voltage in the winding. This can present quite a serious problem to the designer since the head output is very low and the necessary amplification consequently greatly magnifies any hum induced in the head.

To reduce hum it is good practice to screen the head and head transformer in a *Mu-metal* can. The head transformer and any other inductive device may also be arranged so that they can be rotated for minimum hum pick-up, very small adjustments often effecting a noticeable improvement in the signal-to-noise ratio. Another useful device for hum cancellation is the 'hum bucking' coil. This is simply a small coil connected in series with the playback winding but wound in such a way that the hum induced in it is in antiphase to the hum in the playback winding. On orienting this coil with respect to the playback coil, cancellation of hum is possible.

To reduce hum in some very high grade recorders, DC heated valves are employed in the early stages, although AC heated low-noise types are perfectly satisfactory for most

standard equipment. Finally, although it has been mentioned earlier on in this series, we should emphasise the need for adequate smoothing of the HT supply by using capacitors of a generous size in the filter circuit, especially when feeding the input stages in the record amplifier.

In Part 1 we saw that there were three main types of output arrangement possible in a tape recorder amplifier—a low impedance line output, a high impedance output and a loudspeaker output. Let us conclude this article by considering these in a little more detail.

The low impedance output is useful where long runs of cable are required and can be conveniently taken from the cathode circuit of an additional triode stage in the playback amplifier. This circuit is known as a *cathode-follower* and is shown in fig. 5. The potentiometer R_1 is the playback gain control and enables the required amount of signal from the playback amplifier to pass to the cathode-follower. The varying signal at the grid of this stage causes a varying current to pass through the valve and a varying voltage to develop across the cathode resistor R_2 , from which the output is tapped off as shown.

MUCH LOWER

The actual output impedance is very much lower than the value of R_2 (which would itself generally be several tens of thousands of ohms) due to the negative feedback effect whereby *all* the valve's output signal appears at the cathode and the stage gain is reduced to unity. R_3 provides a suitable DC bias voltage to the grid via R_1 in the normal fashion. Low output impedances from this type circuit are particularly suitable since, in addition to permitting lengthy runs of cable, quite high signal voltages may be handled.

The loudspeaker output is another low impedance outlet, but this is usually obtained from the anode circuit of a power output valve. Fig. 6 shows a typical circuit where an additional output socket enables a 15-ohm extension speaker line to be connected. The secondary of the output transformer forms part of a negative feedback loop, which we discussed earlier, and returns some of the output to the cathode of the preceding or an earlier stage.

Most tape recorders provide an output jack so that high impedance signals can be obtained for connection to a nearby control unit. Alternatively, such an output could be used for driving a pair of high impedance headphones for monitoring. With the necessary switching the output can be made to function both on record and playback, and this is useful for quality checking during recording and for monitoring the playback signal when mixing this with a new signal during a second recording.

Fig. 7 gives a possible circuit layout for a high impedance output. The voltage divider in the anode circuit, consisting of R_1 and R_2 , is arranged (R_1 say one tenth of R_2) so that the stage feeds about one tenth of the output to the high impedance socket and the rest to the next stage in the amplifier.

Next month we shall look at the frequency-selective circuits of a tape recorder amplifier and see how these can combat the various losses associated with the record and replay heads.

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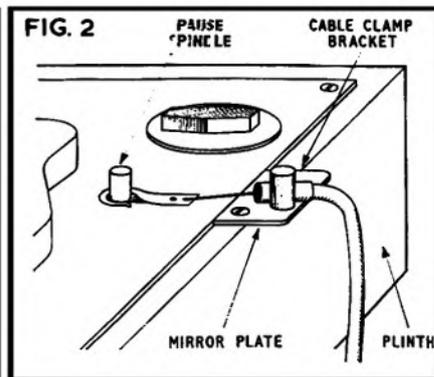
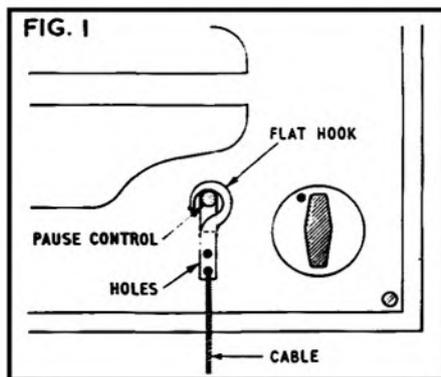
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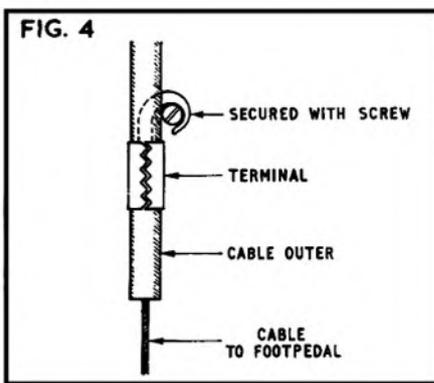
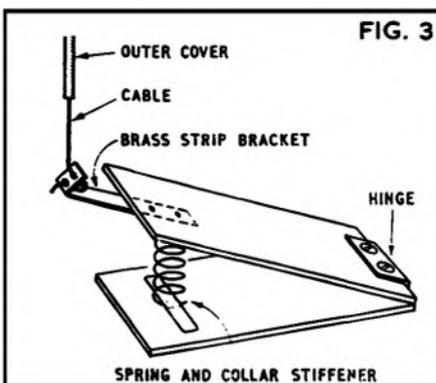
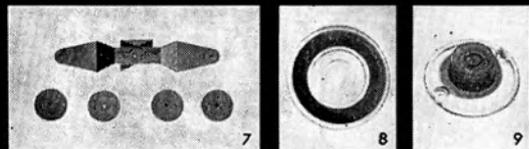
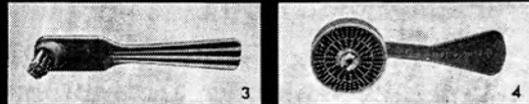


Fig. 2 shows how the cable is taken from the hook to the cable clamp, which is attached to a mirror plate screwed to the plinth. (Remember, at this point, that my deck was on a wooden plinth. Some modification may be necessary when adapting a complete tape recorder.) A three-hole mirror plate was found to be most satisfactory, with two securing screws and the third hole reamed out to take the thread of the cable clamp. My deck stands on a wooden trolley and the cable and outer

cover run down almost to the floor where they are connected to a bracket (brass strip) which is attached to a wooden foot pedal (two slats of wood), fig. 3. A piece of piano wire is coiled into a spring, size being dependent on the size of the foot pedal (my pedal slats are $5\frac{1}{2} \times 2$ in.). This spring helps to return the cable, and thus the hook and pause control, to its original position on the deck. The normal return spring action of the pause control helps as well. The foot pedal is simply made by joining the two slats with a small hinge. The coil spring is attached to the lower slat by glueing (*Evo-Stik*) a plastic collar stiffener through the last turn of the coil spring (see

fig. 3). The top of the spring need not be fixed to the upper slat. The cable is attached to the brass bracket (see fig. 3, also) and finally the outer cable cover is rigidly secured to the trolley. I used another type of hook terminal, a one-piece hook and sleeve, which opens up to accept the outer cover and is then closed tightly around it (see fig. 4).

This remote control works extremely well, is cheap and easy to construct and can be removed if not required. It is a real boon when editing, as the tape can be stopped and started during playback, leaving *both* hands free to manipulate the tape for marking and splicing.



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A NEW REVOX

AN electronic self-stabilising capstan motor and full silicon planar transistorisation are two features of the new *Revox Series 77* stereo tape recorder resulting in low wow and flutter ($\pm 0.08\%$ at $7\frac{1}{2}$ i/s), high signal-to-noise ratio (54dB) and light weight (33 lb.). The 77 is not unlike the existing 736 in styling and facilities, though closer examination shows marked dissimilarity. Spool capacity remains $10\frac{1}{2}$ in., though the tape tension switch is replaced on the 77 by a servo guide acting on the motor stabilising circuit. This circuit senses the speed of the outer-rotating capstan motor flywheel in the form of a tone induced in a tachometer head mounted against teeth indented in the flywheel periphery. Direct drive is achieved at a motor speed of 400 rpm (for $7\frac{1}{2}$ i/s), with an 800Hz tone being fed via an amplifier and limiter to a discriminator. This passes a signal through a three-stage DC amplifier, varying the AC motor supply voltage in such a manner that the tone is kept to 800Hz under varying conditions of strain. Changing from $7\frac{1}{2}$ to $3\frac{3}{4}$ i/s simply involves switching the discriminator to seek 400Hz.

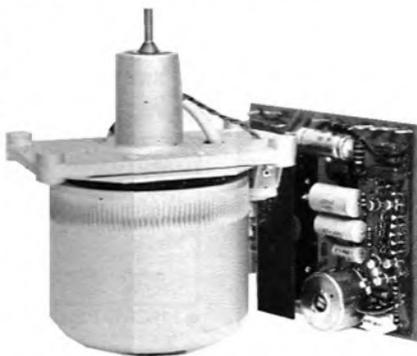
An intriguing feature of this system is that the recorder is independent of both mains voltage and mains frequency; no modi-

fications is necessary when moving from 50Hz to 60Hz mains supplies. In addition to light weight, low power consumption and low heat generation are claimed.

Relays are employed for all mechanical controls, these and the speed selector being completely fool-proof. Track selectors are now located against the left- and right-hand VU-meters. Layout of the tape path has been altered to permit editing.

Other features of the 77 are all-metal heads with improved screening and longer life, plug-in circuit board electronics and a switch on the low-level input for low- or high-impedance microphones, the latter overcoming the need for an external microphone transformer. Bias is adjustable for the two tape speeds and is switched by delayed relays to permit 'click-free' interjection on existing recordings. Equalisation is NAB on the recording channels, playback being switchable from NAB to CCIR.

Two versions of the recorder will be available from early 1968, comprising a teak-finished tape unit with full recording facilities but preamplifier outputs only, and a transportable version with twin-channel monitor amplifier and side-facing speakers. Both models have a socket for stereo headphones. The tape unit will cost approximately £130, while the complete model will be some £150. **Distributor: C. E. Hammond & Co., Ltd., 90 High Street, Eton, Windsor, Berkshire.**



FERGUSON STEREO RECORDER

ONE of the brightest things for years to emerge from British tape equipment manufacturers is the *Ferguson 3232*, a completely self-contained stereo recorder based on the 3214. Finished in a tasteful combination of teak or walnut and tinted transparent Acrylic, it incorporates two side-facing loudspeakers and operates at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{1}{8}$ i/s. The 3232 is transistorised and has coaxial volume, tone and mixing controls to permit stereo or $\frac{1}{2}$ -track mono operation. Stacked signal-level meters and straightforward track transfer switching, plus separate record and play track selectors, render the machine substantially more versatile and simpler to operate than many similarly priced con-

temporaries. Solenoid stop and pause controls, and foil-activated autostop, are featured along with a button-reset four-digit turns counter and a fading-bias automatic head degausser. The 3232 has a quoted frequency range of 40Hz—18kHz at $7\frac{1}{2}$ i/s, with 0.15% RMS wow and flutter. Signal-to-noise ratio is 45dB unweighted while crosstalk is -50dB. Output power is 5W per channel and the price is £72 9s.

The company are also producing a battery recorder designed for *Philips* cassettes. The 3236 will sell for £22 1s. and will be manufactured entirely by the *British Radio Corporation*. Microphone, cassette, gram-lead and external-speaker plug are included in the price. Another member of the Group, *HMV* (nothing to do with *EMI* in this context), are also marketing a machine of similar appearance and identical specification. Their *Model 2236* will cost £24 3s. with accessories, and is supplied with a shoulder carrying case. AC bias gives a signal-to-noise ratio of 36dB at the $1\frac{1}{8}$ i/s running speed, plus a claimed 120Hz to 8kHz ± 3 dB frequency response. Wow and flutter is 0.5% RMS.

Manufacturer: British Radio Corporation Ltd., 284 Southbury Road, Enfield, Middlesex.

MONO RECORDER FROM B & O

BANG and Olufsen have now supplemented their two separate stereo models with a mono recorder, following the basic styling of the 2000 and designated the 1100. The new machine is available in teak or rosewood at £72 9s. and operates at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{1}{8}$ i/s. Transistor electronics deliver up to 10W to the internal speaker, switchable automatic gain control being featured in the record circuitry. The 1100 is $\frac{1}{2}$ -track and has separate bass and treble tone controls, three-digit button-reset revolution counter, and a VU-meter.

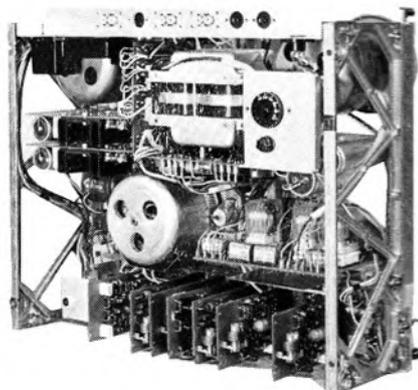
Distributor: Bang and Olufsen U.K. Division, Eastbrook Road, Gloucester.

SANYO TRIO

THREE new stereo tape recorders have been introduced by *Sanyo*, to sell in the £70 region. Model *MR910* operates at $7\frac{1}{2}$ and $3\frac{3}{4}$ i/s with respective claimed frequency responses of 30Hz—15kHz and 50Hz—8 kHz, ± 3 dB. Signal-to-noise ratio is 46dB, crosstalk being -45dB at 1kHz. A stereo monitor amplifier feeds 1.6W per channel to internal speakers. The $\frac{1}{2}$ -track recorder sells for £72 6s.

Also £72 6s. is the *MR800*, a three-speed $\frac{1}{2}$ -track machine offering $1\frac{1}{8}$ i/s in addition to $7\frac{1}{2}$ and $3\frac{3}{4}$ i/s. Greater output power, 6W per channel, and inputs for magnetic cartridges, are accompanied by twin signal-level meters. In common with the *MR910*, this machine accepts 7in. spools and is supplied complete with microphones.

Model *MR161* may be powered from mains
(continued on page 483)



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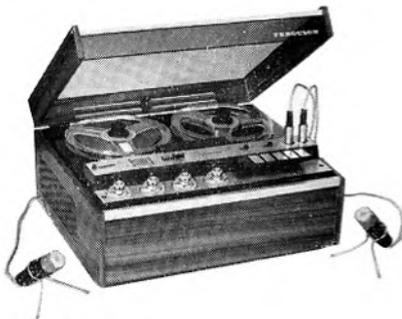
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or batteries and has a spool capacity of 5 in. Speeds are $3\frac{3}{4}$, $1\frac{1}{2}$ and $\frac{1}{8}$ i/s and output power is 800mW per channel (750 mW 'undistorted'). Claimed frequency response at the fastest speed is 100Hz—10kHz \pm 3dB. The $\frac{1}{8}$ -track MR151 incorporates AC bias and sells for £68 5s., including microphones and tape. Distributor: Marubeni-Iida Co. Ltd., 164 Clapham Park Road, London, S.W.4.



Sanyo MR151

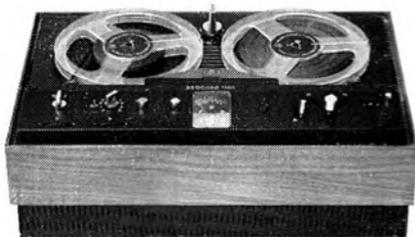


Ferguson 3232

Grundig TK145



Bang and Olufsen 1100



STEREO CASSETTE PLAYER

VAN Der Molen are now producing a stereo cassette player unit, designed to reproduce Philips cassettes through external equipment from its preamplifier output stages. No recording facilities are included. The *Sonic Five* is mains-powered and sells for £17 17s.

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

UHER STEREO PORTABLE

A STEREO version of the 4000L battery portable has been introduced by Uher, to be marketed at £120 15s. in $\frac{1}{8}$ -track or $\frac{1}{4}$ -track form. The 4200 and 4400 closely resemble the 4000L but have track selectors and an additional signal-level meter on the vertical front panel, plus individual microphone inputs. Speeds are $7\frac{1}{2}$, $3\frac{3}{4}$, $1\frac{1}{2}$ and $\frac{1}{8}$ i/s, spool capacity being 5 in. At the fastest speed, wow and flutter is quoted as $\pm 0.2\%$, and frequency range as 40kHz—20kHz. Output power from each of the two monitor amplifiers is 1W, with 53dB dynamic range. Power consumption is approximately 3W.

Also announced by Uher is an amendment in the price of the basic mono 4000L. This is now being sold without microphone at the reduced price of £98 14s. A full-track *Pilot 1000* version is also available for cine application with a retail price tag of £243 15s.

Distributor: Bosch Ltd., 205 Great Portland Street, London, W.1.

RESLO DYNAMIC MICROPHONE

ROBUST dynamic microphone for speech, solo voice or solo musical instrument, has been announced by Reslo. The new unit is aimed at stage and entertainment applications and responds smoothly over the 100Hz—17kHz range. Designated the *EC.1*, it features a cardioid pick-up pattern and may be purchased in *L* (30-50 ohms), *M* (250/600 ohms) and *H* (30-50 ohms 50K) versions. Overall length is $8\frac{1}{2}$ in., with a head diameter of $1\frac{1}{8}$ in. Finish is in black shrival enamel with matt-silver head and cap. Models with alternative finishes can be manufactured in quantity to order.

Manufacturer: Reslosound Ltd., Spring Gardens, London Road, Romford, Essex.

GRUNDIG TK145

NEW from Grundig is the *TK145* $\frac{1}{4}$ -track tape recorder, a mains machine with switchable manual and automatic gain control. Two rotary selectors, to the left and right of the head channel, govern electronic and mechanical modes respectively. The four-position electronic selector gives 'automatic speech', 'automatic music', 'manual' and 'trick' recording facilities, the latter being an erase cutout for superimposition. The recorder operates at $3\frac{3}{4}$ i/s and has a $5\frac{1}{2}$ in. spool capacity. Signal-to-noise ratio is 48dB. Overall dimensions and weight are respectively $15\frac{1}{2}$ x $11\frac{1}{2}$ x 7 in. and 18 $\frac{3}{4}$ lb. Input sensitivity is 100mV at 1.5M, outputs being 500mV at 15K and 2.5W at 5 ohms. A forward-facing loudspeaker and treble tone-control are incorporated. The *TK145* employs a double-ribbon magic-eye and costs £49 17s. 6d.

Distributor: Grundig (Great Britain) Ltd., Newlands Park, Sydenham, London, S.E.26.



Sanyo MR910

Uher 4000S



Reslo EC.1

Van Der Molen Sonic Five



Sanyo MR800



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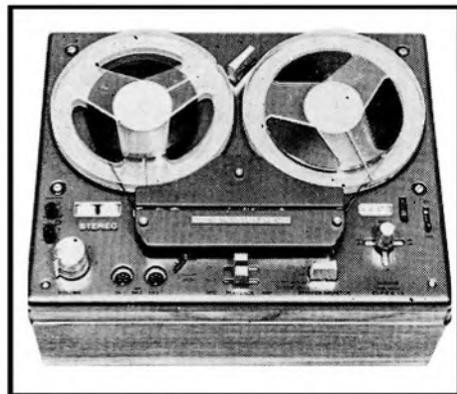
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equipment reviews

TANDBERG SERIES 12

MANUFACTURER'S SPECIFICATION. Fully transistorised $\frac{1}{4}$ -track stereo tape recorder with side-facing internal speakers and power amplifiers. Tape Speeds: $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i/s. **Wow and flutter:** 0.15%, 0.2% and 0.3% respectively. **Frequency Response:** 40Hz-20kHz, 40kHz-12kHz and 40Hz-7kHz respectively, ± 2 dB. **Output Power:** 10W per channel, at 5% distortion. **Signal-to-noise ratio:** 55dB (referred to peak recording level: 5% distortion). **Speed tolerance:** $\pm 2\%$ absolute. **Dimensions:** $15\frac{1}{2} \times 11\frac{1}{2} \times 7$ in. **Weight:** 23 lb. **Price:** £110 5s. **Distributor:** Elstone Electronics Ltd., Hereford House, North Court, Vicar Lane, Leeds 2.



THE external appearance of the Model 12 is very similar to other recorders from the Tandberg stable: teak cabinet with a speaker on each side face; heavy dark grey metal deck cover, with cast metal dress covers over the heads; bright chromium plated control knobs which give an air of solidity to the styling, and the usual Tandberg four position 'joy stick' which controls all tape movement and frees the reels for effortless tape threading. New features are the variable bass and treble tone controls—earlier recorders had only a switched bass lift—and the three-position RECORD, PLAYBACK and AMPLIFIER twin switches, which may be operated together for stereo work or separately for mono, sound-on-sound or track-to-track transfer.

All inputs except microphones are duplicated in phono sockets and standard DIN 5-way sockets. In the same way, external speaker outputs are available as GPO jack or 2-pin DIN sockets. A central channel, or mixed output from the right and left channels, is also available for feeding a centre channel amplifier and speaker or for feeding a mono headset for language laboratory work.

FM-multiplex filters are fitted to all line inputs to ensure that stereo radio recordings are free of beats between the bias frequency and the multiplex switching frequency. Switches are provided so that they may be cut out of circuit for the widest possible frequency-range non-multiplex recordings.

Long term speed stability proved to be within the specified $\pm 2\%$ limits at all parts of a 7in. reel at each of the tape speeds provided.

Short-term speed stability was measured in the usual way on the W.H.M. meter to give RMS wow, and wow and flutter, readings together with simultaneous high speed pen recordings or 'fluttergrams' for analysis of the offending 'wobble' frequencies, fig. 1. A new innovation was to use very low wow and flutter test-tapes to measure the play-only wobble. The top trace on each pen recording is the filtered low frequency 'wow' component on play; the second trace is the wide range wow

FIG. 2 TANDBERG SERIES 12 ($\frac{1}{4}$ TRACK) PLAYBACK RESPONSE

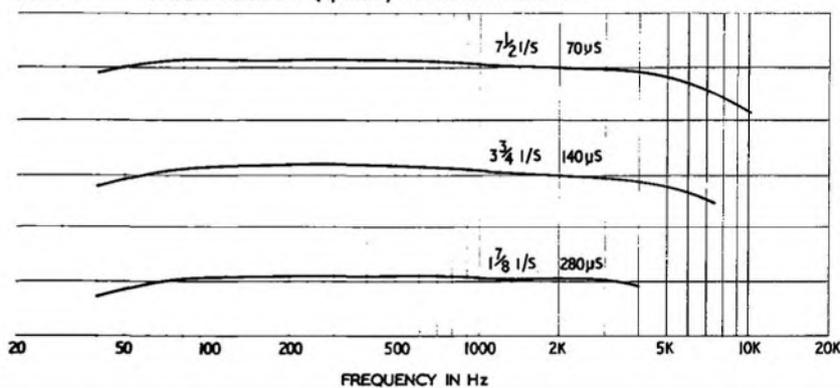
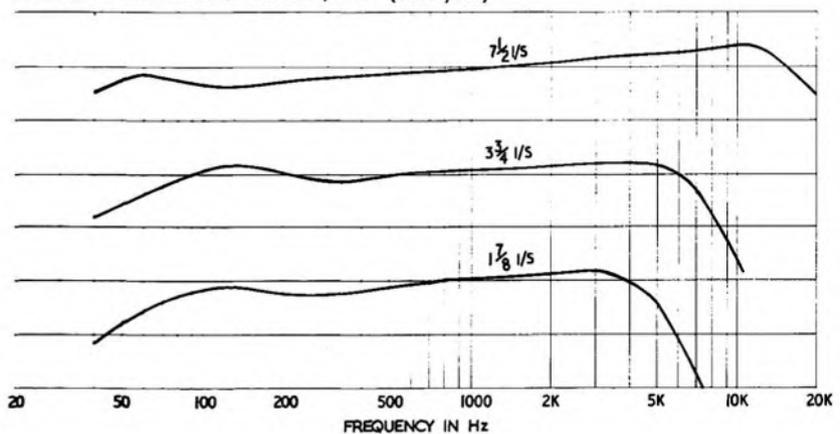


FIG. 3 TANDBERG 12 RECORD/PLAY (LINE IN/OUT)



and flutter content on play only, limited mainly by the 120Hz cut-off in my pen recorder; the third or lower trace is the cumulative wow and flutter components on record-play where some addition or partial cancellation can occur between the recorded and reproduced speed disturbances. It will be seen that the high frequency flutter increases as the tape speed is reduced, and, as such a high frequency cannot be due to any rotating part, it must be due to a friction effect at guides or pressure pad. An unusual feature of the wow or low frequency wobble is that it remains at approximately 10Hz at all tape speeds. This would seem to indicate that it is not due to capstan or idler wheel but to some other rotating part which is coupled to the motor, probably for wind or fast rewind.

Fig. 2 shows the play-only responses at line

output from test-tapes recorded to the CCIR recording characteristics of 70, 140 and 280 μ s for tape speeds of $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i/s respectively. The level responses show that the playback equalisation is close to the desired time-constants with only a slight fall above 5kHz.

The combined record-play responses are shown in fig. 3. Again, responses are close to those of the test-tapes with a slight $\pm 1\frac{1}{2}$ dB deviation at low frequencies due to head contour effects which were missed on the spot frequencies of the test-tapes but made evident by the continuous sweep of the oscillator used for the record-play tests.

The unweighted signal-to-noise (hum) ratio with no tape passing the heads was 40dB referred to test-tape level. A 200Hz high-pass filter to lower the mains hum contribution

(continued on page 487)

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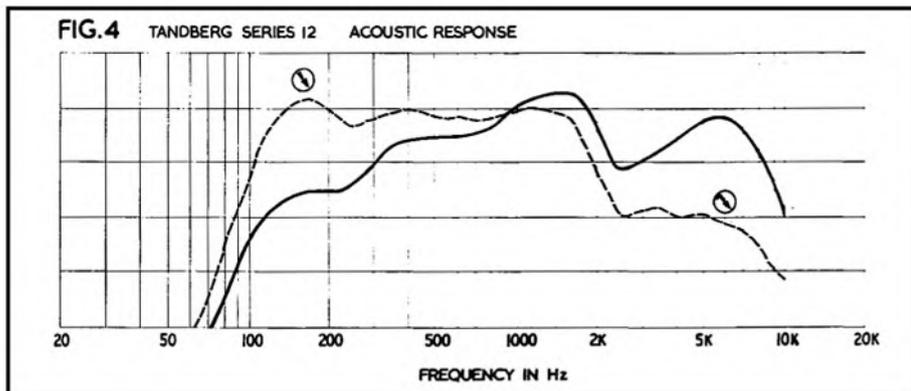


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reduced the system noise to 53dB below test-tape level.

Harmonic distortion measurements at peak recording level, where the magic-eye beams just clashed, gave 3rd harmonic distortion figures of 4.2% at 500Hz, 3.8% at 1kHz and 3.6% at 3kHz (7½ i/s). The level was 14dB above that on the test-tape. Further tests at the more normal 12dB above test-tape level gave readings of 2.5%, 2.3% and 1.6% respectively.

We are still in the process of collecting data on harmonic distortion in tape recorders, but the Tandberg has always had a reputation for very clean sound and the above figures are probably near the lower limit to be found in good quality domestic recorders.

TAPE NOISE

Tape noise, measured through the 200Hz high-pass filter, was 48dB below test-tape level or 60dB below peak recording level after erasing a peak 500Hz signal. Similar tests at 3½ i/s gave readings of -38dB and 50dB for filtered tape noise, and distortion figures of 4.2%, 3.4% and 3.0% at 500, 1,000 and 3,000Hz at peak recording level 12dB above test-tape level.

The acoustic responses of fig. 4 were measured on speaker axis while playing a 25 one-third octave band 7½ i/s white noise test-tape. The arrows show the positions of the bass and treble tone controls. It will be seen that advancing the treble control clockwise reduces the high note response. It would seem more logical to reverse the connections so that it behaves in the same way as the bass lift control. With maximum bass and treble response, the sound output response can be made level within 5dB limits over the range 100Hz to 8kHz.

COMMENT

Wow and flutter is slightly high at the two lower speeds for a machine in this price range, but some attention to friction in the tape path would almost certainly cure the high frequency flutter and the 10Hz wow is not due to the

capstan or flywheel and may be peculiar to my test sample only.

The total dynamic range is extremely wide due to the high peak recording level and the very low tape hiss and system noise.

As noted in my review, I personally would like both tone controls to increase their respective outputs with clockwise rotation. Also a little more top rise would be an advantage for frontal listening off the speaker axis.

LISTENING TESTS

Careful listening tests on wide range external speakers confirm the low distortion measurements and show that the change to transistor circuits has not resulted in any loss of the well known Tandberg 'cleanness' and confirms my own oft-repeated plea to designers to set the recording bias for lowest tape distortion and noise and to turn a deaf ear to the advertising copy writers who demand a level frequency response to 20kHz at 3½ i/s. A glance at fig. 3 will show that a level response to 10kHz at 7½ i/s, 5kHz at 3½ i/s and 3kHz at 1½ i/s is all that can be expected of orthodox heads and tape with no compromise in the optimum bias setting. I look forward to testing the Tandberg cross-field bias recorder to see if the frequency response of such a system can really be extended whilst maintaining the low distortion and low noise of the Model 12 and its predecessors.

A. Tutchings

Editor's Note: We apologise to readers, to Messrs. Tandberg, and to Elstone Electronics, for the omission of our reviewers' wow and flutter pen-recordings. The original of all four figures in this review were lost in the post shortly before we went to press and we were unable to obtain a replacement of fig. 1 in time for inclusion. Should the original drawing turn up, it will be published in the earliest possible issue. As an insurance, however, fresh pen-recordings are being taken of the review model and will be published shortly with a suitable postscript.

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BY DROPOUT

**column
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THIS column will present, through the kindness of the Editor, notes on various aspects of the recording world, as seen through the eyes of one amateur. It is hoped that readers may be stimulated to contribute by writing to me about their experiences: there must be all sorts of helpful things which could and should be passed on. Being a club member, I should be glad to receive items of true interest about clubs: not changes in officials and accounts of manufacturers' demonstrations, but doings and happenings of the kind calculated to make David Kirk withdraw for ever his epithet of "godforsaken clubs". That is, if his epithet *ought* to be withdrawn!

I have often thought of the enormous wealth of material which is collected by recordists—often unintentionally, in this context—which could be of historical value. One has only to imagine that the tape-recorder had existed in the days of Shakespeare, who was an actor and took parts in the plays attributed to him. Scholars know a good deal about the way in which English was pronounced in his day (and before); but what would it be like to hear *his* voice? Under professional rules, the amateur might have had difficulty in recording his voice; but he could have recorded the voices of countless of his contemporaries.

COUNTLESS VOICES

Today, countless voices are recorded: one club I know has hundreds of interviews in its archives, not a few with people who have now ceased to speak or sing. But what will happen to the tapes in the end? Suppose the club

were to cease; suppose the member who at present cares for the tapes were to get fed up and resign?

For years now, keen railway enthusiasts have been recording the sounds of steam before it finally disappears. I myself know two people, each of whom has a vast collection of carefully-identified recordings of trains; but each has made his collection for his own interest and enjoyment, and it is only too easy to visualise an executor to whom *Pendennis Castle* is a ruin in Cornwall.

Natural history is better served: not only has the B.B.C. a splendid library but there are learned societies and scientific foundations all over the world through which collections are made—and to which, by the way, the amateur can contribute, if his recordings be good enough. And one does hear of various projects, such as the recording of dialects, being undertaken by University departments. But to me it all seems sporadic and unorganised; and it was with great interest that I read the note on page 315 of the September 1966 *Tape Recorder* about the *Deutsches Spracharchiv*. Is there anything in this country which corresponds to such a speech-archive? If there be, is it prepared to receive contributions from the amateur; and what kind of contribution does it seek? It seems to me that there is a vast amount of valuable material going to waste at the present. Could somebody do something about it?

The editorial of that same distant issue mentioned the problem of powering battery-driven recorders. The suggestion was that rechargeable accumulators are not always what they are cracked up to be. I have never used one; but I am bound to say that I know of several people who have had trouble with them.

I use a *Telefunken M300*. When it was new I measured the power-consumption and found that on fast-wind, and also on peaks of record and replay, the batteries were being asked for something like half an amp—which is a whole lot to ask from five U2 cells, even the high-power variety. And as renewing the cells cost, at that time, ten shillings, I began to look round for something cheaper.

EXTERNAL SOURCE

This machine, like many others no doubt, is fitted with a socket for the connection of an external source of power at 6V. This is done by a DIN plug which, on insertion, disconnects any batteries there may be in the machine. Six volts is in fact below the optimum, which is 7½; but the machine is arranged so that it will operate between the two. By good fortune I ran into a battery designed to power an electric fence. It has no liquid acid in it, and therefore cannot be upset on car upholstery; and it is not half the size of a car battery, and weighs much less. Given an inexpensive charger, which also comes in handy for the car on occasion, one is in business. I now never rewind on the internal batteries, and indeed use them only on occasions where portability is the prime requirement. For the rest, the fence-battery has been in use for more than two years, with an occasional overnight trickle-charge. I was fortunate to get mine second-hand for a few shillings. A motor-cycle battery will do as well, of course.

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Circuit diagram for Carol Synchronizer CS/1, also 4/4 magnetic R/P head. 39 Rookery Lane, Lincoln.

Good condition June to December 1964 *Tape Recorder*; September, October *Hi-Fi News*. Young, 58 Furzeffeld Road, Welwyn Garden City, Herts.

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J & B Recordings. Tape to disc—latest high level disc cutting, all speeds. Mastering pressings. Studio mobile. 14 Willows Avenue, Surrey. MITcham 9952.

County Recording Service (A.P.R.S.) for tape to disc, master discs and pressings. Suppliers of cutting sapphires for all disc recorders. London Road, Binfield, Berks. Tel. Bracknell 4935.

Professional mobile and dubbing. High quality mobile recording; Tape/Disc copying and mixing; quantity pressings; custom built equipment; professional tape recorders, etc., serviced. L.F. Recordings, 24 West Kensington Mansions, Beaumont Crescent, London, W.14. 01-385 0697.

MISCELLANEOUS

Repairs. Our modern service department, equipped with the latest test equipment (including a wow and flutter meter and multiplex Stereo Signal Generator) is able to repair Hi-Fi and Tape Recording equipment to manufacturers standards. Telesonic Ltd., 92 Tottenham Court Road, London, W.1. 01-636 8177.

Skilled tape recorder repairs carried out by expert personnel of many years experience backed by extensive test equipment: Wow and flutter meter, audio valve voltmeter, audio generator, oscilloscope, etc., with final test performance figures quoted if required—Ferrograph specialists. Tape Recorder Centre, Tel-Lee-Radio, 220 The Broadway, Wimbledon, S.W.19. 01-542 4946.

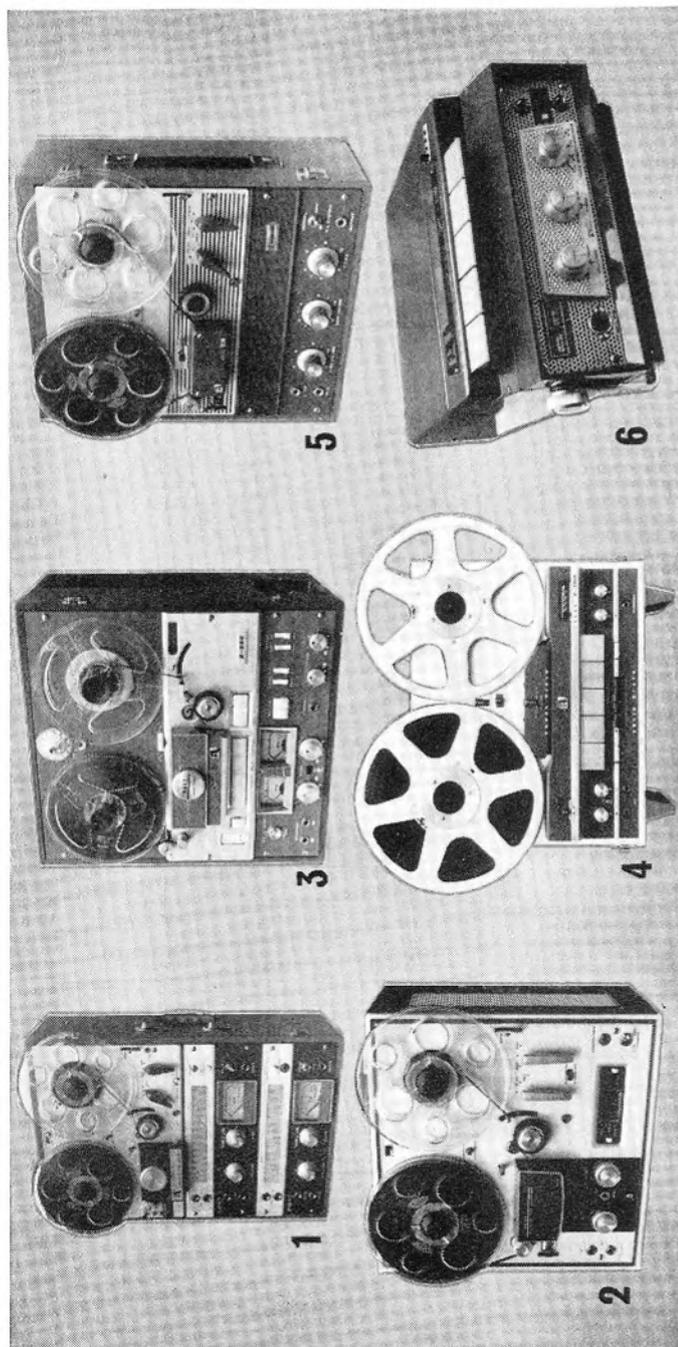
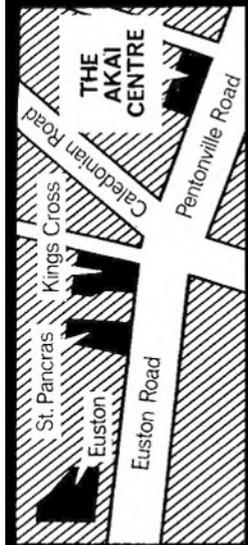
Hi-Fi installations and servicing by professional engineers (assoc. A.P.R.S.). L.F. Recordings, 24 West Kensington Mansions, Beaumont Crescent, London, W.14. 01-385 0697.

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British Patent No. 911518. Magnetic Recording and Playback Head. Owner desires commercial exploitation on reasonable terms by licence or sale. Enquiries: H. D. Fitzpatrick & Co., 5 Park Gardens, Glasgow C.3. and 27 Chancery Lane, London, W.C.2.

Far and Wide Recording Club, Maidstone, Kent.—Details free, s.a.e. please.

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We have a wonderful selection of **BRAND NEW, SHOP SOILED AND SECONDHAND AKAI RECORDERS** Showing savings of up to 50% on original list prices.

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- AKAI 355 One only—s/soiled 175 Gns.
 - AKAI X4 Brand New (Brown model) 79 Gns.
 - AKAI 1710 One only—s/soiled 64 Gns.
 - AKAI M8 2 only 99 Gns.
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 - AKAI X300 One only—s/soiled 169 Gns.

HURRY WHILE STILL AVAILABLE!

- 1. AKAI M8**
A high quality 4-speed, 4 track stereo/mono recorder with Crossfield head. Vertical or horizontal operation. 4 hours stereo recording on 1200ft. standard tape. 2 stereo fill-in speakers. Sound-on-sound. 6 watts per channel. 136 gns.
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A completely self contained, 3 speed, 4 track stereo/mono recorder. Two 7in. x 5in. built-in speakers, 3 watts per channel. Attractive styling and AKAI precision finish. Takes 7in. reels. 79 gns.
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A machine for the advanced amateur or professional, with 3 motors, 3 speeds, 4 heads (including Crossfield bias) and 30 watts per channel output. Fully solid state; push button solenoid operated controls, automatic reverse, repeat and shut-off functions. Built-in echo chamber effect. Full A.B. monitoring. Remote control facilities, etc., etc. 239 gns.
- 4. AKAI X300**
A studio type 3-speed 4 track stereo/mono recorder of professional quality. Fully solid state, 20 watts per channel amplifier. Crossfield heads; 3 hysteresis synchronous motors with direct drive capstan. 10in. reels; keyboard controls, and many other facilities. 190 gns.
- 5. AKAI 910**
A mono recorder, available in four or two track form. Clean and functional styling; two speeds; 3.2 watts output. Built in P.A. system and mixing facilities. 62 gns.
- 6. AKAI X4**
A fully transistorised stereo/mono, battery/mains portable recorder. 4 track; 4 speeds; Crossfield heads; superb low-speed frequency response. Mains-rechargeable battery. 5in. reels. Weights only 11.2lb. 131 gns.

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To all residing overseas, visiting the U.K. or taking up residence abroad we can now offer an exclusive export facility. All Akai equipment can be despatched overseas, free of U.K. Purchase Tax and U.K. Import Duty.

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- 3 tape guides
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- 3 tape clutches
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- 3 tape guides
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- 3 tape supports

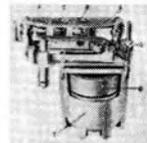
See your nearest Revox dealer for full details and a list of Revox dealers in your area.



See how the Revox 'spins it's reel'

See how the Revox 'spins it's reel'... The Revox recorder is a masterpiece of precision engineering... It is the only mono tape recorder in the world which has three motors, three heads and three transport mechanisms... This is the reason why the Revox has become the standard for both quality and performance in the high fidelity recording field.

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They told you...

“This is a superlative machine, quite the best domestic tape recorder I have experienced.”

Geoffrey Horn
—The Gramophone, May 1964.

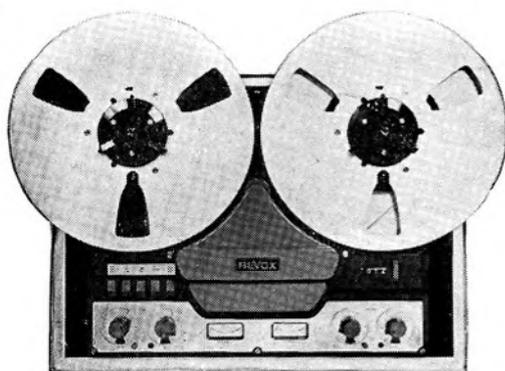
“My comment on this 736HS is to admit that I have squandered the housekeeping money for months to come by investing in it as a reference standard and yardstick against which all future recorders will be judged.”

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—Tape Recorder, May 1967.

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how smooth the response, how clean and exact the treble, how free from wow, flutter and background noise your recordings can be. Enjoy the pleasure and precision of Swiss engineering at its best applied to a tape transport mechanism that has three motors, three heads and a capacity for even professional 10½" spools. Prove for yourself why the Revox has become the standard for both quality and performance in the high fidelity recording field. Complete the coupon below and try a Revox over the weekend—free and completely without obligation



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