MAY 1968 TWO SHILLINGS

tape recorder

CrO_2 -- TOMORROW'S TAPE?

TANDBERG -- A SOCIAL EXPERIMENT

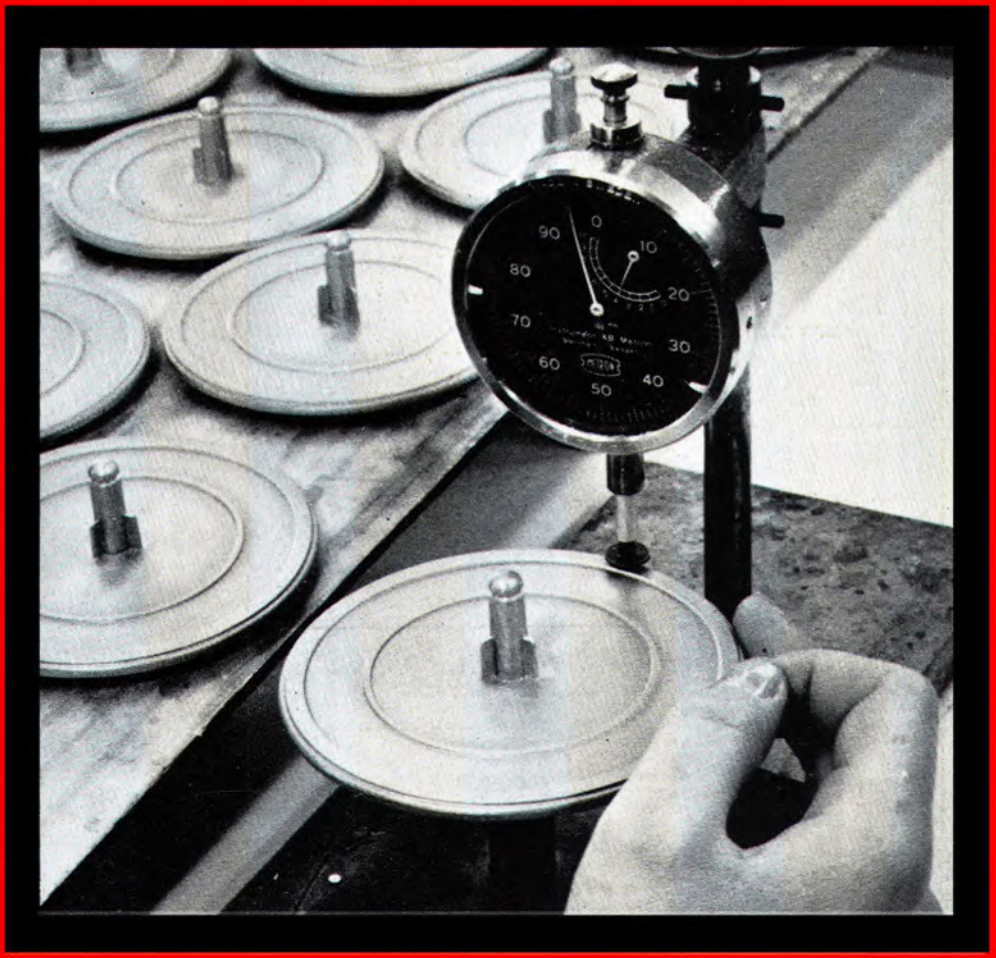
SIMPLE CIRCUITS FOR MATCHING AND MIXING

SCHAUB LORENZ MUSIC CENTER -- FIELD TRIAL

TAPE RECORDER SERVICE

A TAPE PREVIEW OF THE 1968 AUDIO FAIR

TANDBERG 64X REVIEW



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

20% OFF

BASF - EMI - GRUNDIG PHILIPS - SCOTCH - AGFA

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

	LIST PRICE	OUR PRICE
STANDARD PLAY		
5" 600' }	21/-	16/10
5½" 900' } Except Agfa	28/-	22/6
7" 1200' }	35/-	28/-
LONG PLAY		
3" 200' Not Scotch	9/-	7/3
3" 300' Scotch only	9/6	7/6
4" 450'	14/6	11/8
4½" 600' BASF, Agfa only	21/-	16/10
*5" 900'	28/-	22/6
*5½" 1200'	35/-	28/-
*7" 1800'	50/-	40/-
8½" 2400' BASF, Scotch only	72/6	58/-
10" 3280' Agfa only	85/-	68/-
10" 3600' BASF only	95/-	76/-
10½" 4200' Agfa, BASF only	112/-	90/-
SCOTCH DYNARANGE (L/P)		
5" 900'	32/3	25/10
5½" 1200'	40/6	32/6
7" 1800'	57/6	46/-
8½" 2400'	83/6	66/10
COMPACT CASSETTES		
C. 60	17/6	14/-
C. 90	25/-	20/-
C. 120	33/6	27/-

	LIST PRICE	OUR PRICE
DOUBLE PLAY		
3" 300' Not Scotch	14/-	11/3
3" 400' Scotch only	16/6	13/2
4" 600'	25/-	20/-
4½" 900' Agfa, BASF only	30/-	24/-
5" 1200'	42/-	33/8
*5½" 1800'	55/6	44/6
*7" 2400'	77/6	62/-
10" 4600' Agfa only	140/-	112/-
TRIPLE PLAY		
3" 450' Not Scotch	22/-	17/8
3" 600' Scotch only	24/9	19/6
4" 900'	39/-	31/3
*4½" 1200' Agfa, BASF only	49/-	39/3
5" 1800' Not Scotch	66/-	52/10
5½" 2400' Agfa, BASF, 7" 3600' only	90/- / 115/-	72/- / 92/-
QUADRUPLE PLAY		
3" 600' }	36/6	29/6
3½" 800' } Kodak only	46/-	37/-
4" 1200' }	64/6	51/6

GRUNDIG TAPE AVAILABLE ONLY WHERE MARKED WITH ASTERISK

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

FERROGRAPH TAPE—20% OFF!

Brand New. Fully guaranteed and in normal manufacturer's pack.

	LIST PRICE	ONE	THREE	SIX
BN7 1,200' on 7" reel (Dynarange)	50/-	40/-	117/6	230/-
BN8 1,800' on 8½" reel (Dynarange)	71/-	57/-	168/-	330/-
BL7 1,800' on 7" reel (Dynarange)	70/-	56/-	165/-	324/-
BL8 2,400' on 8½" reel (Dynarange)	90/-	72/-	213/-	420/-

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 and 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/-

Please add 2/- P. & P. ORDERS OVER £3 POST FREE.

SENSATIONAL NEW *HALF-PRICE OFFER!*

A bulk purchase of top quality Recording Tape manufactured by one of the Country's leading makers. A polyester based tape with super life black coating. Polythene wrapped, boxed, and fully guaranteed. Available while stocks last in one size only.

	NORMAL VALUE	ONE	THREE	SIX
1,800' on 7" reel. Long Play	50/-	26/6	78/-	150/-

POST & PACKING 2/-. ORDERS OVER £3 POST FREE.

AMPEX TAPE

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

'500' SERIES AUDIO TAPE (MYLAR BASE)

TYPE	DESCRIPTION	LIST PRICE	ONE	THREE	SIX
541-9	900' Long Play on 5" reel	28/-	21/-	61/6	120/-
541-12	1,150' Long Play on 5½" reel	35/-	28/-	82/6	162/-
541-18	1,800' Long Play on 7" reel	50/-	32/6	96/-	189/-
551-12	1,200' Double Play on 5" reel	42/-	35/-	103/6	204/-
551-16	1,650' Double Play on 5½" reel	56/-	45/-	133/6	264/-
551-24	2,400' Double Play on 7" reel	72/6	55/-	163/6	324/-

'600' SERIES PROFESSIONAL AUDIO TAPE (MYLAR BASE)

641-9	900' Long Play on 5" reel	30/6	23/-	66/6	127/6
641-18	1,800' Long Play on 7" reel	52/6	39/6	116/-	226/-
651-12	1,200' Double Play on 5" reel	46/-	34/6	101/-	197/-
651-24	2,400' Double Play on 7" reel	80/-	60/-	177/-	348/-

POST & PACKING 2/-. ORDERS OVER £3 POST FREE.

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

SPECIAL OFFER COMPACT CASSETTES

"MC 90"

Compact Cassettes with 90 mins. playing time. Brand New and packed in normal plastic library box. Available at this exceptional price.

OUR PRICES
"MC 90"
1 for 18/6
3 ,, 54/-
6 ,, 105/-
12 ,, 204/-

Standard pattern to fit Philips, Stella, Elizabethan, Dansette, Sanyo, etc.

Post & Packing 2/- — *Orders over £3 Post Free*

PHILIPS

NOW FROM KJ THE FULL RANGE OF MUSICASSETTES

AVAILABLE BY RETURN POST.
SEND FOR FREE CATALOGUE

TRIPLE PLAY TAPE – 40% 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 stopfoil. In original maker's boxes and polythene wrapped at these EXCEPTIONALLY LOW PRICES.

	LIST PRICE	ONE	THREE	SIX
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/-
1,800' on 5" reel Gevasonor	66/-	41/6	122/-	238/-
2,400' on 5½" reel Zonal	90/-	55/6	165/-	324/-

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

20% off all Grundig and 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%.

MORE FANTASTIC BARGAINS FROM K.J. ENTERPRISES

WE SAVE YOU MONEY!

SPEAKERS GALORE!

SAVE £6.10.0d. on the SONOTONE SOLENT

The fabulous bookshelf speaker system designed and manufactured by Plessey, one of the country's largest electronics groups. Acoustically designed two-speaker system with crossover network.

ORIGINALLY SOLD FOR £18.0.0d.

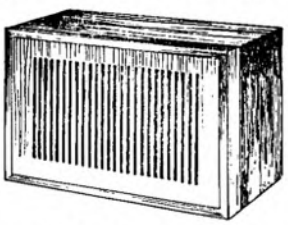
NOW OFFERED AT £11-10-0d

CARRIAGE 10/- EXTRA PER UNIT

THIS OFFER REMAINS OPEN ONLY WHILE STOCKS LAST!

WHAT THE REVIEWERS SAID:

"Recommended without reservation for this category of Loudspeaker". David Phillips & Donald Aldous.
"Sonotone 'Solent' deserves to reach a wide public." John Borwick.
"A worthy member of the Hi-Fi family." R. L. West.



Technical Specification:
Cabinet Size 14" x 9" x 8½"
Woofer 6½", 10,000 Gauss, 1" pole.
Tweeter 3½" Acoustically loaded
Frequency response 40—20,000 cps.
Power Handling 12 watts.
Impedance 8—15 Ohms.
Scandinavian style finish.

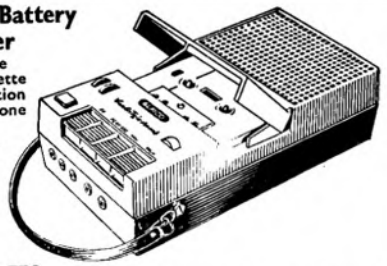
Guaranteed Brand New in Maker's carton

ALSO ANOTHER FANTASTIC PURCHASE

Compact Cassette TAPE RECORDER ONLY 17GNS.

The ELPICO CTR 600 Battery Cassette Tape Recorder

Beautifully styled, pocket-size recorder with "snap-in" cassette loading. Press button operation with separate volume and tone controls. Up to 120 minute playing time on a single cassette. Weighs only 3 lb. 5 oz. Supplied complete with C.60 cassette, remote control microphone, earphone and batteries.



Dimensions 4¾" x 8¾" x 2¾"

ORIGINAL PRICE 24 gns.

Now offered to you, Brand New and fully guaranteed for the sum of £17.17.0d. plus 7/6d. Postage and Packing.

OTHER OUTSTANDING BARGAINS IN "COMPACT CASSETTE" RECORDERS AVAILABLE FROM K. J.

DESCRIPTION	*LIST PRICE*	*OUR PRICE*	*Post and Packing*
Philips 3302 Battery Tape Recorder	25.14.6	20.9.6	7/6
Philips 3303 Battery Tape Recorder	30.9.0	24.7.6	7/6
Philips 3312 Stereo Mains Tape-Recorder (with two x GL 559 loudspeakers)	50.8.0	35.0.0	10/-
	57.15.0	47.0.0	15/-
Grundig C 200 (New Model) Battery Tape-Recorder	38.17.0	31.7.6	7/6
Aiwa TP 1004 Mains/Battery Stereo Tape-Recorder	50.18.6	40.19.0	10/-
Sanyo M.18 Battery Tape-Recorder	24.3.0	20.12.6	7/6

A few only—Philips 3301 at **£18.18.0** plus 7/6 Post and Packing.

K. J. ENTERPRISES (Dept. TR)
17 THE BRIDGE, WEALDSTONE, MIDDX.
Tel: 01-427 0395

VIKING MEANS EXTRA VALUE IN HI-FI STEREO TAPE RECORDERS

Now, for the first time, you can enjoy the superior reproduction and quality engineering of one of America's finest full fidelity tape recorders that is styled for your lounge, but built like a piece of laboratory equipment.

The NEW Viking Model 433 makes a beautiful sound and is unequalled for operating simplicity and reliability. It has three motors, three hyperbolic heads—no pressure pads—off the tape to original monitoring; echo switch, sound on sound and a separate monitor volume control for each channel. An eight position function switch illuminates colour coded windows, there's a four digit counter; automatic shut off; foolproof tape motion and record switch interlock; three speeds and solid state electronics. Just plug in to your existing Hi-Fi—you'll *hear* the difference, or with VIKING 4400 energised loudspeakers you need no elaborate Hi-Fi amplifiers. The 4400 energised loudspeakers deliver 30 watts of music power per channel at a frequency range from 40 to 17,000 cps. There are two superb loudspeaker units in each enclosure with separate volume control, headphone jack, base control and on-off switch. The 4400 will also accept and produce wonderful music from your tuner and record player.

ONE OF THE WORLD'S FINEST TAPE RECORDERS

VISIT THE AUDIO FAIR
18 TO 21 APRIL, 1968—
See and hear the VIKING exhibit at the MORTON HOTEL opposite.

MODEL 433

Ask your dealer or write for full details.

VIKING tape recorders

A DIVISION OF THE TELEX CORPORATION

U.K. Distributors:

TRANSATLANTIC MUSIC TAPES (DISTRIBUTORS) LTD.
BRISTOL & WEST HOUSE, HIGH STREET, SALISBURY, WILTS.

SHARP

Further developments to the highly successful designs of last year have produced the RD 505 and RD 303E. Both matching the SHARP name for reliability, performance and audience appeal.

RD 505

5 YEAR GUARANTEE

to the point of perfection!

Model RD 505. Solid state all transistor tape recorder, twin track, two speeds. Superb recording reproduction with outstanding simplicity of control. Entirely portable, will operate anywhere. The act of inserting the mains plug automatically changes over from batteries to its own built-in A.C. power unit. Designed to play or record in any position. Remote control switch on microphone allows full flexibility in use. Dimensions 12" x 10" x 4". Additional features include 3 digit tape counter, fully variable tone control, large internal speaker and automatic level control. Comes complete with dynamic microphone recording lead, earphone, batteries (6 x Ever Ready LPU2 or equivalents). 5" reel of tape and empty spool. **R.R.P. £39.18.0**

RD303E An all transistor solid state tape recorder. Two speeds, twin track. Fully portable with operation from internal batteries or A.C. mains. Automatic or manual recording level control. Remote control switch on microphone for instant start/stop. Uses 3" reels, utmost simplicity of control with brilliant performance—truly a miniature marvel. Dimensions 11⅝" x 3½" x 7½". Complete with dynamic microphone, recording lead, earphone, batteries (4 x Ever Ready LPU2 or equivalents). 3" reel of tape and empty spool. **R.R.P. £28.17.6**

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Tel: SWInton 3232 (5 lines)

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Address _____

T.8

A REEL Deal...

FOR ALL OWNERS OF 4 TRACK TAPE RECORDERS

69/-VALUE FOR 45/-

STEREO 3¾ ips. 4 TRACK 50/-

(Including Purchase Tax)

(A 90 minute Music Tape value 45/- and a 24/- reel of Polyester Base Long Playing Recording Tape—1 mil—all for 45/-)

This offer enables you to realise the excellent value of the new 4 track tapes released by RECOTAPE and to verify the quality of the new formula RECOTAPE Recording Tape.

Each of the new Recotape 4 track tapes is equal to two complete recordings. Playing time of 45 minutes costs only 25/-; up to 130 minutes for 45/-.

MUSIC FOR ALL plays at 3¾ ips. and can be used on all 4 track Mono or Stereo recorders.

Contents

William Tell Overture, played by the Vienna State Opera Orchestra ; Cuanta La Gusta, played by the London Brass Ensemble ; Waltz from Swan Lake played by Vienna State Opera Orchestra ; Dream of Olwen played by Syd Berman and His Sound Stage Symphony ; Somewhere Over The Rainbow, played by The New Metropolitan Theatre Orchestra ; Grand March from Aida played by Vienna State Opera Orchestra ; March, El Capitan, played by Massed Military Bands ; Waltz Artists Life, played by the Vienna Opera Orchestra ; Stranger in Paradise, played by Syd Berman and His Sound Stage Symphony ; Gipsy Airs, played by the Sudwesfunk Symphony Orchestra ; Heatwave, played by Larry Moreton and His Hammond Organ and Overture 1812, played by the Vienna Symphony Orchestra.

YOU GET MORE MUSIC AT LESS COST WITH

RECOTAPE 4 TRACK TAPES

Ask your dealer for this tape, in case of difficulty send direct to :—

RECOTAPE RECORDINGS LIMITED
36 HIGH STREET, SALISBURY, WILTS.

VISIT THE AUDIO FAIR 18th to 21st APRIL, 1968

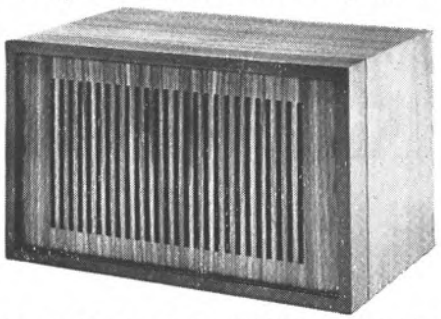
SEE OUR EXHIBIT AT THE MORTON HOTEL, Woburn Place, W.C. (almost opposite)

FANTASTIC BARGAINS

TAPE RECORDERS AT PRE BUDGET PRICES

Telefunken 204E	85 gns.
Beocord 2000K	£145
Beocord 2000T	£150
Uher 4000L	94 gns.
Uher 4200 stereo	119 gns.
Uher 4400 stereo	119 gns.
Philips EL3302	21 gns.
Tandberg Model 12	105 gns.
Tandberg Model 6 x 4 track	118 gns.
Akai X 300 stereo	£185
Revox Model 77	139 gns.
Philips EL3578	44 gns.
Grundig TK245	89 gns.
Philips Model EL3573	36 gns.
Philips Model EL3572	25 gns.

Also many reconditioned models from stock.



SONOTONE SOLENT 2-SPEAKER HI-FI BOOKCASE SPEAKERS

- Tested by *Which?* Magazine
- Imp 8Ω, can be connected direct to most makes of tape recorders.
- Suitable for valve or transistor amplifiers
- Selected by the Design Centre
- Scandinavian style cabinet
- Frequency response 40c/s to 20Kc/s
- Small attractive size, 14" x 9" x 8½"
- On Permanent Demonstration
- Reviewed by Hi-Fi News, Gramophone, Audio Record Review. Free copies available. Send large S.A.E.

NOW LISTED AT £18-11-0 EACH

SPECIAL OFFER 11 GNS. EACH

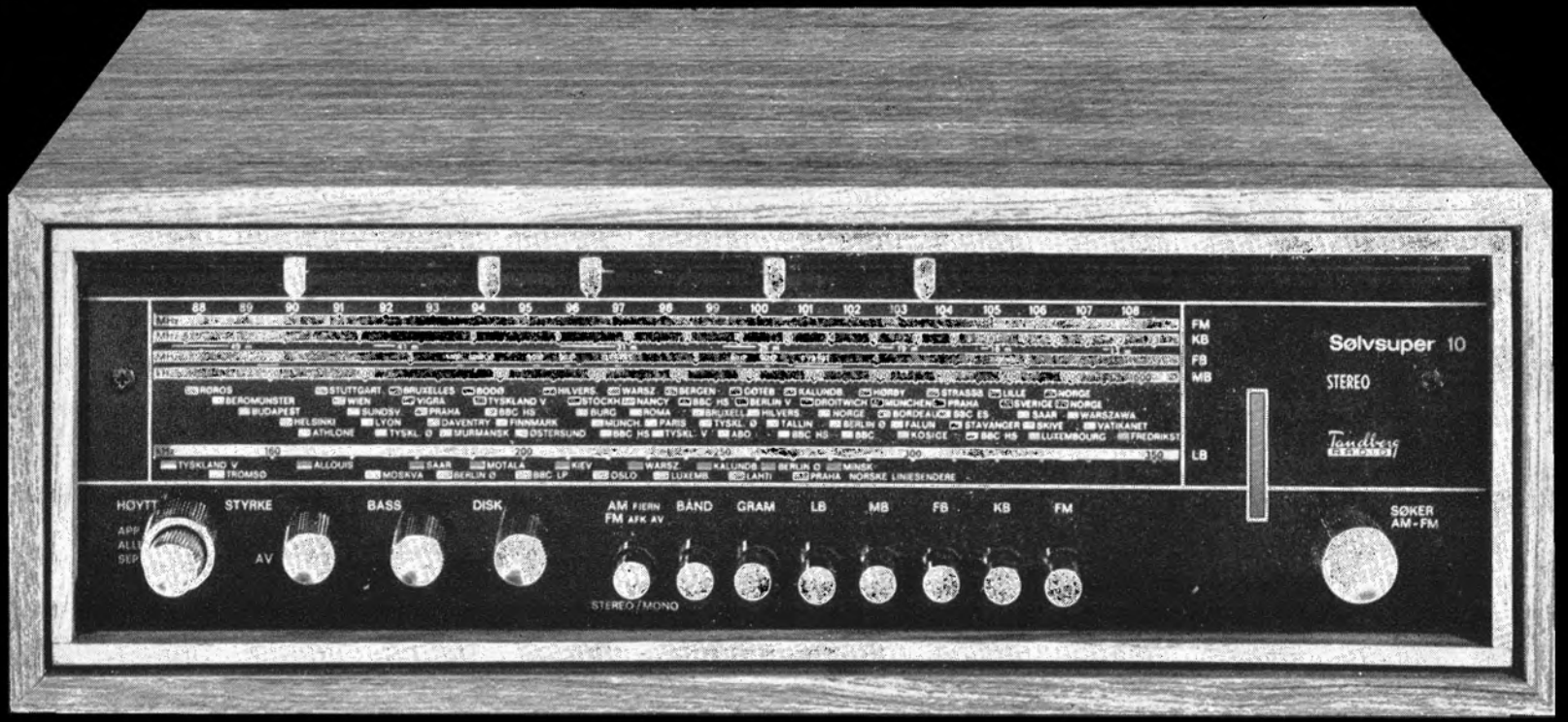
p/p 9/-, or 12/6 C.O.D.

LEE ELECTRONICS

400 Edgware Rd., Paddington 5521

● Will customers kindly note that our showrooms will be closed from 9th to 19th of April inclusive for Easter holidays and stocktaking. Mail order dept. not affected, re-open Saturday, 20th April.

New from Tandberg



Sølvsuper 10.71 combined FM/AM Tuner and Stereo Amplifier

It's all there. Everything the heart of your Hi-Fi system should have. A 12 watt stereo amplifier. An exceptional FM/AM tuner with provision for a stereo reception decoder. Combined in an elegant low line teak case.
The Solvsuper 10.71 incorporates these features :—

- ★ 5 wavebands ; long, medium, short, coastal and FM.
- ★ Automatic frequency control on FM.
- ★ Push button selection of wavebands, or external gramophone tape recorder etc.
- ★ Separate bass and treble controls.
- ★ Adjustable FM station indicators.
- ★ Separate gain controls on each channel.
- ★ Electronic beam tuning indicator.
- ★ 2 x 6 watts output.
- ★ 15″ long x 9″ wide x 5¼″ high.
- ★ £65.0.0.

The Solvsuper is also available in two other versions :—
10.70 with a single built in speaker (mono)
10.72 with two built in speakers (stereo)

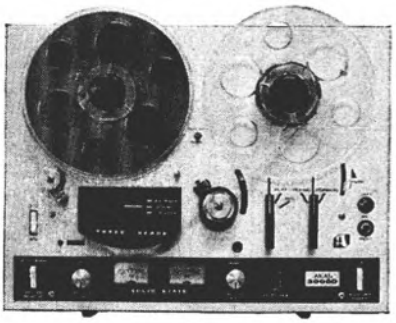
Elstone Electronics Limited,
Hereford House,
Vicar Lane, Leeds 2.

move up to **Tandberg**

See and hear Tandberg at the Audio Fair Stand 24. Demo Room 504

At your service with two superbly equipped Tape Recorder and Hi-Fi Centres and a bigger-than-ever range . . . all on interest-free terms!

TELEFUNKEN 204E Stereo. Special multiple-function switch controls six different functions, gives greater operating convenience and flexibility of control. Mono and stereo—four track recording/playback, frequency response at 7½ i.p.s., 40-18,000 c.p.s. Two built-in speakers, 6 watts per channel output. Save 20 gns! List price 106 gns., our price 86 gns. or on interest free terms **£22.12.0 deposit and 12 monthly payments of £5.12.10.**

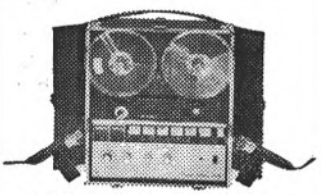


THE SENSATIONAL AKAI 3000D. Superbly engineered, four track, two speed Stereo Tape Deck. High quality, three-head system incorporates all-silicon transistor amplifier.

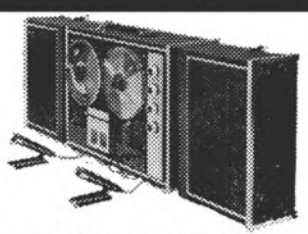
£1 gns. cash, or on interest-free terms, £21.6.0 deposit and 12 monthly payments of £5.6.3.

FREE VINYL COVER worth £7.10.0 to every purchaser of this deck!

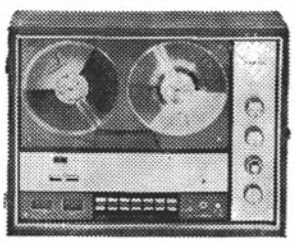
NEW AKAI M9. Now in this country for the first time. Three speeds, 7½, 3¾, 1⅞ i.p.s. Solid state, seven-inch reels, sound on sound facilities, automatic stop, automatic shut-off. Two Vu meters and the famous cross-field head. Frequency response 30-23,000 c.p.s. ±3dB at 7½ i.p.s. Power output 8 watts per channel. £159 or on interest-free terms, £39.15.0 deposit and 12 monthly payments of £9.18.9.



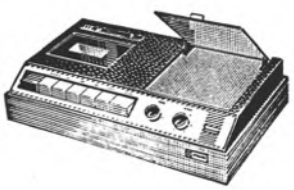
SANYO MR151 Solid State Stereo Tape Recorder. Powered either by batteries or mains, this exciting newly developed Sanyo Model combines all the advantages of a lightweight portable recorder with the performance capability of a large stereo set. Elegant and compact, with three speeds, sound-on-sound facilities. Four track recording and playback, two VU meters. **65gns., or on interest-free terms £17.2.0 deposit and 12 monthly payments of £4.5.3.**



SANYO MR939 Solid State 4-Track 3-speed Tape Recorder. Engineered for superb studio performance and offers professional standard facilities at a sensible price. 4-track mono or stereo recording. Sound-on-Sound and Sound-with-Sound. Two VU meters. Two detachable speakers. Built-in amplifier can be used for P.A. **89 gns. or on interest-free terms £23.8.0 deposit and 12 monthly payments of £5.16.9.**



SANYO MR999 Solid State 4-Track 3-Speed Stereo/Mono Tape Recorder. A really magnificent instrument impeccably styled and finished with 20 watts output power at an incredibly low distortion rate of less than 0.9% at 3 watts. Sound-on-Sound, Sound-with-Sound, two hi-fi speakers. **97 gns. or on interest free terms £25.10.0 deposit and 12 monthly payments of £6.7.3.**



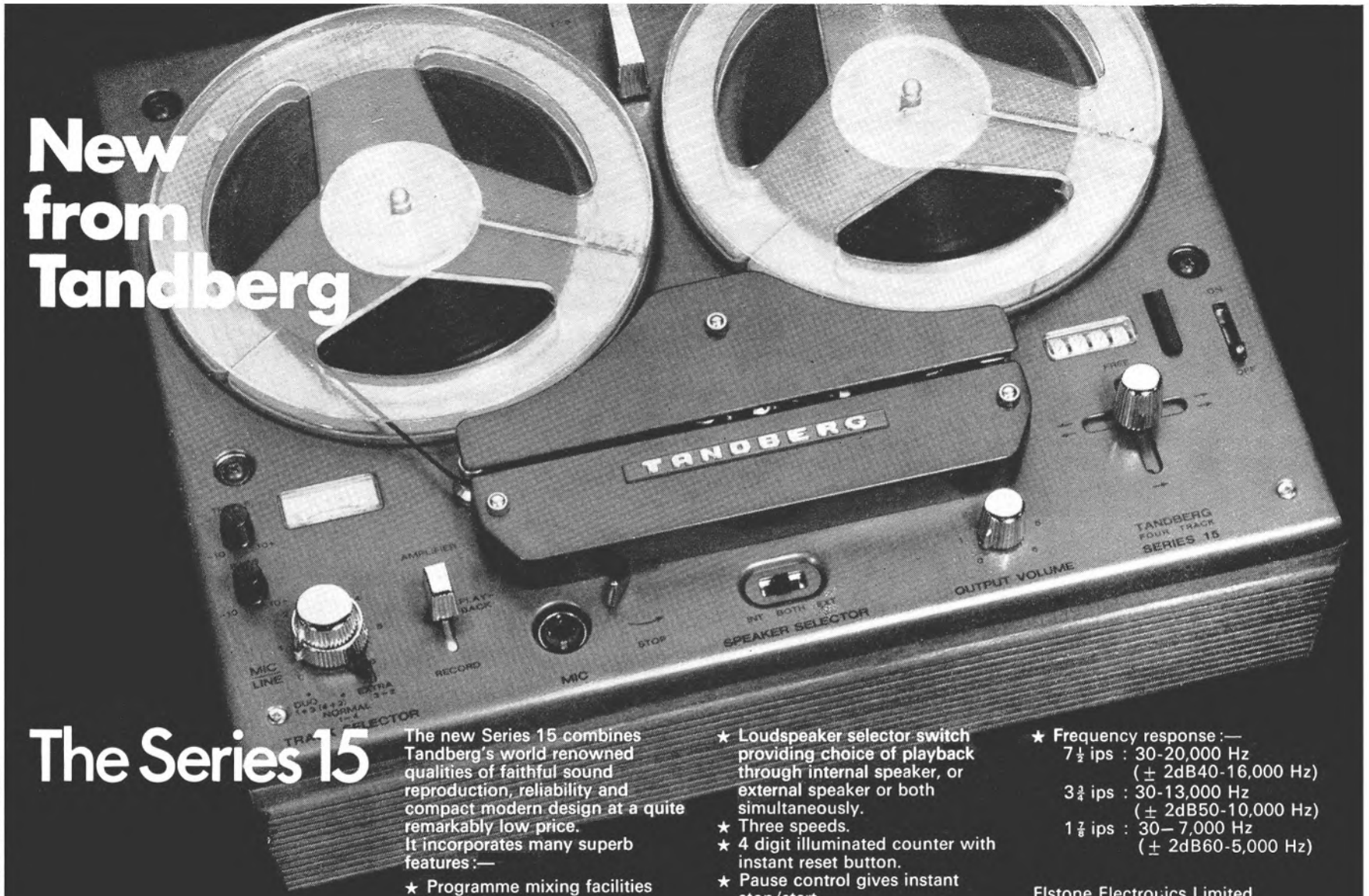
SAVE 10 GNS. Model EL3310 Home Cassette Recorder. List Price 35 gns. ONLY 25 gns. High quality, slim line, 2-track Cassette mains recorder with wide freq. range. Tape speed 1⅞ i.p.s. Housed in teak finished cabinet. **Interest free terms, £6 15s. deposit and 12 monthly payments of £1.2.6. Carr., pkg., ins. 15/-.**

Gt. Britain's Largest Hi-Fi and Tape Recorder Dealers!

Note: All prices and terms are correct at pre-budget press date. Send for current lists or call at either of our two centres. Our ranges include equipment by B & O—FERROGRAPH—SANSUI—REVOX—SONY—DUAL—UHER—BRENELL—AMPEX—etc.

rew **R·E·W (EARLSFIELD) LTD.** ★ **LEADERS IN MAIL ORDER HI-FI** ★

- **HEADQUARTER SHOWROOMS AND MAIL ORDER:** DEPT. TR, 266-8 UPPER TOOTING ROAD, LONDON, S.W.17. *Tel.:* 01-672 8267 or BAL 9175
- **WEST END SHOWROOMS:** 146 CHARING CROSS ROAD, LONDON, W.1. *Tel.:* 01-835 3365 (opposite Astoria Cinema)



New from Tandberg

The Series 15

The new Series 15 combines Tandberg's world renowned qualities of faithful sound reproduction, reliability and compact modern design at a quite remarkably low price.
It incorporates many superb features:—

- ★ Programme mixing facilities with separate controls for microphone and line inputs.
- ★ 10 watts output using an external speaker.
- ★ Volume control for monitoring whilst recording at loudspeaker level.
- ★ Loudspeaker selector switch providing choice of playback through internal speaker, or external speaker or both simultaneously.
- ★ Three speeds.
- ★ 4 digit illuminated counter with instant reset button.
- ★ Pause control gives instant stop/start.
- ★ Separate Bass and Treble lift and cut controls.
- ★ Signal to noise ratio 55db below maximum recording level.
- ★ Frequency response:—
  7½ ips : 30-20,000 Hz (± 2dB40-16,000 Hz)
  3¾ ips : 30-13,000 Hz (± 2dB50-10,000 Hz)
  1⅞ ips : 30—7,000 Hz (± 2dB60-5,000 Hz)

Elstone Electronics Limited,
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Vicar Lane, Leeds 2.

move up to **Tandberg**

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

Send for full leaflet.

only £58/2/10 kit incl. P.T.

Ready-to-use price on request

FOR THIS SPECIFICATION

● ¼ track stereo or mono record and playback at 7½, 3¾ and 1⅞ 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, 3¾ and 1⅞ ips. **Wow and Flutter:** Better than 0.15% rms on 7½ ips; 0.25% rms on 3¾ ips; 0.35% rms on 1⅞ ips. **Tape size:** ¼" wide, Long or Standard play. **Reel Size:** Standard, up to 7"/5¾" spools and tape supplied. **Digital Counter:** 3 digit counter with zero reset. **Heads:** ¼ track erase record and playback. **Microphone:** Moving coil hand microphone (mono) supplied. **Semi-Conductor complement:** 18 transistor, 1 silicon bridge rectifier. **Frequency response:** 3 dB, 40 c/s to 18 Kc/s at 7½ ips. 3 dB, 40 c/s to 12 Kc/s at 3¾ ips. 3 dB, 40 c/s to 7½ Kc/s at 1⅞ ips. **Signal to noise ratio (unweighted):** Better than 40 dB. **Inputs per channel:** Microphone 0.35 mV. Auxiliary 50 mV. **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 Grey and Black Rexine with chrome fittings. **Dimensions:** 19¼" wide x 7⅞" high x 15½" deep.

Latest 12 + 12 watt Stereo Amplifier

TSA-12 (Fully transistorised)

Kit £30.10.0 Ready to use **£42 10 0**

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● 17 transistors, 6 diode circuit ● ± 1 dB, 16 to 50,000 c/s at 12 watts per channel into 8 ohms ● Output suitable for 8 or 15 ohm loudspeakers ● 3 stereo inputs for Gram, Radio and Aux. ● Modern low silhouette styling ● Attractive aluminium, golden anodised front panel ● Handsome assembled and finished walnut veneered cabinet available ● Matches Heathkit models TFM-1 and AFM-2 transistor tuners.

TSA-12 SPECIFICATION: Recommended speaker systems: Cotswold MFS, Berkeley, Avon, SSU-1. **Power Output:** 12 watts rms per channel, 8 ohm loads, 8 watts rms per channel, 15 ohm loads. **Hum and Noise:** Gram.—50O dB. Radio—60 dB.Aux.—60 dB. **Power Response:** 16 c/s to 50 Kc/s, ± 1 dB, 8 c/s to 85 Kc/s, ± 3 dB. **Input Sensitivity and Impedance:** Gram. 5 mV rms. 47 K ohm, Radio 300 mV rms, 180 K ohm. Aux. 300 mV rms. 180 K ohm. **Channel separation:** 45 dB or better. **Harmonic distortion:** (at rated output) 1% or less, 20 c/s to 20 Kc/s. 0.5% or less at 1 Kc/s. **Semi-conductor complement:** 17 transistors, 6 diodes. **Outputs:** 8 and 15 ohm. **Controls:** 6-position source switch, balance control, volume control with switch, bass and treble controls, input level controls. **Power requirements:** 100-125, 200-250 volts, 50-60 c/s, 60 watts at full output. **Dimensions:** 15⅞" wide x 3¾" high x 10" deep.

Attractive low silhouette styling, compact size 3¾" high x 15¾" wide x 10" deep, looks sleek and modern. Use free standing or house in a cabinet.

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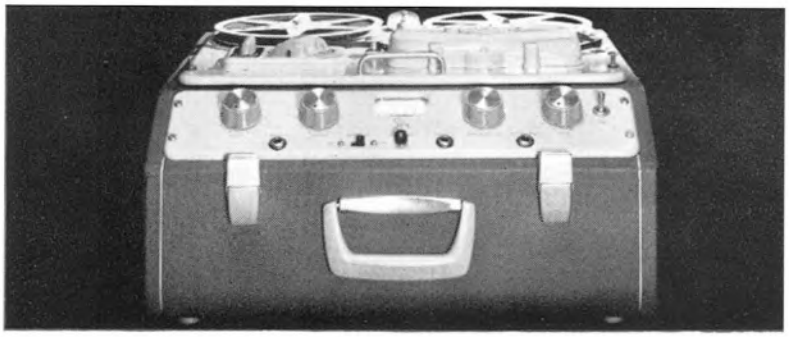
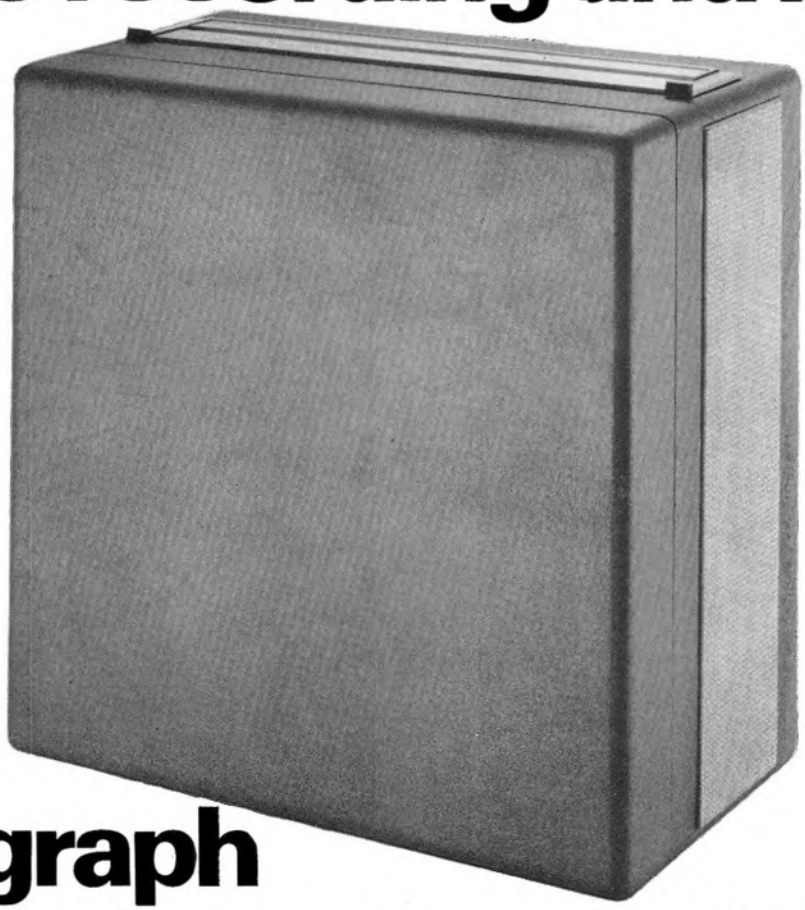
Ferrograph, 1949-1967



Now, another major event in tape-recording and Hi-Fi



Ferrograph New Generation Series 7

the tape recorder with the hearing-is-believing sound

207

Ferrograph quality
Ferrograph reliability
Ferrograph fidelity
plus a unique combination of 30 features

Ferrograph Tape Recorders were the first designed and made in Great Britain—in 1949. Since then they have set the standard of fidelity and unfailing reliability; over the years, Ferrograph have continually improved and added facilities from Series 1 to Series 6, but making no basic changes.

Continuous research and development have now produced a radically new family.

Now, Ferrograph present to you the New Generation, Series 7. Look at its superb new styling, look at its unique range of facilities. As soon as you can, *listen* to it, There is no finer instrument in its class!

To create it, engineers have tested and evaluated every new development. Market research has established what you, the user want by way of facilities —and *all* have been incorporated. Industrial designers have evolved a most appealing presentation and the whole new family is solid state.

Ferrograph New Generation Series 7

This basic Ferrograph instrument is available in Mono, and in Stereo with and without end amplifiers. Each version as a portable, or in elegant hardwood, all with concealed, flush-carrying handles and a new closure design. Every Series 7 instrument is a self-contained chassis-mounted unit, easily fitted into rack or cabinet, easily removed for servicing. Prices from £110.

30 features

Never before **have all these facilities been combined in one tape recorder. Some you know, many you have so far only wished for:**

1. *An entirely new design – with facilities resulting from a study of users' needs gathered over 17 years.*

2. *Modern styling of great functional dignity.*

3. *All silicon solid-state electronics with FET input stages and wide input overload margins.*

4. *Vertical or horizontal operation.*

5. *Unit construction: The 3 individual units i.e. tape deck, power unit and amplifier complex are mounted on a single frame easily removable from cabinet for service or installation in other cabinets or racks.*

6. *3 motors (no belts).*

7. *3 tape speeds.*

8. *Variable speed spooling control for easy indexing and editing.*

9. *Electrical deck operation allowing pre-setting for time-switch starting without need for machine to be previously powered.*

10. *Provision for instantaneous stop/start by electrical remote control.*

11. *Immediate access head block for editing and cleaning.*

12. *Single lever-knob deck operation with pause position.*

13. *Independent press-to-record button for safety and to permit click-free recordings and insertions.*

14. *Adjustable reel height control.*

15. *Damped tension arms for slur-free starting.*

16. *8¼" reel capacity.*

17. *Endless loop cassette facility.*

18. *Provision for signal operated switching units.*

19. *Internal loud speakers (2) – 1 each channel on stereo, 2 phased on mono.*

20. *4 digit, one-press re-set, gear-driven index counter.*

21. *2 inputs per channel with independent mixing (ability to mix 4 inputs into one channel on stereo machine).*

22. *Signal level meter for each channel operative on playback as well as record.*

23. *Tape/Original switching through to output stages.*

24. *Re-record facility on stereo models for multi-play, echo effects etc., without external connections.*

25. *Meters switchable to read 100 kHz bias and erase supply with accessible preset adjustment.*

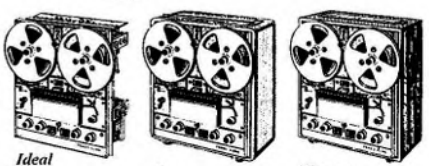
26. *Three outputs per channel i.e.* (1) *line out – level response.* (2) *line out – after tone controls.* (3) *power output – 8-15 ohms.*

27. *Power output 10W per channel.*

28. *Independent tone controls giving full lift and cut to both bass and treble each channel.*

29. *Retractable carrying handle permitting carrying by one or two persons.*

30. *Available in several alternative presentations.*



Ideal for rack mounting | *Grey vinyl case* | *Elegant hardwood case*

Please see next page for Ferrograph stockists

FERROGRAPH

the tape recorder with the hearing-is-believing sound

Listen for yourself

To *know* the Ferrograph New Generation Series 7 you must look at it, listen to it, for yourself. You will find New Generation instruments soon in stock at many of the best tape-recording and Hi-Fi specialists in the country, including the following:

Ferrograph stockists

LONDON AREA

CHISWICK
Masseys Centre of Sound
121/123 *High Street, W.4.*

HOLBORN
Tape Recorder Centre
82 *High Holborn, W.C.1.*
Larg's of Holborn Ltd.
76/77 *High Holborn, W.C.1.*
Imhofs Ltd.
New Oxford Street, W.C.1.

PADDINGTON
Teletape Ltd.
33-59 *Edgware Road, W.2.*

RICHMOND
F. Cave
27 *Hill Street*

STREATHAM
Francis of Streatham
169/170 *Streatham High Road, S.W.16.*

TOOTING
R.E.W. (Earlsfield) Ltd.
266 *Upper Tooting Road, S.W.17.*

TOTTENHAM COURT ROAD
Telesonic Ltd.
92 *Tottenham Court Road, W.1.*

ABERDEEN
C. Bruce Miller
51 *George Street*

BANSTEAD
Raylec Ltd.
43 *Buff Parade, High Street*

BATH
C. Milsom & Son
Northgate

BIRKENHEAD
James McKenzie Ltd.
Grange Road West

BIRMINGHAM
C.H. (High Fidelity) Ltd.
167/169 *Bromsgrove Street, 5.*
Griffin Radio Ltd.
94 *Bristol Street, 5.*
C. H. Young Ltd.
170 *Corporation Street, 2.*

BLACKBURN
Holdings of Blackburn Ltd.
39/41 *Mincing Lane*

BLACKPOOL
F. W. Benfell Ltd.
17 *Cheapside*

BOGNOR REGIS
Tansley & Cooke Ltd.
Sandymount Avenue

BRIGHTON
Averys
77 *St. James's Street*
Lanes Radio
11 *Gardiner Street*
John King Films Ltd.
East Street

BRISTOL
Sound Selection
361-363 *Gloucester Road, 7.*
Audio Bristol Ltd.
Park Street Avenue
Bristol & West Recording Services Ltd.
6 *Park Row, 1.*

BOURNEMOUTH
Tape Recorder Co. (B'mouth) Ltd.
374 *Old Christchurch Road*

CAMBRIDGE
H. S. W. Speechley & Co.
25 *High Street, Linton*

CARDIFF
Sound Film Services
27 *Charles Street*

CHELTENHAM
University Audio
24 *Winchcombe Street*

CHESTER
Lloyd & Wylie Ltd.
42 *Bridge Street*

CHICHESTER
G. A. Colbourne Ltd.
10 *Southgate*

CREWE
Charlesworth (Crewe) Ltd.
14 *High Town*

DERBY
Victor Buckland Ltd.
41/49 *London Road*

EDINBURGH
J. Nicolson
1 *Haddington Place, 7.*

GERRARDS CROSS
Edric Films Ltd.
34/36 *Oak End Way*

GLASGOW
C. H. Steele
141 *St. George's Road, C.2.*

GOODMAYES
Unique Radio
6 *The Facade*

GUILDFORD
P.J. Equipment
3 *Onslow Street*

ILFORD
Ilford Music Shop Ltd.
Pioneer Market, Ilford Lane

BARKING
Davis & Kays
21 *London Road*

KIRKCALDY
Caithness Brothers
270 *High Street*

LEEDS
Becketts Film Services Ltd.
The Headrow, 1.
P.W.B. Audio Ltd.
33 *Call Lane*

LEICESTER
United Film Services
7 *Kings Street*

LIVERPOOL
Beaver Radio Ltd.
60 *Whitechapel*

MANCHESTER
Godleys Radio & T.V. Ltd.
8 *Shudehill*
Lancs Hi-Fi Ltd.
8 *Deansgate, 3.*
Kendal Milne Ltd.
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Turners Ltd.
Pink Lane

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Pelham Street

OXFORD
Westwoods
45 *George Street*

PLYMOUTH
A. E. Ford Ltd.
84 *Cornwall Street*

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McKenna & Brown Ltd.
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348 *Great Cheetham Street East, 7.*

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4 *Bargate Street*

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Wayfarers Radio Ltd.
Burton Arcade

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Daytronics Ltd.
119*a High Street*

TORQUAY
D. & B. Davies Ltd.
Castle Chambers, Union Street

WATFORD
E.M.E. (Watford) Ltd.
188 *Queens Road*

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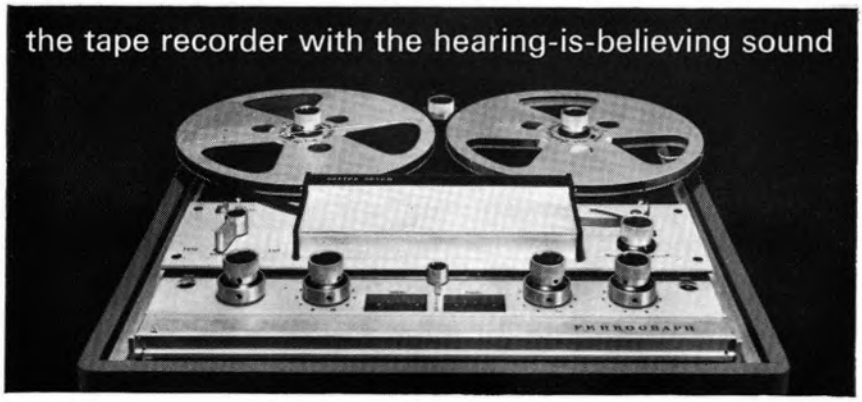
Bowers & Wilkins Ltd.
1 *Beckett Buildings, Littlehampton Road*

FERROGRAPH

If none of these is near enough to you, in case of difficulty, or for free literature, send us the coupon, or give us a ring on WATerloo 1981.



To The Ferrograph Co Ltd
Ferrograph House
84 Blackfriars Road London SE1
Please send me a free brochure on the Ferrograph New Generation Series 7

NAME .....

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T.R.

tape recorder

MAY 1968 VOLUME 10 NUMBER 5

INCORPORATING
SOUND AND CINE

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COVER PICTURE

A stage in the production of Tandberg recorders is illustrated on this month's cover. Spool turntables are here seen undergoing run-out tests before being forwarded to the assembly lines. Other aspects of Tandberg technology and sociology are described on page 222.

SUBSCRIPTION RATES

Annual subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 36s. and 41s. respectively. Overseas subscriptions are 38s. 6d. (U.S.A. $4.60) for *Tape Recorder* and 42s. 6d. (U.S.A. $5.10) 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.**

"IN TERMS OF PERFORMANCE, however, it makes the rest seem toys." Such was the praising conclusion reached in this journal some 12 months ago during a review of a recently discontinued stereo tape recorder. The importer of that model seized upon this, and other equally glowing comments from other journals, and pushed the sentence as hard as he could through the medium of advertising, causing some vexation amongst other manufacturers. In much of this advertising the importer was honest enough to include the word "however" —particularly important in the context of the original review since the preceding paragraphs had contained criticism of the recorder's physical features.

Despite its phono sockets, *despite* the VU-meters, *despite* the absence of a damped pause control and *despite* the obligatory delay on the second channel of any attempted multi-track recordings, this recorder was one of the best and most versatile available to the non-professional.

Looking at other recent machines from various manufacturers, we appear to have reached the situation where tape recorder designers are so far removed from the practical needs of creative and hi-fi minded customers that expensive and well-conceived mechanisms and circuitry are being thrown to waste by pathetic lack of attention to track selectors and output wiring.

The ability to reproduce Channel-A while recording on Channel-B is inherent in all stereo recorders and 'preamps-only' tape units. Even the few with combined output stage and oscillator circuits are capable of powering headphones somewhere along the line. What, then, is the sense of muting the replay circuit of Track-B when recording on Track-A? Nothing is technically more purposeless or infuriating, to the multi-track musician, than to find himself unable to monitor his first recording when preparing to make his second. Search where he might, neither the external loudspeaker socket nor the fixed-level headphone outlet remain in circuit, the duplicated DIN and phono line outputs being similarly barren.

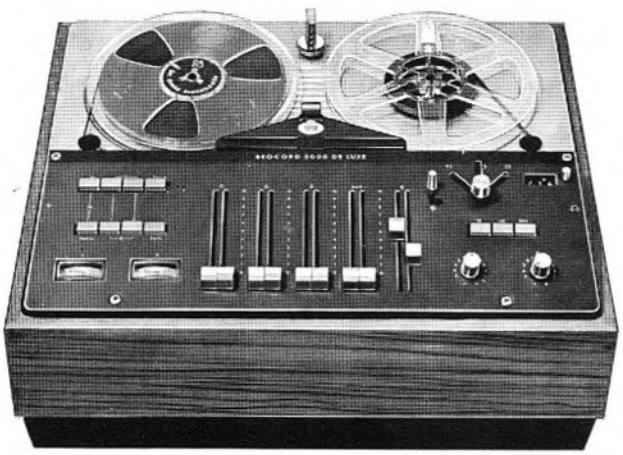
We recently experienced these limitations with an otherwise excellent Japanese stereo recorder. Finding this model useless for our purpose, we turned to a second model from an equally reputable manufacturer, our incredulity growing to consternation when we found this too to be incapable of these simple tasks.

Why, the pro-European reader may ask, were we using Japanese equipment in the first place? The simple answer is that these were the only stereo models to hand with integrated record/play heads. We might otherwise have chosen their bench-mate, a Scandinavian recorder offering almost every imaginable facility that sensible switching can provide, but the multi-track features on this were rendered unusable by the presence of separate record and replay heads. Like all such recorders, it employed the technique of monitoring Track-A from the playback head while taping Track-B some hundreds of milliseconds behind at the staggered recording head.

When can we expect to see a stereo recorder with off-tape monitoring and a *workable* multi-track recording facility in which the unused record head segment may be connected to the replay chain while the opposite track is being recorded? While attending to this, designers might pay closer attention to the 'live/off tape' comparison switch. All too often, a sharp increase or decrease in volume accompanies the switching movement, making detailed comparison very much more difficult. Merely a question of pre-set adjustments.

A Great New Feature will be offered at the Audio Fair by *Teac*. Not so much the result of extensive research—more an obvious rearrangement of existing switch wiring. The facility is that of stereo echo "for recording mania looking for special sound effect". Who, we wonder, are the maniacs?

Is it possible for all these features to be concentrated in ONE tape recorder?



Yes, the BEOCORD has them all!

- Built-in 4-channel mixer section with twin slide potentiometres
- Records on 2 tracks. Plays back on 2 and 4 tracks.
- Trick recordings: Multiplay, sound-on-sound, synchro playback, echo
- Usable as microphone-amplifier during tape replay
- 3 tape speeds
- 2 illuminated recording-level indicators
- Tape control lever
- 4 Bogen heads
- Monitoring
- Instant pause control
- Slack absorbers
- External impedance switches
- 3 replaceable pre-amplifiers
- DIN standard inputs and outputs
- Input and output sockets on base of cabinet
- 2 separate 8-watt output amplifiers
- Automatic stop for tapebreak and end of tape
- Sockets for two pairs of speakers
- Amplifier can be used with motor switched off
- Separate bass and treble controls
- Headphonejack
- Low-impedance microphone input, balanced
- Line input and output, (tape-copying channel)
- Tape index counter
- Voltage switch
- Fully transistorized

A highly advanced tape recorder with professional wow and flutter specifications, crystal clear reproduction, and ample volume output, the Beocord 2000 de Luxe is designed for the exacting audiophile who insists on unlimited possibilities in trick and sound-on-sound recordings etc. The Beocord 2000 de Luxe ranks among the five highest priced semiprofessional tape recorders in the world. It ought to be the highest priced of them all!

Bang & Olufsen
U.K. Sales Division
Eastbrook Road
Gloucester

London Showrooms
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London W1

Solomon & Peres
67/69 Ann Street
Belfast 1

BANG & OLUFSEN A/S BY APPOINTMENT TO THE ROYAL DANISH COURT

B&O Det danske kvalitetsmærke

- for those who consider design and quality before price

WORLD OF TAPE

TAX ON TAPE RECORDERS

"IN addition, I propose to bring within the scope of the tax tape recorders, which will join gramophones at 33⅓%, pre-recorded tapes to join records at 50%, and still and cine projectors to join cameras and other photographic goods, also at 50%. I think this is a wholly justified extension, and that many people will be surprised to know that these goods have so far escaped tax. All these changes both of rate and of scope of purchase tax will apply from midnight tonight."

This extract from the March budget speech is having a profound effect on the audio market, particularly in view of the recent devaluation. Prices quoted in the editorial and advertising pages of this issue are subject to increase, probably in the 20% to 25% region since the tax applies to the manufacturer's price—not the price charged by the retailer.

PHILIPS 'MAJOR' CASSETTE

THE background music rental scheme which has been run by *Peto Scott* for several years is now being extended to cassettes. A new cassette system has been developed by *Philips* for the scheme and employs conventional ¼ in. (6.25 mm.) tape enclosed in a plastic container. Reels in the *Major Cassette* are wound on plastic spools but the external appearance resembles the smaller *Compact Cassette*. Four two-hour tracks are available at a 1⅞ i/s (4.75 cm/s) tape speed, the basic *LGC 2000* player having a claimed frequency response of 100 Hz-10 kHz ±3 dB and a 46 dB signal-to-noise ratio. A 24 V socket is incorporated in the player from which a projector or other sales device may be controlled. The unit may be controlled through a time switch if desired and also used to relay live or recorded sales messages. It is available on hire or for outright purchase.

B & O INCREASE PRICES

PRICES of *Bang & Olufsen* audio equipment have been increased, partly as a result of devaluation. The *2000 K D/L* stereo is now £145 with plinth mounting, while the *2000T L/D*, in portable cabinet, costs £150. The *1500 D/L* stereo tape unit now costs £110, while the mono *1100K* is £80.

Debenhams Electrical and Radio Distribution Ltd., importers of B & O equipment, have reformed under the name *Technomark* and are also now handling *Radford* audio equipment Their address remains *Eastbrook Road, Gloucester*.

PYE COMBINE WITH PETO SCOTT

PYE T.V.T. Ltd. is the name of a new organisation formed by the merger of *Peto Scott* with an existing *Pye* company. Both companies are now owned by the Dutch *Philips* group and will combine their experience in catering for audio, closed circuit television and broadcasting markets.

SCOTTISH SERVICING

TAPE Recorder Maintenance Ltd. have now added a Scottish branch to their group of London and Southampton premises. The new company will be known simply as *Tape Recorder Maintenance (Scotland) Ltd.* and is situated at 48 Carlton Place, Glasgow, C.5 (Telephone 041-429-4432). Comprehensive servicing facilities are offered to owners and retailers of tape recorders and dictation machines.

TAPE AT THE APAE

THE twentieth International Public Address Exhibition was held at the King's Head Hotel, Harrow, from 12th to 14th March. Among the exhibitors were *Lustraphone*, *Reslosound* and *Shure*, displaying their ranges of microphones, stands and public-address accessories. *Grampian*, *AKG*, *Sennheiser*, *STC* and *Fi-Cord* microphones were also on show. Messrs. Desmond and Fisher (respectively representing *Audio and Design* and *STC*) supplemented their exhibits with lectures on "Gun Microphones" and "Noise Cancelling Microphones". Automatic gain control techniques appeared to have reached the P.A. fold in the form of a *Level Loc* unit shown by *Shure*. This is said to maintain sound level when a lecturer or speaker is wobbling from side to side of a microphone.

NEXT MONTH

RECORDING FOR RADIO is the first in a series of articles by Peter Bastin, to appear in our June issue. BBC interviewer Arthur Garratt will describe the techniques of sound reporting, while Mary Alderton takes an informed look at commercial language tapes.

FI-CORD TO EXHIBIT AT EASTBOURNE

AN induction loop teaching system is to be shown by *Fi-Cord International* at the *Itex '68* exhibition from 21st to 24th May. The complete system comprises a tape recorder, audio amplifier, loop installation, and *Beyer* headsets. Each headset incorporates a receiving coil and preamplifier to receive audio signals radiated within the loop. Cost of a typical system would be in the £350 region.

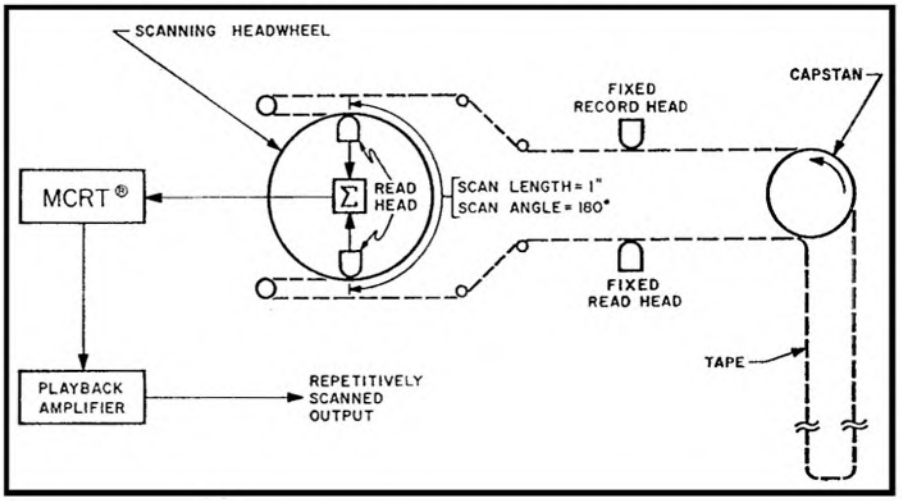
Itex '68 will be held at the Winter Gardens Pavilion, Eastbourne.

BETTER SOUND FROM THE BBC

"BETTER Sound" is the title of a *Radio 3* series commencing on 3rd May and covering the three subsequent Fridays. The first broadcast will describe aspects of radio transmission and reception while the second is concerned with acoustics. Aspects of mono and stereo music reproduction will be examined in the third week, the last Friday being devoted to tape recording. Donald Aldous (*Audio & Record Review*), John Borwick (*The Gramophone*) and John Crabbe (editor of *Tape Recorder* and *Hi-Fi News*) will be among the speakers. A related booklet is available from *BBC Publications*.

NEW MAGNETIC TAPE SYSTEM

A NEW magnetic tape system *Bi-Scan* has been developed by the *Himmelstein Company* of Illinois, USA, to simplify the analysis of random and transient signals. Recordings may be made at 240, 120, 60, 30, 15 or 7½ i/s on loops of 36 in. or greater length, maximum loop rate being 6.7 Hz at 240 i/s. Playback may be through a fixed head with the tape moving conventionally, or by means of a rotating head scanning stationary tape. The head wheel rotates 60 times per second, a thin air film being retained within wheel and tape to eliminate wear. The *Impellor II* employs an entirely pneumatic loop transport in place of mechanical pinch wheels and tension devices. It may be used independently of the scanning wheel for FM audio and wide-band data recording. Headwheels are available in various sizes with scanning lengths up to 8 in. (20 cm.). One dual-channel plug-in headwheel is supplied with the system, capable of reading ½ in. (12.5 mm.) tapes recorded in *Irig* FM format. Its scan length is 1 in. (2.5 cm.).



We'd like you to say a few words...

TK247 de luxe: solid state stereo. Four-track, two-speed. (21 transistors, 4 diodes.) Facilities for complete stereo playback *and* recording. Multi-synchronous recordings and monitoring through built-in speakers or headphones. 2×4W output stages, 4 speakers. Transfer mixing control. Wow and flutter ± 0.12% at 7½ i.p.s., ± 0.15% at 3¾ i.p.s. Frequency response 40-16,000 Hz at 7½ i.p.s. Illuminated VU input meters. Automatic tape stop. Up to 8 hours' playing time per spool. Stylish cabinet in graphite and silver steel trim.
Price: 122 gns.

TK2200: perfect-recording playback anywhere.
Fully transistorised. (18 transistors, 9 diodes.) Two contra-rotating flywheels to stabilise tape speed. Brushless DC motor. Wow and flutter ± 0.4% at 1⅞ i.p.s., ± 0.25% at 3¾ i.p.s. Frequency response 40-15,000 Hz at 3¾ i.p.s. Takes 5" spools. Recordings can be monitored. Remote control stop/start from microphone. VU recording level meter, automatic stop, etc. Converts to mains supply using Grundig's TN12 power pack.
Price: 92 gns.

C200: Grundig precision in a portable recorder.
Fully transistorised. (12 transistors, 3 diodes.) Unique, reliable brushless DC motor. Reproduction of VHF quality. Cassettes give up to 90 minutes' playback. Easy-G control: stop, start, pause, fast forward/rewind, and cassette ejection. Plus recording level control, and continuously variable tone control. Frequency response 80-10,000 Hz; wow and flutter ± 0.4%; output power 800mW. Vertical or horizontal operation. Features the "Instrument Look." Sockets for external power supply, extension speaker, remote control, etc. Weighs only 4½lb.
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TR6

TAPE TRANSPORT MECHANISMS

Part 2 Capstan and flywheel

By G. T. ROGERS

IN the first part of this series I illustrated some of the principal factors concerned in the construction of a tape transport system and also shed some light on why it is necessary for the tape to be driven over the head assembly at a constant speed. This month I shall discuss the capstan and show how its diameter is related to the general design of the deck, the type of capstan motor used and the power transmission employed. I shall also show how the flywheel helps to maintain smooth rotation of the capstan and tape drive by absorbing certain speed irregularities which are present.

The function of the capstan is to drive the tape at an unwavering linear speed. The capstan has a circular motion and so it is necessary to rely on friction between the surfaces of the capstan and tape, together with friction between the surfaces of the pinch-wheel and tape, so that the latter can be pulled in a linear fashion. Let us start by looking a little more closely at this.

Fig. 1a shows a simple arrangement where the tape lies in a direct line which passes through the point of contact between the capstan and pinch-wheel. Assuming that the tape has negligible thickness and that neither it nor the pinch-wheel can be compressed, this system would only allow the tape to make contact at a single point which of course is the point of contact between the capstan and pinch-wheel. In practice, however, the elasticity of the pinch-wheel and tape, and the latter's finite thickness, which can vary between 47 microns for a standard tape to 18 microns for a triple play tape, mean that the area of contact is somewhat magnified as in **fig. 1b.** To a certain extent this increases the friction between the tape on the one hand and the capstan and pinch-wheel on the other, and traction of the tape would be possible. However, slippage, which inevitably occurs with a capstan drive, would be high, causing the long- and short-term speed variations that we discussed last month. Furthermore, increase in the diameter of either the pinch-wheel or capstan has little if any useful effect on the frictional drive force since the area of contact is so small.

A better arrangement, and one which has been used in some high quality machines, is shown in **fig. 2.** The tape guide **A** ensures that the tape wraps *round* the capstan and therefore makes contact with that part of its circumference from **C** to **X, X** being the point at which the capstan and pinch-wheel meet. The guide **B** acts in a similar way and ensures that the tape makes contact with the pinch-wheel beyond **X** to **D.** The advantage of this system is obvious if one remembers that the tape is driven by frictional forces which are directly related to the *area* of contact.

To make use of the friction between the tape and pinch-wheel it is essential that the latter is made to revolve to *drive* the tape and not be driven *by* the tape. To do this the pinch-wheel is machined wider than the tape width so that the capstan is actually in contact with it at the upper and lower edges. The capstan then drives the pinch-wheel by friction at the point **X** in **fig. 2.** With this system the frictional forces are greatest at the point where the capstan and pinch-wheel meet and fall off as the points **C** and **D** are approached.

Applying elementary geometrical principles to this system, we can easily see that if the diameter of the capstan is increased there will be a greater area of tape in direct contact with it, assuming that the tape guides are fixed in position. Similarly, the area of contact between the tape and pinch-wheel depends on the diameter of the latter. Hence the larger the diameter of the capstan and/or pinch-wheel the better the grip on the tape, the smaller the slippage and the better the performance.

Fig. 2 also shows the importance of the position of the tape guides. When the guide is at **B** the area of contact is from **X** to **D** as we have seen. The tape between the guide and **D** lies in a straight line and meets the pinch-wheel at a tangent at **D** where the angle **ODB** is 90°. When the guide is moved to **F** the area of contact is increased from **X** to **E** where the angle **OEF** is 90°.

In practice the position of the tape guides is governed by the size and arrangement of the deck and the maximum spool size to be accommodated. It is also important to avoid causing an unnecessary deflection in the path of the tape as it passes over the guides since this will increase friction and tend to cause a jerky transport. In all conventional tape recorders traction of the tape, by friction, depends on the capstan working efficiently and it can only do this if the pull from the take-up reel more or less balances the drag from the supply reel. I have already explained in Part 1 the importance of the correct tension on the tape and we saw that the capstan acts like an accurate metering device.

(*continued on page 217*)

FIG. 1

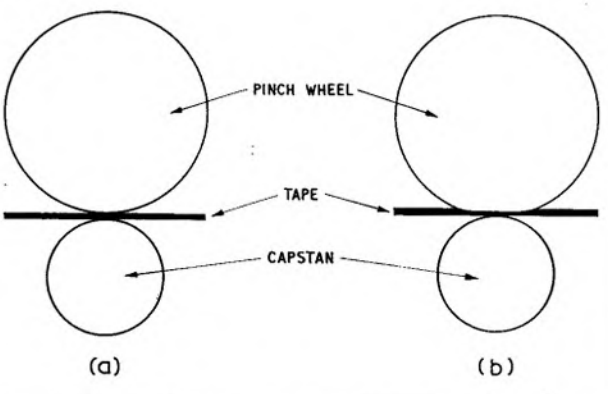
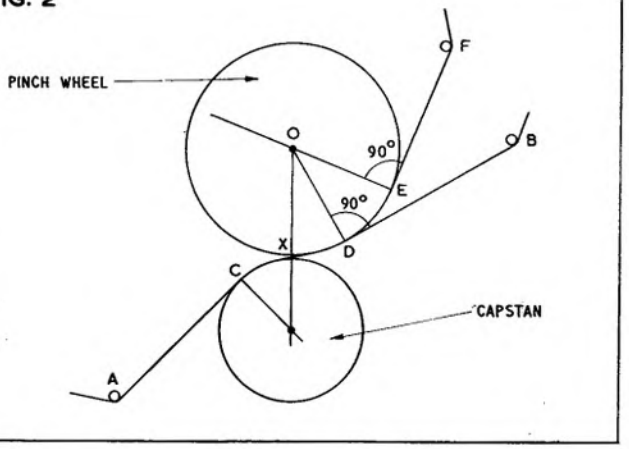


FIG. 2



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Beocord 2000 K De Luxe	32 16 3	8 4 1	125
Beocord 2000 T De Luxe	33 17 3	8 9 4	129
Akai X300	48 11 3	12 2 10	185
Akai X355	62 14 9	15 3 9	239

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Fidelity Playtime 4 ...	7 1 9	1 15 6	27
Fidelity Playmatic 4	8 2 9	2 0 9	31
Elizabethan LZ34 ...	8 18 6	2 4 8	34
Ferguson 3218 ...	8 18 6	2 4 8	34
Ferguson 3222 ...	9 3 9	2 6 0	35
Philips EL4305 ...	9 9 0	2 7 3	36
Telefunken 201 ...	9 17 0	2 8 4	37
Grundig TK140 ...	10 2 2	2 10 7	38½
Philips EL4306 ...	11 0 6	2 15 2	42
Ferguson 3214 ...	11 11 0	2 17 9	44
Truvox 44	12 6 9	3 1 9	47
Ferguson 3216 ...	12 17 3	3 4 4	49
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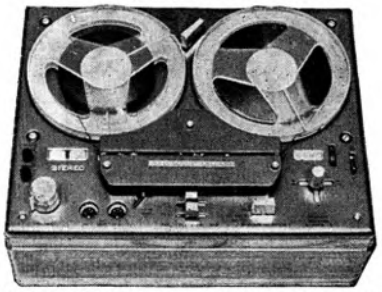

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Sony TC350	19 13 9	4 18 6	75
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Beocord 1500 De Luxe	25 9 3	6 7 4	97
Tandberg 64X ...	33 18 0	7 10 0	118
Revox 77CS ...	36 19 0	9 1 8	139
Revox 77CSVV ...	41 19 0	10 8 4	159
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TAPE TRANSPORT MECHANISMS

CONTINUED

We have also seen how a capstan with a large diameter has a better grip on the tape with less tendency for slippage. Another advantage of larger diameter capstans is that they are more robust. Furthermore, any eccentricity that might be present in the capstan will have a less serious effect on the performance if a large diameter is used. To understand this let us assume that we have the choice of two capstans, one 9 mm. and the other 2 mm. in diameter. Now assuming that no more than 0.2% variation in speed is permitted, we can easily calculate the maximum deformation allowed in each capstan by multiplying the circumference by 0.002. For the larger capstan this works out at 57 microns compared with 13 microns for the smaller. In practice the amount of deformation allowed would be considerably smaller than the figures arrived at here, since capstan eccentricity is by no means the only cause of speed fluctuation.

So far we have talked about two important advantages of a capstan having a large diameter ; however, there is one major drawback to its use which is very much concerned with overall speed constancy in the tape drive. For any given tape speed a larger diameter capstan has to be driven at a slower speed than a thinner capstan. This is shown by the formula ; Tape speed $= xC/60$ centimetres per second, where x is the speed of the capstan in r.p.m. and C its circumference in centimetres. This means that the tape speed is directly proportional to both the speed of the capstan x and its circumference C. So if we increase the diameter of the capstan (remember that circumference is related to the diameter by $C=\pi d$) we will have to reduce its speed so that the linear tape speed remains constant. The drawback of a large capstan arises since it is considerably more difficult and costly to reduce speed fluctuations in a slow-speed spindle.

To discover why this is so let us explain the part played by the *flywheel* in smoothing out fluctuations in the capstan motor speed and suppressing any irregularities in the tape feed generally. It does this by virtue of the fact that it possesses *inertia* a property which resists any force which attempts to move an object or change its existing motion. The energy of a flywheel can be equated to the formula $\frac{1}{2}m\omega^2$ where m is the mass of the wheel and w its speed. With any given flywheel, this formula tells us that its mass will produce only a quarter of the energy at half the speed, and only a sixteenth as much energy at a quarter of the speed. The thing to remember here is that as the *speed* or *mass* of the flywheel is *increased* its effectiveness in smoothing speed variations (which depends on the energy or momentum of the wheel) is very much improved.

Let us consider an example where the tape is unevenly spooled on the supply reel and catches on the reel cheek. This will cause an uneven pull on the capstan which will tend to slow it down intermittently. One of the functions of the $\frac{1}{2}m\omega^2$ in the flywheel is to compensate for this change in capstan load before it has a chance to alter the speed.

From what we have said so far one may argue that a large diameter capstan (slow speed) could be coupled with advantage to a slow but heavy flywheel. While this is true, there are limitations in weight and size of the wheel which are dependent on the size and arrangement of the deck mechanism. For instance, a large heavy flywheel would have to be attached to a really sturdy capstan spindle with bearings designed to take the load without undue wear. A heavy powerful motor would also be required which would need a large space under the deck. All these things tend to be expensive. In some machines, particularly those in the professional studio class, large heavy flywheels are in fact used with a large diameter capstan, but here cost, size and weight are factors of secondary importance to performance and reliability.

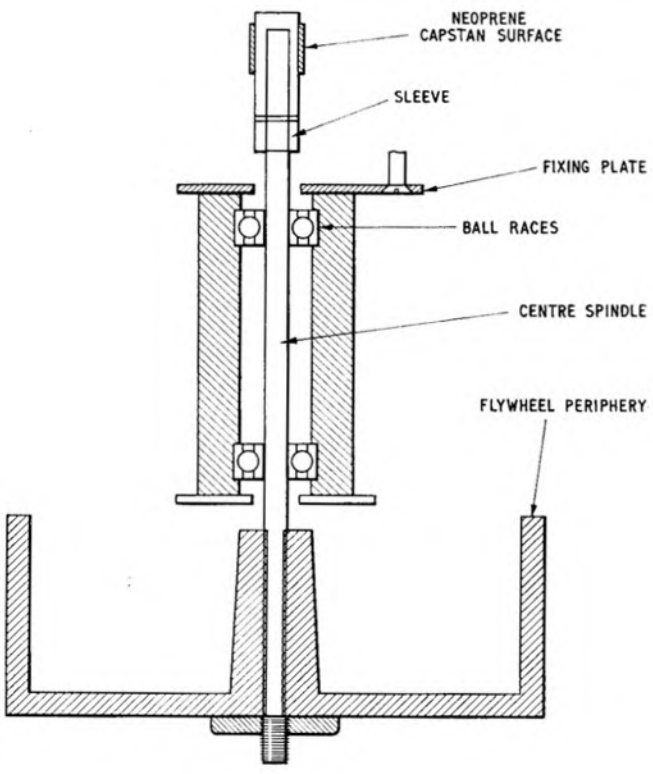
The velocity of the flywheel is greatest at the periphery and diminishes as we go towards its centre. This fact can be used to advantage in domestic and portable tape recorders, where weight and cost are limiting factors in design. In these recorders the flywheel is constructed so that most of its mass is situated near the edge as shown in **fig. 3.** The principle is also used in the *Papst* motor (see Part 1) where the rotor, revolving around the *outside* of the fixed stator, has considerably more flywheel action than that used in the conventional types of motor. In all flywheels, whatever their size or weight, it is important that they be accurately balanced—especially if the recorder, and hence the flywheel, is operated in a vertical position. In this case the effect of gravity will be such that any unevenness in the weight distribution of the wheel will cause alternate slowing and speeding and therefore introduce wow into the system.

In practice the choice of capstan diameter is always a compromise between a better grip on the tape on the one hand and less wobble effects (from a large slow capstan) and on the other, better overall speed constancy resulting from more efficient flywheel action from a thin fast capstan. The choice will to some extent depend on the size and quality of the deck which, as we have seen, is related to cost. If the deck is large and strong enough, a large heavy flywheel can be used which may have sufficient inertia to smooth out speed fluctuation in a large capstan with a slow speed, whereas in a smaller deck, a higher speed would be desirable so that full advantage could be taken from a smaller and lighter flywheel. A corollary of what we have said so far about the capstan and flywheel is that the mechanical performance of a tape recorder design can be improved by using a higher tape speed. This will of course give a faster flywheel without any reduction in the diameter of the capstan and this is one of the reasons (reduced HF distortion is another) why high quality machines are made to operate at 7½ i/s (19 cm/s) or even 15 i/s (38 cm/s).

When the drive motor is directly attached to the capstan spindle its speed of course directly determines the size of the capstan. We shall have more to say about tape recorder motors next month, but it will be useful at this stage to note that the speed of the motor

(*continued on page 229*)

FIG. 3



audio fair '68

HOTEL RUSSELL April 18th-21st

Trade Name	Booth	Dem. Room	Office or Lounge
Acos	77	461	—
Agfa-Gevaert	37	353	318
Akai	8	563	544/562
AKG	88	237	205
Ampex	5	536	505/535
Arena	34	156	114
Armstrong	80	538	539
Audio and Design	65	356	314
Audio & Record Review	81	—	246
Audio Technica	43	202	201
BASF	55	149	162
BBC	Ground Floor		
Beyer	58	215	214
Braun	57	253	254
Brenell	89	242	243
BSR	70	259	216
Celestion	22	534	532/533
Chilton	59	354	—
Connoisseur	83	548	546
Decca	3	648	650
Design Furniture	10	140	138
Diamond Stylus	40	450	451
Dual	72	147	148
Dynatron	35	236	235
Elcom	78	249	—
Electrical & Electronic Trader	75	—	—
Elizabethan	68	258	—
E.M.I.	21	302	301
Ferranti	76	261	—
Ferrograph	53	134	133
Fisher	4	637	639
Garrard	71	234	232/233
Goldring	93	402	401
Goodmans	45	434	405/432/433
The Gramophone	—	—	444
Grampian	38	—	141
Grundig	69	634	633
Hi-Fi News	81	—	244
Hi-Fi Sound	56	—	344
High Fidelity Magazine	86	—	—
Jordan-Watts	30	448	—
KEF	92	542	543
Leak	54	104	137
Lowther	1	204	239/240
Lugton	—	—	250/251
Lustraphone	79	145	—
Medley Musical	39	—	—
Mikrofonbau	41	—	—
Miniconic	26	540	—
Mullard	36	350	351
Multicore Solders	62	—	—
Oki	33	255	—
Ortofon	51	647	—
Parmeko	82	358	315
Philips Hi-Fi	23	336	335
Philips Tape Recorders	25	337	339
Pioneer	9	316	317
Quad	90	604	640
Radionette	31	256	217
Recordaway	20	—	—
Record Housing	29	442	443
Records & Recording	66	—	—
Reslo	15	348	362
Revox-Studer	19	649	646/662
Richard Allan	27	642	644
Richardson	74	359	—
Rogers	48	602	601
Sansui	28	159	118
Sanyo	73	342	340
Scotch	60	347	—
Sennheiser	63	355	—
Shure	91	404	439/440/449
Sinclair	46	248	—
Slot Stereo	52	661	—
SME	61	—	—
Sonotone	49	154	—
STC	6	—	—
Stentorian	85	304	305
Stereosound	32	155	—
Tandberg	24	504	—
Tannoy	67	547	550/551
Tape Recorder	81	—	244
Tape Recorder Spares	84	160	115
Tape Recording Magazine	—	—	343
Teac	7	349	—
Telefunken	47	247	262
Teleton	64	158	—
Thorens	50	—	—
Transcriptors	17	—	—
T.R.D.	16	447	462
Trio	42	260	—
Truvox	94	636	605
Uher	44	361	—
Vortexion	2	334	333
Wharfedale	87	502	501/549
Williman	—	—	346
Wilmex	—	—	363
Wireless World	75	—	—
Yamaha	18	153	116

OUTSIDE SHOWS

Trade Name	Location
Bang & Olufsen	Tavistock Hotel
Centre of Sound	Bonnington Hotel
Heathkit	Grand Hotel
Howland-West	President Hotel
Mastertape	Bedford Hotel
Motion Electronics	Grand Hotel
Radford	Tavistock Hotel
Sony	Tavistock Hotel
Villacousta	President Hotel

A preview of recording equipment to be seen at the 1968 Audio Festival.

WE break with tradition in this year's preview of the London *International Audio Festival and Fair* by splitting the exhibitors into six categories representing the six floors in use at the Hotel Russell. We hope this will prove of greater value to the visitor in his journeys along the maze of stairs and corridors, since it shows exactly what can be found in the tape recording line on any one floor.

Before making our way through the rows of booths in the two ground floor halls, we draw attention to the British Amateur Tape Recording Contest prize-giving that will take place in one of the side rooms on the Saturday of the Fair.

The ground-floor booths customarily contain static displays of equipment that, in most cases, may be heard operating in the demonstration rooms upstairs. *Grampian* and *Multicore* are this year limiting themselves to booth displays, the former showing a substantial range of microphones and recording accessories. The new cardioid dynamic *GC.2* (illustrated) features an easily replaceable diaphragm/coil unit plus on/off switch. Price has not yet been decided.

An intriguing new accessory from *Multicore* is the *Bib 21 Video Splicer*. Modelled on the well-known Bib audio splicer, this accepts ½ in. (12.69 mm.) tape pioneered in video recording by *Sony*.

FIRST FLOOR

A few years ago *Kodak* presented their Quadruple Play tape to an astonished world as an example of the fine tolerances to which the chemical industry was able to work. *BASF* subsequently went one stage further by producing Quintuple Play—five times thinner than Standard Play. This was wisely restricted to the inside of *Philips* cassettes, however, reducing the possibility of damage from careless handling. In Room 149, they will be displaying the BASF *C.120* cassette, employing *Sextuple* Play to achieve a playing time of one hour per track at 1⅞ i/s (4.75 cm/s) —double that of the standard (Triple Play) Philips version. A brand of low-noise, high output tape, *PES35LH*, also makes its debut. A 7 in. (18 cm.) spool containing 1,800 ft. of Long Play costs £2 18s. 6d. while the 10½ in. (27 cm.) 4,200 ft. spool is £6 5s. 6d. Another new item is the BASF *Hobby Box* (illustrated), comprising splicer, cutting blade, splicing tape, red, white and green leader, 50 metal stop foils, 25 spool labels and three tape clips. This costs £1 12s. 6d. Purchased independently the 80 ft. leader tapes are 3s. 6d.

Dual, exhibiting in Room 147, are best known for the *TG.60* stereo tape unit, Nothing new in the recording line is anticipated, the company concentrating on amplifiers and turntables.

There are three outstanding attractions at this year's Audio Fair, one of which is the

Ferrograph Series 7 (illustrated). For 18 years Ferrograph have patronised and improved upon the *Wearite Tape Deck*, evolving one of the most reliable mechanisms ever to come within range of the home consumer. Now, after several years of development, they have graduated to totally new mechanical and electronic designs. The 8¼ in. (21 cm.) spools remain and so do the elephantine (we love elephants !) size and weight. Three motors, an electro-mechanical remote stop/start control, damped tension arms, A-B monitoring, independent bass cut-and-lift and treble cut-and-lift, and a four-digit button-reset counter are features of the new series, prices of which are not significantly higher than the old. Two inputs are provided on each channel, with full mixing facilities for feeding four signals on to one channel of the stereo models. Each channel also has three outputs—flat line, line after tone controls, and 8-15 ohms power. Nine versions are now in production, cheapest being the ½-track mono *713*, operating at 7½, 3¾ and 1⅞ i/s (19, 9.5 and 4.75 cm/s). This incorporates a 10 W RMS power amplifier and monitor speaker and costs £110. Model *713H* offers 15 i/s (38 cm/s) in place of 4.75 cm/s at £115, as does the full-track 715 at £140. (Full-track recording appears remarkably expensive.) The ½-track stereo *702* tape unit is £130, as is the ¼-track stereo *704*. Both have a maximum speed of 19 cm/s, though a 38 cm/s version of the *702* is available at £135. At £150, the *722* offers stereo recording and replay through a 2 x 10 W internal amplifier and speakers at 19, 9.5 and 4.75 cm/s. The ¼-track *724* version has the same price. Most expensive of the series is the £155 *722H*, a ½-track stereo model operating at a 38 cm/s maximum speed and featuring the 2 x 10 W amplifier and speakers. An exceedingly promising family.

Lustraphone, in Room 145, will be displaying a new range of microphones and associated equipment.

"The world's most comprehensive range of pre-packed tape recorder spares" will be visible in Room 160, under the care of the aptly named *Tape Recorder Spares Ltd.* The company plan to introduce nearly 100 new lines, including audio connecting leads, wall-mounting loudspeaker sockets, and other offspring for matching and mixing.

SECOND FLOOR

Two new microphones employing twin capsules will be shown in Room 237 by *AKG*. The £23 *D.200* (illustrated) is described as a cheaper version of the (£32) *D.202ES*, while the more expensive D.224 is intended for studio use. Price is provisionally quoted as £49. This model incorporates a three-position step switch, giving O, 7 dB and 20 dB bass attenuation.

Another Continental microphone manufacturer—*Beyer*—will be exhibiting on the second floor, at Room 215. No details of new models have reached us at the time of writing.

Braun, as in previous years, will be demonstrating their stereo *TG60*. To be seen in Room 253, this operates at 19 and 9.5 cm/s and features a £262 15s. price tag.

Brenell will be demonstrating their full range of mono and stereo recorders, including

(*continued on page 221*)

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the versatile *STB/5/2*, offering separate ½-track record and replay heads plus a further ¼-track play head. Variable bias, four-input mixing and A-B monitoring are offered along with speeds of 38, 19, 9.5 and 4.75 cm/s. Price is £150.

Elizabethan, in Room 258, are to show the new *LZ614* mains/battery cassette recorder. Suitable for *Philips C.60* cassettes and equivalents, this model incorporates an 18 x 9 cm. speaker and is said to have a signal-to-noise ratio of 50 dB at 4.75 cm/s (equal to the *Ampex 602* at 19 cm/s). Price is £34 13s. Also on display will be the *LZ32 Mk. 2* employing the three-speed *BSR TD. 10* deck and retailing at £33 12s. A ¼-track version, the *LZ 34 Mk. 2*, is priced at £35 14s.

The Japanese *Oki* and Swedish *Radionette* companies, represented in Britain by *Denham and Morley Ltd.*, will display their wares in Rooms 255 and 256 respectively. Oki produce a range of mono and stereo mains recorders varying in price from £44 2s. to £208 19s. Radionette, on the other hand, are concentrating on a portable machine with concentrically mounted spools—the *Multicorder*.

The *M203* is one of the major *Telefunken* attractions in Room 247. Using a mechanism similar to the larger *M204E*, it provides full stereo recording facilities plus a mono monitor for £78 15s. Available in ½-track or ¼-track form, the M203 operates at 19 and 9.5 cm/s and weighs 21 lb. Also on show will be the *M300* series of battery portables.

THIRD FLOOR

The *Agfa-Gevaert* range of tapes and accessories will be displayed and demonstrated in Room 353. Though relegated to a booth in 1967, they have in previous years presented some of the most original demonstrations ever seen at the Hotel Russell.

A new exhibitor, a new company and a new recorder: the *Magnetic Tapes Ltd., Chilton 100S*. The mind behind the machine is not so new, however, being that of Mr. T. H. Reps, founder of *Reps (Tape Recorders) Ltd.* His design is claimed to embody all the features desirable in a non-professional recorder—twin peak programme meters, speeds of 19, 9.5 and 4.75 cm/s, separate record and play heads, a *Papst* motor, and so on. The "and so on" includes almost totally silent operation, full solenoid control, damped tension arms, fast but slip-free wind, and a 10 W RMS per channel monitor. Price is £120 15s.

EMI continue with their *BTR4* studio recorders and *L4* battery portables. These are to be shown in Room 302 alongside the new *Sony C.38* battery capacitor microphone. In addition to a Sony video recorder, EMI now market several professional microphones produced by the Japanese company.

Philips occupy two third-floor rooms—336 and 337—the former occupied by their hi-fi division and the latter devoted entirely to tape equipment. Among three new accessories is a new version of the *CE.10* endless cartridge. Designated Type *EL1907/52*, it contains 195 ft. (60 metres) of tape giving a 9 minutes 30 seconds playing time at 9.5 cm/s. Single-coated tape is used in preference to double-coated, to reduce sticking faults; price is £3 10s. A 27s.6d. splicing kit and 6s. *Audio Letter* complete the trio. The latter plays for ten minutes at 9.5 cm/s and is supplied with a postal container.

A demonstration of stereo tape recordings made with two *VRT/L* ribbon microphones is to be given by *Reslo* in Room 348. An improved version of the *UD.1* microphone will make its debut, complete with detachable Perspex ring controlling the cardioid pick-up pattern and an "internal anti-pop filter"; the latter, perhaps, for renderings of *Silent Beatle*?

Sanyo enter the Audio Fair for the first time this year, occupying Room 342.

"Playback" is the title of a quarterly magazine to be introduced by *Scotch* in Room 347. The first issue will contain an interview with Peter Cook and Dudley Moore—"Writing with Tape".

The complete range of *Sennheiser* microphones will be displayed in Room 355. Last year's successful demonstration is to be repeated, with original domestic stereo recordings being reproduced through the *Philharmonic* amplification system. A *Bang & Olufsen 2000* was employed with various pairs of Sennheiser microphones to produce the tape, illustrating the varying characteristics of each pair.

Room 349 will house *Teac*, a Japanese company little known to the British market. Centre of the exhibit will be the *A6010*, a solenoid-controlled stereo tape unit operating at 19 and 9.5 cm/s. Automatic reverse, a four-head plug-in unit, and variable tape tension are among its features, the price being £277 4s. Model *A1600* incorporates a stereo power amplifier and twin lid speakers. Automatic reverse, separate record and play heads, and a dual speed motor are accompanied by stereo echo facilities. The latter is of particular interest since most stereo recorders will only permit single-channel echo effects. Price is £194 5s. Models *A1500*, *A4010S*, *A400* and *A1200* are variations on the A1600, the *A400* being the least expensive at £122 17s.

Uher, another newcomer to the Hotel Russell, are expected to introduce an elaborate stereo recorder based on the *Royal*. The *4000L* mono and *4002* stereo battery portables will be displayed in Room 361.

Despite the introduction of a new *Ferrograph* mechanism, *Vortexion* will probably continue with the existing *Wearite* in their *CBL* for the next few months. We hope for a repetition of last year's demonstration—the reproduction of an original solo piano recording. The piano remains the most demanding instrument in terms of recorded wobble; hence its unpopularity with the majority of other exhibitors. Vortexion will occupy Room 334.

FOURTH FLOOR

A new mono recorder will complement the stereo *DP/A1* which was introduced last year by *Tape Recorder Developments*. It is claimed to be the first recorder ever to be produced with *Mullard* ferrite heads as standard components. A four-speed tape player will also make its debut in *Room 447*.

FIFTH FLOOR

Akai, in Room 563, are replacing the *M8* with a restyled and improved *M9*. A particularly interesting aspect of the new model is the solenoid-controlled pinch-wheel. This is retracted from the capstan whenever automatic stop or automatic mains shut-off are actuated by a tension arm. Model *X-150D* supersedes the *X-100D* as a stereo tape unit designed for use with external amplifiers.

Both the M9 and X-150D feature an entirely unique *Cross-Field* bias system, the former retailing at £159 and the latter at £106. Another comparatively new Akai model to be shown is the £86 *3000D* stereo tape unit. This employs conventional bias and operates at 19 and 9.5 cm/s. A 30-minute recorded demonstration will show the capabilities of each model and will include live recordings made for the occasion.

Ampex are now concentrating on the *753* stereo tape unit, a versatile three-head machine using twin-capstan drive and costing £95 11s. Speeds are 19, 9.5 and 4.75 cm/s. Rooms 535 and 536 will also reverberate to the sounds of *1163* and *2163* recorders reproducing Ampex stereo tape records. The *AG-20* battery portable will be on show alongside an *AG-440* console machine.

Another battery recorder likely to attract attention is the *Series 11*, to be shown by *Tandberg* in Room 504. The transistor *Series 15* will be introduced and the *64X* demonstrated (see review on page 241). Introduced in 1967, the latter incorporates an opposing-field bias system to combat self-erasure.

SIXTH FLOOR

The sixth floor of the Hotel Russell has hitherto been a relatively distant and deserted region. This year, however, it harbours three exhibitors of direct interest to users of tape equipment. *Grundig*, in Room 634, will be demonstrating the products of their prolific energies, including an updated version of the *TS340*, a complete stereo machine with three heads and two VU-meters.

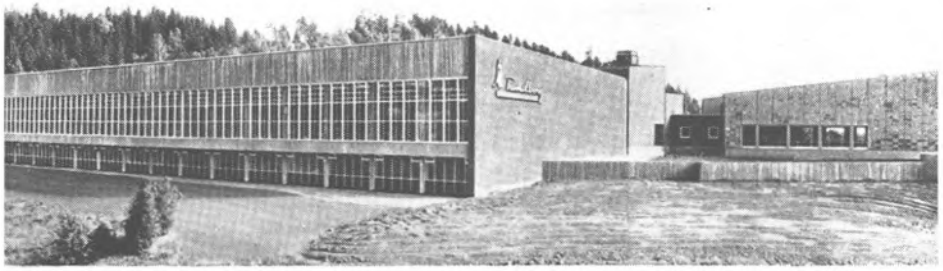
Rather less prolific are *Revox-Studer* whose new *77* represents their first major design change in 15 years. An electronic servo system governs the 19 and 9.75 cm/s tape speeds, though the extent of the mechanical and circuit changes are masked by the external cabinet, which deceptively suggests a relationship to the *736*. The basic chassis-only 77 costs £140 14s. while chassis plus teak case come to £145 19s. 10 + 10 W plug-in amplifier panels can be added for £21. Revox will occupy Room 649.

Last but certainly not least, in Room 636, we find *Truvox*. At the time of writing we are informed that a Series 200 is in the wind, though no information has been supplied by the manufacturer.

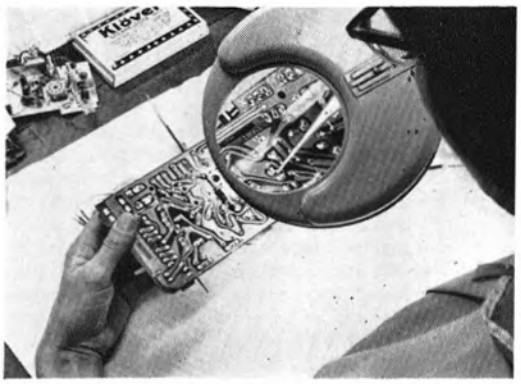
Outside the Audio Fare, in the immediate vicinity of Russell Square, several companies will be holding small exhibitions of their own. *Bang & Olufsen* and *Sony* will be at the Tavistock Hotel while *Daystrom*, as of old, will have rooms in the Grand. The Bedford Hotel, finally, will provide sanctuary for *Mastertape*.

Tickets are required for the Audio Fair and can be obtained free of charge from provincial audio retailers or by writing, with stamped addressed envelope, to *Audio House, 42 Manchester Street, London, W.1*, or to this editorial office.

The Hotel Russell is situated to the east of Tottenham Court Road. Nearest tube station is Russell Square.



1 External view of the new Kjeller premises.
2 Kjeller electronics assembly hall.
3 Printed circuit boards are examined for soldering flaws.



2

TANDBERG
– A SOCIAL EXPERIMENT

"ANOTHER leading entrepreneur, Vebjørn Tandberg, started the *Tandberg* radio and tape recorder works in 1933. When it eventually turned into one of Norway's biggest little businesses he continued as chairman, but turned the whole operation over to his employees. They plow all the profits back into the business, enjoy top wages and a 39-hour week, and studiously avoid any blue-collar-versus-white-collar distinctions. This odd enterprise is a sort of halfway house between the typical company and the co-op."

When I selected Donald Connery's book *The Scandinavians** as reading matter for the flight to Norway, I little expected to read, within its pages, of the very company that I was visiting. Vebjørn Tandberg is more than the successful industrialist I had envisaged, however; he is revered throughout Norway as a pioneer in labour relations and social welfare. The Tandberg experiment commenced in 1930 when a young civil engineer, newly graduated from the Norwegian Institute of Technology, travelled south from Trondheim to Oslo where he formed a one-man business manufacturing loudspeakers. In 1932, Vebjørn Tandberg expanded his interests to the production of radio receivers, anticipating the Norwegian Broadcasting Corporation which was to be formed five months later.

Between 1836 and 1935, 861,000 Norwegians left their country in search of prosperity, the majority settling in the USA. This was an enormous figure for the nation to lose (even today its population is below 4,000,000) and the drain served to aggravate the depressed Norwegian economy. Yet despite these conditions, and the impending gloom of European war, the tiny company grew furiously from a quartet of two engineers, one assistant and one salesman in 1933, through 40 employees in 1937, to a staff of 90 in 1939.

In the years before the war, Mr. Tandberg became increasingly alarmed by the future he foresaw. As a bachelor, on the one hand, he lacked an immediate heir to whom he could entrust the company; as an idealist, on the other, he felt a strong sense of responsibility for the well-being of his staff. Their comparative security would inevitably be jeopardised whether he retained or sold his factory, since all privately owned industries were liable to confiscation by the menacing German invaders.

An Oslo lawyer, consulted for a solution to the dilemma, produced an idea that strongly appealed to Tandberg's financial sense and moral convictions. On the lawyer's advice, *Tandberg Radiofabrikk A/S* was transformed into a Foundation controlled by a tribunal of employees with the former owner at the helm. In his new role of Managing Director, Mr. Tandberg became vulnerable to dismissal for mismanagement—a position that he has held and evidently enjoyed ever since.

In 1939, after a frantic bid for neutrality, Norway was plunged deep into war. Her 1,500 miles of sparsely populated coastline rendered the country hopelessly vulnerable to occupation —in which state she spent almost the entire six-year struggle. Although resenting their invaders, the people of southern Norway were not excessively disturbed in their way of life by occupation. Bitter resistance was confined, at first, to the northern provinces. But for Tandberg a nationwide ban on the possession of radio receivers threatened disaster. A policy of 'Responsible Optimism' was initiated to persuade the public to order receivers for delivery after the war. The campaign succeeded, 5,000 radios being placed in sealed stores in the years preceding 1945.

Three years after the war, Vebjørn Tandberg insisted upon the first of several major improvements in working conditions that were to establish the atmosphere of a factory family in the years ahead. Before 1948 the company had conformed to the practice, common even today, of employing production and assembly staff for longer hours than clerical and administrative workers. In that year, the entire company was aligned to a 39-hour week—a cut of three hours from the time originally demanded of manual staff.

Demand for radio receivers persisted into the next decade, 1950 being marked by a move from confined premises in central Oslo to a 100,000 sq. ft. plant at Kjelsås, three miles north of the city. Designed by a leading Norwegian architect, Thorlief Jenson, the building was erected in a rural setting over-

Published by Eyre and Spottiswoode.

4

BY DAVID KIRK

4 Central Tandberg premises at Kjelsas.

5 Employees relax in the grounds of the Kjelsas plant.

6 Tape recorder production lines in the Kjelsas 'Hangar', each line representing a complete series.

5

6

looking Lake Maridalsvatn.

When radio sales eventually fell, in 1952, the Tandberg company developed their first tape recorder. Two thousand *Series 1* machines were produced before a single definite order was received.

In 1954 the familiar Tandberg joystick control superseded a rotating mode selector, setting a style the company have followed and gradually improved upon for 14 years. Spurred on by the success of their tape equipment, they have expanded further into the television and teaching-machine markets.

A seven-storey building was added to the Kjelsås factory in 1962, providing another 70,000 sq. ft. for research and development. Two years ago yet another factory was opened —a 160,000 sq. ft. premises with a second gigantic assembly hall. This is situated 11 miles west of Kjelsås at Kjeller. Able to return all profits into the company, the Tandberg Foundation now plans to erect a new satellite factory every five years.

The Kjeller plant was modelled on the Kjelsås premises and employs 500 of the total 1,200 people working for the company. The Kjeller production hall alone contains a staff of 350, who assemble and test 25,000 televisions, 45,000 radios and 40,000 loudspeakers each year in addition to constructing the printed-board circuitry of the five tape recorders.

Despite their substantial size, the two factories create a misleading impression of the company's real stature. Kjelsås is the centre of a network of smaller companies—mostly Norwegian but including the British *Goodmans*—manufacturing circuit boards, mechanical parts, cabinets, speaker units and chassis for Tandberg products. Every component, from screws and idlers to deck plates and trade marks, is made to rigid specification by independent specialist factories. Tandberg regard this distribution of labour as a prime factor in securing reliable components at modest cost. No one company, in their view, can excel in all fields of metal handling — casting, turning, stamping and plating.

A staff of 60 is engaged at Kjelsås in making tape-heads, again from shells and laminations manufactured by an outside contractor. Each lamination is freed of swarf before being stacked with others into a core. Coils are then spun on to the cores which are sealed in their shells with *Araldite*. To protect employees from the effects of inhaling this resin, it is worked under glass in individually air-conditioned bench units.

Completed heads are polished on a *Payne* rotating grinder before being checked for electrical conformity. They travel then by lift to the ground floor assembly hall, known among Tandberg employees as "The Hangar".

Visitors to Kjelsås are treated to the imposing view of six production lines, each running the length of the hall and each devoted to one of the current Tandberg recorders. The two-speed *Series 8*, the three-speed *Series 9*, the stereo *Series 12*, the controversial *6X*, the *Series 13* cartridge recorder and the new *Series 11* battery portable—each begins life as a handful of components beneath a great arched window, progressing towards the visitors' balcony where it arrives completed, tested and loosely packed.

Every tenth unit leaving the Kjeller or Kjelsås lines is subjected to quality control, in addition to the thorough tests made on all equipment immediately after assembly. There, mere passing of time has been found to introduce faults in products, slowly cooling solder joints changing electrical values or breaking circuit. Circuits manufactured at Kjeller are placed on a slow conveyor intended solely to aggravate faults which may be present.

Assembly staff are moved occasionally from one production line to another, eliminating the excessive tedium of repetitive work. They are trained for their new posts at benches on the far left of the Kjelsås "Hangar" in the company of newly recruited employees.

With its low population, Norway presents its industries with a limited source of labour. Working conditions at Tandberg are held in such wide regard, however, that an average of 20 letters arrive each day requesting employment.

One of the most recent features adopted on Tandberg recorders is opposing-field bias. The company's retention of peak-reading electronic level indicators has gained them a rather

(continued overleaf)

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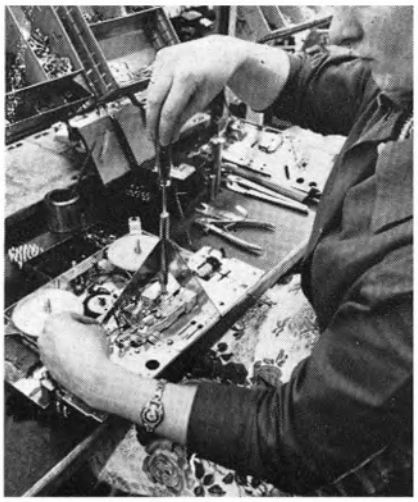

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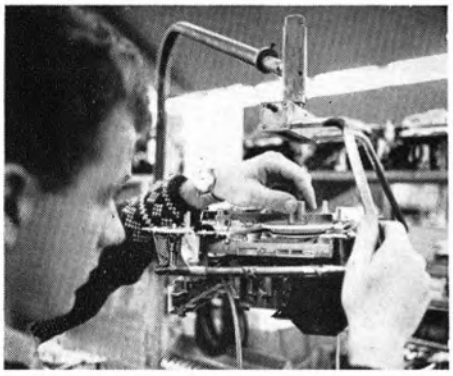

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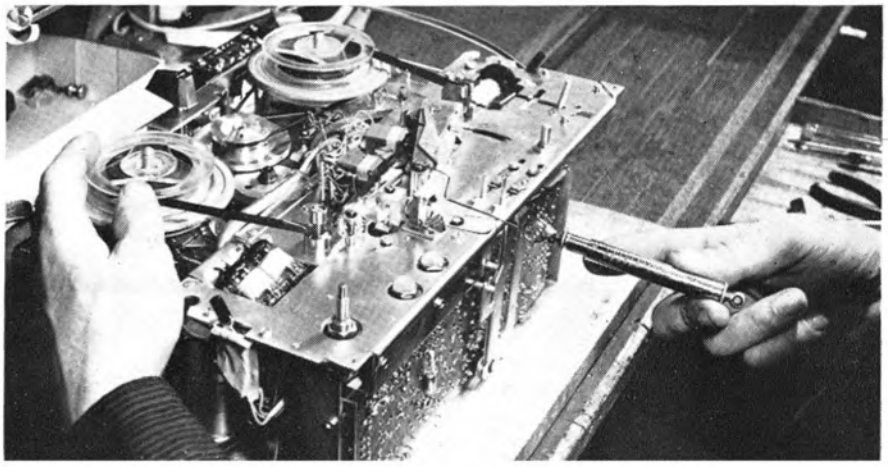

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conservative name; was the adoption of a seemingly unproved technique out of character for the company? Mr. L. Nødtvedt, who led the team which developed Tandberg's version of the system, is confident that he has split the facts from the myths which surrounded earlier commercial applications. Having studied the work of the *ITT Research Institute*, Camras, and other pioneers, his team then examined existing domestic recorders employing bias heads. These were found to rely primarily on the tape following the curve of the record head (**fig. 1**), theoretically leaving the bias field before self-erasure could attenuate the HF end of the recorded scale. Although an attractive idea, this had precisely the same disadvantages as underbiasing in a conventional recorder—namely, improved treble response but greater distortion and poorer signal-to-noise ratio.

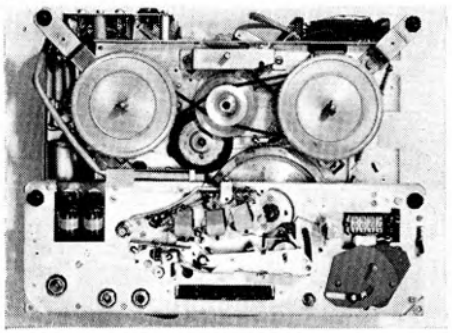
To obtain the full benefit of an independent bias head, it was found necessary to stagger the pole gaps by some 25 microns (**fig. 2**). Although this distance was not critical, the magnetic characteristics of the bias head were, and much of the research at Kjelsås has been centred on this component. In the 6X, Tandberg claim to have improved both frequency response and distortion at 3¾ and 1⅞ i/s (9.5 and 4.75 cm/s), though Mr. Nødtvedt frankly admitted that it was aurally indistinguishable from the conventional Series 6 at 7½ i/s (19 cm/s). Opposing-field bias is at its best at very low tape speeds. Cost, he indicated, was the prime reason why the Series 11 battery portable lacked an opposing-field head.

The 11 employs a sophisticated tachometer-controlled drive system and was developed with an eye very closely on the broadcasting and film industries. One of the three versions now being manufactured incorporates a pilot head designed to accept the tone generated by a cine camera. This tone is recorded transversely across the tape and consequently appears out of phase (and therefore self-cancelling) to the audio heads. When the film is later projected, it is kept in exact synchronisation with the sound track by a locking pulse from the pilot head.

The Series 13 cassette recorder is the logical off-spring of Tandberg's catering for the educational market, though its potential applications cover a wider field. As part of the Tandberg language laboratory, a Series 13 fitted with a short loop cartridge tapes entire lessons from the master recording and may be switched at any instant to reproduce the preceding few seconds still on the loop. This has the virtue of permitting instantaneous replay of difficult passages of a course, the master tape being simultaneously paused until the 13 is switched back to record. The unit is envisaged as a source of background music in factories, stores, and at exhibitions. It has two tracks, selected by switching from one head segment to another, with full record and replay facilities up to a 20 x 8 cm. internal speaker. Endless cartridges offer an uninterrupted source of information or music, though a short stop foil can be inserted into the loop to halt the unit at any desired point.

Having previously puzzled over the identity of the Huldra—Tandberg's much-photographed

6



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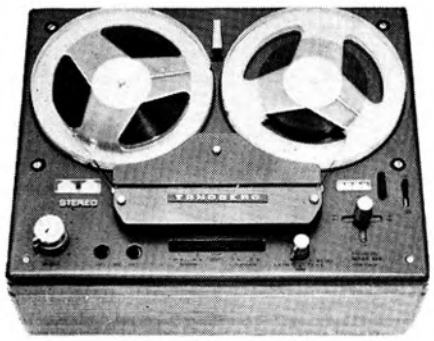

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1 A stage in head production.

2 A special tool is employed to align the capstan spindle.

3 The upper plate is screwed in position.

4 Accurate turntable alignment is essential if spools are not to scrape the deck.

5 Pad pressure is measured with a spring balance.

6 The completed mechanism—a Series 6.

7 Samples are subjected to reliability tests, including a sojourn in a heat chamber.

8 The end product—a Series 6X.

FIG. 1

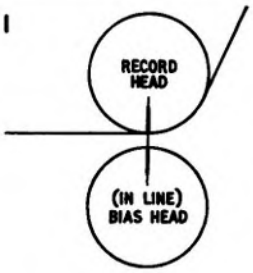
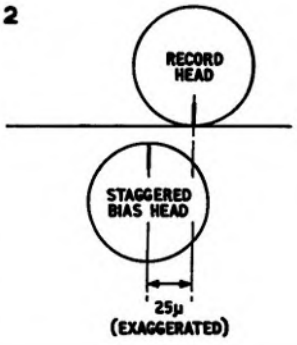


FIG. 2



female trading symbol—I felt some slight disappointment when introduced to a bronze statue. She stands bare-footed in the grounds of the Kjelsås plant and appeared quite unnerved by the thick snow and –20°C prevailing during my January visit. Produced by sculptor Dyre Vaa, the Huldra is a mythical acquaintance of the Mountain King (immortalised beyond Norway by Ibsen and Grieg). Tiring of regal company, she sought rescue at the hands of Ellaan—a young fellow today employed in the grounds of the Kjeller factory. The two figures face each other across the 11 miles separating the two plants. The Huldra represents perfection—a quality the non-profit-making Foundation seeks in all its products.

Like his trading symbol, Vebjørn Tandberg is himself something of a legend in Norway. In addition to being an authority on social relations, he has come to represent the Norwegian dislike of naked bureaucracy. In one passage of *The Scandinavians*, the author quotes a Bergen businessman's belief that "a Norwegian worker given the choice of a 10 per cent pay rise for himself or a 10 per cent reduction in his boss's salary would cut down his boss every time". Consciously or unconsciously, Mr. Tandberg has displayed the ability to remove the cloak of condescension from visiting bureaucrats. His staff speak with delight of the visit by Anastas Mikoyan, whose arrival was preceded by an entourage of austere Russian bodyguards. Impressed by Mr. Tandberg's informal dress and modest manner, Mikoyan announced "I wish to be like you" and promptly removed his coat; the bodyguards too completed the visit in shirtsleeves. Asked whether his organisation qualified as capitalism or communism, Mr. Tandberg replied: "A bit of both I suppose". On another occasion, a visiting politician was humbled to find the Managing Director following behind with his suitcases.

What of the future? Will any one director or group of employees combine their financial interests and reduce the organisation to its former mercenary status? In fact this is not possible since, contrary to general belief, the Tandberg staff do not possess tangible shares in their company. They do, however, enjoy a profit-sharing plan giving a bonus of 1% of their average annual pay, after a preliminary five-year period, for each year that they continue to work with the company. This continues to a maximum of 20%. A policy of this nature cannot fail to intensify the atmosphere of personal involvement needed in conscientious staff. The Tandberg design team certainly seem to have caught the spirit and are leading the Foundation towards commercial immortality.

In conclusion I would like to thank Mr. Pettersen, Mr. Myhrvold and, needless to say, Mr. Tandberg for their hospitality during my stay in Oslo. Particular thanks are due to Mr. Spiten for taking a delayed aircraft, an infrequent taxi service and a frozen car battery in his stride for the benefit of a not-quite-frostbitten journalist. I am also grateful to John Farnell and Arthur Dakin for making the journey possible.

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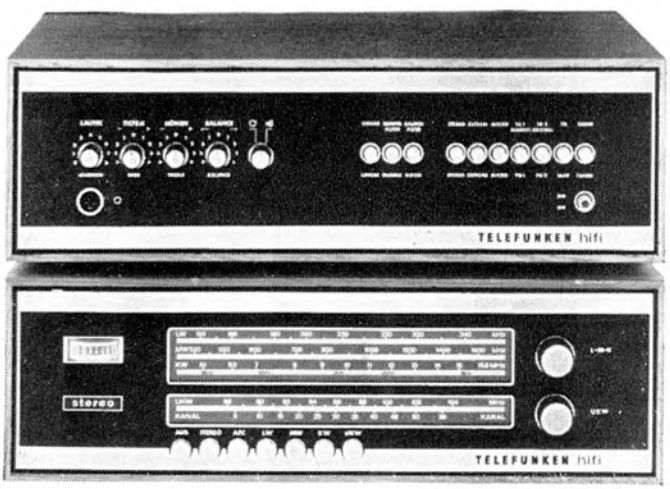

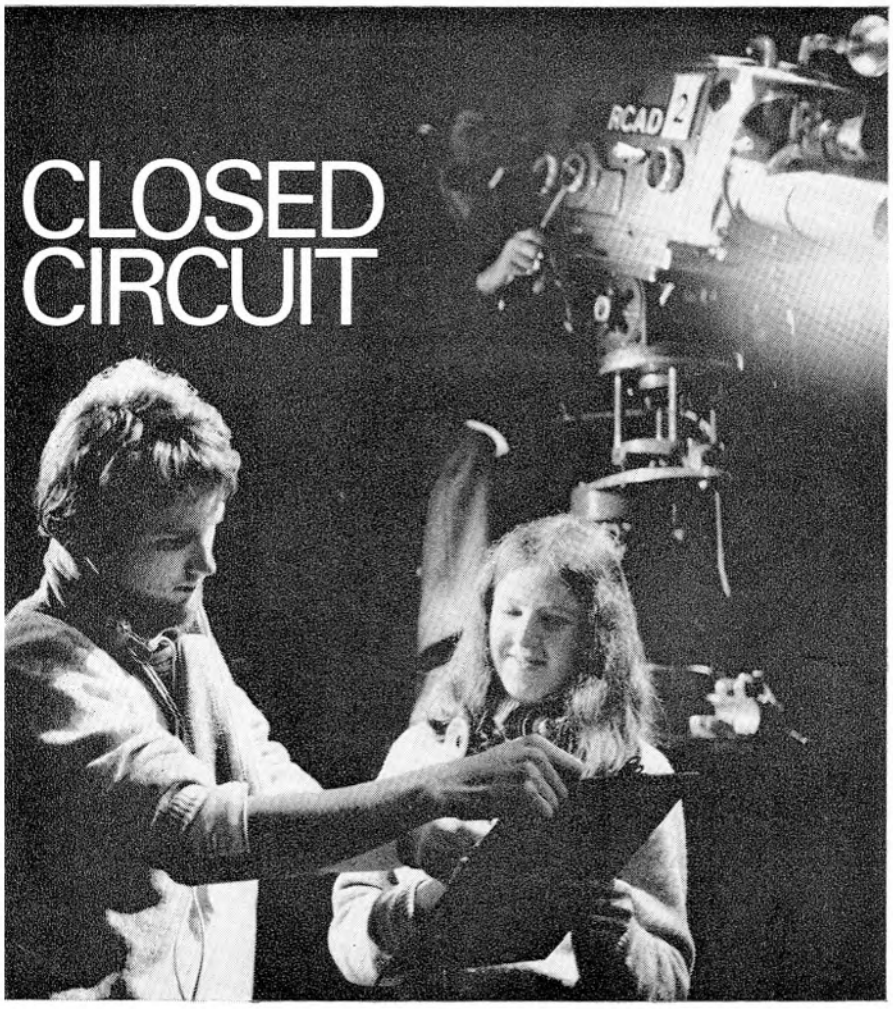

BROMLEY TELEVISION PRODUCTION COURSE

BY RICHARD GOLDING

"THIS is a great place to fire one's enthusiasm," said Nicky Phillips, camera operator for the day. "I know so much more now about television than I ever thought I *could* know. It's the same with all of us—once the glamour wears off you get so involved with the medium that nothing outside it matters any more and the feeling, when one of your ideas has worked out successfully, is terrific!"

He was talking about the two-year course at the Film and Television Department at Ravensbourne College of Art and Design, Bromley, Kent, where 28 full-time students are together on one of the most comprehensive television production courses in the country.

The Department has recently moved from smaller accommodation in the main College building and now occupies the whole of the ground floor of what was once a primary school. At either end of the suite of classrooms there is a sound-stage and the classrooms have been converted into various workshops, equipment rooms and a control room complete with sound and vision mixing consoles and a bank of monitors.

Studio A, the major sound-stage, was mainly constructed by the staff themselves—Head of Department Bob Butler, Chief Engineer John Lisney, and Sound Engineer Godric Beresford-Jones—who worked practically the whole of last summer's vacation to get the place ready for the new influx of students in September. The studio is 80 ft. long by 23 ft. wide and 14½ ft. high, large enough to carry more than two full sets and still leave just enough room for manoeuvre, though the staff would like the ceiling to be much higher. The sound-proofing was carried out by an outside firm and consists of 25 mm. thick rock-wool and 25 mm. air space overlaid with chicken-wire and battened down over ceiling and walls.

On first sight the equipment is fairly impressive and includes no less than eight image-orthicon and three vidicon TV cameras, a camera crane, various camera pedestals and an *MR70* microphone boom—but when you look around there are all sorts of surprises for one used to the bare basics of educational TV. There is a complete tele-cine system, half-a-dozen 35 mm. and 16 mm. editing machines, racks of equipment, a huge outside broadcast van with generator and, above all, an *Ampex* transverse-scan video recorder.

And so it should be, for the aim of this course is to present a professional television studio situation to the students so that when they receive the College Diploma at the end of their studies they are fully trained in all aspects of television and motion picture film production. Indeed, the training they receive during their first year is so thorough that some students are creamed off by Television Companies when they are barely into their second year.

Entry requirements are five O-levels with preference given to students having two A-levels at 17-plus, for the Directors' course, and four O-levels at 16-plus for the Technical Operators' course, after a personal interview. Suitable mature students are eligible but there is a long waiting list which will probably not be satisfied until the Department moves into a new, specially designed TV complex in two or three years time. By then the course may be extended to a three years duration and the entry requirements may be higher.

The Directors' course examines primarily the role of the director/producer in the industry, and the students undertake the planning and direction of their own exercises which correspond closely to full professional work. All other aspects of production are then introduced with Script Writing, Art Direction, Acting, Production, Post Production and Editing, followed by supporting studies including Period Studies (history of furniture, architecture and costume), English Language and Literature, Music, Social History, and Communication Theory.

A nerve-wracking feature for the newcomer is the 'Presentation" which takes place in the large studio once a month. Students write a script and they have to stand up before the staff and other students to talk about it for 10 minutes. Then follows a five-minute question time in which their ideas are pulled to pieces by the others. The script must be viable; it can be an adaptation of a book or short story, it can be for radio, for film, or for television, but it must be real. A script which meets with universal approval is then given to a director allocated to produce it. "These presentations are a valuable part of the course," said Bob Butler, "for they give the students experience in communicating their ideas to others".

Once a script has been chosen for production the various production roles are allocated to the students and their "red action files" made up. These are files with a red cover which the students must carry with them at all times and contain a copy of the dialogue, a fully made up sound and visual shooting script, and a call list showing the complete commitments of all the crew at all times.

There are many ways in which these exercises and results are examined. 16 mm. *Arriflex*, *Cameflex* and *Bolex* cameras are available for filming. The second studio may be used for CCTV with the mobile O.B. unit as an outside control room and the programme taped on the Ampex or smaller *Philips* helical-scan VTR.

On major projects in Studio A, first years act as assistants to second year students and gain experience in camera work, lighting and sound recording under professional conditions.

The major project occupying almost the whole of the spring term was the production of four of Alberto Moravia's *Roman Tales*. This was a quartet of stories set in Italy around

(*continued on page 229*)

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AGFA MAGNETON RECORDING TAPES

1937 and produced by four different directors under staff supervision. Although the four stories have different styles of presentation, continuity has been written in so that they can be edited together to make a one-hour programme and recorded as such on the Ampex.

Roman Tales presented many challenges to the students; a very complicated flashback sequence was overcome successfully, and the Art Directors came up with an idea that may well be incorporated into all future Ravensbourne set design. The sets were constructed of open frames rather than solid flats and the frames were bolted together in any series of combinations required to leave necessary apertures for doors and windows; card or wallpaper being attached to the open frames to complete the set walls.

This project had worries for the staff too, one of which was whether the technical facilities could keep up with the pace of the directors.

There are seven Technical Operators in training among the 28 students on the course and the staff is quite proud of them. "So far," it was said, "they have never let us down on any transmission and on this production they were marvellous".

These technical students do seem to work very hard indeed but they also appear to enjoy it. Quite obviously the department must work to a very tight budget and consequently most of the equipment has to be bought second-hand, and second-hand apparatus comes complete with plenty of problems. Furthermore, these students spend two days of their week in attending lectures on basic television and electronics.

But then everyone at Ravensbourne is working full-out. The O.B. unit goes out on regular assignments to various schools and colleges and is now being geared-up to present outside broadcast news programmes. The idea is that the van will be loaded overnight with four image-orthicon cameras and a video recorder and will set off early the next morning to televise a complete situation such as a day in the life of a fire-brigade in an outlying district; or to make a short-notice recording of any outstanding news item in the area.

Early starts and late finishes are nothing new to the students. During the term before last they were working on a production at Keston Ponds and the set, a ruined chapel, had to be erected very early indeed. This meant them leaving the College at five in the morning and returning at three the following morning. And they also had the transportation of a boat to contend with!

The course is also involved with other colleges, one as far away as Kingston-on-Hull, in the co-production of programmes on varied educational themes; and this year's summer term production in Studio A will have the co-operation of the Rose Bruford School of Drama, Sidcup, Kent.

This is intended to serve two purposes; to give the television students an opportunity of working with trained actors; and to give the drama students professional experience under live cameras. The drama school will supply 23 actors and the full resources of their costume department and will come along every other week during the term to rehearse two days on the set, to camera rehearse the following two days, and to transmit the last day.

There is a great deal happening at Ravensbourne but they are hampered by lack of space. The equipment exists for a 35/16 mm. dubbing suite but there is no room to set it up properly. Studio A ceiling needs to be 15 feet higher to allow technicians up on the lighting grid. More room is needed in the workshops and so on. But the lack of space is tempered by the general atmosphere of enthusiasm among staff and students. Two years ago, when they were working in even more crowded conditions, they won seven awards in the ICOGRADA bi-annual competition in Yugoslavia. In a few years, with the luxury of a new TV complex and colour TV on the programme, who knows what they might achieve. Provided, of course, that the television companies do not lure them away too early during their studies.

depends on the frequency of the mains supply and the number of poles in the motor. The *field* in a two-pole motor, connected to a 50 Hz supply for example, would rotate at 50 times a second or 3,000 times a minute. In a conventional motor the speed of the rotor which is coupled to the capstan spindle would be somewhat less than this—say 2,800 r.p.m. To translate this into capstan diameter (for a tape speed of (19 cm/s) we can use our formula : tape speed $= xC/60$ and $C = \pi d$, when the diameter d works out at 1.3 mm. Obviously a capstan of this diameter is too fragile to use and the only way to increase its diameter and maintain a direct drive is to reduce the speed of the motor.

This can be done by increasing the number of poles. A four-pole motor runs at approximately half the speed of a two-pole motor and therefore the diameter of the capstan can be doubled to keep the speed at 19 cm/s. The capstan diameter of 2.6 mm. is just about thick enough for practical purposes, but if a speed of 9.5 cm/s is required an eight pole motor would have to be used.

A direct drive for the capstan spindle therefore imposes direct limitations on its size which can be troublesome at the lower tape speeds, though it has the advantage of a slip-free linkage between the motor and spindle, resulting in an excellent long-term speed stability. In many high quality machines a direct drive is the method of choice. The *Revox 736* for instance used a Papst hysteresis multipole motor coupled through a damping device to the flywheel, applying direct drive to a very thin capstan spindle.

In most machines the power from the capstan motor is transmitted to the flywheel by a mechanical linkage such as a rubber cord or idler wheel so a speed reduction can be achieved. This enables the advantages of a large or moderate sized capstan diameter to be coupled to an ordinary high-speed induction motor. However, I shall have more to say about this in a later article.

Having decided on the diameter of the capstan, the size and weight of the flywheel, and also on their arrangement, the designer has to specify the materials to use and the accuracy to which the parts have to be machined. A point of considerable importance related to this is whether the performance of a tape deck as measured routinely in manufacture will apply after the recorder has been in use for several months. Obviously the guides, heads, capstan and pinch wheel have to be scrupulously clean to obtain the best performance in any machine, but the pointer to reliability is a high standard of mechanical construction and assembly.

I have already mentioned the important points in the design of the capstan and flywheel, and it may be inferred that these parts must be machined to very close tolerance and also be concentric with their axes. It is equally important that the bearings in which the spindles of the capstan and pinch-wheel run are of high quality so that uneven friction and noisy operation are avoided. In addition, the axes of these two spindles must be exactly in alignment and perpendicular to the deck plate. This enables the pinch-wheel to exert equal pressure over the entire tape width which is essential for a smooth tape drive.

Fig. 3 shows a simplified diagram of the capstan and flywheel arrangement used in the Series 6 *Wearite* tape decks. This assembly uses two ball races which correctly align the centre spindle and keep it at right-angles to the fixing plate. The heavy, accurately balanced flywheel is attached as shown to the bottom end of the spindle and is held in place by a thumb screw. This is useful since it enables the weight to be removed from the capstan when the recorder is carried any distance, thus avoiding any risk of bending the spindle. The capstan face is made of very tough, warp-free 'neoprene' rubber which has a high coefficient of friction and this coating is machined concentric after it has been fixed to the capstan sleeve. This is a very close fit on to the centre spindle and is held in position by a screw passing through the spindle.

The advantages of a carefully designed capstan and flywheel assembly will only be apparent if the drive motor and the necessary power linkage is built to the same high standard. Next month we shall make a start on tape recorder motors.

" 'No tax at all?' I said. 'No', they said. 'How long have they been around ?', I said. 'Twenty years', they said, 'Blimey !', I said, 'Lets put 'em up a third.' "

MATCHING & MIXING

some hashes and hook-ups by john fisher

THESE jottings were inspired by H. W. Hellyer's mention, in his February *Tape Recorder* article on servicing the *Reps* machines, of the requests he gets for devices to modify the Reps inputs to customers' requirements. The circuits that follow are ones that I have jotted down from time to time, the first stemming directly from that article. **Fig. 1** is designed to match a low output crystal or ceramic cartridge such as the *Decca Deram* (or any other high impedance source needing a load of several megohms) to the radio input of a tape recorder or the high level input of an amplifier or mixer. The circuit is basically an *n-p-n/p-n-p* AC/DC feedback pair of transistors followed by an emitter-follower, and bootstrapping to minimise the shunting effect of the bias resistor in the first stage. With the specified transistors the noise performance is good, bandwidth wide and linearity excellent. The output impedance is low, allowing long connecting leads to the equipment it is to feed without noise pick-up or high frequency losses provided co-ax lead is used for connection. The current drain is small, and the circuit can economically be fed from batteries which help eliminate hum problems and increase the unit's versatility.

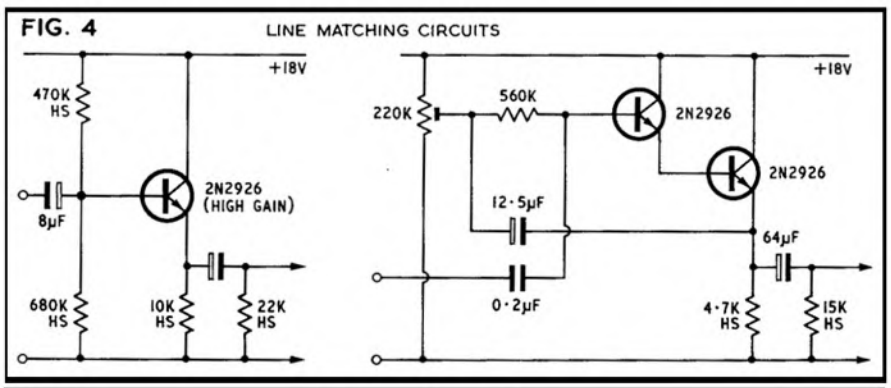
The circuit provides a voltage gain of just over four as it stands and is therefore ideal for matching a cartridge like the Deram to the radio input of many recorders. If necessary the gain can be increased by reducing the value of R_1 to say 470 ohms (at the expense of slight reduction of input impedance) or increasing R_2 to 10 K. It is not advisable to increase R_2 above this value otherwise the very low current resulting in T_1 will make the overall current gain fall too far with a loss of input impedance and linearity. The emitter-follower may be omitted if the lead from the preamp is short and it is to feed a high impedance input. The bootstrapping capacitor C_1 may be omitted if the input impedance is not required to be greater than about 1 M, and the 22 M resistor across the input may be omitted if there is a DC path through the source. The 2N3707 should preferably be selected for high gain. If the circuit is to be used with low level signal sources, e.g. crystal microphones, the second (p-n-p) transistor should preferably be a low-noise type such as the 2G308 or one of the new inexpensive low-noise silicon types available from *Texas*. The present bias adjustment resistor is set to give a reading of about 9 V at the emitter of Tr_3, and can be fixed with a blob of wax.

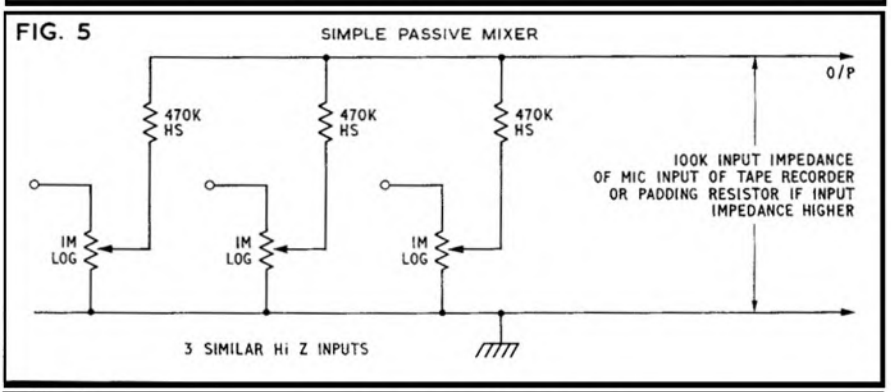
The circuit is capable of further variations and the one that follows is derived from it, **fig. 2** being slightly better suited to low-level high-gain operation and easily adapted to provide frequency correction to suit tape-heads, magnetic cartridges, etc.

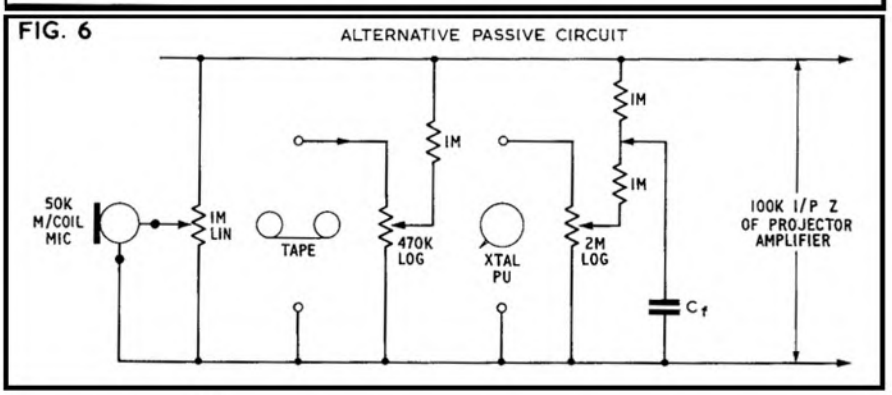
The circuit gives an input impedance of several hundred kilohms and low impedance output. With flat response, the gain is given by $\frac{R_4 + R_5}{R_5}$. With a value of 6.8 K for R_4 the voltage gain is 8, for instance. A value of .0047 μF for C_2 and 22 K for R_3 are the nearest preferred values for 100 μS tape replay equalisation from a high impedance tape head. The value of R_3 is chosen to give the right time-constant $(R_3 + R_5)C_2$. The 22 K and 68 K biasing resistors may be replaced if preferred by a 100 K preset resistor. Suitable subminiature presets are available from *G. W. Smith & Co.* of *Lisle Street, London*, or from *Henrys Radio, Edgware Road*. All other resistors should be high stability types, close tolerance for equalising components. The resistor in series with the output is merely to protect the emitter-follower transistor against short circuit and may be omitted.

The first stage is run at very low current and the voltage across it is lower than with the first circuit ; unless the 2N930 is used the first stage transistor should be chosen for high gain. The noise performance of the circuit is good. The second transistor should be a low-noise type ; silicon or germanium types can be used. The starred resistors should preferably be low-noise metal film types, or at least high stability cracked carbon types.

Another simple circuit that can be used with low level signals if necessary is shown in **fig. 3**, and uses *n-p-n* silicon transistors only. Compound transistors are available for this application, with internal connections between the transistors, but it is still simpler and cheaper to use separate transistors—preferably a low-noise type for the first transistor and almost any small-signal type for the second ; three suggested types are given for each. The compound pair give a high input imped-







ance, low noise and definite voltage gain. An emitter-follower may precede the output capacitor if required, as in the other circuits. The base bias preset is adjusted for about half supply volts at the collectors for maximum signal handling ability, or the voltage across the transistors may be reduced to minimise noise with low level signals.

The circuit as drawn gives an input impedance greater than 1 M, with voltage gain of about 20. Gain may be increased by reducing the value of the emitter resistor (at the expense of input impedance) or by increasing the value of the collector resistor to say 22 K. Among the uses to which this circuit has been put—using two 2N929's—was to replace a valve mic preamp in a friend's short-wave transmitter, in order to reduce hum. It is used with a high impedance moving-coil or crystal microphone; and while this is obviously only for speech—and long range communication at that—he is a purist who believes in putting out an undistorted signal and aims at a signal-to-noise ratio at the transmitter of 50 dB or better. His first contact, using the new preamp, hailed on a quiet band from the depths of Africa, reported favourably on its performance!

If anyone else thinks of using the circuit for this purpose, however, it *is* important to screen the preamp very carefully to keep RF out, as the circuit bandwidth can be very high and tuned filters or high frequency roll-off in the amplifier may be necessary. The microphone case should also be well screened and the screened cable of the leads should use a closely woven braid and not the simpler wrapped or twisted screening that is becoming more and more common, particularly in lightweight microphone cables. Even without a transmitter in the house these cables with non-woven braid can give trouble with interference from taxis, police cars and the like, which appears to afflict them particularly badly.

If the problem is one of impedance matching or avoiding hum pick-up in a long connecting lead between, say, two tape recorders, with no change in levels required, the simplest matching device is a simple emitter-follower or a Darlington pair. These, operating with the line inputs and outputs of tape recorders or amplifiers, will require no special noise precautions and inexpensive *n-p-n* silicon transistors may be used. The first circuit in **fig. 4** will accept a source of 100 K provided the output is not loaded, and the low output impedance reduces the likelihood of hum pick-up and high frequency loss in the leads if the preamp is mounted close to or at the output of the first recorder. The second circuit, with the bias circuit bootstrapped, presents a much higher input impedance and lower output impedance and can feed low/medium impedance loads if required.

Fig. 5 is a simple passive unit which can be of use to a sound-and-cine enthusiast or to anyone requiring to mix three sources such as

(*continued on page 235*)

FIG. 1 PIEZO-ELECTRIC CARTRIDGE PREAMPLIFIER

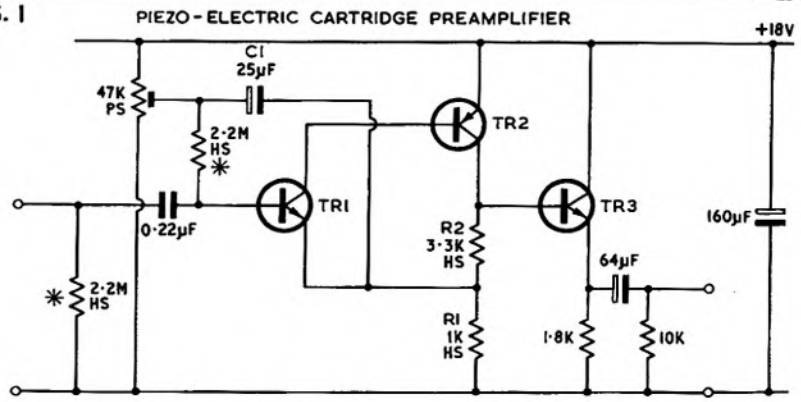
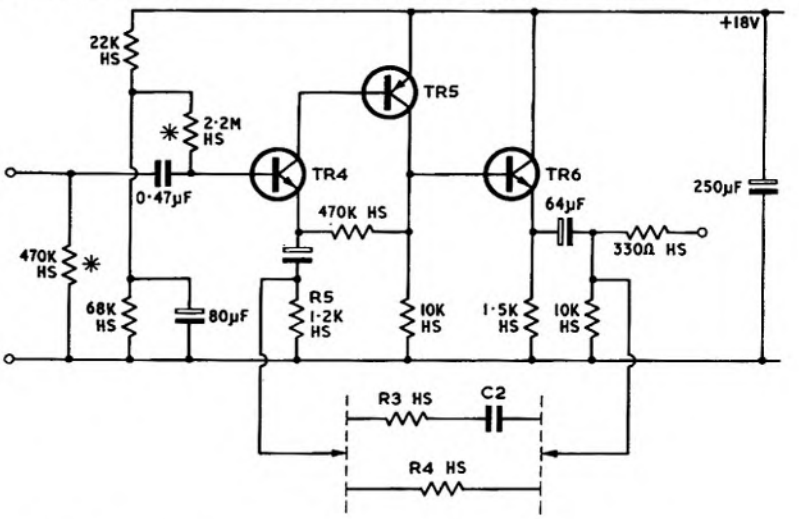


FIG 2. HIGH GAIN PREAMPLIFIER FOR MAGNETIC CARTRIDGES AND TAPE HEADS

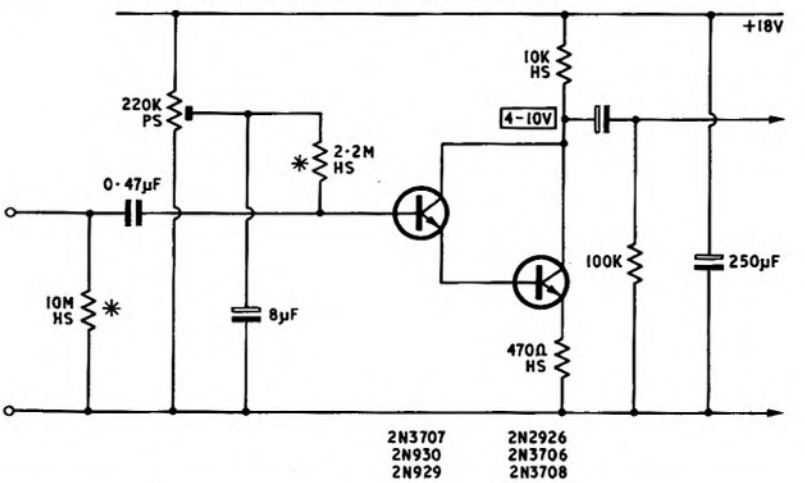


TR4 2N3707, 2N930, BC109

TR5 2G309, 2G308 (GERMANIUM) BCY71, 2N4061 (SILICON)

TR6 2N2926, 2N3706, 2N3708

FIG. 3 HIGH-GAIN MICROPHONE PREAMPLIFIER



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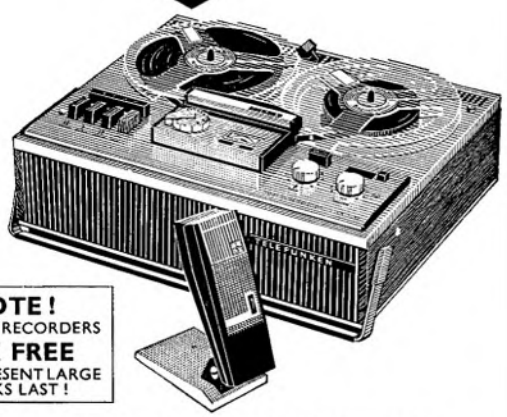

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THE SCHAUB LORENZ 5001 MUSIC CENTER

BY DAVID KIRK

MANUFACTURER'S SPECIFICATION.

Frequency range: 40 Hz - 14 Hz at 10.5 cm/s average speed. **Wow and flutter:** 0.2%. **Dynamic range:** 45 dB. **Loudspeakers:** 21 cm. diameter and 6.5 cm. diameter. **Heads:** Erase and record/play ¼-track with automatic change-over. **Capacity:** 126 tracks of 22 minutes duration, total 46 hours 12 minutes. **Manufacturer: Schaub Lorenz Vertreibsgesellschaft MBH, 753 Pforzheim, Postfach 1720, Ostliche 132, West Germany. Distributor: R. L. Henson Ltd., 21 Lodge Lane, North Finchley, London, N.12.**

EARLY in 1965 the West German *Schaub Lorenz* company introduced a unique magnetic recording system employing 4 in. (10.2 cm.) tape and movable heads to attain 126 tracks of 22 minutes duration. The mechanism was conceived as part of a complete audio entertainment system and was to be sold with an integrated AM/FM radio or alternatively combined with a complete radio and disc-reproducing chain.

Precisely what was ultimately marketed where does not seem to be clear, though I do recall seeing the radio/tape/gram version on sale in Copenhagen during 1966. Possibly the price (£383 5s.) restricted sales of the latter system. At £288 15s., the radio/tape *5001* version was a similarly expensive form of entertainment.

Whether price, copyright protection, or production difficulties were responsible, the fact remains that some 800 *Music Centers* have found their way into the hands of a London wholesale company at less than a quarter of the original price. They are now being sold direct to the public at £72 9s. A visit to their Finchley premises confirmed that a substantial quantity of spares had also been imported and I was informed that one of the company's staff had received service training at the Schaub Lorenz factory.

The 5001 Music Center (American spelling) comprises a three-waveband AM and FM radio linked to the tape mechanism. 21 cm. and 6.5 cm. speakers are mounted to the left of the cabinet. Separate mains switches allow the radio to be powered alone or in conjunction with the tape unit. The recorder employs part of the radio circuitry, however, and cannot be switched on until the radio itself is operating.

Although all the instructions supplied with the 5001 were in German, the controls were quite simple to identify. The dial and selector to the right of the cabinet evidently were the means of moving from one track to another. Left of the dial was a graduated scale, resembling a colourless thermometer, which evidently displayed the tape's position along its 22-minute run. Beneath lay a small transparent window through which part of a red and white wheel was visible, its purpose being to indicate tape motion.

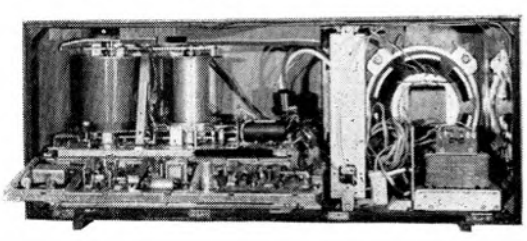
A plastic panel between the track selector and radio controls governed all tape movement. The two rectangular buttons RADIO and TAPE provided the means of switching on mains power. Next to this was a small white WIEDERGABE, a German expression that could have meant anything from FAST WIND to FUSE BLOWER. It meant neither. Pressing WIEDER, GABE set the small white wheel in motion-actuating the playback mechanism through a solenoid. PAUSE meant exactly what it said, again working through a solenoid, but STOP held a few surprises. This button causes the tape to wind back at what sounded an extremely fast speed. If 800 Englishmen buy a 5001, then 800 Englishmen will endure the seconds of panic I felt when searching for a control to stop the STOP. In addition to its solenoid mechanism, however, the unit incorporates a sequential switching device which halts the tape when it reaches the leader, runs it forward again to the nominal beginning of the track, and declares itself ready for action by switching on a dial lamp. To the right of STOP is a red button marked AUFNAHME which *Telefunken* and *Uher* have already familiarised as meaning RECORD. Like most solenoid machines, the 5001 lacks an effective interlock against accidental erasure. Schaub Lorenz have overcome the problem by requiring the operator to twist the button slightly before being able to press it inward. AUFNAHME may be selected from a neutral tape position or during playback and immediately causes a red light to replace the white indicator lamp behind the selector dial.

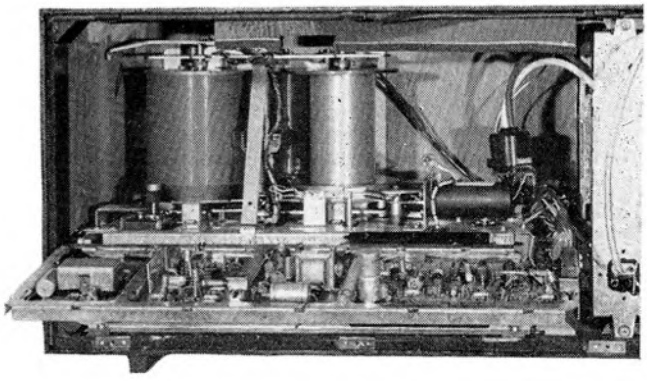
There are no gain controls or meters with which to fiddle, automatic gain control making the unit very straightforward to operate but, at the same time, preventing the fade in and out of programmes recorded only in fragment.

Four rotary controls protruding from the radio panel govern tuning, treble (DISKANT),

(*continued on page 235*)

Above: Front view of 5001 with track-selector covering panel removed.
Below: Rear view showing hinged circuit board, mains transformer and loudspeaker.
Right: Close-up of the transport mechanism. Fast rewind motor spindle is visible at lower left of supply reel.





bass and volume. The latter knob, situated on the bottom left of the four, is the only one of the four without an obvious label or purpose.

Though unfamiliar in layout, then, the 5001 is quite foolproof with or without an instruction booklet. To prove the point, I left the unit in the hands of a younger sister (17 years, moderate intelligence) who was almost entirely familiar with the controls after 15 minutes of experiment.

Note the *almost*. The Music Center seems initially to have a mind of its own. Tiring of a certain recording, it will occasionally emit a rasping hum, stop, move itself on to the following track, rewind itself and then proceed to play whatever music, speech or tape hiss that track may contain. Far from being haunted, the recorder embodies a sophisticated sensing device also found on the more elaborate *Ampex* machines. When the STOP button is pressed after a period of recording, the tape continues its forward motion for a few seconds during which a low frequency tone is recorded. When the tape is later played, this hum actuates the stop/rewind mechanism and also automatically changes the track. Like AGC, this can have its disadvantages in certain situations. If one records a fairly long item, for example, later placing a short piece of music over the start of a track, the unit will switch itself to the following track at the end of the short piece without continuing to the other material on the present track. Judicious use of the pause control overcomes this problem when it arises, however.

More annoying, though again a minor point considering the purpose of the 5001, is the total absence of a fast-forward spooling facility. If you desire to show off a recorded item at the very end of a track, that item cannot be reached in less than 20 minutes or so. A few dozen idlers or belts might have achieved this feature, though the manufacturer obviously did not want to over-complicate the mechanism.

Had the 5001 been a mechanical nightmare —which it might, considering what it has to accomplish—it would have been returned to the importer and no report would have been prepared. Obviously it is an obsolete model and unlikely to be familiar to the electrical servicing trade. In fact, however, the recorder is visibly simple in conception once the hinged rear circuit boards have been pulled down. A stabilised DC motor drives the take-up drum through an idler, causing the tape to be pulled relatively slowly past the heads, increasing speed as the effective hub diameter increases. Average speed is 10.5 cm/s. Rewind is very much faster, the tape being driven by a separate AC motor pulled against the supply drum rim by a solenoid. The most intricate part of the system was not the transport mechanism at all but the track selector. The 126 tracks are divided into sets of nine, indicated on the moving dial as *A.1*, *A.2*, etc., and culminating 46 hours away at *0.9*. Before mathematically-minded readers rush for their pens, I should mention that the letter *I* is for some reason omitted from the scale. The selector knob clicks positively from one track to the next and drives the erase and record/play heads through a series of cogs. The two heads are mounted on a single bracket and one hopefully assumes that any change in alignment would be common to both heads.

The 10.2 cm. tape is manufactured by *BASF* and showed little sign of dropout during the three weeks intensive use the 5001 received. A substantial margin at each edge eliminates the outer-track fading common to most medium price ¼-track recorders. Hiss was the most obvious fault in the system but this was still low enough to be easily confused with hiss in the radio itself. A good external VHF aerial would probably eliminate the latter but, with the internal aerial, broadcast and taped material were very difficult to distinguish. In terms of quality, the 5001 was comparable to a £40 ¼-track recorder, reproduced through a fairly good external radio or one-piece radiogram. Wow was audible but not distressing and corresponded to the idler rotation frequency. Flutter may have been present but was sufficiently low to be masked by distortion in the amplifier chain. At extreme settings of the tone controls, the cabinet thumped and tizzed in a rather tiring manner and an external speaker would probably have improved matters considerably. Care should be taken when recording to prevent loudspeaker and cabinet vibration returning to the tape itself since this might cause flutter; so much for logic —in reality the effect was never noticed. The 5001 made a better noise on its own speaker than even the best conventional recorders through theirs. I regard the *Ferrographs* and the *Revox 736* respectively as having the best monitor quality, though they too have a tendency to thump when fed with excess bass. (Who will be the first to fit a *Goodmans Maxim* as an internal monitor?)

An unusual multi-pin connector is fitted to the rear of the unit to permit connection of external equipment. A small preamplifier is supplied, allowing the equally detestable DIN plugs to be connected without excessive fuss. The 5001 accepts signals from external tape equipment, at line level, though the AGC makes it difficult to select an optimum input since anything slightly off the ideal is compensated for by the record circuit, at the expense of greater distortion or increased noise. This applies, of course, to all machines with automatic gain control. Recording from the 5001 is possible through the multi-pin socket.

Despite its size, the Music Center is a fascinating plaything, growing more valuable to the user as its tracks begin to fill. With increasing use, however, the problem of head cleaning is inevitable. There is no simple route to the head faces, other than removing the chassis from the cabinet and dismantling the tape transport. When approached on the subject, the importer suggested squirting petrol on the tape, switching to WIEDERGABE and letting the tape itself perform the task, cleaning the tape as it winds on to the take-up drum. Oddly, the idea seems entirely practical.

two tape recorders and disc, or radio, tape and disc, or tape, disc and microphone, without the need for complex mixing and matching circuits. It is designed to feed the microphone input of the tape recorder, with the insertion losses in the mixer providing the necessary attenuation to match the high level sources to the high sensitivity input of the recorder. Passive mixers of this type are generally less suitable for mixing several microphones as the insertion losses put some strain on the noise performance of the input stages of the tape recorder as well as increasing the likelihood of trouble from hum at these low levels. However, it is possible to cater for an input from a single high-output high-impedance moving-coil microphone (a crystal microphone needs an input inpedance of Megohms and is therefore less suitable).

The first circuit is for three similar inputs at high level. Interaction between the controls is small because of the 470 K isolating resistors and the relatively lower impedance at the mixing point due to the input impedance of the microphone input of the recorder (often about 100 K) or the padding resistor across the output if the recorder's input impedance is higher.

The second circuit (**fig. 6**) is one which was made up to go with a 16 mm. sound film projector to allow the operator to mix microphone, sound effects discs and tape, as necessary, when projecting occasional silent films. It was not felt that for the amount of silent-film work involved, an active-circuit mixer with fuller facilities would be justified. There is some reduction in gain on the other channels as the microphone is faded up, but in practice this has not proved troublesome and the effect is small. The microphone control acts as a series attenuator, and the loading of the microphone at the bottom of the control (with its effect on frequency response) is not significant as the microphone output is then down 20 dB which is low enough not to matter as the main gain is normally adjusted to suit a fully-open microphone control. The crystal pickup input presents an impedance of between 1 and 2 M, which is about adequate; the capacitor Cf was added and adjusted by ear to compensate to some degree for high frequency peaks in the cartridge in use and to provide a measure of filtering and tone adjustment. The lead between the mixer and the amplifier input must be kept short to avoid noise pick-up. An *Oxo* tin or similar metal box can be used to house the components.

All the preamps described can be conveniently built in small metal tins such as *Gold Block* tobacco tins or *Sucrets* cough sweet tins which are compact and robust, and soldered connections can be made to them. A pair of small 9 V batteries is the most convenient way of providing the 18 V supplies, unless a well smoothed auxiliary supply is available. The circuits will work down to 9 V or so, though the linearity will suffer slightly, but the 2N2926s should be substituted with higher voltage devices if the voltage is increased. The 2N2926 transistors are available at about half a crown from *Jermyn Industries*. The *Mullard* BCY71 can be obtained to order from certain London dealers, and the rest are available from *Texas Instruments* or *Quarndon Electronics*.

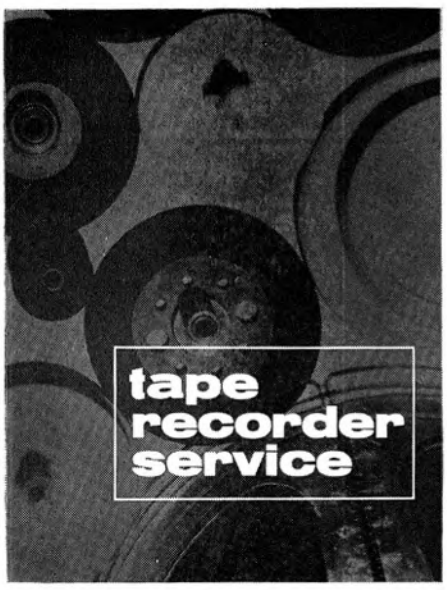
TECHNICAL authors grow thick skins. What with trying to run a service department during the day—plus all the exasperation *that* can entail—then cooping oneself up in the evenings to hammer out some deathless prose while wiser folk (like our Editor) are enjoying themselves at some concert or knocking holes in walls to modify room resonance, we grow callouses on the sensitive spots.

Nevertheless, having been justifiably chided a couple of times of late for giving an opinion, rather than stating pure fact, this contributor intends to stick unequivocally to service information for the remainder of this article. And what better way to do so than to reduce the verbiage?

So, how do we get away with that subterfuge? You may well ask. We humbly beg the aid of our draughtsman in redrawing some of those abominable jottings that adorn our workshop notebook, and illustrate some of the deck details of both these machines, the *VR7*, discussed last month, and the *VR4*, whose circuit is on the accompanying page.

But first, a note or two about the circuit. Comparing it with the VR7 of last month, we first see that it is completely transistorised, even to the extent of dispensing with a magic eye and using an edge-reading meter. Incidentally, for the several readers who request specific information on modifying magic eye to meter, and who apparently missed some interesting discussions in this magazine last year, comparison of circuits like this may well help them in their own construction.

In this circuit there is an implicit answer to another question often posed: how do we manage when we combine two sections of an amplifier with opposite polarity. Stage A has positive chassis return and Stage B employs the negative return mode—the usual question being, shall I blow something up? The answer of course, is *no* . . . we hope. Exactly these conditions obtain in the VR4 input stages. The preamplifier is a BC108, which my little book tells me is a "Silicon *n-p-n* epitaxial planar transistor" and being *n-p-n* it has its collector positive, whereas the OC44 which it feeds is *p-n-p* and has a negative voltage applied to the collector.



VAN DER MOLEN VR4

BY H. W. HELLYER

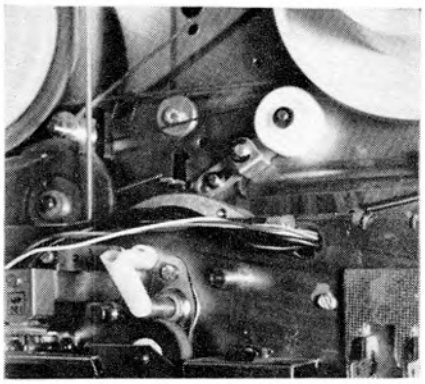


FIG. 2

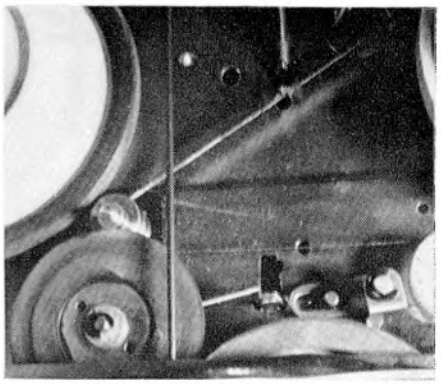


FIG. 2A

Taking care that the relative bias voltages are correct, with respect to the positive or negative side of the circuit, all that remains is to ensure that the signal is applied between the correct terminals. And the vital point that must be hammered home is that to the signal the top rail, or 'HT line', is virtually at chassis potential. This is because of the heavy decoupling. With, in this case, 2,000 μF at the voltage feed end of the circuit, 1,000 μF after the first filter, and a further pair of 125 μF each after later interstage filters, there is not going to be much audio left to get back into the power circuits. So the input signal can be applied, as it is, between the base of the input transistor and chassis—even though, in this case, the chassis is the collector return line. I hope I have made my point, but must underline it with one more observation; when joining up circuits, as during experiments, remember always to keep the chassis return lines complete and constant to keep the chance of hum caused by inductive pick-up to the minimum possible. This, I regret, is not always so easy to do.

From the collector of the first stage, the signal is applied, again between chassis and take-off point, to the gain control and thence to the base of the OC44, which is now 'right way up', i.e. negative at the top. This is the great beauty of transistorised circuits, and something it is very difficult to do with valves. Shockley and Brattain should have done their stuff when we oldtimers were apprentices; then we would not have had to unlearn all our old 'electron stream' ideas. For the readers who are still hesitant about transistors, let us pray the foregoing offers some little encouragement.

Further comparisons with the two circuits are invalid. The BC109, used in the VR7, is a low-noise version with slightly higher current gain. This is not so important, as the extensive feedback loops tend to even gain figures out. But the output stages of the VR4 are completely transistorised, using an AD161-AD162 complementary push-pull pair giving a 5 W output to a 20 cm. loudspeaker. Impedance of the loudspeaker is a nominal 8 ohms at 1 kHz, and the rated frequency response of the circuits at 7½ i/s (19 cm/s) is genuinely within ±3dB from 40 Hz to 15 kHz.

But enough—we can read all about that in the brochures. Readers of *Tape Recorder* will probably be aware that both these machines are intended to be operated vertically—no compromise, for gravity plays a part in the lever system and the flywheel bearing is a spring-and-cup type, not the conventional retained 'ball'.

The motor pulley does a three-fold job. **Fig. 2** shows the central portion of the deck, with these functions readily illustrated. During playback, the pulley drives the rubber idler, whose level is determined by the usual ramping device for speed selection, (i.e. engagement with the appropriate step on the pulley). The idler engages the flywheel, whose rim can just be seen. The capstan is concentric with the flywheel spindle and a nylon limiter is used to prevent outward throw. Within the upper flywheel bearing, plainly visible in **fig. 2,** is a compression spring, and here we find one possibility of rough running if dirt has found its way inside. Fortunately, removal, cleaning, relubrication, and, if need be, slight retensioning of the spring, is very easily carried out once the clamp has been removed.

The second function of the motor pulley is to act as a belt drive, with a fair degree of slip. In **fig. 2,** the belt is shown tensioned, as for take-up during play, and in **fig. 2a,** we see the belt slack, in the neutral position. Now this belt has been a bit of a bother, and the makers have found it necessary to modify it for a slightly shorter type, with a rubber 'tyre' now inserted in the belt channel of the right-hand spool to offer a little more friction. (Models later than Serial No. 10500.) Somewhere I remember reading that this belt took nine years to develop. It is the sort of fabric and rubber belt that several other machines employ, but longer and thinner than many of its rivals—perhaps that explains the attenuated period of gestation. However, if it needs replacing, as it will when heat and dirt take their toll, use the later type and fit the rubber tyre to the right-hand spool, and then make the necessary clutch adjustments and there should be no further trouble. These clutch adjustments we shall come to in a moment.

Before that, we must discuss the third function of the motor pulley drive, and this

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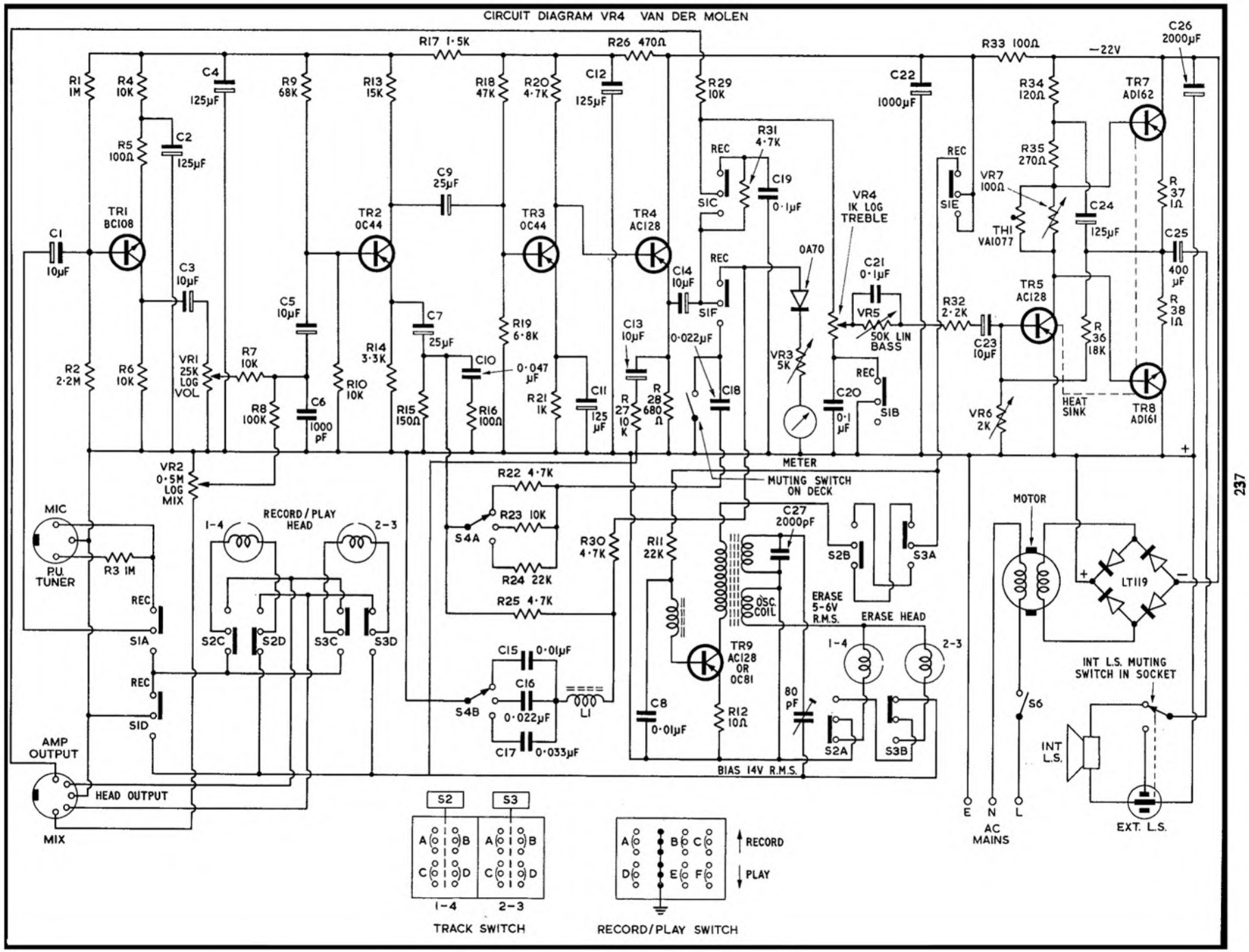


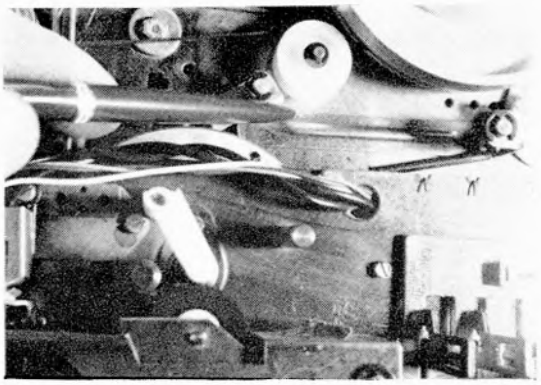


FIG. 4

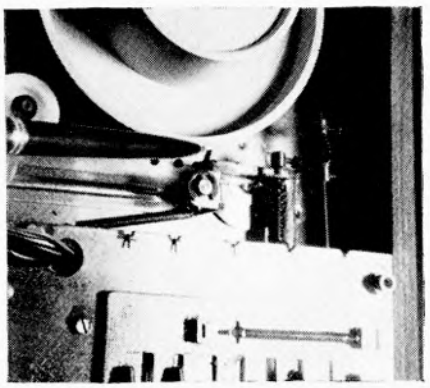


FIG. 4A

is for fast rewind. Its importance is twofold : first, it has to impel the left-hand spool quickly and smoothly to achieve an even winding of tape, and second, the spool carrier must be 'clutched' in a way that permits this direct drive while retaining some back torque during play or record. This is by no means easy, as those who have taken the trouble to read the two books by Messrs. Spring and Schroder, recently reviewed in these columns, will readily recognise. It is especially difficult with a vertically operated machine, where the gravity system, taking advantage of the weight of tape on the spool cannot be employed.

The answer is a form of clutch that gives a light outward thrust during play but is easily overcome during fast rewind. A small felt disc is used, just as in many other clutches, but it is mounted on a 'spider' that sits concentrically around the hub bushing that protrudes from the deck. Its three 'fingers' just engage through holes in the bearing flange and its outward tension is given by a light compression spring. For what it is worth, my drawing of **fig. 3** shows the assembly in sectional view, while **fig. 2a** gives some idea of the removable tyre that is fitted around the outer edge of the left-hand spool carrier, and the way it engages the motor pulley when the whole bearing is moved by the long 'cycle-spoke' arrangement running horizontally across the centre of the photograph.

Incidentally, the vertical 'spoke' is the one that actuates the brake lever assembly : this runs along the top of the deck.

This left clutch assembly needs some attention if there is an excess of back drag. Slight wow can be caused, and lead one to investigate the 'usual' causes, flywheel, pinch roller and its mounting bracket or take-up spool, where incorrect setting of the bearing bracket, which is adjustable, may sometimes be the origin. But if the obvious causes are ruled out, never overlook this possibility of erratic 'drag'. Check, especially, the setting of the rod and lever at the key end of the system, where stickiness may cause the bearing of the left spool to be too close inwards, and even allow the edge of the tyre to scuff the motor pulley occasionally.

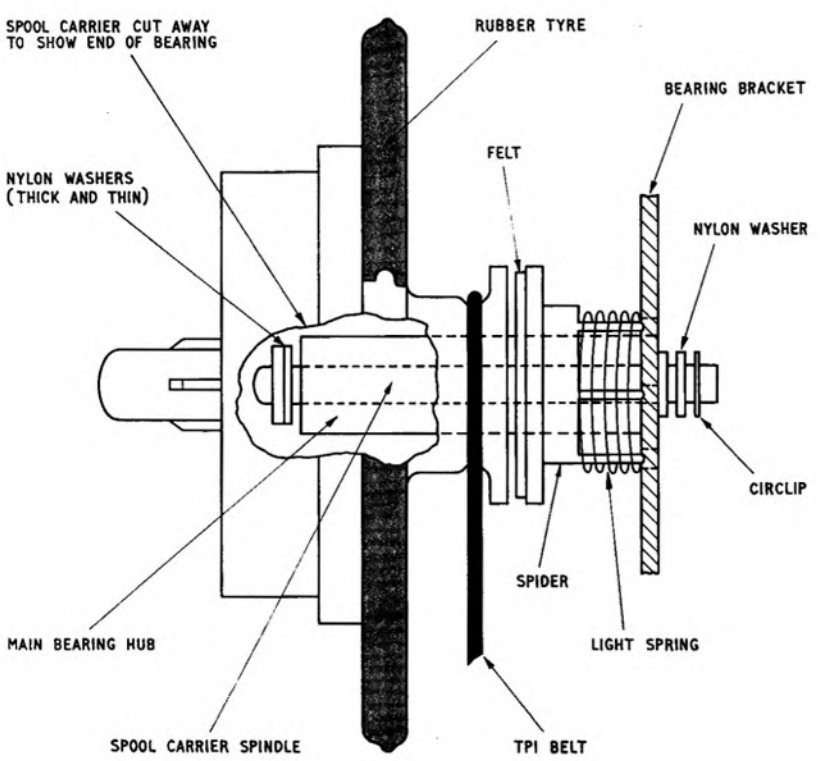
But more usual is a drying of the nylon washers, shown in **fig, 3,** between the inner part of the spool carrier and the barrel and again at the rear of the spindle, under the circlip. Take care when dismantling and reassembling to refit these washers in the right order. There are thick and thin versions to get the right spacing.

Another hidden cause of back-drag may be a sticky tape position indicator, or, more usually, its pulley. The TPI belt comes up and over the inner hub of the left spool carrier. So far, there has been no problem with belts, but dust and heat can cause sticking TPI gears and pulleys on any machine, despite the maker's care in design. One such instance we had seemed to have been operated in the coalhouse.

And so to take-up, the trickiest problem of the lot. Mr. Van Der Molen was most helpful when the original batch of the VR7 machines came on the market and two or three evinced take-up troubles. I blush to think of his telephone bill and can do no better than pass on his advice. The take-up is achieved by partially tensioning the fabric/rubber belt to the right-hand spool carrier. Slipping drive on the motor pulley allows the tension to be maintained correctly throughout the 7 in. (18 cm.) spool. But this depends on the movement of both the spool carrier on its bearing and the white plastic pulley shown in our photo, **fig. 4,** and the pivot lever on which it is mounted. In our photo it is shown in the take-up position, i.e., in the Play mode, and it will be noted that the arm sits roughly horizontally. This is the position to aim at, advocates Mr. Van Der Molen, and to get this one must adjust *not* the lever linkage at the bottom but the spool carrier bearing bracket.

(*continued on page 244*)

FIG. 3



CrO_2 -tomorrow's tape?

A REPORT ON DUPONT 'CROLYN' BY EDWARD TATNALL CANBY

REPRINTED FROM FEBRUARY 1968 'AUDIO'

A MONTH after I learned about a dramatic new kind of magnetic tape based on a chromium dioxide compound, the august *DuPont* company gave an informal demonstration of the new product, which they call *Crolyn*, before a potent and intensely interested group of audio engineers at a meeting of the New York section of the *Audio Engineering Society* (AES). This slightly inquisitive non-engineer (who had been foresighted enough to become a charter member of the Audio Engineering Society many long years ago) hastened to the scene to listen in, and hopefully to sniff the winds of change.

They blew all right. They fairly whistled around the slightly antique New York hotel ballroom that Bob Fine has converted into a very un-antique recording studio. This was one of those Major Occasions. Or so I felt. A great deal more than just another new and better tape was involved here.

It was a peculiar meeting in a way. Great Commercial Empires have a distinctive style of presentation for their new products, as those of us who have attended press reviews, seminars, technical convention presentations and the like have long since discovered. It might be called the cryptic underplay, or the super-soft sell. The larger the Commercial Empire, the slicker is the presentation—and the more utterly offhand are the 'claims'. Indeed, the air of genial informality can get so intense you can slice it with a knife! You have to be on the spot to appreciate the phenomenon. Sometimes you can learn more from mere tones of voice, from fleeting smiles or frowns, from very expressive deadpans, than you can from the actual words.

After all, it is a huge responsibility for a man to stand up before a professional audience and represent, in his person, perhaps a cool billion dollars of sheer corporate entity. And to talk about a new potential that also may involve enormous investment sums. If you were acting as Mr. DuPont, personified, wouldn't you play it cool?

And so I give my full admiration to the two DuPont gents (I'll leave them their anonymity) who so engagingly and offhandedly described DuPont's new tape for us. They were surprisingly straightforward, I thought, and remarkably unevasive. Only once or twice did I get that certain feeling that maybe, behind a deadpan answer to a probing question, there just might be a bit more involved than was being said in so many words. The net result added up to a very impressive presentation—underplay or no. That is, that this chrome tape is going to be as big a thing in our audio field, I would guess, as it already promises in the large first-priority areas of computer and instrumentation where it is now in limited commercial production.

NO SINGLE TAPE

A few basics. First—we must understand that to develop a 'family' of tapes from a single new magnetic compound of this sort involves a long period of research and experiment. There is no single tape for all purposes, and desirable characteristics vary greatly. They even vary within our relatively simple audio field. It seems wholly reasonable for DuPont to have turned first to the pressing needs of the non-audio tape areas, formulating its new tape first in those special terms. Audio inevitably comes further down on the priority list—we are a bit smaller than we think, you know. But, *unless* there are fundamental problems, basic faults or disadvantages, the audio demands will inevitably be investigated and audio tapes will be formulated to fit our special requirements. Business is business, and nowhere more so than *chez* DuPont. They'll admit it cheerfully.

Chromium dioxide, the basic new material, is a synthetic that does not exist in nature. It is derived from chromium trioxide at high temperatures (above 375°C) and a pressure of 3000 atmospheres of oxygen. You won't be synthesizing it in your kitchen sink. (Presumably the stuff could occur at the pressures and temperatures found near the earth's centre. But we aren't likely to be mining around down there in the near future.) DuPont was the first to synthesize it and when the rather extraordinary magnetic properties of this material became apparent, they inevitably went into the preliminary developments that would lead to a new tape.

The dioxide comes in needle-like crystals (roughly 10:1 in configuration, length to width), as DuPont puts it, "acicular, single domain particles which can be varied in length from four to 400 microinches'' and with a coercivity that "can be varied from 25 to over 700 oersteds". The saturation flux density is 6100 gauss and the Curie point is 126°C. This oxide has "a higher magnetic moment per unit of volume than gamma iron oxide typically used in conventional magnetic tape"; and this overall characteristic "leads to many practical advantages in the various industries which rely on magnetic tape for information recording". That may be the understatement of the year. In the Canby lingo, the stuff just has more umph per inch—a lot more. And—so far—very few serious problems, actual or anticipated.

It is especially significant, if I read the photomicrographs I saw correctly, that chromium dioxide forms a marvellously even and smooth coating for tape, the particles much more uniformly dispersed and much smaller than even the best iron oxide in present high-grade low-noise tape. This, you see, slants the spotlight straight in the direction of our most vital area of present development in audio:

(*continued overleaf*)

slow-speed, narrow-track tape recording. And, as we shall see, so do other factors.

There are some grand DuPont diagrams to illustrate the umph of this chromium dioxide. Its basic hysteresis loop is fantastic—superimposed on that of top-quality iron oxide tape, it starts lower, goes up much higher, and has longer, straighter slanting sides. The signal-to-noise ratio, necessarily somewhat variable from one type of formulation to another, is claimed *from 3 to 8 dB better* than comparable iron oxide tapes. You get both a higher signal *and* a lower noise, for the same input, though—at least on the instrumentation tape now being made—the maximum advantage seems to be well above 100 kHz. Even with my limited savvy in these technical areas, I still get the strong impression that similar S/N advantages will show up when the basic material is adapted specifically to audio needs.

Videotape is the big second-string market coming up for chrome tape, after the computers and the instrumentation needs are satisfied. Videotape gets much closer to our audio characteristics; for the same basic problem exists there as in present audio cassette recording—how to get more signal on less tape. We were given a beautiful endless-loop video demonstration on a pair of *Sony* machines, one of them adapted to run at half-speed, 3¾ i/s (9.5 cm/s). Each loop was made up half of standard tape, half chromium, and the picture thus jumped, AB-style, from one tape directly to the other. (Because bias requirements are quite different, a higher bias being needed for chrome, the bias was manually switched as the tape patches went by.)

This dual demo proved an important point which applies directly to audio. At 7½ i/s (19 cm/s), the standard Sony tape speed, there was only a slight difference in picture quality between chrome and iron oxide tape. Explanation: *Other factors than the tape itself* were the limiting ones. The same thing will be true, generally, in terms of chromium tape used in higher speed audio recordings, though there are still, so to speak, residual advantages.

However, when the half-speed video-tape loop was played at 9.5 cm/s, the difference in picture quality was striking—chalky highlights, ragged details, grainy snow, from the standard oxide tape; a startlingly smooth, clear picture from the chrome. Slow-speed resolution! In fact, and this is the basic improvement factor at speeds where the tape itself is now often at fault, the ratio of quality was approximately two to one. That is, at 9.5 cm/s, chrome tape on the Sony gives as good a picture as iron oxide tape at 19. Momentous, yes?

CRITICAL SPEEDS

Once again, the maximum and most significant advantage of chrome occurs at the critical slow speeds (or, more precisely, short wavelengths on the tape) where iron oxide itself, even the best, has now become a basic limiting factor. It is in this critical area, the area of the slow-speed cassette for us, where the full 2:1 advantage will apply. And in unexpected other ways, too.

For example: cassette tape requires a thin oxide coating, as well as a thin base. At the *same* speed, a chromium coating *half as thick* as an iron oxide coating on polyester material will give the *same* response. And the slower the speed, the more microscopic the actual recorded wave-shapes, the greater is the chrome advantage.

In this specific connection, I must quote DuPont in respect to its present instrumentation chrome tape. The significant performance factors here have to do with such things as information integrity at high bit rates per inch (bpi), flux changes per inch, etc. (where the same general doubling of performance is shown); but the following seems just as likely to apply to our own audio field, if and when:

PRONOUNCED SUPERIORITY

"At the shortest recorded wave lengths—60 microinches on 2 MHz recorders—the superiority of Crolyn is most pronounced. (And) the performance advantage of Crolyn tapes over high-quality iron oxide tapes *appears to widen at still shorter recorded wave lengths*, based on results from experimental and laboratory recording equipment." (Italics mine.)

In the question period after DuPont's New York presentation, someone asked about prospective frequency response under audio conditions at very slow speeds. With the utmost casualness, as though it really weren't very important, the DuPont man said (and I quote, more or less verbatim: "Oh, I'd say with optimum heads and so on, 20 kHz at 1⅞ i/s (4.75 cm/s)".

20 kHz ! 20,000 cycles — if I may use the old terminology! Natch, this was only in the rough, this answer, without associated figures. But no matter. If I read it correctly, what he meant was simply that the particle size and uniformity of distribution, plus the inherent magnetic quality of this chrome material, should make possible this superb frequency range at the new and ultra-important cassette speed. Wow! Some tape. I want it.

LIVELY QUESTIONING

Is there a catch? Are there many catches? Well, the questioning was lively, but DuPont was pretty quick. Not until question No. 14 (I counted them) did someone ask what seemed to me a clincher—how about abrasion? Well, they said, that is largely a matter of the formulation of the binder, rather than the basic oxide itself, and there are, of course, many binder formulations. When pressed further, the DuPont man said flatly that the chromium dioxide crystals themselves are *not* more abrasive than those of iron oxide. He said it. I wrote it down. But—and here is the advantage of being present in person—I thought that I detected just the merest whiff of an understandable evasion in this interchange. Yet, after all, DuPont is still in the midst of developing this wholly new tape, and has not even (at this writing) made a start in the audio direction. Moreover, if the instrumentation tape is already in commercial use (via Honeywell equipment designed especially for it), then there are surely answers, if indeed there is any serious problem of abrasion. We've had such problems before.

Print through? On present instrumentation chrome tape, *7 dB better* than equivalent low-noise iron oxide tape. That's what they say. Bias and erase? No unusual problems, though some machines will require higher bias levels than now available. Stability? Only limited by the tape base. That is, they have not yet been able to destroy a recording without destroying the base itself. Storage? "No problems"—this after several years' experience to date. Changes needed in equipment? According to normal practice, only in recording—not in playback. Any trouble in binding to base? None. DuPont says it knows all about those things, and didn't really expect any problems, other than the normal ones with tape.

Somebody wanted to know what advantage there would be in using chrome tape for higher-speed mastering, since the most immediate advantage seems to be at very slow speeds. The answer to this I missed in part, and so got down only a dangling comparative: ". . . 3 dB more, at 3% harmonic-distortion output; also on up to saturation". Sort of incomplete, that statement, but it sounds hopeful.

How about film striping? How about magnetic discs? Haven't even thought about them. Later, later, later. How much will it cost? Here the DuPont men waxed very cryptic—and who could blame them? A whole industry depends on it. But they did opine that in the video-computer areas their chrome tape would cost from 20% to 50% more than, presumably, standard high-quality iron oxide tapes.

Considering that you can use only half as much tape for the same quality of resolution—and the same will be generally true in audio—this would make the stuff reasonably cheap I'd say. But at mastering speeds, which probably will not be reduced for the new tape, the cost factor will revolve around the improvements to be had without speed changes. And in effect the same is true of slow-speed tape in cassette and similar form.

So there you have it. Most of it, anyhow. I must say again that, having been in the actual presence of the DuPont representatives and having seen and heard their demo material, I am reasonably convinced that no major, glaring deficiencies in chrome tape were being glossed over or even minimized, at least as of its present stage of development. I speak only for me, not for DuPont—I am no part of their Big Commercial Empire! (Though my Daddy used to horse around with the DuPont boys back in the old days in Wilmington, he didn't acquire any stock, alas.) I'm just an intensely interested outside audio observer—and so are you, I'll bet.

WHEN?

Two *big* questions just had to be answered before we all left that AES meeting if we were to sleep tight and feel right. One of them was forthcoming—No. 16. *When?* I am still not quite sure I could have heard right; but what DuPont said, I *think*, was: "We certainly hope to have something concrete (in audio tape) to tell you, to sell you, in 1968".

Now if I'm getting those DuPont boys into trouble, I am truly sorry. It just might have been 1969, they said. Or meant. Anyhow—without much doubt we'll be seeing and hearing this stuff in the near future, formulated precisely and specifically for audio use.

The other question? Oddly, nobody asked it. Will anybody *else* be able to make chromium dioxide tape and sell it competitively? Like, say, pardon the expression: *3M? You* ask DuPont. I didn't.

TANDBERG 64X
STEREO TAPE UNIT

THE Tandberg *Series 6* has been with us for six years. I reviewed the original *62* ½-track recorder in April 1962. The external appearance of the *64X* is almost identical to the old model and the playback response from test tapes, wow and flutter readings, and pen recordings, are so similar that they might have been taken on the same machine.

The record/play responses however have been extended upwards by one octave at each of the three speeds by the use of the new opposing-field bias system. Yes, it really does work on this machine and with lower tape distortion than ever before! However, let us go through the standard sequence of tests before getting down to a closer look at the biasing system.

The pen recordings of **fig. 1** show the short term speed fluctuations and RMS flutter bridge readings at the three tape speeds. Combined wow and flutter on record/play of the standard 3.15 kHz test tone at 7½ i/s (19 cm/s) remained stable at 0.07% with 20 Hz capstan wow and high frequency friction flutter in about equal proportions. At 3¾ i/s (9.5 cm/s) the top trace shows a slight trace of 10 Hz wow, but this was the worst reading obtained over a series of tests and was due to the adding of the record and play wows for a short interval. Best and worst readings were 0.08% and 0.085%. In the same way, 5 Hz wow is evident on the top trace of the 1⅞ i/s (4.75 cm/s) fluttergrams at 0.14% with cancellation taking place on the lower trace to give an RMS reading of 0.12%.

The upper panel shows the total wow and flutter, and the wow-only readings, from low-wobble test tapes at each of the three speeds. These are the kind of results to be expected from good quality pre-recorded tapes.

Long term speed stability was within ±1% at all parts of a 7 in. (18 cm.) reel.

Fast wind or rewind of an 18 cm. reel of LP tape (1,800 ft.) was accomplished in just less than two and a half minutes.

The tape position counter is driven from the right-hand take up turntable and clocks up exactly one digit per reel revolution, i.e., 10 reel revolutions give a reading of 10.

The play-only response from standard test tapes are shown in **fig. 2** and these indicate that the level record/play responses of **fig. 3** are recorded to approximately 50, 100 and 200 μS characteristics respectively.

System noise, unweighted, was 42 dB below test tape level. System hiss, with a 500 Hz high-pass filter to eliminate hum and low frequency noise, was 52 dB below test tape level.

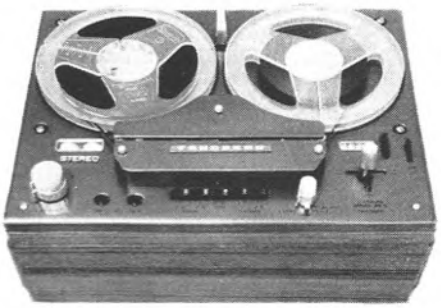
The record/play responses of **fig. 3** were taken at 10 dB below test tape level to allow for the very considerable (20 dB) pre-emphasis used at the lower tape speeds. At 19 cm/s the recording top lift was only 12 dB at 20 kHz.

These responses completely meet the specification figures and show that the cross field bias *may* be responsible for this improvement *if* it can be shown that the tape is adequately biased and that distortion at lower frequencies is satisfactorily low. It should be noted that my frequency response curves refer to the auxiliary, or direct line, input. A separate input socket is provided on each channel to accept FM stereo broadcasts. A steep notch filter comes into effect at 19 kHz to remove broadcast switching tones which might otherwise beat with the bias oscillator.

First a carefully calibrated full-track tape was used to establish 'test tape level'. This was done to eliminate any possibility of error due to vertical placement of the tracks on the normal test tapes. Track 3, near the centre of the width of the tape, was used to eliminate edge effects which might have upset the readings had Track 1 been used. Test tones of 500 Hz, 1 kHz and 3 kHz were next recorded at test tape level and at precisely 12 dB above test tape level from an oscillator with harmonic distortion of less than 0.2% at these frequencies. On playback, the line output of the recorder was first passed through a 500 Hz high pass filter to eliminate hum and low frequency noise and then fed to a harmonic distortion meter which rejects the fundamental test tone leaving only the harmonics and distortion products for measurement on an RMS meter. A CRO was used to examine the distortion residue to estimate the order of the harmonics and to see that noise and hum were not giving unduly pessimistic readings.

The harmonic distortion readings at 19 cm/s were 1.9% at 500 Hz, 1.8% at 1 kHz and 3.0% at 3 kHz at peak recording level (±12 dB on

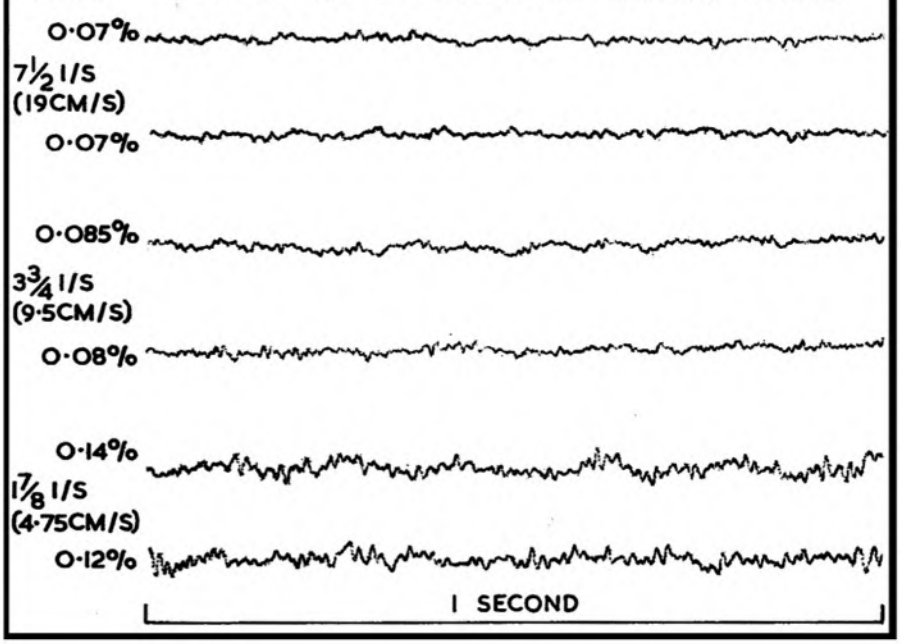
(*continued on page 243*)

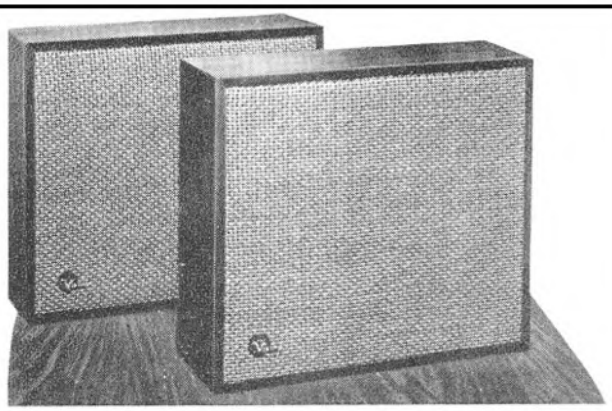


MANUFACTURER'S SPECIFICATION. Quarter-track stereo tape unit with opposing-field bias. **Tape speeds:** 7½, 3¾ and 1⅞ i/s (19, 9.5 and 4.75 cm/s). **Frequency response** (respective): 30 Hz-20 kHz, 30 Hz-15 kHz and 40 Hz-9 kHz, ± 2 dB. **Oscillator:** 85.5 kHz. **Signal-to-noise rat.o:** 62 dB at 19 cm/s, 59 dB at 9.5 cm/s and 56 dB at 4.75 cm/s. **Wow and flutter:** less than 0.1% RMS at 19 cm/s. 0.15% at 9.5 cm/s and 0.25% at 4.75 cm/s. **Cross-talk rejection:** 60 dB **Dimensions:** 39 x 28.5 x 17 cm. **Weight:** 23 lb. **Price:** £123 18s. **Distributor:** Elstone Electronics Ltd., Hereford House, Vicar Lane, Leeds 2.

PLAY ONLY WOW AND FLUTTER FROM TEST TAPE		
7½ i/s	W+F	0.07%
	Wow	0.04%
3¾ i/s	W+F	0.08%
	Wow	0.05%
1⅞ i/s	W+F	0.13%
	Wow	0.08%

FIG. 1 TANDBERG 64X CUMULATIVE RECORD/PLAY WOBBLE





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5¾"	900'	11/6	8/-
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4"	450'	6/-	5/-
5"	900'	11/6	9/-
5¾"	1200'	16/-	10/6
7"	1800'	23/-	14/-
Double Play			
3"	400'	6/-	4/-
4"	600'	8/6	7/-
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5" 600'	5/6	16/-	5" 900'	7/6	22/-	5" 1200'	11/-	32/-	5" 1/6
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test tape). These readings may be compared to similar readings taken during a recent review of the *Tandberg Series 12* recorder of 2.5%, 2.3% and 1.6% respectively. Normal readings for semi-professional equipment would be 3.0%, and 5.0% for reasonable quality domestic recorders. Thus the 64X cross field system gets full marks; it extends the high frequency response and lowers the distortion at low frequencies. Distortion at test tape level was 0.8%, 0.8% and 1.1% at test frequencies.

One significant fact emerges from these readings that will lead to a better understanding of the operation of the opposing-field bias system: where bias is applied to the oxide side of the tape, as in orthodox recorders, the 3 kHz distortion is usually *less* than that at lower frequencies (see above figures for Series 12 recorder and other recent reviews), but on the present cross field recorder, where the bias is applied from the base side of the tape, the 3 kHz distortion is slightly higher than at lower frequencies.

A crude way of explaining the advantages of opposing-field bias would be to say that if normal bias from the record head is increased so that the full depth of the oxide layer is properly biased for minimum distortion of middle and low frequencies, then the surface of the oxide on which the short wavelength high frequency signals are recorded is considerably over-biased and the high frequency signals are in fact partly erased.

When the bias is applied *through* the tape from the opposing bias head, the deepest part of the oxide layer is adequately biased and the bias is weaker at the surface where the high frequency signals are recorded.

A further factor is that interaction between the applied bias field and that induced into the record head, and radiated from its gap, reduces the leakage bias flux beyond the gap so that the above high frequency 'erasing' is markedly reduced.

Due to the deep penetration of the bias in the opposing field system, care must be taken to reduce even harmonic distortion of the bias waveform. This kind of distortion is equivalent to a very slight DC bias which would show up tape coating imperfections that would not be obvious with normal bias. A transistor push-pull oscillator feeds the erase heads directly, but separate push-pull transistor buffer amplifiers are provided for each bias head to reduce track to track cross talk and to eliminate variations in bias due to head loading.

System noise has already been given as 52 dB below test tape level or 64 dB below peak recording level (via 500 Hz high pass filter) and peak level 1 kHz tone erased on the machine was 57 dB below peak level. Bulk erased tape noise was 60 dB below peak. Unweighted readings were approximately 10 dB worse than

(continued overleaf)

FIG. 2 TANDBERG 64X PLAY–ONLY RESPONSE (TEST TAPE TO LINE OUTPUT)

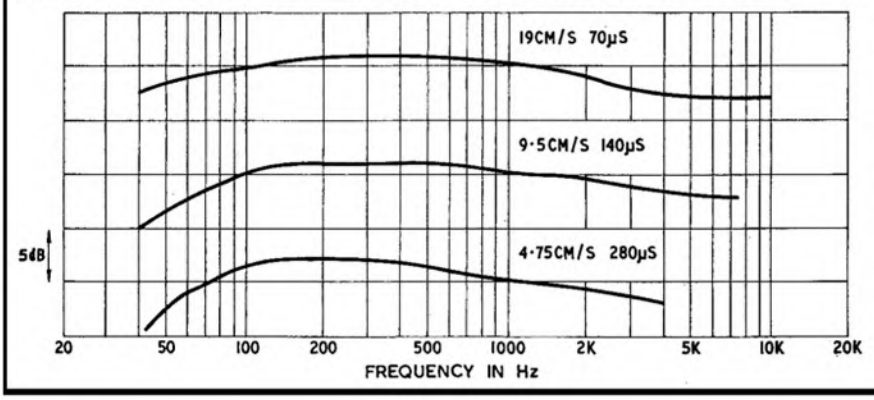
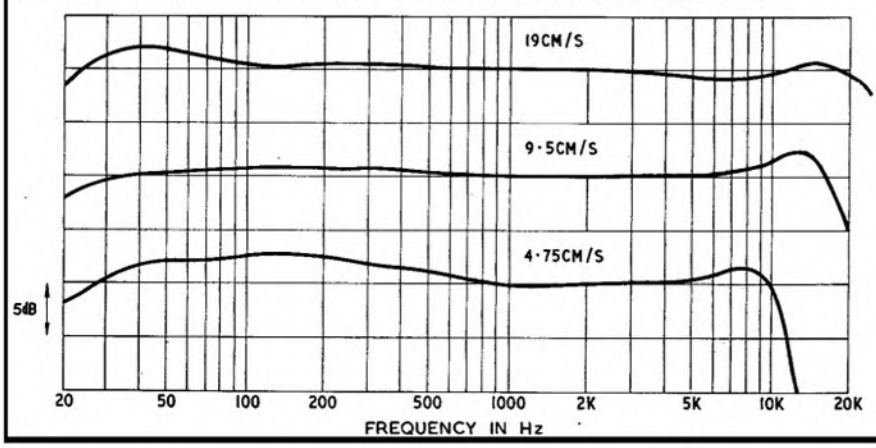


FIG. 3 TANDBERG 64X RECORD / PLAY RESPONSE (AUX. INPUT TO LINE OUT)



TANDBERG 64X REVIEW CONTINUED

these figures due to low frequency noise and slight mains hum, but a 50 dB unweighted signal-to-noise ratio is still excellent for a ¼-track recorder. Tape overload is very gradual and the reproduced waveform is only slightly rounded at the peaks at 15 dB above test tape level.

COMMENT

At the end of my review on the Model 12 (November 1967) I said that I would be interested to see if the low distortion of the Series 12 could be maintained with an extended frequency response by using cross field bias. The answer is that the distortion is slightly lower at middle and low frequencies and that the high frequency responses have been extended to

TAPE RECORDER SERVICE CONTINUED

At the top right of the deck a single screw secures this and is in a slotted hole. Move the bearing by very small degrees until the correct balance of take-up is achieved with the lever horizontal. Test with full and empty spool on the right-hand carrier, and then switch to fast forward wind and note that the pulley does not foul the edge of the spool carrier, if it does, adjustment may have to be made to the nutted 'stopper' at the end of the 'spoke' that is pulled down by the key lever. This item is more clearly seen in **fig. 4a**, which also gives a clue to the gravity device I mentioned before.

The outer end of that horizontal lever terminates in a lead weight, and this acts against the rather hard compression spring on the relevant spoke. The pivot point is indicated and it will be noted that there is also a fairly long return spring at the bottom of this pivot bracket, hooked into a cut-out in the deck.

PIVOTED BRACKET

The important point is that the pulley itself is not mounted directly on this lever, but a pivoted bracket. It has a slot to enable it to ride freely upwards for full engagement on fast wind, and here we may find a bit of trouble if the slide action is a bit reluctant. I have once or twice modified the action by adding a small washer under this pivot bracket,

ADVERTISERS

limits set mainly by the gaps of the playback heads.

With modern fine gap heads it is now possible to replay recordings of up to 4 kHz per inch tape speed, but, up till now, it has been extremely difficult to record such frequencies on to the tape without under biasing and the consequent risk of high distortion at middle and low frequencies.

I must admit that the bias has been switched to a slightly lower level at the lowest speed of 4.75 cm/s, but 11 kHz at this speed is better than 5 kHz per inch tape speed and who cares about a little more distortion at this speed! Even so, there were no symptoms of under biasing at this lowest speed and, apart from a slight extra hiss, there was nothing to indicate that the capacity of the tape was being pushed to the limit. **A. Tutchings.**

---

where it slides on the fixed pin, to achieve clearance from the pin's shoulders. But this is an emergency measure, not recommended procedure.

The brakes are unconventional but—touch wood—not troublesome, and need no illustration in this case. To the right, a felt pad is looped over a lug on the main bar to engage the outer rim of the spool carrier, to the left, a small neoprene roller is spring-loaded in a cutout of the same main bar to engage the outer rubber tyre of the spool carrier and the spring allows the spool to come to a stop without the brutal snatch that a direct brake would have given. Quite a simple, and effective idea, again depending on the lever linkage for its initial setting, and adjustable if necessary by the nutted 'stopper' on the spoke.

PAIR OF PLATES

Finally, the pressure roller assembly, which consists of a pair of plates with semicircular cutouts in which the upper and lower ends of the roller spindle sit. These plates are engaged by a forked spring whose fixed end is screwed to the main engagement bracket. Apart from the need to clean and lubricate the spindle once in a while, there should be no bother. In fact, for the VR4 and VR7 range as a whole I can say, quite honestly, there are few service bothers. Most important, perhaps, everything is so easy to get at—and that is worth a lot to the busy engineer !

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FOR SALE—TRADE

Blackburn has Lancashire's leading Hi-Fidelity/Tape Recorder stockists and Electronic Engineers at Holdings Audio Centre, Mincing Lane/Darwent Street, Blackburn (Tel. 59595).

Transistorised OSC./Milli-Voltmeter, combined test unit for professional and hi-fi equipment. £39.6.0 plus 8/6 p. and p. Enquiries to Lander Electronics, 24 West Kensington Mansions, Beaumont Crescent, London W.14. Tel. 01-385-0697.

30% off BASF tape, L.P. 7in. reel 1,800ft. 33/-, D.P. 7in. reel 2,400ft. 52/6. P. & P. 5/- per order. W.S.L., 104 Norwood High Street, S.E.27.

Your sole U.K. agent for spares/service of the Saja recorder. C. Braddock Ltd. (Blackpool 45049).

Clearance by order of Liquidator. £20,000 of video tape recorders and ancillary equipment. Any quantity supplied. Box No. 535 (London).

Blackburn has Lancashire's leading Hi-Fidelity/Tape Recorder stockists and Electronic Engineers at Holdings Audio Centre, Mincing Lane/Darwent Street, Blackburn (Tel. 59595).

Always be careful (and money-wise) before buying quality equipment. Send your requirement list to Audio Supply Association for evaluation and quotation. See below . . .

If quality matters consult first our 70-page, photographically illustrated catalogue (5/6) and equipment housing guide (1/6). Members enjoy unbiased advisory service, preferential terms (cash only, no H.P.). Membership 7/6. Our associates also manufacture records from your own tapes, or record the Master at our studios (Steinway Grand). Bulk terms for choirs, fund-raising. Please specify requirements. Audio Supply Association, 18 Blenheim Road, London W.4.

Standard Play. 3" 150' tapes 3s. 3d. each. C.W.O. Peter Goodall, 15 Farmley Gardens, Glengormley, Newtownabbey, Co. Antrim, N. Ireland.

STUDIO FACILITIES

Rapid Recording Service. Records made from your own tapes (48-hour service). Master Discs and pressings. Recording Studio—Demo Discs. Mobile Recordings, any distance. Brochure from 21 Bishops Close, E.17.

Your tapes to disc. 7in. 45—18/-, 10in. L.P. —48/-, 12in. L.P.—55/-. 4-day postal service. Masters and Vinylite pressings. Top professional quality. S.A.E. photo leaflet: Deroy Studios, High Bank, Hawk Street, Carnforth, Lancs.

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

TAPE EXCHANGE

Tapespondents. Free sound magazines. Far and Wide Recording Club, Eccles, Maidstone. Details free (S.A.E. please).

Chatterbox Recording Club. The free membership tapesponding club. S.a.e. details. 368 Rush Green Road, Romford, Essex.

Unbelievable ! —only 3¾d. per week to belong to Britain's Largest Liveliest Tape-X-Change but send 3d. stamp now for particulars: **Worldwide Tapetalk,** 35 The Gardens, Harrow.

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.

Get Do-it-Yourself Gardening Annual 1967. Top features include: Gardening with water—a special six page illustrated section covering plastics, concrete ponds and pools, waterfalls, pumps, water gardens and fish; Round the year in garden and greenhouse; How to cope with weeds; An orchard in a garage space; A perfect lawn in six weeks; Timber in your garden; Building with decorative blocks; New annuals to grow in '67; Starting with soft fruit; Growing bulbs in pots; Home-made garden frames; Modern garden furniture. 3/- from newsagents or 3/11 (pp) from Link House, Dingwall Avenue, Croydon CR9 2TA.

Free with **Do it Yourself Gardening Annual** 1968—a packet of guaranteed-to-grow Crackerjack African Marigold seeds. These magnificent plants have superb golden and yellow blooms 3in. to 4in. across. Other top features include: 20 ways to a better garden; Complete guide to lawns; How to cope with pests and diseases; Labelling garden plants; Easy-to-build lily pool; The rose—Queen of flowers; Gardening without soil—beginners guide to hydroponics; What's new in vegetables for 1968; Caring for house plants. 3/- from newsagents or 3/11 (pp) from Link House, Dingwall Avenue, Croydon CR9 2TA.

WANTED

Goon Show connoisseur wishes to contact other collectors with view to exchanging recordings. Lipscombe, Gorse Farm House, Bradford Road, Corsham, Wilts.

Lee Electronics. The Tape Recorder and Hi-Fi Specialists wish to purchase good quality Tape and Hi-Fi Equipment for cash. 400 Edgware Road, W.2. Phone PAD 5521.

Highest prices offered for good quality Tape Recorders and Hi-Fi. R.E.W., 266 Upper Tooting Road, London S.W.17.

Wanted. Taped Jane Austen material at 3¾ i.p.s., i.e. "Pride and Prejudice", "Persuasion", etc. Box No. 935 (Aberdeen).

Sanyo puts you in the world class

Introducing the new MR 939 recorder with these outstanding features

- 7 watts per channel
- 4 tracks, 3 speeds
- Sound on sound
- Sound with sound
- Built-in public address system

Tape speeds
7½ ips (19 cm/sec)
3¾ ips (9.5 cm/sec)
1⅞ ips (4.8 cm/sec)

Wow and flutter
7½ ips: 0.15% R.M.S.
3¾ ips: 0.20% R.M.S.
1⅞ ips: 0.30% R.M.S.

Recording time
96 min at 7½ ips
(Stereo 1200ft. tape)
192 min at 3¾ ips
(Stereo 1200ft. tape)
384 min at 1⅞ ips
(Stereo 1200ft. tape)

Signal-to-noise ratio
45 db

Output power
Music power 7W x 2
Undistorted 4W x 2

Frequency response
7½ ips 20–20,000 c/s
(30–15kc ± 3db)
3¾ ips 30–13,000 c/s
1⅞ ips 30–8,000 c/s

Erase rate
65 db

Crosstalk
50 db (channel-channel)
65 db (track-track)

Output impedance:
Line out: 2 Kohm
Speaker out: 8 ohm
Headphone: 10 Kohm

Input impedance
Microphone: 50 Kohm
Aux: 100 Kohm

Weight
26.3 lbs (16.5 kg)

Accessories
Microphone x 2
Recording tape 7″ x1
Empty reel 7″ x 1
Patch cord x 2
Reel stopper x 2
Splicing tape x 1
Microphone stand x 2

SANYO

RELIABILITY IS BUILT IN

BASF are exhibiting at **Booth 55** and screening "The Timeless Track" in **Demonstration Room 149** at the Audio Fair —18th - 21st April 1968.

New from BASF a low noise, high output tape for TOP QUALITY recording

From BASF comes the magnetic tape you've all been waiting for. Called PES 35 LH, this tape combines low background noise with a high modulation range at recording level. In recording terms, that means PES 35 LH will give you top-quality sound reproduction free of that irritating background 'hiss'—*whatever* tape recorder you use.

The range:

Spool diameter	Tape length
5″	900′
5¾″	1200′
7″	1800′
8½″	2400′
10″	3600′
10½″	4200′

The neatest tool-kit yet

The all-in-one Hobby Box is compact, comprehensive and ideal for every splicing enthusiast. It contains: splicer; marking pencil; cutting blade; 33′ of splicing tape 0.7″ wide; 80′ lengths of red, white and green leader tapes; 50 pieces of 6″ metallised foil; 25 spool labels in green and red; 3 tape clips.

SEE THEM AT YOUR DEALER— NOW

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