

OCTOBER 1967 TWO SHILLINGS

**tape**

**recorder**

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BUYING A  
TAPE RECORDER

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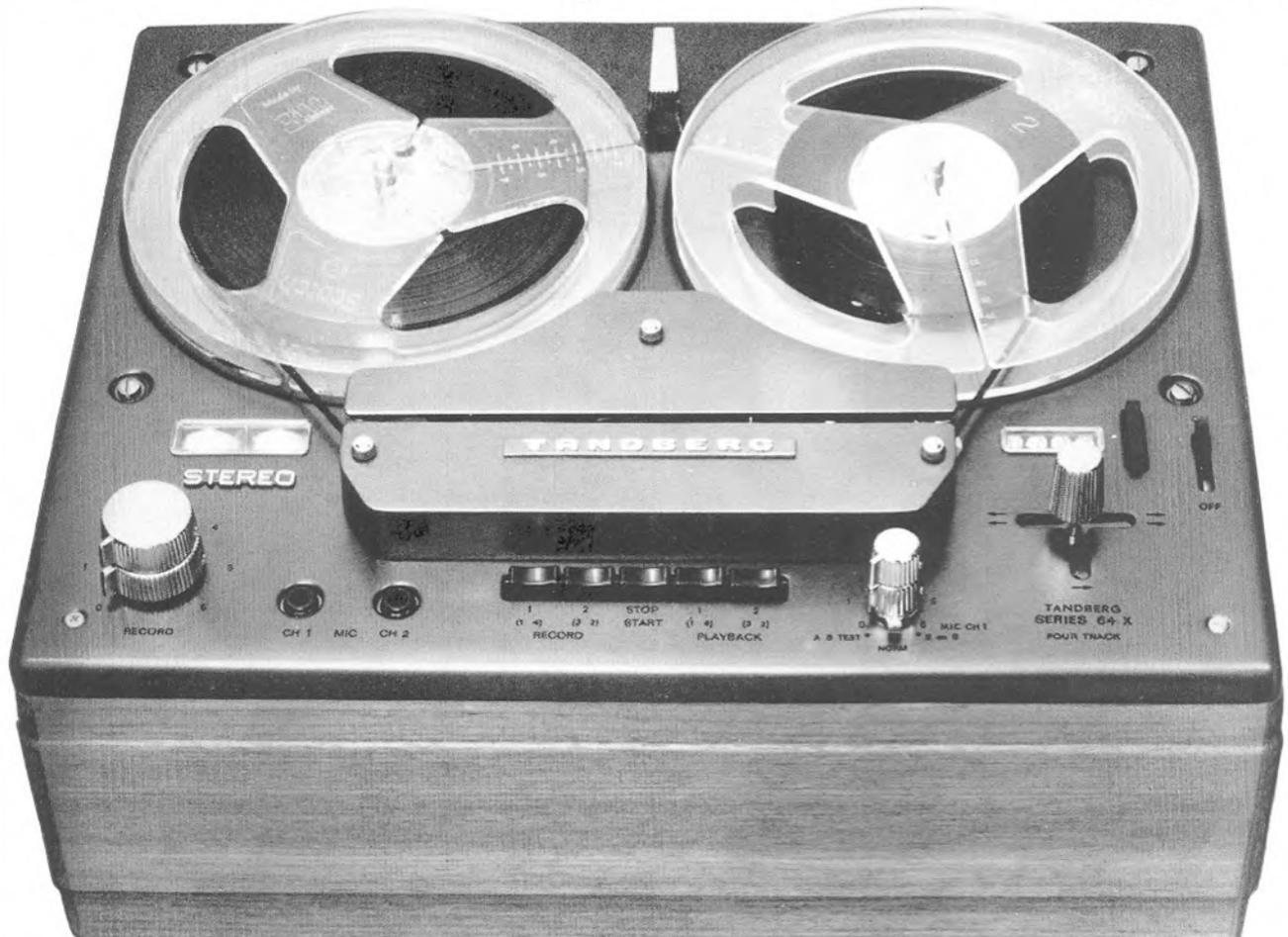
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SERVICING SOUND  
TAPE RECORDERS

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# The outstanding new Tandberg 6x



The world's best stereo tape deck plus new bias head for guaranteed frequency response and unbeatable signal to noise ratio

Tandberg have taken their finest tape deck, added a Bias head and refined the circuitry. The result is the Tandberg Model 64X.

**Frequency Response:**

7½" per sec: 20-25,000 c/s

(± 2 dB 40-20,000 c/s)

3¾" per sec: 20-18,000 c/s

(± 2 dB 40-15,000 c/s)

1½" per sec: 30-12,000 c/s

(± 2 dB 40-8,000 c/s)

**Signal to noise ratio:**

7½" per sec: 62 dB.    3¾" per sec: 59 dB.

1½" per sec: 56 dB.

\* Also incorporates Multiplex Filters (for stereo radio recording).

\* A centre channel amplifier for simultaneous playback of two tracks into mono headphones.

\* A fully transistorised oscillator circuit.

\* Cathode follower outputs.

\* 'On and off the tape' monitoring.

\* 'Sound on sound' facilities.

\* Superb teak and stove enamel finish.

The Tandberg 2 or 4 track, 3 speed Series 6X. 115 Gns.

Please send me full details on the Tandberg

**SERIES 6X**

Also full details on the Series

8    9    12

tick as appropriate

Name .....

Address .....

Post to Dept. TR 11  
Elstone Electronics Limited,  
Hereford House, North Court,  
off Vicar Lane, Leeds, 2.

**Tandberg**

The best in Hi-Fi is expensive—  
but it costs much less the

**Heathkit** way

DAYSTROM

**3+3W De-luxe HI-FI STEREO AMPLIFIER Model S-33H**



An inexpensive stereo-mono amplifier with the high sensitivity necessary for lightweight miniature ceramic pick-ups (e.g., Decca Deram). Attractive two-tone grey Perspex panel.

Kit **£15.17.6** Assembled **£21.7.6**

**9+9W HI-FI STEREO AMPLIFIER Model S-99**



18 watt output (9 watts per channel with 0.2 per cent distortion). It has ganged controls. Stereo/Mono gram, radio and tape recorder inputs and push-button selection. Ultra-linear push-pull output. P.C. boards. Attractive Perspex front panel with golden surround and grey metal cabinet.

Kit **£28.9.6** Assembled **£38.9.6**

**5W HI-FI MONO AMPLIFIER Model MA-5**



A low-priced general purpose Hi-Fidelity amplifier for those who do not require a stereophonic system. Separate bass and treble controls. Gram and Radio inputs. Suitable for most crystal pick-ups. A printed circuit simplifies construction.

Kit **£11.9.6** Assembled **£15.15.0**

**20+20W HI-FI TRANSISTOR STEREO AMPLIFIER Model AA-22U**



20 transistor, 10 diode circuit gives outstanding performance. 5 Stereo inputs per channel. Outputs for 4, 8 or 16Ω speakers. Versatile controls, 5 position source selector switch—3 position mode switch, dual tandem. VOL., BASS, TREBLE controls. Attractive low-silhouette styling. A handsome unit that will fit in almost anywhere.

Kit **£39.10.0** less cabinet. Assembled **£57.10.0**  
Walnut Cabinet £2.5.0 extra

**HI-FI STEREO CONTROL UNIT Model USC-1**



Incorporates all worthwhile features for Hi-Fidelity stereo and mono. Push-button selection, accurately matched ganged controls to +1dB. Negative feedback rumble and variable low-pass filters. Printed circuit boards. Accepts inputs from most tape-heads and any stereo or mono pick-up.

Kit **£19.19.0** Assembled **£27.5.0**

**HI-FI MONO POWER AMPLIFIER Model MA-12**



A compact Hi-Fidelity power amplifier (including auxiliary power supply). 12 watts output. Wide frequency range and low distortion.

Kit **£12.18.0** Assembled **£16.18.0**

**MONO CONTROL UNIT UMC-1**

5 switched inputs. Output up to 0.25v.  
Kit **£9.2.6** Assembled **£14.2.6**

**NEW! TRANSISTOR AM/FM Stereo/Mono TUNER**



Designed to match the Transistor Amplifier, Model AA-22U.

18 transistor, 7 diode circuit. AM: LW/MW, FM Stereo and FM Mono tuning. Automatic stereo indicator light. Stereo phase control. AFC.

AGC. Pre-assembled and aligned front-end FM unit. Separate AM and FM circuit boards. Self-powered. Low-silhouette styling, fully finished walnut veneered cabinet (optional extra).

For your convenience this model is available in two sections:— Unit AFM-2T RF Tuning Heart **£7.17.6** incl. P.T. Unit AFM-2A IF Amp and P.S. **£24.9.6**.

**TOTAL PRICE/KIT £32.7.0** (less cabinet)  
(Cabinet £2.5.0 extra)

**De luxe TRANSISTOR FM TUNER Model TFM-IS (Stereo) TFM-IM (Mono)**

Designed to match the Transistor Amplifier Model AA-22U. Self-powered. Tuning range 88-108 Mc/s. Pre-assembled and aligned. RF tuning heart. 4 stage IF amplifier.

Total price Mono Kit Model TFM-IM **£20.19.0** incl. P.T.

Total price Stereo Kit Model TFM-IS **£24.18.0** incl. P.T.

Cabinet **£2.5.0** extra. Send for full specification details.

**NEW! Stereo Record Player**

Automatic playing of 16, 33, 45 and 78 rpm records. All transistor—cool instant operation. Dual LP/78 stylus. Plays mono or stereo records. Suitcase portability. Detachable speaker enclosure for best stereo effect. Two 8" x 5" special loudspeakers. For 220-250v A.C. mains operation.



kit **£27.15.0** incl. P.T.

Model STR-1

**HI-FI AM/FM RADIO TUNER Model AFM-1**

Available in two units, sold separately for your convenience. Tuning Heart (AFM-T1—£4.13.6 incl. P.T.) and IF Amplifier (AFM-A1—£22.11.6). Printed circuit board; 8 valves; consecutive FM limiting and ratio detector. Tuning range FM: 88-108 Mc/s; AM: 16-50, 200-550, 900-2,000m switched wide and narrow AM bandwidth. Built-in power supply.



Total price. Kit **£27.5.0**

**AVAILABLE SHORTLY**

Portable Stereo Tape Recorder Kit, model STR-1

- ½ track stereo or mono record and playback.
  - 7½, 3½ and 1½ ips ● 18 transistor circuit
  - Two 8" x 5" quality loudspeakers ● 4 watts output per channel
- Kit **£45.18.0**



See the complete **HEATHKIT** range in our **New**

**FREE COLOUR CATALOGUE**

All prices quoted are Mail Order prices, and include FREE delivery in U.K. only, retail prices in general slightly higher. Deferred Terms available on orders above £10. Extended terms available over £75.

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Please send me **FREE CATALOGUE** (Yes/No) .....

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

**NAME** .....

(Block Capitals)

**ADDRESS** .....

**BERKELEY Slim-line HI-FI SPEAKER SYSTEM**



Fully-finished walnut veneered cabinet for faster assembly. Special 12in. bass unit and 4in. mid/high frequency unit. Range 30-17,000 c/s. Power handling 15 watts. Built-in Balance Control. Takes up only 17in. x 7½in. of floor area x 26in. high. Suitable for use with amplifiers having 8 to 16Ω output.

Kit **£19.10.0** Assembled **£24.0.0**

**AVON Compact Bookshelf SPEAKER**

**A "Mini" Speaker with HI-FI performance**

Compact size, wide 50-19,000 c/s range. Specially designed speakers 6½in. Bass, 3½in. totally enclosed Treble unit. Inductor Capacitor cross-over network. Fully finished cabinet.



Total price kit **£13.16.0** incl. P.T.

**HI-FI SPEAKER SYSTEM Model SSU-1**

Ducted-port bass reflex cabinet "in the white". Frequency response is 40-16,000 c/s. Power rating 10 watts. Matched speaker units 8in. high flux (12,000 lines) with hyperbolic cone and 4in. wide angle dispersion type for higher frequencies.



Kit (with legs) **£12.12.0** (less legs) **£11.17.6** inc. P.T.

**TRUVOX TAPE DECKS**

D-106 ½ track stereo.  
D-108 ½ track stereo.  
3 motors. Balanced heavy flywheel. Pause control. Numerical counter. Push button control. Either model



**£39.15.0** each

**COTSWOLD MFS SPEAKER SYSTEM**

Similar performance to standard model, but designed to give best possible results with minimum floor space. Size 36in. high x 16½in. wide x 14in. deep.



Either model Kit **£25.12.0**  
Assembled in the white **£33.17.0**

**3+3W TRANSISTOR AMPLIFIER Model TS-23**



Breaks the price barrier in transistor amplifier cost. 16 transistor, 4 diode circuit. Good frequency response. Separate BASS, TREBLE, BAL. VOL. Controls.

Kit (less cabinet) **£17.15.0**  
Kit (with finished cabinet) **£18.19.0**

**When in LONDON**  
visit our **HEATHKIT CENTRE**  
233 Tottenham Court Road, W.1.  
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We hope you will visit us and inspect the British Heathkit range and a selection of American models  
We open **MON-FRI 9 am-5.30 pm.**  
**Sat. 9 am-1 pm.**



save repair costs, ensure better recording and reproduction

# Bib tape head maintenance kit

in handy plastic wallet

for reel and cassette tape recorders and dictating machines

### 10 APPLICATOR & POLISHER STICKS

Have pads at each end, may be bent to reach tape heads and all parts of tape path.

### 2 BLUE PLASTIC APPLICATOR TOOLS

Fitted with felt pads for applying Bib Cleaner, alcohol or meths. to tape heads, capstan and pinchwheel.

### 2 WHITE PLASTIC POLISHER TOOLS

Fitted with felt pads to polish parts to which cleaner has been applied.



### 4-oz. BOTTLE BIB TAPE HEAD CLEANER

Approved by leading tape recorder and dictating machine manufacturers. Also cleans all parts of these machines.

### DOUBLE ENDED BRUSH

For loosening oxide and dirt.

### PACKET OF TISSUES

Assists cleaning of Applicator Tool and for removing oxide from base plate.

### 5-PAGE INSTRUCTION LEAFLET

Blue plastic wallet folds to 5"x4".

**12/6**  
each

Replacements include: Size F: Packet of 2 Applicator Tools 2/6d; Size G: Packet of 2 Polisher Tools 2/6d; Size H: Packet of 20 Applicator & Polisher Sticks 1/-; Size A: 4-oz. Bottle Bib Cleaner 4/6d. All prices are recommended retail. From Electrical and Audio shops. If unobtainable write to:

MULTICORE SOLDERS LTD., HEMEL HEMPSTEAD, HERTS. TEL: HEMEL HEMPSTEAD 3636



## whatever the make . . .



**AKAI 1710 4-Track Stereo.** 3 speeds  $1\frac{1}{2}$ ,  $3\frac{1}{2}$  and  $7\frac{1}{2}$  (15 i.p.s. optional extra). F.M. Multiplex ready. Two built-in speakers. Automatic shut-off. Horizontal or vertical use. Demonstration tape included.

79 gns. Deposit £27 13s. 0d. and 12 monthly payments of £4 14s. 2d.

**AKAI M8 4-Track Stereo, 4 speeds**  $1\frac{1}{2}$ ,  $3\frac{1}{2}$ ,  $7\frac{1}{2}$  and 15 i.p.s. Three heads including Cross-field. Two-speed Hysteresis Synchronous motor. Sound on Sound. Biased for F.M. Multiplex. Two speakers. Tape Cleaner. Four digital counter with reset. Vertical or horizontal use **125 Gns.**  
Deposit £44 5s. 0d.  
12 monthly payments of £7 5s. 0d.



★ **INTEREST-FREE H.P. TERMS**

Open Saturday 6 p.m. Friday 6.30 p.m. If unable to call write for brochures.

PART EXCHANGES

	Deposit	12 Monthly Payments	Cash Price
	£ s. d.	£ s. d.	£ s. d.
<b>MAINS 4-TRACK</b>			
Telefunken 201	11 18 0	1 19 8	34
Ferguson 3222	12 5 0	2 0 10	35
Grundig TK140	13 6 0	2 4 4	38
Philips EL3558	14 14 0	2 9 0	42
Ferguson 3224	15 8 0	2 11 4	44
Wyndor Vanguard	20 13 0	3 8 10	59
Philips EL3556	21 14 0	3 12 4	62
<b>MAINS 2-TRACK</b>			
Ferguson 3220	8 15 0	1 9 2	25
Grundig TK 120	10 6 6	1 14 5	29½
Tandberg 823...	18 18 0	3 3 0	54
Brenell Mk. 5/3	25 18 0	4 6 4	74
Brenell Mk. 5/3 'M'	32 11 0	5 8 6	93
Ferrograph 631	33 5 0	5 10 10	95
Ferrograph 633 Connoisseur	42 0 0	7 0 0	120
<b>STEREO/MONO</b>			
Philips EL3312	16 16 0	2 16 0	48
Sony TC 250A	19 19 0	3 6 6	57
Philips EL3555	26 5 0	4 7 6	75
Akai 1710	27 13 0	4 12 2	79
Sony TC 260	33 19 0	5 13 2	97
Tandberg Series 12...	36 15 0	6 2 6	105
Truvox PD 104	36 15 0	6 2 6	105
Beocord 1500...	36 15 0	6 2 6	105
Beocord 2000K De Luxe	43 15 0	7 5 10	125
Revox 736	44 9 0	7 8 2	127
Beocord 2000T De Luxe	45 3 0	7 10 6	129
Akai X-300	65 5 0	10 15 0	185
Akai X-355	83 6 4	13 17 9	239
<b>BATTERY</b>			
Philips EL3302	9 9 0	1 11 6	27
Telefunken 301 4-T	18 18 0	3 3 0	54
Akai X-4 Stereo	34 13 0	5 15 6	99
Uher 4000L	36 1 0	6 0 2	103

# THE RECORDER CO

DEPT. R) 186-188 WEST END LANE, WEST HAMPSTEAD, LONDON, NW6

Telephone: 01-794 4977



# SONY research makes the difference

## MODEL TC 250A—FEATURES

4 track stereophonic and monophonic recording and playback □ Long life precision all transistor circuit □ Single lever control for all tape functions □ Smooth and wide frequency response □ Vertical and horizontal operation □ All idler beltless tape driving mechanism □ Two tape speeds ( $7\frac{1}{2}$  and  $3\frac{3}{4}$  ips) □ 7" reel capacity □ Automatic shut off switch □ Two VU meters □ Integrated record/playback connector.

## SPECIFICATIONS:

**Power requirement:** 100, 110, 117, 125, 220 or 240 V. 40 W, 50/60 cps.

**Tape speed:** Instantaneous selection,  $7\frac{1}{2}$  and  $3\frac{3}{4}$  ips.

**Frequency response:** 30-18,000 cps at  $7\frac{1}{2}$  ips  $\pm$  3db 50-15,000 cps at  $7\frac{1}{2}$  ips 30-13,000 cps at  $3\frac{3}{4}$  ips.

**Signal-to-noise ratio:** Better than 50 db.

**Wow and Flutter:** Less than 0.19% at  $7\frac{1}{2}$  ips. Less than 0.25% at  $3\frac{3}{4}$  ips.

**Harmonic distortion:** 1% at 0 db line output.

**Erase head:** In-line (stacked) quarter track, EF17-2902H.

**Record/Playback head:** In-line (stacked) quarter track, PP30-420.

**Level indication:** Two VU meters (calibrated to 0 VU at 12 db below saturation of tape).

**Reel size:** 7" or smaller.

**Input:** Microphone

Sensitivity: -72 db (0.2mV)

Impedance: low (will accommodate any microphone from 250-1K ohm impedance)

Auxiliary

Sensitivity: -18 db (0.1V)

Impedance: approx. 200K ohms

Integrated record/playback connector

Sensitivity: -42 db (6.15mV)

Impedance: approx. 100K ohms

**Output:**

Line

Output level: 0 db (0.775V)

Impedance: optimum load impedance 2K ohms

Integrated record/playback connector

Output level: 0 db (0.775V)

Impedance: optimum load impedance 100K ohms

**Transistors:** 2SD64 (x6), 2SB382 (x2), 2SB383 (x2).

**Weight:** Approx 16.9 lbs.

**Dimensions:** 14.2 (W) x 6.3 (H) x 11.4" (D).

**Accessories:** Sony 7" empty reel. Connecting leads. Head cleaning ribbon. Pinch roller.

Recommended retail price: **57 Gns.**

Sony offer the finest range of tape recorders from the battery portable TC 900 to the studio quality 777, together with a fully comprehensive range of accessories. For further details see your Sony dealer or write to:

**Sony U.K. Division,**  
Eastbrook Road, Gloucester.  
Tel: Gloucester 21591

London Showroom,  
70-71 Welbeck Street, London, W.1  
Tel: 01-486 2143

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# K. J. ENTERPRISES



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!

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

### PHILIPS — BASF — EMI — GRUNDIG

STANDARD PLAY	List	Our price	DOUBLE PLAY	List	Our price
4" 300' Philips	10/6	8/6	3" 300'	14/-	11/3
5" 600'	21/-	16/10	4" 600'	25/-	20/-
5 1/2" 900'	28/-	22/6	4 1/2" 900' (BASF)	30/-	24/-
7" 1200'	35/-	28/-	5" 1200'	42/-	33/8
LONG PLAY			*5 1/2" 1800'	55/6	44/6
3" 210'	9/-	7/3	*7" 2400'	77/6	62/-
4" 450'	14/6	11/8	TRIPLE PLAY		
4 1/2" 600' BASF	21/-	16/10	3" 450'	22/-	17/8
*5" 900'	28/-	22/6	4" 900'	39/-	31/3
*5 1/2" 1200'	35/-	28/-	*4 1/2" 1200' (BASF)	49/-	39/3
*7" 1800'	50/-	40/-	5" 1800'	66/-	52/10
8 1/2" 2400' } BASF	72/6	58/-	5 1/2" 2400' } (BASF)	90/-	72/-
10" 3600' } ONLY	95/-	76/-	7" 3600' }	115/-	92/-
C.60 Cassette	17/6	14/-			
C.90 Cassette	25/-	20/-			

### SCOTCH

STANDARD PLAY	List	Our price	DOUBLE PLAY	List	Our price
5" 600'	20/6	16/4	3" 400'	16/6	13/2
5 1/2" 850'	27/6	22/-	4" 600'	24/6	19/6
7" 1200'	35/-	28/-	5" 1200'	41/9	33/6
LONG-PLAY			5 1/2" 1800'	55/-	44/-
3" 300'	9/6	7/6	7" 2400'	76/6	61/-
4" 450'	14/6	11/8	TRIPLE PLAY		
5" 900'	22/-	17/8	3" 600'	24/9	19/6
5 1/2" 1200'	34/6	27/6	4" 900'	38/6	30/6
7" 1800'	49/-	39/-	DYNARANGE (L/P)		
8 1/2" 2400'	72/6	58/-	5" 900'	32/3	25/10
STANDARD (ACETATE)			5 1/2" 1200'	40/6	32/6
5 1/2" 850'	24/6	19/6	7" 1800'	57/6	46/-
7" 1200'	30/-	24/-	8 1/2" 2400'	83/6	66/10

Grundig tape available only where marked with asterisk \*  
POSTAGE AND PACKING 2/-

ORDERS OVER £3 POST FREE

### PHONOBAND—Pre-recorded STEREO tapes from Sweden

Brilliantly recorded, 1/4-track stereo tapes, superb quality Classical Jazz and Light Music at Tape speeds of 7 1/2 i.p.s. (7" reels) and 3 1/2 i.p.s. (5" reels). PRICES FROM 49/6.

Send for our Full Colour Catalogue and Price List.

### AGFA TAPE—HALF PRICE!

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

Type	Description	List Price	One	Three	Six
PE 21	1200' S/P 7" reel	35/-	19/6	55/6	105/-

Also available at substantial reductions:  
 PE 31 1200' L/P 5 1/2" reel 35/- 24/6 71/- 137/-  
 Post and Packing 2/-, ORDERS OVER £3 POST FREE.

### BASF TAPE—30% REDUCTION

A Special Offer of the famous Premium Grade BASF Tape. Brand new, boxed with Full Leader, stop foil and "Polythene sealed". Multiples of three 4' size can be supplied in the BASF 3 compartment plastic library cassettes at no extra cost.

TYPE	DESCRIPTION	LIST PRICE	ONE	THREE	SIX
LGS26	600' D/P 4" reel	25/-	17/-	49/-	93/-
LGS26	1200' D/P 5" reel	42/-	29/6	86/-	166/-
LGS26	1800' D/P 5 1/2" reel	55/-	38/6	112/6	219/-
LGS26	2400' D/P 7" reel	77/6	49/6	145/6	285/-

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

### ILFORD TAPE NEAR HALF PRICE

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

	List Price	One	Three	Six
900' on 5" reel	28/-	16/6	48/-	90/-
1800' on 7" reel	50/-	32/6	95/-	180/-

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

### TRIPLE PLAY TAPE—HALF PRICE!

A large purchase from two world renowned manufacturers enables us to make this unique half-price offer. Brand new, fully guaranteed, premium grade Polyester Base Tape with FULL LEADER and stop foil. In original maker's boxes and polythene wrapped at these EXCEPTIONALLY LOW PRICES!

	List Price	One	Three	Six
1800' on 5" reel GEVASONOR	66/-	34/-	101/-	198/-
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/-
2400' on 5 1/2" reel ZONAL	90/-	55/6	165/-	324/-

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

### Don't forget our other ACCESSORY BARGAINS!

- Tape Head Demagnetiser, essential for any enthusiast! Ready for immediate use. Fully guaranteed. Worth 50/- ... Only 27/6 P. & P. 2/-
- Tape Splicer, fully auto., no razor blades. Worth 32/6 ... Only 16/6 P. & P. 2/-
- International Polyester Tape 2400' 7" reel (boxed) ... Only 25/- P. & P. 2/-
- Gevasonor 10" 3600' L/P Polyester (boxed) ... Only 64/- Post Free
- Gevasonor 8 1/2" 2,400' L/P Polyester (boxed) ... Only 48/6 P. & P. 2/-
- Gevasonor 3" 300' L/P Polyester (boxed) ... 6 for 37/6 P. & P. 2/-

20% off all Grundig 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)**  
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 Please supply your lists and goods as detailed below:

Qty	Description of Goods	Amount
Total for post and packing		

I enclose my remittance for Total £ .....  
 NAME.....  
 ADDRESS.....  
 (Print Please).....  
 October 1967

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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%.

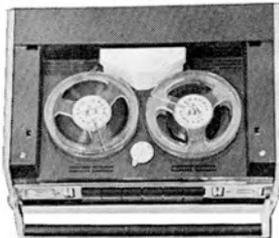
# MORE FANTASTIC BARGAINS FROM **K.J. ENTERPRISES**

**WE SAVE YOU MONEY!**

**GRUNDIG**

## TK6L MAINS/BATTERY TAPE RECORDER

A superb lightweight mains or battery-operated Tape-Recorder. A touch of a button gives you twin-track recording, two speeds (1½ and 3½ i.p.s.), and four hours' playback in the very finest Grundig tradition. Full range of facilities and takes up to 4½" reels. Covered by full maker's guarantee. Supplied complete with dynamic Microphone. 1200' tape, spare spool and direct recording lead.



Dimensions  
12½" x 5½" x 9½"  
Weight 13½lb.

**SAVE £13.16.0**

List Price £69.6.0.

**OUR PRICE £55.10.0**

Post and Packing 10/-.

**SAVE £14!**

## GRUNDIG TK23L TAPE RECORDER



½ Track Mono recorder. Tape Speed 3½ i.p.s., takes up to 5½" reels. Frequency response 60 to 12,000 c.p.s. Manual and Automatic recording level control. Dimensions 13½" x 10½" x 6½". Weight 22lb.

Supplied complete with microphone and usual accessories. Brand New, fully guaranteed and sealed in manufacturer's carton.

List Price £51.9.0

**OUR PRICE £37.9.0**

Carr. & insurance 15/-

## ELIZABETHAN LZ.612

### MAINS/BATTERY All Transistor PHILIPS CASSETTE TAPE RECORDER

Superb sound from 10" Loudspeaker, with 5 watts "push-pull" output. Separate bass and treble controls. Independent mixing on both record and playback.

Dimensions 17½" wide, 12½" high, 7½" deep  
Weight 18lb.

**SAVE £12.5.0**

List Price £47.5.0.

**OUR PRICE £35**

Post and Packing 7/6

Elizabethan  
LZ.612



## PHILIPS CASSETTE TRANSISTORISED TAPE RECORDER

**SAVE £8.8.0**

Fully transistorised Cassette Tape Recorder, battery operated. Simple push-button operation with easy 'snap-in' cassette loading, giving up to 90 minutes recording from microphone, radio, etc. Weight 3lb. Pocket 'Paper-back' size. Supplied with shoulder strap, microphone, tape and recording lead.

Full maker's guarantee.

List Price 27 gns. **OUR PRICE 19 gns.**

Post and Packing 7/6



Elizabethan  
LZ.9102T

## K. J. ENTERPRISES (Dept. TR)

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(Opposite Harrow and Wealdstone station)

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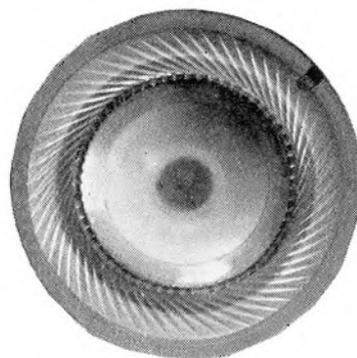
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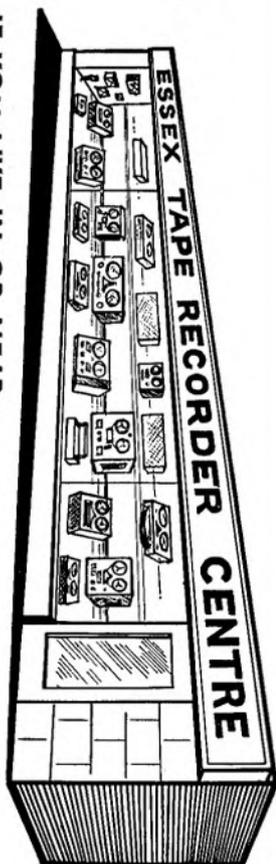
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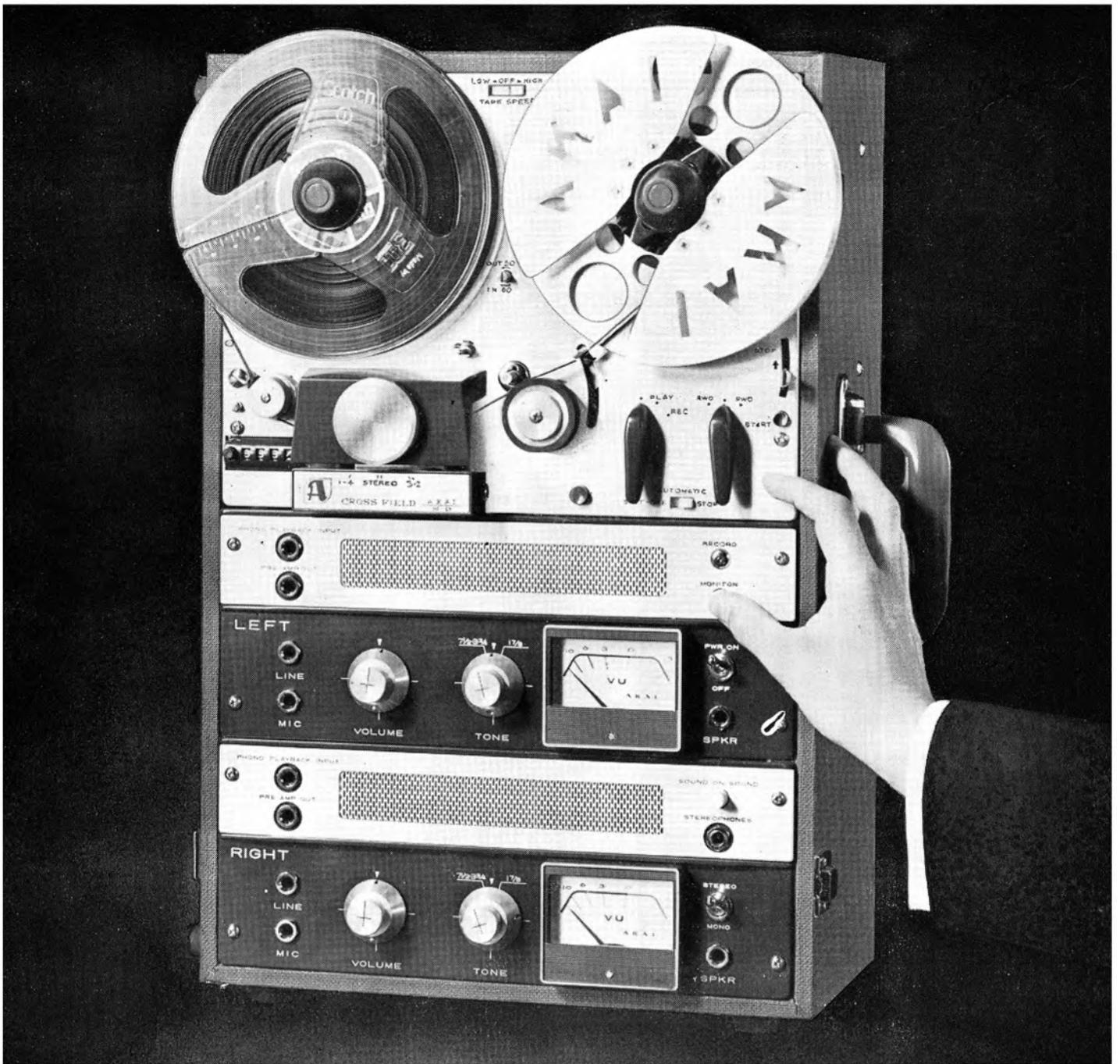
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# tape recorder

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OCTOBER 1967 VOLUME 9 NUMBER 10

INCORPORATING  
SOUND AND CINE

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JOHN CRABBE

**DEPUTY EDITOR**  
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## COVER PICTURE

'Worth its weight in gold' is a term that might reasonably be applied to the £65 STC capacitor microphone adorning this month's cover. Whether readers will have similar regard for the restyled cover itself is not for us to decide. If we are to criticise others for shoddiness, however, we must make the best of our own products.

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## SUBSCRIPTION RATES

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

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THE COPYRIGHT ACT (1956) is one of those deliciously involved documents which few people have bothered to learn in detail and by which even fewer are content to live. But the protection of composers', performers' and engineers' rights does not *have* to be so complex as it is in this country. Impractical legislation in West Germany, for example, was recently replaced by a percentage surcharge on the retail price of tape recorders. In return for this compulsory payment, which was distributed appropriately among the parties involved, the purchaser gains the right to record for private pleasure whatever he desires.

As part of an intensified campaign to sink the remaining Pop Pirates, the BBC cannon are being loaded with great stocks of Rolling Stones, and similar high explosives, to be shot daily across the ether. The Performing Rights Society, anxious that the Rolling Stones should not starve, has sought a revision of the blanket payment system by which the Corporation wriggles out of the copyright problem.

It is not generally realised that the BBC is comparatively generous towards the private individual where its own material is concerned. The opening chimes of Big Ben, and the 'all our own work' news programmes that generally follow, are freely offered to the domestic tape recording enthusiast for his personal education and entertainment. This is not the limit of the freedom they offer—the *Radio Times* has recently included a notice stating in concrete terms what may and may not be done with broadcasts. Some moral satisfaction may be gained from an examination of this notice, which, when broken from its burdensome 80-word sentences into English, is an accurate précis of an involved situation:

The sound and vision components of television broadcasts and radio programmes may be recorded without permission from the BBC, provided this is undertaken purely for private purposes.

No permission is needed from the BBC, or the copyright owners, to record broadcast musical and literary material if "the recording can be described as fair dealing for the purposes of research or private study." Performance to non-paying audiences does *not* constitute fair dealing.

Gramophone records are another matter. There is no need to obtain permission from the performers in any broadcast commercial recording (holders of the MCPS licence please note!). Permission is needed, however, from the company which issued the recording, and this permission is difficult to obtain in practice. Again, this paragraph is concerned entirely with the private individual.

The freedom of the individual to do in his own home as he pleases is currently raging around a quite unrelated subject—drugs.

Recent reviews in the national press of *Sleep* by Gay Gaer Luce and Julius Segal (*Heinemann* 50s.) have endeavoured to equate the little-known dangers of alcohol, barbiturates and other 'nice' drugs with the superficially innocent activity known by some as 'sleep-learning'. Research into brain-activity during sleep suggests that dreaming serves an important, if little understood, function in counter-balancing the strains imposed during daytime. Both 'sleep-learning' and chemical drugs can reduce or increase the natural ratio of dream periods to other stages of sleep, with consequent deterioration of daytime character.

The positive educational virtues of sleep-learning have never been proved, despite isolated reports of success made, in most cases, by individuals with a commercial interest in the elaborate accessories. Since unbiased research suggests an element of danger in practising sleep-learning—danger of a thoroughly mundane and unromantic kind—the 'technique' becomes doubly questionable. Add to these factors the little matter of cost—for the purchase of a fully solenoid-controlled time-switch operated system, or a steep and regular service bill for new idlers and pinch wheels—and sleep-learning becomes even more doubtful than the future of cassettes (!).

Aldous Huxley's futuristic *Brave New World* contained several hopeful dreams and many nightmares. 'Sleep-learning', it would seem, falls into the former category; an attractive idea but, in its present simplicity, no more than a dream.

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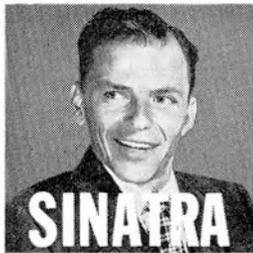
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# WORLD OF TAPE



## OPTACORD 600 NOW BEING IMPORTED

AFTER a false start early in 1966, *Highgate Acoustics* are now proceeding with distribution in the South of England, of *Loewe Opta Optacord 600* and *600S* video tape recorders. Both models employ single-head helical scan to achieve a video frequency range of 10Hz—2.5MHz, with a fixed audio functioning from 50Hz—10kHz. The basic 600 costs £850 while the more versatile 600S, offering slow-motion and freezing, is £1,025. One-inch tape is employed at 15 cm/s to give a maximum recording time of one hour per reel. Longer reels, with a capacity of 80 minutes, will shortly be available for the machine.

## REW CONFRONT FOYLES

NUMBER 122, Charing Cross Road, is the address of premises newly opened in London by *REW Earlsfield*. The West End branch is located just opposite *Foyles* bookshop and is stocked to cater for the tape and hi-fi enthusiast, with additional facilities to deal with export orders.

## FBTRC—NEW NAME, NEW BULLETIN

INCREASED emphasis on recruiting individual enthusiasts, in addition to groups of amateurs, is reflected by a change of name for the Federation of British Tape Recording Clubs which now boasts the formidable title *Federation of British Tape Recordists and Clubs*. This new move is accompanied, in the Summer edition of the Federation's *Bulletin*, by a welcome for club news from groups not nominally associated with the FBTRC. The journal is also being offered to non-member clubs and individuals for an annual subscription of 7s. 6d. Editor is *John Bradley*, 33 Fairlawnes, Maldon Road, Wallington, Surrey.

## AUDIO AND DESIGN DISTRIBUTE SENNHEISER

DISTRIBUTION to the retail trade of *Sennheiser* microphones is now being undertaken by *Audio and Design* of 40 Queen Street, Maidenhead, Berkshire. The *Audio Engineering Company* continues to be responsible for importing the German manufacturer's range.

## TAPE ENTERS THE COMMONS

THE increasing difficulty of recruiting shorthand writers with "sufficient skill to record our debates" was claimed by the Leader of the House, Richard Crossman, to be the reason for experimenting with tape recorders during morning sittings of the new session. Specification required of *Hansard* reporters is better than 180 words per minute in return for a basic salary of £2,062.

## DOMESTIC DOLBY

THE Dolby noise-reduction system, introduced a year ago as a means of improving the signal-to-noise ratio of professional tape and audio equipment, is shortly to be incorporated in a 'domestic' recorder. The recorder is being developed by the American *KLH* company and will be marketed in the USA for about £170, some £30 of which is devoted to the noise-reduction circuitry. A 'Domestic Dolby' will also be produced in unit form, for use with existing equipment, to sell in the £60 region. This contrasts very favourably with the £700 price-tag of the professional system.

## NEXT MONTH

A NEW SERIES of articles under the collective title *Closed Circuit* will appear in our November issue, published on October 14th. Written by Richard Golding, the series will investigate equipment and techniques used in closed-circuit television systems, with a wealth of practical advice for tomorrow's owner of a domestic video recorder. Philip Towell of the 'Boston Soundhunters' will describe the pleasures and problems of recording in Czechoslovakia.

## MINI BAGPIPES AT THE RUSSELL

LONDON'S Hotel Russell, annual host to the *Audio Fair*, was recently the scene of the sixth *British Musical Instrument Trade Fair*. The influence of magnetic tape appeared lately to have vanished, since even the once-popular tape-loop echo systems had been replaced by rotating drum equipment of the type shown by *Arbiter*. Automatic 'backing' devices were similarly devoid of tape, percussive instruments being simulated very effectively by purely electronic means.

An instrument of original appearance and singular sound was a small reed-organ set in a form of guitar body and intended for use on a shoulderstrap. This made intriguing use of acoustic feedback and deliberate distortion to achieve acute pain in the ears of your reporter.

Electronic organs and electric guitars, between them, greatly outnumbered acoustic instruments. The last word in originality, however, came from the latter category, in the form of miniaturised bag-pipes. These, it was explained, were direct descendants of the goat-skin bag-pipes introduced to Scotland by the Romans.



## NEW DATA-STORAGE TECHNIQUE

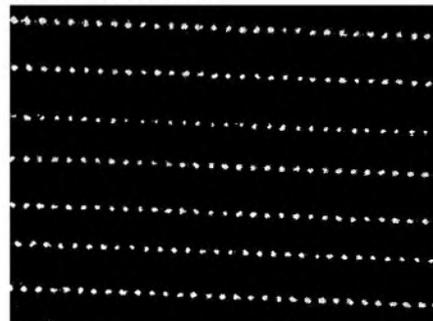
RESEARCH into more efficient methods of storing large quantities of electrical information has resulted in ingenious applications of magnetic recording, photographic film-scanning and electron-beam systems. Some five years ago, the *Precision Instrument Company* of Palo Alto, California, commenced development of a completely new approach to data storage, combining the helical scan technique, employed on some video tape recorders, with a laser. The result is the *Unicon* process.

Unicon uses a laser to burn holes in an opaque tape coating so that light may pass through the tape. The idea is analogous to punching holes in paper, with each hole (or lack of a hole) representing a logical 1 or 0 bit. The difference is the minute size of the laser holes—one thousandth of a millimetre across.

The holes are burnt in successive parallel lines at a slight angle across the tape and covering the entire tape area. The resultant storage density is 645 million bits per square inch.

Reading the tape involves the reverse of this process. A low-powered continuous laser beam is aimed on the tape as it rolls by. Where a hole appears, the beam shines through to register as an electrical pulse which is fed to a computer, printer or other recording medium. The replay laser operates during recording, to provide a simultaneous verification of accuracy.

The *Precision Instrument Company* consider the *Unicon* process to be unique in several ways. Its capacity is the greatest storage density yet achieved. A "standard" 2,400ft. reel of *Unicon* tape could store as much data as 47,500 similar reels of modern magnetic tape. Recording rates of 12 million bits per second can be achieved, the resultant tapes being totally free from long-term fading. They cannot be erased.



IT is pleasant being able to say that this month's contribution is "in response to popular demand." Not only pleasant, but gratifying, to be able to satisfy a few of those desperate souls who cry: "I cannot get any information anywhere."

Usually it turns out that they have a tape recorder with some odd name, or no name at all, and no local retailer wants to know them. The tape recorder dealer—if there is one within hailing distance—is disinclined to undertake repairs to 'unlisted' goods. In a way, it is hard to blame him. Even in our own establishment, where we flourish a banner "We mend all makes", there is a reluctance to accept some of the cheaper and nastier models. Not because they are harder to do (though they often are harder to do), but because the repair, even when done to the best of our ability, may not be satisfactory. It is surprising how many owners, having taken delivery of a mended machine, expect it to come up to *Revox* standards, though the whole caboodle, when new, probably cost less than Mr. Studer's motor. Well, Mr. Papst's then!

So it is that we get letters appealing for data or circuits or mere advice on where to take the white elephant. And so often we have to disappoint our correspondents because it is hardly possible, despite careful descriptions and laborious drawings, to identify their equipment. No use saying "My machine is a *Civic*—it says so on the top." But a few notes in general on the subject of the 'blanket name' tape recorders in the next couple of articles may help owners to iron out their own little difficulties. *Nil desperandum*.

By 'blanket name' I mean those machines made by quite worthy manufacturers, but labelled with the house name of what usually turns out to be a combine, a mail order business or a chain of dealers. At the risk of being trodden on for breaking trade confidences, I offer a short list of the more popular house names and the people who shelter behind them.

*Abbey*—this is the title for machines marketed on behalf of *British Relay* and other associated companies. *Civic* and *Emston* are both names that have been widely used by the *Stores Trust* group, that is, *J. & M. Stone* and *Broadmeads*. *John James* will also be found in this list of 'parents'. The other pebble on the beach, *J. & F. Stone*, markets *Portadyne* gear.

*Defiant* and *Pageant* are both *Co-operative* titles, *Spinney* is the name for goods put out by *Littlewoods* (i.e., *Independent Stores Association*). *RETRA* is the obvious child of the *Radio & Television Retailers' Association* and *Westminster* is from *Curry's Ltd.*

So much for parentage. But what really matters is the machine, not the label, and here we strike a rock. The way big business carries on, roughly, is to contract to buy a

large quantity of a chosen model, sometimes an exclusive line, from a well-known manufacturer. In exchange for the large slice of 'safe' business—and it really is large, when we find ourselves in the world of the *Gussies* and *John James* and the buying power of *Curry's*—the tape recorder manufacturer allows the trade name of the marketing company to be put on the goods in place of his own. This becomes a sales gimmick—virtue out of necessity. The trade name of *Challenge*, which *Great Universal Stores* dreamed up a few years ago, is now better known than many of the bona fide manufacturers who have thrived in its shadow, and who would probably not exist now, but for Sir Isaac Wolfson's business.

Unfortunately, the same cover name may be given to the products of several different companies, and such details as model numbers, or such refinements as service manuals, are often notable by their absence. It is lucky for us that the same machines, or their very near relatives, are still marketed under the original maker's name.

I have deliberately chosen the *Sound* models as this month's feature. Partly because *Civic* have used these, in slightly modified form, restyled cabinets, even different physical layouts; partly because *Tape Recorder Electronics Ltd.* has been marketing them under its own *Sound* title for quite a long time. Regular readers may remember a few notes on *Sound* models in the January 1964 issue.

In that article the distinctions between the various models were given; *One-Four*, *Three-Two*, *Slimline*, *Riviera*, and so on.

There are three groups of circuits from the TRE (*Sound*) stable that need concern us. These are the *A37-A40*, as in fig. 1, the *A41* and *A46*, as in fig. 2 and, next month, the *A41A-A44G* with a similar circuit but some important structural changes and component alterations, and the Elizabethan *LZ29L* which was widely used in a range of *Civic* and other models, again with only styling and structural changes.

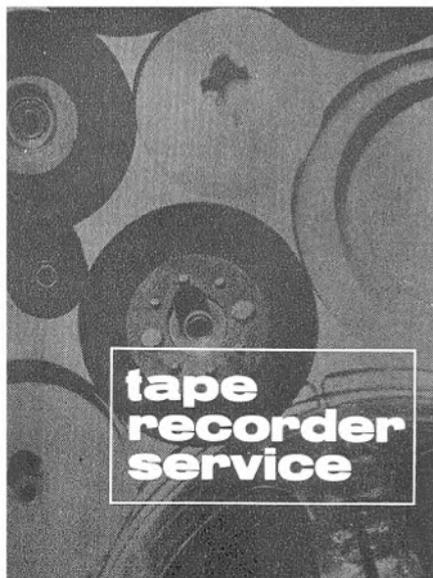
All the TRE circuits were used with *BSR* and *Magnavox* (then *Collaro*) *Studio* decks, in both  $\frac{1}{2}$ - and  $\frac{1}{4}$ -track versions. In practically all cases, the microphones were of the crystal type, usually *Acos 39* and *40*, although some distributors favoured alternatives; again, with their own house name blatantly plastered across the front. In some instances, as with the Elizabethan adoption, the facelift consisted of the addition of an extra loudspeaker and small facilities such as superimposition or parallel-playback where the original circuit did not have this highly desirable sales feature.

The circuit of fig. 1 is thus given in its most comprehensive form, that is with  $\frac{1}{4}$ -track and superimpose switching shown. If your own machine appears vaguely similar but without

(continued overleaf)

SOME  
SOUND  
VARIATIONS

BY H. W. HELLYER



COMPONENT	MODEL			
	A37	A38	A39	A40
C1	100pF	47pF	47pF	100pF
R1	omitted	68 ohms	omitted	330 ohms
R2	680 ohms	220 ohms	680 ohms	680 ohms
R3	47K	100K	47K	100K
R4	470K	220K	470K	470K
C2	100pF	47pF	100pF	47pF
C3	100pF	47pF	100pF	47pF





such refinements, it should not be difficult to eliminate them mentally when trouble-shooting. A feature not shown is the hum-bucking coil, usually a few turns of fine wire wound on a grommet and suspended by a twist of copper or a length of heavy-gauge wire, wired in series with the record/play head winding.

The first thing that jumps to mind is that **fig. 1** is incomplete; some components are numbered but have no value given. These are the components that vary according to the head being used. C1, with R4 across it, is part of the series feed circuit during record and an equalising network for replay. R1 and R2 are the pair used for oscillator load during superimposition, while R1, omitted when 1/2-track erase heads are employed, acts as a current limiter for the 1/2-track erase head winding. C2 and C3 are part of the bias feed circuit, and

some experiment with bias adjustment can be made by altering these values slightly or replacing C2 with a 50pF trimmer, variable type, having a fixed 50pF across it in the 1/2-track type of machine.

One of the most prevalent faults with these circuits was oscillator failure. In many cases the symptoms were that erase vanished and bias was absent, but some bias could be regained when recording on clean, i.e., bulk-erased tape, if the erase head was disconnected. The fault was often the 5kpF *Suflex* capacitor across the coil, or a breakdown of the 5kpF return capacitor decoupling the screen grid of the pentode section of the ECL86. The mistake is to replace these with under-rated components. 500V DC working voltage is necessary. These components carry an HT of over 200V plus the quite considerable, though short-term, peaks of the oscillatory voltage.

Attention should always be given to the variable resistor which is the grid leak of the oscillator. This little joker has a habit of developing poor connections at the ends of the track, and after a goodly period of use the contact between slider and track can become a bit chancy. As the usual position is tapped near the top, temporary shunting with a 100K, not forgetting to link slider and top when doing so, or better still, disconnecting the existing control for the test, may perk up a failing oscillator. But as correct oscillator output is necessary for good recording, and a remarkable improvement in quality can be effected with a change of bias to suit the tape in use, this is at best a rough test, and a new component is the ultimate solution.

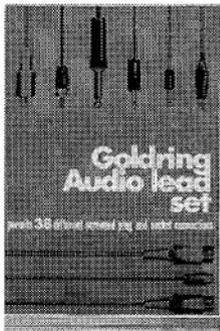
The A41/A46 circuit of **fig. 2** is shown in the 1/2-track version, this being the one most widely 'borrowed'. The A46 had the addition of a tweeter fed by a 12μF capacitor (electrolytic) from the main loudspeaker speech-coil. The mains transformer was a little heavier, with a 212V tapping, as in the A37 versions and there were small component changes. These can be an improvement so details are as follows: the .003μF/500V from the anode of the oscillator to the 'A' tapping of the oscillator coil is increased to twice the capacity and 750V working. (See previous notes on the subject!) When this is done, the 4.7kpF across the coil can usefully be increased to 5kpF and the .005μF from this point to the variable resistor reduced to 3kpF. But note that these changes should not be done singly—all or nothing is the order of the day.

**Fig. 2**, incidentally, is for machines using the BSR deck, and is more or less an 'economy' circuit. Compare it with **fig. 1** and you will note that the extra preamplifier stage makes a big difference to the subsequent amplifiers and helps to reduce hum and noise. Look for small factors, such as the bias components, reduced grid load resistors, a more stable feedback circuit, plus, of course, a limited input mixing facility.

While this column does not set out to be a do-it-yourself guide, and it is not our intention to advise on explicit changes, a little study of similar but slightly modified circuits may give the handyman ideas about improving his own models. We are always glad to hear of any such modifications, and shall pass them on when space is available.



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# DON'T WASTE YOUR MONEY

## POINTS TO CONSIDER WHEN BUYING A TAPE RECORDER BY PETER TURNER

**T**HOUGH I look back with affection upon the day when I set out to buy my first recorder, I have to admit that I embarked then upon a very expensive career in learning the hard way. I knew nothing, but nothing, about the subject. In those days the only firm advertising widely to the public at large was Grundig: indeed, 'Grundig' meant tape-recorder rather as 'Hoover' once meant vacuum-cleaner. I knew that there were other makes, of course; but all I wanted, at that moment, was something with which I could help myself to prepare, time, and subsequently record small scripts for broadcast talks. I had no ideas in mind for anything else. Little did I know; but as things turned out, I bought a machine which would do what I wanted, and do it perfectly well: it was a small, somewhat coffin-shaped machine by Philips, called, if I remember rightly, the *Recordergram Minor*. It had one speed— $3\frac{1}{2}$  i/s—and all the functions were controlled by a single, large central knob.

Knowing, as I said, nothing, I looked in the windows of several shops to see what was on offer in a small town. I had no better reason for buying the Philips than the price, which was the lowest I could find. The only reason why I went to the shop I did was because they were displaying that machine. Whether that shop had adequate servicing facilities I never had occasion to find out, as I was dead lucky: my recorder functioned in the shop, and went on functioning after I got it home. I thought it was marvellous; and so, as far as it went, it was.

It was only when, after some time, I began to want to record music, that whiffs of discontent blew up. I noticed a curious effect for which I had then no name, but which I now recognise as wow. I now know that that particular machine did tend to suffer from a binding clutch on one of the spools; but in any case the number of machines which would record music satisfactorily at that speed in those days was very small. It did not cross my mind that the fault I was complaining of might be put right. The truth was that the hi-fi bug was getting into my system.

I will not recount the next stage, and the

next, and the next, as the years went by: my object is rather to prevent, if I can, some other poor soul from falling into my silly mistakes. And the first mistake to avoid is that of buying a first machine in ignorance. Today, the choice is far wider than it was when I began; but that, if anything, adds to the danger.

What do you propose to do with your recorder? More, what may you find, at a later stage, that you would like to do with it? Recorders are in many ways like cameras: there is no harm in starting with a box-Brownie provided that you are not disappointed when you later hear about coupled rangefinders, fresnel screens and wide-angle lenses and find that your instrument will have none of these things. In the same way, if your heart's desire is to exchange tape-letters with your cousins in Samarkand, you can do perfectly well with a thirty-pound recorder and its crystal microphone; but you will be in trouble if your interests extend themselves to multi-track feature-tapes. In the world of the camera, it is possible to buy a basic body upon which you can later, should your interest grow, graft all the gadgets. Unfortunately, that is not quite so easy with a recorder—not so easy, I maintain, as it should be—but you can take it that the cheaper machines will not have the range and adaptability of the better ones, though they may be surprisingly good performers, at any rate when they are new: knock hell out of them for a year, and things may well be different.

My plea is that you should rather hold back for a time, and invest in a good machine, than do as I did, and rush out and look for something you can pay for at this moment. If you rightly ask "What is a good one?", I should like to make a further suggestion: that you obtain a few books about recording, and read them before you even start to look round with a view to purchase. Those books will give you an idea of the range and possibilities which a recorder makes available to you; they will teach you what a good machine should do, and what facilities you can reasonably expect to find on it. If, like me when I began, you do not know that recording-bias exists, let alone what it is; and if expressions like hysteresis-synchronous

motor and A-B comparison are Greek to you—well, you can either follow the advice of somebody you think you can trust, or you can get a little wiser before you start. Finding that a machine will not do what you want, and part-exchanging it for another (in general for a very small part of the price of the new one) may be good for trade, but it isn't good for your pocket; and though the poor workman blames his tools, if you have an ear for quality you cannot be satisfied, ultimately, with the second-rate.

One question you will have to face, and which did not exist in my day, is that of mono or stereo. There will be those who disagree with me violently, but I have come to the conclusion that for the amateur recordist, mono is far more practical than stereo. The advent of stereo broadcasting may alter this view; but so far as work in the field is concerned, I think that amateurs rarely have access to material which would make stereo the method of choice. It is true that stereo machines can be used in the mono mode; but the fact is that that is the only mode in which most of them are used, and there is little point in paying for what one does not use. Further, problems arise with track-width when mono and stereo machines are mixed (for dubbing, for example); and there is the matter of cross-talk between tracks which can be troublesome in mono use. Perhaps you already have stereo radio or a stereo gramophone, and are sure that you could not bear Aunt Mabel's rendering of *The Lost Chord* in mono—well, you know what to do; but to buy a stereo machine, and find that 99.999% of your recordings are in mono, induces the feeling that one should go off and have one's head examined. If you decide for stereo, articles and reviews in *Tape Recorder* will help you to choose a good machine: the standards for stereo being, if anything, more stringent than for mono.

But the best recorder in the world—which ever that may be—is no use for live recording without a microphone. One of the snags with stereo is that you will need at least two microphones; and these tend to be costly animals.

(continued on page 428)

# elements of tape recorder circuits

## PART 5 INTRODUCING THE AMPLIFIER BY G. T. ROGERS

**B**ROADLY speaking the amplifier of a tape recorder can be divided into two parts—the record amplifier and the playback amplifier, each having the necessary pre-emphasis circuitry for equalisation. In addition the record amplifier must have an associated circuit for driving the modulation indicator.

In many tape recorders a simple integrated record/playback amplifier is used in conjunction with a dual purpose record/replay head and here operation of an appropriate selector switch automatically changes the circuit so that it can function in either mode. During playback the bias oscillator supply and the signal to the record head will be cut out of circuit, and in many machines the record level indicator is operative during the recording only.

In other machines, usually semi-professional or professional, separate amplifiers are used for record and playback in conjunction with separate record and replay heads. This enables the *playback* amplifier to operate during recording so that the signal going on the tape can be monitored and a check kept on recording quality.

There are many tape recorders sold in this country, and to describe in detail the various amplifier circuits employed in these would be a difficult task and we would probably get confused in the process. Instead it is intended to describe the working of a typical system and the principles on which amplifiers are based.

### THIRD ELECTRODE

The simplest amplifier is the triode valve and, as its name implies, it contains a third electrode called the control grid, which is mounted between the anode and cathode and is perforated so that electrons can pass through it. The valve was introduced in 1907 by an American, Lee De Forest, a prominent pioneer of radio. Let us first see how this works.

If we assume that the voltage at the grid of the valve is made negative with respect to the anode, as with the diode, electrons will begin to leave the negative space charge at the cathode due to the anode's attraction, but when they

reach the grid some of them will be repelled back and fewer electrons will reach the anode. This means that the anode current will be reduced. If on the other hand the grid is made more positive, electrons will be accelerated through it and the anode current will be increased. Fig. 1 shows a simple amplifier circuit with an alternating voltage input applied to the grid. In practice the grid must always be maintained at a negative potential with respect to the cathode by the so called *grid bias* voltage, but its magnitude in the negative direction will depend on the varying input voltage applied to it.

If for example the grid bias is  $-6V$  with respect to the cathode and an AC input of  $4V$  peak is applied, the actual grid voltage will be  $-6-4=-10V$  at the negative peak and  $-6+4=-2V$  at the positive peak. A varying input voltage will therefore be translated into a varying grid voltage which is always negative with respect to the cathode. In practice a grid bias battery as shown in fig. 1 is not employed. Instead the bias potential is developed across a cathode resistor, see  $R_2$  in fig. 5. When the valve conducts, the anode current passes through this resistor and a voltage is developed across it ( $V=IR$ ). Since one end of the cathode resistor is always at earth potential, the voltage at the other end must be positive relative to earth. However, the control grid itself is also returned to earth through the grid resistor  $R_1$  and so the cathode is always positive with respect to the grid, which of course is the same as saying that the grid is negative relative to the cathode—hence our negative grid bias.

Now the number of electrons penetrating the grid and arriving at the anode depends on the potential of the grid relative to the cathode and so it is easy to see that with a varying input voltage there will be a corresponding varying current at the anode.

The variation of anode current when a varying signal is applied to the grid can be conveniently represented by the mutual characteristic curve X-Y for the triode illust-

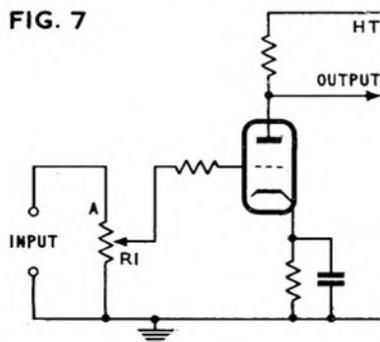
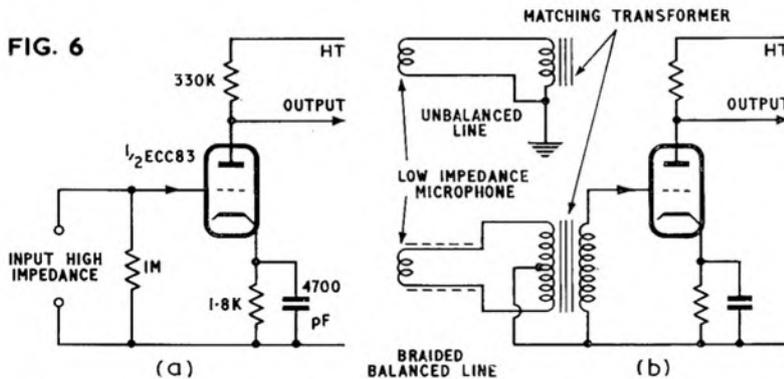
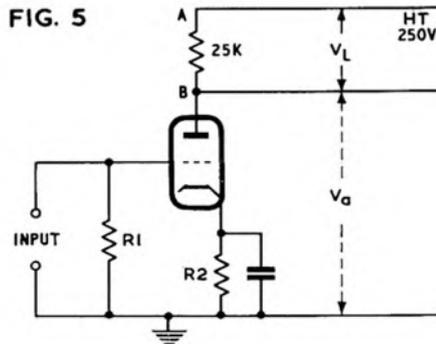
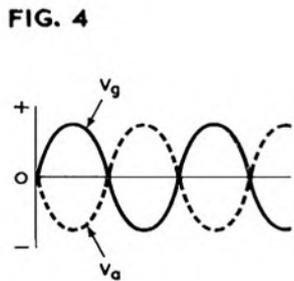
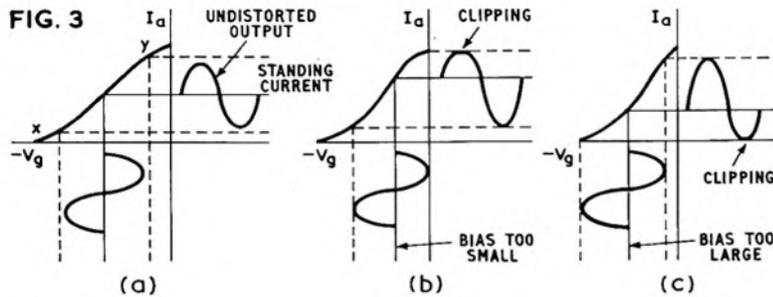
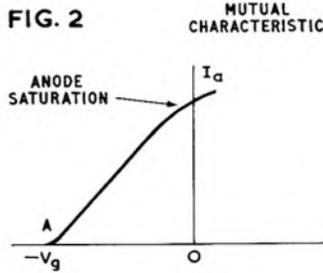
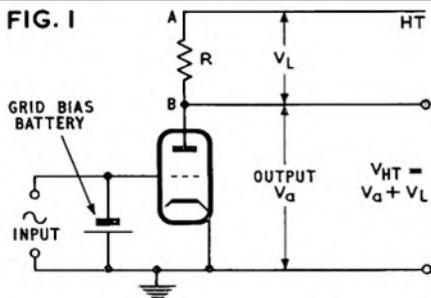
rated in fig. 2. This curve ( $V_g-I_a$  curve) shows that an increase of the grid voltage in the negative direction,  $-V_g$ , causes a gradual reduction in the number of electrons arriving at the anode, and thus a decrease in the anode current,  $I_a$ , until point A is reached when no current flows. This point is known as the cut-off point. Fortunately the curve is almost straight over a considerable range of grid voltages.

### SINE-WAVE INPUT

Fig. 3a shows the same curve with a pure sine-wave input applied to the negative grid and a corresponding variation of current at the anode. In this diagram the variation of the anode current (output signal) is undistorted and this means that the valve is biased to the most linear part of the characteristic curve, and is operating under linear conditions. Now let us suppose that the grid bias voltage is reduced as shown in fig. 3b. Here the negative peaks of the signal are handled satisfactorily, but on positive peaks the input signal pushes the valve towards anode current saturation where it operates on the non-linear part of the characteristic curve. As shown, this produces severe clipping of the positive peaks which results in bad distortion in the output. Too much grid bias, fig. 3c, also causes distortion, but here it is due to clipping on the negative peaks since the valve is operating beyond the anode cut-off point. In Part 1 of this series we mentioned that bad distortion can also result from overloading the amplifier with excess input signal. In this case clipping occurs on both the positive and negative peaks of the anode current output.

### ANODE VOLTAGE

Returning now to fig. 1, we notice that the output of the valve is given as the anode voltage  $V_a$ . How is this related to the anode current? We have seen that a positive signal at the grid produces an increase in the anode current, but this also increases the voltage across the load resistor R.



Now one end of this is connected to the high tension (HT) line at A, which means that an increased voltage across R can only occur if the potential at the other end, at B is reduced. This, of course, means that the voltage between B and ground, the anode voltage, is also reduced. Increase in the input voltage to the grid therefore decreases the output voltage  $V_a$ ; the input and output voltages of a triode amplifier are therefore out of phase as shown in fig. 4.

To make this clearer let us put in some values, fig. 5. If the valve draws 10mA it can be shown using Ohm's law that there will be a voltage drop of 250V in the 25K resistor. This means that the bottom end will be 250V negative to the other end which is connected to the HT supply. Under these conditions the anode voltage  $V_a$  will be zero. When the grid is properly biased the valve might draw, say, 4mA, so that there will be a voltage drop of 100V across the anode resistor leaving the anode at  $250 - 100 = 150V$  positive.

On applying a positive signal to the grid,  $-V_g$  will be decreased, the anode current  $I_a$  increased and the anode voltage  $V_a$  reduced. The important thing to get clear from all this is that comparatively small changes in grid voltages caused by varying the input signal produce large changes in anode volts—the triode therefore behaves as an efficient voltage amplifier and the power to achieve this is drawn from the HT supply.

The foregoing sheds some light on the function of the triode valve as a voltage amplifier and how it can be used under linear conditions to give an undistorted output, a correct setting of the bias being important here. Let us now consider the input to the first stage in a record amplifier in a little more detail and see how this can achieve correct matching between the source (microphone amplifier or tuner) and the input grid. The intrinsic impedance of a valve grid is very high, in the order of many millions of ohms, but in practice this is reduced to the value of the grid resistor which itself may be as much as 1M or 2M. Fig. 6a shows a typical input stage of 1M suitable for a high-impedance (high-Z) signal source.

#### CONNECTED DIRECTLY

This means that signals can be connected directly to the input, assuming these are of the correct level—say from a high-impedance microphone. This is convenient, but the length of cable used to make the connection is severely limited to a maximum of about 15ft. if loss of high frequencies is to be avoided. Longer cables, however, have such capacitance that, in conjunction with the input capacitance of the valve, they act as a serious shunt for frequencies much above 5kHz. The problem of cable length is solved if we use a low impedance microphone where the signal is carried predominantly as current rather than voltage.

Now if we connect a low impedance ribbon microphone directly to a high impedance input circuit we get what is called a *mismatch*. In Part 1, when we dealt with Ohm's law, we showed that for a given voltage there is a greater current flow in a low resistance circuit than in one of high resistance. Conversely, a greater voltage is required to transfer a given

(continued on page 409)

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



## The Ferrograph

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

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# Ferrograph

THE INCOMPARABLE TAPE RECORDER

power through a high resistance than a low resistance circuit. The same applies to our high impedance input: a high voltage at low current is required to work it.

However, a low impedance microphone generates a greater signal *current* than signal *voltage*—the opposite of what we want for a high impedance input. In fig. 6b this problem is solved by the use of a step-up matching transformer, which increases the signal voltage and decreases the signal current from the microphone. Using the formula  $Z_s/pZ = n^2/n_0^2 = t$  (see part 3) we can easily work out the turns ratio  $t$  required to increase the source output to that required by the control grid.

#### TYPICAL EXAMPLE

Taking a typical example, suppose that a source impedance of 100 ohms has to be matched to an input of 1M. Now the turns ratio of the transformer is equal to the square root of the impedance ratio (amplifier impedance divided by the microphone impedance). So 1M divided by 100 ohms gives 10,000 and the square root of 10,000 is 100. Therefore a suitable matching transformer would have a turns ratio of 1:100 for the primary and secondary coils respectively, and the signal voltage from the microphone would be stepped up 100 times to a level suitable for driving the high impedance circuit. In a perfectly efficient transformer the power transformer would be 100% and the signal current would be accordingly reduced 100 times. In practice, however, power is lost for a number of reasons (eddy currents, etc.) and some signal power is lost in the process.

A low impedance input like fig. 6b is par-

ticularly useful, since it permits long runs of cable from the low impedance source; a fact which is taken into account by makers of many professional microphones where impedances in the range 30-600 ohms are encountered. The balanced cable connection fig. 6b cancels out, with respect to ground, any hum and noise picked up by each cable lead and is therefore better than an unbalanced line (see fig. 6b inset) where really long runs are required.

#### ANOTHER WAY

Another way of matching low impedance inputs to high impedance amplifiers is by using a transistor circuit. Unlike valves, transistors operate from signal *current* as distinct from signal *voltage* and as such they are ideally suited for connection to low impedance microphones. (See the article, 'Transistor Microphone Booster' by Gordon J. King, November 1956.)

In the high and low impedance inputs so far described there is no means of attenuating the signal voltage. This is usual for a low level input on a tape recorder, and in consequence its sensitivity would be in the 1-2mV range—about right for many types of microphone likely to be encountered by the enthusiast. High level signal sources require a different type of input. Because the voltage is so high (100-300mV) an attenuator (fig. 7) is necessary to reduce this to a level within the range of the amplifier stage. In this circuit the input impedance is determined by the resistance  $R$ ; which also functions as the record level control for the input, maximum level being obtained when the slider is at A.

Next month we shall continue with amplifiers, and amongst other things see how simple mixing of low and high level inputs can be achieved.

#### ... about a Reps R.10

From: K. A. Gilbert, 5 Curtis Road, Emerson Park, Hornchurch, Essex.

DEAR SIR, In your July Editorial you suggest that the small British firm making recorders with other people's decks does not tend to inspire trust in the user. While I am unable to comment on this in general terms, I would like to say that, in one case at least, this is not so.

I have had a *Reps R.10* for nearly three years, during which time it has had steady use and, apart from offering fewer facilities, compares well with a much more expensive machine. The makers have supplied a circuit diagram and, on two occasions, readily answered queries on adjustments. The second case recently concerned a slipping take-up spool turntable. Full details for making the adjustment were sent with an apology for not replying more quickly (actually they took a week). The result was a satisfactory machine without a repair bill, and a very satisfied customer.  
*Yours faithfully*

#### ... about preventing accidental erasure

From: John Hone, 10 Aldbourne Road, London W.12.

DEAR SIR, H. W. Hellyer asks for readers' views on record-interlock safety devices ('That Little Extra', August *Tape Recorder*).

An idea which I feel would be the least worrying and the most useful is that of activating the record button whenever a plug is inserted into the microphone or gram input. The mechanism could be so arranged that neither recording nor erasure could occur if no equipment were connected to the input sockets. A spring grip arrangement could be made to lock the plug in position when recording was taking place.  
*Yours faithfully*

(Mr. Hone's idea would certainly overcome the risk of accidental erasure when a machine is used by inexperienced individuals—Ed.)

## OUR READERS WRITE . . .

#### ... about wow and flutter

From: E. G. Lennard, Lennard Developments Ltd., 7 Slades Hill, Enfield, Middlesex.

DEAR SIR, I am writing with reference to W. H. Myall's article 'A Closer Look at Wow and Flutter' in your August issue.

Though in a way a competitor of Mr. Myall's, I would nevertheless like to thank you for publishing his article, not only because it is well written and explains in simple terms what wow and flutter (or 'wobble?') are all about, but also because it can only help to make enthusiasts more aware of these problems.

In fact the only thing I would like to comment upon is his reference to 3kHz on page 318, column two; this, with respect, is outdated. The DIN and CCIR recognised frequency is now 3.15kHz and the relevant BSI specification will also presently be altered to 3.15kHz. Our instrument (*Lennard Developments import the ME101 Wow and Flutter Meter*—Ed.) is supplied set to 3.15kHz but can, if necessary, be switched back to 3kHz. To the best of our knowledge this was

only done on two meters out of many dozens supplied over the last 18 months.

*Yours faithfully*

#### ... about PTFE

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

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

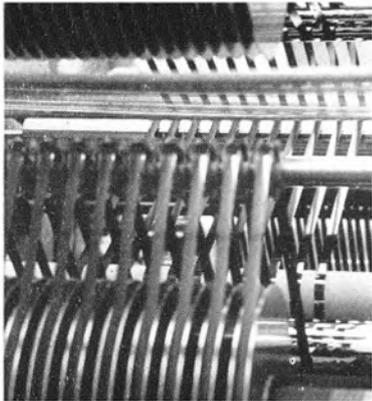
The PTFE sleeve works well and I have overcome the problem of mounting it on the deck of my *Grundig* by employing the automatic stop pin as a support—though this prevents that mechanism from working of course. Readers may find, as I have done, that the squeak disappears when the sleeve is used and that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

#### ... about 'that little extra'

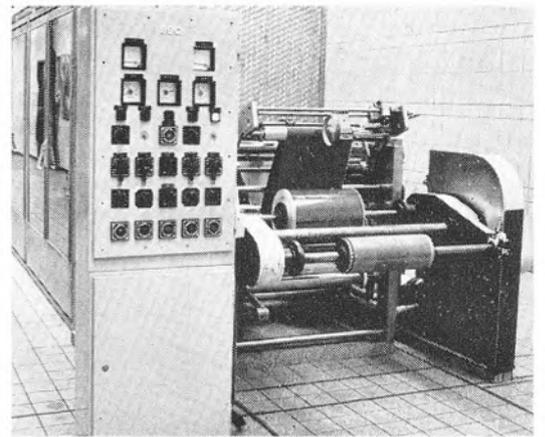
From: R. Tootell, 10 Ashley Crescent, Swinton, Manchester, Lancs.

DEAR SIR, After reading H. W. Hellyer's article 'That Little Extra', I feel bound to suggest, albeit somewhat jocularly, that perhaps a percentage of the vast range of tape recorders now available would offer better value if a few of the little extras provided were removed. The saving in cost could be put to better use in improving the basic specification and lengthening the useful life of these instruments.

The only additional facility I can suggest with respect to my own instrument, a Series 5 *Ferrograph*, would be the provision of a suitable stay to support the hinged deck in a semi-raised position in order to facilitate periodic inspection and cleaning of the recorder without undue risk. In all other respects, for my own purposes, I consider this recorder to be as nearly faultless as one can reasonably, or sometimes even unreasonably, demand.  
*Yours faithfully*



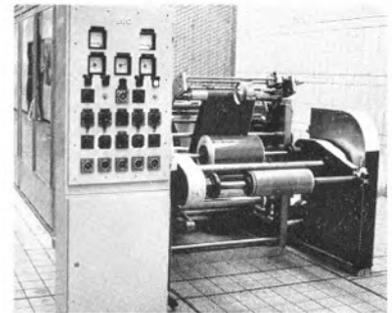
Part of the slitting mechanism, here showing cutting of 2in. computer tapes.



Leaving the drying chamber, the magnetic film is wound into blocks.



A sample of domestic tape from each block is inspected to ensure consistent quality.

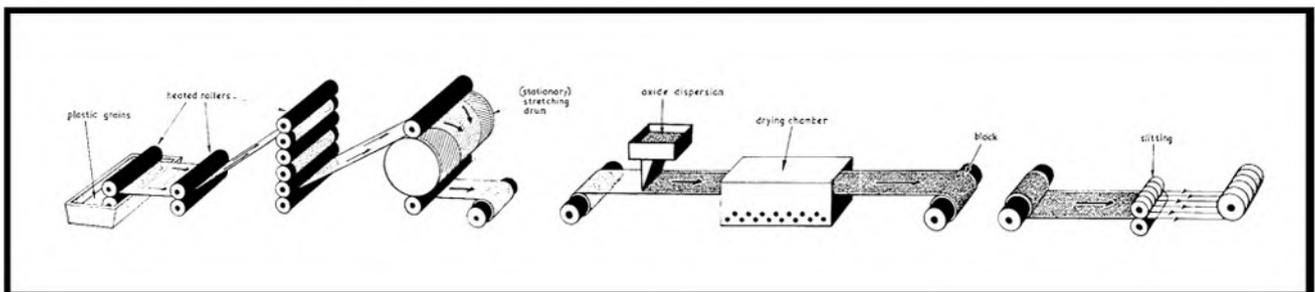


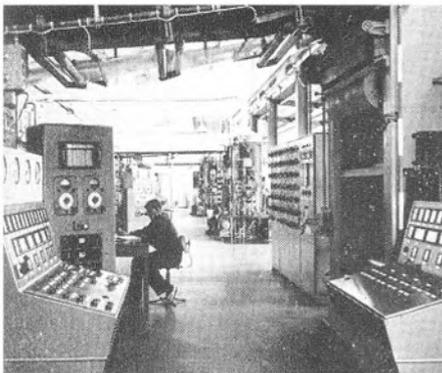
Leaving the drying chamber, the magnetic film is wound into blocks.



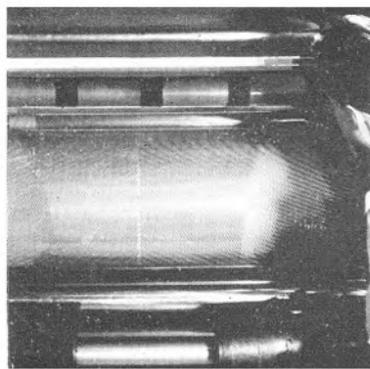
# INSIDE BASF

AN EXERCISE IN SOUND CHEMISTRY □ BY DAVID KIRK

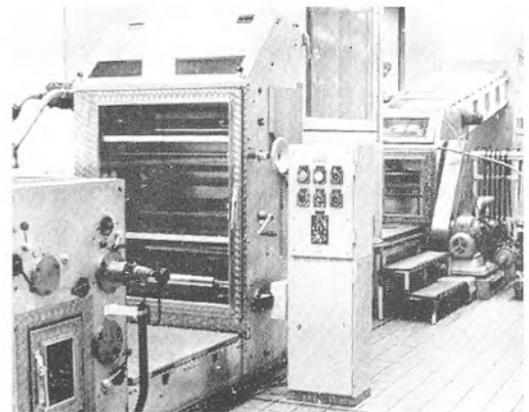




The beginning of the line. Luvitherm film is rolled from heated plastic grains and routed overhead to stretching equipment.



Here the film is fed slowly across a stationary drum and wound off from below by a faster roller.



Coating machines at Willstätt feed dispersion evenly across the base film.

IN our limited sphere of sound recording the initials *BASF* represent one of the more respected brands of magnetic tape. But in other fields, for other specialists, *BASF* signifies food, clothing, building, transport, cosmetics, entertainment and medicine. At the end of the day when we are laid to rest, it may even mean a tapered box bonded by *BASF* wood adhesive.

*BASF* is a giant. Seventy years before it developed the world's first plastic-based recording tape, the company was producing textile dyes and raw chemicals for the European market. It is probably unique among members of the twentieth century electronics industry, in having possessed a branch in Tsarist Russia.

If any one man could claim the major role in founding *BASF*, it was Friedrich Engelhorn. Born in 1821, he entered the goldsmith's trade and eventually became a successful jeweller. In 1848, foreseeing the impending technological revolution, he established a gasworks at Mannheim. Thirteen years later his interests expanded into the production of coal-tar dyes, exploiting a by-product of gas-manufacture that had hitherto been deposited as waste. This venture, and further profitable essays into the field of chemical production, accrued part of the capital on which the *BASF* company was to be founded.

In 1865, new financial arrangements and a change of name. Engelhorn's *CFDCC* (*Chemische Fabrik Dyckerhoff, Clemm & Cie*) became part of *Badische Anilin- & Soda-Fabrik*, merging after eight years with another manufacturer of dye-stuffs, *Rudolph Knosp & Heinrich Siegle*.

From the beginning, *BASF* invested a large portion of its budget in research, and this policy, combined with efficient administration, set a pattern of growth that was to survive the devastation of two wars. The central factory today, extending 3½ miles along the Rhine at Ludwigshafen, is a monument to the three hundred thousand employees who have worked for the company in the hundred years of its existence.

The visitor is so engulfed by colossal dimensions—50 miles of streets, 1,000 miles of pipes, 120 miles of standard-gauge railway, and annual chemical production figures running to millions of tons—that the figures become meaningless in their enormity.

Some 5,000 separate products are currently being produced at Ludwigshafen, ranging from raw chemicals and fertilisers to the base

materials for plastic car bodies and synthetic fibres. The range of items transported by rail, road and Rhine from the main plant is enormous, and so too is the range of temperatures at which they are manufactured. Hottest of the *BASF* processes is the splitting of light naphtha to acetylene, which occurs at above 1,500°C. At the other extreme, the extraction of gases from air involves low-temperature distillation at—200°C.

Chemical theory is growing increasingly more complex for the unaided human mind, but the installation of computers at Ludwigshafen is now aiding the 8,000 personnel engaged in research (among a total of 47,000 employees). On the practical side, computers are now controlling processes beyond the capabilities of human operators. One such computer, currently being installed in a glass-walled suite, was originally developed for the American *Polaris* Project and was purchased by *BASF* after being found unsuited to its intended role.

Far from creating redundancy, automation has resulted in new products for new markets.

Electrical power consumed at Ludwigshafen equals that needed for the whole of Denmark and is generated by two oil-burning and one coal-burning power stations on the plant. An additional power station adjoins the company's own coal-mine at Marl and feeds power via the *Rheinisch-West Falisches Electricity Works* grid.

Such are the resources behind the *BASF* trade-mark that adorns their unassuming plastic spools.

The importance of tape production in the *BASF* scheme should not be underestimated. Not only has the company played a dominant role in the early development of this medium, in conjunction with *AEG*; they have also foreseen the rapid increase in demand for instrumentation and computer tape. To meet this demand, and the expanding market for domestic sound tape, they have built and equipped a £7 million factory at Willstätt, some 70 miles south of Ludwigshafen, to cater purely for tape production. Additional factories in Gien (France) and Waltham (Massachusetts, U.S.A.) make a total of four plants engaged in producing *BASF* tape.

At the Berlin Radio Exhibition in 1935 the German public was first introduced to plastic tape. 165,000 ft. was supplied by *BASF* for demonstration with another new development—an *AEG* magnetic recorder.

Improvements to recording equipment and tapes followed rapidly, superior oxide materials and AC bias resulting in slower tape speed and higher signal-to-noise ratio. The days of 40 i/s sound recording were over. As the years moved on, *Luvitherm* (*PVC*) plastics began to replace acetate, offering greater resistance to wear. No acetate tapes are manufactured nowadays by *BASF*.

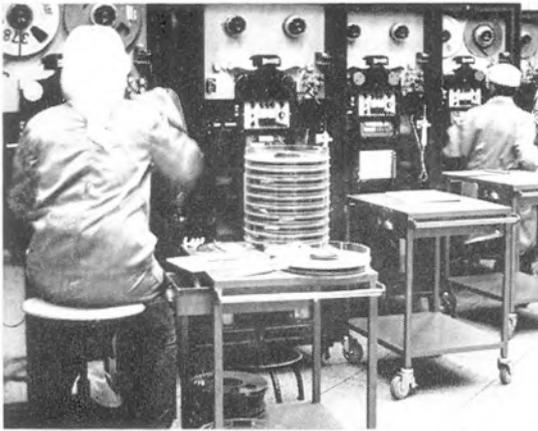
Development since 1946 has been slow and pains-taking. Magnetic tapes have been reduced in thickness and width to such a degree that the thinnest must now be confined within delicate cassette mechanisms if they are to be handled safely by domestic equipment and human fingers. Tighter production tolerances have reduced dropout and idealised coercivity to a degree where discernible sound recording is possible on tracks 1/8 in. wide at less than 1 i/s. The magnetic-oxide medium has, it seems, been exploited to the full.

The process of manufacturing tape, while not inherently expensive, requires complex precision-made equipment and totally dust-free conditions that raise the overhead cost to millions of pounds. At Willstätt, the mixing and coating plants are divided into 'dirty' and 'clean' zones, respectively 'normal' (rural) and 'dust-free'. The 'dirty' area is itself remarkably clean but lies outside the air-lock system through which 'clean' staff, in their carefully designed overalls, must enter to work.

Commenced in November 1964 and in operation 18 months later, the Willstätt factory is laid out in a pattern resembling the letter T. The two limbs comprise air-cooling plants, steam boilers, and liquid chemical stores (to the right of the photograph), and equipment-maintenance workshops (left foreground).

Raw chemicals for the coating are transported from Ludwigshafen and held in the liquid storage tanks where they are analysed before being pumped through overhead pipes to the dispersion plant. A deserted hall of great mixing drums, this plant is almost entirely automated. Here, iron oxide and lacquer are dissolved in a solvent, pulverised and thoroughly mixed to achieve uniform dispersion. The resultant combination then passes from the tanks through a filtration plant, to remove any surviving clotted particles, and on to the coating machines.

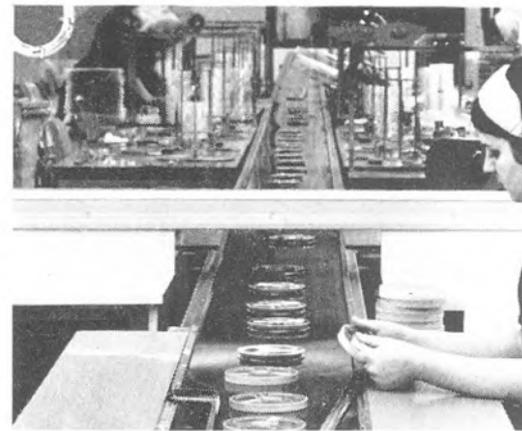
Plastic film is supplied to Willstätt from Ludwigshafen, in common with the raw



Computer tapes are examined individually, since a flaw could result in inaccurate information handling.



Final stage of production. The tape is wound on to branded plastic spools.



Preliminary packing in dust-proof 'cheese boxes'.

chemicals, and not manufactured on the premises. The process of manufacturing Luvitherm, outlined in the drawing, commences with the preparation of finely sifted granular plastic. This is removed from a trough on the periphery of a heated metal roller and squeezed into a rough semi-opaque sheet. A further chain of heated cylinders rolls the sheet into a film of uniform thickness, the precise dimension being automatically controlled to within one micron by a radioactive sensing element.

In its resultant form, the film possesses the properties of a satisfactory tape base, with one undesired addition: it is highly prone to stretching. To prevent deformation under the stress of everyday use, the film is stretched to predetermined limits before the coating is applied. Leaving the rolling machinery, the base is drawn at 250°C to three times its former length, across a stationary helically-engraved drum.

Now some 18in. wide, the sheet is wound on to cylindrical spindles and transferred to a rewinding machine, where trapped air-bubbles and foreign matter are removed and lin. margins trimmed from each edge.

Additional meticulous attention to cleanliness occurs at Willstätt, where the base reels are washed and dried within the air-conditioned white zone before being loaded on to the coating machines. The most critical point in tape production is the coating head, where oxide dispersion is spread evenly across the moving sheet. A further sensing element monitors the coating thickness. Still in moist condition, the film is passed through a magnetic field to align the oxide particles along the longitudinal plane in which recording will ultimately occur.

A hot-air drying tunnel hardens the coating, evaporating much of the liquid solvent for recovery and eventual re-use. From this apparatus the film passes yet another sensor to be checked for coating thickness before being wound on to a final wide reel.

The reels (or 'blocks') are now transferred to high-precision slitting equipment where they are cut to the required width within hundredths of a millimetre.

A sample of tape from each block is passed to an inspection point where major physical and electromagnetic parameters are measured against a norm and filed, with a small clipping of the subject tape, for future reference. Testing of computer tape is even more strin-

gent, every inch of every reel produced by BASF being checked for coating and slitting imperfections.

Slit tapes are wound into large reels which are then placed on re-spooling decks where they are transferred to the branded plastic spools. Coloured leaders and trailers are spliced manually while other tapes are being re-spooled, taking advantage of the delay in winding each reel.

Attempts have been made to automate the attachment of leaders, but this is only economical with very small tapes where short spooling periods and low individual value render manual techniques impractical. In such cases, wide leader-film is sometimes spliced to the 16in. block before slitting.

One component not manufactured by BASF, either at Willstätt or Ludwigshafen, is the plastic spool on which the tape is sold. These are purchased from a separate company. The Willstätt plant does, however, stamp its own 'cheese-boxes'—tight-fitting plastic drums in which the spools are housed. A conveyor belt carries finished tapes out from the 'clean' zone spooling tables to a packing bench where the drums are fitted. Even at this stage, poor winding or a visible flaw may condemn a tape to destruction.

Packaged tapes are stored in a large warehouse at the foot of the T-shaped building from where they are transported.

Like their contemporaries, BASF maintain a close watch on sales and market trends. The greatest potential European market for domestic tape, as it happens, is West Germany, where four million recorders are divided between 20% of the country's 20 million

households. It is estimated that 15% of households in Britain possess recorders, based on a figure approaching three million machines. 13% of Swiss families are calculated to own tape equipment, with Austria, France and Holland falling into the 5-10% category.

The number of potential 'mouths' for BASF tape are increasing at a rate of seven to ten million per year, five million recorders having been produced in Japan alone during 1965. West German industry manufactured nearly one million units during that period, though few other countries exceed 100,000 recorders annually. Few peoples appear to possess the Englishman's enthusiasm for active spare-time hobbies, though even in Britain tape sales are not significantly above the estimated European average of one tape per machine per year.

The development of the *Philips* miniature cassette, and the anticipated explosion in the currently infinitesimal domestic video recording market, are both expected to offer worthwhile outlets for the ever-increasing energy of BASF. Professional video tapes are now being made at Willstätt and the company is poised to produce domestic video tape when a clear standard medium is accepted by the industry. At present, the ½in. system popularised by *Sony* is in the lead, but BASF will watch the trends of the next year or two before coming to a decision.

In the meantime, the *Badische Anilin- & Soda-Fabrik* plants continue their unending task, creating ammonia to rejuvenate the acid soils that feed humanity. Creating, too, the chemical foundations upon which modern civilisation, and life itself, are built.



View from the air of the BASF works at Ludwigshafen, covering 4.8 square miles.

don't  
buy  
**any** tape  
...buy  
**EMITAPE**

Listen to the cleaner sound of the new, improved range of Emitape. It's unbelievable – so clear, so crisp. Emitape gives you the consistent quality which adds so much to listening pleasure. With every reel you buy there's a dust-proof library case to give lasting enjoyment to everything you record. So ask for Emitape – by name.



# PPM OR VU

BY DAVID ROBINSON

PART TWO

photographs by Graham Roe

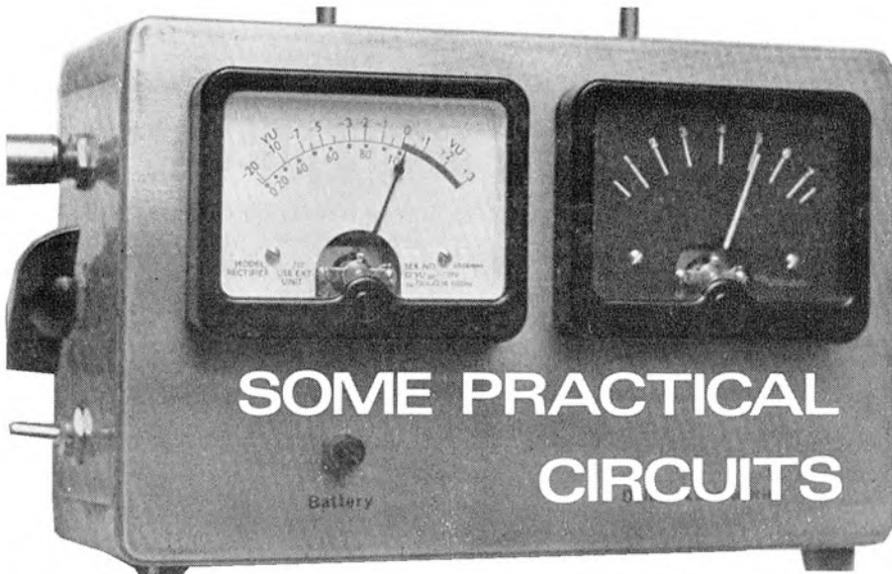


Fig. 1. The author's portable VU/PPM unit.

LAST month we explained the major differences between the two main types of professional metering equipment; this month we will discuss some practical circuits which can be used by themselves or easily adapted for building into existing equipment. Fig. 1 shows a portable metering unit used for demonstrations which incorporates both a VU and a PPM—in this way everyone is satisfied! It does, however, illustrate the compact size of an add-on unit; if required, the VU can be replaced by a second PPM or vice-versa, as there is room inside for two of the basic circuits.

The circuits themselves have been designed to work from a 24V supply, and batteries form a very convenient method of providing this voltage; they will have a long life as the current demand is low—less than 20mA for

the whole PPM unit. Alternatively, a mains power supply can be built, and a suitable unit will be described. The basic circuit itself may possibly be powered from other sources of supply already available.

The most difficult part to design is the peak programme meter amplifier, so this was produced first, the other circuits then being made compatible with it. As we discussed in Part I, one of the most important parts in this amplifier is the capacitor which must be charged rapidly and yet takes a long time to decay. To comply with the normal broadcasting practice, the circuit must have a rise-time of 2.5mS, and a decay time-constant of one second. It is no longer difficult to make a cheap transistorised amplifier with an input impedance of 1M; a capacitor of 1 $\mu$ F then gives the required decay characteristic. The

source impedance when charging the capacitor is thus fixed at 2.5K. In practice, the amplifier input impedance is designed to be higher than 1M to accommodate circuit tolerances, and a fixed resistor added across the capacitor to give the required value.

The voltage swing required on the capacitor and the correct drive impedance can be achieved by using a transformer fed from a low output impedance amplifier. A centre-tapped secondary allows full-wave-rectification to be used. As was explained in Part I, this takes care of any differences between positive and negative peaks in the signal, which can be 8dB or so with music signals. Looking at the circuit in more detail (fig. 2) Tr1 is an amplifying stage feeding into a complementary emitter-follower output stage. Both AC and DC feedback are used to stabilise the gain and operating point of the amplifier. The purpose of the networks in the collector of Tr1 will be explained later.

#### NOT ELECTROLYTIC

The output of the Tr3 stage is coupled into the transformer via C5 and at the secondary (fig. 3) is rectified by D1 and D2 to charge C6. The latter must not be electrolytic since, in general, the leakage of such types effectively means that the capacitor itself has a lower DC impedance than 1M, and thus the decay time would be shortened.

The voltage on C6 is measured by the compound emitter-follower Tr4 and Tr5; these two transistors are chosen to have a very good current gain (*hfe*) even at low collector currents. This ensures good meter linearity at low readings when the current, in Tr4 particularly, is only a few microamps. The voltage on C6 thus appears (less the two base-emitter drops) entirely across R19. Tr5 must then pass a current which is directly proportional to the input voltage, and the same current will be passed to the network in the collector circuit, which includes the meter. At first, all the current passes through the meter; as it increases, the voltage developed across the three variable resistors also increases, to reach a point when D3 starts to conduct. With the silicon diodes used, this is when the voltage across it is about 0.5V. When D3 is conducting, R22 shunts some of the current from the meter. In the same fashion, first D4 then D5 is switched into conduction, bleeding more and more current from the meter. In this way, a logarithmic law is achieved.

In order to achieve a frequency response which is flat to within  $\pm\frac{1}{2}$ dB over the audio range, the transformer characteristics have to be compensated. A small resonance at 50kHz is removed by C4; low and high frequency compensation is completed by two RC networks in the collector of Tr1.

#### EASY TO ALIGN

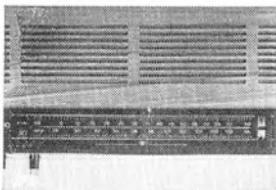
It is very easy to align the completed PPM. First, Tr4 and Tr5 are biased so that they are just not conducting; this requires about 1 to 1.2V on the base of Tr4. R14 is varied slightly until the meter barely indicates with no input signal; it can then be replaced with a resistor whose value is the next standard value above that which just caused the meter to move. An input signal of 1kHz is then applied at a level which produces a reading of 1 $\frac{1}{2}$  on the meter,

(continued on page 417)

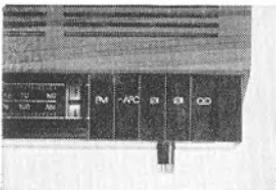


# Bang & Olufsen

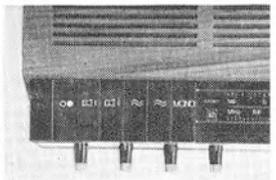
## for those who consider design and quality before price



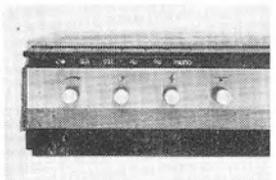
Distinct tuning scale calibrated in mHz and log. Centre null point tuning indicator and illuminated stereo indicator.



Piano Key selections for instantaneous mode switching Fly-wheel balanced tuning control.



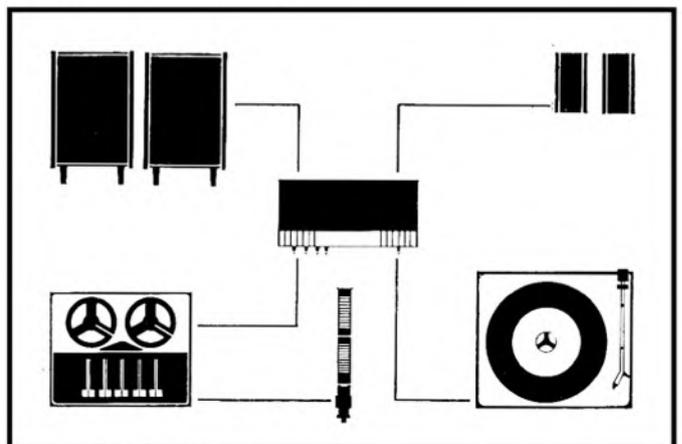
Tapered variable volume, bass, treble and balance controls Piano Key operated filters, loudspeaker selection and mono/stereo selector.



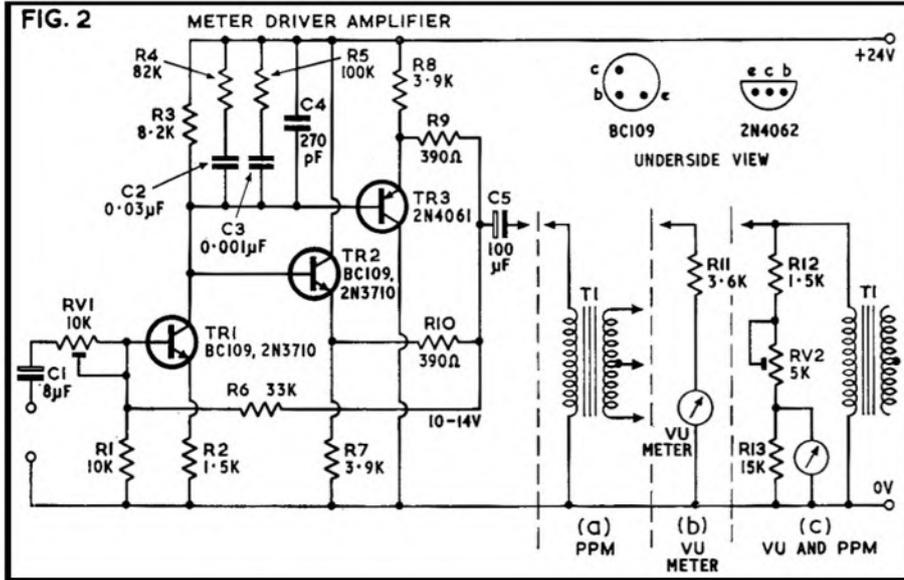
Piano Key identification duplicated on front face for eye-level recognition giving increased scope for arrangement.

**Beomaster 1000 K** A design style introduced by B & O the success of which is reflected in the trend it has created. Powerful 15 watt RMS per channel stereo amplifier integrated to a stereo FM radio section and presented in a solid teak or rosewood cabinet.

Now with a black facia and simplified tuning scale, the Beomaster 1000 K is the natural choice for the Audio enthusiasts and music lovers who also appreciate graceful up-to-the-minute design.



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**United Kingdom Division,**  
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 Telephone: Gloucester 21591.  
**London Showrooms:**  
 70/71 Welbeck Street, W.1.  
 Telephone: 01-486 2144.



and is then increased by exactly 6dB. The Law 1 control, RV3, is then adjusted until the meter reads 3. The input is again increased by 6dB, and RV4 adjusted to give a reading of 4½; a final 6dB increase allows RV5 to be set for a reading of 6 on the meter. The whole procedure should then be repeated as the preset adjustments are slightly interdependent. The final result should be within the specification of a broadcast meter, that is to within ±½dB of the correct 4dB per division, with the possibility of this error being slightly greater over the first two divisions. Finally, RV1 is set to give a reading of 6 for the peak recording level used in the system being monitored.

FOR THIS READING

The sensitivity of the unit is 850mV for this reading of 6, at an input impedance of 4K; with RV1 at a maximum the sensitivity is 2.8V RMS and the input impedance is 14K—and obviously RV1 can be adjusted between these limits, or higher input voltages can be accommodated with a simple input attenuator. The frequency response is ±½dB from 45Hz to 20kHz; the -3dB points are 20Hz and 40kHz.

The VU meter can in theory be placed directly across a 600-ohm standard line—and this is of course one of its big advantages. However, most amateurs do not use low impedance lines at this level, so that it is usually necessary to have a buffer amplifier of some description. The circuit of fig. 2 can be used for this, this time with C5 feeding direct to the meter as in (b). A word of warning here: some VU meters have the 3.6K series resistor built in permanently, some need it added externally; hence R11. Check your actual meter before adding R11. The simplest method of finding this out is to apply a 1kHz signal to the VU, adjusting it for full scale deflection. Add a series resistor of 3.9K, and if the meter has not got the added internal resistor it will indicate half-scale and R11 is needed. If R11 is already in the meter, the needle will drop to about 65% of full scale.

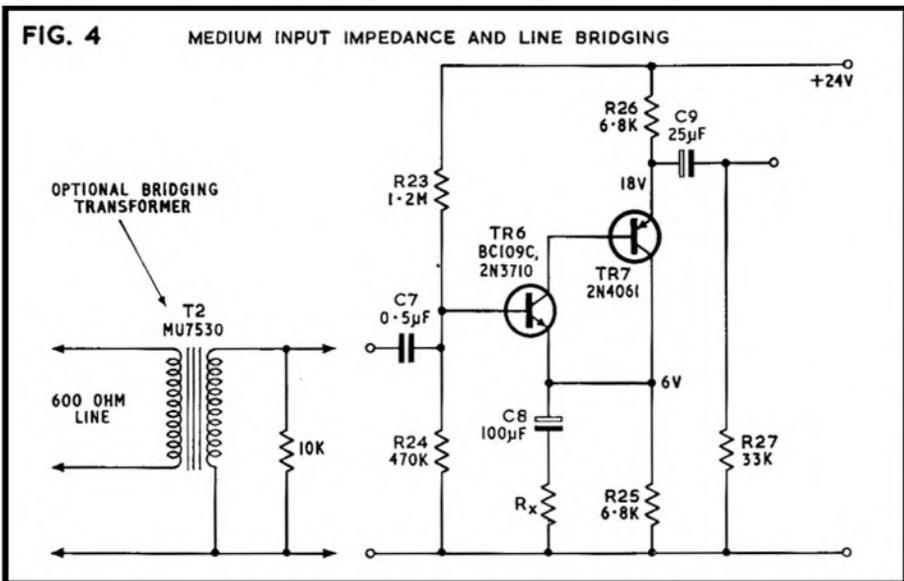
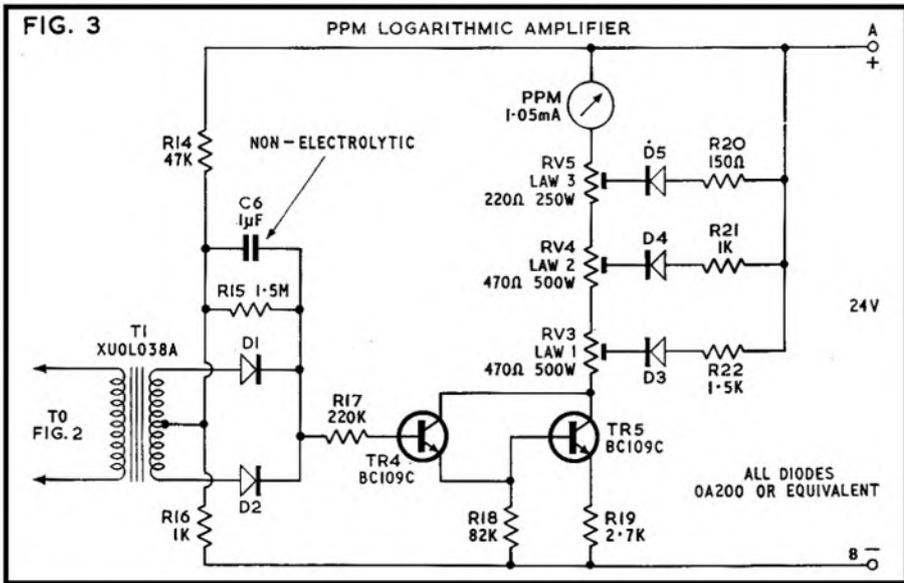
The only setting-up for this circuit is to adjust RV1 for the correct reading on the VU. Ideally this should be done by playing back a standard NAB or Ampex test-tape which starts with a short section recorded at 0 VU; the record side is adjusted to read 0 for a tone which records to the same level as the test-tape. Care must be taken if a DIN test-tape is used, since these are recorded to a level of 4dB above the Ampex; since the last calibration of the VU is only 3dB above 0 VU, this level is above the end stop.

4DB BELOW

If no test-tape is to hand, the VU should be set so that it indicates 0 VU for a tone 4dB below peak recording level. By adopting this difference, the ballistics of the VU are partially compensated. With RVI at a minimum, 0 VU is indicated for an input of about 300mV.

If for some reason both a VU and a PPM are required, as in the instrument in fig. 1, then fig. 2(c) shows a suitable arrangement. The VU should be set to read 0 for the PPM reading of 5, as implied above; because the

(continued on page 419)



YES, I'M SMALL.  
YES, I'M BATTERY POWERED.  
NO, MY MUSIC IS NOT A LITTLE...SOUND  
IT'S A BIG...SOUND!

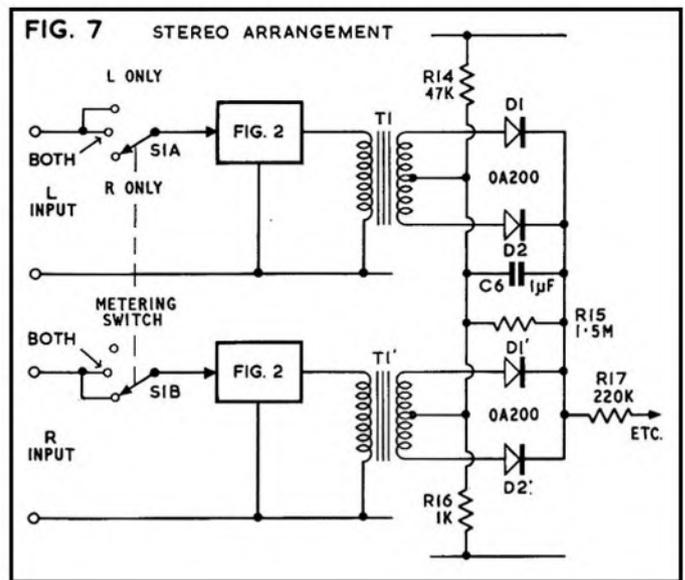
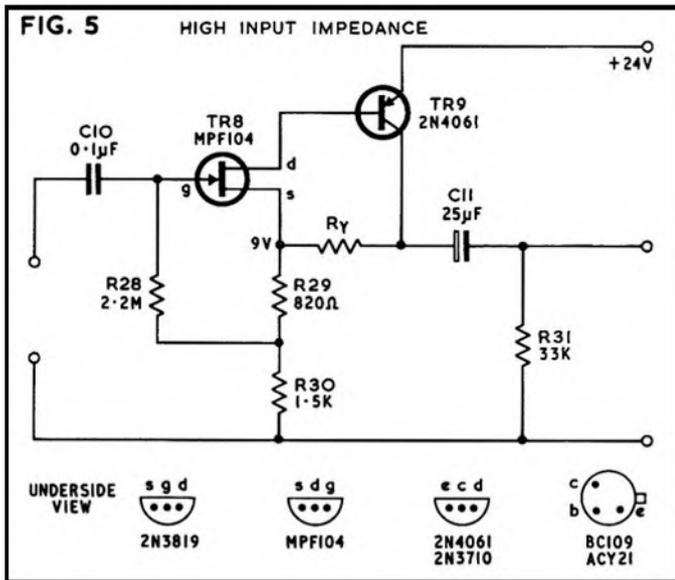


If ever it was true that there's good stuff in little bundles, it's true of Philips 4200. Six 1.5 Volt batteries give 40 hours play – excellent play – anywhere! Reproduction is fantastic for so compact and lightweight a tape recorder – it's a beautiful 8 lb. example of Philips quality. And the price? Equally fantastic! With 3" double play tape, 3" empty spool, sensitive microphone, recording/playback lead – 26 gns. Another advantage: Philips High Fidelity Low-noise tape is available at no extra cost than ordinary tape in sizes to fit the 4200.



**PHILIPS**

PHILIPS ELECTRICAL LTD.,  
CENTURY HOUSE, SHAFTESBURY AVE., LONDON, W.C.2.



**PPM OR VU? CONTINUED**

voltage at the transformer primary to drive the PPM circuit is higher than that required for the VU alone, a simple attenuator has to be used which still presents an impedance of 3.6K to the VU—this is assuming the resistor R11 is not in the meter. RV2 gives a small range of adjustment to allow the two meters to be matched exactly.

This covers the basic circuits, but there are some applications where the levels and impedances are not satisfactory. The next two circuits, figs. 4 and 5, cater for other requirements. Professional systems usually use balanced 600-ohm lines, and to monitor these a bridging input is essential, together with an input impedance of about 10K. The circuit of fig. 4 gives unity gain and an input impedance of 300K; by adjusting resistor  $R_x$  it can also be made to give gain. With this resistor equal to zero, the gain of the circuit is about 46dB, or 200 times, and the input impedance only

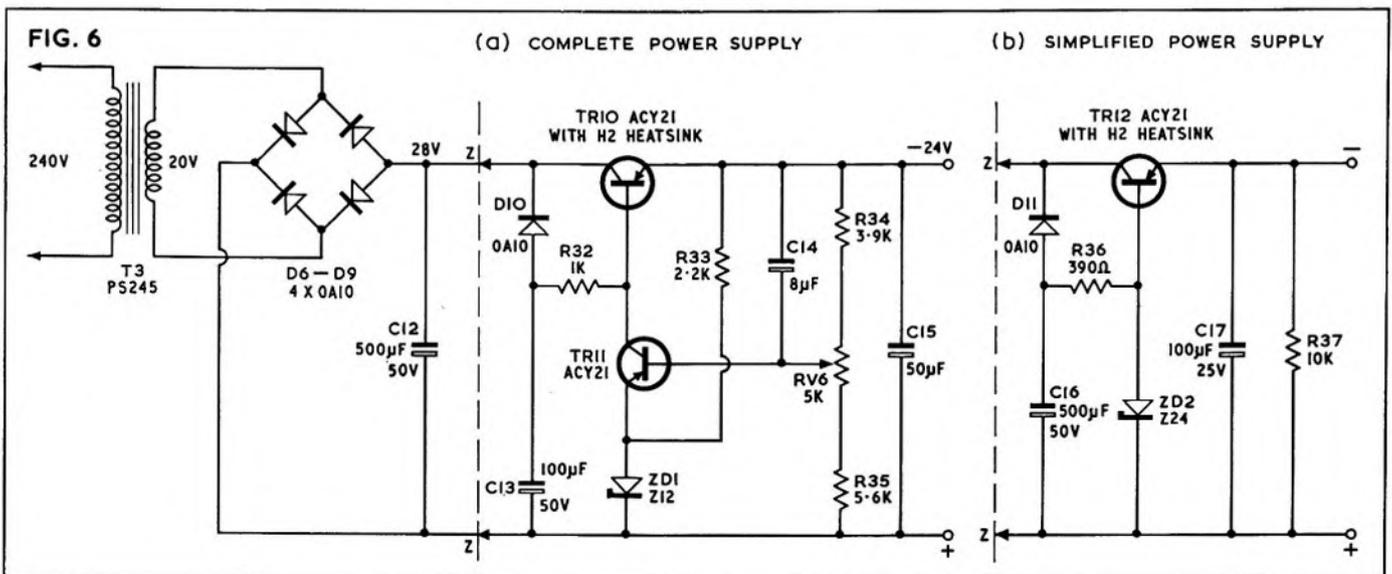
slightly lowered to 150K. Obviously, intermediate values of gain can be chosen by varying  $R_x$  between zero and infinity; a value of 6.8K gives a gain of 6dB, or two times. The output impedance is in the region of 6K, so that this circuit will drive the basic unit directly; for this use, C9 and R27 should be omitted, and C1 connected the other way around since the voltage on Tr7 collector is higher than on Tr1 base. To provide a balanced input, a high quality line bridging transformer can be used, which lowers the input impedance to 10K.

For use with valve units in particular, the input impedance of fig. 4 may not be sufficiently high; fig. 5 shows a design which gives 5M input impedance. This is obtained by using a field-effect transistor—once exotic and expensive, but now fairly cheap and easy to obtain. (The type used costs 10s.) The F.E.T. feeds directly into the base of a conventional bipolar transistor, and with  $R_y$  at zero, all the output signal is fed back. The gain is therefore unity, but the output impedance is very low, in

the vicinity of 40 ohms. This circuit can also be modified to give some gain, by varying  $R_y$ ; with  $R_y=R_{29}+R_{30}$ , the gain is 6dB. However, the output impedance changes, and in this case is then 110 ohms, which is of course still low and very suitable for direct connection to the main unit. Here again, C1 is reversed and both C11 and R31 omitted.

All the circuits are shown for a positive supply, but if an existing negative supply is to be used, they can be very simply rearranged. In figs. 2, 4, and 5 it is a case of reversing the polarity of all electrolytics, and using different transistors. For BC109 use 2N4061, and for 2N4061 use either BC109 or 2N3710. The F.E.T. is changed to a 2N3820. The circuit of fig. 3 is not polarity conscious, which is why the supply is merely labelled + and -; either + or - line can be grounded or commoned. The transistors in this circuit must not be substituted as those chosen are by far the best for the application.

Fig. 6 shows two simple power supplies, one (continued on page 427)



# YOUR OBEDIENT SERVANT

## part 2

### computers and data stores

WHEN some extra-terrestrial historian comes to write the history of our twentieth century it is certain that the development of the electronic computer will prove to be one of the major threads of influence in a very complex tapestry.

Note the adjective 'electronic'. This is inserted to disarm those critics who will rush to point out that Confucius, him said, man with abacus, he fear no creditor. Mechanical computers have been in use since way back, and as long ago as the 17th century there was a form of analogue computer, a kind of slide-rule known as 'Napier's Bones'. But it was two centuries later, when Charles Babbage turned his genius to 'counting machines', that the real computer, as we regard it, was born. He called his mechanical adding machine an 'analytical engine'. He was rapidly followed by Charles Xavier Thomas, a Frenchman, who invented a multiplying machine and this led to the comptometer, which had its birth in 1885, in America thanks to a gentleman named Felt. Electricity was called into service first when Hollerith used it to develop his punched-card-sensing machine.

This is all a long way from magnetic tape, and, indeed, it was not until the nineteen-forties that the computer in its present form came into being. The first electronic computer, the ENIAC, was completed in 1947. It was 1951 before *Remington Rand* came forth with a commercial model, and this was not surprising when we consider that the 'electronics' of the early devices were based on thermionic valves. Good as these were, the failure rate was too high to be able to guarantee more than seven hours out of ten without breakdown. If the same solution came out twice from ENIAC's 18 thousand valve circuits, it was considered to be correct!

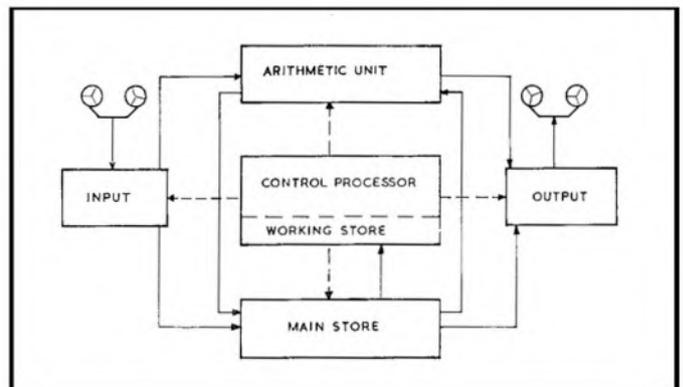
In addition to the vulnerable double-triode valves that were in vogue twenty years ago, the resistors and capacitors were the normal types of component used in radio equipment. This meant that early computers were extremely large and clumsy with, by comparison with modern types, relatively slow switching speeds. Transistors and microminiaturisation have between them made possible the 'computer in a hat-box' that attracted so much interest last year.

There was no sudden change-over when the transistor made its debut in 1948. Although there were in fact a few experimental computers made with point-contact transistors, it was not until the more robust junction device came along that reliability improved.

Hand-in-hand with transistor development went the stages of improvement for diodes. Selenium rectifiers of the old type gave way to point-contact germanium devices with a lower internal capacitance. This is an important factor for a high-speed switching device.



The computer is sometimes accused of rendering human labour obsolete. An irony is visible in this photograph, which shows a giant tape reel from a *Honeywell Datamatic* computer —itself made redundant by the newly-installed *H-800-111* in the background.



Point-contact diodes could operate at high speeds, but were not sufficiently robust; they were soon overtaken by junction semiconductors made by the alloying technique.

Alloyed transistors came on the scene about 1954 and switching time was reduced to about a microsecond. Alloyed diodes had been introduced some while before this but the real advance came soon after when, around 1955, the gold-bonded diode entered the arena. Gold is an impurity as far as silicon or germanium are concerned, and introducing a small amount as a 'killer' stepped up the switching time. It was in 1957 that silicon became a more widely used material and both transistors and diodes improved in 1960 by the use of the planar technique, where the p-n junction is protected by a thin film. This has led to further advances in microminiaturisation, the real reduction in physical size and the field-effect transistor, with several additional advantages.

That is only a very brief look at the history of semiconductors, necessary to lay the ground. We shall perhaps get back to some of the special diodes and later types of transistor after considering the computer as a whole. And even this statement is misleading, for we must consider different types of computer: digital, analogue and hybrid. While we are about it, we can consider memory stores and data processing, with a glance at logic and some of the peripheral equipment which nowadays forms such an encouraging part of Britain's export drive.

So, first, what is a computer, what does it do, and how does it perform its fantastic tricks? The initial part of the answer must be to state what it is *not*—and that is the fiction of popular journalism, the 'electronic brain'. True, there are computers that can learn, that can discriminate between 'right' and 'wrong' and, to this extent, can 'think'. But the present-day computer is no more than a calculating machine, dependent on the instructions, or 'programme' of its human operator and powerless to make any sort of personal decision. Their chief advantage is the phenomenal (by human standards) speed of calculation. Mathematical problems that would take a lifetime for us to work out can be tackled in seconds by the modern digital computer.

It should be remembered that the *digital* computer operates by counting—more about the details later. The *analogue* computer, however, works by measurement. It represents numbers by the magnitude of a physical quantity—or refer to its name, by making a physical analogy. A whole science has grown up around this technique, embracing dimensional analysis, fluidics and our more familiar electronic machine that operates on a time scale for making dynamic measurements—which is where it has the advantage over the digital computer.

Before the purist jumps on me, let me hasten to admit the above is a glaring simplification. It is true that the digital computer is more accurate when dealing with discrete figures. Fixed intervals or quantities at high speeds are its bread and butter; but the analogue equipment solves problems where the input quantities vary with time and can be arranged to work to the same time scale. Hence the term 'real-time', which we may come up against. In general, analogue computers fall into two distinct categories: simulators, which operate almost as a model of the system under test; and differential analysers, which solve problems that have been reduced to mathematical equations. And just to confuse the issue a bit more, a new breed of hybrid computers has evolved, especially in the field of industrial control, combining the speed and memory of the digital type with the flexibility and the dynamic advantages of the analogue type.

For the benefit of those who are still with me (more erudite readers will have left long since in disgust, and, not being a Roddam or a Scroggie, I may have frightened off some of the genuine pilgrims), let us define the two main types of computer by their original breeds. The digital computer is purely a counting device—its ancestor is the abacus, or, to go even farther back than the Chinese, the grooves cut in stone some five thousand years ago in the Tigris-Euphrates valley, with pebbles (or some poor victim's knucklebones) as the counters. The analogue computer is a form of slide-rule, where linear divisions on the scale can be used to represent other quantities and an answer read off in the same terms by juggling the fixed scales and the slide. If we consider that a physical occurrence can be described in the terms of a differential equation then an analogue computer will solve any such physical problem directly (as in a scale model) or indirectly (as in the planimeter, which integrates, measuring the area under a curve).

Coming back to our brief . . . the use of magnetic tape applies mainly to the digital computer, its input feed and its memory, so a few general words here may be applicable. This magazine is devoted to magnetic recording—not just to the preservation of Grandma's bumbling or the budgie's chirps—and we must be forgiven some digression into the fascinating subject of magnetic memory stores when the time comes. This is particularly relevant when we remember that magnetic recording is still regarded as the cheapest, simplest and most reliable method of storing a large quantity of information in such a way that quick access to any desired part is available when needed. There have been some remarkable developments in recent years that have already made themselves felt in the design of 'domestic' recorders. Not least important has been the improvement of tape itself.

But before we can begin to consider why magnetic tape is so important to the computer industry, we must retrace a little and discuss the computer itself, what it is and what it does.

Basic layout of a typical digital computer is shown in the drawing, from which we can see that there are five principal parts. These are the programme controller, input section, store, arithmetic unit, and output section. Magnetic tape is shown as the input and output medium in this case, but punched paper tape, punched cards or direct keystroke may be used for the input, while the output can also be fed to punched tape or cards, or directly to a line printer or electric typewriter. In the store section, which can be further sub-divided into an external and an internal store, magnetic tape again takes its place. But whereas the internal 'working' store may consist of ferrite cores, enabling a fast readout, the external store may be required to hold a vast number of 'bits' of information, forming the computer's long-term 'memory'.

This information has to be readily available and a typical speed for magnetic tape, supposing this has been recorded with a form of code which the computer can understand, is 96 thousand characters a second. With magnetic cards, another storage device, if five thousand million facts are stored as characters, any one can be located in one-third of a second. The mind boggles!

Note that arrowed paths in the drawing show the passage of information as solid lines and the control signals as broken lines. Before any work is done, a programme has to be prepared. This is a highly specialised job—just look at the advertisements in the specialist magazines and 'top' newspapers if you doubt this.

The computer is programmed, data being fed to the input section and read by the computer. Previously recorded data will be loaded into the storage device. Both lots of data are fed to the main processor, which makes the necessary calculations and passes them to the output section. At the same time, the new data derived from this process is passed to the memory devices to bring the files up to date.

In the heart of the machine, the arithmetic unit makes logical decisions. It adds, subtracts, multiplies and divides, compares and calculates, according to the programme which has been set. Logic circuits are another fascinating subject and, with your leave, we shall deal with them at greater length in a later article.

The internal working store is another subject that is worth a closer look, even though it may be a number of simple 'yes-no' switches. External stores need only a brief description, which can usefully round off this month's look at the uses of the magnetic medium. One such

(continued on page 427)

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Reducing background noise

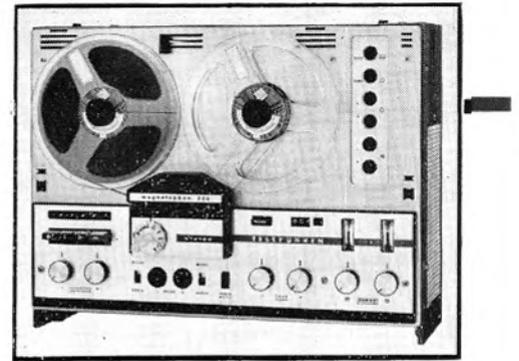
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# equipment reviews

## TELEFUNKEN M.204 E



**MANUFACTURER'S SPECIFICATION.** Quarter-track stereo tape recorder with self-contained power amplifiers and side-facing speakers. **Tape speeds:**  $7\frac{1}{2}$  and  $3\frac{3}{4}$  i/s. **Frequency range:** 40Hz-18kHz ( $7\frac{1}{2}$  i/s), 40Hz-15kHz ( $3\frac{3}{4}$  i/s). **Wow and flutter:**  $\pm 0.2\%$  ( $7\frac{1}{2}$  i/s),  $\pm 0.3\%$  ( $3\frac{3}{4}$  i/s). **Signal-to-noise ratio:** 50dB. **Bias frequency:** 85kHz. **Inputs:** Mic 0.15mV at 2K; Radio 0.15mV at 2K; Gram 150mV at 2.2M. **Outputs:** Radio 1.5V at 8K; External Speakers 6W at 10 ohms. **Dimensions:**  $18\frac{1}{2} \times 13\frac{1}{2} \times 8\frac{1}{2}$  in. **Weight:** 32lb. **Price:** £111 6s. **Distributor:** AEG (Great Britain) Ltd., Lonsdale Chambers, 27 Chancery Lane, London, W.C.2.

THIS self-contained stereo recorder has been designed for use in the vertical position and, if placed near the corner of a room so that sound from the vertical elliptical speakers is reflected from the walls, gives a surprisingly solid stereo image.

It can of course be used in the more normal horizontal position for close-up stereo or mono listening.

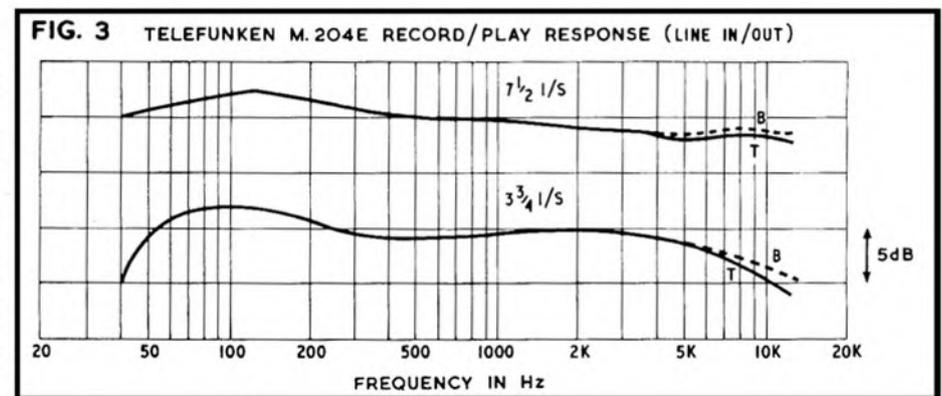
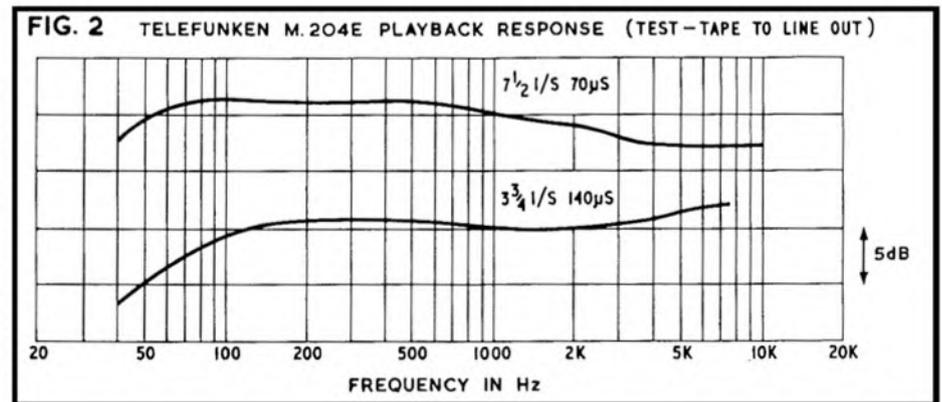
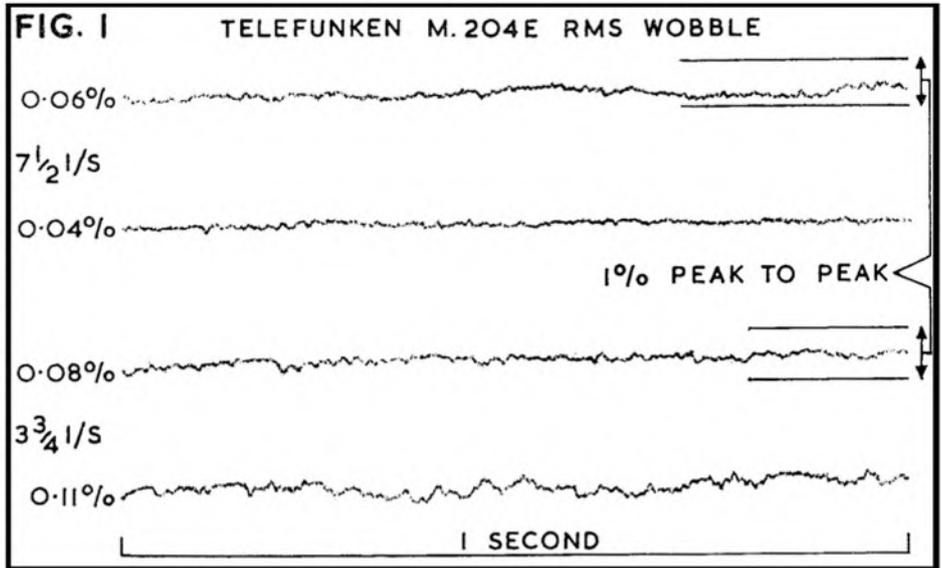
The layout of controls and input-output sockets is unconventional in that all sockets are on the front (top) deck panel. The left and right microphone inputs are just below the multi-function selector switch on the head cover, and the rest of the sockets are arranged vertically to the right of the take-up spool. The  $7\frac{1}{2}$  i/s- $3\frac{3}{4}$  i/s speed lever flips over like a giant toggle switch above and between the tape spools. The tape motion controls are to the left of the panel and comprise a stop bar and the usual wind left, wind right, start and record press tabs. The pause control is to the right of the heads next to the tape position counter; and to the right of this again are the two vertical VU-meters. The record-level controls are directly below the meters. Slide switches change over from microphone to radio inputs and a press switch controls mains power. The playback level controls are to the left, directly below the press tabs. The function switch on the head cover provides the following facilities: stereo, track transfer from 2 to 1, track 1 mono, track 2 mono, track transfer from 1 to 2 and finally parallel playback of tracks 1 and 2.

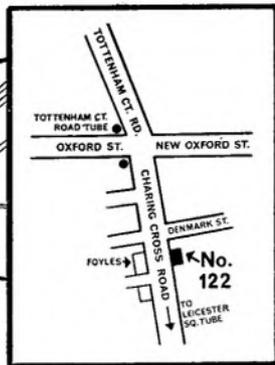
The specification defines the wow and flutter in terms of plus and minus peak limits. The fluttergrams of fig. 1 show that the peak deviation is well within the specified range and that the RMS readings of 0.04% to 0.06% at  $7\frac{1}{2}$  i/s and 0.08% to 0.11% at  $3\frac{3}{4}$  i/s are to high standards.

The play-only responses of fig. 2, from 70 and 140 $\mu$ S test-tapes to line outputs, show that the  $7\frac{1}{2}$  i/s equalisation is near the NAB 50 $\mu$ S characteristic while the  $3\frac{3}{4}$  i/s playback response matches the 140 $\mu$ S characteristic over most of the range. Top and bottom track responses were almost identical on these playback tests.

System noise, with no tape passing the heads, was extremely low at 43dB on the top track and 41dB below test-tape level on the bottom track. Bulk-erased tape noise was at least -40dB on both tracks, and tape erased on the machine gave the same unweighted meter reading with a just discernible increase in hiss. This indicates excellent bias and erase wave-

(continued on page 425)





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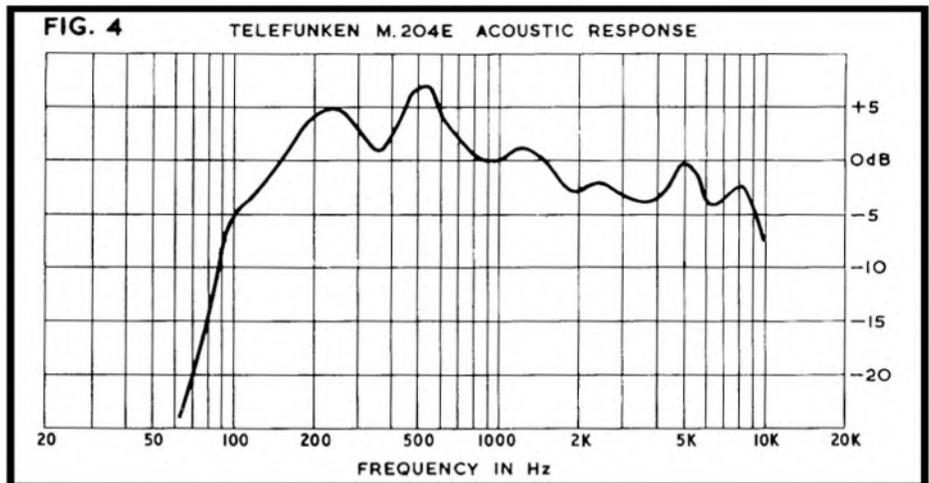
form from the 85kHz single transistor oscillator.

Overload recording tests at 500Hz proved that a level 14dB above test-tape level could be recorded with no more than 5% third harmonic distortion. This figure added to the erased tape noise gives the very satisfactory unweighted signal-to-noise ratio of 54dB.

Continuous frequency sweeps from 40Hz to 15kHz showed the responses to be free of bumps or dips due to head contour effects in the low frequency range and with only a 1dB difference in the extreme high frequency responses of the top and bottom tracks, **fig. 3.**

The acoustic response of **fig. 4,** taken on the axis of one of the internal speakers, shows evidence of cabinet resonance in the 250 to 500Hz range and also indicates that the high note response, although smooth, falls gently with increasing frequency even on the speaker axis where the high note response is at a maximum.

The only effect of the tone controls is to cut the treble still further and this, combined with the NAB playback response, left a definite need for more high note response on all the pre-recorded stereo tapes tried on this machine.



## COMMENT

Despite the slightly unbalanced acoustic response, my subjective impressions were on the whole favourable. The sound is clean and the stereo effect smooth and yet solid. The transistor circuits account for the almost complete absence of hum or background noise. I have remarked on this effect before, but it

hits me anew each time I come back to a really quiet transistorised playback system. In this case it may have been aided and abetted by the falling top response of this particular recorder, but even with wide-range external speakers the effect was still there, together with a much improved frequency balance and overall stereo performance. **A. Tutchings**

## BIB TAPE HEAD MAINTENANCE KIT

**MANUFACTURER'S SPECIFICATION.** Tape head cleaning kit comprising one bottle of Bib Instrument Cleaner, two blue Tape Head Applicator Tools, two white Tape Head Polisher Tools, ten Applicator and Polisher Sticks, one double-ended brush, one packet of cleaning tissues, and an Instruction Leaflet. Price: 12s. 6d. (Replacement set of two Applicator or two Polisher Tools: 2s. 6d. Replacement set of 20 Applicator and Polisher Sticks: 1s.) **Manufacturer: Multicore Solders Ltd., Hemel Hempstead, Hertfordshire.**

Photograph one third life size.



**W**HEN first taken home, the sample Maintenance Kit was deposited on a shelf until such time as one of the household recorders developed into a sufficiently dirty subject. However, it proved unnecessary to sit down with deliberation and test the accessory, as an eight year old *Ferrograph 2 A/H* was purchased some days later and wheeled in for rejuvenation. After a damaged head and one or two minor components had been replaced, all the tools in the *Bib* wallet were brought to bear on the oxide-encrusted deck.

From the outset, the tools proved vastly more effective and certainly more convenient than the makeshift combination of clean rag, cotton wool and match-sticks that I have been accustomed to using. The 'broom' end of the double-ended brush made quick work of removing the carpet of oxide and dust that had gathered on the deck plate around the heads and capstan. A 360° miniature toothbrush at the opposite end of the tool was not needed in this case, but offers a strong scrubbing action for dirt-encrusted regions of the tape path,

including the head face. The nylon bristles gain rigidity from being barely an eighth of an inch from the wire core, without displaying any tendency to scratch.

The new record/play head did not need cleaning but the erase-head still retained evidence of extensive use. A drop of Instrument Cleaner was therefore applied to the felt tip of a blue plastic tool bearing the words *Tape Head Applicator* and engaged against the head face. Light scrubbing action transferred the staining particles from the head to the felt, after which the physically identical white-coloured *Tape Head Polisher* was applied to absorb any remaining dirt or liquid. The protruding can containing each head on the *Ferrograph* does not hinder the entry of these tools. Both applicators and polishers are suitable for the heads of *Philips* cassette machines, though ten rigid cotton-wool sticks are also included for this type of equipment.

*Bib Instrument Cleaner* has been on the market for some time and is an effective anti-

static smear-free fluid suitable for amplifier panels, plastics, metal and glass. (It is not suitable for gramophone records.)

The *Kleenex* tissues supplied in the wallet need no introduction. At first they seemed superfluous to such a kit and I hoped they would still be to hand when the next hay-fever season arrived. They do have a purpose, however: to clean the cleaners. Having applied a damp head-polisher to the *Ferrograph's* soiled (rubber) capstan, I realised that the tools were accumulating more dirt than the subjects they would in future be cleaning. The instruction leaflet explained, however, that the felt and cotton-wool tips could be cleaned on the tissues.

I have used one other commercial tape-head cleaning device, which admittedly removed oxide and dust from the head channel, but replaced these particles with much greater quantities of clinging soapy fluff. The *Bib Tape Head Maintenance Kit* performs faultlessly the task for which it is intended.

**David Kirk**

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## PPM OR VU? CONTINUED

(a) more suitable for a high quality studio type of instrument, the other (b) for domestic use. The first uses a fully regulated feedback unit, while the second is only partially stabilised by the zener diode ZD2. In fact the difference in cost is only small, but one uses more space than the other and this may be important. Either output terminal may be grounded to give either positive or negative supplies.

Finally, a word about stereo systems. The first and easiest method is to have two completely separate meters, mounted closely together, with two amplifiers and, in the case of the PPM, two logarithmic systems. An even better solution is to have a single meter with two separate movements inside, which are quite independent. The needles are mounted concentrically, so that differences in levels between the left and right channels are very easy to see. This meter, again from Ernest Turner, is only available for the PPM type of instruments, but is more expensive than two meters.

The final solution to be discussed is an economy method which for the type of applications of most users is entirely satisfactory; one meter is used to measure only the greater of the left or right signals. Since we measure the peak level to allow the signal to be recorded without distortion, it does not matter which is the signal that causes any distortion. To keep the system properly adjusted for stereo, recording level changes must be applied equally to both channels. An overload in either channel will cause the operator to lower the gain in both channels, so that a measurement of the larger of the two signals will give the necessary information. One pitfall

to avoid is that the unit must only measure the larger of the signals, and not the sum. Fig. 7 shows an easy solution for the PPM circuit; consider first the case of a fixed input to the left channel only. C6 is charged by this signal, and diodes D1 and D2 are biased off. A right input can then be added, increasing in amplitude from zero; eventually the level is such that these two diodes start to conduct, which will be when the right input is just greater than the left. Thus only the greater signal is indicated on the meter. A switch at the input allows either the left or right signal only to be measured.

These two articles have described the most important features of the two metering systems from a theoretical aspect, and then some practical circuits which, by using the subsidiary circuits also described, are well suited for adding to existing systems or for building into new designs. As a practical point, no expensive components other than the meters are used, which makes the circuits very suitable for the home constructor.

### LIST OF SUPPLIERS

**PPM movement:** Ernest Turner Ltd., Chiltern Works, High Wycombe, Buckinghamshire. Model 702, rapid, fsd 1050 $\mu$ A, scale to LW516. Price just under £7.

**VU-meter:** Model 702 as in article. Price about £8 10s. (Other types from Henry's Radio—see below.)

**PPM transformers:** Gardners Transformers Ltd., Somerford, Christchurch, Hampshire. Price £3 10s. including postage and packing. (Henry's Radio, 303 Edgware Road, London W.2 can supply all remaining components, including mains transformer, transistors, diodes, field-effect transistors, zener diode, H2 heat sink, resistors and capacitors, etc.)

## YOUR OBEDIENT SERVANT CONTINUED

device is the magnetic drum, a motorised cylinder which rotates at very high speed and has a thin coating of magnetic material. The machining is to a very high degree of accuracy. The information is prepared on the drum and read from it in much the same way as magnetic tape. In fact, the drum can be considered as a very wide multi-track tape loop. The signals are recorded or read back either by switched heads fixed to scan each track, or by movable heads that can travel to line up with the appropriate tracks, or by some combination of the two methods.

Magnetic disc storage is somewhat similar. Oxide-coated metal discs have a number of concentric tracks on each side, scanned by magnetic heads. A short access time is possible with disc and the ease with which the discs can be changed is an advantage. A modification is the cutting up of the magnetic medium into thin cards, and this leads to one form of storage device for special applications.

Delay line storage is another versatile device. The electronic signal is transduced into acoustic energy, with a resultant reduced transmission speed. This new signal is transmitted at the speed of sound through the delay line, then re-converted to electronic form, is reshaped, processed and fed back as sound to

the delay line and so on, cycling all the time until required. The advantage is that the relatively slow speed of transmission allows storage of a large number of 'bits' but expense is one limitation. A form of delay line is a mercury-filled glass or steel tank with a quartz crystal at each end acting as a transducer. Another uses nickel wire with small copper coils at each end, forming a more compact assembly that is less sensitive to temperature variation.

Finally, thin-film memory stores must be mentioned. These are thin metal films on substrates of materials such as glass; iron, nickel or cobalt may be used as the deposit, besides several proprietary metals, being deposited by vaporisation. A strong magnetic field is applied parallel to the plates while this is done. The deposition is in the form of tiny dots and because of the direction of magnetisation they have directional characteristics. Each dot can represent a digit. Contact with the thin film can be made by printed circuit boards and the access time becomes very short indeed. Some authorities forecast a changeover to thin film for many of the more sophisticated computer memories. With the advent of better film materials, the addition of integrated circuit techniques and the wider use of microminiaturisation, we shall see many of our future computers housed in the secretary's handbag rather than the opposite.

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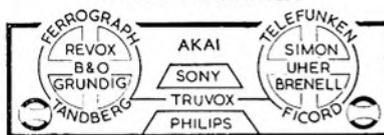
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As time goes on, you may find that you need more than one microphone, either for use simultaneously through a mixer, or for different types of material. I suggest that you make a start with one of the high-quality dynamic types which have become available of recent years, and which make an excellent job both of speech and music. For about £20 one can buy an instrument which will do almost anything in amateur practice; and having heard the results when professional microphones, often costing more than the recorder itself, are used with amateur machines, I am of the opinion that it is not worthwhile plugging a £50 microphone, let alone a £150 one, into a £60 recorder. If you are using the kind of equipment which can do justice to, say, a *Neumann* condenser microphone, you are not likely to be reading this. On the other hand, do avoid the mistake of getting some glittering, oriental marvel which you are assured is "as good as the best".

#### STANDARDS OF PERFECTION

Having got a good machine for the type of recording you wish to engage in, and a microphone with which to transfer the sound waves into electrical impulses and hence to your record-head, there arises the question of what tape to magnetise. There are excellent tapes of different brands, manufactured to very high standards of perfection; and there are also many different 'brands' of cheap tape on offer, some of which, I am assured by people whose knowledge I respect, are very good. My advice, based on my own experience, is to stick to that brand of tape which is advised by the maker of your machine, and for which your machine has been adjusted. Where the standard, well-known tapes are used, you may well not be able to tell any difference between brands (though you would never think so from advertisements!); but my experience with cheap tapes is that you can never be quite sure what you are getting: few, if any, of the firms marketing such tape make it themselves—indeed, the number of firms actually *manufacturing* tape is quite small. One of my favourite recordings is marred by a sudden drop in volume-level lasting for several seconds before bouncing back; and it was made on an other-

wise flawless reel of cheap tape. One has also been told that cheap tapes can sometimes be abrasive and cause rapid head-wear. Recognised brands of tape are expensive—I should say far too expensive; but they are reliable. Cheap tape is tempting but can be a false economy. Nowadays I prefer to put up with less tape than I should like to have rather than risk disappointment.

We are now equipped with recorder, microphone and tape. My next suggestion is that you rest content with that for quite a time. You will read about lots of gadgets and extras, and advertisers will try to convince you that you cannot get on without them. Put Satan behind you! My advice would be to make quite sure that the gadget you think you need really will add to your pleasure and effectiveness as a recordist. You may find that it will; and by then you will have a good idea of just what it is that you need.

#### OBVIOUS EXAMPLE

Take, as an obvious example, the question of a microphone-stand. Many mikes come provided with some kind of simple table-stand; and it is surprising how many situations can be coped with without using anything more than that, or even without it: ingenuity and a piece of string will get you by. But you may well find that you feel that a proper mike-stand would be a truly worthwhile extra. Don't go off to a dealer and buy the first you see, or the cheapest you see. I was caught that way, and found that the extension-tube, when not fully out, vibrated against the outer-tube when stimulated by loud sounds, and communicated the vibration to the microphone, with horrible results: penny wise, pound foolish. The best microphone stands can be adapted to take various types and lengths of extension, and are virtually booms as well as plain stands. They have solid tripods which will not be easily overturned.

You will have gathered that the burden of my song is the folly of rushing in before you really know what you want; and the folly of buying the cheapest in the hope that it will do. Believe me, it costs more money to buy several imitations than one real thing. It does happen from time to time that the cheapest is also the best; but it takes knowledge to be sure of that, and knowledge is the thing the beginner lacks. If you have a dealer or a friend who really knows, you are indeed fortunate; but, in default of that, try to find exactly what you want a piece of equipment to do, and refuse all substitutes. It should be—and it is—possible to make a start with equipment which will keep pace with your growing interest and skill, and which will not need replacing for a long time. I know of few people who have brought it off, and I am quite sure that the principal reason is because they rushed in and bought for the wrong reason. Buy wisely, and you can build up a rig which costs little, if any, more than what too many end up with: a series of boss-shot trades-in of haphazard purchases. I know the machine I might have bought, more than a decade ago. I might still be using it, like the friend who bought three, the oldest at least 15, all going strong yet. He also bought a microphone for each of them; and they are still in use. He laughs like a drain when I tell him some of my stories . . .

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<b>PHILIPS EL4306</b>	Latest 1967 4-track, 2-speed model. List £44.2.0. Brand new, boxed.	Our price	<b>36 GNS.</b>
<b>SABA TK230</b>	Superb 4 track, 3 speed stereo model. Absolutely as new. List £100.	Our price	<b>39 GNS.</b>
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<b>AKAI M8</b>	Stereo. One only S/S. Latest 1967 model. List £146.	Our price	<b>99 GNS.</b>
<b>TELEFUNKEN 85KL De luxe</b>	Superb 2 track model. As new. List £95.	Our price	<b>39 GNS.</b>
<b>TANDBERG 64</b>	4 track, 3 speed Hi Fi tape unit. List £115. One only.	As new. Our price	<b>69 GNS.</b>
<b>REVOX 736</b>	2 track stereo. Brand new. S/S. List £135 9 0.	Our price	<b>109 GNS.</b>
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<b>GRUNDIG TK45</b>	4 track stereo. Perfect condition. One only. List £112.	Our price	<b>59 GNS.</b>
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