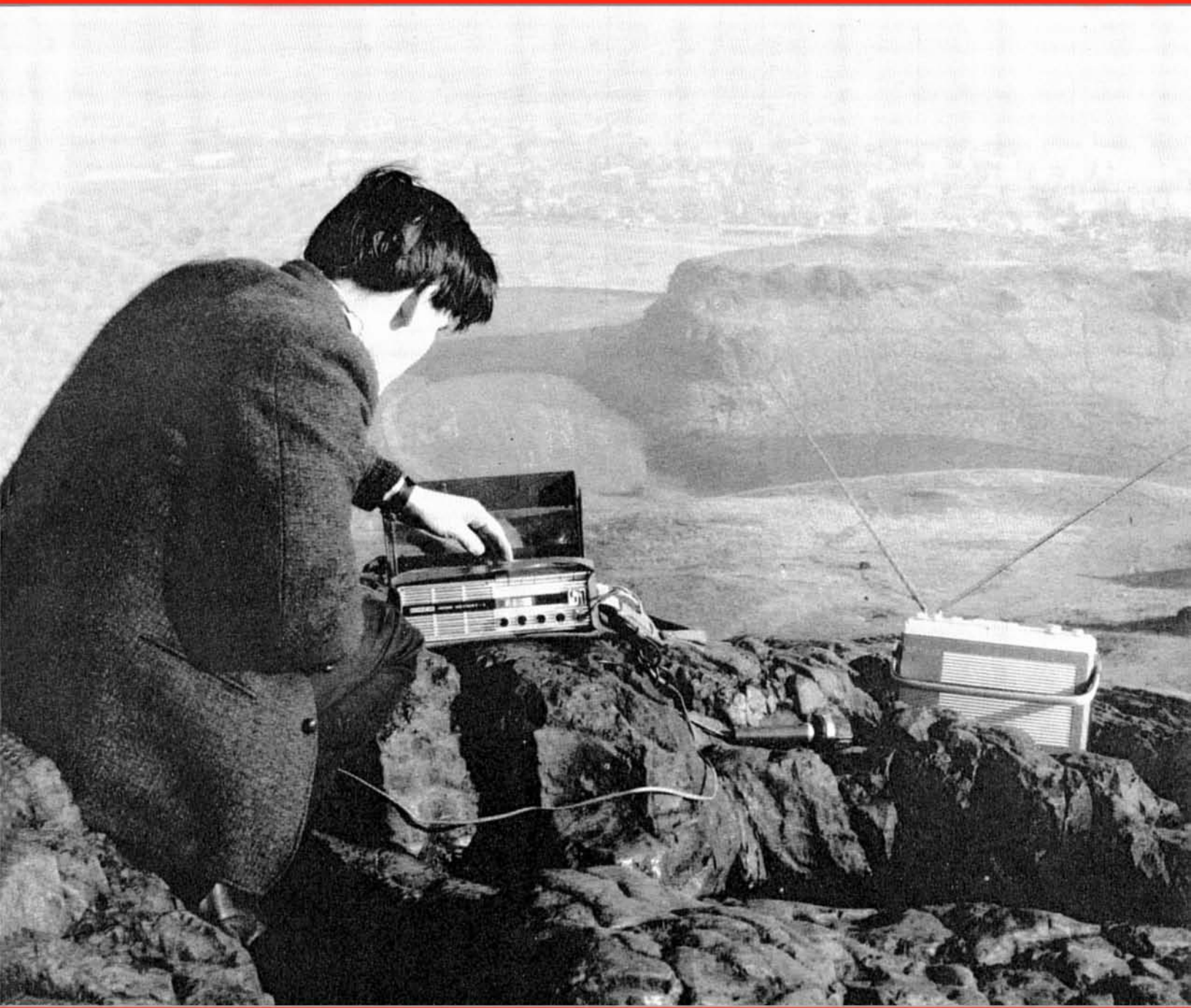
SEPTEMBER 1967 TWO SHILLINGS

tape recorder



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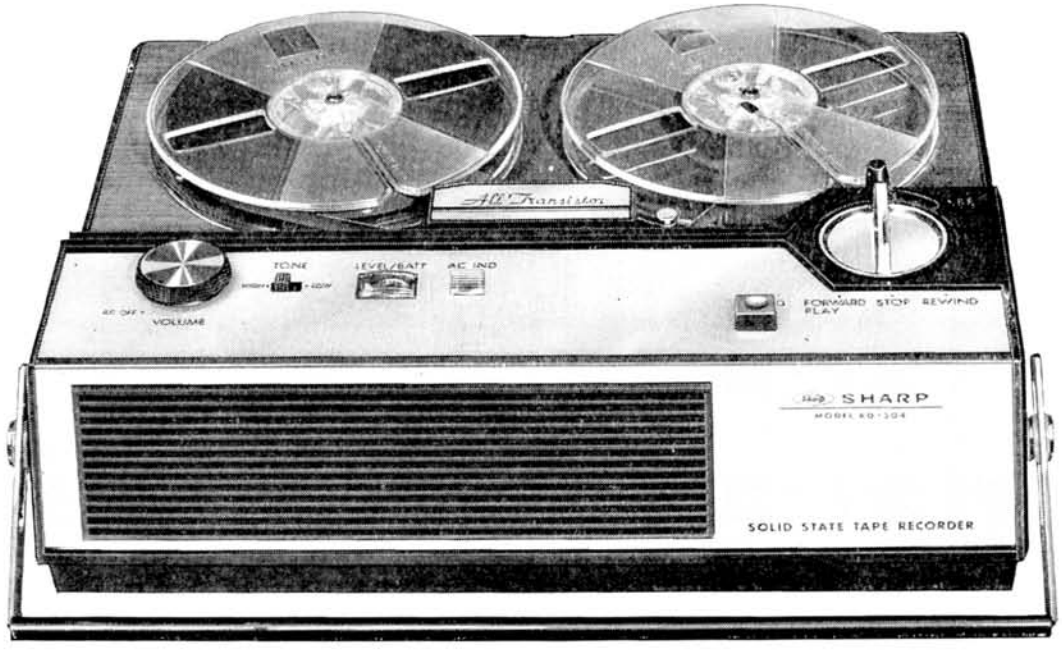

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An all-transistor solid state Tape Recorder. For operation by batteries or AC mains, twin track, two speeds. Superb recording and reproduction. Plug in to the mains. It automatically changes from batteries to its built-in AC power unit. Remote control switch on microphone allows full flexibility in use. Dimensions: 12″x3¾″x9¼″ Complete with dynamic microphone, recording lead, earphone, batteries (6 x sharp UM—1) 5″ tape reel, empty spool.

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T2

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The all-purpose Home and Office mono tape recorder with professional performance

The Tandberg Series 8 is a 2 or 4 track, 2 speed ($3\frac{3}{4}$ips and $1\frac{7}{8}$ips), mono tape recorder offering versatility, design and sound quality usually found only in professional machines.

The Series 8 features:

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* Superb finish—Grey stove enamel finish on deck. Durable, beautiful teak surround.
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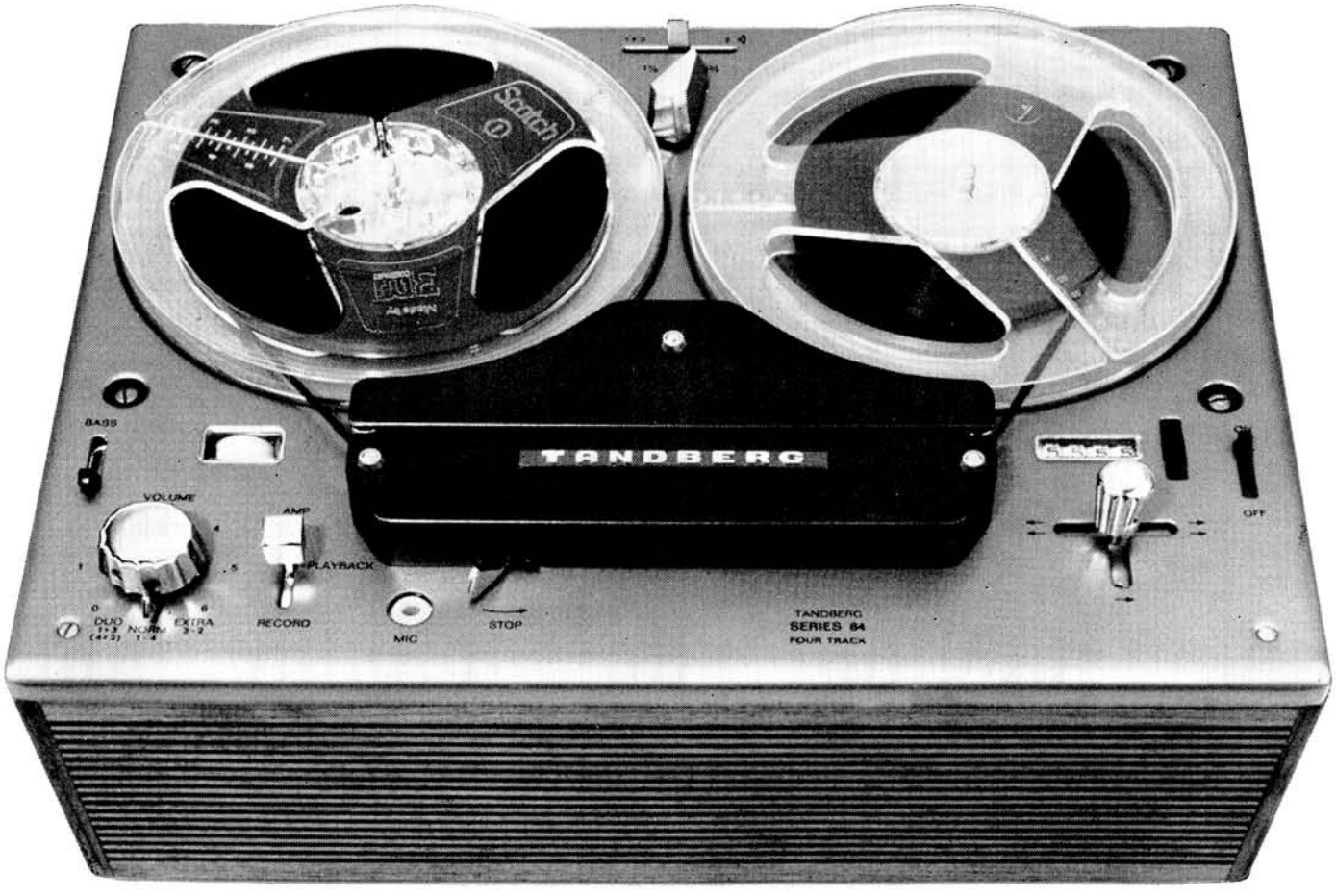

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5" 900'	28/-	22/6
5¾" 1200'	35/-	28/-
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10" 3600' ONLY ...	95/-	76/-
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C.90 Cassette ...	27/6	22/10

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4½" 1200' (BASF)	49/-	39/3
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5¾" 2400' (BASF)	90/-	72/-
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SCOTCH

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4" 450'	14/6	11/8
5" 900'	27/6	22/-
5¾" 1200'	34/6	27/6
7" 1800'	49/-	39/-
8¼" 2400'	72/6	58/-
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7" 1200'	30/-	24/-

DOUBLE PLAY	List	Our price
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5" 1200'	41/9	33/6
5¾" 1800'	55/-	44/-
7" 2400'	76/6	61/-
TRIPLE-PLAY		
3" 600'	24/9	19/6
4" 900'	38/6	30/6
DYNARANGE (L/P)		
5" 900'	32/3	25/10
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Brilliantly recorded, ¼-track stereo tapes superb quality Classical Jazz and Light Music at Tape speeds of 7½ i.p.s. (7" reels) and 3¾ i.p.s. (5" reels). **PRICES FROM 49/6.**

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Brand new, fully guaranteed, Premium Grade Magnetic Tape. Complete with the specially designed Grundig Tape Storage Container. Full leader and stop foil at both ends and suitable for use with all makes of tape-recorder.

DON'T MISS THIS RARE OPPORTUNITY, SEND NOW!

Type	Description	List Price	One	Three	Six
GL 18 (TLP3) ...	1800' L/P 7" reel	50/-	29/6	86/-	165/-
ALSO AVAILABLE AT SUBSTANTIAL REDUCTIONS					
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GD 15 (TDP8) ...	1800' D/P 5¾" reel	52/6	42/6	126/-	246/-

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

TRIPLE PLAY TAPE – HALF PRICE!

A large purchase from a "SHY" world renowned manufacturer 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!

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1800' on 5" reel	66/-	34/-	101/-	198/-
ALSO AVAILABLE AT SUBSTANTIAL REDUCTIONS				
450' on 3" reel	22/-	14/-	40/6	78/-
600' on 3" reel	27/6	17/6	51/-	99/-
900' on 4" reel	39/-	24/6	72/-	140/-
2400' on 5¾" reel	90/-	55/6	165/-	324/-

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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/-
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International Polyester Tape 2400' 7" reel (boxed) **Only 25/-** P. & P. 2/-
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PE 31	1800' L/P 7" reel	50/-	32/6	95/-	180/-

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!

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900' on 5" reel	28/-	16/6	48/-	90/-
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Please add 2/- P. & P. ORDERS OVER £3 POST FREE.

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September 1967

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WE SAVE YOU MONEY!

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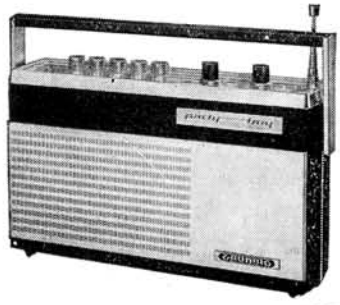
TK6L MAINS/BATTERY TAPE-RECORDER

A superb lightweight mains or battery-operated Tape-Recorder. A touch of a button gives you twin-track recording, two speeds (1⅞ and 3¾ 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
12¾" × 5½" × 9½"
Weight 13¾lb.

SAVE £13.16.0

List Price £69.6.0. **OUR PRICE £55.10.0.** Post and Packing 10/-.



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SAVE £4.5.9

Grundig "PARTY BOY" TRANSISTOR PORTABLE RADIO

8 transistors and 4 diodes. Gives crystal clear reception on VHF, Long, Medium and Short wave-bands.
Connecting sockets for external loudspeaker or earphone, external aerial, external power supply, car aerial and diode.
Finished in Black and Silver with chrome telescopic aerial.
Dimensions 11" × 6½" × 3½"
Full maker's guarantee. Brilliant performer.

List Price £25.10.9 **OUR PRICE £21.5.0.** Post and Packing 7/6

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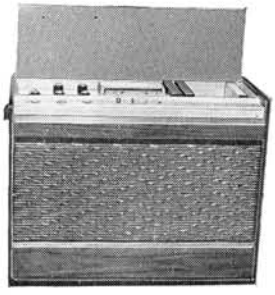
Superb sound from 10" Loudspeaker, with 5 watts "push-pull" output. Separate bass and treble controls. Independent mixing on both record and playback.
Weight 18lb.
Dimensions 17¼" wide, 12½" high, 7½" deep



SAVE £12.5.0

List Price £47.5.0.

OUR PRICE £35

Post and Packing 7/6

Elizabethan LZ.612

Elizabethan LZ.9102T

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.**

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THE AUDIO CENTRE DEFLUXER specially supplied to us by the Ferrograph company

THE AUDIO CENTRE DEFLUXER complete with Instructions

60/-

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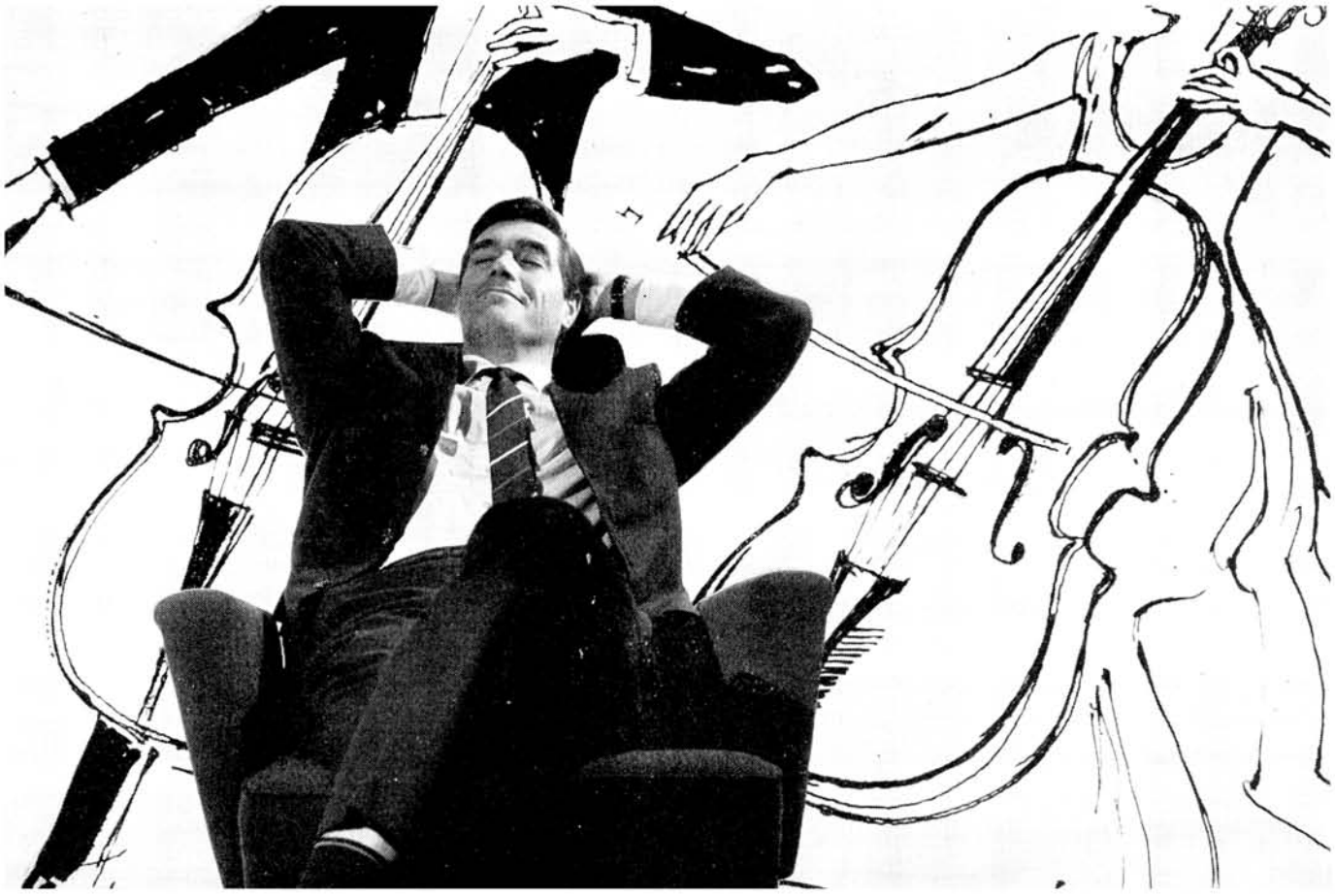

Sanyo puts you in the world class.

From Sanyo, a new range of magnificent hi-fidelity equipment that puts your sound in the world class. As an example the MR 800, Sanyo's impressive stereo mono tape deck, 4 track, 3 speed, about 69 guineas. Some choice features of its specification are included here – but get the full story from your hi-fi dealers. Sanyo also make solid state tape recorders (battery and mains/battery), tuner/amplifiers, record players.

Specification:
Tape Speeds: 7½ ips (19 cm/sec). 3¾ ips. (9.5 cm/sec). 1⅞ ips (4.75 cm/sec). *Erase Rate:* Less than 65 dB. *Dimensions:* 20″(w) x 10″(d) x 16″(h). *Accessories:* Microphone x 2, recording tape 7″, empty reel 7″, patch cord x 2, reel stopper x 2, splicing tape, speaker lead wire x 2, capstan sleeve, microphone stand x 2.

SANYO

RELIABILITY IS BUILT IN

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

tape recorder

SEPTEMBER 1967 VOLUME 9 NUMBER 9

INCORPORATING
SOUND AND CINE

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DEPUTY EDITOR
DAVID KIRK

ADVERTISEMENT MANAGER
ROBIN WELLS

Editorial and Advertising Offices:
LINK HOUSE
DINGWALL AVENUE
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COVER PICTURE

The last cover in our present format (see page 357 for details of our new presentation) depicts a member of that rare breed of FM DXers recording from a B & O portable on to his Uher 4000 portable. It is to be hoped that the microphone is not being used for this task, or the hard won tape may well be marred by 'industrial noises off' from down the hill.

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.

TRUVOX ARE ENTERING the video tape recording business. Not manufacturing, yet, but importing the products of the Japanese *Shiba Electric* company. Highly competitive prices suited to the domestic market are anticipated and the choice of ½in. tape as the recording medium suggests an impending battle with *Sony*.

Interesting news, and just the latest in the long line of developments that must ultimately bring the television recorder within financial reach of every family in the country. The data and communications industries are advancing so rapidly in Britain and overseas that the £100 video recorder is now certain to arrive sooner or later. The question is not *whether* but *when*.

Until recently, television techniques and equipment have been a subject of mere academic interest to ourselves and, we would presume, to our readers. Yet the inventive minds behind the laser, cross-field bias, and the rotating head are progressing so rapidly that we may soon be in the position of affording television equipment without having the knowledge by which it may be deployed to the full.

In our usual spirit of informative helpfulness (!) we propose to tackle this problem before it arises by opening our pages to the pens of writers professionally involved with the new generation of helical-scan recorders and closed circuit television techniques.

Can helical-scan tapes be edited? What is involved (financially and technically) in the mixing of video signals? What are the effects of print-through and wobble on a video tape? Can one feed into and out of an existing receiver? Is there a visual companion to musique concrète? These are just a few of the questions that *Tape Recorder*, ever keen to keep up with technical progress, will endeavour to answer in coming months.

Our cine friends, despite the difficulties that beset their efforts to synchronise a stuttering and variable 16 frames per second with a nominal 3¾ i/s, are keen to point out the limitations of video tape for creative work. We have discussed some of these supposed disadvantages with H. W. Hellyer, who is currently involved in demonstrating and servicing the Sony system, and find that the major criticisms are unfounded.

Take editing, for example. A Sony video recording may be inched manually, frame by frame, until the desired cutting point is found. The rotating head permits monitoring while inching, on a screen of substantially greater size than the average 8mm editor-viewer. Two chinagraph pencil marks, two 90° cuts, one 90° join, and the splice is complete. All perfectly straightforward; the interesting fact is that picture break-up across the splice lasts for only seven frames—less than one third of a second. A cause of slight initial annoyance, perhaps, but preferable to the rattling clatter of a cine projector.

Tape and head wear, and the cost of replacement, instill fear into cine and tape enthusiasts alike. On professional-quality helical-scan recorders, until comparatively recently, oxide break-up commenced within seconds of scanning a (single-frame) stationary tape. There have been improvements since then, including tough tapes that simply wore out the video head instead; but a soak test of the Sony ran for ten minutes on a single frame before break-up of the oxide coating (and hence of the picture) were detected. Contributor Hellyer claims to have experienced no more trouble with head (and tape) wear than might be expected on audio recorders. Replacement of the quartz video heads, as and when it becomes necessary, costs just 15 gns. per pair. Replacement vidicons for the £150 camera amount to 25 gns., which is very modest.

A bright future for tape recording, then, and a bright new cover for *Tape Recorder* from next month. A copy of this can be seen on page 359 and will, we hope, meet with general approval. Any resemblance to the *Akai M8* is purely coincidental!

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The Best in Hi-Fi is expensive— but it costs much less the Heathkit DAYSTROM *way*

The only way to get superb quality of reproduction at an economical price is by buying direct from the actual producer and by building the models yourself. That is why the HEATHKIT WAY costs much less.

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**

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 I.F. 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.

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

Available in two units, sold separately for your convenience. Tuning Heart (AFM-TI—**£4.13.6** inc. P.T.) and I.F. Amplifier (AFM-AI—**£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**

HI-FI FM RADIO TUNER Model FM-4U

Also available in two units. Tuning unit (FMT-4U—**£2.15.0** incl. P.T.) despatched, wired and tested, and I.F. amplifier (FMA-4U—**£13.13.0**). Printed circuit for I.F. amplifier and ratio detector. Built-in power supply; 7 valves. Tuning range 88-108 Mc/s.

Total price. Kit **£16.8.0**

A Tuner requires an Audio Amplifier. For a suitable Decoder see below.

FM STEREO DECODER Model SD-1

Can be used with most valve/transistor FM Tuners. Self powered. 7 transistor, 1 silicon diode. Automatic stereo-indicator. Easy to build and easy to operate.

Kit **£8.10.0** Assembled **£12.5.0**

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GLOUCESTER (not shown) Kit **£18.10.0** (inc. P.T.)

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

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A "Mini" Speaker with HI-FI performance

Compact size, wide 50-19,000 c/s range. Specially designed speakers 6½in. Bass, 3¾in. totally enclosed Treble unit. Inductor Capacitor cross-over network. Fully finished cabinet.

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

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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 ¼ track stereo.
D-108 ¼ track stereo.
3 motors. Balanced heavy fly-wheel. Pause control. Numerical counter. Push button control. Either model

£39.15.0 each

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WORLD OF TAPE

JUNIORS REPEAT SUCCESS

PUPILS of Boutcher Primary School, London, S.E.1, have carried off the prize for the Junior Section of the *Grundig Schools' Recording Contest* for the second year running. A Grundig *C.100* battery cassette recorder was presented to the school recently in the presence of the participant children, their parents and the School Governors. Mr. Paul Ranger, Deputy Headmaster, helped to produce the tape as an extension of the Drama and English syllabus.

Winners of the Senior Section and Overall Prize were Brecon Secondary Modern Technical School, whose 10-minute entry was based on Robert Browning's poem *'The Piper of Hamelin'*. A TK.120 tape recorder and trophy were awarded.

MASTERTAPED ECHO

ARTIFICIAL reverberation, flutter and echo effects from a rotating metal drum are made possible, in the *Arbiter* range of delay units, by a half thou' coating of *Mastertape Magnetic Paint*. The drum rotates at a peripheral speed of 20 i/s within a series of heads comprising erase, record and one or more play. Wear of heads and coating is completely eliminated as precise machining permits the heads to be placed just out of contact with the drum. The 3¾in. drum is concentric to ±0.2 thou'. Mono and stereo units are available, with delays of between 80 and 240mS and a useful frequency range of up to 5kHz. The units are manufactured by **Arbiter Electronics Ltd., 33 Woodthorpe Road, Ashford, Middlesex.**

DIGESTICASSETTES?

"MOOD Music for Listening and Relaxation" is the title of a library being offered by the *Reader's Digest* magazine on *Philips Musicassettes*. Four introductory cassettes are being marketed at £6, bringing a new phase to the sale of music which has proceeded on LP discs for the past seven years. Mr. Victor Ross, sales director of the publication, has been quoted as anticipating a worthwhile future for the Philips cassette system.

FIRST UHER LANGUAGE LABORATORY

THE first *Uher* language laboratory installed in this country, and one of the largest now in use, has been supplied to the Language Tuition Centre in London's Oxford Street. A complex of four control consoles connects the 100-booth installation.

NEW CATEGORY FOR BATRC

IN memory of Eric Jones, their founder and president until his recent death at the age of 42, the *Cotswold Tape Recording Society* have offered the *British Amateur Tape Recording Contest* a trophy to be presented to the producer of the best tape submitted by a physically-handicapped contestant. Competitors are asked to indicate any such handicap when submitting entry forms.

Potential competitors are reminded that entry forms appeared in the May *Tape Recorder* and are also obtainable from this office or **The Secretary, British Amateur Tape Recording Contest, 33 Fairlawnes, Maldon Road, Wallington, Surrey.** Audio dealers are also invited to support the Contest by publicising it to their customers and displaying entry forms.

HOSPITAL BROADCASTING FEDERATION

RESPONDING to suggestions made in the recent feature by a member of the *Colchester Hospital Broadcasting Service* (June *Tape Recorder*), Mr. J. Patton Moncrieff would like to hear from organisers of such services with a view to forming a Federation. Mr. Moncrieff is co-founder of *Forth Radio Network* which serves 16 hospitals in and around Edinburgh, Stirling and Dunfermline. He may be contacted at **21 Gayfield Square, Edinburgh 1, Scotland.**

AGFA ANNUAL

LATEST edition of the lively *Magneton Magazine* is now available from *Agfa*. English-language versions of the German publication are being produced at least once a year and are available free of charge from most audio and photographic retailers or direct from the publisher. Readers wishing to join the mailing list are invited to forward their address to **Agfa-Gevaert Ltd., Great West Road, Brentford, Middlesex.**

NEW PREMISES FOR TRM

TAPE Recorder Maintenance Ltd. and the associate company *Tape Recorder Spares* have lately completed a move from one part of South London to another. They now occupy premises at **Harmsworth House, 9 Harmsworth Street, London, S.E.17.**

NEXT MONTH

A RE-DESIGNED COVER will adorn the October issue when it appears on Thursday 14th September. David Robinson will lead off with circuits and facts relating to the construction of a peak programme meter (for the benefit of those not owning *Ferrographs*, *Vortexions* or *Brenells*) while David Kirk describes a tour of the *BASF* factories. H. W. Hellyer will discourse on computer memory systems with Alec Tutchings reviewing the *Telefunken M.204E*.

PAPST CONCESSION FOR IMPECTRON

UNITED Kingdom concession for *Papst* fractional HP external-rotor motors has been granted to the *Impectron Group*. The Papst Sales Division is being operated from the group's new premises at **23-31** King Street, London, W.3.

WALTER 101 PRESSURE ROLLERS

PRESSURE rollers for the long-obsolete *Walter 101* recorder are now obtainable at 12s. 6d. each, post paid, from **C. Braddock Ltd., 266 Waterloo Road, Blackpool, Lancashire.** Only a small number of these parts are available and are not suitable for other Walter models. The company are also the sole source of *Saja* spares.

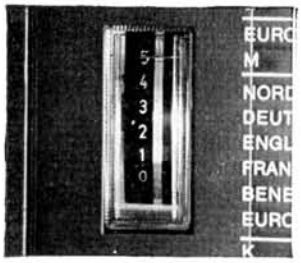
ACCESSORY SURVEY POSTSCRIPT

ABSENTEES from the survey of tape recording accessories, published last month, have been rounded up and returned to us by *Ferrograph* and *Philips*. The former company rightly chastise us for omitting one of the first endless tape cassettes marketed in this country. Their *Endless Loop Cassette* is still in production 17 years after its introduction and costs £7. A price increase is also brought to our notice; the *Wearite Defluxer* has been £3 since the beginning of last year.

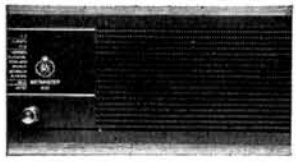
The prolific Philips organisation would add the following items to our survey: *EL1901/50* Tape Splicing Kit, price £1 3s. *EL1995* Slide Synchronising Unit, price 12 gns. *ET4740/00* 5in. Spool Container, price 3s. *ET4741/00* 5¾in. Spool Container, price 3s. 6d. *ET4742/00* 7in. Spool Container, price 4s. The Company also produce an *ET4743* Cassette Container and *ET4744* Cassette Rack, both at 2s. 6d.

Bang & Olufsen

for those who consider design and quality before price



Calibrated Radicator, for absolute accuracy in station selection.



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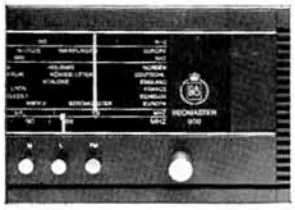
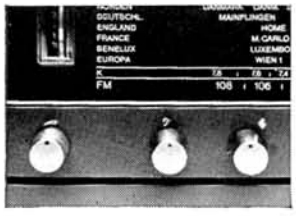


Duplex tuning indicator drive system with separate A.M. & F.M. cursors, push-button wavechange and mode selectors, for simplicity of operation.



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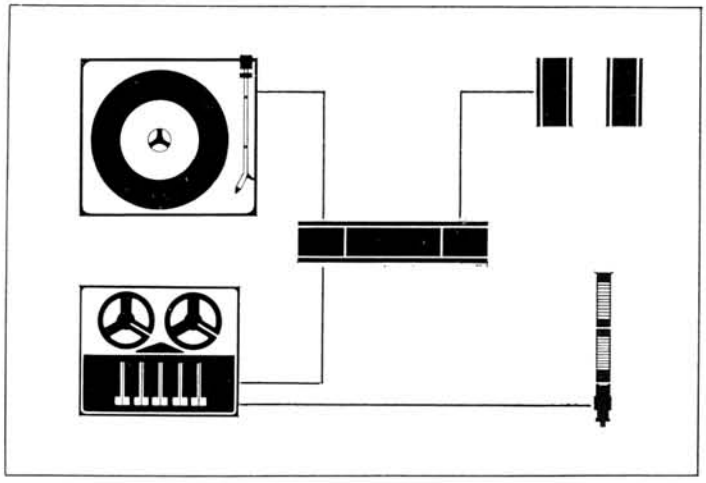
BEOMASTER 900k. 4 Waveband stereo table radio. Top audio specifications comparable to regular High Fidelity standards. Designed the Danish way with universal appeal and constructed in solid Teak or Rosewood. For those who wish to use separate loudspeakers the Beomaster 900 M is available.



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From our ever-massive post bag, which expands still further whenever we publish anything on tape recorder design, we judge that there is an army of budding designers waiting for an opportunity to tell manufacturers what should be done, undone, put in or left out of the 'ideal' machine. Many people in the trade would welcome a systematic analysis of design preferences, especially from the readers of an enthusiast's publication such as Tape Recorder, *and particularly as applied to models in what we have for some years called the 'semi-professional' category.*

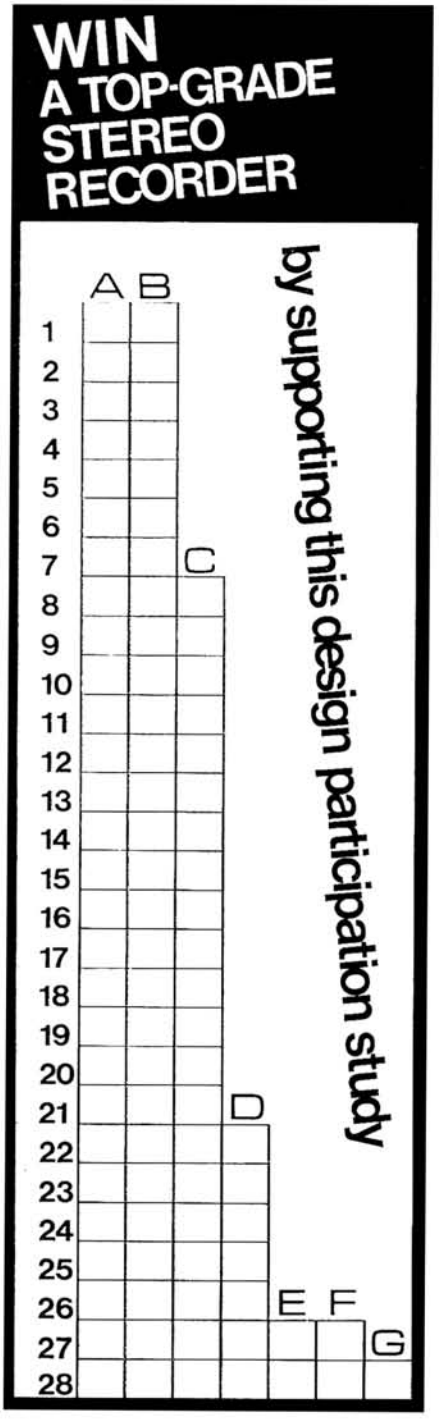
We have prepared this questionnaire to enable readers to influence manufacturers by effectively participating in a design study, the full results of which will be published in due course. As an added attraction, Messrs. Ferrograph *have kindly donated one of their superb stereo machines (model preferred by winner) in support of this important enquiry, to be awarded to the entrant whose design preferences are regarded as optimum by our panel of judges.*

Tackling the questionnaire is simplicity itself. We have built up a 'specification' for a hypothetical recorder, with various design alternatives against each of 28 items. Decide your own preference for each feature, note its letter designation (A, B, C, etc.), then place a tick in the appropriate column against the relevant question number (one choice only *in all cases, and no extraneous comments or other marks please). After considering the tape recorder you have thus specified, enter the anticipated price against question No. 29 —and please be realistic about this !*

To complete your participation in this design study, fill in your name and address overleaf, tear out this page, fold up as indicated and post (no stamp needed in the U.K.). Closing date for receipt of entries will be **Thursday, 14th September,** *one month after publication of this issue.*

Time taken to analyse the results will depend on the number of entries received, but we hope to print a full report in the December issue (published 14th November), together with the winner's name and—possibly—a photograph of him receiving the prize if he (or she !) happens to live in the London area.

This design competition is open to any person normally resident in the U.K. who is not an employee (or relative thereof) of Link House Publications Ltd., The Ferrograph Co. Ltd., or associated companies. The judges will examine all entries received by the closing date and award the prize to that entrant who in their opinion has selected the most nearly optimum specification for a high quality domestic tape recorder. In the event of several entrants offering equally good specifications, the judges will select as winner the one suggesting the most sensible prices in answer to question No. 29. The winner will be informed by post before publication of the December issue of Tape Recorder.



1. Form. The disposition of the various amplifiers and controls, i.e. beneath, or at the side of the mechanical section, can affect the relative overall dimensions. The preferred disposition, assuming vertical operation, shall favour a form which is:—
A. *broad and low* **B.** *narrow and tall*

2. Styling. The styling shall favour .—
A. *a functional instrument presentation*
B. *a domestic furniture approach*

3. Accessory Stowage. Space for the stowage of principal accessories, i.e. microphones, etc.:—
A. *should be provided* **B.** *should not be provided*

4. Rewind Control. Having selected the fast-wind function, an additional control for the fine adjustment of rewind speed and direction :—
A. *shall be provided* **B.** *is unnecessary*

5. Loading. Automatic threading of the tape is :—
A. *highly desirable* **B.** *non-essential*

6. Automatic Stop. Automatic stop arrangements are necessary on :—
A. *record and replay functions only*
B. *record, playback and rewind*

7. Stereo Monitoring. The cost of duplicating the meter system on each channel of a stereo recorder as opposed to one switched system is :—
A. *warranted* **B.** *unwarranted*

8. Mounting. The recorder shall be designed :—
A. *for horizontal operation* (lying flat, deck plate horizontal)
B. *for vertical operation* (deck plate vertical)
C. *to operate equally well in both planes*

9. Cabinets. The recorder shall be contained in a case of :—
A. *natural wood for a predominantly static role*
B. *natural wood in a basically portable form*
C. *plastic or plastic-covered general-purpose case*

10. Colour. On the basis of a restricted colour choice the preferred colour scheme for the deck and panel is:—
A. *black and silver* **B.** *two tone grey*
C. *bronze derivatives*

11. Inbuilding. The placement of controls, socket access, etc., shall allow inbuilding into existing cabinets or systems by :—
A. *easy removal of the mechanics and electronics as a discrete unit from its own case*
B. *inclusion with case complete*
C. *inbuilding facility is unimportant*

12. Transparent Cover. A rigid transparent plastic cover should be available :—
A. *as a dust cover for the equipment when not in use*
B. *as a cover for the mechanical unit while operating* (*see* **23**) or
C. *provision of a cover is unimportant*

13. Reel Sizes. Bearing in mind the availability of long play tapes, the maximum reel diameter which should be accommodated is :—
A. 10½*in.* **B.** 8½*in.* **C.** 7*in.*

14. Rewind Time. The preferred rewind time for a 1200ft. reel of standard thickness tape is :—
A. *approx* 3 *mins.* **B.** *approx* 2 *mins.*
C. *approx* 1 *min.*

15. Indexing. Position-finding along the length of the tape shall be provided by means of :—
A. *a clock type counter registering reel turns*
B. *a digital counter registering reel turns*
C. *a tape footage counter.*

16. Controls. The most desirable means of accommodating stereo controls is by :—
A. *two completely separate amplifier panels each with its individual controls and meter*
B. *a single amplifier panel with concentric dual controls and meters*
C. *a single panel with ganged controls so that both channels are varied simultaneously by a single knob*

17. Tone Controls. These shall be fitted on each channel to provide for :—
A. *bass-cut and treble-cut only*
B. *bass-cut-and-lift and treble-cut-and-lift*
C. *inbuilt tone controls are unnecessary*

18. Bias Adjustment. Variable bias control shall be :—
A. *omitted (bias fixed)*
B. *variable in two steps for the main tape categories*
C. *continuously variable with meter indication*

19. Mixing. The ability to mix with independent gain controls shall be provided as follows :—
A. *no mixing required*
B. *two inputs, i.e. microphone and radio*
C. *three inputs*

20. Life. The normal useful working life envisaged for the machine shall be :—
A. 5 *years* **B.** 10 *years* **C.** 15 *years*

21. Maintenance. The general engineering standard of the machine shall be such that after the expiry of the guarantee period, the overall annual maintenance cost as a percentage of its original cost should not exceed:—
A. 5% **B.** 10% **C.** 15%

22. Weight. Having regard to the subsequent performance requirements, the weight should not exceed:—
A. 30*lb.* **B.** 40*lb.* **C.** 50*lb.* **D.** *unimportant*

23. Overall size. Having regard to **13,** smaller case sizes may require some reel diameters to overhang. It should be possible to close the lid for stowing or carrying with the following reels in position :—
A. 10½*in.* **B.** 8½*in.* **C.** 7*in.* or
D. *all reels may be removed*

24. Loudspeakers. In the case of stereo machines having power output stages, loudspeakers shall be provided as follows :—
A. *none*
B. *one switchable to either channel or both*
C. *two speakers, one for each channel, inbuilt*
D. *two speakers, as matching units, supplied separately*

25. Recording Level Monitor. The recording level shall be monitored by :—
A. *magic eye*
B. *VU-meter*
C. *sustained peak-programme meter*
D. *automatic electronic control*

26. Operating Instructions. A handbook shall be provided. In addition to simple operating instructions it shall contain :—
A. *no additional information*
B. *advice on recording techniques, i.e. microphone placement, etc.*
C. *technical data on the instrument in lieu of recording techniques*
D. *at some increased cost, a comprehensive manual with full technical and servicing information.*

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27. Outputs. Bearing in mind cost factors and possible ownership of other amplifier systems, the principal output power of each channel shall be :—

A. 2*W* **B.** 5*W* **C.** 10*W* **D.** 20*W*
E. *at low-level (1V) only*
F. *low-level with simple single monitor stage.*

28. Operating Speeds. The number and range of operating speeds shall be :—

A. 15 *and* $7\frac{1}{2}$ *i/s*
B. $7\frac{1}{2}$ *and* $3\frac{3}{4}$ *i/s*
C. $3\frac{3}{4}$ *and* $1\frac{7}{8}$ *i/s*
D. 15, $7\frac{1}{2}$ *and* $3\frac{3}{4}$ *i/s*
E. $7\frac{1}{2}$, $3\frac{3}{4}$ *and* $1\frac{7}{8}$ *i/s*
F. 15, $7\frac{1}{2}$, $3\frac{3}{4}$ *and* $1\frac{7}{8}$ *i/s*
G. $7\frac{1}{2}$, $3\frac{3}{4}$, $1\frac{7}{8}$ *and* $\frac{15}{16}$ *i/s*

29. The anticipated price of machines meeting this specification would be :—

(mono).....

(stereo).....

READERS' PROBLEMS

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

TAPE CODING STANDARD

Dear Sir, I would be grateful if you would tell me the British Standard colour system for leaders and trailers on recording tape.

Yours faithfully, **P.F., Cheltenham.**

B.S.1568:1960 states that leaders to new unrecorded Standard Play tapes should be white, while trailers should be red. This colouring also applies to monophonic "tape records". Leaders to stereo "tape records" should be yellow with, again, red trailers. Colour coding for long play and "extra long play" (double play) has been under consideration for the past seven years.

EXPLOSIONS BY REMOTE CONTROL

Dear Sir, When using the remote control switch on my *Sony TC-900* microphone a loud bang and sometimes a squeal accompany the switching action. The switch is fairly stiff but is nevertheless potentially useful when recording on the move. I would appreciate any advice you can supply.

Yours faithfully, **B.T., London, N.3.**

There should certainly not be such noises as you describe, and neither should the switch be very stiff. It may be that the contacts are not quite touching, or, more likely, that the plastic part is sliding on a rough channel. These plastic halves are heat-moulded in large quantities and the odd article with 'flash' on the break-away edge is bound to get through. We have had this several times with British Radio Corporation microphones, HMV and Ferguson, who use the same type of switch. Fortunately, the trouble is easy to cure.

One other possibility is that the pin on the remote control socket is not cleanly operating the isolating blade. This double-part plug has a rather thin remote pin with a very fine insulating washer between the two parts, and we have had one or two making bad contact. Check also that the knurled outer clamp ring is tight on the socket.

Finally, as the TC900 is a fairly new machine, it seems likely that this one is under guarantee, and you should have recourse to your local Sony service agent, who is, I believe, Nusound Ltd. Ideally, take it back to the source from which it was obtained and ask for service.

MATCHING A TANDBERG

Dear Sir, I would be grateful for your advice on a problem I have encountered when recording on a *Tandberg 62* tape recorder from a *Telefunken Salzburg 2554 MX* radiogram.

With my previous tape recorder, a *Telefunken 85K*, I used to record FM transmissions from the tuner of the radiogram, reproducing quite satisfactorily through the radiogram amplifier. However, on attempting to do the same with my new Tandberg, there seems to be some treble cut at all speeds. I have tried recording with various brands of tape but the effect remains. The recorder has been back to *Elstone Electronics* for checking, but I am informed that it is in perfect working order. Neither they nor the Telefunken distributors have been able to enlighten me as I have been told that I should have no difficulty with the connection.

Yours faithfully, **K.J.W., London E.6.**

The low-level input of the 62 is of the same impedance as the radio input of the 85K, but the former needs a minimum input of 4mV to produce a fully-modulated tape. So the first problem is to get enough voltage. If you are taking off at the detector, this should be no problem. But on the other hand, whereas the 85 will accept a much wider matching variation and the detector output of the radiogram is probably a megohm or so, the Tandberg is more fussy, and if there is adequate output from the gram you should provide a matching pad, using a 100K resistor across the low-level input with 470K or so in series with the feed from the gram.

On the playback side, the Tandberg gives 1.5V with the playback controls at maximum, into a load impedance of 10K upwards. The 85 delivered the same output into 18K, so again, if you are feeding to the gram at a correct input you may need to match down slightly, with a 47K across the Tandberg and a series resistor that will have to be found by experiment across the complete pad—effectively in series to the gram input. Start at 47K and work upwards, so long as the voltage is available. It would be preferable to do this with a known good test-tape, though a good pre-recorded tape is the best alternative. Get the replay conditions right first, then tackle the recording side to achieve the same results.

In each case, if there is a loss of top, and your connections are as short as can be, shunt the series resistor with between 0.001 and 0.01μF. Do not overdo this or your response curve will acquire a hump !

A HISSING ST-1

Dear Sir, I have an *Akai ST-1* stereo tape recorder which, although recording and replaying excellently, accompanies everything with an annoying hiss. I de-magnetise the heads regularly and have had them re-aligned, but the hiss remains. Can you advise me on the cause and cure?

Yours faithfully, **P.W., Omagh, N. Ireland.**

These machines are inclined to be very 'toppy' and the greatest care has to be exercised in recording at the correct level—right up to full modulation as often as possible, to get the best signal-to-noise ratio. The most hiss occurs on playback, and by recording at full depth, modulating the tape sufficiently, the S/N ratio is greatly improved on replay.

You should not use the machine with full treble except for clarifying speech. We have found that there is a tendency to 'open the door too wide' on the part of several manufacturers, whose treble control, at the upper end, allows the curve to be over-emphasised. Much depends on the type of control and its operation (see George Tillett on 'What Matters in Amplifiers' in the Audio Annual 1966).

To check the noise level, record with no input on a good portion of tape, then replay this erased section at half gain with tone controls in mid position. Hiss should not obtrude until about two-thirds rotation of volume control. Note the position. Go back and record a signal with pretty full musical content—not just speech. Make sure the tape is being fully modulated. Then replay this recording. You should find that the marked position of the volume control now gives you uncomfortably loud replay. In other words, the hiss should not be present until either the gain is too high or tone controls at the end of travel.

If it is still too bad, we advise recourse to an Akai agent. You may find it necessary to do several modifications on the amplifier.

REMOVING AN LZ24 COVER

Dear Sir, I am having trouble with my *Elizabethan LZ 24* tape recorder. I know where the fault lies but cannot remove the deck cover. Everything will unscrew except the single deck control for record/play. I would be glad if you could help me in this matter.

Yours faithfully, **A.T., Dagenham, Essex.**

The record/play knob does not unscrew, though it looks as if it should. It can be pulled straight off, but is usually extremely tight. Slide a thin piece of card beneath the knob, insert a wide blade between knob and card, and lever with one hand while pulling upwards with the other.

If you have been trying to unscrew the control, the possibility is that the spring insert is already cracking in the plastic and you may have to replace the knob anyway. Do not forget to release the motor assembly when dismantling —and, equally important, secure it when reassembling.

MICROPHONE REPAIRS

Dear Sir, I have a Japanese dynamic microphone, the coil of which hás been displaced by a slight knock. Could you please put me in contact with anyone able to repair it?

Yours faithfully, **D.H., Ledbury.**

We sympathise with you in your problem of trying to get microphone repairs carried out privately. It is sufficient of a quandary through the trade. You may have to resort to sending it to one of the addresses below via a radio or hi-fi dealer but there is no reason why you should not make preliminary enquiries. A stamped, addressed envelope helps get a quicker reply, even to trade sources.

J. Rayner & Sons (Grimsby) Ltd., 136/140 Freeman Street, Grimsby, Lincs.

Electronics-Aid, 46 Alphington Street, Exeter, Devon.

V. & S. Installations, 143 Upper Bridge Street, Chelmsford, Essex.

Patronics Electronic Engineering Co., 37 Durban Road, Watford, Herts.

ELEMENTS OF TAPE RECORDER CIRCUITS

BY G. T. ROGERS

PART FOUR □ POWER SUPPLIES

As its name implies, the power supply circuit is necessary to supply the high tension (HT) and low tension (LT) voltages which power the various circuits of the tape recorder. Nowadays the HT, which is some 200-350V, is rectified AC and feeds the anodes of the amplifier valves, and other valves used in the oscillator and record-level-indicator circuits. The HT voltage from the rectifier, as we shall see, is not steady, in fact it has a ripple on it which if used directly by the amplifiers, especially at the early stages, would lead to a high level of hum in the signal output. To prevent this the rectifier is connected to a filter circuit which is designed to filter and smooth out the ripple voltage and produce a steady DC supply.

The low tension, usually 6.3V AC for the valve heaters, is conveniently taken from a low voltage winding on the transformer secondary. In transistors the requirements are rather different; here only a single voltage in the order of 10V is required, it being termed the *supply* or *bias* voltage to distinguish it from voltages of a similar order found in valve circuits.

Let us start this month by introducing the phenomenon of thermionic emission and the rudimentary working of the diode valve, and then see why this component is an almost perfect rectifier (changing AC into DC).

It was mentioned in Part 1 that metallic conductors have electrons in them which are free to move about within the metal. Under certain conditions, however, such as when the metal is heated in a vacuum, these electrons acquire sufficient extra energy to enable them to penetrate and be emitted from the surface of a metal to form what is known as a negative space charge. This phenomenon, known as *thermionic emission*, was studied extensively by Sir O. W. Richardson, and it was shown that the number of electrons emitted per square cm. of the metal surface depended only on the temperature and nature of the metal concerned.

A thermionic valve consists of an evacuated glass tube in which are mounted a number of metal electrodes which connect to the pins at the base of the valve. Electrons are emitted from one of these electrodes, called the *cathode*, this being usually constructed in the form of a nickel cylinder coated with a highly emissive oxide such as strontium or barium oxide. In directly heated valves, the cathode itself is connected to a low tension voltage which heats it directly to a dull red glow, and although this might seem a convenient arrangement, in practice it requires the use of a low tension battery to supply the steady DC voltage. The emission of electrons from an AC directly-heated cathode is very irregular because of the varying voltage, and in modern valves an indirect means of heating the cathode is employed, enabling the use of low tension AC which is easily obtained from the mains transformer. The cathode in this type of valve is illustrated in **fig. 1(a)** where the heater or filament **H** is a fine tungsten wire heated by low tension AC and insulated by a silicon sheath from the nickel cylindrical cathode **C**.

The simplest valve, introduced in 1904 by J. A. Fleming and known as the *diode*, has another electrode—the *anode* surrounding the cathode. When the anode is maintained at a positive potential relative to the cathode, electrons flow from the negative space charge to the anode as shown in **fig. 1(b)**, and the valve conducts. When, on the other hand, the anode is at a negative potential relative to the cathode, the anode has a repulsive effect on the electrons in the space charge and the valve does not conduct. Now if we apply an alternating voltage to the valve, the current will flow when the anode is positive but not when the negative half cycle is applied to the anode (that is when it is negative with respect to the cathode). The diode valve therefore behaves as a one-way 'gate', or rectifier, converting AC into DC.

The simplest circuit, the so-called half-wave rectifier, employs the diode valve as shown in **fig. 2(a)**. In this circuit AC mains is first converted by the transformer into high tension (usually 200-350V) at very low current and, as shown, this transformer also supplies the low tension AC. When the anode **A** is positive in the positive half cycle, the valve conducts and a current flows through the load resistance **R** as shown. In the negative half of the same cycle, the anode is negative and no current flows through **R**. Therefore there will be a voltage in one direction (unidirectional) across the load, and since half the sine-wave input is suppressed, **fig. 2(b)**, there is inevitably an interruption of the output which must be smoothed out.

CONTINUOUS OUTPUT

In order to make the rectified output continuous, although still varying between peak and mean voltage, two half-wave rectifiers can be arranged in opposite phase so that both the negative and positive halves of the AC input are utilised. This is the method adopted in many tape recorder power supplies, for the subsequent smoothing is made easier and a very steady output is obtained. In practice these two rectifiers are combined in one envelope to form the usual full-wave rectifier, as shown in **fig. 3(a)**. In the positive part of the cycle, **A** might be positive and **B** negative relative to the centre tap **X** of the transformer, and current will flow by electrons being attracted by anode **A**. In the negative part of the cycle, **B** will then be positive and again current will flow, but this time through anode A_2. The rectified voltage which appears across **R** is shown in the accompanying waveform **(fig. 3(b))**.

The metal rectifier, which can be used in place of the thermionic diode and double diode in the circuits described above, is illustrated in **fig. 4(a)**, together with its characteristic (current —p.d.) curve **(b)**. When the copper disc is oxidised on one of its circular faces, a current will flow easily from the copper-oxide to the copper face when a p.d. is applied, but hardly at all in the direction copper-to-copper-oxide when the p.d. is reversed. The metal rectifier, like the diode valve, therefore behaves as a one-way gate having a high resistance in one direction and a low resistance in the other. This is shown in the characteristic curve, where the negative values for the current and voltage indicate their reverse direction through the rectifier.

Another type of rectifying device, which will become popular in the future because of its small size and great efficiency, is the silicon diode. These devices have an extremely low forward resistance and hence good voltage regulation, which minimises the need for elaborate filtering.

All types of rectifier have a stated maximum power output, the voltage output depending on the current taken by the load circuit which it is supplying. Clearly, if the required power is beyond the resources of a given rectifier, then it must be duplicated or a larger value chosen. One very efficient way of combining rectifiers, which is wid ly used with metal, silicon or germanium diodes, is by the so-called bridge circuit, **fig. 5(a)**. As shown in the accompanying waveform **(6)**, the output is similar to that obtained from a double diode, and full-wave rectification is achieved. An alternative arrangement for full-wave rectification is shown in **fig. 5(b)**, analogous to the valve circuit in **fig. 3(a)**.

HALF THE TURNS

Where high values of rectified voltage are required the voltage-doubler circuit depicted in **fig. 6** is sometimes used. In this arrangement the transformer secondary only needs half the turns normally required in a conventional rectifier, though as the power remains the same, the current is doubled. The illustrated circuit uses two silicon diodes and, since these are very efficient, very little voltage drop occurs. The low resistance **R** is often included to prevent the diode passing a damaging surge of current when the power is first switched on.

In transistor tape recorders, where only a single relatively low supply voltage is needed, the power unit can be quite simple. All that is generally necessary is an ordinary germanium diode fed from a low voltage transformer to give half-wave rectification, or a pair of diodes in conjunction with a centre-tapped low-voltage

winding (**fig. 5(b)**) for full-wave rectification. The bridge circuit, using four diodes as shown in **fig. 5(a)** can also be used with an untapped low voltage winding, and good smoothing is possible by the use of a filter of modest capacity. A full account of power circuits suitable for a small transistor amplifier is given in Gordon J. King's article *Towards Better Taping* (Aug. 1965).

As we have seen, the output voltage of the rectifier, although it is unidirectional, is by no means steady. It is the work of the filter circuit then to smooth the AC ripple so that a purely DC voltage can be supplied to the amplifier stages, thus preventing AC hum signals being added to the valve output.

In **fig. 6** the two electrolytic capacitors C1 and C2 (reservoir capacitors) represent a simple but effective filter. With this arrangement the AC ripple will be considerably reduced in the output since it will pass through the capacitor, whereas the DC voltage will not. Clearly, for a given HT voltage and current a suitably high value of capacitor will have to be chosen so that the path through the latter offers less impedance (reactance) to the AC than the resistance offered by the load connected to the power unit. In general the HT output will be governed by the current taken from the rectifier, that is the load imposed by the associated circuitry. However, for a given current the rectified voltage will increase as the capacitance of the reservoir capacitor is increased. To prevent overloading, therefore, manufacturers always quote for a rectifier a value for the reservoir capacitor into which it has been designed to operate, together with an appropriate value for the AC input.

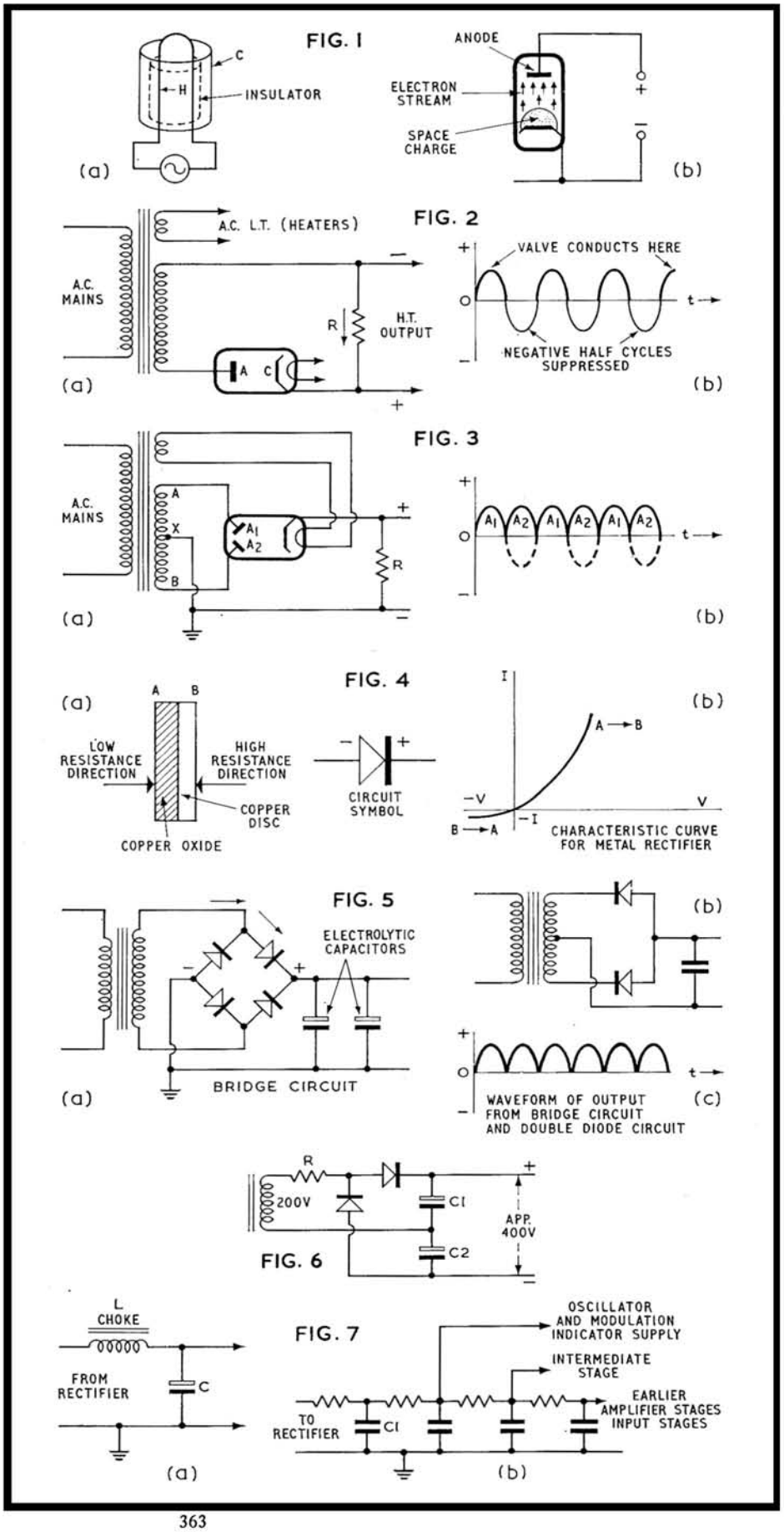
EXPENSIVE METHOD

Good voltage regulation can be obtained using a choke (inductor) input as shown in **fig. 7(a)**, although this method, if it is to be good, is generally expensive. Beyond a minimum critical value, which depends on the current demand, increase of the choke inductance, and hence impedance to AC, decreases the ripple in the rectified output. This is clear from the formula $X_1 = 2\pi fL$) which was introduced last month. Further smoothing is taken over by the capacitor C and this, in conjunction with the inductance, completes a resonant circuit. To avoid undesirable resonances, which might lead to mains hum in the output, the fundamental resonance must be well below the supply frequency, a fact which must be taken into account when values for the inductance and capacitance are chosen.

TYPICAL FILTER

Fig. 7(b) shows a typical resistance-capacitance smoothing filter for a tape recorder, and as indicated the HT can be tapped from the circuit at various points so that additional smoothing is only added for sensitive parts such as early amplifier stages. The first capacitor, **C**, must of course be able to withstand the peak voltage of the rectifier, and to ensure reliability it usually has a test voltage of at least three times the DC working voltage.

Next month we shall move on and consider the tape recorder amplifier and show how a *triode* valve behaves as a simple and efficient voltage amplifier.



PPM OR VU

DAVID ROBINSON FEEDS SOME FACTS INTO THE METER CONTROVERSY

NEARLY every tape recorder has some means of indicating the normal signal and overload levels so that it is possible to make distortion-free tapes. There is a wide variety of indicators ranging from neons which flash in sequence, through magic-eyes of various kinds, to the meter. The decision on which type is incorporated into the recorder is usually decided by the relative costs; for older domestic recorders using valves, the obvious choice was the magic eye. In many ways this gives an excellent result and is often to be preferred to cheap meters.

The arrival of transistors in tape recorders has meant that the magic-eye is used less and less, firstly since it needs considerable power merely to heat the cathode, and secondly since it requires a high voltage on the anode which is not easily arranged in a low voltage circuit. The meter has therefore been appearing more frequently in cheaper recorders, since it only requires a low current and voltage and is also fairly cheap. Professional machines have nearly always been supplied with meters, and these are predominantly of the Volume Unit (VU) or Peak Programme Meter (PPM) types; any reader of this magazine will know how tempers can rise over the relative merits of these two systems of measurement! The photographs opposite, by courtesy of *Ernest Turner Ltd.*, show the two meters for comparison in identical cases, and illustrate the distinctive character of each. There is a great deal of confusion over the various parameters of the meters, and over the many pros and cons of each; it is the purpose of this article to try and explain some of these, and in so doing to make the choice of meter easier.

The VU-meter originated in the United States when there was a need for standardisation between the many radio stations which were springing up at the start of sound broadcasting. There was, of course, much interchange of programmes between studios, and of necessity some system had to be devised for measuring levels at various points in the transmission chain. The method of measurement had to be very simple and not use complex equipment; it had to be easily added at various points in a chain, and it had to be cheap so that even small concerns could afford to invest in it—and this is still true today. The system finally adopted uses an ordinary moving coil meter incorporating a metal oxide rectifier, but with a tight specification laid down to ensure that all VU's have the same characteristics.

Bell Telephone Laboratories drew up the first specification for the VU in 1940, and readers interested in the original document can find it in either the *Bell System Technical Journal*, January 1940, or in the Proc. IRE 28, 1940. This document specifies the most important features of the instrument; the most significant are the sensitivity and dynamics. The dynamic properties must be such that when a step input is applied to the meter of an amplitude which causes full scale deflection, the overshoot is between 1 and 1½%; the needle must arrive within 99% of full scale in 300 milliseconds. It should have a well defined impedance of 3.9K, and also a controlled sensitivity—with a series resistor of 3.6K (making a total of 7.5K) and input signal of +4dBm (1.228V in 600 ohms), the needle should be within 70 to 80% of full scale, that is on the 0 VU mark.

SIMILAR METERS

There had, of course, been similar meters up to this time, but this was the first attempt at standardisation. A meter built to these exacting specifications is not cheap, and from a well-known manufacturer who guarantees the performance, the price is about £8 15s. 0d. Other versions are available at lower cost, however these should be treated with extreme caution if an accurate VU is required—in particular, the overshoot characteristics may suffer in low cost instruments. The price in the USA is cheaper since the VU is the major system in use.

The main advantage is that for this price the instrument is complete—there are no further amplifiers to add to the unit. This implies that there is a suitable point in the circuit or output point where the signal is correct in amplitude and impedance, or larger in amplitude so that it can be attenuated and still give the correct impedance. It is possible to reduce the external 3.6K resistor to increase the sensitivity, but this allows the non-linearity of the meter rectifier to reflect back into the main circuit and adds more distortion there; also the ballistic properties can be affected. The distortion is, of course, always present, but for most purposes—and certainly for magnetic tape recording—it is quite negligible.

INACCURATE STEP

Since it takes a full 300mS to respond to a step input, the VU meter will not respond accurately to short sharp pulses such as occur in harpsichord or guitar music. By the time the meter has started to respond to the pulse, the pulse has finished; as there is no storage mechanism the meter never moves to the full scale. **Fig. 2** explains this in more detail. The longer the input pulse, the more chance there is of reaching the true reading of the peak. Alternatively, the more rapid the sequence of pulses, the more accurate the reading. This corresponds closely to the auditory sensation of loudness or volume—short sharp pulses do not sound nearly as loud as longer lasting sounds of the same amplitude—and hence the term Volume Unit meter.

The peak programme meter was initially developed about 1936 by the BBC, and in its modern form is in use throughout broadcasting organisations in this country and in many European countries. It was designed with the express purpose of reading the peak level of the incoming signal. The term PPM has become the accepted name for both the meter and the special logarithmic amplifier that is nearly always used with it, and throughout this article PPM will refer to the two, except for a few obvious exceptions.

By careful design of the ballistics, the meter itself is improved over the VU giving a rise time of 40mS—considerably better than the VU. It is well damped, and produces a low overshoot of about 5% (less than 1dB at normal operating level). But even this rapid meter is not fast enough to respond to the sharp peaks mentioned earlier. Some type of storage device is needed as well in the amplifier section of the instrument, and the effect of this is to allow the meter more time to reach the peak. This is shown in **fig. 3.** The input signal is peak rectified and is used to charge a capacitor with a circuit time constant of 2.5mS; that is, the charge is very nearly fully transferred in 10mS. The resulting DC is then applied to the meter via a circuit which presents a discharge impedance of 1M. The result of this is shown in **fig. 3** and it can be seen that even fast pulses will give a reading which is substantially full scale.

'Peak Programme Meter' also implies a special scale, one which is linear in dB. In the heading photograph the PPM is shown with graduations from 1 to 7; each of these corresponds to 4dB. Contrast this with the VU which has a linear voltage scale.

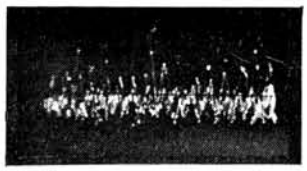
The price of the meter shown is £6 16s., but on top of this is the cost of the amplifier which must go with it, making it much more expensive than the VU-meter. The amplifier requires quite a few components since it must include the storage mechanism, and also provide the logarithmic indication which must be both accurate and stable.

Both the PPM and the VU are arranged to read positive and negative peaks by using full wave rectifier techniques, since it has been shown that differences of up to 8dB occur in musical sounds (see **fig. 4**).

So much for the specification of the units—we must now discuss the relative merits of each system. Firstly, in broadcasting in general and tape recording in particular, we are especially interested in the peak signal since distortion in amplifiers and on tape is linked to the amplitude of the signal and not to its duration. If we are to avoid this overload distortion we must be able to measure peaks correctly. We have seen that the VU cannot do this on all types of music. A very interesting experiment

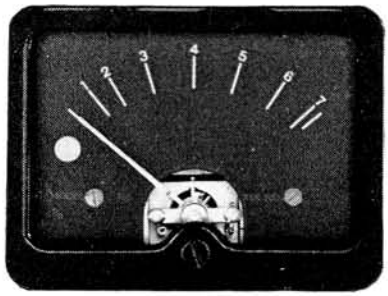
(*continued on page 377*)

FIG. 4



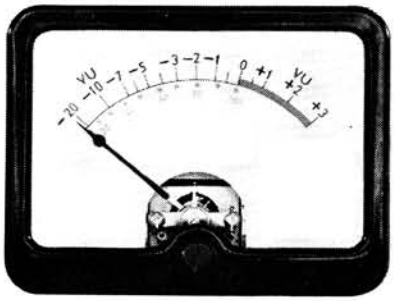
Audio Waveform with widely differing positive and negative peaks.

FIG. 1A



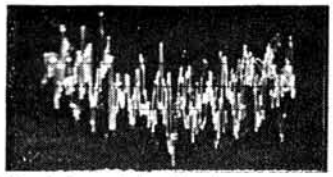
Ernest Turner Peak Programme Meter

FIG. 1B

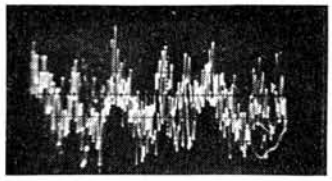


Ernest Turner Vu-meter

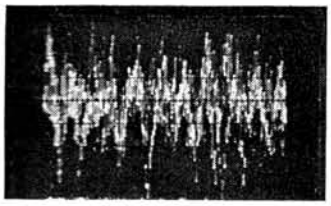
FIG 5



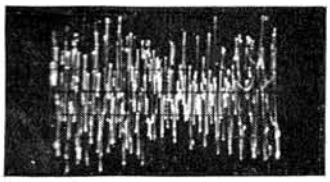
(a) Bach harpsichord solo. **PPM5 VU -7**



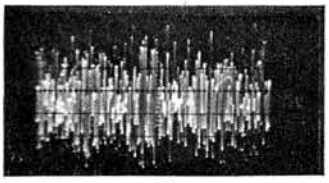
(b) Franck, full organ. **PPM5 VU -6**



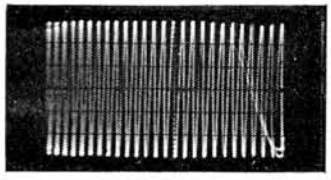
(c) Clavichord. **PPM5 VU -5**



(d) Verdi, full orchestra and chorus. **PPM5 VU -4**



(e) Positive organ, flute tone. **PPM5 VU -4**



(f) 1kHz tone. **PPM5 VU 0**

FIG. 2 GENERALISED RESPONSE OF METERS TO VARIOUS INPUT WAVEFORMS

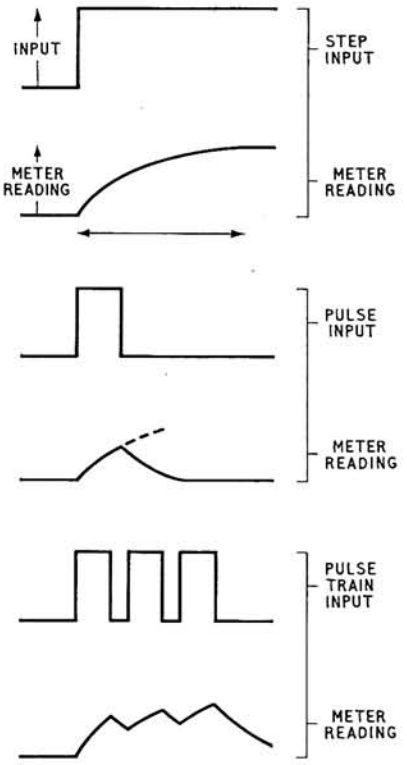
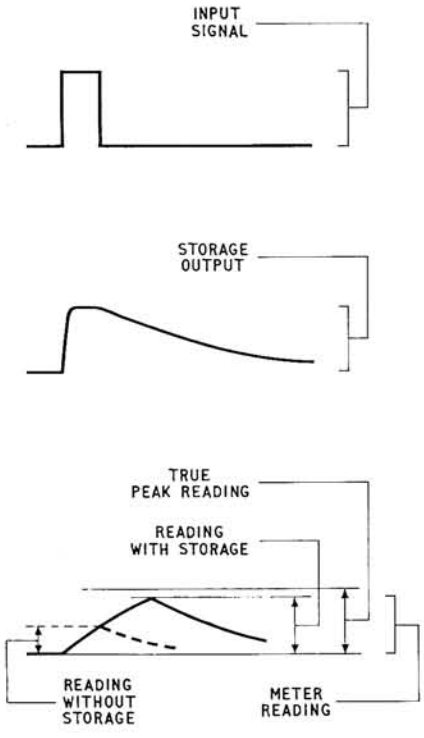


FIG. 3 EFFECT OF ADDING STORAGE MECHANISM TO METER



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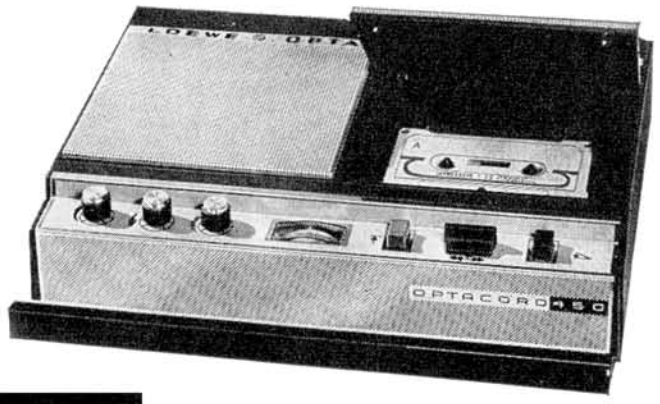

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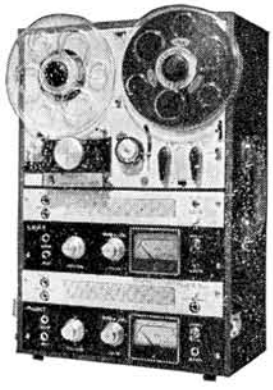

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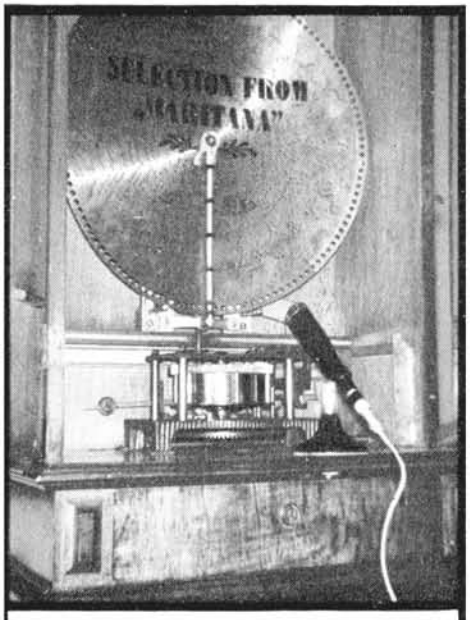


MUSIC FROM CLOCKWORK

JOHN ASHCROFT AND FI-CORD CAPTURE A POLYPHON

THE Liverpool Daily Post recently ran a feature describing a *polyphon* displayed at Birkenhead's Williamson Art Gallery. The machine was in one corner of the foyer, and visitors could drop a penny into its slot and hear a performance. This struck me as interesting material—I had often heard of such instruments, but never encountered one.

Possibly I could have strolled in with an unobtrusive portable and spent a few coppers adding to my 'archives' without attracting attention ; but this is definitely the wrong technique. A courteous approach to appropriate officials is not only good manners but almost always ensures an interested response ; and, in fact, may open the door to more interesting possibilities.

I wrote to the curator, explaining that I would like to record at least some of the polyphon's repertoire and, if possible, an explanation of its origins—for my own collection, and for the library of the Merseyside Tape Recording Society. Back came a friendly letter granting full permission, depending only on the agreement of Dr. Robert Burnett, the collector who owned the instrument and had loaned it to the Gallery. My letter had been passed on.

Dr. Burnett wrote giving a warm go-ahead and offering to come along and give a personal explanation and demonstration. We fixed a mutually convenient time, and along I went. Equipment was a problem—not realising what I was in for, and not wishing to intrude too much or inconvenience any authorities, I simply took a Fi-Cord 202 and a Grampian DP4 microphone, with a spare 18ft. lead, also the mains unit in case a suitable power-point was within reach.

Talk about learning by experience ! I wish I'd inquired about such angles earlier—the curator, Mr. G. Stratton, and his assistant, Mr. K. Conway, did their utmost to see me comfortably installed and well-equipped ; they lent me a reel of mains extension lead that would have gone twice round the block, and showed me the nearest power points, they gave me the handle of the polyphon and free access to its repertoire of metal discs, and enough pennies from the collecting tray to keep it going all morning. After explaining exactly how the instrument worked, and providing a cup of tea, they left me entirely on my own to go ahead undisturbed.

I could easily have taken a mains machine and as many microphones as I liked. As it was, I resolved to do my best with the equipment I had brought.

CORNER DWARF

Like a fat dwarf grandfather clock, the polyphon stood in a corner. Glass-panelled doors in its upper half gave access to the mechanism : the discs—about 20in. in diameter, and curiously flexible—were stored in a cupboard beneath. With its dark brown woodwork the instrument gave a vintage Victorian air to this corner of the modern museum.

You insert the handle into the side panel, crank up the clockwork motor, and take a disc from the cupboard. The disc fits rather like a gramophone record on to a spindle, but stands vertically—enhancing the suggestion of a clock—and is held in place by a folding lever that clips on to the spindle. Insert a penny, and as the clatter dies down the disc slowly moves, revolving just once and taking two minutes to turn—and out comes the sound.

The austere setting suddenly seemed full of a gentle, glowing tinkle, a warm chiming as melody and chords spread into the adjacent halls. As the last echoes died a lady strolled curiously from the maritime section, glanced at my equipment and said : "Is *that* where the music came from ? It was lovely."

This was one problem—people were liable to enter from the street, letting in a rumble of traffic, and clip-clop their way to various parts of the gallery, or come over and form a somewhat distracting though attentive audience. And the chiming tones of this polyphon proved devilishly difficult to record well ! I tried two or three balance checks, monitoring on a pair of Armstrong Type F headphones, and ran into problems galore.

With the microphone 15-20ft. from the polyphon, reverberation and extraneous noise (due to recording on a high gain) were frightening ; with the microphone about 6-8ft. from the polyphon, reverberation was actually pleasant, conveying atmosphere, but the extraneous noises were still noticeable. Finally I opened the instrument's doors and stood the microphone 'on the threshold,' recording at a much lower gain. This got rid of nearly all the extraneous noise, but tended to include some mechanical effects—including a cheery clatter as, halfway through each performance, the penny finally dropped from a little bracket into the innards of the instrument.

A member of the staff paused, watched sympathetically, and confided ; "We had a BBC fellow here once ; he spent hours moving his microphones around and still wasn't happy with the final recordings." I felt better—but not much !

A 'sample replay' worried me. I should have checked the tapes at home. They were new, my favourite brand which had never before let me down, and had simply been played from a 7in. spool on to three smaller ones. I learned then (and have since confirmed) that my Fi-Cord and that brand of tape have frequent disagreements. It's not a bias mismatch : the recording on sustained notes proved crumbly here and there, as though the tape were not maintaining contact with the heads. The tape was certainly not sticking and twanging loose as it wound : visually all was going perfectly, but the results sounded far from it.

Dr. Burnett arrived—a tall slim man with twinkling eyes, a quick smile, and a clear concise manner of speech that made for real recording-without-tears : little if any editing was required on his explanations.

"The traditional Swiss musical boxes", he said, "had a cylinder with tiny pins in its surface. As the cylinder revolved the pins plucked and released the teeth of a metal comb, the different teeth giving different notes. But not many boxes had interchangeable cylinders ; and also the pins had to be inserted by hand, which made the cylinders expensive."

The polyphon, invented in Leipzig in the 1880's, used metal discs whose surfaces were prickling with tiny tabs formed by punching out the metal after cutting round three sides of a rectangle. As the disc slowly revolved, these scores of tabs turned little wheels which in turn plucked out the notes. The discs were cheaper than cylinders—and they could be mass-produced.

Soon the Polyphon Company was issuing the current 'hits' for use on the big machines in public places and the smaller ones in private homes. "This instrument isn't one of the very early ones," said Dr. Burnett. "It was made, probably, in the early years of this century, and these coin-operated models were used largely in public houses, pier pavilions, amusement arcades . . . it was, if you like, the forerunner of the modern juke-box."

But Edison's cylinder phonograph was on the market by 1890 ; and the reproduction of voices, military bands and orchestras gave serious challenge to the music-box and polyphon industries. Then came Berliner's discs, and again mass-production hit the market and eventually drove out the cylinders . . .

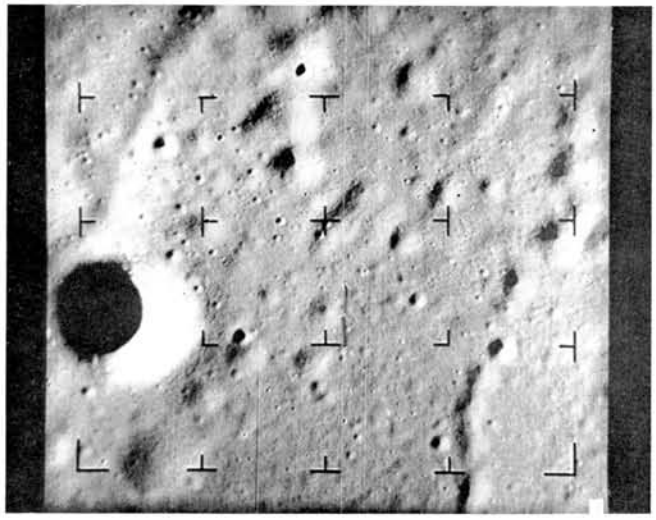
DRIVEN OUT

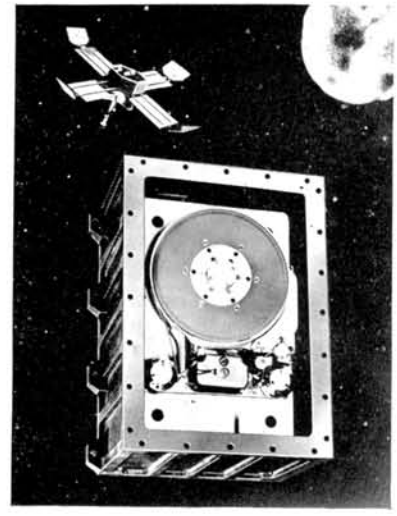
Strange, history repeating itself ! Cylinder musical boxes being driven out by mass-produced metal discs ; then wax cylinders threatening the earlier systems only to be challenged in turn by wax discs . . . and now of course we have tape !

"The original Swiss cylinder musical boxes were on the way out," said Dr. Burnett, "and the First World War more or less finished off this industry. A few later boxes were made, but most were meant as novelties, rather than designed to be listened to for the music they produce."

Frankly, I'd always regard musical boxes as novelties rather than as an early method of

(*continued on page 371*)





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FROM TELEGRAPHONE TO MARINER FOUR

PART ONE

BY H. W. HELLYER

MAGNETIC tape has a history more involved and a bit longer than may be realised. Present-day uses are remarkably wide; future applications are enormous. In the following notes we hope to open a few doors to the past, shed a little light on the present and perhaps wedge open a window or two upon the future.

Historically, everybody is aware that Valdemar Poulsen chalked up a first for Denmark with his *Telegraphone*, way back in 1898. We do not need to repeat the textbook facts, which have appeared in these and companion pages many times before. Everybody is aware that developments went on in Germany in the mid-thirties and that tape recording really broke out into the open at the end of World War II.

Not so widely published is the fact that, when the German tapes were . . . acquired . . . and taken over to America for research and development, some backroom boys over there had already progressed beyond costly paper-backed tapes. A company with a long record of producing adhesives was tentatively feeling its way into the tape market and experimenting with a magnetic tape—though not for the prime purpose of recording.

Indeed, physicist Dr. W. W. Wetzel and chemist C. Hegdal of *3M (Minnesota Mining & Manufacturing)* were in the novel position of having worked out a product for which there was no immediate use—there being no machine on which to play it! It was not until a Minneapolis radio shop acquired one of the first tape recorders, a *Brush* model, that these two venturers were able to try out their precious tapes. No doubt they were as delighted as their Board of Directors when the 'new-fangled contraption' worked. (Probably they were forgiven for spending precious time during which they were supposed to be developing tapes for sealing, masking, splicing and joining.)

As a further matter of historic interest, readers may like to know that the ensuing demonstration by Dr. Wetzel included not the *Star-Spangled Banner*, the *Hymn to the Republic* or the *New World Symphony* but a piece ripe for rediscovery by some modern pop group, entitled *Who Put the Overalls in Mrs. Murphy's Chowder*.

Previously, recording had been hampered by the need for fast-running steel wire and steel tape and. despite Poulsen's sensational exhibition at the beginning of the century, it was not until the mid-thirties that Germany began to make anything commercially from the basic idea. And even then the noise limitations and a dynamic range that could hardly exceed 20dB were as much a drawback as its gobbling up of tape.

In the early days, recording was *across* the wire or tape rather than along it, as we now consider normal. It is interesting to note that a 'perpendicular' technique is employed in the high quality video tape recorders at present in use, and that a compromise method of slant-tracking, obtained by helical scan, is the choice of the leading companies in the competitive lower-priced VTR field. The reason, of course, is to increase the relative head-to-tape velocity by making both tape *and* recording/playback heads move and thus increase the bandwidth. This is vital for video recording as the frequencies handled extend into several million Hertz instead of the range of about one-fiftieth of this amount we need for ordinary audio work. For video-recording, special tapes have been developed with the 'grain' of the oxide orientated at right angles to the tape length.

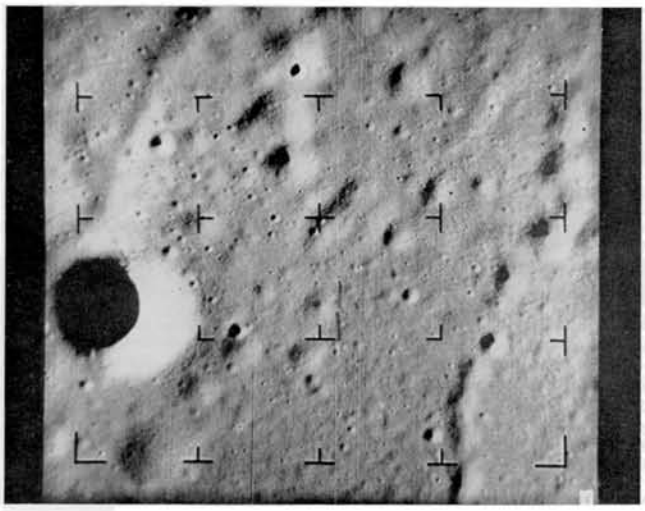
Even Lee de Forest's contribution to electronics, the invention of the amplifying valve, did little to boost tape recording, although, again, it is of historic interest to note that one of the first applications of the three-electrode valve was as an amplifier for a Poulsen Telegraphone. And that was in the spring of 1912!

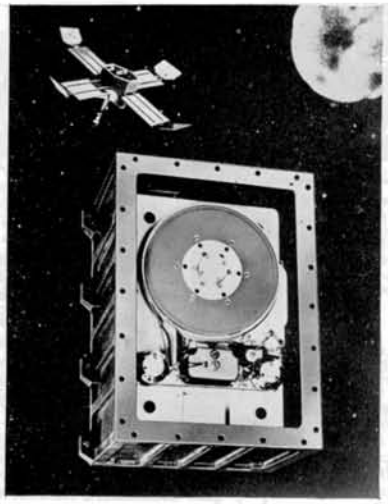
We shall skip lightly over the invention of the ring-type head, Plfeumer's original patent, the *Magnetophone*, *Blattnerphone* and *Marconi-Stille* among early machines, with only a passing note that the Magnetophone was actually the first machine to use coated magnetic tape of the type that we know now—although the materials were very inferior. In fact, the problem of developing a good quality oxide and, equally important, an effective binder, occupied a number of clever men for a long time. Nobody pretends we have reached perfection yet—not by a long way when we read some of those horrific technical papers on dropout. Just wait until we come to record in colour!

Another matter of purely historic interest: it

your obedient servant

FROM TELEGRAPHONE TO MARINER FOUR





PART ONE

BY H. W. HELLYER

was as long ago as 1933 that two Japanese gentlemen, Kato and Takei, filed a patent for the mixing of metallic oxide powders to make a magnetic material. And while we are reminiscing, let us recall that it was 46 years ago that Carlson described the basic principles of high frequency biasing. True, Poulsen had paved the way by recommending premagnetisation, but every experimenter was thinking along the lines of a DC bias until the United States Navy, in the persons of W. L. Carlson and G. W. Carpenter, tried out AC techniques to cut down the background noise. By 1927 they had worked out their ideas and applied them to steel wires and tapes, and since then the principle has been accepted.

It is perhaps ironic to note that the wheel has turned full circle, and with modern videotape recording AC bias has been made superfluous by using the lower frequency signal to modulate an FM carrier which finally modulates the tape. This helps reduce the fluctuations in level caused by variations in tape and head contact, which result in amplitude changes—these being to the greater extent limited out by the demodulating circuits. Noise peaks are 'chopped off' so to speak, and the precious signal is 'protected' within the FM carrier.

Wars always have their side-effect benefits of technological advance. No doubt Henry's troops came home with tougher buskins, and look what Waterloo did for the footwear trade. But World War II, if it did nothing else, spurred the Germans on to great improvements in magnetic recording techniques. The *Tonschreiber* was certainly a machine far ahead of anything else in the field, even if the tapes did tend to separate with use. Oxide coating and HF bias were part of the tape scene now, and when the American lads got their hands on this equipment advances came apace. Soon, agicular gamma ferric oxide was being used, and plastic-backed tapes took over from paper. Acetate graduated to polyester some years later, and experiments went on all the time to fine down the oxide dispersion, until the tensilised tape and then the sandwich layer of very fine plastic protecting the oxide was announced. But we have jumped ahead of ourselves.

In the days when improved tape was making commercial recording feasible, there were very few machines on which the novel material could be used. No market, in fact. And this is where the Old Groaner comes into the picture. Bing Crosby gave the medium a fillip by having his immediate post-war shows transcribed by engineer John Mullin, and the *Ampex* company (now a byword for quality machines) provided the first few machines that the *American Broadcasting Company* needed for the expansion of the programme. Mullin had used a Magnetophone and German tape for Crosby's original transcriptions. Compared with this, the 3M '*Scotch*', of which *ABC* had ordered one and a half million feet, had a 14dB superiority and a frequency range of up to 15kHz at $7\frac{1}{2}$ i/s, against the Magnetophone's limit of 10kHz at 30 i/s. With twice the coercive force and the possibility of repeated erasure, the later brands were really the pioneers of the tapes and tape recorders we are using today.

In the early days it was felt that tape would be primarily domestic—or at most, an aid to entertainment. With an eye on the home player market, many firms began developing simplified tape recorders that employed the existing tapes.

But time has proved the great scope of the medium and today we find tape in all kinds of industrial applications—far too many to be enumerated here. Mention of a few will illustrate the point.

Take medicine: no, no, not *that* bottle, Alice! The modern scourge, heart disease, is usually investigated by a pen-writing device, tracing wavy lines on paper which rolls out regularly to give a time-based graph. A slightly more sophisticated method is to pick up signals from the electrical activity of the heart and the various chambers, valves, and other parts of the body related to the beating heart, to feed the signals picked up by different kinds of transducers to amplifiers, and produce a signal on photographic paper. This is all very fine, and reasonably accurate; but there is a limit to the time period for each test, and a very real difficulty in correlating results over a period to make any long-term assessment of disease symptoms. Magnetic tape eases this problem.

At Guy's Hospital, Dr. D. H. Deuchar, Physician to the Cardiac Department, uses a multi-channel tape recorder unit. The tape is

(*continued on page 371*)

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Scotch *Type 499*, an instrumentation grade, and there are two principal applications. In the first, chest movements of the patient are picked up by microphones on the chest wall, and pulse movements are picked up by transducers at other vital points, such as a neck artery. Respiration may be picked up by another transducer. The signals are fed through a five-channel unit and give taped records that are either phono-cardiograms or ballisto-cardiograms, relating to sound or movement of the body.

The second main method is a pressure record, taken by fine catheters introduced into blood vessels, and even entering the heart itself. The two recordings can be studied in the same way as the usual cardiogram. There are now tape viewers that make traces immediately visible without altering the tape oxide or the signal magnetisation structure.

This is useful for diagnostic purposes, and the time scale is greatly extended by the use of tape; but the real advantage is the ability to feed these taped records immediately into a computer. They are, of course, a form of analogue record and by feeding them through a tri-digital converter they are available in digital form that can be fed into a suitably programmed computer. The research is speeded up greatly and, owing to the continuous nature of such taped records, no details are missed. As a point of interest, these methods also entail much less discomfort to the patient.

We have mentioned two other lines of approach that are worth further study: instrumentation and computer records. It is hoped to spend a little more time on the latter in subsequent articles, with a few words on logic; but the former device, the instrumentation tape recorder, is worth a quick look at this stage.

Perhaps the most obvious facility is the communications network of space research. The performance of both the craft and the astronauts must be monitored constantly. The only way this can be done with miniature equipment is by using some form of tape recorder. It is no use picking up the telephone to ask an astronaut more than a hundred million miles away how he feels—and even Mars is not a signatory to the Phonopost scheme!

Take an example: the sending back of pictures from far distant places. We are now familiar with the photos such as that taken by the *Ranger 9* spacecraft just about eight seconds before it hit the moon. The remarkably clear delineation of the large crater (1⅝ miles across) shows what can be done by virtually direct transmission. Which is all very fine, but we are faced with a different problem when taking pictures of a planet 144 million miles away. (Actual communications distance when the *Mariner Four* spacecraft passed Mars was 241,397,000 kilometres, or 150 million miles.) To get these remarkable pictures that made the world goggle, a single television camera took 21 black-and-white pictures. Now, to get any sort of reasonable picture over this distance, a radio transmission rate of 8.33 bits per second is needed. (More about 'bits'—binary digits—after; suffice to say at present that this is an extremely slow speed for picture transmission.) Pictures, recorded two at a time, give a data store rate of 10,700 bits per second, so some method of storage and retransmission is needed, because any pictures that are to give lairly good details need 250,000 or so bits of information. So the actual pictures taken are stored on tape as digital bits at 10,700 a second.

In the actual machine used, the same Scotch instrumentation tape as was used in the Ranger shots is employed, but the recorder operates at one-hundredth of an inch per second. Yes, that's right, you hi-fi fans, 1/100 i/s. The recorder is turned off after recording each pair of pictures and playback of the resulting storage takes—or rather, took—8 hours 20 minutes for each picture. The tape was 330 feet long and "thinner than a razor blade, not quite so wide as a pencil—costing only fourteen shillings" as the 3M publicity boys so picturesquely described it. This was quite a feat, and they were right to be proud of it—we are a little too prone to take things for granted. We see an 'Early Bird' link from some remote site and say "Hmm! Not so good as the studio transmissions", forgetting that it is a remarkable achievement to get a picture at all.

It is hoped, in further articles along this theme, to disturb this blasé attitude somewhat. We, who aim our paltry microphones at some passing blackbird and think we have conjured up a miracle, must remember that most of the finer development points that make our domestic recording possible began as a backroom boy's doodle in the research department of some industrial octopus.

Tape recording is now established in geophysical research—for example, in oil location—for the analysis of seismic records, for controlling all manner of machine tools, mail sorting, warehouse routeing, spray guns for paint and other materials, automobile, aircraft and other industrial testing, and even for the humble recording of the toll calls in the telephone exchanges. There are few jobs the Dickensian clerk with the quill in his mittened paw carried out that are not better and more quickly done on tape.

Perhaps the most prolific growth in the tape field has been in computer work. This is a subject all on its own and in the next article we shall start to unravel a few of those 1984 mysteries.

reproducing music mechanically—but I soon changed my mind, for he led me into an adjacent display room and showed me some of his rarer boxes. One by one, he brought a selection from the cases for me to inspect and record—the bulk of his collection seemed to be on display, if bulk is not too brutal a word for such combinations of craftsmanship and musical beauty.

Some were 150 years old and looked brand-new; some were as small as a packet of cigarettes, uttering exquisite sparkles of sound; some were shoebox-sized with deeper chimes; a few resembled half-scale coffins with gleaming cylinders a yard long and to whose rich deep tones my equipment had little hope of rendering anything resembling justice.

Again, acoustics and extraneous noise were against me, and tape dropout crept in here and there; recording these musical boxes in a small and normally furnished room using a ribbon microphone and mains machine might be simple, though I have my doubts—recording them adequately, even at 7½ i/s with the Fi-Cord and Grampian, in a large museum, is not so simple. As with the polyphon, close-up recording on lower gain emphasised any mechanical noise, whereas anything else invited occasional distant footsteps, voices, and (once) a truly horrific door-slam.

Some boxes were straightforward comb and pin instruments; additional sounds were provided by bells—and one box had bells and drums in addition to the music produced from the comb.

"The drums can be cut out at will, by this brass lever," explained Dr. Burnett, "and I think most people would cut them out, as their sound isn't very pleasant." However, we recorded 'the lot', and the dry clatter conveys suggestions of a quaint bucolic brass band.

STAGGERING MINIATURE

But the most staggering instrument—the one that gave the VU-meter its worst fright for months, and the one which still makes me marvel on hearing the tape—was a beautifully made miniature, the size of a packet of ten cigarettes if this simile isn't sacrilege. Its lid was an inlaid picture of a Swiss scene. Dr. Burnett wound it carefully, and held it between thumb and fingers.

For a second nothing happened. Then the lid shot open, out popped a little feathered jewel of a bird no bigger than a thumb-nail—and the bird proceeded to flap its wings brightly, turn its head from side to side, open and close its tiny beak—and *sing* !

Yes, sing—a lively, trilling whistle, up and down the scale, that seemingly went on as effortlessly and blithely as any skylark while I stared in disbelief.

Scarcely less startling was a slightly larger bird in a cage, this one merely moving its head as it whistled cheerfully. The secret lay in a miniature piston-driven Swannee whistle built into the base of the boxes. I took a few colour slides, and the first bird-box appears on the screen as a tiny glittering thing held between fingers that look alarmingly huge.

In almost comical contrast, the recital ended with a Sublime Harmony Box over three feet long, with interchangeable cylinders, three melodies per cylinder. It performed marvellously, rolling out the chimes of *The Old Folks at Home* today as eloquently as it must have done in Switzerland some eighty or more years earlier.

"It's true that some of these boxes were in poor condition," admitted Dr Burnett, "and I've managed to repair many of them. But that's one of the things about collecting early Swiss musical boxes: you may come across one and think, 'Ah, I can very soon put that right'—but you may easily find that you can't!"

Nevertheless, the boxes displayed within locked cases, silently gleaming in the gallery, were a striking and musical reminder of 19th century craftsmanship; and, despite some problems with tape and acoustics, I was able to capture some nostalgic and fascinating sounds—linked by the voice of a genuinely charming man.

BRENELL STB.1, STB.2 AND HI-FI TAPE LINK

BY H. W. HELLYER

RECENT correspondence shows that this contributor is slipping. The lately concluded but by no means forgotten Questionnaire gave service as a subject needing a bit more airing. My friends whisper to me that the last few articles in this section have concerned themselves less with service than with a description of the goods.

Mea culpa. But there is a partly valid reason. *Brenell* machines have occupied our space just lately, and if we are honest about it we shall have to admit that the amount of service information in the form of direct hints and tips that we could offer about these tape recorders would not be much of a contribution. None of your 'twist this, bend that, attach a spring balance and a horse and dray and watch for the flickering of the test lamp'. Information is forthright, adjustments are very few and seldom needed, tests are quite conventional.

This bears out one of my previous arguments: the most effective service article is that which gives basic information about the gear. If it can fill in a few gaps that the reader has failed to plug, so much the better.

Some of this information, it seems apparent, is about the braking system of the general run of Brenell decks. There are a few small differences, and we have already pointed out one or two necessary tests and adjustments. But as far as braking is concerned, we should emphasise that many of the troubles people experience happen because the machine is either used wrongly, or its action is not fully understood.

The later decks have a very fast rewind with controlling braking action. If you load uneven spools, you will certainly get spillage. Many users have pre-recorded tapes on 5in. spools. Playing these on to a normal 7in., and then back, presents no problem. But rewinding, or forward winding to select given portions, often leads to slack spooling and then the machine is blamed. If dissimilar spools are used, then the spillage must be controlled by the rocking action described last month.

LARGER SPOOLS

Models designed to take the larger spools have an additional cork-lined brake operating on the right-hand spool carrier in the rewind mode. This brake comes into action only when the small knob to the left of the Rewind knob is pressed, when the knob is turned to Rewind (i.e., to the left). There is a coupling cable that can be adjusted to alter the tension of this brake. Alteration should only be made by this adjustment, *not* at the brake mounting or shoe itself. The correct tension is achieved when minimum vibration of the tape between left spool and the nearest guide is observed. The adjustment becomes quite obvious on inspection.

One fault that should be guarded against, and which can give symptoms that seem like braking or motor troubles, may be simply loose spool-carriers. These are grub-screws secured to the motor spindles and can work loose. The makers recommend a touch of *Loctite* inserted in the spool-holder before final adjustment and tightening of the grub-screws. Note that spool height is adjustable by moving the spool carrier on the spindle, but before getting too hasty when the tape rubs the spool flange, please check first that the spool itself is not warped—by no means an uncommon occurrence ! And remember the adjustable guide. Small points, but they can be important.

The pause brake, which operates on the left spool carrier should be clear until the pause knob is moved. A bent shoe is a possibility here, and occasionally the cork gets chipped and sits unevenly. The other brake on this carrier is the stabiliser, which has a 4BA nut clamping it to the deck, and some adjustment may be necessary to prevent irregular unwinding when a full 7in. spool is on the left during Record or Play. Too much tension on this brake may cause wow, or should we say 'wobble'? (*Not in this case*—**Ed.**).

Main brake adjustment has already been dealt with. It is worth reiterating that the locknuts should always be tightened after adjustment—easily forgotten—and that care must be taken not to move the adjusting screw of each brake as the locknuts are clamped home.

DIFFERENT HEADS

Another point that does not always receive publicity is the head data of the Brenell decks. Different heads have been used, but those for which information is most often requested—I suspect because owners are carrying out modifications—are the stereo heads in the *Bogen* range. There are wide differences between the record and play heads, although the latter can be employed as a combination head quite successfully. Therefore the figures given below relate to both functions. These stereo heads are ¼-track, stacked, designated *2/2*. This distinguishes them from the 'normal' stereo head, which is a quarter-track, *2/4*. As a matter of interest, to make it possible for owners to get the widest use from their machines, Brenell fit a 2/4 replay head on the *STB.1* deck as an extra. This can be switched into circuit in place of the 2/2 replay head, and to special order the opposite combination can be supplied. That is : 2/4 erase, 2/4 record, 2/4 play and 2/2 play.

In common with other makers of professional equipment, Brenell do not really seem to approve of quarter-track recording. This may seem ironic to newcomers to the art, who are being bashed with blatant publicity about the superiority of cassettes, low speeds and narrow tracks, but you will find that the serious user still wants that extra little edge of wide response and good signal-to-noise ratio that ¼-track recording can give, all other things being equal. He bemoans the cost of tape, but would rather extend his library than compromise on quality. So we find people like Brenell (and *Bang & Olufsen* with their *2000K*) fitting a switched 2/4 head as a grudging admission that lesser standards exist.

Head details, as promised :

Recording head, *UK202*, 2/2 track. Inductance 120mH ; impedance at 1kHz 780 ohms ; DC resistance 75 ohms ; bias at 100kHz, 23V at 1mA ; recording current (3¾ i/s) 120μA ; output at 2kHz (3¾ i/s) 2.4mV.

Replay head, *UK200*, 2/2 track. Inductance 550mH ; impedance 3.5K ; DC resistance 300 ohms ; bias (100kHz) 70V at 0.8mA ; record current 50μA ; output at 2kHz (3¾ i/s) 5.8mV.

Erase head *BL210*, 2/2 track : Inductance 2mH, erase current 55 μA ; erase volts, 80V at 100kHz.

Details of recording currents, etc., are given for the replay head, and output figures for the record head, for these are, naturally, usable for either purpose. But design is for the best features for the exact function, and to aid

(*continued on page 375*)

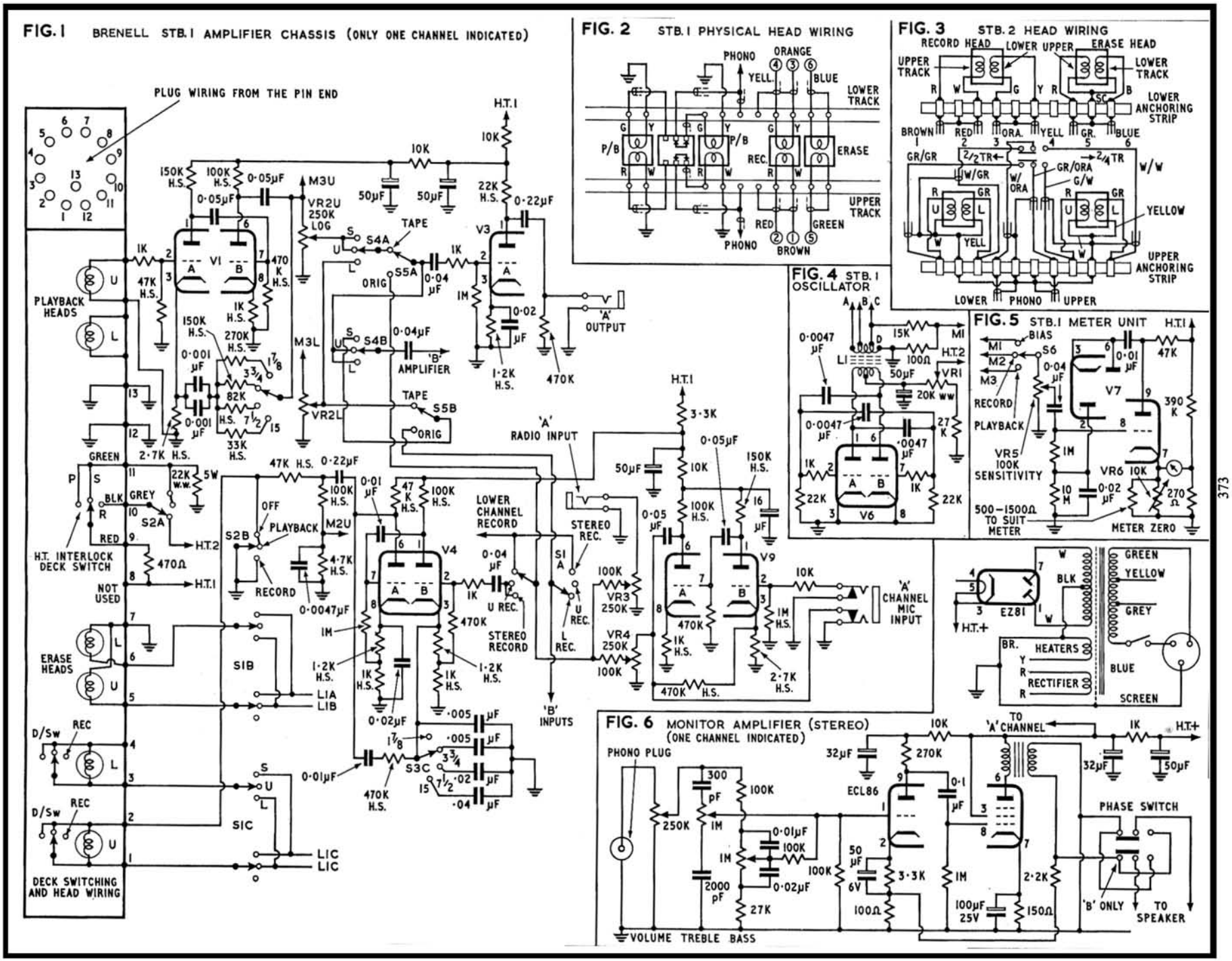
FIG. 1 BRENELL STB.1 AMPLIFIER CHASSIS (ONLY ONE CHANNEL INDICATED)
PLUG WIRING FROM THE PIN END
DECK SWITCHING AND HEAD WIRING
PLAYBACK HEADS
ERASE HEADS
H.T. INTERLOCK DECK SWITCH
NOT USED
RECORD
PLAYBACK
OFF
TAPE
ORIG
'A' RADIO INPUT
'A' OUTPUT
'B' AMPLIFIER
LOWER CHANNEL RECORD
STEREO REC.
U REC.
L REC.
STEREO RECORD
'B' INPUTS
'A' CHANNEL MIC INPUT
FIG. 2 STB.1 PHYSICAL HEAD WIRING
PHONO
ORANGE
YELL.
BLUE
LOWER TRACK
ERASE
REC.
UPPER TRACK
RED
GREEN
BROWN
FIG. 3 STB.2 HEAD WIRING
RECORD HEAD
LOWER UPPER
ERASE HEAD
UPPER TRACK
LOWER TRACK
LOWER ANCHORING STRIP
UPPER ANCHORING STRIP
YELLOW
W/W
LOWER PHONO UPPER
FIG. 4 STB.1 OSCILLATOR
FIG. 5 STB.1 METER UNIT
BIAS
RECORD
PLAYBACK
VR5 100K SENSITIVITY
500–1500Ω TO SUIT METER
METER ZERO
EZ81
H.T.+
HEATERS
RECTIFIER
SCREEN
FIG. 6 MONITOR AMPLIFIER (STEREO) (ONE CHANNEL INDICATED)
PHONO PLUG
ECL86
TO 'A' CHANNEL
PHASE SWITCH
'B' ONLY
TO SPEAKER
VOLUME TREBLE BASS

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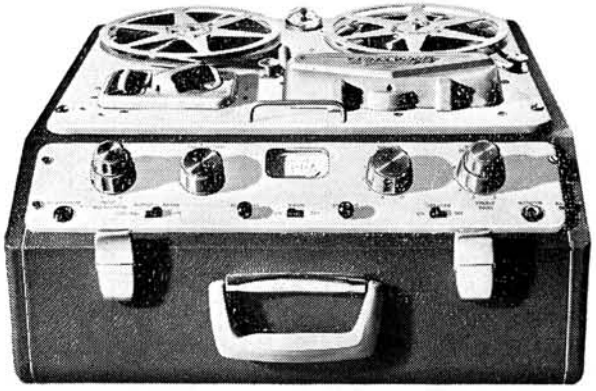

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field trials of battery portables

NO. 21 SANYO MR-101

BY DAVID KIRK

Manufacturer's Specification. Half-track battery tape recorder. **Tape speeds:** 3¾ and 1⅞ i/s (capstan-sleeve change). **Frequency range:** 100Hz-5kHz. **Signal-to-noise ratio:** 40dB. **Spool capacity:** 3½in. **Price:** £29 8s. including microphone and shoulder-case. **Distributor: Sanyo Service and Sales, Marubeni-Iida House, 164 Clapham Park Road, London, S.W.4.**

IF tape recorders must be made of plastic, the *MR-101* is to my eye a masterpiece of its application to cabinets. All controls are sensibly positioned on the near upper side of the case, with connecting sockets on the vertical front panel. Mechanical control is obtained through plastic press tabs, these governing stop, rewind, fast-forward, play and record, from left to right respectively. The record button contrasts in red against the black mode selectors and interlocks with the adjacent play tab. Moving left from the stop tab, the finger covers an edge-operated tone control and gain control, level calibrations being visible in a small window above each knob. On the far left is a miniature meter.

Three miniature jack sockets on the vertical front panel permit connection of microphone, gram and external loudspeaker. Two smaller sockets (sub-miniature ?) are provided for a foot-switch and remote battery cutout. The microphone cable is terminated in a double plug moulding which fits the microphone and remote 'pause' sockets simultaneously. This particular pause device is a little more useful than most (within the realm of battery portables) since the amplifier and meter remain in operation.

We hear, from time to time, of new idler compositions developed to resist 'flat' formation. The *Sanyo* does not enjoy such a composition, however, as frequent use of the pause control—leaving capstan and pinch-wheel in tight contact—resulted in an audible 'knocking'. This idler deformation is very much a permanent feature, several months after its first appearance. Replacement of the faulty components is the obvious remedy, though a short spell in boiling water tends to bring the rubber back to its former shape.

The small deck section follows a pattern seemingly stereotyped for low-price Japanese portables, the tape bending through an angle of some 80°, past DC-biased erase and record heads and on through a sleeved capstan to the take-up spool. In this instance, one has the choice of threading direct from capstan to take-up spool or via a metal guide pillar.

The capstan bearing is reasonably free of play and visible eccentricity, but the wow on reproduced material is nevertheless too great for serious listening.

Distortion is severe on the internal monitor but tolerable when feeding through an external speaker. Even under these conditions, however, commutator noise is high. The MR-101 is electrically one of the noisiest machines yet tested. Fortunately the bulk of this noise is confined to the replay chain and little actually finds its way on to the tape. Despite this, tape hiss and the very limited useful frequency range render the overall recording quality unsatisfactory, even allowing for price.

Power is supplied by six *U2*-size cells which are stored in a compartment entered from the base of the cabinet. Insertion is simplified by the provision of two plastic tube supports. A socket is incorporated to accept 9V DC from an external power source.

The MR-101 is supplied with a leather carrying case and shoulder strap. Unclipping three studs gives access to the controls, loudspeaker and deck panel. One of the female studs detached itself from the leather within days of commencing the field-trial. Whilst easy enough to attach to the recorder, the shoulder strap attachments are somewhat stiff and prone to severe wear whenever the case is removed from the machine.

After the attractive little Sanyo *Micropack*, this machine comes as a disappointment. Sanyo are not resting on their laurels, however, for rumours of an essay into the video-recording field suggest that they will join their competitors in the technological great leap forward.

TAPE RECORDER SERVICE CONTINUED

design we must ensure that other conditions are right. In particular, we should always keep the bias at the correct level for the particular tape we are using.

There is no special mystique about this. The magnetic coating on the tape has its own characteristics, which will vary slightly from make to make, and type to type (regrettably, also from batch to batch). To get the best compromise figure between output and distortion and the best signal-to-noise ratio, we choose the exact bias figure that suits the tape we are using. On the STB.1, facilities are provided to vary the bias level, and the meter is switched to give the necessary reading. This is the extra touch of professionalism, for which, of course, we have to pay.

The Brenell STB.1 amplifier chassis is given in **fig. 1.** This is one channel only and shows also the head wiring data as arranged for both tracks, with numbered connections to the plug and socket points. Note that the microphone input is at lower right and the preamplifier output at upper right. Volume controls are ganged.

Other circuit details are given in **figs. 1-6** in case ambitious readers would like to do something similar to their own machines that are limited by a fixed bias facility. A word of warning, however. This bias is varied by a limited alteration of HT to the common point of a tapped primary of a push-pull oscillator. Many other circuits depend on a series capacitor and there are very definite limits to the adjustment that can be made. You *cannot* modify the circuit of the single tuned-anode/tuned-grid or the modified Hartley type of oscillator, and only to a limited extent to the Colpitt's oscillator, by simply making the HT variable. Sorry, but there it is : the stage will have to be rebuilt. In any case the decided waveform advantages of the push-pull oscillator, plus the available power from it, make this a worthy conversion.

Bias variation as measured with a valve voltmeter is between 60 and 30V at the erase head, for each track, and between 50 and 25V at the record head. Note that when the machine is in the stereo mode, and bias is applied to both tracks of a stacked head, the readings will not double. Because of the change in impedances when the windings damp the oscillator, the readings will be lower. In fact, the erase voltage on stereo is 70V with the bias control at maximum, and the bias at the record head under the same conditions is 45V, reducing to 20V as the control is turned down. This has the added bonus, of course, of reducing inter-track action, a feature that could well be imitated on other machines.

(continued on page 377)

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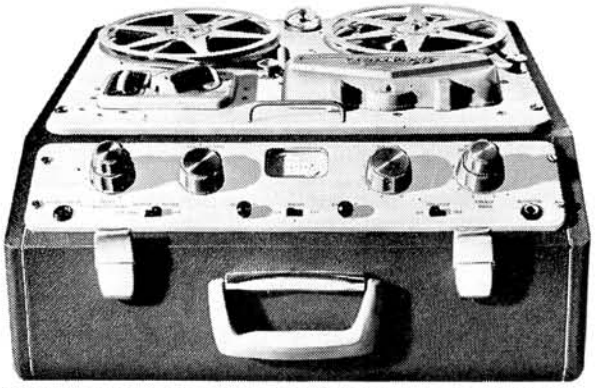

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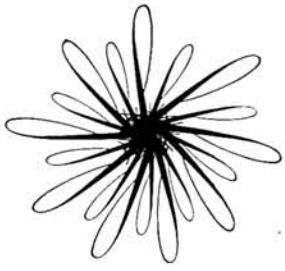

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(similar to a BBC film) was arranged to demonstrate this.

A series of photographs was made from the face of an oscilloscope (showing true peaks), and the readings of the PPM and VU were noted for different examples of music (**fig. 5**). The replay level of the gramophone used was in each case set to read a peak of 5 on the PPM. The PPM and the oscilloscope agreed quite well on the examples and, as expected, the VU showed a fall in reading as the wave form departs more and more from the true sine wave and becomes more complex and full of transients.

MAIN DIFFERENCES

This experiment points out the main differences between the two meters, and shows that there must be careful interpretation of the meter readings. If the VU is treated as a peak meter and the recording gain altered to give always a nominal peak level, then the amount of instantaneous distortion alters depending on the type of music being recorded. Some skill or experience is required here; the PPM always gives the peak reading, so that by following it carefully there is much less likelihood of any distortion through over-recording. However, it can lead to over cautiousness instead; after all the important factor to remember is that on both domestic and professional machines the tape hiss is the most annoying factor in a recording, and it is essential to record at as high a level as possible. If the recording sounds clean and free from distortion, even though the meter is pegged firmly at the right-hand side, then this is surely satisfactory, although the theoretical distortion may be astronomical. Very often too much attention is given to theory and not enough to the final sound.

It is interesting to note that the two major recording companies in this country differ over their meters, one using VU's and the other PPM's; records made by either are excellently reviewed, so that it is obviously possible to produce identical results with the two systems. For interest it is worth noting that the PPM in question has different time constants to those used by the BBC, and indeed there are many opinions both here and on the Continent as to the correct values to use. Probably one day a standard will be decided upon, perhaps along the lines of the present EBU recommended standard.

A disadvantage of the VU-meter is in the compression of the scale, which is brought out in the heading photographs, and briefly mentioned earlier. It is very useful to have a system which covers as much of the range as possible; low signal levels on the VU give a very small deflection, and the first meaningful reading is at about —15dB. The PPM instrument on the other hand has a corresponding lowest reading of about —22dB.

Turning to the high end, the ballistics of the VU can lead to a rather unfortunate state of affairs during line-up conditions. Most organisations record tapes so that the peak level corresponds to about 2% tape distortion. With many tapes this distortion is produced with a flux of 200mS per tape width, and the current DIN test tapes have this level recorded as a reference level. This will give a reading of 6 on the PPM, but taking into account the VU ballistics, must be set for +4 on that instrument—which is of course off the scale. The *Ampex* test tapes are recorded to a lower level, to give 0 VU or PPM 5; this corresponds to a distortion of 1% on a particular piece of tape used in the early days of setting standards. Using the Ampex tapes, to the NAB standards, the user must remember that peak recording level is 4dB above test tape level. And it is extremely difficult to use the DIN tape on a machine with VU's! This apparently simple difference has led to a great deal of confusion, particularly with devices which need to be set up and operated at peak recording levels.

INTERESTING ARGUMENT

One interesting argument for using VU meters in recording pop music is that since competition between companies is very fierce, the louder the sound without distortion, the more successful the record; the VU has a very wide scale around —3 to +3dB, so the exact level can be judged more accurately!

This short survey has covered the major differences between the two most widely used systems of meters; the conclusion is that either type will give the same results with an operator experienced in its use. Each has a very different action, and there are always devotees of each type prepared to argue vehemently about the relative merits. So take your choice!

This article has covered the majority of the technical differences; next month Part II will describe some add-on circuits incorporating the two meters for constructors who wish to improve the metering system on their installations. Both stereo and mono circuits will be covered.

Adjusting the bias is simple on machines such as this, with immediate readout (i.e., the recordings just made can be replayed and the effects of adjustments are immediately seen). First, we determine our reference frequency, normally 1kHz, and inject a signal to the recording amplifier at this frequency. After the frequency response tests have been made, we have a useful reference figure. We adjust a bias filter for minimum reading on the meter, then inject 1kHz at 20dB below 150mV into the **A** radio input and note what reading we get on the filter. This is then our reference and we adjust for a 3dB drop from this figure at the upper frequency (top-level) figure. That is, at 14kHz on the 7½ i/s speed, or at 11kHz at 3¾ i/s.

A word about this bias filter. This is a tuned 7mH choke in series with a 150pF capacitor to form an acceptor circuit, the two wired across a 47K resistor and fitted into a screened can with a jack-plug mounting. With the filter inserted in the Output socket, first the machine is switched to Record, the Play volume control is turned up and the filter core is adjusted for minimum reading on a valve-voltmeter connected across it. This tunes out the bias that may affect readings at the output socket.

A more laborious way of adjusting is simply to take spot readings, 'kill' the oscillator and note any modification to the readings caused by bias breakthrough. Indeed, the only effective way to make adjustments to a 'normal' machine with only a common record/play head is to take these spot readings—if necessary prepare a graph—and mark the adjuster to tally with readings. There are several general hints on bias adjustment and this is a practical subject on its own which will have to wait for a little more space to be available before we can digress.

As regards the diagrams—I have cheated a little. The layout of the STB.1 and 2 series, with the attractive printed panels that at first make one wonder whether Brenell have suffered a reformation, tempts one to split the circuit into component sections ; and this is very convenient. As some sections are common to the STB.1 and 2 and also to the *Hi-Fi Tape Link*, and others have only minor variations, there is no point in publishing three separate circuits—so I have not asked to do so. We can regard the main difference between the STB.1 and STB.2 as the fact that the latter has its own monitoring playback amplifier section (one for each channel), which is shown in **fig. 6.** This is not intended to be a hi-fi world-shaker. It is what it says, a monitor—but for all that, quite as good as many another output stage purporting to be wonderful. The other difference worth noting is that the output of the STB.2 is from a cathode follower, V3 (see **fig. 1**) now being a whole ECC81 for each channel, instead of being split. Anode of the new section goes to the lower end of the 10K filter resistor, signal is taken from the previous anode via a 0.1μF to the second triode grid, which has a 220K resistor to the junction of a 1K and 47K, the latter being the earthy end (i.e., the load) of the cathode resistor. The signal is taken off from this junction via a 0.18μF to the **A** output jack socket.

The head assembly wiring has been given in the two separate insets, **figs. 2** and **3,** but deck wiring data, which differs very little, has been left out to save space. The main diagram is of the record and play amplifier (or, more properly, pre-amplifier) of one channel of the STB.1. This includes the head connections so that **figs. 2** and **3** should not be necessary, but are included to give the physical layout of the head wiring, which experience has proved to be the greatest stumbling block.

The mains power pack section is seen in the upper part of **fig. 6.** It is very similar to those we have seen before, with the refinement of a separate metal rectifier for DC heating of the valves.

Other sections of this drawing montage are **figs. 4** and **5.** The former shows the STB.1 oscillator circuit. The STB.2 is similar but has an additional tapping on the secondary and a 15K as the lower leg of the HT potentiometer. This component may be changed on any unit to suit conditions, and various values have been found. The oscillator in the Hi-Fi Tape Link has further small changes but is basically similar.

The cathode components of the STB.2 differ slightly from the STB.1 meter unit of **fig. 5,** to suit the meter that is used. Note that there may even be slight differences between each channel.

And that, for this month, is it !

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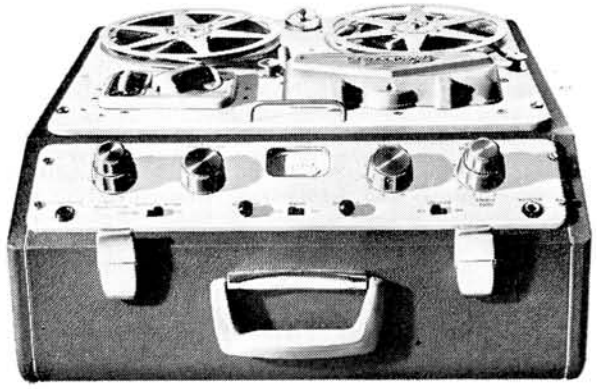

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TR 14

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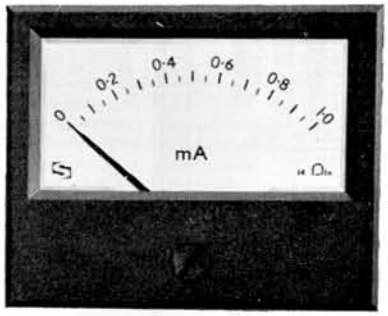
REALISING the importance of clean head-faces and pressure-pads, *Multicore Solders* have introduced a *Bib Tape Head Maintenance Kit*, comprising a bottle of Bib Instrument Cleaner, twelve applicators and polishers, double-ended brush, cleaning tissues and five-page instruction folder. The tools are designed to suit all reel-to-reel and cassette machines and, where necessary, may be employed without removal of the head-channel covers. Inset (as on the *Ferrograph*) and open-face heads can be reached easily and cleaned without risk of scratching. The kit is supplied in a plastic wallet and costs 12s. 6d.

Manufacturer: Multicore Solders Ltd., Multicore Works, Maylands Avenue, Hemel Hempstead, Hertfordshire.

BULK TAPE ERASER

AN addition to the *Weircliffe* range of professional and industrial bulk erasers is the *Model 30*, selling at £12 10s. It is designed primarily for the office-equipment market and offers facilities for immediate erasure of 3in. tapes and cassettes. The unit is of neat construction and measures approximately 5 x 5½ x 4in.

Manufacturer: Amos of Exeter Ltd., Weircliffe Court, Exwick, Exeter.



SIFAM MINIATURE METER

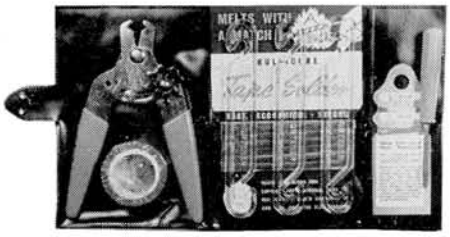
COMPLEMENTING the *Sifam Director* series of moving-coil measuring instruments is the *Director 14* sub-miniature meter. It is designed for flush mounting and requires a circular panel cutout of 1½in. diameter. Overall face dimensions are 1.92in. high by 1.65in. wide, the effective scale length being 1.34in. The meter is constructed to B.S. 89:1954 standards with an accuracy of ±2½% of full-scale deflection. Finish is matt black. Pictured life-size, the Model 14 joins a series comprising four sizes, up to a maximum scale length of 3.75in.

Manufacturer: Sifam Electrical Instrument Co. Ltd., Woodland Road, Torquay, Devon.

LOW-PRICE CARDIOID

NEWLY introduced by the *London Microphone Company* is a cardioid dynamic microphone to sell at £4 14s. 6d. This is the price of the 200/500-ohm *LM 200* which is also available with 50/60-ohm impedance at £4 17s. 6d. and 200-ohms/50K at £5 9s. 6d. Claimed effective frequency range is 50Hz-15kHz, sensitivity of the 200-ohm model being —74dB ref. 1V/dyne/cm², 0.2mV/μBar. Front-to-back discrimination is 18-20dB at 1kHz. The LM 200 comes complete with 6ft. twin-screened cable and presentation box, weighs 4¼oz., and has dimensions of 1¼in. diameter, tapering over 5½in. to ¾in.

Manufacturer: London Microphone Co. Ltd., 182/4 Campden Hill Road, London W.8.



HOME ELECTRICIAN'S KIT

THREE Bib Flex Shorteners, a *Model 8 Wirestripper*, one card *Ersin Multicore* soldering tape, 5 and 15A fuse-wire, a screwdriver and a reel of insulating tape comprise the *Bib Electrician's Kit*. The tools are housed in a plastic wallet which folds to 4 x 5½in. dimensions for storage. The Wirestripper has an eight-gauge thickness selector and inbuilt wire-cutter. It is available with the complete kit for 14s. 6d. or may be purchased separately at 8s. 6d.

Manufacturer: Multicore Solders Ltd., Multicore Works, Maylands Avenue, Hemel Hempstead, Hertfordshire.

FERGUSON MAINS/BATTERY PORTABLE

BRITISH Radio Corporation are now marketing a *Sanyo* mains/battery tape recorder under the *Ferguson* label. The 3234 is a ¼-track machine operating at 3¾ and 1⅞ i/s and weighing 10lb. Output power is quoted as 800mW, fed to a 4½ x 2½in. internal speaker. Effective frequency range is quoted as 100Hz-7kHz at the fastest speed. The recorder will function from a 220-240V 50Hz mains supply or six *U2*-type cells. Overall dimensions are 11¾ x 9½ x 3½in. and the recommended price, including microphone, tape, connecting leads and accessory pouch, is £35 14s.

Distributor: British Radio Corporation Ltd., Thorn House, Upper St. Martins Lane, London W.C.2.

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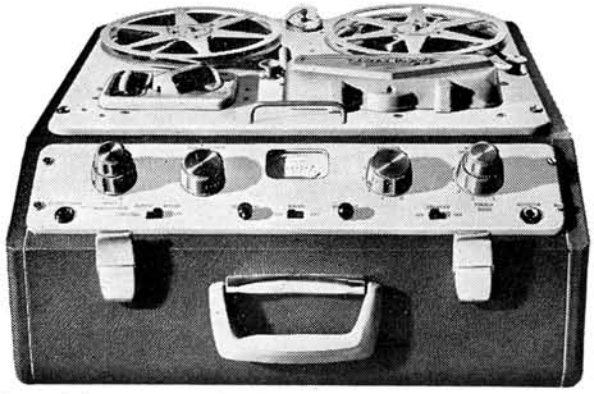

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4" 300'	4/-	10/-	4" 450'	5/-	14/-	4" 600'	6/9	19/6	4" 1/8
5" 600'	6/-	17/6	5" 900'	8/-	23/6	5" 1200'	12/6	37/-	5" 1/9
5½" 900'	7/-	20/6	5½" 1200'	10/6	30/6	5½" 1800'	17/-	50/-	5½" 1/9
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equipment reviews

EMI L4 BATTERY PORTABLE

MANUFACTURER'S SPECIFICATION. Semi-professional battery recorder. **Power supply:** 14V rechargeable lead-acid battery with three hours charge life. **Current consumption:** 250mA on record. **Wow and flutter:** better than 0.2 % RMS at 7½ i/s, better than 0.3% RMS at 3¾ i/s. **Speed stability:** better than 0.5% throughout reel with constant 14V supply. **Frequency response:** 50Hz—12kHz ±2dB at 7½ i/s. **Signal-to-noise ratio:** 50dB unweighted for 0.2mV (microphone input) with gain set for peak recording level. **Inputs:** *Microphones* 0.05mV at 30 and 50 ohms; *Line*–270mV at 20K (bridging) for peak recording level. **Outputs:** *Line*–0dBm (0.775V), 200mW to internal speaker. 50 ohms headset. **Recording characteristics:** 70 S IEC standard. **Spool capacity:** 4½in. **Price** (less microphone and battery charger): £120. **Manufacturer: EMI Electronics Ltd., Broadcast and Recording Division, Hayes, Middlesex.**

I WOULD refer interested readers to David Kirk's field-trial of this recorder, which appeared in the February issue this year, for operating notes and subjective impressions of various aspects of its performance.

My first reaction as I unpacked the new machine was that it promised to be a vast improvement on the *EMI RE 321* which I reviewed in November 1961. The RE 321 was transistorised but had no erase facilities; bulk-erased tape had to be used, and only hand rewind was provided via a little handle and gear train on the lid of the box. The new machine seemed to handle the tape nicely, with a reasonably fast rewind operated by one of the press-tabs on the side of the machine but, like David, I found that the rewind lever seemed to insinuate itself under my finger no matter which function I meant to select and, more often than not, the tape left the take-up reel before I could find the right button to stop it.

Tape threading was easy, as it only had to be laid across the head faces and led into the radial slot of the take-up reel. The supply reel tended to run loose so that the outer turns of tape dropped on to the deck panel, but the sloping plated guides always seemed to lead it up to the heads without mishap.

Mechanical motor noise was reasonably low with the lid closed, but the non-directional *Grampian DP4* microphone provided picked up some mechanical noise in a quiet room even when separated from the machine by the full extent of the 8ft. microphone lead.

Electrical motor noise or 'hash' was so bad on this first review sample that it was promptly returned to the manufacturer for examination. The replacement machine was considerably better, but some noise was audible on playback, although very little was recorded on the tape.

Speech recordings sounded quite awful on the internal speaker, but OK on headphones or via an external amplifier and speaker from the line output socket. Gentle probing disclosed the fact that the 3in. speaker cone was well off centre and was fouling the magnet gap. It could be cleared for short tests by pressing a pencil point against the cone surround; the quality was just adequate for checking the recording on the tape but much inferior to that provided by a well-known Dutch £27 portable recorder.

Test-tone recordings disclosed a slight 'burble' at both tape speeds, and the flutter-grams of **fig. 1** show it to be a 40Hz disturbance

(*continued on page 383*)

FIG. 1 EMI L4 WOBBLE

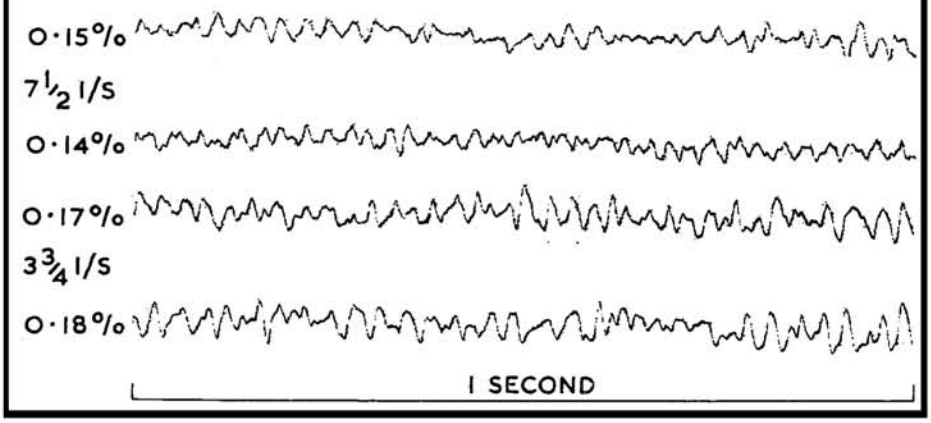


FIG. 2 EMI L4 PLAYBACK RESPONSE (TEST–TAPE TO LINE OUT)

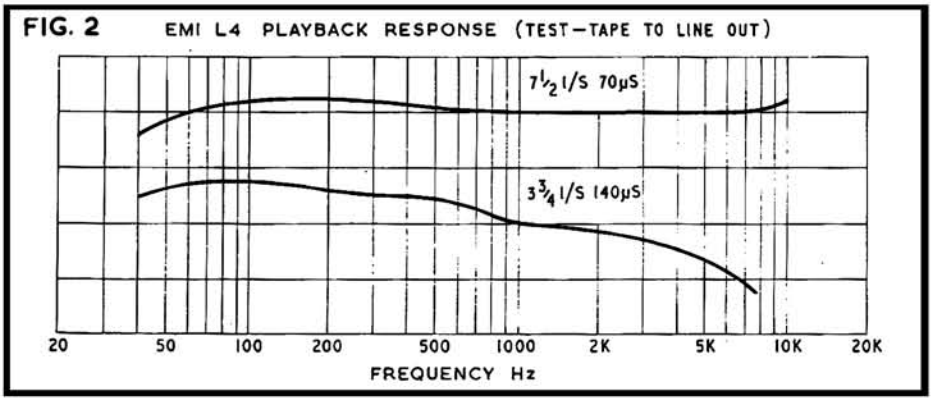
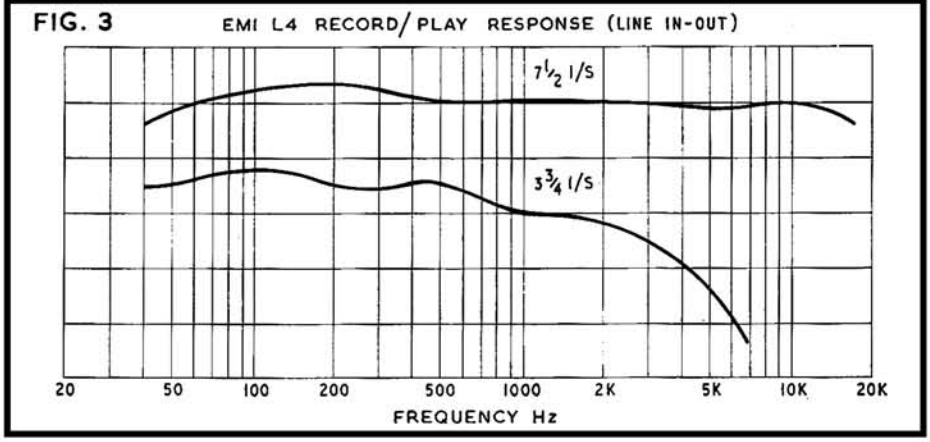


FIG. 3 EMI L4 RECORD/PLAY RESPONSE (LINE IN-OUT)



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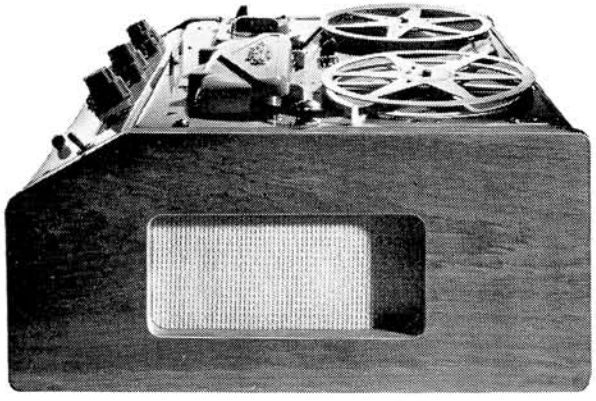

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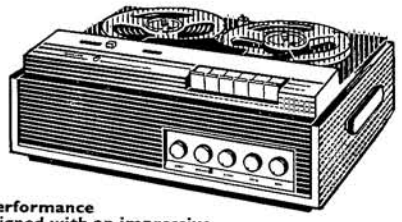

Own this luxury high performance machine, beautifully designed with an impressive array of technical features, and teak finished cabinet for that furniture look, plus !

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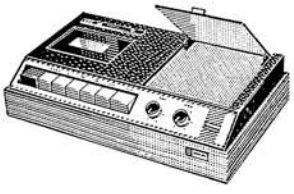

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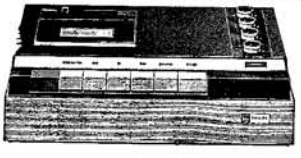

The ultimate in Stereo-Cassette recording, this 2-track machine offers a wide freq. range for superb performance. **Interest free terms, 14 gns. deposit and 12 monthly payments of £2 9s. Carr. pkg. ins. 15/-.** Also available for above (recommended type) Stereo speaker. List price 10 gns. **OUR PRICE only 8 gns. (2 req.).**

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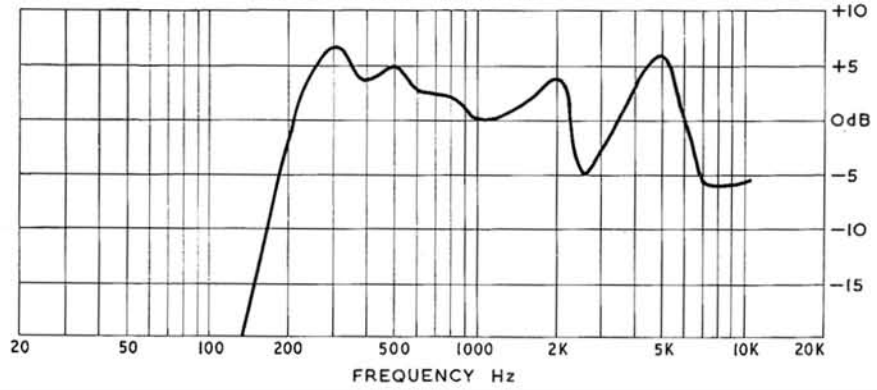
FIG. 4 EMI L4 ACOUSTIC RESPONSE



due apparently to the drive motor, as it is the same on both speeds. The flywheel smoothing is slightly more effective at 7½ i/s, with RMS wobble ranging from 0.14% to 0.15%, increasing to 0.17% to 0.18% at 3¾ i/s. Although within the specification limits, these readings are high for a semi-professional machine.

PLAYBACK CHARACTERISTICS

The playback characteristics of the recorder were measured by playing standard test-tapes recorded to CCIR 70 and 140 μS time-constants at the two tape speeds provided on this machine. The 7½ i/s response was almost faultless and within ±1dB limits from 40Hz to 10kHz, the highest frequency on the test-tape. The 3¾ i/s response shows that the playback equalisation is not switched for the lower speed, with a total tilt of 6-7dB between 100Hz and 5kHz.

System noise, with no tape passing the heads, was 43dB below test-tape level. When the motor was switched off the system noise dropped to 55dB below test-tape level. Anything better than 40dB below test-tape level would normally be considered excellent, but motor 'hash' is in a class by itself, and the 'spiky' quality of the noise gives a very low RMS meter reading which does not relate to its subjective annoyance value.

Recording tests showed that peak recording level, at 3% third harmonic distortion (12dB above test-tape level), was recorded at 0dB on the VU-type record-level meter. Test-tape level was naturally recorded at —12dB, which is very near the lower end of the meter scale. This means in practice that most recordings have to be made with the meter needle barely leaving the lower part of the scale, and normal meter readings, kicking occasionally into the red, result in obviously over-recorded tapes.

RECORD-PLAY RESPONSES

Sliding-tone frequency runs were recorded at test-tape level (—12dB) at the two tape speeds to give the record-play responses of **fig. 3.** These show slight evidence of head contour effects due to the short pole face length of the playback head, but such effects do not occur on recording, so that the actual recording on the tape will be very close indeed to a true CCIR 70μS characteristic at 7½ i/s. This was confirmed by playing the tape on my *Revox 736HS* to give a ruler line response to 10kHz, —1.5dB at 12kHz. The 3¾ i/s record-play response shows even further top loss due to lack of extra recording pre-emphasis, with a drop of more than 10dB between 100Hz and 5kHz.

Fig. 4 shows the acoustic response of the cabinet and monitor speaker obtained by playing a one-third octave band white-noise test-tape, recorded to the 70μS characteristic at 7½ i/s, and measuring the sound output of the speaker on axis with a calibrated microphone.

COMMENT

Although the L4 fully meets the rather carefully written specification, it can not be recommended as a general-purpose portable recorder. It is designed to *record* tapes which will play well on fully professional playback equipment at 7½ i/s.

Little attention has been paid to the playback characteristics beyond the line output, and the low speed of 3¾ i/s does not merit serious consideration for professional or amateur use as offered in the L4.

Even for professional recording, the VU-meter calibration needs some attention. It is not a true VU-meter as used in standard broadcast practice, since the dynamics of the meter are not suited to this application. It could be made more useful by adopting the compromise used in many domestic recorders of increasing the sensitivity of the meter amplifier so that the meter reads —6dB for standard test-tape recording level instead of the present —12dB.

The complete suppression of motor 'hash' is also almost completely impossible without basic redesign of the motor governor system. The present just adequate performance obviously depends on very careful dressing of the motor leads and critical earthing of screened leads to avoid 'earth loop' injection of noise into the sensitive microphone and head amplifier circuits.

A. Tutchings

a matter of choice

SOME OBSERVATIONS ON THE QUESTIONNAIRE

BY H. W. HELLYER

AS a contributor, I feel gratified at the results of the recent questionnaire. *Tape Recorder Service* well up in the voting and *Readers' Problems* at the head of the poll. Bless you, dear readers!

But as a professional engineer I must feel a few qualms. Even making allowance for what the Editor calls a 'highly motivated' sample of readers, we are surprised that the technical angle of *Tape Recorder* should be so strongly stressed by those who filled up their forms. Especially as so many use the 'top-pop' machines. Surprised, and pleased, for it shows that we are catering for a committed group of enthusiasts, who are striving to better their equipment; to widen their field of knowledge.

But there's the rub! Only 2.1% of the readers who answered owned no tape recorder at all. Perhaps, like the acting profession, they were temporarily 'resting'? The 'average reader' with his 1.624 recorders must make up for the lack. (And, incidentally, if the 35% who want less humour will forgive the jibe, we have had a few of those .624 types of tape recorder in for repair.)

If we take a wider look at the potential tape recorder market and analyse tastes and opinions, we come up with some rather curious facts and figures. Some of them augment the findings of the Questionnaire, others appear to go right against the grain.

We can take this wider look as the result of a competition dreamed up by our (*Bristol and Cardiff Tape Recorder and Hi-Fi Centres*) Managing Director, R. J. Lovell, some while ago, which offered as a prize a tape recorder of the winner's choice, with a bonus £25 for any such winner who had already bought a machine during the competition period. Like all such promotion schemes, this competition had a hard strata of reason under the top layer of publicity. This was to find out which features were regarded as most desirable by potential owners and to analyse their choices of machine. Such information is a valuable guide to marketing policy.

The competitor was asked whether he/she owned a tape recorder already, to what use he proposed to put it, and was asked to state a reason for wanting a machine. As a further guide, the entrants were sub-divided into age groups, and the answers came from our two shops, each in a main city in the West Country and Wales.

Desirable features were listed as below, and competitors were required to list twelve in order of priority.

A Large diameter spools.
B Reliability.
C Output for external amplifier.
D Push-button controls.
E Choice of tape speeds.
F Quick rewind time.
G High output.
H Mixing of inputs.
I Monitoring through speaker.
J Superimpose facility.
K After sales servicing.
L Straight through amplifier.
M Tape position indicator.
N Good looks.
O Pause control.
P Effective tone control.
Q Four tracks.
R Distortion free reproduction.
S Wide frequency response.

Before reading on, our 'committed sample' may care to have a go themselves. We have argued in these pages very often about what an ideal machine should be. What would be *your* priorities? (*Tell us by using the form on page* 359 — **Ed.**)

Of our entrants, 76% of whom *did not* already own a tape recorder, an overwhelming number plumped for feature **B**—Reliability. And next on the list came **R**—Distortion free reproduction. After these two far-out leaders came an almost insignificant sprinkling of all the other features, the need for four tracks being a very low third. There were some curious omissions: straight-thro' amplifier facility came very low in the poll, and the choice of tape speeds hardly merited a mention. Language learning was given as a reason for wanting a machine by a very high percentage.

Age groups were another interesting division. Well over two-thirds split neatly into 'Under-20' and 'Over-40' groups. Market research people would probably point a moral here. And, incidentally, the female element was fairly strong, representing some 24%; but just how many of these were 'Mums' entering on behalf of the family it would be rather hard to say

The real meat of the survey was in the list of required tape recorders, and here, some of the figures bear out those of the Questionnaire. Again, a moral? Is this simply because of the power of manufacturers' advertising? Too much space would be needed for a complete statistical breakdown, but the important findings were as follows:

Philips, Cossor, Stella	23%
Grundig	15%
Reps	11%
Wyndsor	8%
Truvox	5%
Magnavox	5%
Telefunken	4%

All others, including *Ferrograph, Brenell, Revox, B. & O., Sony, Loewe-Opta, Ferguson, Elizabethan, Robuk* and *Fidelity*, came below 1%. In one respect our survey beat the *Tape Recorder* questionnaire, however. We managed to gather in ten of those worthy souls who grace every poll; who, when asked what machine they would vote for, said: "Don't Know".

CLASSIFIED ADVERTISEMENTS

Advertisements for this section must be pre-paid. The rate is 6d. per word (private), minimum 7s. 6d., Box Nos. 1s. 6d. extra. Trade rates 9d. per word, minimum 12s., Box Nos. 2s. extra. Copy and remittance for advertisements in **OCTOBER 1967** issue must reach these offices by **18th AUGUST** addressed to: The Advertisement Manager, Tape Recorder, Link House, Dingwall Avenue, Croydon, CR9 2TA.

Replies to Box Nos. should be addressed to the Advertisement Manager, Tape Recorder, Link House, Dingwall Avenue, Croydon, CR9 2TA, and the Box No. is quoted on the outside of the envelope. The district after Box No. indicates its locality.

SITUATIONS VACANT

Manager required for Tape Recorder and Hi-Fi Centre in Cardiff. Sales experience and knowledge of equipment an asset. Sales training given to suitable enthusiast. Apply to head office : 107 Stokes Croft, Bristol 1.

Young man wanted with some knowledge of tape recorders, Greater London applicants only. Box No. 518, (London.)

Brunel University, Division of Languages. Technician required as soon as possible for the maintenance including minor repair work and major component replacement, of Shipton language laboratory equipment at Hillingdon. Practical experience and knowledge of circuit diagrams essential. Brief training with manufacturers will be arranged. Salary scale within £713-£998 plus additional allowances up to £80 p.a. for approved qualifications. Applications in writing giving full details of age, qualifications, experience and names of two referees to the Academic Registrar, (EMS) Brunel University, Kingston Lane, Uxbridge.

FOR SALE—PRIVATE

Vortexion C.B.L./5 stereo tape recorder, in excellent condition. Plus two Vortexion M8 ribbon microphones. £100. Owner emigrating. A. P. Hughes, Horsham, Sussex. 'Phone Southwater 556.

Stern 4 channel mixer modified for Grundig condenser mics., £6. G.C.M. mics., £3 each, also Teisco m/c 30/-. Grampian folding stand £2. Wharfedale speaker in case £5. Box No. 517 (Derbyshire.)

FOR SALE—TRADE

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

Pre-recorded tape cassettes for Philips, Dansette, Stereo-tone recorder players. 6d. stamps bring catalogue and details of money-saving library and part exchange services. Jiffy-fast postal service of over 400 domestic and imported items. Musicassette Supply Company, 13/501 Angel Street, Worcester.

Hi-Fi and Stereo by modern Continental manufacturers and also latest Tape Recorders. Write to us for introductory leaflets and lists. Part-exchanges arranged. From Wallace Heaton (City Sale) Ltd., 93 Fleet Street, London, E.C.4.

"Have you an old Saja tape recorder ? " "Do you wish to trade it in ? " "We will make you a better offer against a new machine from the following choice." Tandberg, Revox, Grundig, B & O, Eltra, Ampex. Write for full details to the Tape Recorder Centre, 266 Waterloo Road, Blackpool, Lancs. Tel. 45049.

W.H.M. Wow and Flutter Meter (RMS) £48. Net U.K., Leaflets, specification and test report on request. 35 Villiers Road, Watford.

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

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

American 4 Track Stero Tapes covering most famous labels at realistic prices. Why pay more ? Imported directly by us, saving distributors profits. Vast collection at 75/- each —send S.A.E. for free lists or call at London showrooms : Teletape of Marble Arch, 33 Edgware Road, W.2.

20% cash discount on most famous makes of Tape Recorders, Hi-Fi equipment, Cameras and Typewriters. Join England's largest Mail Order Club now and enjoy the advantages of bulk buying. Send 5/- for membership card, catalogues, price lists or S.A.E. for free quotations and leaflets. C.B.A., (Dept. A1) 370 St. Albans Road, Watford, Herts.

Petersfield Camera Centre Ltd. supply the trade with A.K.G. Microphones, Uher Tape Recorders. Deliveries ex stock. 37 Lavant Street, Petersfield, Hants. Telephone 2651/2/3.

WANTED

Fully automatic continual play back only ¼" tape machine required to take 10" spools—with fast wind, 4 track stereo and mono, 3¾ and 7½ or 3¾ only. Amateur, Semi or full professional model. Alexander, 25 Langham Gardens, London, N.21. Telephone LABurnum 5678.

Back Numbers of Tape Recorder. June '62, Jan. '64, April, May, June '64, Oct. '64. Will pay 2/6d. for each copy in good condition. Box No. 591, (Surrey.)

Energetic importing distributor to market fine quality line of excellently-priced American PVC and Polyester magnetic recording tapes throughout U.K. Box No. 520, (U.S.A.)

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

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

Fi-cord recorder, battery charger required quickly please. Iliffe, Brookfield, Wigton, Cumberland.

STUDIO FACILITIES

Studio Republic presents a superior disc cutting service for the skilled amateur and semi-professional. Mono and stereo acetates and pressings ; studio and mobile recordings ; dubbing. Church Farm, Pinner, Middx. 01-868 5555.

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

7in. 45 from 18/-, 10in. LP 42/-, 12in. LP 48/-. 3-day postal return service. High level disc cutters, Limiters, Equalisers, variable pitch, etc. Professional work at provincial rates, 40ft. Studio. Trade terms available. S.a.e. leaflet to : Deroy Sound Service, High Bank, Hawk Street, Carnforth, Lancs.

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

MISCELLANEOUS

G.T.R.E. American Tape Club. Postcard Shows, Sound Mags. Write : Trix Cosier, 12 Yeovil Close, Orpington, Kent.

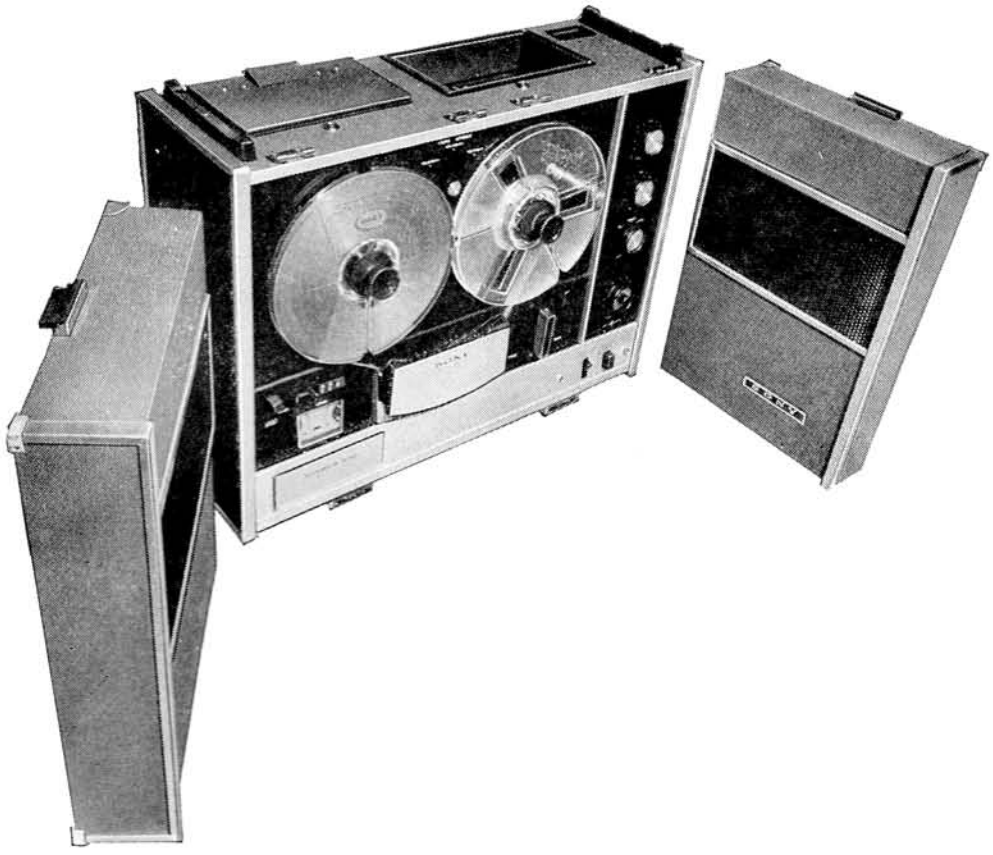
Chatterbox Recording Club, free membership, badges, stickers, etc. S.a.e. to 368 Rush Green Road, Romford, Essex.

Magazines in sound—tape exchanges—details free. Far & Wide Recording Club, Eccles, Maidstone. S.a.e.

Free—an evening's entertainment. Come and hear the Wharfedale sound. Wednesday 13th September, 1967, Windsor Hall, Northgate, Blackburn, Lancs. No tickets required. Seats for 800. Programme commences 7.45 p.m. Doors open 7.15 p.m. Presented by Holdings Audio Centre, 39/41 Mincing Lane, Blackburn, Lancs.

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

Get 1967 AUDIO ANNUAL. Top features include : A fresh look at audio dynamics ; Details of a new membrane loudspeaker ; Acoustics in ancient Greek theatres ; Some reflections on audio history ; A look at stereo radio ; Basic problems of energy conversion discussed ; Listening to music in the home ; Reducing background noise. Plus a selection of the more important equipment reviews that appeared in HI-FI NEWS and TAPE RECORDER during 1966. 5/- from newsagents or 6/- (pp) from Link House, Dingwall Avenue, Croydon, CR9 2TA.



SONY research makes the difference

Model TC530 – Features: 4-track stereophonic and monophonic recording and playback ☐ Quadradial (4-way) speaker system ☐ High precision all silicon solid state circuit ☐ Vertical or horizontal operation ☐ "Retractamatic" pinch roller for easiest tape threading ☐ 3-speed, full 7" reel capacity ☐ Tape position indicator ☐ Instantaneous pause control ☐ Two illuminated, calibrated VU meters ☐ Automatic "Sentinel" tape stop ☐ Stereo headset jack.

Specifications:

Power requirements: 65W, 100-125V and 220-240V AC. 50/60 c/s.

Tape speed: 7½ ips., 3¾ ips. and 1⅞ ips. instantaneous switching with automatic equalization change.

Reels: 7" diameter or smaller.

Recording system: 4-track stereophonic or monophonic.

Frequency response: 30-20,000 cps. at 7½ ips. (± 3dB 50-15,000 cps. at 7½ ips.) 30-13,000 cps. at 3¾ ips.
30-10,000 cps. at 1⅞ ips.

Wow and flutter: Less than 0.17% at 7½ ips. Less than 0.3% at 3¾ ips. Less than 0.4% at 1⅞ ips.

Power output: 5W R.M.S. per channel.

Signal-to-noise ratio: Better than 48 dB (at peak record level).

Harmonic distortion: Less than 3% at 0 dB line output.

Level indication: Calibrated VU meter x 2.

Tone controls: Separate controls for bass and treble.

Inputs: Low impedance microphone inputs: transistorised (will accommodate any microphone from 250 ohms to 1K ohm impedance). Sensitivity –72 dB (0.19mV) High impedance (100K ohms) Auxiliary: Sensitivity –22dB (0.06V).

Outputs: Line outputs: 0 dB (0.775V), load impedance 100K ohms.
Speaker outputs: load impedance 2 x 8 ohms.
Binaural monitor output: will accommodate stereo headset Model DR-3C (10K ohms impedance).
Integrated record/playback connector.

Input: Sensitivity –62 dB (0.6mV) Impedance 10K ohms.

Output: Sensitivity 0dB (0.775V) Impedance 10K ohms.

Dimensions: 19 11/16" wide x 9 15/16" high x 15 7/16" deep.

Weight: 41 lbs. 10 ozs.

Accessories: Stereo recorded 5" tape, 7" reel. Two SONY dynamic microphone (F-96), Integrated record replay connector type RK-46 60c/s Motor pulley, Reel cap, Head cleaning ribbon, Splicing Tape.

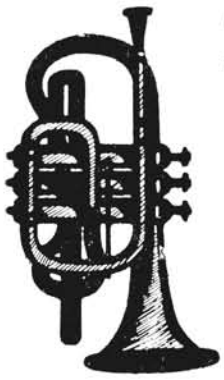
Recommended retail price **120 gns.**

Sony offer the finest range of tape recorders from the battery portable TC 900 to the studio quality TC777.

For further details see your Sony dealer or write to:

Sony U.K. Division,
Eastbrook Road, Gloucester.
Tel: Gloucester 21591
London Showroom,
70-71 Welbeck Street, London, W.1
Tel: 01-486 2143

SONY®
RESEARCH MAKES THE DIFFERENCE



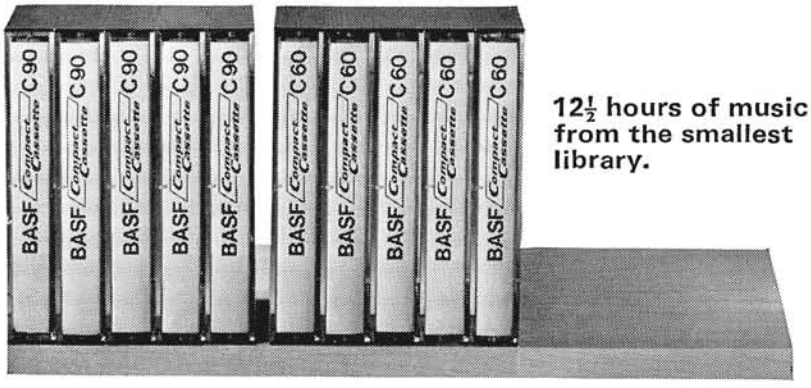
90 minutes of music -exactly as you wish.

Actual size of cassette C.90.

With the BASF Compact Cassette C.90 you can record 90 minutes of music—45 minutes on each track. Beat, Jazz, Pop—anything you like! You could, for example, make up a small tape library like this:-
5 BASF Compact Cassettes C.60=5 hours playing time. 5 BASF Compact Cassettes C.90=7½ hours.
You can then have 12½ hours of music filed together—Music as you like it. A cheap and practical tape library in the minimum space.
Ask your dealer about the new BASF Compact Cassettes C.60 and C.90. And remember, every cassette comes with a handy reference index which enables you to make a note of each recording—and quickly find it when you want to play it.

BASF United Kingdom Limited,
5a Gillespie Road, London, N.5.
Telephone: 01-226 2011.

BASF



12½ hours of music—from the smallest library.