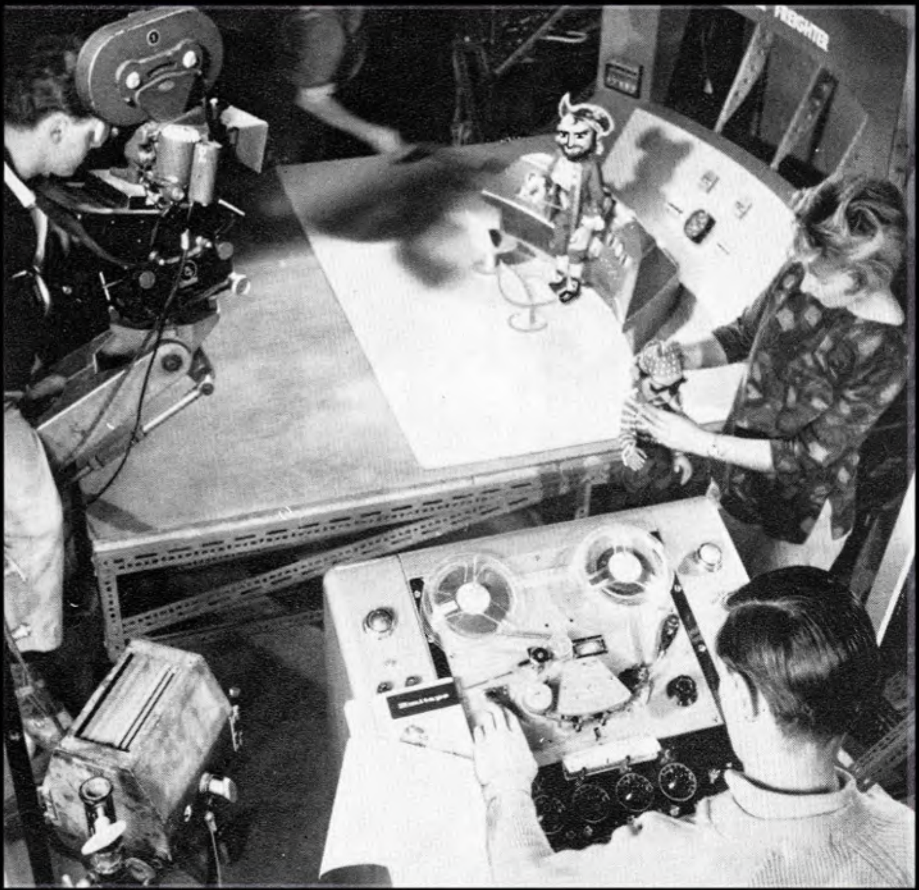
NOVEMBER 1969 2s 6d

tape recorder



Two brilliant new additions to the Beocord range

BEOCORD 1800

BEOCORD 2400

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

Whether you prefer to centre your High Fidelity system around a separate amplifier, or to base it on an amplifier integrated into one of the audio units, your needs for a tape recorder to complete your system can be satisfied by choosing one of these new Beocords. Both machines exceed the minimum requirements for DIN 45.500, and have operational facilities comprehensive enough to attract the semi-professional as well as the domestic user. These include a 3 digit tape counter with push button reset. Foil operated auto stop plus thyristor controlled photo-stop for end of tape, tape break or programme scanning. Push button selection of A-B monitoring, sound on sound, echo, syncroplay, mono left, mono right, mixed mono, or stereo play. New hyperbolically ground tape heads with special patented machining give greatly improved contact between tape and tape head and less friction and noise during operation, resulting in less wear to tapes and tape heads.

The Beocord 1800 – designed for use with a High Fidelity amplifier such as the Beolab 5000 or Beomaster 1400.
Available in 2 versions: (a) $\frac{1}{2}$ track record and replay with extra switched $\frac{1}{4}$ track replay head, (b) $\frac{1}{4}$ track record and replay only. Sockets duplicated in DIN and phono type to simplify connection. Special amplifier and volume control for output to headphone sockets.

The Beocord 2400 – complete with its own stereo amplifier section giving 2 x 10 watts RMS output. $\frac{1}{4}$ track record and replay. 4 dual channel inputs in mixer section including a magnetic P.U. input. Bass, treble and split channel volume controls. Switched output for 2 pairs of speakers. The amplifier may be operated independent of the motor.

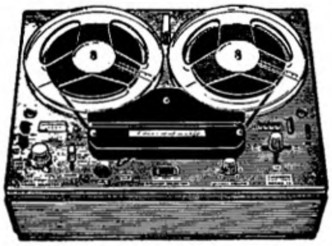
As we want people who choose B & O to receive really good service, every effort has been made to appoint only dealers of the highest ability and integrity and this policy may necessarily limit the number in your town or city. So write today for the name and address of your nearest dealer and for further information about the B & O range to :—

Bang & Olufsen U.K. Limited. Eastbrook Road, Gloucester. Telephone: 0452 21591
London Showrooms: 70/71 Welbeck Street, London, W.1. Telephone: 01-486 2144.

F. CAVE

- ★ CASH DISCOUNTS
- ★ MAIL ORDER SPECIALISTS
- ★ DEMONSTRATION & INSTALLATION
- ★ H.P. TERMS ARRANGED

HI-FI EQUIPMENT AND TAPE RECORDER SPECIALIST



CAVES are the TANDBERG SPECIALISTS

ON DEMONSTRATION

1641X STEREO

1200X STEREO

OFFERS ON TAPE RECORDERS

AKAI 1710W	£92 0 0
AKAI M9	£155 0 0
SANYO MR800	£79 0 0
SANYO 929	£84 10 0
SANYO MR801	£69 10 0
STANDARD SR100	£15 15 0
PHILIPS EL3302 CASSETTE ...	£21 19 6
GRUNDIG TK 120	£34 10 6

HI-FI EQUIPMENT

Armstrong 426 Tuner/Amplifier	£76 0 0
Leak Sandwich Speakers	£37 19 6
Quad 33 Control unit	£38 12 6
Quad 303 Amplifier	£48 12 6
Teleton 7AT-FET Tuner/Amplifier	£104 7 6
Thorens TD 150 Mk 2	£37 12 6
Sansui 400 Tuner/Amplifier	£112 10 0

BUDGET SYSTEMS ON OFFER

Teleton CMS 400 Tuner Amplifier with Turntable and Speakers Complete for **£110**

Radon Amplifier and Speakers with Garrard SP25 Turntable Complete for **£49**

Teleton R8000 Tuner Amplifier with matching speakers **£60**

Teleton SAQ203 Amplifier Radon Speakers, SP25 Turntable and magnetic Cartridge complete for **£71 10**

B.A.S.F./PHILIPS/SCOTCH/GRUNDIG RECORDING TAPE

	Spool	Length	Suggested Retail Price	Our Price
STANDARD PLAY	4"	300'	14/6	11/2
	5"	600'	22/2	16/11
	5¾"	900'	29/5	22/5
	7"	1200'	36/7	27/10
LONG PLAY	4"	450'	15/6	11/10
	4½"	600'	22/-	16/9
	5"	900'	29/2	22/2
	5¾"	1200'	36/4	27/7
	7"	1800'	51/6	39/-
DOUBLE PLAY	4"	600'	26/-	19/9
	4½"	900'	31/-	23/6
	5"	1200'	43/2	32/8
	5¾"	1800'	56/11	43/1
	7"	2400'	79/1	59/9
TRIPLE PLAY	4"	900'	40/-	30/3
	4½"	1200'	50/-	37/9
	5"	1800'	67/1	50/7
	5¾"	2400'	91/4	68/10
	7"	3600'	116/8	88/5
B.A.S.F. 'ROUND PACK'	7" STD	1200'	OUR PRICE	21/6
	5" L/P	1200'	OUR PRICE	21/6
	7" L/P	1800'	OUR PRICE	31/9
	5¾" D/P	1800'	OUR PRICE	32/6
	7" D/P	2400'	OUR PRICE	45/-

SPECIAL LOW NOISE BY FAMOUS MANUFACTURERS

	Spool	Length	Price	Mail Orders
STANDARD PLAY	5"	600'	12/3	(orders under
	5¾"	900'	16/-	£3 0 0 are
	7"	1200'	21/-	subject to
LONG PLAY	5"	900'	16/-	2/6 package
	5¾"	1200'	21/-	and postage.)
	7"	1800'	27/-	

RECOMMENDED:

CASSETTES PHILIPS/B.A.S.F.

	Suggested Retail Price	Our Price
C-60 (Std.)	18/-	13/6
C-90 (L/P.)	25/6	19/6
C-120 (D/P.)	34/-	25/6

MAXELL CASSETTES

(Philips Type)	Our Price
C-60	9/6
C-90	13/9
C-120	18/6

AKAI 4000D
NOW ON
DEMONSTRATION

SPECIAL PRICES ON MANY FAMOUS MAKES

Tape Recorders Available: Teleton, Standard, Dual, Philips, Akai, Ferrograph, Awia, Fidelity, Grundig, Nivico, Marconiphone, Revox, Tandberg, Telefunken, Crown, Wyndsor, National, Truvox, Sanyo, Dansette and many others.

Hi-Fi Equipment Available: Armstrong, Dual, Nivico, Goodmans, Grampian, Leak, Lowther, Lux, Crown, Philips, Quad, Radon, Rogers, Jordan-Watts K.E.F., Sanyo, Teleton, Celestion, Decca, Marconiphone, Connoisseur, Goldring, Thorens, Transcriptor, Vortexion, Tannoy, Kenneth J. Elwin, Ortofon, Bowers & Wilkens, Pioneer, Hitachi, Murphy, Monark, Rotel, J. E. Sudgen, Sound City, Bluespot, Beyer, Reslo-sound, Stanton, Dansette and many others.

F. CAVE 5 BRIDGE STREET, RICHMOND, SURREY

MAIL ORDER,

Dept. TR, 27 HILL STREET, RICHMOND, SURREY. PHONE: 01-948 1441 up to 8 p.m.

1/- Stamp for lists

Ferrograph Series 7 - a lifetime of recording

Ferrograph Tape Recorders have been famous ever since 1949. A lifetime's experience of making fine recorders goes into every one of Ferrograph's brilliant new Series 7.

And there is a lifetime's recording *in* every Ferrograph instrument. Many of the earliest Ferrographs are giving perfect service today, nearly twenty years later. You can be sure your Ferrograph will do the same for you. It will give dependable service for many, many years to come. It will keep its value. It will need the minimum of service. Spare parts will remain available for a lifetime's recording. That's how Ferrograph got its name.

Available in Mono, and in Stereo with and without end amplifiers; combining a unique range of 30 recording facilities, including:

- **All silicon solid-state electronics with FET input stages and wide input overload margins.**
- **Vertical or horizontal operation.**
- **Unit construction: The 3 individual units i.e. tape deck, power unit and amplifier complex are mounted on a single frame easily removable from cabinet for service or installation in other cabinets or racks.**
- **3 motors (no belts). 3 tape speeds.**
- **Variable speed spooling control for easy indexing and editing.**
- **Electrical deck operation allowing pre-setting for time-switch starting without need for machine to be previously powered.**
- **Provision for instantaneous stop/start by electrical remote control.**
- **Single lever-knob deck operation with pause position.**
- **Independent press-to-record button for safety and to permit click-free recording and insertions.**
- **8¼" reel capacity.**
- **Endless loop cassette facility.**
- **Internal loud speakers (2)—1 each channel on stereo, 2 phased on mono.**
- **4 digit, one-press re-set, gear-driven index counter.**
- **2 inputs per channel with independent mixing (ability to mix 4 inputs into one channel on stereo machine).**
- **Signal level meter for each channel operative on playback as well as record.**
- **Tape/original switching through to output stages.**
- **Re-record facility on stereo models for multi-play, echo effects etc, without external connections.**
- **Meters switchable to read 100 kHz bias and erase supply with accessible preset adjustment.**
- **Three outputs per channel i.e. (1) line out—level response. (2) line out—after tone controls. (3) power output—8-15 ohms.**
- **Power output 10W per channel.**
- **Independent tone controls giving full lift and cut to both bass and treble each channel.**
- **Retractable carrying handle permitting carrying by one or two persons.**

U.K. Retail prices from £150 incl. P.T.

See and hear Ferrograph Series 7 recorders at your local Ferrograph stockist, or post coupon for details and address of nearest Ferrograph specialist (or ring 01-589 4485)

FERROGRAPH

To the Ferrograph Co Ltd, Mercury House, 195 Knightsbridge, London SW7

Please send me FREE brochure on Ferrograph Series 7 Tape Recorders ☐ *Please tick*

OR send me the new Ferrograph Manual, for which I enclose £1 ☐

NAME ....

ADDRESS ....

.... **TR**

Listen for yourself

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

Ferrograph stockists

London Dealers
C. C. Goodwin (Sales) Ltd., *7 The Broadway, Wood Green, N22.*
Francis of Streatham, *Tape Recorder Specialists, 169-173 Streatham High Road, SW16.*
Hampstead High Fidelity *91a Heath Street, NW3.*
Imhofs, *112-116 New Oxford St., WC1.*
Largs of Holborn, *76/77 High Holborn, WC1*
Nusound, *242/4 Pentonville Rd., N1*
Nusound, *82 High Holborn, WC1.*
Nusound, *228 Bishopsgate, EC2.*
Nusound, *360 Kilburn High Road, NW6.*
Nusound, *36 Lewisham High Street, SE13.*
Nusound, *2 Maryland Station, E15.*
The Recorder Co., *186-188 West End Lane, W. Hampstead, NW6.*
REW (Earlsfield) Ltd. *266-268 Upper Tooting Road, SW17.*
REW (Earlsfield) Ltd., *146 Charing Cross Road, WC2.*
Telesonic Ltd., *92 Tottenham Court Road, W1.*
Teletape Ltd., *33 Edgware Road, W2.*
Teletape Ltd., *84/88 Shaftesbury Ave., W1.*

Aberdeen
Aberdeen Radio Co., *12 Hadden Street.*
Aberdeen Sound Centre Ltd., *25A Belmont Street.*

Banstead
Raylec Limited, *43 Buff Parade, High St.*

Birmingham
Chas H. Young Ltd., *170-172 Corporation St., Birmingham 4.*
C.H. (Hi-Fidelity) Ltd., *167-169 Bromsgrove St., Birmingham 5.*
Cine-Equipments Ltd., *Audio Visual Department, 9A Dale End, Birmingham 4.*

Blackburn
Holdings Audio Centre, *39-41 Mincing Lane.*

Blackpool
F. Benfell Limited, *7 Cheapside (Abingdon Street).*

Bolton
Harker & Howarth, *Churchgate.*

Boscombe
Tape Recorders (Bournemouth) Ltd., *874 Christchurch Road.*

Bournemouth
Forrester's, *National Radio Suppliers Ltd., 70-72 Holdenhurst Road.*

Brighton
Averys, *77 St. James's Street.*
Lanes Radio Ltd., *11 Gardner Street.*

Bristol
Audio Bristol, *Park Street Avenue, Bristol 1.*
Bristol & West Recording Service Ltd., *6 Park Row, Bristol 1.*
Tape Recorder & Hi-Fi Centres Ltd., *82 Stokes Croft.*

Bromley
Bromley Sound, *32 Letchworth Drive.*

Bury
J. Smith & Son (The Rock) Ltd., *184 The Rock.*

Cambridge
University Audio, *1 and 2 Peas Hill.*

Canterbury
Canterbury Hi-Fi Centre *26 St. Dunstan's Street.*

Cardiff
The Roath Radio & Television Co., *23/27 Morgan Arcade, Cardiff CF1 2AF.*
Sound Film Services *(Cinema Liaison Ltd.), 27 Charles Street.*
Tape Recorder & Hi-Fi Centres Ltd., *Oxford Arcade, The Hayes.*

Castle Douglas
John Mitchell, *141 King Street.*

Coventry
Coventry Hi-fi Centre, *13 City Arcade.*
Coventry Tape Recorder Services, *33 King William Street.*

Crewe
Charlesworths of Crewe Ltd., *28 Hightown.*

Darlington
McKenna & Brown Ltd., *11 Bond Gate.*

Derby
Bucklands of Derby, *41-49 London Road.*

Doncaster
Tom Jacques Ltd., *Sound and Electronic Engineers, 16 Wood Street.*

Dorchester
Suttons, *Hardye Arcade.*

Edinburgh
J. B. Fulton Associates Ltd., *16 Howe St., Eainburgh 3*
J. J. Mitchel (Cameras) Ltd., *Haymarket Corner, Edinburgh 11.*

Epping
Chew & Osborne Ltd., *148 High Street.*

Farnham
Lloyd of Keyworth Ltd., *26/28 Downing Street.*

Glasgow
McCormack Ltd., *33 Bath Street.*

Goodmayes
Unique Radio Ltd., *The Facade, High Road.*

Gravesend
Bennett & Brown (Gravesend) Ltd., *58, 60b and 60c Wrotham Road.*

Grimsby
Lincolnshire Instrument Co., *Hi-fi House, 69-71 Cartergate.*

Guildford
Merrow Sound Ltd., *229 Epsom Rd., Merrow.*
P.J. Equipments Ltd., *3 Onslow Street.*

High Wycombe
Hughes Photographic & Hi-Fi Specialists, *7 High Street.*

Huddersfield
Woods, *The Music Shop, New Street.*

Ilford
Nusound, *87/100 Ilford Lane.*

Kettering
Paul Taylor & Partners Ltd., *1 Silver Street.*

Leeds
Beckett Film Services Ltd., *Audio-Visual Specialists 46/48 The Headrow, Leeds LS1 8EL.*
Vallance Audio Lab., *20 New Market Street.*

Leicester
United Film Service, *13 King Street.*

Liverpool
Beaver Radio (L'pool) Ltd., *20/22 Whitechapel.*

Lowestoft
Hughes (Lowestoft) Ltd. *62 London Road North.*

Maidstone
Sloman & Pettitt, *Pudding Lane.*

Manchester
Lancs High Fidelity Ltd., *248 Wilmslow Road, Manchester 14.*

Mansfield
Syd Booth, *11 Queen Street.*

Middlesbrough
McKenna & Brown Ltd., *Linthorpe Road.*

Newcastle
Clement Wain Limited, *Redlion Square.*

Newcastle upon Tyne
Turners (Newcastle-upon-Tyne) Ltd., *Camera House, Pink Lane.*

Norwich
Suttons, *16-18 Exchange Street.*

Nottingham
The Audio Centre, *28/30 Pelham Street.*
Peter Anson Electronics, *165 Arkwright Street.*
Nottingham Tape Recorders Ltd., *11 Burton Street.*

Oxford
Westwoods, *46 George St., Oxford.*

Plymouth
Albert E. Ford Ltd., *84 Cornwall Street.*

Portsmouth
H. R. Knight Ltd., *71 Tangier Road.*

Ramsgate
Tom Joyce, *147 Boundary Road.*

Redcar
McKenna & Brown Ltd., *135 High Street.*

Reigate
Alan Laurenson & Co., *9 Bell Street.*

Salisbury
Suttons Music Centre, *Blue Boar Row.*

Sheffield
Sheffield Sound Centre, *101 Ecclesall Road.*

Solihull
C.H. (Hi-Fidelity) Ltd., *12 Drury Lane.*

Southampton
Hamilton Electronics (Southampton) Ltd., *35 London Road.*
Suttons, *421 Shirley Road.*

South Shields
Saville's, *5/7 Keppel Street.*

Stafford
Tom Reekie Ltd., *10 Bridge Street.*

Stockport
W. J. & M. Baylis Ltd., *611 Gorton Road, Reddish.*

Stockton on Tees
Bond & Mason, Radio-TV-Hi-Fi-Electrical, *94 Church Road.*

Stoke-on-Trent
Wilson's Radio Ltd., *30/32 Liverpool Road.*

Sudbury
The Record Shop, *King Street.*

Sunderland
Saxons (Sunderland) Ltd. *Photographic Dealers, 20-22 Waterloo Place.*

Swansea
Holt, *Radio, TV, Hi-Fi, Audio, Electronics, Picton Arcade, Oxford Street.*

Teddington
Daytronics Ltd., *119A High Street.*

Truro
Fords (Prop. E. J. E. Vivian), *9 Pydar Street.*

Wealdstone
K.J. Enterprises, *17 The Bridge.*

Wilmslow
The Hi-Fi & Tape Recorder Lounge, *Green Lane.*

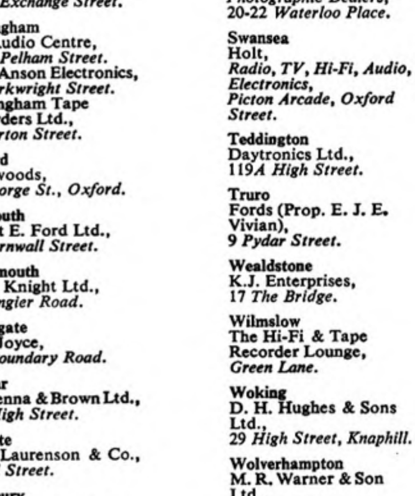
Woking
D. H. Hughes & Sons Ltd., *29 High Street, Knaphill.*

Wolverhampton
M. R. Warner & Son Ltd., *26 Chapel Ash.*

Worthing
Bowers & Wilkins Ltd., *1 Becket Buildings, Littlehampton Road.*

If none of these is near enough to you, in case of difficulty, or for free literature, send us the coupon, or give us a ring on 01-589 4485

FERROGRAPH



To The Ferrograph Co. Ltd., Mercury House, 195 Knightsbridge, London SW7

☐ *Please send me a free brochure on the Ferrograph Series 7*
☐ *or the new Ferrograph Manual for which I enclose £1*

NAME...

ADDRESS .... TR

SIMPLY SUPERB!

the new brenell...

MODEL ST STEREO

Probably the most important new recorder of the year!

The new ST400/200 recorders are different from all previous Brenells. All transistorized electronics; shelf-mounting cabinet; simplified controls.
Sound quality is even better than ever—as good as you can hear: Three-motor deck performance and reliability; quality components throughout. All usual facilities are available.
ST400/200 recorders are designed to give you exactly what you expect from a Brenell today.
Only the price is less than you may expect... £145 recommended. You pay no import duties... no high selling costs... only for a top-quality recorder, well made. It's a fine formula!

- Mono or stereo operation
- Choice of 2 or 4-track models
- 3 outer-rotor motors
- 3 tape speeds
- 2 recording level meters
- Full input/output and control facilities

A range of Brenell mono and stereo recorders is available, together with Brenell deck and tape-link.

See them at the International Audio Fair, Stand 98 Section C

brenell

BRENELL ENGINEERING COMPANY LTD. 231/5 Liverpool Road, London, N.1. Telephone: 01-607 8271

FRANCIS OF STREATHAM

LONDON'S FOREMOST TANDBERG STOCKISTS

DECKS WITH PRE-AMPS
(Microphones extra)
Akai 4000D, Stereo
Sony 801, 3 sp. 4 Tr. Stereo
Sony 355 3 sp. 4 Tr. Stereo
Sony 255 Stereo
Tandberg 6000X 3 sp. 2/4 Tr. Stereo
Tandberg 1600D
Telefunken 201 De luxe
Telefunken 203 Studio
Philips 3 sp. 4 Tr. Stereo

COMPLETE TAPE RECORDERS
Ampex 800 Series Stereo
Ampex 1100 Stereo
Ampex 2100 Stereo
*Akai 1710W Stereo
*Akai M.9 Stereo
*Akai 1800 Dual-purpose stereo 8 track cartridge and tape recorder
*Brenell Mk. 5/M Series III Mono
*Brenell Mk. 5 Series III Mono
*Brenell ST200 2 Tr. Stereo
*Brenell ST400 4 Tr. Stereo
Ferguson 3232 4 Tr. Stereo
Ferguson 3226 Mono
Ferguson 3224 Mono
Ferguson 3216 Mono
*Ferrograph 713
*Ferrograph 702/4
*Ferrograph 722/4
Fidelity Studio 4 Tr. Mono
Fidelity 'Braemar' 2 or 4 Tr. Mono
Grundig TK140 DL 4 Tr. Mono
Grundig TK120 DL 2 Tr. Mono
*Grundig TK245 DL Stereo/Mono
*Grundig TR247 DL 4 Tr. Stereo
Grundig 145 DL 4 Tr. Auto Mono
*Grundig TK320 3 sp. 2/4 Tr. Stereo
*Grundig TK340 DL 4 Tr. Stereo/3 sp.
Philips 4307 4 Tr. Single speed Mono
Philips 4305 2 sp. 4 Tr. Mono
*Philips Professional PRO.12
Philips Stereo 4404 2 sp. 4 Tr.
Philips Stereo Cassette 3312 with 2 sp.
Philips 4407 3 sp. 4 Tr. Stereo
*Philips 4408 Prof. 3 sp. 3 Tr. Stereo
Pye 9106 Auto M
*Revox 77 Stereo Transistor
*Sanyo 801 St. Pre-Amp.
Sanyo 929 4 Tr. 2 sp. Stereo
Sanyo 939 4 Tr. 2 sp. Stereo
*Sanyo 990 3 sp. 4 Tr. Stereo
Sharp RD.706 2 sp./2 Tr./Batt. Mains
*Tandberg 15 2 or 4 Tr./3 sp./Mono
*Tandberg Series 12X 3 sp. 2/4 Tr. St.
Telefunken 204 T.S.
*Telefunken M207 2 sp. 4 Tr. Stereo
Telefunken 501 4 Tr.
Telefunken 200 2 Tr. Mono
Telefunken 203 Stereo/Mono 2 sp 4 Tr.
Telefunken 201 Mono 4 Tr.
*Uher 7/4 4 Tr. Mono
Wyndsor Vanguard 3 sp. 4 Tr. Mono

BATTERY PORTABLE & CASSETTE
Philips RR482 Cassette/AM FM Radio
Philips RR290 Cassette/AM Radio
AKAI 10 V 4 Tr./St/BM
Standard Series 11-2
Ferguson Cassette 3240
Grundig Cassette C.200
Aiwa Cassette Batt/Mains
Philips 2205 Batt/Mains Cassette
Philips EL3302 Cassette
Stella 9112AT Bat./Mains Cassette
Pye Cassette
Sharp 505 2 Tr./2 sp./BM
National 4 Tr./2 sp./Batt. Mains
Telefunken 302 4 Tr. 2 sp. Mono
*Uher 4000L 4 Tr. 2 sp. Mono
*Uher 4200/4400 2/4 Tr. 4 sp. Stereo

* Microphones extra

FOR A FAIR AND DEPENDABLE DEAL IN

TAPE and HI-FI

★ Minimum Deposit and no Interest or Service Charges on H.P. up to 18 months ★ Free Service during Guarantee period
★ Fair Part Exchange Allowance on your old Recorder
★ Reconditioned Recorders available to personal shoppers only

● **MAINS POWER PACKS**
Philips, Stella
Telefunken 300 with cell
Uher 4000 with cell

● **MICROPHONES, MIXERS etc. by**
AKG, Hammond, Grampian, Reslo, Acos, Film Industries, Telefunken, Beyer, Sennheiser, etc.

Bib and E.M.I. splicers, Matching transformers, Defluxers, Bulk Erasers, etc.

Uher Mixer
Eagle Mixer
Hammond 5-way Mixer
Philips Pre-amp.

Also stands, booms, fittings.
Pre-recorded tapes and music cassettes by Columbia, H.M.V. and all E.M.I. labels, etc.
Tapes in all grades and lengths by: B.A.S.F., Scotch, Philips, E.M.I.
Cassettes by Philips, etc.

Headphones by AKG, Ampex, Akai, Sansui, Nikko, Philips

GARRARD SP25 MARK II
Less Cartridge, Special Price
£12 15 0
Brand new, in maker's carton.
Carriage paid in U.K. Guaranteed.

NOTE. When writing, please quote TRR.10 and include s.a.e. for reply.

HI-FI DEPT.

● **AMPLIFIERS**
Quad, Rogers, Arena, Philips, Goodman, Nikko, Sansui, Sanyo, ARD, Leak, Armstrong, Tripletone, Tandberg.

● **TUNERS**
Quad, Rogers, Leak, Armstrong, Tripletone, Arena, Nikko, Goodman, Huldra.

● **LOUDSPEAKERS**
Quad, Rogers, Kef Wharfedale, Goodman, Tannoy, Lowther, Leak, Tandberg, Arena, Celestion.

● **MOTORS, PICKUPS**

GARRARD incl. SP.25 401, etc.	Thorens Tannoy
Goldring	Shure
Connoisseur	Empire
Audiotee	Sonotone
Neat	SME
Acos	BSR
Dual	Pickering

All types of Diamond and Sapphire styli, stereo and mono: Microlifts, Garrard, Goldring and Acos Pressure Gauges, Disc Preener, Acos Dust Bug: Cabinets by Clearview.

169-173 STREATHAM HIGH ROAD, LONDON, S.W.16

Between St. Leonard's Church and Streatham Station

01-769 0466: 01-769-0192

Please note this is our only address. Free parking Prentis Road, 2 mins. away
OPEN ALL DAY SATURDAY—EARLY CLOSING WEDNESDAY

Of all P.V.C. recording tapes......

'Synchrotape' is the one unconditionally guaranteed

Only the finest materials go into the production of British-made Synchrotape. The result . . . . no stretching . . . . no snapping . . . . no storage deterioration. Perfect for mono or stereo . . . . two or four track.

Synchrotape is so easy to use. Most sizes have coloured leaders, trailers, metallic stop-foils, and include a free booklet with unique recording log and are packed in skin-wrapped, colour-coded boxes.

Synchrotape's unconditional guarantee speaks volume to the technical enthusiast . . . . underwriting its claim to be the finest value in P.V.C. Recording Tape on the British market.

And there's a bonus. Most sizes of Synchrotape carry a built-in insurance against theft or fire damage to your recorder . . . . and also contain coupons towards the special half-price tape splicer offer.

SIZE	STANDARD	LONG	DOUBLE	TRIPLE
BASE	P.V.C.		POLYESTER/P.V.C.	
2¾"		200'- 5/9d.	300'- 8/9d.	
3"	150'- 4/9d.	225'- 6/3d.	300'- 8/9d.	450'- 13/9d.
4"		450'- 12/-	600'- 18/-	900'- 27/-
5"	600'- 15/-	900'- 18/6d.	1200'- 28/6d.	1800'- 45/-
5¾"	900'- 18/6d.	1200'- 22/6d.	1800'- 36/-	2400'- 57/6d.
7"	1200'- 22/6d.	1800'- 28/6d.	2400'- 48/-	3600'- 75/-

Comprehensive Synchrotape Editing Kit 29/6d. plus 7/2d. P. Tax.

'Synchrotape' ADASTRA ELECTRONICS LTD.,

167, Finchley Road, Swiss Cottage, London, N.W.3. England. (01-624 8164/5)

FANTASTIC DISCOUNT PRICES

- Recording Tapes
- Tape-Recorders
- Hi-Fi Equipment
- FM, AM and AM Radios
- Record Players
- Microphones
- Headphones
- Amps. and Tuners
- Turntables
- Cartridges
- Loudspeakers
- Plugs and Leads
- Accessories

FREE

1969 CATALOGUE
140 Pages
SEND TODAY

ILFORD —ZONAL TAPE
UP TO 40% OFF!

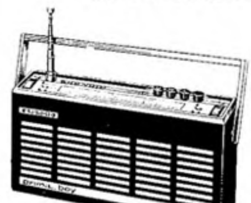
NEW KJ SPECTACULAR

From the Motion Picture and Magnetic Products Division of **ILFORD LTD.** we are proud to present a New Stupendous **BARGAIN OFFER!** Never before have you been offered such a breathtaking opportunity. **ILFORD-ZONAL** premium grade magnetic tape (extensively used by the B.B.C.) at a terrific reduction of 40%! Brand New, Boxed, Fully Guaranteed and complete with leaders, trailers and stop foil. **UNIQUE TO KJ.**

DESCRIPTION	LIST PRICE	ONE	THREE	SIX
900′ on 5″ reel Long Play P.V.C.	29/1	17/6	50/6	96/6
1200′ on 5¾″ reel Long Play P.V.C.	36/1	22/6	65/–	125/–
1800′ on 7″ reel Long Play P.V.C.	51/4	29/6	86/–	165/–
1200′ on 5″ reel Double Play (Polyester) ...	43/1	27/9	81/–	157/6
1800′ on 5¾″ reel Double Play (Polyester) ...	56/1	36/–	105/–	204/–
2400′ on 7″ reel Double Play (Polyester) ...	78/10	49/6	145/6	285/–

Post and Packing 2/6 — Orders over £5 post free

BARGAINS OF THE MONTH



GRUNDIG "PRIMA BOY" RADIO

SAVE £10

K. J. PRICE £22.10.0!

A compact LW/MW/VHF Transistor Battery Radio with padded Black leather grain cabinet, 400 MW output, tone control, sockets diode, car aerial and earphone. Dimensions 8¼″ x 4¾″ x 2⅜″ (List Price £32.11.0).

OTHER SENSATIONAL TRANSISTOR RADIO OFFERS:

DESCRIPTION	*LIST PRICE*	*OUR PRICE*
FERGUSON 3148 LW/MW/SW/VHF (PRESIDENT)	30 0 0	22 10 0
FERGUSON 3152 LW/MW/SW/VHF (PADDED CABINET)	39 3 0	29 15 0
FERGUSON 3164 LW/MW/SW (PERSONAL PORTABLE)	10 12 6	8 19 6
JUST A FEW LEFT!		
GARRARD WB2 BASE FOR LAB 80	4 13 8	3 19 6
GARRARD SPC2 DUST COVER FOR ABOVE	4 8 10	3 16 0

BRANDED TAPES 20% OFF!

Scotch — Agfa — GRUNDIG — BASF — PHILIPS — EMI

DESCRIPTION		LIST PRICE	OUR PRICE ONE	THREE	SIX
900′ L/P on 5″ reel	...	29/-	23/6	69/9	137/9
1200′ L/P on 5¾″ reel	...	36/-	29/-	86/-	170/-
1800′ L/P on 7″ reel	...	51/-	41/6	123/-	243/-
1200′ D/P on 5″ reel	...	43/-	34/6	102/3	202/-
1800′ D/P on 5¾″ reel	...	56/6	45/6	135/-	266/9
2400′ D/P on 7″ reel	...	79/-	63/6	188/3	372/-
1800′ L/P Dynarange	...	58/-	46/6	137/9	272/3

Post and Packing 2/6 — Orders over £5 post free

The above are examples from the complete ranges held in stock. SEE OUR CATALOGUE FOR FULLER INFORMATION.

Compact Cassettes
UP TO HALF PRICE

Compact Cassettes with 60, 90 & 120 minutes playing time. Brand New and packed in normal plastic library box. Available at this exceptional price

Standard pattern to fit Philips, Stella, Elizabethan Dansette, Sanyo, Ferguson, Bush, HMV, Sony, etc.

MAXELL

MC.60	MC.90	MC.120
1 for 10/6	1 for 14/–	1 for 18/6
3 for 30/–	3 for 40/6	3 for 54/–
6 for 55/6	6 for 78/–	6 for 105/–
12 for 105/–	12 for 150/–	12 for 204/–

Post and Packing 2/6. Orders over £5 post free:
Must not be confused with cheaper American Overture Cassettes advertised elsewhere

BRANDED CASSETTES (BASF or PHILIPS)

	ONE	THREE	SIX
C.60	14/3	42/3	83/6
C.90	20/3	60/–	118/6
C.120	27/–	80/–	158/–

Post and Packing 2/6. Orders over £5 post free.

K. J. ENTERPRISES (Dept. TR11)

(HEAD OFFICE & MAIL-ORDER DIVISION)
33 BRIDLE PATH, WATFORD, HERTS.
Telephone: WATFORD (92) 22338 (3 lines)
(Close to Watford Junction Station)

SHOWROOMS (For callers only)
17 The Bridge, WEALDSTONE, MIDDX.
(Opposite Harrow & Wealdstone Station)
Telephone: 01-427 7758

HOURS: 9.30 a.m. — 5.30 p.m. Closed Lunch 12.30 — 1.45.
Close 1 p.m. Saturday

WE'VE MOVED!

Have you been impressed by the KJ SUPER SERVICE? We hope so, and the ever increasing volume of mail-order seems to prove the point. To maintain efficient handling of your requirements, we have taken a further 8,000 square feet of warehousing and office premises to house our Head Office and Mail-Order Division. All correspondence should now be addressed to 33 Bridle Path, Watford, Herts. WD2 4AA.

tape recorder

NOVEMBER 1969 VOLUME 11 NUMBER 11

INCORPORATING
SOUND AND CINE

EDITOR
JOHN CRABBE

DEPUTY EDITOR
DAVID KIRK

ADVERTISEMENT MANAGER
ROBIN WELLS

Editorial and Advertising Offices:
LINK HOUSE,
DINGWALL AVENUE,
CROYDON, CR9 2TA
Telephone: 01-686 2599

COVER PICTURE

The techniques of synchronising taped sound with cine film are discussed on page 444 of this issue by Richard Golding. A.P. Films of Slough had a third factor to contend with when producing the *Fireball XL5* children's television series: the electronic activation of each puppet's mouth. This and the later tape to 35mm film transfer were achieved with two EMI *TR90*'s.

SUBSCRIPTION RATES

Annual home and overseas subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 30s. and 47s. respectively, U.S.A. $4.30 & $5.60. Six-month subscriptions are 15s. *(Tape Recorder)* and 24s. *(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.

WE SHALL BE in excellent company at this year's Audio Fair. Not only are we sharing part of Olympia with a handful of photographic dealers and manufacturers, we are also honoured by the presence of (wait for it) The Dairy Show. Eighty audio demonstration rooms and a prophesied 300 cattle under one roof could make considerable demands on the insulating properties of the 'Audio Studios' (to quote the official label), to say nothing of acoustic breakthrough between one room and another.

It may take more than 300 cattle to attract visitors from the recording industry to the 1969 Audio Fair. In past years, the Fair has been one of the few exhibitions catering even remotely for manufacturers of studio equipment and has been patronised by Studer, STC, AKG and the industrial divisions of Philips and Ampex. None of these companies will be represented this year. Studer (F.W.O. Bauch) and Ampex have switched their support to the APRS Exhibition; Philips (Pye TVT) have stayed out in the cold.

Four companies spanning both the industrial and domestic recording markets have also opted out of the Audio Fair this year: Reslo, Grampian, Chilton and Vortexion. At least one further company in this category is known to have been of two minds about exhibiting.

The result is an Audio Fair aimed more than ever at the gramophone record consumer. This division of recording and reproducing interests could be fortunate as it may herald increased support for next year's APRS Exhibition, a promising youngster that deserves solid backing from British manufacturers.

It is not so much his equipment as his attitude to recording which separates a domestic tape man from a professional. One studio engineer of our acquaintance produced a series of location recordings on a 4.75 cm/s cassette portable, dubbed them up to 38 and had them accepted for use by the BBC. Another bought himself a 38 cm/s Revox (the type reviewed on page 466) and declared it markedly superior to his employer's console equipment. This was no slur on the latter, which is several thousand pounds more reliable, but proves that professional results are within reach of the modestly wealthy individual.

Most readers will be aware of the trade restrictions that existed until a few years ago on the public circulation of commercial circuits. We have endeavoured to do our bit over the years in publishing circuits with service articles and reviews, and now claim that, where domestic recorders are concerned (the problem never arose with industrial equipment), few circuits are withheld from the general public.

Much the same situation exists, oddly enough, in the realm of microphone placing. Most London studios have evolved their own ideas of 'good technique', some engineers treating them as trade secrets. This is fair enough, except that some of the secrets which leak out through reliable channels completely contradict each other. The situation may seem chaotic, but is in fact quite clear cut : microphone placing is not a science (yet), it is an art. It comprises a few basic rules relating to physical damage, stereo positioning, noise, frequency balance, instrumental balance, and reverberation, any or all of which may be ignored (by the pop producer at least) in favour of a new gimmick or effect. To quote Bob Fisher's* quite serious comment on pop techniques: 'If a microphone is placed inside a porcelain pot, then it is Right to place a microphone inside a porcelain pot'.

We recently played some stereo jazz recordings made on the editorial *RE 301* (crossed cardioid pair) to a recording engineer specialising in classical music, and later to an engineer specialising in pop. Their comments, and we respect them both, may provide at least a grain of guidance to anyone disturbed by the 'subtle criticism' in record reviews. One considered the crossed-pair too far forward (the classical man) while the other (the multichannel close-mike man) considered it too far back.

* Sales Engineer, STC.

FEATURE ARTICLES

REGULAR ITEMS

EQUIPMENT REVIEWS

SONY

For spot-on sound . . . from on-the-spot recording – Model TC 800A, a compact battery/mains portable mono tape recorder for the discriminating enthusiast. Three speeds ($1\frac{7}{8}$, $3\frac{3}{4}$, $7\frac{1}{2}$ i.p.s), two tracks, 5″ reel capacity, and a servo-controlled motor for precise timing accuracy. An automatic recording level control (with manual over-ride) ensures perfect recordings every time. And to complete the picture, there's that superb finish which Sony make the rule.

Recommended retail price £84.15.0

Recording system 2-track monaural.
Power requirements AC 110, 120, 220 or 240V, 50/60 Hz; DC 12V.
Power consumption AC 8 watts (max).
Reels 5 in. or smaller.
Tape speed $7\frac{1}{2}$ ips (19 cm/s), $3\frac{3}{4}$ ips (9·5 cm/s), $1\frac{7}{8}$ ips (4·8 cm/s).
Frequency response 30 Hz – 18 kHz at $7\frac{1}{2}$ ips; 30 Hz – 13 kHz at $3\frac{3}{4}$ ips; 30 Hz – 7 kHz at $1\frac{7}{8}$ ips.
Power output 1 watt.
Inputs Microphone: sensitivity 0·195 mV, impedance 600 ohms.
Line: sensitivity 0·055V, impedance approx. 100k ohms.
Remote control.
Speed tuning.
Output Monitor: standard output level 0·775V (load impedance 10k ohms).

Motor D-503F DC servo-motor.
Speaker $3\frac{1}{8}$ in x $6\frac{1}{4}$ in.
Battery life Up to $6\frac{1}{2}$ hours in continuous recording (with supplied batteries).
Dimensions $12\frac{1}{4}$ in. (w) x $4\frac{3}{16}$ in. (h) x $10\frac{1}{4}$ in. (d).
Weight 11 lb. 13 oz. with batteries.
Accessories Microphone (F-85 MTL), pre-recorded tape (5 in. tape), Sony reel (R-5A), connecting cord (RK-36), head cleaning ribbon, super batteries, magnetic earphone (ME-20).
Optional accessories Telephone pick-up (TP-4S), car battery cord (DCC-2AW), remote control (RM-6), microphone mixer (MX-600M), foot switch (FS-5), carrying case (CK-8B).

SONY®
RESEARCH MAKES THE DIFFERENCE
Sony (UK) Ltd Ascot Road, Bedfont, Feltham, Middlesex

WORLD OF TAPE

ELECTRONIC MUSIC SOCIETY

DETAILS CONCERNING A survey of electronic music studios appeared in this column in July 1968. The survey was organised by the Arts Council of Great Britain and has resulted in a list of more than forty actively engaged in the preparation of electronic music. Partly as a result, the British Society for Electronic Music was inaugurated in February with a committee comprising Peter Maxwell Davis (chairman), Peter Zinovieff, James Murdoch, Don Banks, Tristram Cary and Hugh Davis. Its main aim is the foundation of a National Studio for Electronic Music though such a centre would be expected to cover a wider field. Its envisaged facilities will include:

1. Central processing rooms with sound generation equipment, a tape recording room, and several composing rooms, each a self-contained working unit but linked to the central system.
2. An acoustic research laboratory.
3. A lecture hall also suitable for small concerts.
4. A large recital hall linked (with the lecture hall) to a studio, projection and lighting equipment.
5. A library/archive of discs, audio tapes and video tapes.
6. Accommodation for composers.

The society has already organised one concert at the Royal Festival Hall and similar events will be held in the future. Further details of the society may be obtained from its administrator, John Woolf, SPNM, 29 Exhibition Road, London S.W.7.

DUPLICATING PLANT FOR SOUTH AFRICAN STUDIO

AN ORDER FOR high-speed duplication equipment has been won by Leevers-Rich from Manley Van Niekerk Studios (Pty) Ltd. of Johannesburg. The plant will handle the production of cassette and eight-track cartridge tape records for domestic tape players which are becoming increasingly popular in South Africa, particularly in cars. The contract, including installation supervision, is worth approximately £30,000.

BSI SPECIFICATIONS

A NEW BSI PUBLICATION relating to the use of magnetic tape recording and reproducing equipment in schools is now available, price 8s., from the BSI Sales Branch, 101/113 Pentonville Road, London N.1. The standard, *BS 3499/8B*, specifies safety, security, connectors, a warning light on mains powered equipment, wow and flutter limits, signal-to-noise ratio, distortion, frequency response at 19.05 and 9.53 cm/s (or 9.35 cm/s, the BSI press release was confused), and audio electrical output power. Bass and treble tone controls are recommended for equipment above a certain size, operating on replay only. Appendices deal with tape track positions (for '4-track' and '2-track'), storage and handling of recordings, and the information a supplier should forward to the purchaser. The importance of adequate servicing is emphasised in a foreword.

Also introduced is *BS 3499/9C*, concerned with electronic organs and priced 6s.

BBC 'USING A TAPE RECORDER'

A SERIES OF programmes for people using tape recorders for business, pleasure, or for education, will be broadcast by the BBC in December. 'Using a Tape Recorder' will be heard in Radio 3 on Tuesdays at 6.30 p.m. from December 2 to 30, and on Saturdays at 11 a.m., Radio 4, from January 3 to 17.

HOSPITAL BROADCASTS

THE ORGANISERS OF 'Tyne Sound' would like to contact hospital broadcasting teams in the UK with a view to organising an exchange of programmes. Interested parties are asked to write to D. A. Morton, 31 Ridgewood Gardens, South Gosforth, Newcastle-on-Tyne 3.

PHILIPS 8mm FILM LOOPS

SOUND SERVICES LTD., Kingston Road, London S.W.19, have been appointed to distribute Philips 8 mm Film Loops. All loops in the series are animated, in colour, and available either in Standard 8 or Super 8. Prices are in the £3 10s. to £7 region. Crystallography, semiconductor physics, television and diffusion are covered by the present series which comprises 26 titles. All are available for ten day preview.

Stellavox *SP7* professional stereo battery recorder described in last month's 'New Products'.

BEYER MICROPHONES

A NEW COMPANY has been formed to handle Beyer microphones and accessories in the UK. The company is Beyer Dynamic (GB) Ltd., 1 Clair Road, Haywards Heath, Sussex (Tel.: 0444-51003). S.B. Duer, formerly of Fi-Cord, is managing director.

CALREC CAPACITOR MICROPHONES

THE RANGE OF capacitor microphones marketed by Fi-Cord, until their recent demise, is now available direct from Calder Recordings Ltd., Regent Street, Hebden Bridge, Yorkshire, the manufacturer. Six models are being produced, ranging from the £45 8s. *CM1050* studio cardioid to the £20 3s. *CM600* omni.

APPOINTMENTS—LEEVERS-RICH

MR. N. V. NICHOLS has returned to Leevers-Rich after a period with Radford Electronics Ltd. and the EMI Group. He joins as Sales Engineer. Mr. Peter Richards, who has been with the company since 1959 and recently joined the board, has been promoted from Works Manager to General Manager.

STOLEN FERROGRAPH

A BRAND NEW Ferrograph *704W*, Serial number 73215, was stolen on Sunday, September 28 from *Tape Recorder* contributor John Shuttleworth. Any reader coming across this serial number is asked to communicate with the Editor.

APPOINTMENTS—MULLARD

MR. T. ASPIN has been appointed Technical Manager of Mullard Ltd., Industrial Electronics Division. He will be responsible for establishing long term development policy in the fields of passive components, assemblies, semiconductors and ICs. Mr. Aspin joined Mullard in 1946 and was General Product Manager of the Consumer Electronics Division from 1966.

NEXT MONTH

JOHN FISHER DESCRIBES the construction of a 'dubbing box' providing tone control facilities between mixer and recorder or between recorders. Angus McKenzie contributes *Azimuthing with White Noise* while Alec Tutchings reviews the Akai *X360* bi-directional stereo recorder and Foster *FSA-1* stereo microphone system. David Kirk interviews Tom Reps (Managing Director, Magnetic Tapes Ltd.) on the problems of designing and manufacturing the Chilton *100S*.

The Five Rules of Matching

Anthony Eden describes the simple arithmetic of connecting audio equipment

IN this article we shall be discussing some of the rules that apply when matching the output from one piece of equipment with the input of another. Then we shall consider some of the cases where these rules are broken and how matters can be remedied.

There are five basic rules to consider when matching one piece of equipment to another. It is important to remember that these rules apply only when *voltages* are being considered and another set of rules is required for *power* matching. All manufacturers quote input sensitivities and rated output levels in terms of voltage with the exception of loudspeaker matching which is invariably quoted in terms of power (i.e. watts). Power matching requires a different set of matching criteria.

Consider the case in which we have two units A and B and it is desired to feed the output from A into B (for example feeding a radio tuner into a tape recorder). The five rules to consider are:

(1) The signal from A should be equal to or greater than the maximum input sensitivity of B.

(2) The signal from A, as a general rule, should not exceed 5 times the input sensitivity of B.

(3) The impedance of A should be equal to or less than that of B.

(4) Any variation from a flat frequency response at the output of A is corrected for at the input to B. For example, it is no use feeding the output from a magnetic pick-up cartridge into the microphone socket of a tape recorder even though rules 1, 2 and 3 may be satisfied, since the recording characteristic of the disc is arranged to be frequency dependent and the input of B must be arranged to compensate for this.

(5) When connecting unit A to unit B, be sure that no earth loop is created. If, for example, A is a mains powered radio tuner which is earthed at the mains and B is a tape recorder similarly earthed, any earth connection between the two units will result in what is called an earth-loop and the recording may be seriously affected by hum.

A much simpler rule to remember is this: Connect up, switch on and only when trouble becomes apparent start a critical examination.

It may be remembered that rules 1, 2 and 3 also apply when matching a microphone to a tape recorder (February 1969 *Tape Recorder*), since a microphone is a voltage source. Let us now consider each of these rules in turn, and how problems may be overcome.

Rule 1 is a fundamental one and assuming that the manufacturers have stated the input and output voltages correctly (this is usually the case) we can readily ascertain if this rule is fulfilled. Insufficient voltage to drive the input of a tape recorder presented more problems when valves were used in tape recorders. It was quite frequent to find tape recorders with a radio input sensitivity of 250 mV and radio tuners with an output of only 150 mV thus presenting a matching problem. However with the advent of transistorised tape recorders the radio inputs to tape recorders have generally been increased to about 50-100 mV. Generally speaking, if a voltage increase is apparent in order to load the input of unit B fully, then only a small increase is called for and an amplifier with a 10 dB gain (3.2 times voltage gain) will in most cases be sufficient. A suitable low-noise amplifier fulfilling this specification is shown in **fig. 1**. The input to the amplifier can be any impedance up to 0.5 M without loss of bass response and any input up to 1 V maximum. The output impedance is very low and so can be fed into any impedance input. Such an amplifier is ideally suited where, for example, a radio tuner has an output of 100 mV at 250 K and is to be fed into a tape recorder of maximum input sensitivity 150 mV at say 50 K. The amplifier will step up the tuner output to about 300 mV which is then ideally suited for feeding into the tape recorder. It should be remembered that the output from an FM radio tuner can be quoted in one of several ways. If the output is quoted as 'up to 500 mV' this indicates that for 100% modulation of the carrier the output will be 500 mV. If the output is quoted as '250 mV for 50% deviation', this means that a typical transmission will deviate the carrier frequency by half its total permissible deviation and will in consequence be producing 250 mV which is half its total output. Hence the maximum output will be (2 x 250) mV, i.e. 500 mV. Ideally the output from unit A should be 1.5 to 3 times the maximum input sensitivity of unit B, thus giving sufficient flexibility for variations of output and input.

Rule 2 considers the reverse problem of rule 1. Where the output from A is considerably larger than that of B it is quite possible for the input stage of unit B to become overloaded and distortion will result. For example, the average output from the Leak *Troughline* stereo tuner is about 80 mV, to be fed into a load of 50 K. The input to the Beocord *1100* is 2 mV at 50 K. Now to match these two units requires that the Beocord must stand more than a 40 times overload (32 dB). Whilst this could be a possibility it is a most undesirable state of affairs and some form of attenuation is required. Either a fixed potential divider or a variable potentiometer can be used. If the output from unit A requires a load of at least 100 K then the total value of the divider network (R1+R2) in **fig. 2** needs to fulfil this demand.

Thus R1 + R2 = 100 K and from the problem set above $V_{in} = 80$ mV and V_{out} has to be 2 mV. As the ratio of R1 to R2 alters so we alter the ratio of V_{in} to V_{out} and we find that:

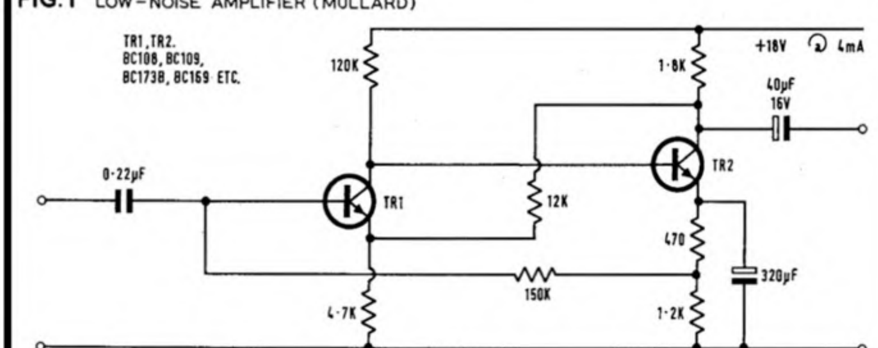
$$\frac{V_{out}}{V_{in}} = \frac{R2}{R1 + R2}$$

$$\text{therefore } \frac{2}{80} \text{ approx.} = \frac{R2}{100\text{ K.}}$$

Typical values for R1 and R2 respectively would be 100 K and 2.7 K. A quick glance back to our original rules will show that we have satisfied the output conditions for impedance matching, as well as ensuring that the input to the tape recorder is not overloaded.

Rule 3 considers a problem that we looked at with regard to microphone matching (February 1969). The same rules apply always when voltages are being considered. It is always advisable to load the output of unit A with as high a load as practicable even if the output impedence is quoted as 600 ohms. What this value refers to is the result of an analysis of the circuit and **not** the recommended load. Some manufacturers still quote the output impedance from their units as 600 ohms even though it has no relevance to practical matching problems. The value of 600 ohms was originally the value of impedance used for connecting broadcasting links to the Post Office land lines but it was important here to have impedance matching because power matching was used. The reason for this is that a land line

FIG. 1 LOW-NOISE AMPLIFIER (MULLARD)



can be considered as a continuous array of capacitative, inductive and resistive elements and assume a 'characteristic' impedance of about 600 ohms. These lines are so long that their impedance is independent of the connection at the far end and in order to obtain optimum energy transfer it is necessary to match the output from the broadcast unit with the characteristic impedance of the cable. It is easy to realise now why there is no point in making the output impedance of a unit 600 ohms, except to imitate the broadcasting authorities!

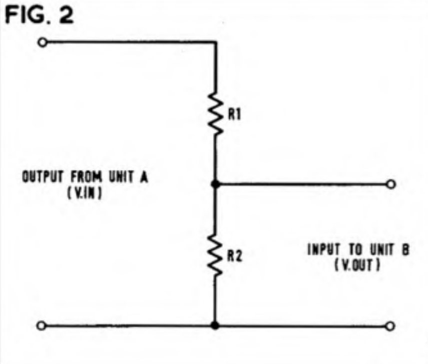
It is well to ask at this point how the frequency response and output voltage will be affected by placing a load across an output which has the same value as its output impedance. Consider first the effect on the frequency response. Normally the output coupling capacitor will cause a loss of bass response since the reactance of the capacitor would be appreciable with such a load. This problem was more apparent in the days of the valve driven cathode-follower circuit and an output coupling capacitor of much greater than 0.2 μF could be quite bulky. The Revox *736*, for example, has an output impedance of about 1.3 K and the result of loading it with a 1.3 K load for various frequencies is shown in **fig. 3.**

A second problem also arises if a matched load is used. The output level drops significantly compared with the open circuit output. The result of this is shown in **fig. 4,** plotting output voltage against load at a frequency of 1 kHz.

The two graphs indicate the importance of not loading voltage output circuits more than is recommended by the designer.

One way of overcoming the impedance matching problem has already been described—namely that of using a potential divider network. This is excellent if we also wish to attenuate the signal being fed into unit B. However suppose that we have an output from unit A of 100 mV at 100 K which is being fed into unit B with an input sensitivity of 100 mV input at 2 K, how can we overcome this problem? Although this case is unusual, it can and does occur. The solution is not very simple and can only be successfully handled using an active impedance converter. An emitter-follower circuit provides one answer but a better solution was offered in '*Microphone Matching*' (February 1969) using the compound emitter-follower circuit. This circuit has an input impedance up to 4 M and an output impedance of 70 ohms at unity voltage gain.

FIG. 2



Thus, we have now overcome most of the problems likely to occur with impedance matching. It should be remembered that if an *input impedance* is stated as 10 K it means that we can safely apply any input load up to this value without degrading performance. If there is sufficient feedback in the circuit it means that the value of the input impedance can well exceed the 10 K value without detriment to the circuit. However it is not advisable to work an amplifier under such conditions.

The above may be summarised in a table as follows:

Input Impedance	**Output Impedance**
Input load: Up to but not exceeding the input impedance. Failure to observe this may result in a curtailment of the frequency response.	**Output load:** As a guide should be 25 times greater than the output impedance. Failure to observe this may result in a reduction in the rated output voltage and a curtailment of the frequency response.

Rule 4 is self-explanatory and problems tend to occur where it is desired to feed the output from a pickup cartridge directly into the input socket of a tape recorder. Crystal and ceramic pickup cartridges are rather easier to feed into a tape recorder than magnetic cartridges. The crystal pickup will produce up to 500 mV output and the ceramic up to about 100 mV. If these pickups are fed into loads of about 2 M or greater, the frequency response of the cartridges approximately compensates for the recording characteristic of the disc. If the input is sufficiently sensitive to withstand it, a series 2.2 M resistor will ensure that a reasonably level frequency response can be obtained. However it should be remembered that if the input impedance to the tape recorder is low in comparison with the 2.2 M series resistor then the signal available at the input will be reduced and we shall have the potential divider type network of **fig. 2.** Let us take an example. If we wished to feed the output from a ceramic cartridge type Sonotone *9TAHC* into a Philips *EL3575* tape recorder, the *9TAHC* will typically produce about 100 mV output and the Philips tape recorder has a suitable input of 2 mV at 20 K. From the formula we find that R1 = 2.2 M, R2 = 20 K and V_{in} = 100 mV. Thus V2 = 1 mV. Now, at peak output from the cartridge, it should be just about possible to fully load the input to the Philips tape recorder with this matching network.

The matching of magnetic cartridges cannot successfully be carried out for direct feed into a tape recorder unless either a special socket is available with the necessary equalisation (i.e. Beocord *2000* and Chilton *100 S*) or the pickup is first fed into an amplifier providing the necessary correction, a corrected high level signal then being fed into the tape recorder.

Rule 5 is very often overlooked when connecting up separate units of equipment via the mains supply. A good general purpose rule is as follows: Where a number of units of equipment feed into a central amplifier, then this amplifier should be earthed and all the other units should be isolated from the earth lead. The converse problem can also arise where no earth connection is made and hum can result. This problem most often occurs with low voltage circuits such as magnetic pickup and microphone sources. Even if no hum problems are apparent it is a wise precaution to earth the equipment, both from an electrical safety viewpoint as well as ensuring that hum is kept to an absolute minimum.

This then concludes our study of inter-equipment matching. The same rules apply whether in mono or stereo, the only difference being that the left and right earthlead channels are normally commoned together and so obviously only one mains earthed lead is required. In conclusion, it is worthwhile using good quality screened cable for linking one piece of equipment with another.

FIG. 3 REVOX 736 ON OPEN CIRCUIT AND WHEN LOADED WITH 1·3K

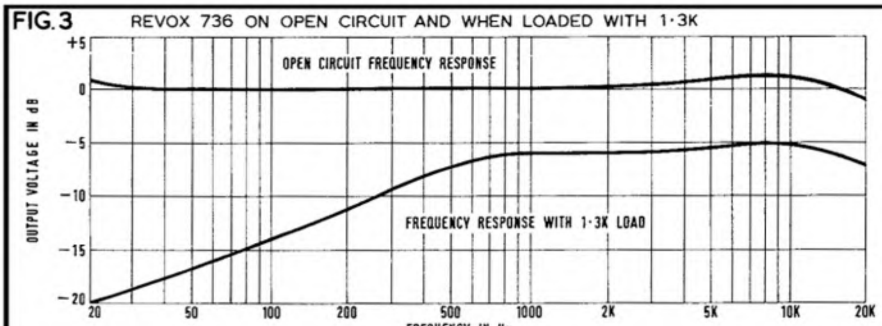
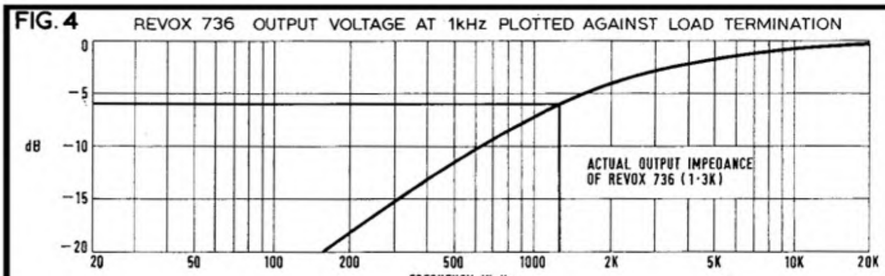


FIG. 4 REVOX 736 OUTPUT VOLTAGE AT 1kHz PLOTTED AGAINST LOAD TERMINATION

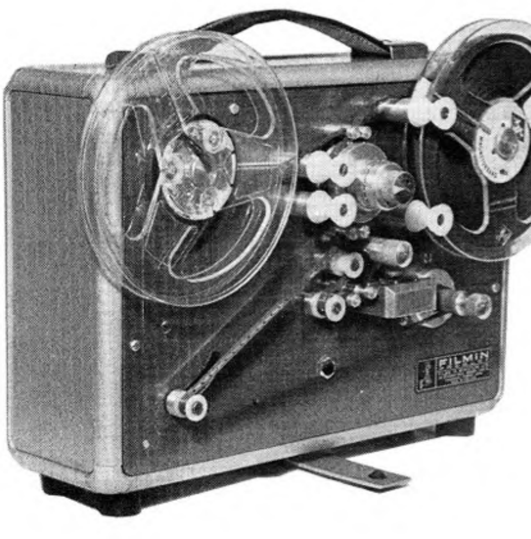


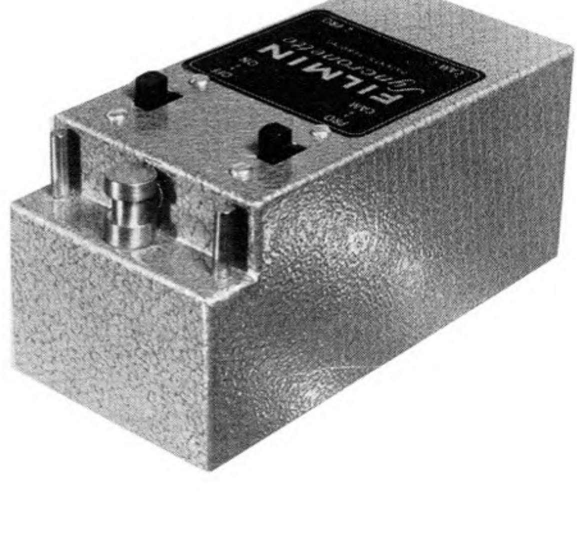
Synchronising **Tape** with **Film**

Part One A survey of current techniques and a close look at the Carol Cinesound
By Richard Golding

IN April this year, when it was made known that the Fairchild Model *900* 8 mm sound recording camera was to be introduced into this country at a price around £425, it seemed that we British, at last, had recognized 8 mm as a serious film gauge. This was the single-system, sound-on-film magnetic stripe camera with electric drive and 62 m magazine. It could be used most efficiently with a portable transfer system such as the Siemens 8 mm double-band magnetic projector and appeared to be the answer to professional lip-sync on 8 mm. But like its predecessor the *Cinephonic 8*, the market was not quite ready. The objections made against it were that the pre-striped film had a separation between sound and film that made cutting impossible and that the striped film had to be specially imported from America. With regard to the first point, 8 mm producers are obviously reluctant to go to the trouble and cost of extra prints and rerecorded sound whereas the Auricon people have been doing this for years on 16 mm. Secondly, the mere fact that 8 mm pre-striped film is readily available in America indicates that 8 mm single-system is taken seriously over there. Nine years ago when the Cinephonic first appeared prospects looked good for 8 mm sound on film. The Japanese and Americans were experimenting with 8 mm optical sound. The Eumig *C5* Zoom-Reflex 8 mm camera appeared. This was designed to start and to stop in conjunction with a small tape recorder carried over the shoulder. When the button was pressed, both units started together, but the synchronisation afterwards depended on the ability of each separate unit to keep up a constant speed. There were too, a very large number of sync units for controlling projection speed against tape speed, and there were some very good 8 mm stripe projectors on which post synchronisation could be carried out.

Since then there has been a great deal of movement in the design of cine cameras. 'Super 8' appeared and has been so successful (from the selling point of view at least) that there is only one manufacturer now who is





still making a standard 8 mm camera. It is all Super 8 now, with long range zooms, solid-state meter circuits, transistor speed control of the motor, fade shutters, and servo motors to operate the lens iris. You can pay up to £400 for a model in this gauge but, with the exception of the Pathe *DS8* (this takes double Super 8), they will all be cartridge loading and thus incompatible with the design of a single-system magnetic stripe sound camera. The only Super 8 camera with a provision for sync-pulse operation with a small cassette recorder is the Zeiss-Ikon *Moviflex S* but this is not available in this country. Similarly, selling in France but not available here is the French made Phonimaj tape recorder. This is designed to operate with the Bauer *D* range of cine cameras and uses pulses fed through a multi-core cable to provide perfect synchronisation for 15 or 20 sequences on a 15 m film and to give synchronised sound to edited film and during editing, mixing or dubbing. The recorder is powered by six 1.5 V batteries; on location it is slung on a shoulder strap, the 8 cm spools being easily accessible at the top. Also in France, Pathe Movie Sonics offer the Erlson tape recorder originally designed to be used with the Pathe Webo 8 mm, 9.5 mm, and 16 mm cameras. A small impulse generator is mounted on a one turn to one picture shaft of the camera and relays its signals to a special control track on the recorder. A headset is supplied for monitoring on the spot, and for projection the pulse generator can be mounted on a 1-to-1 shaft on the projector. No more than two frames can slip at starting and this can be recovered almost immediately. The Erlson weighs less than 3 kg.

All very well for the French and Germans but what about us over here? Well, there is any amount of equipment that can be adapted for use with 8 mm providing that you have a budget to cover the cost. There are the Nagra and the Uher pulse-sync systems and the new generation Tandberg pulse-sync recorders that seem to be selling like hot cakes at the moment. There is also the fantastic (for me anyway) Perfectone with its crystal control (more about this later). But for those who want sync on 8 mm at very reasonable cost there are two very efficient units available, both British made, the Cinesound and the Synchronette.

The Synchronette, manufactured by *Films in Miniature Ltd., Romsey, Hampshire,* uses perforated tape to give automatic synchronisation between almost any electric drive camera, any gauge, any speed, and a mains or portable tape recorder. It can be used with a silent projector, to control its speed, and with a number of stripe projectors to provide automatic transfer of perforated tape to stripe. The scanning head of the *Synchronette* consists of a miniature exciter-lamp and a photo-electric cell. When the tape recorder is started, this scanning system reads the perforations and, by regulating the power supplied to the camera, automatically ensures that one frame of film moves through the picture gate for every tape perforation that passes through the scanning head. Thus camera and recorder are locked in sync. For sound editing, two other units may be added to the system, the *Editone* which plugs into the *Synchronette* and gives an automatic start and stop tone on the tape; and the *Edisync* which can be coupled to a sound or silent projector or even to a film viewer.

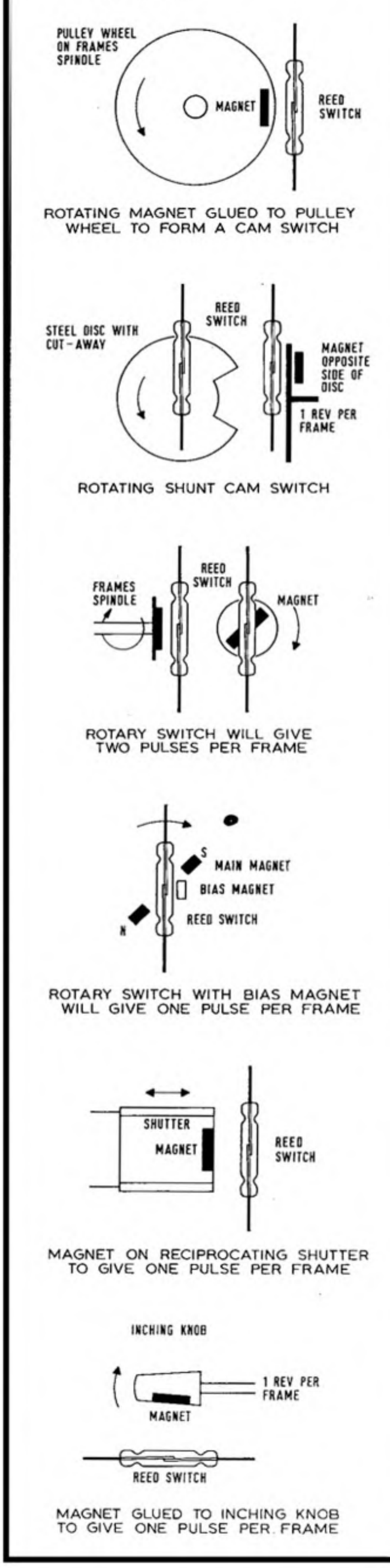
The Synchronette is only suitable for use with 16/18 f/s projectors, but it will control cameras at 24/25 f/s as well as 16/18 f/s; this will depend on the type of tape purchased. Prices of these units are: *Synchronette Mark II* £29 3s. 5d.; *Editone* £13 18s. 3d.; *Edisync* ½-track £48 10s. 3d.; *Edisync* ¼-track £50 18s. 11d. Slight modifications are needed to cameras and projectors. The camera needs to be fitted with two sockets for a simple plug-in lead from the synchroniser. The internal modification to the camera involves the fitting of a transmitter contact, driven by the camera's own mechanism. Films in Miniature can arrange for agents to carry out this conversion at a cost between £4 and £10, depending on the type of camera. The same with projector modification; the costs here being between £5 and £8.

The simplicity of the system is attractive. Editing is on a 'one for one' basis, i.e. one perforation of tape equals one frame of film so however many frames of film you remove, take the same number of tape perforations. With the addition of the Edisync you can have virtually professional editing facilities. Move the film backwards or forwards and the perforated tape follows it precisely, with every frame of tape locked to every frame of film. Also with the Edisync, accurate tape transfer is provided by means of a magnetic head wired to the miniature jack socket on the front panel. The Edisync will also synchronise a projector. All you have to do is to interrupt the film path through the projector by pulling out a loop of film ahead of one of the sprockets. This loop is threaded around the drive-sprocket of the *Edisync* which, in turn, drives the tape in perfect sync. Output from the *Edisync* may be fed into any amplifier and speaker system.

Synchropulse, pulse-sync, pilotton, neo pilot tone, call it what you will, gives greater flexibility than perforated tape and was invented and developed in this country by Norman Leevers who thus gave the film industry its first really portable sound equipment. Leevers-Rich synchropulse held sway for about ten years and then the two Swiss recorders, the Nagra and the Perfectone, the first all-transistor portable filmsound equipment, suddenly burst on the scene. These new recorders were designed mainly for newsreel work but they were soon recognised as being very suitable for many other kinds of sound filming and one or other of them became standard equipment on location, sometimes even being used for sync playback in the studios in place of the acetate disc. The first pulse-sync for the advanced amateur or small sponsored professional came in 1964 with the invention of the low cost, solid state, Carol *Cinesound.*

The *Cinesound* works on the following principle; if an electric motor is switched on and then off, the motor will obviously start running and then stop again, but if it is switched on and off continuously, then it will continue to run at a speed which will be slower than if it were fully switched on; if the time of this on/off cycle can be made to be in direct relationship to the frame speed of the projector, and the tape recorder made to perform the switching on and the projector the switching off, then the projector will run in 100% sync with the tape. (*continued on page 473*)

FIG. 1 TYPICAL METHODS OF PULSE GENERATION USING REED SWITCH AND MAGNET



MAGNET GLUED TO INCHING KNOB TO GIVE ONE PULSE PER FRAME

Model MR-990

Solid state mains stereo/mono tape recorder

Solid state, 14-transistor circuitry delivering 10 watts maximum music power per channel. 4-track monaural/stereo operation. 3 speeds controlled by single change lever. Greatest tape economy: 8 hours on one 7″ reel at 4-track monaural operation. Varied applications: recording from tuner, turntable, or microphones. Playback through loudspeakers supplied or separate amplifier. Other facilities include sound-on-sound, sound-with-sound, pause control and automatic shut-off device. Line output socket and 5 pin DIN (rec./pb.) socket. Headphone and speaker jacks on front panel.

SPECIFICATIONS

Recording system:
AC bias $\frac{1}{4}$ track
Erasing system:
AC erasing $\frac{1}{4}$ track
Tape speeds:
$7\frac{1}{2}$ ips (19cm/sec)
$3\frac{3}{4}$ ips (9.5cm/sec)
$1\frac{7}{8}$ ips (4.8cm/sec)
Wow & flutter:
$7\frac{1}{2}$ ips: 0.15% R.M.S.
$3\frac{3}{4}$ ips: 0.20% R.M.S.
$1\frac{7}{8}$ ips: 0.30% R.M.S.
Recording time:
96 min at $7\frac{1}{2}$ ips
(stereo 7″ 1200ft. tape)
192 min at $3\frac{3}{4}$ ips
(stereo 7″ 1200ft tape)
384 min at $1\frac{7}{8}$ ips
(stereo 7″ 1200 ft. tape)
Level indication:
VU meter x 2
Output power:
Music: 10W x 2. Undistorted: 5W x 2
Frequency response:
$7\frac{1}{2}$ ips: 20-21,000 c/s
($\pm$3db 30-16,000 c/s)
$3\frac{3}{4}$ ips: 30-13,000 c/s
$1\frac{7}{8}$ ips: 30-9,000 c/s
Signal-to-noise ratio: 45 db
Cross talk:
50 db (channel-channel)
Output impedance:
Ext. SP: 8 ohm x 2
Line out: 1k ohm x 2
Headphone: 10k ohm or 8 ohm
Microphone:
Dynamic microphone
Speakers:
4″ (10cm) free edge permanent dynamic speaker x 2
Monitor:
Headphone or speaker
Power source:
AC 100V, 117V, 125V, 220V, 240V
Dimensions:
Main unit 20″ (w) x 10″ (d) x 16″ (h)
Speaker boxes: $9\frac{1}{2}$″ (w) x $5\frac{1}{2}$″ (d) x 16″ (h)
Weight:
35.2 lbs. (17kg)

The MR-990 is available from the Sanyo dealer in your area, specially selected for first-class before-and-after-sales service. Or you can write for illustrated leaflet to:

Sanyo Marubeni (U.K.) Ltd.,
Bushey Mill Lane, Watford, Herts.
Telephone: 92 25355.

SANYO

People the world over agree there's something about a Sanyo

OUR READERS write

. . . about local radio

From: Nigel Fell, BBC Radio Leeds, Merrion Centre, Leeds 2.

Dear Sir, I feel compelled to write in reply to the article 'Local Radio' in your September edition.

Mr Wright claims '. . . many amateur enthusiasts can claim a quality better than is possible in Local Radio'.

The signal transmitted by Radio Leeds is flat up to 18 kHz, as compared with the 9 kHz of Holme Moss. At 19 kHz a 35 dB attenuation is inserted into the circuit to prevent unwanted triggering of stereo decoders on domestic receivers.

The programmes are monitored in Studio 1 through a Goodmans *Tri-axiom* loudspeaker and I defy anybody to tell the difference between the Studio output and the check transmitter receiver.

Mr Wright finds it unwise to attempt anything musically ambitious. In Studio 2 we employ up to seven microphone channels plus additional facilities such as echo, reverberation, and double tracking. A response selection amplifier (RSA) is employed to give any desired effects which we might choose to use in pop music.

Monitoring in Studio 2 is carried out through an *LSU/10*, which is generally acknowledged as the finest unit of its kind in the world.

Successful recordings of pop groups of ten have been made. Four is common.

Other musical programmes are recorded on location, again using up to seven microphones, and the total output of local music amounts to over four hours a week of the best of jazz, country and western, folk, serious and popular music.

Yours faithfully,

. . . about a microphone amplifier

From: Anthony Eden, 1 Lambolle Road, Swiss Cottage, London N.W.3.

Dear Sir, With reference to F. C. Judd's article in the September issue entitled 'Pre-amplification and Mixing', I should like to make a few small points which I think may have slipped his attention.

1. The current consumption of the unit shown in **fig. 1** is slightly under 4 mA not 2 mA as stated. The second stage alone consumes about 3.6 mA.

2. His statement 'It will operate with a 200 ohm microphone, but at reduced sensitivity' is misleading. Since the 200 ohm microphone is working into virtually open circuit, the sensitivity of the microphone cannot be reduced. The gain of the amplifier is independent of the input impedance and consequently its gain cannot be reduced. What then is operating at reduced sensitivity? What I think he means is that the output of a normal 200 ohm microphone is not sufficient to load fully the input to the amplifier without the introduction of considerable noise. A typical output from such a microphone is about 0.2 mV and this will reduce the signal-to-noise ratio to about 38 dB.

3. A typical signal input level of 3 mV will be amplified to 350 mV. It can be readily demonstrated that the overload point of the amplifier occurs at 2.1 V output. This means that the overload factor is $\frac{2.1}{0.35}$ = 16 dB. This figure is far too narrow for microphone operation and a figure of 30 dB at least is required if peaks from the microphone are not to be clipped. The only practicable solution is to use the amplifier with an input not exceeding 500 μV. (i.e. from a microphone of 0.5 to 2 K impedance). The signal-to-noise ratio is then about 45 dB.

4. He quotes a signal-to-noise ratio of 60 dB and quotes an input impedance of 100 K so presumably the noise has been measured with this value of input resistor. Now, 60 dB below an output of 350 mV is 350 μV. This means that, since it has been amplified 120 times, the noise of the input resistor will be less than 3 μV (for a 0 dB NF Amplifier). However, the noise generated by a 100 K resistor measured on a 20 kHz bandwidth at 300° K is 5.5 μV. Thus, as it stands, the value of 60 dB is meaningless and this indicates that either the measurement was made on a restricted bandwidth or with an input resistor of less than 100 K. I should be most grateful to know how the measurement was made.

5. He states '. . . slight changes in component value may be necessary for optimum performance. It is recommended that only the transistors specified are used'. What is optimum performance? You may like to criticise the following analysis, but as I see it the circuit is independent of the transistor parameters and depends solely on the feedback resistors R_4, R_1 and R_3. The equivalent circuit of **fig. 1** may be represented as follows: Using Nodal Analysis we have:

$$Is = (Gs + Yie_1)V_1 - Yie_1V_2$$
$$0 = -G_4V_2 + Yfe_2V_3 + (G_4 + G_L)V_4$$
$$0 = -(Yie_1 + Yfe_1)V_1 + (Yie_1 + Yfe_1 + G_4 + G_1)V_2 - G_XV_4$$
$$0 = Yfe_1V_1 - Yfe_1V_2 + (G_2 + G_L)V_4.$$

The ratio of $\frac{V_4}{V_1}$ is required for gain of the amplifier. This can be solved either by solving the above four equations or more elegantly by solving the equations using a determinant of the circuit. The result of this is that, to a reasonable approximation $\frac{V_4}{V_1} = 1 + \frac{G_1 + G_3}{G_4}$

Since $R_1 \gg R_3$ this approximates to

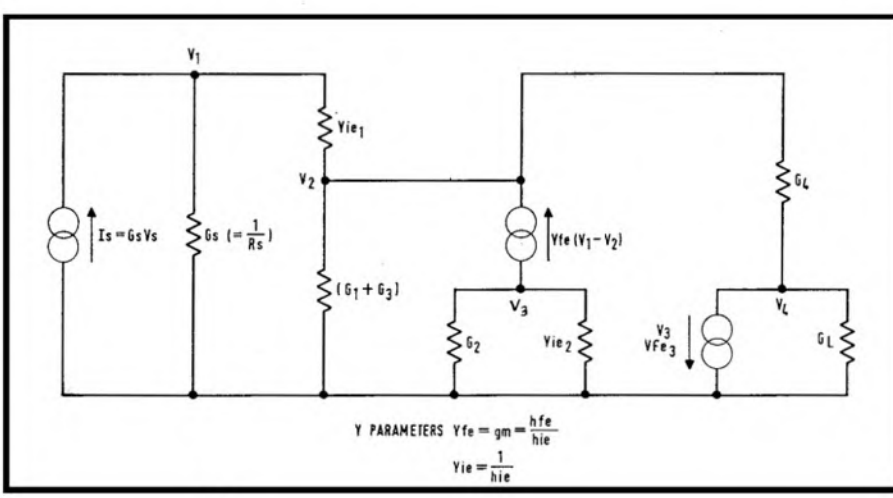
$$\frac{V_4}{V_1} = \frac{R_4}{R_3}$$

This means that, to a good approximation, the gain depends solely upon the values of R_4 and R_3 and is therefore 120 times or 41.6 dB. Therefore any transistor can be used that satisfies the DC operating conditions (almost all *n-p-n* silicon transistors) and in fact any good low noise transistor could be used. Close control of the values of R_4 and R_3 will closely control the performance of the circuit up to at least 20 kHz.

Basically, this type of 'voltage output-series input' circuit is one of the best and most stable circuits on the market except that the circuit has been incorrectly used as a microphone amplifier. Mullard in their manual describe better circuits from a matching, noise, and distortion point of view than the one Mr Judd described.

Yours faithfully,

A copy of this letter was forwarded to Mr Judd who offered no comment.—**Ed.**

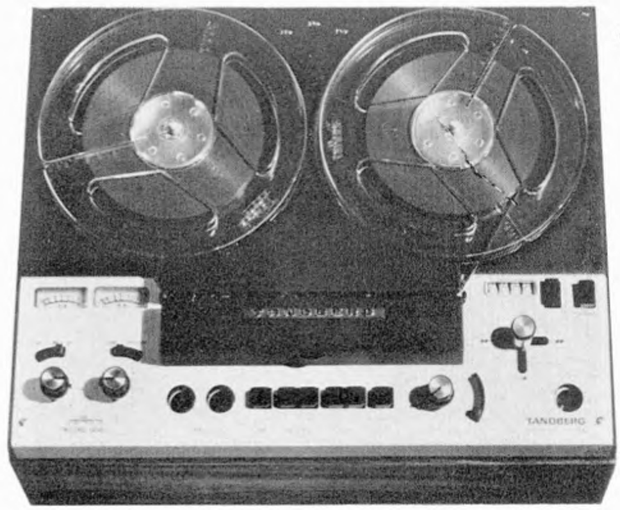


AUDIO FAIR 69

A PREVIEW OF NEW RECORDING EQUIPMENT AT THE OLYMPIA INTERNATIONAL AUDIO AND PHOTO-CINE FAIRS 1969

B

A



C

A Sony *50* Compact Cassette recorder.
B Telefunken *205* stereo.
C Tandberg *6000X* stereo tape unit.

THE largest exhibition of sound equipment ever launched in this country opens on Thursday October 16 at the London Olympia. Eighty-seven companies representing the audio industry are collaborating with fourteen from the photographic industry at the *International Audio and Photo-Cine Fairs 1969*.

The Audio Fair dates back to 1956, when an off-shoot of the British Sound Recording Association Exhibition was held at the Washington Hotel in Curzon Street. (The first BSRA Exhibition, for the record, was held in May 1948 at the St. Ermin's Hotel.) In 1957 the Audio Fair took place at the Waldorf Hotel and in 1959 at the Hotel Russell. But even this, seven floors spanning the full width of Russell Square, proved in the end too small for the thousands of visitors the fair attracted.

Moving to Olympia solves the space problem aggravated at the Russell by queueing in its narrow corridors. Demonstration room dimensions will be consistent, approximately 5 x 6 m, each housing up to 30 seats set out in five rows of six.

The success of the 1969 Fair will depend largely on the effectiveness of the acoustic insulation provided by the demonstration room structures. A mixture of hardboard and plasterboard is being used for the walls, each ceiling being of hardboard alone. The flooring will be felt-covered concrete. Ventilation will rely on an extractor fan.

This will not be the first attempt to demonstrate audio equipment in a large exhibition hall. Some years ago, Daystrom set up a listening room at Olympia for the *Do It Yourself Exhibition*. The venture was not entirely successful we learn from the Editor of *DIY*, since the acoustic isolation failed to keep out extraneous noise, mainly from machine tools. These same tools created mains interference. Some visitors complained of inadequate ventilation. At Düsseldorf last year, however, prefabrication techniques were used with much greater success in a 'one roof' audio exhibition. Ventilation there was shelved in favour of piped refrigeration.

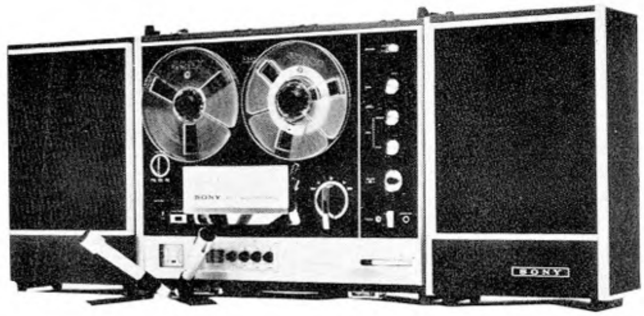
The Russell Hotel Audio Fairs were aimed mainly at audio enthusiasts, tickets being circulated mainly through equipment retailers. This year, the exhibition is being aimed at a wider public through advertising on television and in non-specialist publications. Admission, previously free, is now 4s. per head, children 2s.

A trade and press preview from 10 a.m. to 4 p.m. precedes the public opening of the audio section, 4 p.m. to 9 p.m. on Thursday 16. Opening times are 10 a.m. to 9 p.m. on Friday 17, Saturday 18, and the following Monday, Tuesday and Wednesday. The exhibition will be closed on the Sunday.

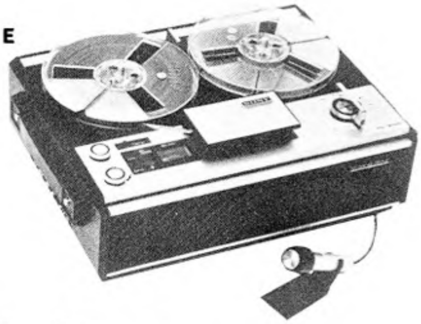
An underground shuttle service will operate throughout the exhibition period between Kensington and Olympia. Bus routes passing the hall are 701, 702, 704, 705, 714, and 716 (green) and 9, 27, 28, 49, 73 and 91 (red).

D

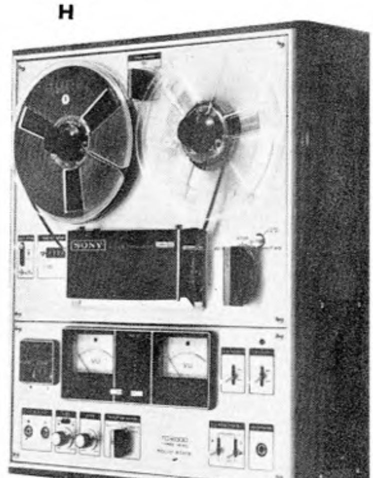
G



E



H



F

J

D Brenell *ST200* stereo.
E Sony *106*.
F and **J** Melodium microphones.
G Sony *560* stereo.
H Sony *630D* stereo tape unit.
I Sony 252D stereo tape unit.

A 'ten minute long explosion of sound' accompanied by colour pictures of London has been prepared by **Agfa-Gevaert** to demonstrate their new *PE.36* LP, *PE.46* DP and *PE.66* TP low-noise tapes. These are being marketed alongside their standard range and cost 5% to 10% more.

Keith Monks (Audio) Ltd., exhibiting under the **Audio & Design** trade name, will display a range of *Melodium* microphones they are now importing from France. These range from a studio ribbon model at £45 to a Lavalier microphone at £9 4s. 3d.

Visitors to the **BASF** room will be invited to hear on headphones a selection of music 'For a City' and to take away a ½-track stereo copy. LP *35LH*, DP *26LH* and TP *18LH* low noise tapes will be displayed alongside Compact Cassettes in the new *KK8* container, described as ideal for tape correspondence.

Centrepiece of the **Bang & Olufsen** demonstration will be the new *2400*, a ¼-track stereo recorder operating at 19, 9.5 and 4.75 cm/s. Hyperbolic heads and silicon transistor circuitry are claimed to contribute to a 60 dB signal-to-noise ratio at 19 cm/s with low noise tapes. Four pairs of slide potentiometers govern microphone, radio, gramophone and line inputs, a fifth pair controlling output level from the internal power amplifiers.

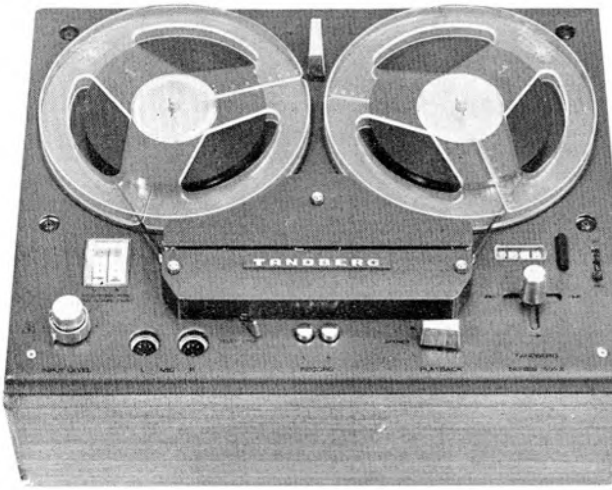
The recently introduced *ST200* transistor stereo recorder will be demonstrated by **Brenell.** Retailing at £145 including tax, it operates at 19, 9.5 and 4.75 cm/s and accommodates spools of up to 21 cm diameter. Three outer-rotor motors are employed, the capstan motor being hysteresis synchronous. 19 cm/s specification includes 0.08% wobble, 40 Hz to 14 kHz ±2 dB frequency response, 56 dB weighted signal-to-noise ratio, 60 dB crosstalk rejection (with HF bias on second track) and 3% third-harmonic distortion. Output power from the internal amplifier is 6 W RMS per channel, bass and treble controls providing —14 to +10 dB at 100 Hz and −18 to +5 dB at 10 kHz respectively. The tone controls operate during both record and play. Input sensitivities are 50 μV at 200 ohms (microphone) and 40 mV at 220 K. Outputs are 200 mV into 47 K (external amplifier), 2 V at 100 ohms (headphones or external amplifier) and 15 ohms (external loudspeaker).

The presentation of **British Amateur Tape Recording Contest** prizes will be made at the Audio Fair by Mr. Douglas Brown.

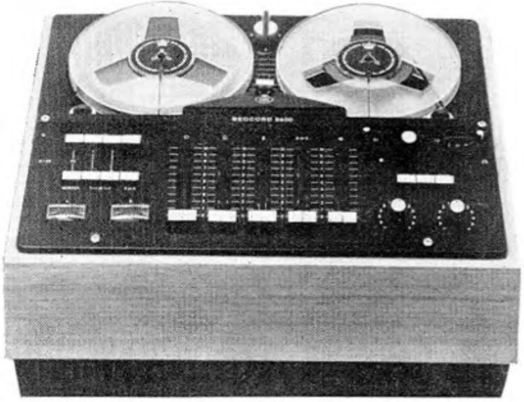
A universal synchroniser for tape recorders and automatic relay-change slide projectors will be shown for the first time by **Colton**, in addition to a tape storage rack and an extensive range of gramophone accessories.

No new recorders are expected from **Dual** and the company's tape interests will be represented by the *TG28* stereo tape unit. This relatively low-price design incorporates supply and take-up tension servos and operates at 19 and 9.5 cm/s. *(continued overleaf)*

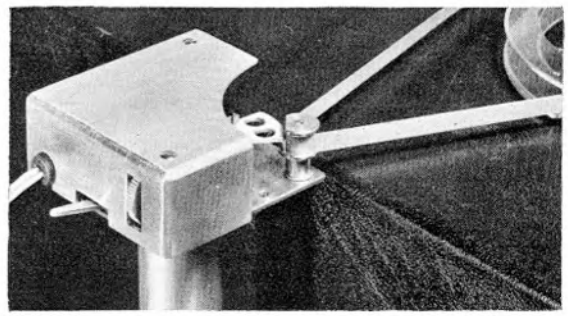
K



L



M



N

K Tandberg ***1600X*** **stereo tape unit.**
L Trio ***TT-10*** **stereo tape unit.**
M Bang & Olufsen ***2400*** **stereo.**
N Colton universal slide synchroniser.

A highlight of the 1968 Audio Fair for many visitors must have been the introduction of the Ferrograph *Seven* series of recorders. The series was not given a formal demonstration last year, the emphasis then being on encouraging visitors to see and handle the mechanism at close hand. Eight versions of the *Series Seven* are available, varying in price from £174 13s. 6d. to £212 7s. 6d. All carry tax though a tax free *Series Y* range is available for industrial application.

Eight recorders will be displayed and demonstrated by **Grundig**, including the *C200*, a cassette battery portable costing £36 17s. 6d. and a ¼-track reel-to-reel machine, the £55 18s. 10d. *TK149*.

Two new stereo ribbon microphones, the *4-25* and *4-35*, will be on show at the **Lustraphone** stand. Also to be displayed are the established *Series Four* ribbon and dynamic models, the noise-cancelling twin-ribbon *4-70*, and a range of stands, mounts, booms and accessories.

Splicers for 6.25 mm and 12.5 mm tape will be seen on the **Multicore** stand. The Bib range of audio accessories also includes head cleaning kits, several permutations of fluid applicators, brushes, tissues, polishers and anti-static fluid. Prices are from £3 9s. 6d., a kit intended for studios and service organisations, to 9s. 9d.

All six headphones in the American **Koss** range will be demonstrated by the importers, Tape Music Distributors Ltd. Model *ESP-9* incorporates capacitor transducers and, built into one earpiece, self-polarizing circuitry. This takes its energy from the audio signal itself or from a separate AC line. Claimed frequency response is 15 Hz to 15 kHz ± 2 dB with 0.2% THD at 110 dB SPL. The headphones work from 4 to 16 ohm amplifier power outputs and cost £69. Other Koss models, moving-coil, are the £45 *ESP-6*, £37 10s *ESP-7*, £23 *PRO-4A*, £16 10s. *KO727* and £12 10s. *K-6*.

A ¼-track stereo recorder with a comparatively low price, £76 10s. including tax, will be shown by **Philips**. Designated the *4404*, it operates at 19, 9.5 and 4.75 cm/s and accepts 18 cm spools. The *4407* costing £101 19s. 4d., has more elaborate tone controls and mixing facilities, independent level meters on each channel and greater output power. Most versatile of the Philips domestic range is the *PRO-12*, aimed at the keen amateur and priced at approximately £235 including tax. Tape speeds are 19 and 9.5 cm/s.

Revox, who have hitherto specialised solely in recording equipment, will this year demonstrate the *A.50* 40 W continuous sine-wave per channel amplifier and *A.76* FM IC/transistor hybrid stereo tuner. Prices are £103 19s. (*A.50*) and £156 9s. (*A.76*). The *A.77* recorder in its domestic form varies from £187 19s. (stereo unit in wood or metal surround) to £223 13s. (internal amplifiers and speakers). NAB versions for studio/industrial applications start at £138 tax free. Visitors to the Revox room will be able to make their own recordings, monitoring on headphones.

Seven mains ¼-track stereo recorders and a series of battery portable reel-to-reel and cassette machines are to be exhibited by **Sanyo**. Prices are £132 5s. (*MR-990*), £112 5s. (*MR-939*), £101 5s. (*MR-999*), £97 5s. (*MR-929*), £90 15s. (*MR-151* stereo mains/battery and *MR-800*), £84 15s. (*MR-910*) and £79 15s. (*MR-801*).

No less than 13 new recorders will be

found in the **Sony** demonstration room, in addition to the recently announced *666D* and *630* (October 'New Products'). The *630D* is a tape unit version of the *630* and costs £164 15s. Model *560*, at £240, features a foil-free automatic reverse and, though conceived as a mains design, may be powered direct from a 12 V DC car battery.

The *TC540* is another ¼-track stereo recorder and costs £149 15s. Two LF monitor speakers are incorporated in the cabinet, middle and high frequencies being fed to detachable lid units. Similar facilities but detachable speakers only, are accommodated in the £99 15s. *TC-252*. Model *106* is a ½-track mono machine with switched manual or automatic level control and a £58 10s. price tag.

All the Sony models hitherto mentioned operate at 19, 9.5 and 4.75 cm/s. The *252D* is an exception, a stereo tape unit operating at 9.5 and 4.75 cm/s and costing £72 15s.

A three-speed version of the *800* battery portable is being introduced. The *800A* operates at 19, 9.5 and 4.75 cm/s, takes 13 cm spools and retails at £84 15s. Six new cassette models will be shown, including a 144 x 91 x 36 mm ($5\frac{7}{16}$ x $3\frac{9}{16}$ x $1\frac{7}{16}$ inches if that doesn't impress you) battery recorder with a built in microphone and loudspeaker. The *50* is described as a high quality Compact Cassette recorder for office, commercial or personal use. At £83 15s. it needs to be.

The £97 15s. *124CS* is a mains/battery stereo cassette recorder with a twin element microphone and detachable extension speakers. Specified wobble at 4.75 cm/s is 0.28% RMS. An 'electret' capacitor microphone is built into the *80* cassette recorder, again designed for office use. Price is £49 15s.

Separate loudspeakers are supplied with the *130* mains stereo cassette recorder. This model retails at £112 including stereo microphone. The *125* is essentially a tape unit version of the *130* and costs £62 10s. Designed for car installation, model *20* is yet another stereo cassette machine, supplied complete with a pair of speakers and selling at £74 15s.

Teac and **Trio** will both be represented at the exhibition by B. H. Morris & Co. (Radio) Ltd. Trio, who formally concentrated on amplifiers and tuners, have produced a three-head ¼-track stereo tape unit. Speeds of the *TT-10* are 19, 9.5 and 4.75 cm/s and spool capacity is 18 cm.

The new *6000X* stereo tape unit represents the first major change of **Tandberg** styling for many years. Basic mechanism and four-way joy-stick are the same but the control panel contrasts brightly with the rest of the deck. This design replaces the *6X* and costs £193 10s. Model *1600X* is a low-price ¼-track stereo tape unit costing £89 10s. In common with the *6000X*, it employs back bias.

Telefunken will demonstrate the *204TS* as part of a complete domestic audio system. A ¼-track stereo recorder with 19, 9.5 and 4.75 cm/s speeds and internal side-facing loudspeakers, the *204TS* retails at £124 19s. Among new models on display, though not for demonstration, will be the *201 de luxe*, *202*, *205* and *207*.

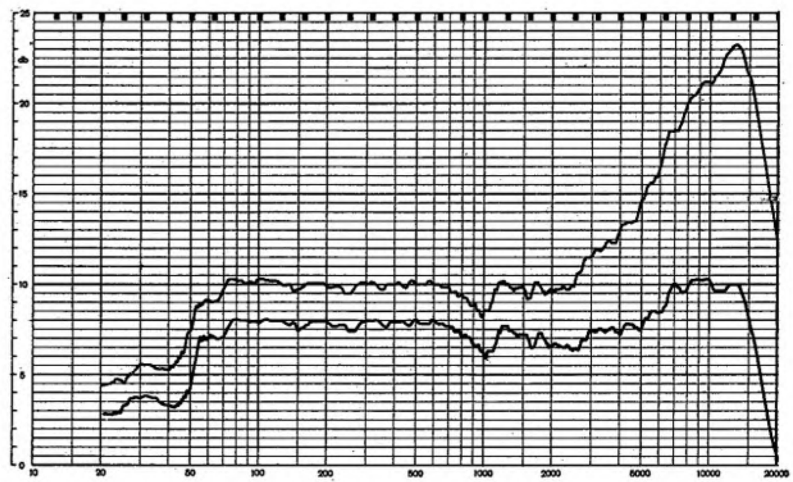
Visitors to the 1968 Audio Fair will note the absence this year of Ampex, Chilton, Grampian Reslo, Sennheiser, STC, Studer, Truvox, Tape Recorder Developments and Vortexion. A formidable list to lose but a loss that the Audio Fair seems healthy enough to withstand.

AUDIO EXHIBITORS

Trade Name	Manufacturer or Distributor	Location
Agfa-Gevaert	Agfa-Gevaert Ltd.	Upstairs North
Aiwa	Aiwa Co. Ltd.	Downstairs
Akai	Rank Organisation	Upstairs North
Arena	Highgate Acoustics	Downstairs
Armstrong	Armstrong Audio Ltd.	Upstairs South
Audio & Design	Keith Monks (Audio) Ltd.	Downstairs
Audio Packs	Tape Recorder Spares Ltd.	Upstairs South
Audio Record Review	Heathcock Press Ltd.	With Hi-Fi News
Audio Technica	Shriro (UK) Ltd.	Upstairs North
BASF	BASF (UK) Ltd.	Upstairs North
B & O	Bang & Olufsen (UK) Ltd.	Downstairs
B & W	Bowers & Wilkins Electronics Ltd.	Downstairs
Brenell	Brenell Engineering Co.	Downstairs
BBC	British Broadcasting Corporation	Downstairs
BSR	BSR Ltd.	Upstairs South
Bush	Rank Bush Murphy Ltd.	Upstairs North
Celestion	Rola Celestion Ltd.	Upstairs North
Colton	Colton & Co. (Lapidaries) Ltd.	Downstairs
Connoisseur	A. R. Sugden & Co. Ltd.	Upstairs North
Decca	Decca Record Co. Ltd.	Upstairs South
Diamond Stylus	The Diamond Stylus Co. Ltd.	Upstairs South
Dual	Dual Electronics Ltd.	Downstairs
Electrical & Electronic Trader	Iliffe Ltd.	With Wireless World
EMI	EMI Electronics Ltd.	Upstairs South
FBTRC	Federation of British Tape Recordists and Clubs	Downstairs
Ferguson	British Radio Corporation Ltd.	Upstairs North
Ferranti	Ferranti Ltd.	Upstairs North
Ferrograph	The Ferrograph Co. Ltd.	Upstairs South
Garrard	Garrard Engineering Ltd.	Upstairs North
Goldring	Goldring Manufacturing Co. Ltd.	Upstairs South
Goodmans	Goodmans Loudspeakers Ltd.	Upstairs North
The Gramophone	General Gramophone Publications Ltd.	Downstairs
Grundig	Grundig (GB) Ltd.	Upstairs North
Hacker	Hacker Radio Ltd.	Downstairs
Heathkit	Daystrom Ltd.	Upstairs North
HFDA	Hi-Fi Dealers Association	Downstairs
Hi-Fi News	Link House Publications Ltd.	With Tape Recorder
Hi-Fi Sound	Haymarket Press Ltd.	Upstairs North
High Fidelity Magazine	Billboard Publications Ltd.	Upstairs South
HMV	British Radio Corporation Ltd.	Upstairs North
Howland-West	Howland-West Ltd.	Downstairs
Jordan-Watts	Boosey and Hawkes (Sales) Ltd.	Downstairs
KEF	KEF Electronics Ltd.	Upstairs South
Koss	Tape Music Distributors Ltd.	Downstairs
Leak	H. J. Leak & Co. Ltd.	Upstairs South
Lowther	Lowther Manufacturing Co. Ltd.	Upstairs North
Lustraphone	Lustraphone Ltd.	Upstairs North
Lux	Shriro (UK) Ltd.	Upstairs North
Luxor	Highgate Acoustics	Downstairs
MB Microfonbau	Denham & Morley Ltd.	Downstairs
Metrosound	Metrosound Manufacturing Co. Ltd.	Upstairs South
Mordaunt-Short	Mordaunt-Short Ltd.	Upstairs South
Mullard	Mullard Ltd.	Downstairs
Multicore	Multicore Solders Ltd.	Downstairs
Ortofon	Metrosound (Sales) Ltd.	Upstairs South
Peerless	P. F. & A. R. Holme Ltd.	Downstairs
Perdio	Dansette Products Ltd.	Upstairs North
Philips	Philips Electrical Ltd.	Upstairs North
Philips Records	Philips Records Ltd.	Downstairs
Pickering	Highgate Optical & Industrial Co. Ltd.	Downstairs
Pioneer	Swisstone Ltd.	Upstairs South
Practical Electronics	IPC Magazine Ltd.	Downstairs
Practical Wireless	IPC Magazine Ltd.	With Practical Electronics
Quad	Acoustical Manufacturing Co. Ltd.	Upstairs South
Record Housing	N. & S. B. Field & Co.	Upstairs North
Records & Recording	Hansom Books Ltd.	Downstairs
Revox	Revox Ltd.	Upstairs North
Rotel	Rank Organisation	Upstairs South
Richard Allan	Richard Allan Radio Ltd.	Upstairs North
Sansui	Brush Clevite Co. Ltd.	Downstairs
Sanyo	Marubeni-Iida	Downstairs
Scotch	Minnesota Mining & Manufact'g Co. Ltd.	Upstairs South
Shure	Shure Electronics Ltd.	Upstairs North
Sinclair	Sinclair Radionics Ltd.	Downstairs
SME	SME Ltd.	Upstairs North
Sony	Sony (UK) Ltd.	Upstairs North
Tandberg	Elstone Electronics Ltd.	Upstairs North
Tape Recorder	Link House Publications Ltd.	Downstairs
Tape Recording Magazine	Print & Press Services Ltd.	Downstairs
Teac	B. H. Morris & Co. (Radio) Ltd.	Upstairs North
Telefunken	AEG (GB) Ltd.	Upstairs South
Teleton	Teleton Electro (UK) Ltd.	Downstairs
Thorens	Metrosound (Sales) Ltd.	Upstairs South
Toshiba	Hanimex (UK) Ltd.	Upstairs South
Transcriptors	Transcriptors Ltd.	Downstairs
Trio	B. H. Morris & Co. (Radio) Ltd.	Upstairs North
Uher	Bosch Ltd.	Upstairs North
Wharfedale	Rank Wharfedale Ltd.	Upstairs North
Whiteley	Whiteley Electrical Radio Co. Ltd.	Upstairs South
Wireless World	Iliffe Ltd.	Downstairs
Yamaha	Actina Ltd.	Downstairs

Constructing a Capacitor Microphone

John Penty describes an easily built omni-directional unit



B & K frequency response traces with 0.25 μF capacitor at output (lower curve) and without capacitor.

TO produce a tape comparable in quality with that of a professional studio the advanced amateur recordist often lacks only one item of equipment—a high-grade capacitor microphone. His actual machine, although not as rugged and capable of giving day-in and day-out high quality performance as the studio equipment, is usually capable of providing a frequency response of 40 to 18 kHz ±3 dB at a decently low level of distortion and noise. This frequency response is considerably better than most dynamic or ribbon type microphones in the £15 to £20 price bracket. It is true that capacitor microphones are available for less than £50 but the cost of the well-known makes is very much higher.

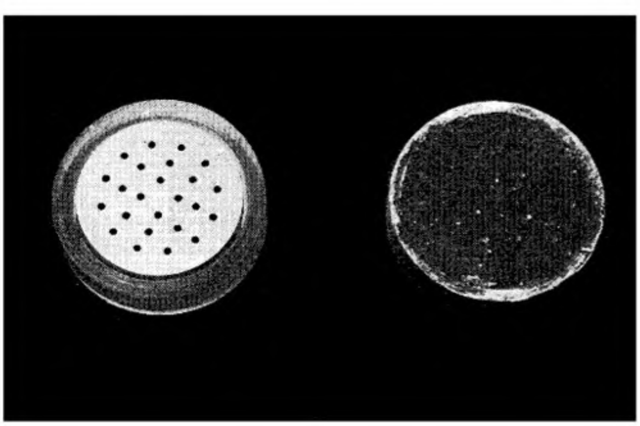
This constructional article is the outcome of many months of experiments to create a capacitor microphone using an FET head amplifier and powered from dry batteries. The results have proved that, with only a lathe, drilling machine, small tools and reasonable skill, such a microphone can be produced giving a performance very close to that obtained from the best professional models.

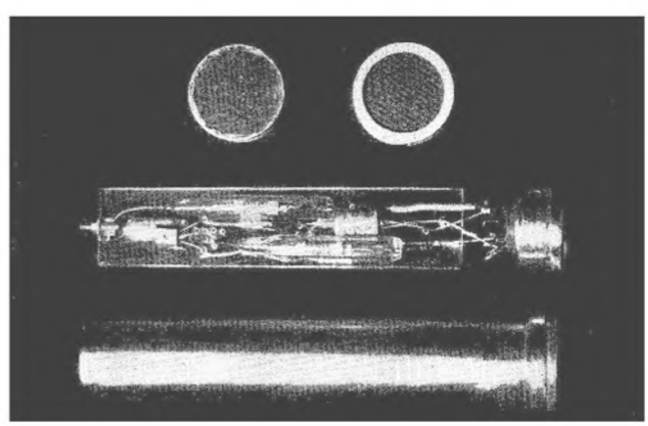
The case is a $4\frac{1}{4}$in. length of $\frac{3}{4}$in. diameter copper water pipe, machined square at each end. The cap that holds the capsule is in two parts turned from 25mm brass rod. The short sleeve is bored to a puch fit on the copper tube to the sizes shown in the diagram and a thread screw cut between 45 and 50 turns per inch, depending on the lathe wheels available. This is pressed and soldered to one end of the tube with $\frac{1}{16}$in. of thread beyond the end of the tube. The cap is next machined to size and screw cut inside to an easy fit on the sleeve. When completed the capsule is gripped between cap and sleeve and this in turn holds the amplifier board, which is screwed to the back of the capsule.

To complete the case, the base ring is turned a sliding fit in the $\frac{3}{4}$ in. tube; this is then drilled to take a four-core screened cable, either standard or light gauge, or opened out to a press fit for a five-pin DIN socket, as shown in the photograph. The ring is held in place by a 10 BA screw. The cap is finished by fitting a disc of fine copper gauze in the front recess and securing with solder. The completed case can now be chromium-plated.

Making the capsule demands care, good machining and thorough cleaning. The back-plate is turned from Dural rod and after turning to size the positions for the acoustic holes are centre punched. These are indexed by employing a 24-tooth gear wheel on the lathe spindle or by a dividing head. With a 24-tooth wheel, every sixth, third or second tooth will index 4, 8 and 12 hole positions.

To centre pop accurately a simple punch





Editor's Note : *Readers wishing to construct capacitor microphones suitable for crossed-pair stereo recording to await Trevor Attewell's cardioid design which will be described in the January and February issues.*

guide held in the tool post is required. This consists of a piece of ⅜in. square steel a few centimetres long drilled across one end with a ⅛in. diameter hole. The punch is 2in. of ⅛in. silver steel with a point ground at one end. This slides in the hole and the assembly is held in the tool post with the punch point level with the centre of the work. The top slide is now wound back 1/16in. and at each of the four hole positions a light tap on the punch will produce a clean and accurate mark for drilling. After repeating this operation for the middle and outer rings of holes, the blank is parted or sawn off and the back cleaned up and drilled and tapped to 10 BA. To drill holes of 0.035 inch diameter and ⅜in. deep requires a drill running at high speed fitted with a depth stop. Most electric drills can be adapted to do this.

As a broken piece of drill can rarely be got out of a hole, special care must be taken to avoid this happening. Use plenty of thin oil and withdraw the drill frequently to clear the flutes for each hole. The final finish on the backplate is obtained by grinding the face flat on either a new fine oilstone or on a piece of very fine wet and dry paper on a sheet of glass. When finished the face should be flat with a fine matt surface. All traces of dirt and grinding paste must now be cleaned away by washing in petrol or cellulose thinners, prodding each hole with a wire until quite clean. The Perspex ring is now turned to size and bored to a press fit for the backplate. At the same time as boring, a skin is taken across the front face of the ring, on which the diaphragm will be stuck. The backplate is now given a smear of Araldite and pressed into the ring from the back. To set the gap at 37μ (1.5 thou.), a feeler gauge of this thickness is used to space the backplate from a piece of flat ground steel held across the front face of the capsule. Allow about 24 hours for this to set.

The diaphragm has now to be stuck on to the capsule. This diaphragm is a piece of 25 gauge Melinex aluminium sputtered on one side. As this material is only 6μ thick it is very difficult to handle, but the method now to be described has been found simple and straightforward in practice. Cut a 1¼in. hole in a 2in. square of 18 or 20 gauge aluminium sheer, lightly coat around the hole with Evostik and attach a 2in. square of Melinex over the hole with the metallised side to the plate. When set this can be turned over and placed over the capsule, plain side to the backplate. Pressure with a weight of 4 oz. will now stretch the Melinex evenly and at the correct tension. A very thin and smooth film of Araldite is applied around the Perspex edge of the capsule after again checking for ingress of dust or dirt. Then press the capsule in the centre of the Melinex, turn over and apply the weight. Leave this assembly to set for at least 24 hours before trimming the edge with a razor blade and removing the capsule from the ring. When assembled the capsule circuit is completed by the aluminium sputtering on the outside of the Melinex being earthed by the cap.

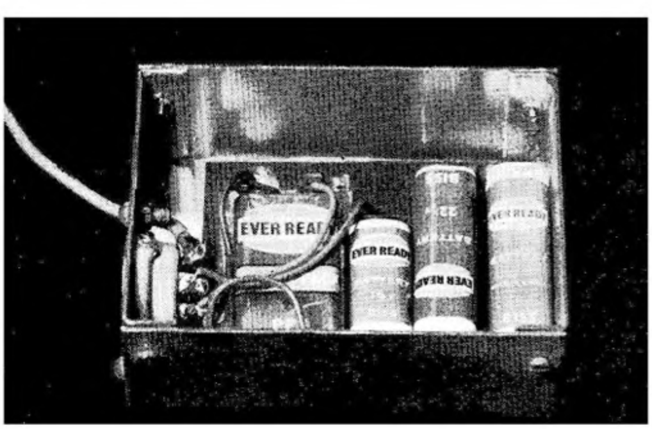
The head amplifier consists of a high input impedance FET followed by a *p-n-p* transistor as a cathode follower. The capsule capacity is about 50 pF giving it an impedance of over 60 M at 50 Hz. The amplifier input impedance has, therefore, to be at least double this value. This calls for two high value resistors in the input. These are normally difficult to find and expensive. Fortunately, a supply of glass encapsulated resistors of values between 125 M and 1,000 M is available from Proops and any two of these resistors between the values stated seem to work well in this amplifier.

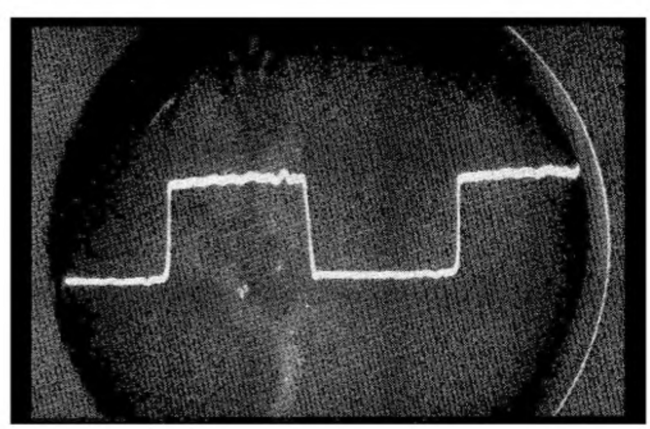
The insulation of all components in the input circuit, including the panel board has to be of a very high order to keep noise (hiss) to a minimum level. Therefore, ¼in. Perspex is used for the components board. This is drilled and tapped 10 BA in the centre of one end and a 10 BA screw put in and the head cut off. A small brass solder tag is locked in place with a 10 BA nut and 1/16in. of thread left to screw into the capsule. The suggested layout for components (see sketch) has been found to work well and allow room for the completed board to slide into the ¾in. diameter tube. The output impedance is about 100 ohms and the microphone feeds into a 200 ohm unbalanced line.

The microphone is powered by a 9 V *PP4* battery for the amplifier and two 22.5 V and one 15 V flash-gun batteries for the capsule polarizing voltage. These can be mounted in any convenient box. A small panel with spring contacts to connect the flash batteries is required, with an Octal or DIN socket on this box to act as a switch and connector for the 2 m of four-core cable. A screened output lead from the box can be terminated with a jack plug to connect with further cable, if required.

First tests on samples of the completed

(continued on page 455)





New Tandberg 1600X stereo tape deck

4 tracks. Frequency response: 40-18,000; 40-14,000; 40-8,000 cycles ± 2dB at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s. respectively. Signal-to-noise ratio better than −55dB −53dB and −52dB at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s. respectively. Wow and flutter less than 1 R.M.S., ·15 R.M.S. and, 35 R.M.S. at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s. respectively. Cross talk better than − 60dB. ·9v output per channel. Teak cabinet. £89.10.0

Send me full details

NAME

ADDRESS

Farnell - Tandberg **Dept.TR5**
Hereford House
Vicar Lane, Leeds 2

Cross-field bias head. Under £90

move up to **Tandberg** 

Farnell-Tandberg Ltd., Hereford House, Vicar Lane, Leeds 2.

microphone showed that the capsules had a rising HF response. This was confirmed later when, with the co-operation of friends with access to B & K frequency response recorders, some pen recordings were made in an anechoic chamber. Fortunately, the shape of the response was such that suitable correction only needed a 0.2 μF to 0.4 μF capacitor across the output of the head amplifier, the chosen value being dependent on the individual listening response obtained and personal preferences in sound quality. Incidentally, this capacitor is best housed in the battery container as it is unlikely that the microphone case can accept it.

The bass end is very flat right down to 30 Hz. Additional checks were made with electrostatic excitation* of the diaphragm and a 1 kHz. square wave displayed on a CRO showed the remarkably flat overall response.

The finished microphone has now been in regular use for several months and has been put into active service at a number of recording sessions. At these sessions, the opportunity was taken to compare its performance with other high-grade microphones from reputable manufacturers, including the STC *4038*. The sound was monitored on a Quad ELS speaker and on A. R. Bailey's *Wireless World* design studio speaker system. The principal aural impression is one of extreme clarity and naturalness. Sounds with steep wavefronts, such as the triangle, the tympani, and certain instruments of the brass section, take on a vividly realistic presence when picked up by this capacitor microphone. Speech reproduction is natural with no excessive sibilance.

The finished microphone is robust and free from microphony and hum induction. If balanced line output is required, a 1:1 transformer can be fitted in the battery box.

In conclusion, I would like to extend my thanks to Mr. D. E. O'n. Waddington for the head amplifier circuit, which formed part of the sensitive FET Voltmeter design in *Wireless World*, May 1968.

**Electrostatic Excitation for Capacitor Microphones*, from 'Acoustical Techniques and Transducers' by M. L. Gayford, Macdonald & Evans, 1961. (Appendix IV, page 349.)

COMPONENTS

Transistors:

T_1: *2N 3819*
T_2: *2N 3702*

R_1: 250 M (from *Proop Bros. Ltd.,*
R_2: 250 M *52 Tottenham Court Road, London, W1 P0BA)*
or any value between 125 M to 1,000 M

Resistors:

R_3: 12 K
R_4: 2.7 K (0.25 W, low noise)
R_5: 1.5 K

Capacitors:

C_1: 1000 pF Polystyrene
C_2: 50 μF 6.4 V Mullard Miniature Electrolytic
C_3: 0.2 μF approx. (to be determined by experiment)
Octal or DIN socket

Diaphragm Material:

25 gauge Vapcolex Metallised Melinex. One square foot (cost around 3s. 6d.) aluminized on one side, from
George M. Whiley Ltd.,
Victoria Road,
South Ruislip,
Middlesex.

FIG. 1 CAPSULE AND CASE LAYOUT

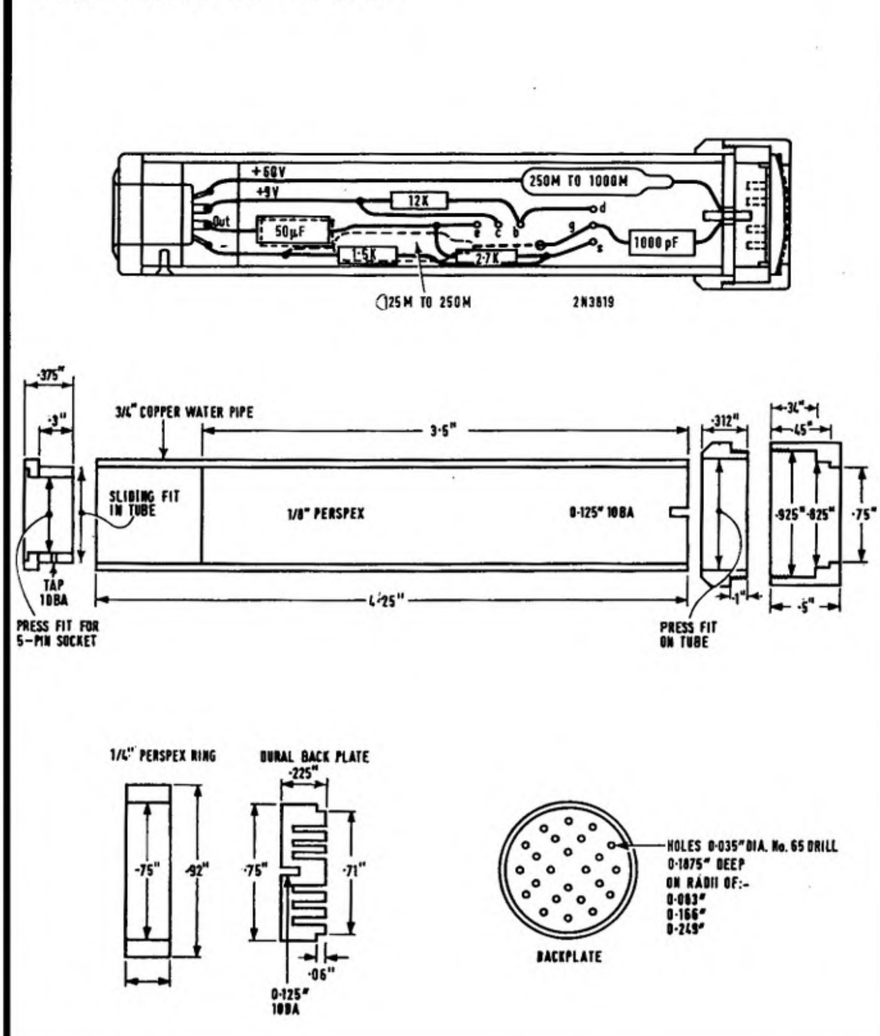
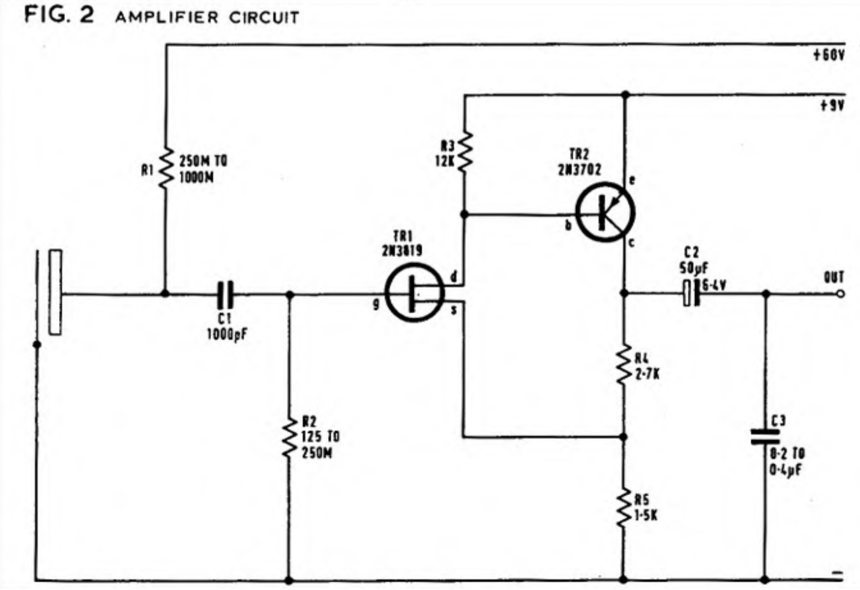


FIG. 2 AMPLIFIER CIRCUIT



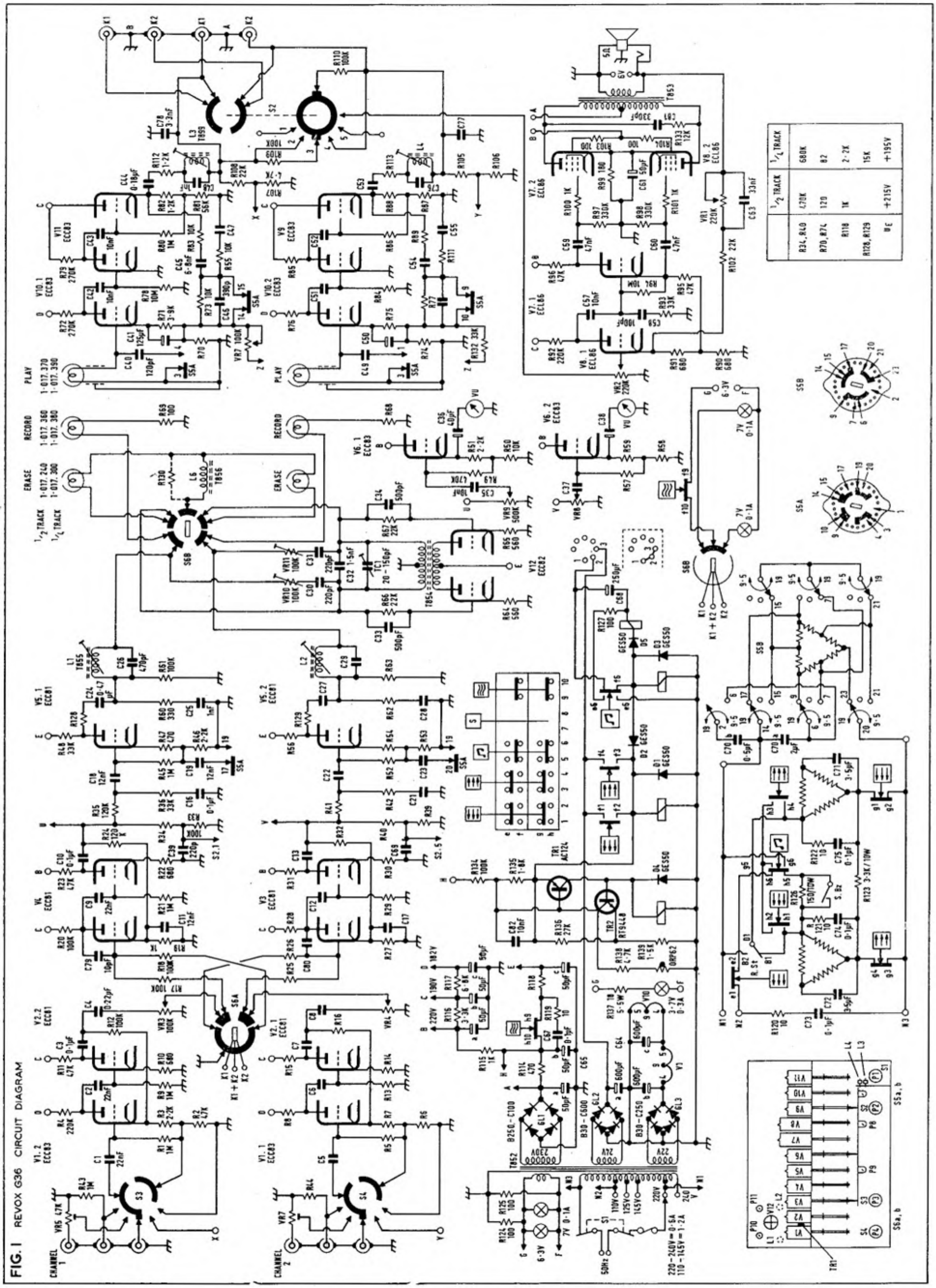
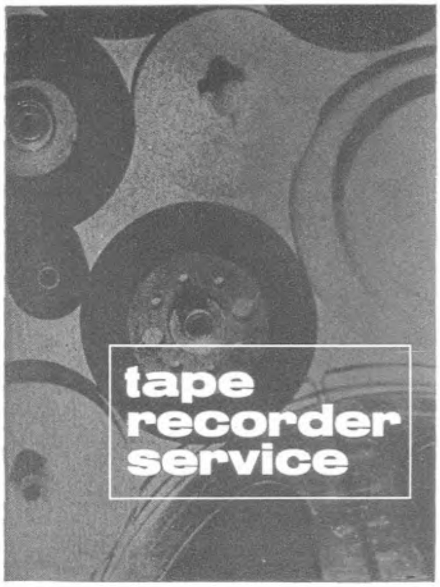


FIG. 1 REVOX G36 CIRCUIT DIAGRAM



SOME GENERAL PROBLEMS

BY H. W. HELLYER

READER G. H. D. of Thetford, Norfolk, recently completed the construction of a Paraline loudspeaker from plans in *Five Speakers, How to Make Them*. On connecting the loudspeaker outlet of his Akai *X4*, he was disturbed by an immediate jump in hum level compared with the quality of the recorder's internal monitor. Investigation showed the mains unit to be responsible, since the hum vanished when operating from batteries. Hiss also worried G.H.D., whose letter ended with a frantic threat to tear his hair out. This is a case, I fear, of 'opening the window'. The plain answer is that the very much wider range (and higher electro-acoustic efficiency) of the Paraline is reproducing hum and hiss that was previously hidden by the inferior internal speaker. The Paraline cannot be blamed for doing its job properly and blame must lay at the door of the Akai. Hum in the power unit can sometimes be cured by replacing the large electrolytics and adding another filter section at the tape recorder connector end. If the transformer is at fault, however, there is little that can be done about it. Little, too, to do about hiss, which is excessive on many Akai models, short of redesigning the input stages.

W.P.T. of Scarborough purchased a Revox *736* in October 1967 and was from the outset bedevilled by a noisy capstan motor. Its rhythmic mechanical thudding was intermittent at first but rapidly deteriorated. The machine was eventually returned to the importer's northern representative who informed W.P.T. that the noise was caused by the spindle moving vertically in its seating. The offending bearing was packed with heavy grease and returned to its owner, but within a few days demanded further attention. This is in fact a legitimate method of reducing endplay and is effective for the lifetime of the motor if done properly. As the fault has recurred, I would suspect one of two things. First, a flaw in the bearing, causing overheating, subsequent loss of lubrication, and recurrence of endplay. Alternatively, a drive fault that accentuates the endplay regardless of packing. In either case this warrants further investigation. I know at least two *736* owners who have put up with the noise for months, believing it to be inherent in the Papst motor design. This is far from being the cause, however, and the motor should develop no more than a soft whistle when in operation. The *736* does not take kindly to kitchen table transplants and persistent badgering of the importer is the only way to get things done. Hammonds care sufficiently about their reputation to replace an incurable motor.

There is nothing wrong with F.J.B. of Peterborough's Grundig *TK120*. The only problem is that he wishes to use the recorder in his boat and wonders whether a commercial vibrator would work effectively from a 12 V car battery. It is not in fact possible to run the *TK120* from anything but a sinusoidal supply, either 110-117 V at 60 Hz or 200-240 V at 50 Hz. Vibrator supply units are not suitable for the synchronous motor in this machine. Although there are electronic converter units on the market, notably those by Valradio Ltd., they are rather an expensive proposition and would cost more than a decent battery portable. The latter is the ideal solution, working from internal batteries or through a car battery adaptor.

F.A.B. of Cobham owns a Philips *EL3586* battery portable which takes some four seconds to reach its 4.75 cm/s speed (who was it said tape recorders are like people, no two being the same?) and has to be helped by hand when rewinding. The root cause of this trouble is probably the motor, which is designed to work under very close tolerances and suffers from sluggish action if the drive conditions are incorrect. The pivot points and driving surfaces all have to be clean and correctly tensioned. This is no design on which to learn tape recorder servicing and I implore owners of the *EL3586* and *EL4200* to return faulty models to Combined Electronic Services (the Philips service network) or to a competent dealer. Sorry to be so damping.

S.E. of Llanelli bought himself a Bang & Olufsen *2000T* some time ago and sent me a long angry letter detailing its faults (flutter, a stiff feed spool, an inoperative tape counter and a switch that didn't). The local B & O dealer from whom the recorder had been purchased delayed three months before collecting it and a further month before forwarding it to the B & O importer in Gloucester. Two months later, he was still awaiting its return. First, allow me to jump in quickly with a defence of B & O, and particularly of the *2000T*. I can assert confidently, having bought one myself and maltreated it abominably, lugging it around the country in the boot of my car on various lecture-demonstrations: it has never given me any trouble and is a versatile match to any of the other equipment I care to couple to it. Small troubles can develop on *anything*. S.E. ended his letter by

(continued overleaf)

Editor's Note: *We learn with regret that H. W. Hellyer is currently down with bronchitis and unable to contribute this month's column. To keep the flag flying in a series that has run non-stop for nearly seven years, we have assembled some of his recent correspondence on servicing matters with readers. Mac Hellyer has long been the backbone of our Advisory Service, in collusion with Graham Balmain and John Fisher, and the following notes have been a pleasure to prepare.*

promising to buy British in future, but I could make his hair stand with tales of faults I have experienced on new British equipment! But the dance he has been led was unforgivable and he was right to complain.

This illustrates one argument I have been making for a long time (granted, I have a vested interest, as Technical Director of a local Tape Recorder Centre). If you want good after-sales-service on domestic equipment, you simply *must* buy from the specialist. The little man down the road may be very helpful but he is not equipped to do repairs on elaborate and delicate equipment. It would not be economic for him to invest in a £500 'scope and £100 wobblemeter for two or three jobs a year. Don't blame him too much but nag him to get on to the distributors who should have given S.E. much better service.

C.C. of Sutton Coldfield was troubled by what he described as 'a gargle on any note from middle-C up, especially sustained ones and complex tones like the tenor saxophone'. The fault was present in his Tandberg *64X* which objected to new tape (*Dynarange* and others) but performed decently after the tape had been polished by a few runs. His final comment is, and I detect a musician's scepticism, 'to judge by the amount of miracle *Superlife* coating which sheds at the erase head during running-in, there is nothing wrong with the pad pressure'. It is quite true that tapes which have been 'polished' by a few preliminary runs give better results than new reels, notably an extra two or three decibels around the 10 to 15 kHz mark. However, C.C.'s trouble seems more like the usual Tandberg trouble of erase head pressure-pad tensioning. Check the leaf spring and the surface of the pad itself. This surface should be quite soft, even fluffy, and it may be necessary to treat the pad in the usual way, with a drop of spirit lightly applied at the front end, ensuring that the spirit does not soak all the way through to the mounting to loosen it.

Check also that the back-bias head is not fouling on the front of the record head plates; I have had a couple of these with record heads very slightly lifted so that the bias head is ineffectively retarded.

Your remarks about oxide shedding at the erase head give the clue: really there should be an absolute minimum. I have found *Dynarange* the best bet on these machines, or the professional BASF *PES40*. C.C.'s letter suggested the commercial development of a bulk tape polisher, along the lines of a bulk eraser. The best bulk polisher is the contoured head of your machine!

Another Tandberg owner, this time of a conventionally biased *Series 6*, is B.S.A. of Ilford. His unit records happily but, on playback, the left-hand channel frequently diminishes to a low signal level, sometimes to nothing. Neutralising the replay control causes a static discharge through the left-hand (*Ditton 10*) loudspeaker. This fault is generally caused by a leaky interstage capacitor but, on rare occasions, can be instigated by valve trouble. Since the trouble occurs only on replay, the cause is localised to the playback preamplifier. The two relevant valves are the *ECC82* and *ECC83* at the end of the playback printed board remote from the equalisation switch. The most likely cause is a leaky coupler between the first and second stages, a 0.22 μF capacitor situated right beside the *ECC83*. This proximity is, I think, one reason why it fails.

E.B. of North Vancouver, British Columbia, sent in a service enquiry complete with a solution. He had been bothered with a persistent mechanical ticking in his Uher *4000S*, so noisy that it was reaching the microphone. The noise ceased when he depressed the pause control, which led him to suspect the pinch-wheel. This was quiet enough when spun by hand, but two tiny spots of fine lubricating oil in its top bearing cured the fault completely. I have had troubles with ticking Uher battery portables and most of these have originated with the digital spool rotation counter. In fact, I have had to change one or two of these. Other persistent faults have been the spool drive belt (fortunately very easy to change), the motor (on early production runs), the zener diode in the regulator circuit, and the spring and collar (also, regrettably, the circlip) of the spool retainers. But these are minor matters when compared with the very fine performance of the *4000* design, especially when a good microphone is employed.

N.F. of St. Saviour, Jersey, owns a Stuzzi recorder and has been unable to contact the importers, Recording Devices Ltd., at their Kensington address. The company now lives at 274 Worton Road, Isleworth, Middlesex.

VTR CIRCUITRY PART 3

BY HENRY MAXWELL

HAVING left Part Two with a cliff-hanger we must plunge quickly into the subject of the multivibrator before getting involved in descriptions of practical circuits. We have followed the video input signal through its comparatively simple path to the modulator. Energising of the tape is by a frequency-modulated signal, for reasons we have already outlined. These generators can be formidably complicated pieces of hardware in high-powered transmitters but in the circuits of video tape recorders we are concerned with fairly straightforward examples and it may be wise to pause at this stage to make sure we are talking the same language.

Multivibrators, especially in transistor designs, can take several quite different forms. Because of our familiarity with valve circuits, especially television timebases, we tend to speak of any two-valve or two-transistor circuit with regenerative action and switching between stable and quasi-stable states as 'a multivibrator'.

The genuine multivibrator has two quasi-stable states. The circuit oscillates between these two states in the absence of external triggering.

In its basic form, the transistor multivibrator circuit is like **fig. 1,** looking very like the familiar valve circuit with its characteristic cross-coupling. When Tr1 is bottomed, Tr2 is cut off and vice versa. At the moment of switching on, random current due to imbalance, which is practically inevitable, will cause one of the pair to take more current than the other, and regenerative action causes it to turn on fully while its opposite number switches off.

It is interesting to examine the voltage waveforms at base and collector of each of the pair through one cycle of operation. Presuming that Tr1 is switching on first, base current will flow through R2; collector current through R1. Knowing the specifications of the semiconductor, we can arrange that Tr1 is driven into saturation with a known base current and R1 is chosen to obtain this state. These are *n-p-n* transistors, so in **fig. 2** we note that the cycle starts with base voltage at a value positive to the zero line and the collector voltage is at the saturation level, a little above zero. As Tr1 switches on, the charge on C1 takes the base of Tr2 negative. There is a little initial flip of collector current on the curve (c) where C1 reaches its charged state from switching on—an important short period for some applications, such as computer switching, but which need not concern us here.

C1 now discharges through R3 and the base of Tr2 is taken to a small positive value, and there is again a little twitch to the waveform as Tr2 turns on. The collector drops to saturation level and the opposite state of affairs occurs, with C2 discharging through R2 and C1 charging through R1. The time constant for the capacitors to charge through the collector loads is shorter than for their discharge through the base resistors. Regenerative action follows.

If the circuit is symmetrical, resistors and capacitors for each of the pair equal, the time period for on and off states is the same. If one capacitor is larger than the other (this being a more convenient way of altering the time constant than changing a resistor, which alters DC conditions), discharge time is longer for the larger capacitor and the relevant transistor is held OFF longer. So one collector gives short positive-going pulses, the other gives relatively long pulses, also positive-going.

A circuit sometimes seen and not always fully explained is the diode loaded emitter configuration of **fig. 3.** Purpose of the diodes is to protect the transistor against breakdown, where the supply voltage of the circuit may be greater than the maximum reverse bias of the base-emitter junctions (**fig. 2 b** and **d**).

Diodes, and some additional components may also be met in circuits like **fig. 4,** where faster rise and fall times from the collectors are needed. Sharpening up the leading edges of pulses is a great design game: in this case, the diodes act as gates and the added resistors provide a charge path for the capacitors, alternatively to the collector loads. The circuit is used with high gain transistors.

We can divide our multivibrator circuits into three types; astable (free-running), monostable and bistable (flip-flop). The astable multivibrator switches repetitively between the two momentarily stable states. The monostable sets itself to one state when switched on and then resets to the other when triggered. It then stays in the switched state until the discharge period determined by the circuit values allow it to switch back again. But the flip-flop stays in the alternative switched state until again triggered. This is the fundamental difference between the three types and the main reason

(*continued on page 461*)

FIG. 2 VOLTAGE WAVEFORMS AT COLLECTORS AND BASES OF FIG. 1 TRANSISTORS

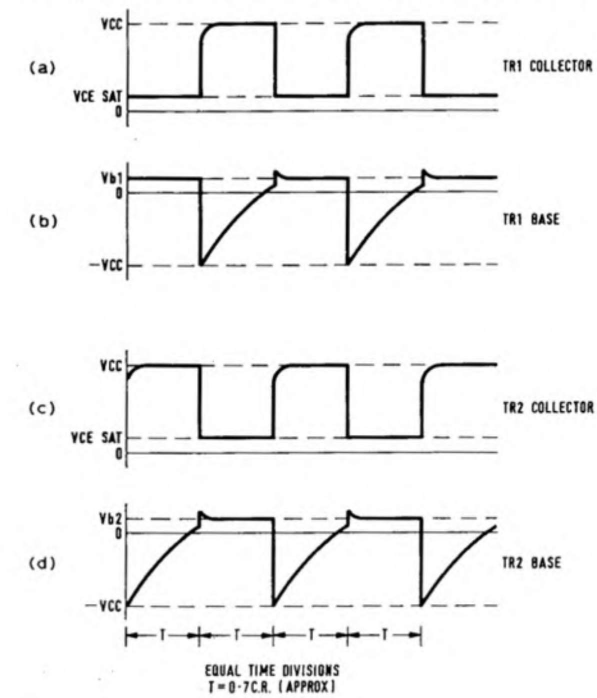
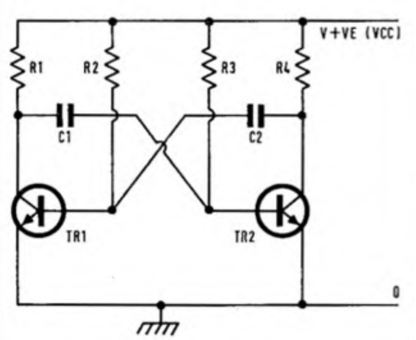


FIG. 1 BASIC MULTIVIBRATOR CIRCUIT, FREQUENCY DETERMINED BY VALUES OF C AND R.



UP TO 50% OFF!

BRITAIN'S ONLY TAPE RECORDER MART

specialising in the SALE, EXCHANGE and PURCHASE of every make of high quality Tape Recorder. Brenell, Ferrograph, Ampex, B & O, etc., we have the lot!

Fantastic savings of **up to 50 per cent off** original list prices for **Personal Callers only.** Our stocks change daily—**call today**—well over **100 models to choose** from—**all guaranteed** you pay **no tax** on secondhand machines.

TYPICAL BARGAINS

ALL WITH 3 MONTHS WRITTEN GUARANTEE
(Note: M—Mono, S—Stereo, BP—Battery Portable, 4—4 track, 2—2 track)

GRUNDIG TK40 (M/2) ... ... **Our price ONLY 35 gns.**
SONY TC500 (S/4) ... ... **Our price ONLY 57 gns.**
AKAI M9 (S/4) ... ... **Our price ONLY 115 gns.**
SONY TC800 (BP/M/2) ... ... **Our price ONLY 49 gns.**
VORTEXION WVB/4 (M/2) ... ... **Our price ONLY 52 gns.**
TANDBERG 1241 (S/4) ... ... **Our price ONLY 69 gns.**
REVOX 736 (S/4) ... ... **Our price ONLY 95 gns.**
FERROGRAPH 5A/N (M/2) ... ... **Our price ONLY 55 gns.**
PHILIPS EL3534 (S/4) ... ... **Our price ONLY 59 gns.**
BRENELL MK5M Series III (M/2) ... **Our price ONLY 69 gns.**
TELEFUNKEN 85KL (M/2) ... ... **Our price ONLY 39 gns.**
SONY TC260 (S/4) ... ... **Our price ONLY 72 gns.**
AKAI 1710 (S/4) ... ... **Our price ONLY 65 gns.**
SONY TC250A (S/4) ... ... **Our price ONLY 48 gns.**
VORTEXION CBL/5 (S/2) ... ... **Our price ONLY 89 gns.**
FERROGRAPH 422 (S/2) ... ... **Our price ONLY 59 gns.**
PHILIPS EL3549 (M/2) ... ... **Our price ONLY 29 gns.**
FERROGRAPH 631 (M/2) ... ... **Our price ONLY 72 gns.**

NOTE:—THESE ARE NOW EVEN BETTER VALUE AS YOU PAY NO TAX ON SECONDHAND RECORDERS.

FERROGRAPH 622 (S/2) ... ... **Our price ONLY 79 gns.**
AKAI M8 (S/4) ... ... **Our price ONLY 79 gns.**
SANYO 929 (S/4) ... ... **Our price ONLY 59 gns.**
SONY TC200 (S/4) ... ... **Our price ONLY 52 gns.**
TANDBERG 74 (S/4) ... ... **Our price ONLY 49 gns.**
VORTEXION WVA/4 (M/2) ... ... **Our price ONLY 45 gns.**
TANDBERG 62 (S/2) ... ... **Our price ONLY 75 gns.**
REVOX E36 (S/2) ... ... **Our price ONLY 79 gns.**
FERROGRAPH 4A/N (M/2) ... ... **Our price ONLY 49 gns.**
PHILIPS EL3536 (S/4) ... ... **Our price ONLY 39 gns.**
REPS R10 (M/2) ... ... **Our price ONLY 29 gns.**
BRENELL MK5 Series III (M/2)... ... **Our price ONLY 52 gns.**
TELEFUNKEN M300 (BP/M/2) ... ... **Our price ONLY 39 gns.**
WYNDSOR VANGUARD (M/4) ... **Our price ONLY 49 gns.**
TELEFUNKEN 204E (S/4) ... ... **Our price ONLY 69 gns.**
AKAI X4 (BP/S/4) ... ... **Our price ONLY 69 gns.**
PHILIPS EL3301 (BP/M/2) ... ... **Our price ONLY 16 gns.**
SANYO 151 (BP/S/4) ... ... **Our price ONLY 45 gns.**

PERSONAL CALLERS ONLY

NEW TAPE RECORDERS

We also stock every make and model of New Tape Recorder plus a complete range of accessories.

Part of the NuSound Organisation

THE TAPE RECORDER MART

242/4 PENTONVILLE ROAD, LONDON, N.1

(200 YDS. KINGS CROSS) TERminus 8200 (HALF DAY THURSDAY)

WE SPECIALISE IN BRAND NEW

TOP QUALITY BRITISH P.V.C. MYLAR & POLYESTER RECORDING TAPES WITH FITTED LEADERS, Etc., EX 3"

Thanks to bulk purchase we can offer tensilised HI-FI tapes, manufactured by a British firm of world repute. All boxed individually (sealed if required) in polythene. Our tapes are not to be confused with imported sub-standard or used tapes. Full-money refund if not delighted.

This month :— DRY "SPLICE" (3/9) given FREE with every order.

Std.				L.P.				D.P.				Boxed	
	Length	ea.	3 for		Length	ea.	3 for		Length	ea.	3 for	empty	spls
3"	150'	2/-	5/9	3"	220'	2/6	7/-	3"	400'	4/6	13/-	3"	7d.
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
5¾"	900'	7/-	20/6	5¾"	1200'	10/6	30/6	5¾"	1800'	17/-	50/-	5¾"	1/9
7"	1200'	9/-	25/6	7"	1800'	13/-	38/6	7"	2400'	21/-	61/-	7"	2/-

All orders despatched by return. *Postage and Packing 1/9 per order.*

STARMAN TAPES, 421 Staines Road, Bedfont, Middlesex

To all TAPE Recordists: *P.V.C. & Polyester Tapes*

BUY BRITISH

I'm backing Britain

YOU SAVE MONEY AND SAVE THE POUND

"A STERLING IDEA"

". . . high quality and rapid service I have found in you . . ."
N.F.H. of Canterbury.

The playbacks are crystal clear and I am sure no better results could be obtained by other dearer brands on the market.
Yours sincerely,
W.S., Hants.

Free library cassette with orders over £5.0.0

New	3"	5"	5¾"	7"
Stan.	150'	600'	900'	1200'
Play ea.	**2/-**	**6/-**	**7/-**	**9/-**
3 for	5/9	17/6	20/6	25/6
Long	240'	900'	1200'	1800'
Play ea.	**2/6**	**8/-**	**10/6**	**13/-**
3 for	7/-	23/6	30/6	38/6
Double	300'	1200'	1800'	2400'
Play ea.	**4/6**	**12/6**	**17/-**	**21/-**
3 for	13/-	37/-	50/-	61/-

Free List full Range of Triple-Play

Mora Trading Co. (TR/181) *Postage 1/9 per order Posted the same day*

Mora Works, Mora Road, N.W.2 *Mail only.* *Money-back gtd.*

RAPID RECORDING SERVICE

L.P.s from your own tapes. Master discs and pressings. Recording Studio, Multi-channel facilities for transfer to 8 or 16 mm film tracks. Sound effects library on discs.

Associated Company
EDUCATIONAL RECORDINGS LTD.

MEMORY TRAINING.
Are you the victim of "I forgot" or "I don't remember". Time, money and success can be gained by the possessor of a good memory. A bad memory brings about missed opportunities, lack of advancement and failure.
Our Psycho-tape No. ST/9 will develop your mental powers in such a way that you will remember lists of words, telephone numbers, names, facts and figures.
Send for particulars of this and 20 other tapes on self-improvement.
Distributors of the Cassette battery/mains Sleep-o-matic Unit. Pillow speakers. Time clocks.
Publications: "Sleep-learning. Its Theory, Application and Technique" "Mental Power through Sleep-suggestion".

Brochures from:

RAPID RECORDING SERVICE
21 Bishops Close, London, E.17

MORE QUALITY BARGAINS IN

EXCHANGE & MART 8d

EVERY THURSDAY

if you are a RADIO, TV or TAPE enthusiast

why we cannot simply talk about 'a multivibrator' without defining it. We shall come across all three types in VTR circuits.

Our last reference (at the end of Part Two) was to an astable multivibrator, used as the generator of the Sony frequency modulation circuit, and having a free-running frequency determined by component values. **Fig. 5** shows the basic circuit.

We can see that this circuit actually bears some resemblance to the theoretical circuits we have used to illustrate the point—an unusual circumstance, it seems, in this type of demonstration! Although every manufacturer or designer appears to have his own ideas about the putting of theory into practice, and much fun can be had with new circuits trying to trace out the purpose of apparently superfluous components. Sony employ a simple circuit, capable of easy adjustment, rock-steady in operation, and accessible.

We note that both the collector voltage and the emitter voltage for the matched transistors can be adjusted individually for balance. DC clamping has already been done, at the modulator. A varying DC is applied to the bases, in step with the incoming modulation and, as we have seen, slightly tailored. The base input voltage increase causes the output frequency to rise. We are, in effect, altering the value of R in the CR combination by altering the applied voltage to the base. There is nothing magical about the CR formula; all that happens is that in a given time the capacitor discharges (or charges) to alter the effective emitter-base voltage and turn the transistor on or off, providing the swing we need. So if we alter that base voltage ourselves, we can control the frequency.

This may help to explain why, as we saw last time, the carrier frequency setting is back in the modulator drive circuit, not on the generator itself. Actual setting up depends very much on the clamping of the modulator so that the black level of the video signal is exactly right. Then, excursions of the signal have reference to this level and frequency is stable about a set figure.

The basic oscillator in this circuit runs at 1.7 MHz, and this has to be quite carefully adjusted. Increase in basic frequency will cause a plasticity in the picture that is very

FIG. 5 ASTABLE MULTIVIBRATOR IS USED AS THE FREQUENCY GENERATOR IN THE SONY RECORDING CIRCUIT

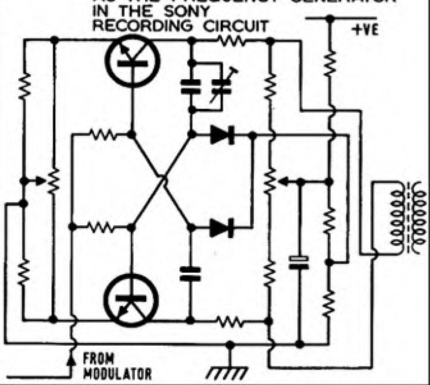


FIG. 3 DIODE LOADED EMITTER CIRCUIT PROTECTS THE TRANSISTORS FROM BREAKDOWN WHERE SUPPLY EXCEEDS REVERSE EMITTER - BASE JUNCTION BIAS.

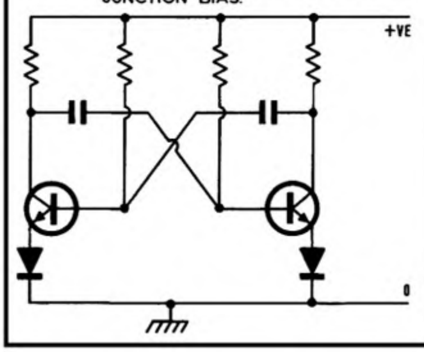
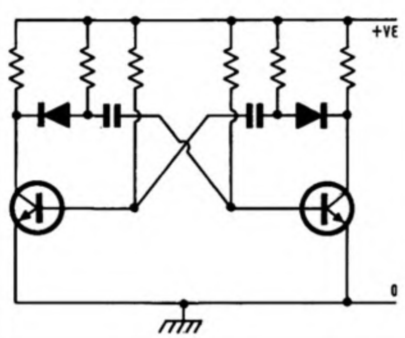


FIG. 4 GATING DIODES IN THE COLLECTOR CIRCUITS IMPROVE RISE TIMES



difficult to eradicate—and this is a general observation, not peculiar to the circuit we are examining at present. One of the troubles relevant to this appears to be the problem of carrier leak. At various parts of the circuit we find precautions taken against breakthrough of the carrier and there is always a temptation to alter the generator balance circuits to cure it. Indeed, in the Sony *2000*, though certainly not so much in the *2100*, it was sometimes necessary to touch up the generator balance controls and then go back over the whole clamping and clipping adjustment procedure and finally to check the modulation indication, which can be affected. All to get rid of a few wavering patterns on the screen!

Take-off from this kind of generator should be balanced, and Sony use a very special kind of coupling transformer with a floating primary. We shall revert to this point later. Before discussing any more processing of the circuit, however, it may be an idea to look at an alternative version, and the Loewe-Opta *Optacord 600* series of video tape recorders, which have not yet received much mention, can provide us with good examples.

Once again, the free-running oscillator has its frequency controlled by alteration of the base voltage. Stabilisation of the drive voltage is obtained by the use of a zener diode (what did we do before these were developed I wonder?), and the take-off this time is across the balanced collector loads, again using a floating winding of a coupling transformer.

The interesting part about this circuit is that the basic oscillator frequency is 3.3 MHz and the adjustable input resistor, to whose slider the modulator couples the varying voltage for video drive, is set for minimum output of the second harmonic of the carrier frequency, i.e. 6.6 MHz. The resistor across the primary of the take-off transformer is set for correct depth of modulation, not for any relative frequency change. In practice it directly regulates the amount of modulating current through the video head.

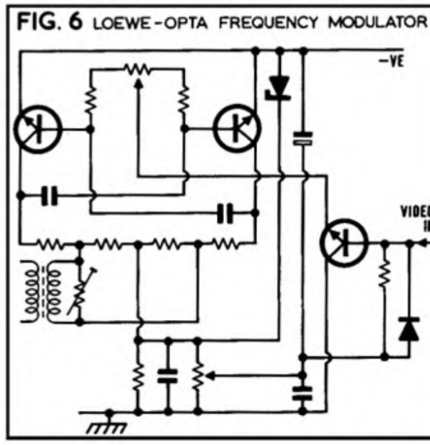
A brief word in general about the *600* series may help set the scene. It has not been possible to discuss it before as there was no circuit issued and I have, in fact, had to wait for the generosity of my friends in Dusseldorf before I could borrow one and discuss details, though practical information and my usual back-of-envelope scribbled notes were available in abundance.

This is a hybrid machine, a pair of *PCL84* valves having crept into the circuit. Helical scan, using a single head, which traces a single field per revolution, while the tape moves past at 15 cm/s. This gives a relative motion of 19 m/s (metres per second) and permits a claimed bandwidth of 3 MHz. For recording and replay on the same machine, up to a hundred minutes performance may be accommodated but to ensure compatibility it is necessary to reduce this to 72 minutes.

One very useful feature is a variable speed fast rewind, from zero velocity to 60 times the recording speed. At low rewind speeds, the machine is still in the play mode and monitoring is possible. As an extension to this facility, still pictures can be displayed by setting to rewind and halting the machine. Later versions, the *603* range, automatically adjust for best scanning of the still frame and can be set to advance, frame by frame, giving a slow-motion effect. Tape width is 25 mm.

Continuous scan is achieved by a 360° wrap around the drum and helical systems as previously described. Head rotating speed is 3,000 r.p.m. and track width 0.15 mm. Synchronisation is by sampling of the vertical pulses and similar comparator systems to the Sony which we shall discuss in detail later. The two tape speeds, 15.22 cm/s for the single machine use, 21.5 cm/s for compatible use, are a novel VTR feature, and the relevant control circuitry will merit our future attention.

FIG. 6 LOEWE-OPTA FREQUENCY MODULATOR



the synthesis of musical instrument tone

Part Two
By Robert M. Youngson

A THEORETICAL alternative to pitch control by variable inductance is control by variable capacitance. It is, however, in practice so difficult economically to achieve adequate capacitance swing, that, notwithstanding advances such as variable capacitance diodes and gyrator circuit techniques, the method is still barely practicable.

The large family of R.C. oscillators contain a number of members which can be arranged to have adequate frequency stability. Control by variation of either resistance or voltage is feasible, and probably the most flexible and practicable means, currently, of managing the fine control of pitch is by the use of light dependent resistors. The light source must not be energised with A.C. or the tones will be modulated with mains frequency hum. Circuits of various R.C. oscillators are given in **figs. 9** to **13.**

So far we have considered only those instruments characterised by non-continuous tuning. Entirely different problems of pitch control arise if we decide that continuous sliding pitch is essential. The important point, however, is that an instrument capable of glissando must be capable of playing chromatically (i.e. in accurate semitone intervals) and it is necessary to fulfil this double requirement, while still providing for reasonable ease of accurate playing.

It is reasonable to enquire whether the faculties of glissando (which occurs very seldom in serious music) or portamento (which is more often a matter of expression than of the composer's intention and is often an artistic fault) justify the trouble of providing them. The answer to this question depends on the extent to which you are willing to compromise and the degree of difficulty in providing satisfactory control with continuous tuning.

A minor degree of portamento is, of course, available in the kind of arrangement already described but, even if the pitch variation range of each note is fully half a semitone on each side of the mean, so that there is a continuous frequency cover over the whole range of the instrument, neither full portamento nor smooth glissando is a practical possibility using the means suggested.

Gliding-tone circuits are very easily arranged and it is easy to design a single oscillator which will cover the required frequency range (about 1:10) in one sweep. Suitable frequency stability at any frequency within the range can also be achieved without much difficulty by stabilising the power supplies and by good design. Among the simplest suitable circuits are relaxation oscillators using unijunction devices, in which the time constant of the charging circuit is varied by varying the resistive element (**figs. 14** and **15**) and emitter-coupled oscillators similarly controlled (**fig. 16**). Other suitable oscillators are shown in **figs. 17** and **18.**

It is when we come to the control of these oscillators that the trouble begins. In considering variable resistance control, the most obvious evolutionary step from a rotating control (which, however calibrated, is inherently quite unsuitable for this purpose) is an extended resistive element equal in length to the equivalent section of keyboard and having such a resistivity that the appropriate pitches are produced when contact is made at suitable points along its length. It is not actually necessary to employ an electrode held at the end of a flexible wire, since various methods have been developed to make contact at the point required. (see below)

Such a system, ignores the useful conventional orientation of accidentals and playing is

FIG. 9 TUNNEL DIODE VARIABLE FREQUENCY OSCILLATOR. THE TWO STATES OF THE DIODE ARE VOLTAGE DETERMINED.

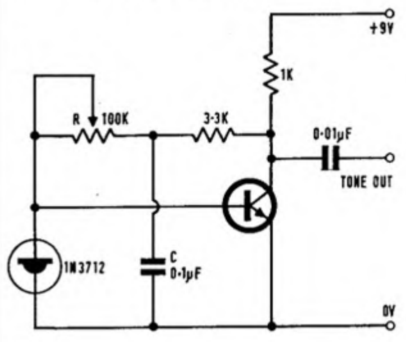


FIG. 10 PHASE-SHIFT RC OSCILLATOR THIS CAN BE TUNED BY VARYING THE VALUE OF ONE RESISTIVE ARM.

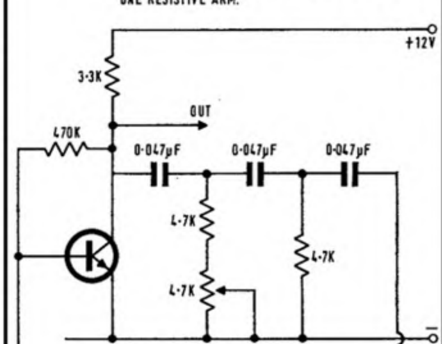


FIG. 11 WEIN BRIDGE OSCILLATOR

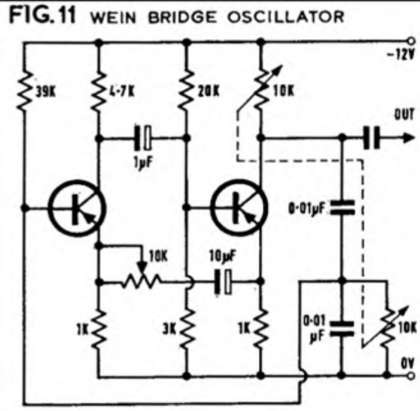


FIG. 12 TWIN-T FEEDBACK OSCILLATOR

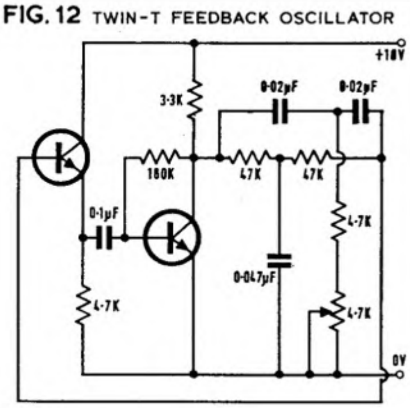


FIG. 13 WIDE-RANGE VARIABLE FREQUENCY SAWTOOTH RELAXATION OSCILLATOR USING AN N-P-N/P-N-P TRANSISTOR COMBINATION

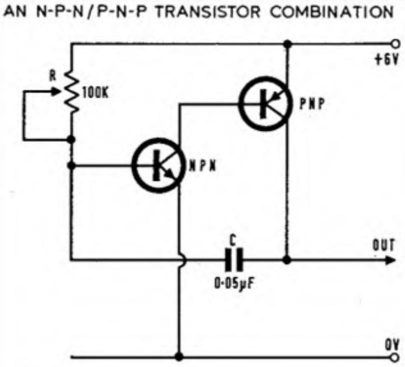
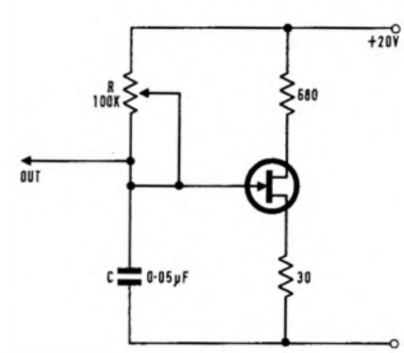


FIG. 14 SIMPLE UNIJUNCTION SAWTOOTH RELAXATION OSCILLATOR



made more difficult. A second resistive strip can, of course, be placed behind the first and both marked with the positions for the notes. In this case, much trouble is saved by providing a separate oscillator for each strip.

A major objection to the system lies in the difficulty of providing satisfactory contact arrangement. One approach is to arrange for a stretched flexible metal strip to lie just above each resistive line so that finger pressure at the appropriate point causes contact to be made. As may be imagined it is not easy with such a system to achieve accurate intonation since the breadth of a finger covers too large a proportion of the total length of the resistive strip. It is true that the resistance in circuit is only that part between one end of the strip and the corresponding edge of the area of contact but, nevertheless, the accuracy of finger placement must approach that of the violinist. Vibrato can be managed, with a little practice, by rolling the finger in a manner similar to that of a string player.

Another possible approach is to provide a contactor which can be slid along a conducting guide to the appropriate position and then pressed down to make contact with the resistive element. Alternatively, the contact can be attached to the underside of a endless flexible metal tape which, while lying immediately above the tuning resistor strip, can be moved on rollers so that the contact can rapidly be brought to any desired position over it.

In any such system, contact resistance must be very low and must nor vary with differences in finger pressure. If significant contact resistance occurs while the finger is descending, the note will be initiated at a lower pitch than the nominal and a quite unacceptable starting transient will result. A similar adventitious sound may occur at the end of the note when the finger is lifted. This difficulty is not easily overcome by improvement in the contact arrangements but can be solved by arranging for the oscillator to be switched on a few milliseconds after contact is made. This can be done by arranging for the variation in resistance to alter the time-constant, not directly but by changing the bias of a transistor through which the main tuning capacitor charges. The switch-on of this charging transistor can then be delayed by means of a second time-constant circuit (R_1, C_1 in **fig. 19**). This method has the additional advantage of permitting controlled variation in the attack of the instrument by making R_1 variable, or alternatively by switching in different values for C_1.

This type of continuous-tuning instrument, is capable of reasonable results, but it is inherently inferior to one having a separate oscillator for each note in the chromatic scale. Single oscillator instruments can, of course, be designed for use with a keyboard and some of the simplest and cheapest arrangements possible may thus be achieved. In these designs, the key switches bring in progressively changing values of capacitance or, preferably, resistance. Fine pitch control and vibrato is then most easily obtained by a separate control device acting directly, and independently, on the frequency of the oscillator, but you must see to it that the effect on frequency of a given movement of this control does not vary too much between one end of the gamut and the other.

One suggestion is given in **fig. 20.** The illumination of the LDR is via one fixed and one movable sheet of 'polaroid'. The latter is so articulated that lateral movement of the key switch button causes it to rotate slightly and thus change the intensity of light falling on the LDR. This will change its resistance and consequently the frequency of oscillation. As an alternative a simple shutter system may be used. The amount of control effected can be adjusted by shunting the LDR with a variable resistor.

In the design of musical instrument analogues one should remember that conventional means of pitch selection, such as keyboards, need not necessarily be the optimum. The factors which determined the present standard keyboard were not solely anatomical and physiological but also included the necessity to provide enough room to accommodate, within the breadth of each key, the required mechanical linkages or striking or plucking mechanism. Other factors, such as the standard depression distance and playing weight, may likewise be a compromise between convenience and practicability. Trained keyboard musicians have, of course, become so conditioned to the present arrangements that they are inclined to be intolerant of even minor changes and are understandably persuaded that these standards are absolutes.

There is little doubt that, on economic grounds alone, the present conventional

(continued on page 465)

FIG. 16 EMITTER-COUPLED VARIABLE-FREQUENCY OSCILLATOR

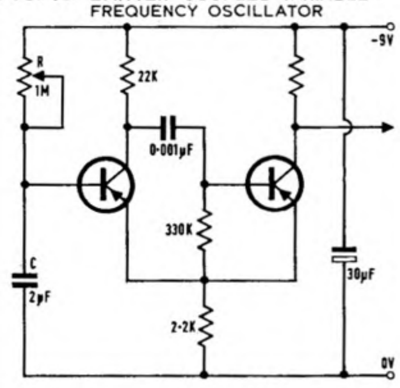


FIG. 17 VARIABLE-FREQUENCY MULTIVIBRATOR

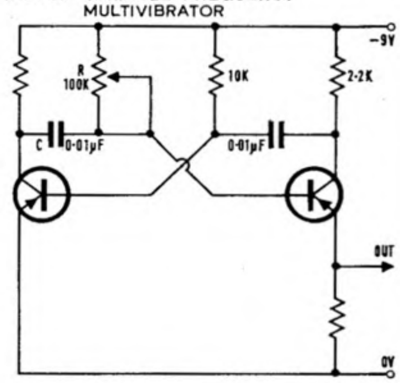


FIG. 18 UNIJUNCTION SAWTOOTH OSCILLATOR WITH CONTROLLABLE LINEARITY

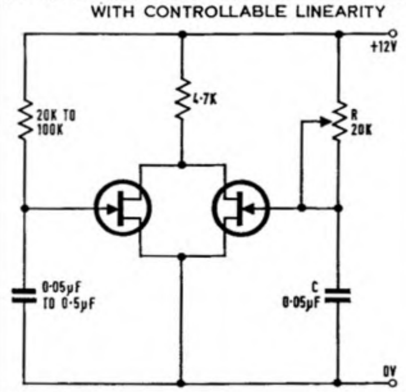


FIG. 19 UNIJUNCTION OSCILLATOR WITH CONTROLLABLE TURN-ON RATE

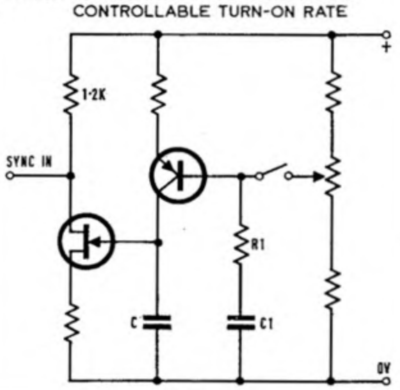


FIG. 20 METHOD OF OBTAINING FINE PITCH CONTROL AND VIBRATO OF RESISTANCE DEPENDENT OSCILLATORS.

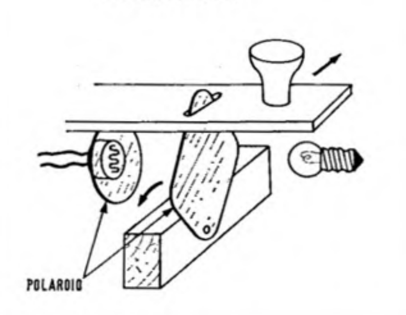
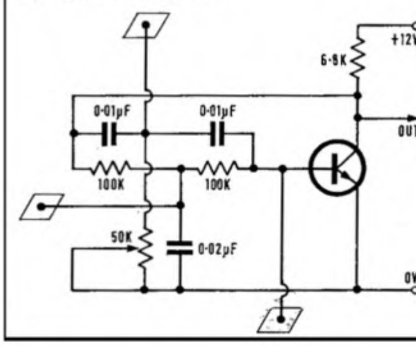


FIG. 23 TWIN-T RINGING OSCILLATOR

THE CIRCUIT IS SHOCKED INTO BRIEF OSCILLATION BY A TOUCH ON ANY ONE OF THE PLATES. MUST BE ADJUSTED TO BE JUST BELOW THE THRESHOLD OF OSCILLATION



GUARANTEED QUALITY AND SATISFACTION

4 TRACK STEREO/MONO

	Deposit			12 Monthly Payments			Cash Price		
	£	s.	d.	£	s.	d.	£	s.	d.
Philips EL3312 ...	23	4	1	3	14	5	67	17	1
Philips N4404 ...	26	17	0	4	5	0	77	17	0
Ferguson 3232 ...	33	5	0	5	1	10	93	5	0
Sanyo MR929 ...	33	4	9	5	6	10	97	4	9
Philips N4407 ...	35	15	10	5	13	4	103	15	4
Akai 1710W ...	37	15	7	6	2	1	111	0	5
Sanyo MR939 ...	38	13	6	6	2	3	112	0	2
Sony TC230 ...	40	11	9	6	15	0	121	11	9
Telefunken 204TS	41	19	0	6	13	4	124	19	0
Grundig TK247 ...	45	10	9	7	2	4	130	18	9
Sanyo MR990 ...	44	18	0	7	5	0	131	18	1
Philips 4408 ...	46	19	5	7	8	9	136	3	10
Sony TC530 ...	49	12	3	8	1	8	146	12	3
Tandberg 1241X ...	49	0	0	8	6	8	149	0	0
Beocord 2000K ...	53	5	0	8	17	6	159	15	0
Beocord 2000T ...	55	5	0	9	4	2	165	15	0
National Console-Aire	62	0	0	10	5	0	185	0	0
Akai M9	68	12	4	10	16	8	198	12	4
Akai 1800SD ...	68	12	4	11	1	2	202	13	10
Ferrograph 724 ...	68	16	9	11	6	8	204	16	9
Revox 1222/4 ...	74	11	0	12	8	6	223	13	0

4 TRACK MONAURAL

	Deposit			12 Monthly Payments			Cash Price		
Fidelity Braemar...	11	12	8	1	17	4	34	4	8
Fidelity Studio ...	15	17	10	2	10	2	46	0	10
Grundig TK144 ...	16	10	1	2	11	11	47	13	1
Philips 4307 ...	16	15	3	2	13	1	48	11	11
Ferguson 3228 ...	16	16	8	2	13	4	48	16	0
Ferguson 3238 ...	20	12	0	3	5	0	59	12	0
Philips 4308 ...	20	14	2	3	5	7	60	0	10
Ferguson 3216 ...	22	16	0	3	12	2	66	2	0
Tandberg 1541 ...	28	0	0	4	10	0	82	0	0
Reps HW10-4T ...	28	16	9	4	11	2	83	10	1

STEREO TAPE UNITS

	Deposit			12 Monthly Payments			Cash Price		
	£	s.	d.	£	s.	d.	£	s.	d.
Sanyo MR801 ...	27	9	5	4	6	8	79	9	5
Akai 4000D... ...	29	10	0	4	16	8	87	10	0
Tandberg 1641X ...	30	0	0	4	19	2	89	10	0
Sony TC355 ...	34	2	6	5	10	0	100	2	6
Beocord 1500 ...	42	10	0	7	0	0	126	10	0
Tandberg 62/64X...	53	0	0	8	13	4	157	0	0
Beocord 1800 ...	60	15	0	9	18	4	179	15	0
Revox 1102/4 ...	63	19	0	10	6	8	187	19	0
Ferrograph 702/704	64	15	8	10	16	8	194	15	8

Special Offer

AKAI M9 High Fidelity Stereo - 50 GNS. OFF
Cross-field Head. 40 Watts Music Power 4 Tracks, 4 Speeds.
Sound-on-Sound Three Heads. 2 Built in Speakers.
BRAND NEW. MAKERS 12 MONTHS GUARANTEE & INSTRUCTIONS - **145 Gns.**
INTEREST FREE H.P. TERMS Deposit **£52 5s. 0d.**
12 Monthly Payments **£8 6s. 8d.**

AKAI 1710W
BRAND NEW. Reduced from 104 Gns. Our Price **85 Gns.**
Interest Free H.P. Terms. Deposit **£30 5s. 0d.**
12 Monthly Payments **£4 18s. 4d.**

PHILIPS EL3302 Cassette
Brand New. Special Offer **24 Gns.**

INTEREST FREE H.P. TERMS

OPEN SATURDAY 6 p.m. FRIDAY 6.30 p.m. IF UNABLE TO CALL, WRITE FOR BROCHURES, PART EXCHANGES ALSO 18 AND 24 MONTHLY TERMS.

Telefunken Special Offer

TELEFUNKEN 300 Battery/Portable
- 5" Tape capacity.
- Volume and Stop/Start controls in handle.
- Complete with micro phone.

Reduced from 61 Gns. Our price **45 Gns.**
Initial Deposit **15 Gns.** 12 monthly Instalments **£2.12.6.**

TELEFUNKEN 301
Similar specification as for Model 300 but 4-track.
Reduced from £70.17.6. Our price **51 Gns.**
Initial Deposit **17 Gns.** 12 monthly Instalments **£2.19.6.**

TELEFUNKEN 302
- 4-Track
- 2 speeds $3\frac{3}{4}$ & $1\frac{7}{8}$ ips.

Reduced from £77.8.9 Our Price **56 Gns.**
Initial Deposit **£19.12.0.** 12 Monthly Instalments **£3.5.4.**

MUSIC CASSETTES

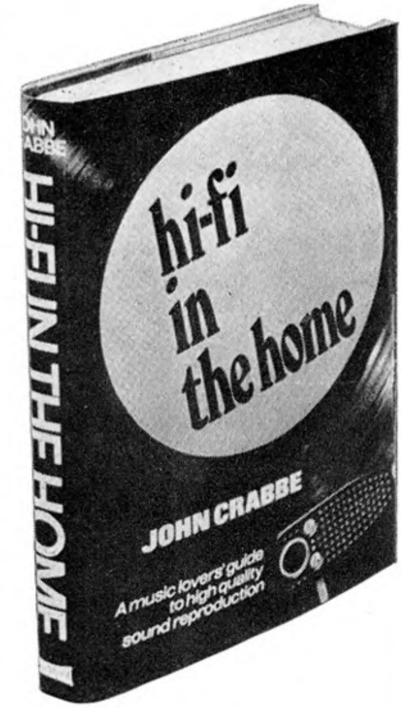
Large selection of over 200 different titles to choose from at a reduced price of 47/6 each. Write for lists.

this is the name THE RECORDER CO

(DEPT. R) 186-188 WEST END LANE, WEST HAMPSTEAD, LONDON, NW6
Telephone: 01-794 4977

HI-FI in the Home

by John Crabbe, editor of Hi-Fi News and Tape Recorder



"the most up-to-date and comprehensive treatment on domestic hi-fi yet in print"
AUDIO RECORD REVIEW

"gives copious advice on practically any aspect of the topic you can imagine . . . Should be a very useful guide to anyone on the threshold of heavy expenditure who is rightly wary of the smooth talk in the hi-fi shop"
THE MUSICAL TIMES

"written with the authority of a dedicated professional, it could well become a recognised standard on the subject . . . Deserves a place on the bookshelf of all who are interested in improving the quality of sound reproduction in the home"
ELECTRICAL & RADIO TRADING

"a practical and helpful book . . . Mr. Crabbe explains everything and includes a sizeable glossary and plenty of diagrams"
THE TIMES

40/- from booksellers
or direct from the Publishers (post 2/-)

BLANDFORD PRESS, 167 HIGH HOLBORN, LONDON, W.C.1

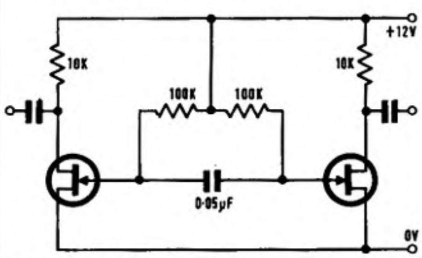
musical instruments (and in particular polyphonic instruments) will give way to electronic. As they do there is likely to be a no less radical evolution in the process of pitch selection.

It is, of course, possible to play an electronic musical instrument without even touching it: beat frequency oscillators in which pitch alterations are achieved by changes in 'hand capacity' have been commonplace for many years and a modern example is given in **fig. 21.** Unfortunately, however skilfully the player may manage accurate intonation (and this is extremely difficult) such instruments can play discrete notes only by incorporating an interrupter switch which is, of necessity, independent of the pitch selection process. The separation of the two functions adds to the difficulty of playing but, if the switch can be operated by the same hand which determines the pitch, a useful flexibility is achieved and the other hand is freed to operate dynamic and timbre controls, etc. This has the disadvantage that the playing hand must be connected to the instrument either by a wire or a radio or light link and some physical device, however small, must be held. An alternative is a foot-operated switch, but this is not very satisfactory in rapid passages. All in all, the method probably involves too many playing difficulties to become universally acceptable.

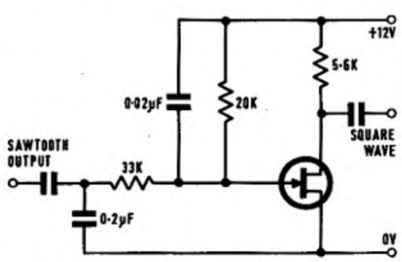
The most likely future method will involve simple light touch with the fingertips on small circular metallic elevations, the arrangement of which will be determined by ergonomic principles rather than by convention. Such a contact system can operate in two main ways, either by an actual flow of signal current through the body of the player (the electrical resistance between the finger tips and any other part of the body is a mere 10 KΩ to 50 KΩ depending on the dryness of the skin)

(continued on page 469)

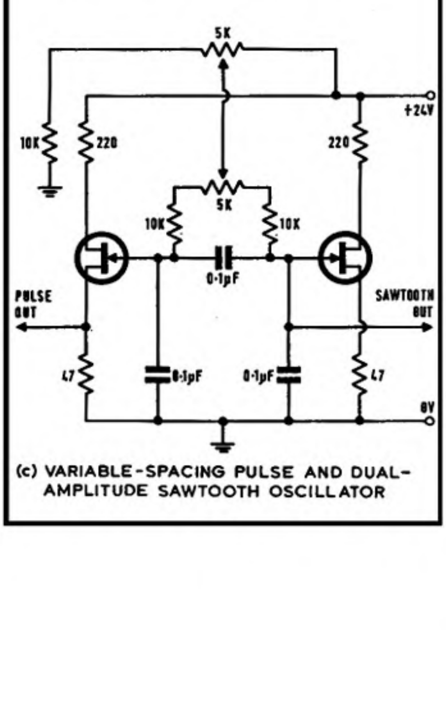
FIG. 15 OTHER UNIJUNCTION OSCILLATORS



(a) SQUARE-WAVE OSCILLATOR

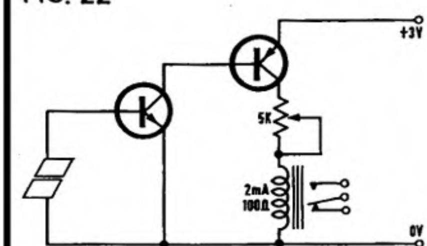


(b) SQUARE/SAWTOOTH OSCILLATOR

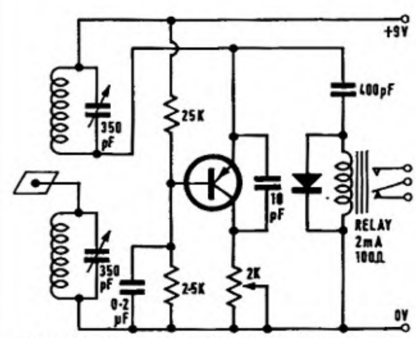


(c) VARIABLE-SPACING PULSE AND DUAL-AMPLITUDE SAWTOOTH OSCILLATOR

FIG. 22



(a) SIMPLE TOUCH-PLATE RELAY CONTROL. THE RELAY MAY BE A "LATCHING" TYPE OR MAY BE USED TO CONTROL FURTHER RELAYS OF ANY TYPE.



(b) HAND CAPACITY RELAY CONTROL. THE MATCHED CIRCUITS DETUNE AND THE RESULTING HETERODYNE CURRENT CLOSES THE RELAY.

FIG. 25 BISTABLE MULTIVIBRATOR FREQUENCY DIVIDER, USING DIODE STEERING

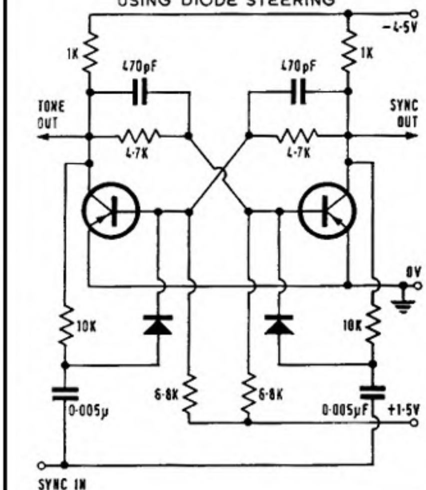


FIG. 24 NPN–PNP RELAXATION OSCILLATOR USED AS A FREQUENCY DIVIDER

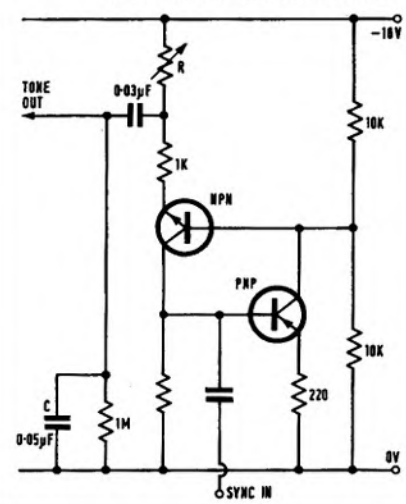
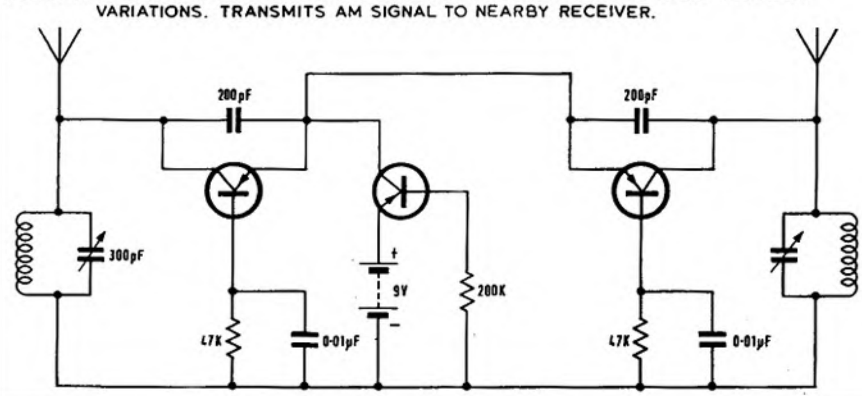


FIG. 21 'THEREMIN' BEAT FREQUENCY OSCILLATOR CONTROLLED BY HAND-CAPACITY VARIATIONS. TRANSMITS AM SIGNAL TO NEARBY RECEIVER.



equipment reviews

REVOX HS77 NAB AND IEC PROFESSIONAL

MANUFACTURER'S SPECIFICATION (Agfa *PE36* at 38 cm/s). Professional mains transportable stereo recorders with tachometer capstan motor speed control. **Tape transport:** Direct capstan drive, separate motors for fast forward and reverse wind. **Wow and flutter:** 0.04% maximum. **Tape slip:** less than 0.2%. **Spool capacity:** 26.5 cm, NAB hubs. **Frequency response:** 30 Hz-20 kHz ±1.5dB. **Distortion:** 2%. **Equalisation:** NAB or IEC to order. **Signal-to-noise ratio:** 60 dB. **Cross-talk** (1 kHz): 45 dB stereo, 60 dB mono. **Tape speeds:** 38 and 19 cm/s. **Bias frequency:** 120 kHz. **Inputs:** 0.15 mV at 50 ohms to 6 K or 2 mV at 100 K (*microphone*, switchable); 2 mV at 33 K (*radio*); 40 mV at 1 M (*auxiliary*). **Outputs:** 2.5 V at 600 ohms (*line*); 1.2 V at 2.5 K (*radio*). **Weight:** 15 kg. **Dimensions:** 359 x 215 x 413 mm (plus spool overhang). **Prices:** On application. **Manufacturer:** Willi Studer GmbH, CH-8105 Regensdorf, Zurich, Switzerland. **Distributor: Revox Ltd, 90 High St., Windsor, Berkshire.**

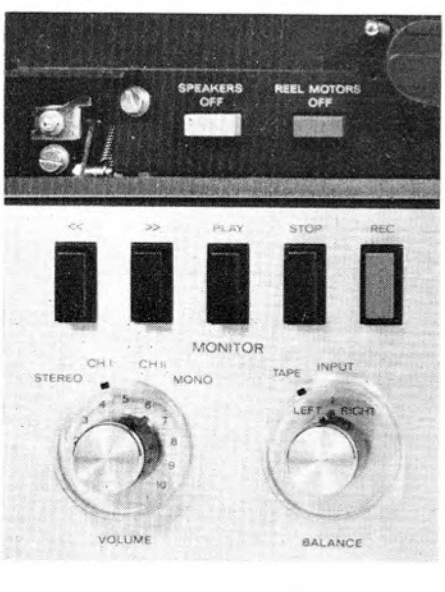


FIG.1 REVOX HS77/NAB RECORD-PLAY WOW AND FLUTTER

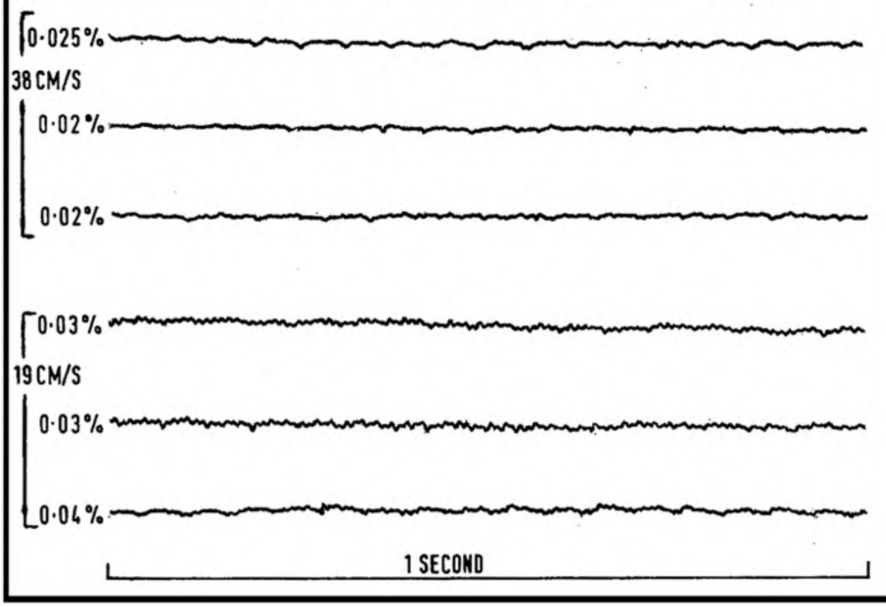
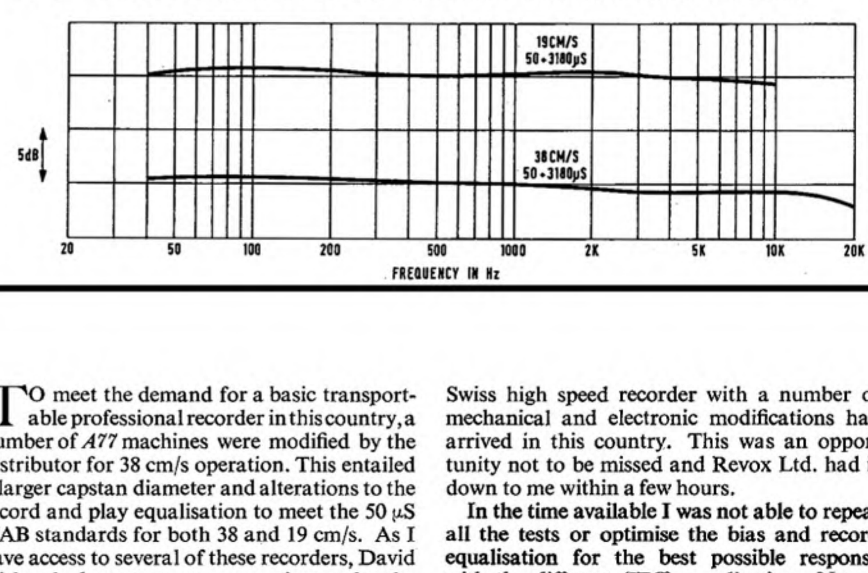


FIG. 2 REVOX HS77/NAB PLAY-ONLY FREQUENCY RESPONSE (TEST TAPES TO LINE OUT)



TO meet the demand for a basic transportable professional recorder in this country, a number of *A77* machines were modified by the distributor for 38 cm/s operation. This entailed a larger capstan diameter and alterations to the record and play equalisation to meet the 50 µS NAB standards for both 38 and 19 cm/s. As I have access to several of these recorders, David Kirk asked me to prepare a review under the conditions suggested in his October Editorial, i.e. I was to be allowed to set the bias and equalisation for optimum performance on any given type of tape. As he forecast, such tests used up a vast amount of time as test tapes, for example, had to be checked one against the other to make sure that the published responses were as accurate as possible and did not include small errors in the calibration.

It was therefore with some consternation and considerable interest that we learned, only a few days before publishing deadline, that a Swiss high speed recorder with a number of mechanical and electronic modifications had arrived in this country. This was an opportunity not to be missed and Revox Ltd. had it down to me within a few hours.

In the time available I was not able to repeat all the tests or optimise the bias and record equalisation for the best possible response with the different (IEC) equalisation. Nevertheless there were significant improvements in wow and flutter, signal-to-noise ratio and cross-erase which take the *77* design a further step towards perfection. The modifications to the Swiss machine listed were as follows:
(a) Metal spool carriers to eliminate static charge on metal spools and (together with b) to give slightly faster and more even tape winding.
(b) Roller bearing on left-hand tape guide to give lower friction and appreciably less wow and flutter.

FIG. 3 REVOX HS77/IEC PLAY-ONLY FREQUENCY RESPONSE (TEST TAPES TO LINE OUT)

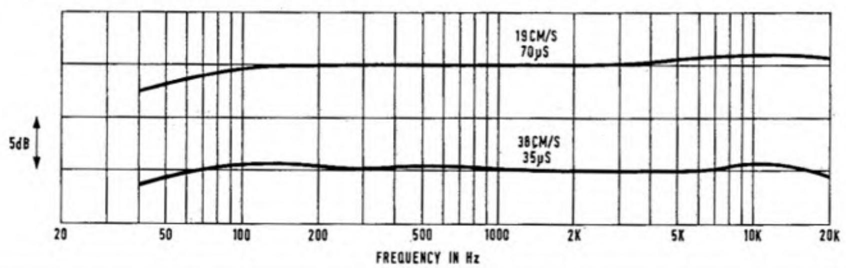


FIG. 4 REVOX HS77 (IEC AND NAB) PLAYBACK AMPLIFIER FREQUENCY RESPONSES

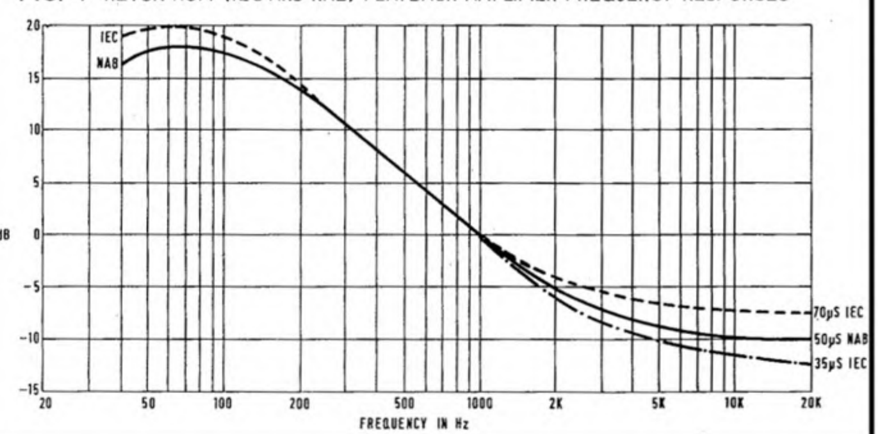
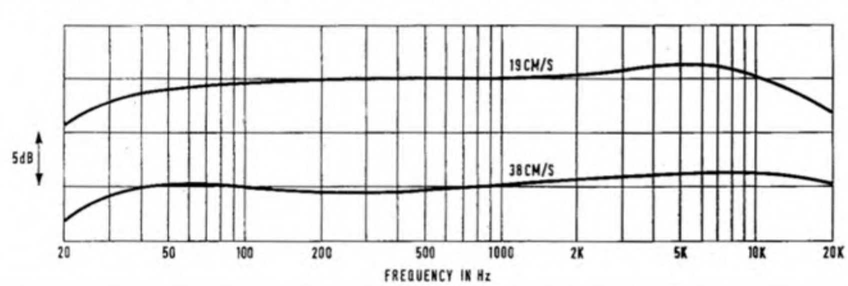


FIG. 5 REVOX HS77/NAB RECORD-PLAY FREQUENCY RESPONSE LINE IN, AGFA PE36, LINE OUT



(c) Damped transient absorber near left hand guide to give better starting.

(d) Wider pinch roller to reduce tape slip (my measurements on the width of the old and new pinch rollers showed them to be nearly identical, so perhaps this modification is yet to come).

Fig. 1 shows the pen recordings of cumulative wow and flutter at 38 and on the UK modified (*HS77/NAB*) recorder. At 19 cm/s the WHM fluttermeter reading remained steady at 0.03% RMS for long periods. Only occasionally did it rise to 0.04% as record and play speed fluctuations come into step for short periods. At 38 cm/s, the meter reading remained rock steady at 0.02% RMS with very occasional excursions to an absolute maximum of 0.025%.

On the Swiss machine, the 19 cm/s reading was 0.03% and I could not coax it any higher by slipping or phasing the tape for cumulative adding of any of the wobble components. At 38 cm/s we hit an all-time low of *0.015%* **RMS combined wow and flutter** with occasional short rises to an absolute maximum of 0.02%.

Fig. 2 shows the responses at line output when playing 19 and 38 cm/s NAB test tapes with 50 µS high note pre-emphasis and 3180 µS bass pre-emphasis. It will be seen that playback equalisation is exact within 1 dB to 10 kHz at the lower speed, and to 15 kHz at 38 cm/s. The solid curve in **fig. 3** shows the electrical equalisation as measured from head terminals to line output.

The *HS77/IEC* was tested with IEC 70 and 35 µS test tapes to give the play-only responses of **fig. 4.** These response are level within 1 dB limits to 20 kHz at either speed with a very slight bass roll-off below 100 Hz at each speed.

The UK *HS77/NAB* was tested with the recommended Agfa *PE 36* LP tape, bias and HF recording pre-emphasis was carefully adjusted at each speed to give the overall responses of **fig. 5** which are within the specified limits.

1 kHz 32 mM/mm reference tape level was recorded at +2 dB on the VU-meter scale. Total harmonic distortion at this level was 0.8%, mainly third harmonic. Unweighted system noise, with no tape passing the heads, was −56 dB on reference tape level. Weighting to the IEC 'A' response, which matches that of the ear at low listening level, gave a reading of −63 dB.

Bulk erased tape was 61.5 dB below reference and machine-erased tape was exactly 60 dB below 32 mM/mm 1 kHz reference tape level.

All the above distortion and noise levels were identical at 19 and 38 cm/s.

The Swiss *HS77/IEC* recorder was tested with the identical *Agfa PE36* LP tape to give the overall frequency responses of **fig. 6.** It was obvious that the top track bias was a bit low at 19 cm/s, resulting in the rising high note response and very slightly lower mid and low frequency responses shown by the solid curve. The bottom track was nearer the optimum bias and pre-emphasis settings for the recommended Agfa tape as shown by the dotted response at 19 cm/s.

At 38 cm/s top and bottom tracks were almost identical and the response was within the specified limits from 30 to 20 kHz.

Unweighted system noise was −58 dB below reference tape level and weighting it to the IEC 'A' response gave the very low reading of −66 dB. This reading remained the same at 19 and 38 cm/s.

Bulk-erased tape noise was −62.5 dB at 19 and −64 dB at 38 cm/s.

Machine-erased noise was −60.5 dB at 19 cm/s and −62 dB at 38 cm/s.

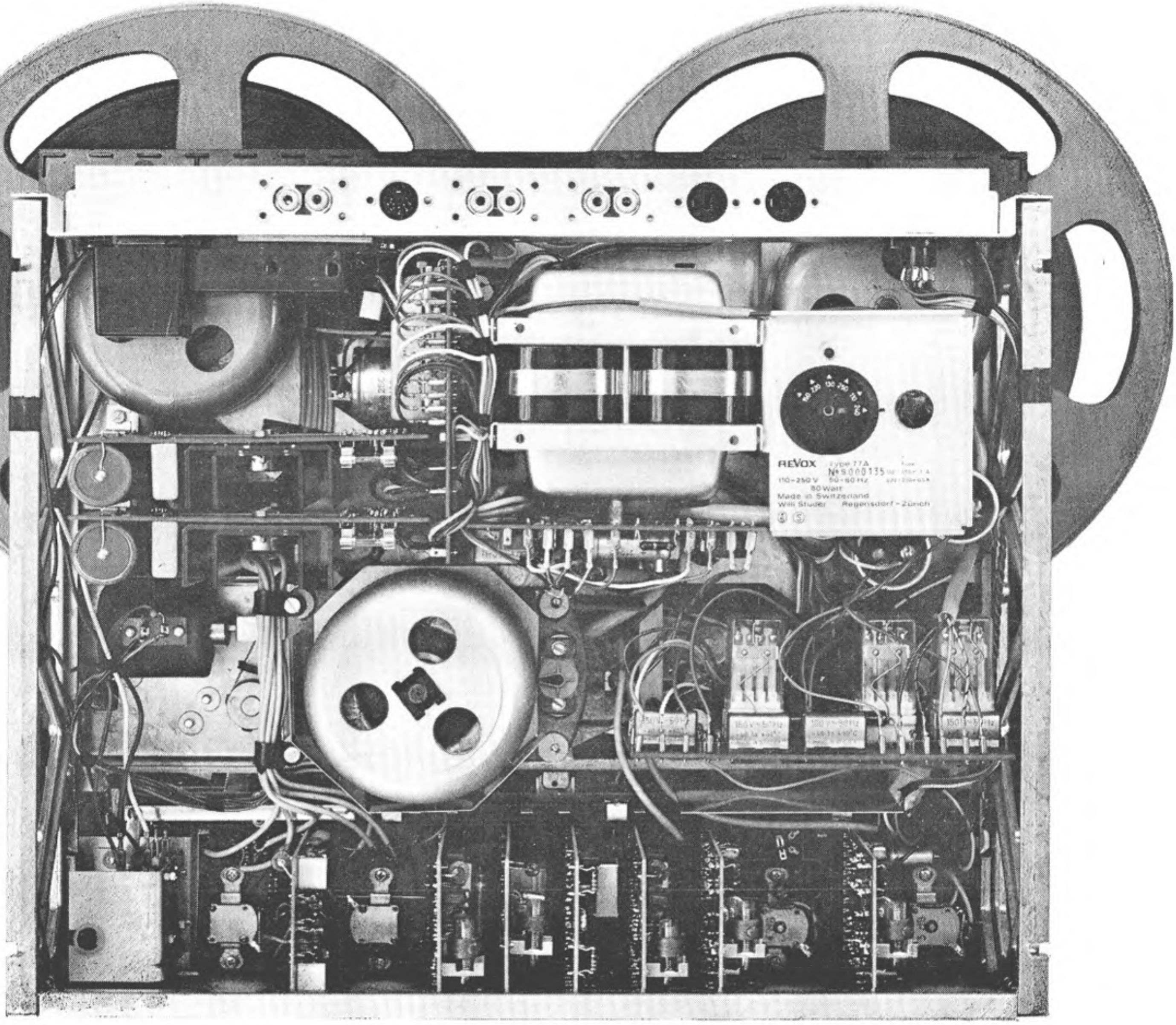
These noise differences with tape speed are mainly due to the change of extreme HF response as the playback equalisation is switched from 70 to 35 µS as shown in **fig. 4.**

The 19 cm/s 1 kHz harmonic distortion at 32 mM/mm was very slightly higher than the other recorder at 0.9% and it dropped to 0.75% at 38 cm/s. This could be due to the slight under biasing of the top track on which the measurements were made, or it could be due to the 3 dB difference in equalisation at 3 kHz (3rd harmonic) as again shown in **fig. 2.**

There was another small difference in the two recorders which could only be detected if the machines were used for industrial or scientific purposes, such as the production of test tapes, where 0.5 to 1 dB differences in extreme high note response were significant. If a mono recording of 10 kHz was recorded on the top track only of the NAB machine and erase and bias applied to the bottom track, either by switching heads or reversing the tape and leaving the bias and erase on the top track, then the 10 kHz signal dropped by 0.5 to 1 dB whenever the other track was erased. The trouble was traced to the erase head, as inserting a slip of paper between the erase head and the tape stopped the effect. It was also proved that the fault was not present on stereo recording.

Measurements showed that the voltage across each section of the erase head was 15 V on stereo recording, but rose to 25 V when

(continued on page 469)


REVOX
Type 77A
Nº 5000135
110-250 V 50-60 Hz
80 Watt
Made in Switzerland
Willi Studer Regensdorf-Zürich

only one erase head was in use. This indicates that on mono the erase head is over powered and cross coupling within the head powers the unused head with 6 to 7 V which is sufficient to just begin to erase high frequencies on the unused track.

Screwing in the ferrite core of the dummy load coil L601 dropped the volts to 20, reducing the effect slightly, but this caused a change of volts on the record heads on switching from mono to stereo which could not be tolerated as the frequency responses were markedly altered.

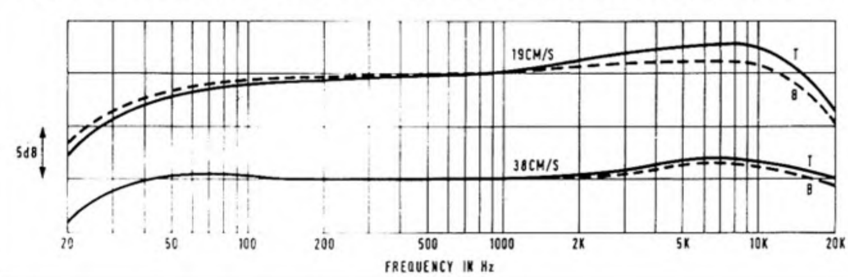
On the Swiss *HS77 IEC* the fault did not show up at all, although the same change of volts appeared across the erase heads on switching from mono to stereo I can only assume that the impedance or depth of the gap in the erase head has been altered slightly as the type number has been changed from *Z740* to *Z940*.

COMMENT

The last few paragraphs, showing concern over a 0.5 to 1dB difference in response, indicates that these *HS77* machines are in an entirely different class to the average domestic recorder and that testing and adjusting these machines to such high standards is a long and time-consuming job. It is made somewhat easier on these recorders by grouping all presets for bias, meter, record equalisation for each speed and track, etc., along the base of the recorder so that when it is removed from the cabinet they are fully accessible and well identified for adjustment with the recorder in a vertical operating position.

These recording instruments set new standards in wow, flutter, frequency response and signal-to-noise ratio which must ultimately benefit the design of transportable studio recorders.

FIG. 6 REVOX HS77/IEC RECORD-PLAY FREQUENCY RESPONSE LINE IN, AGFA PE36, LINE OUT



or by means of switching and control circuits actuated by the capacitative changes occurring when the contacts are touched. There is virtually no limit to the range of control which can be effected in this way. Relatively simple capacitance or resistance switches can operate semiconductor gates each controlling as many signal lines as is desired, quantitative control can be exercised so that variations in finger pressure can determine dynamic changes, vibrato or tremolo can be produced by finger movements and so on. Three germinal circuits by which these controls can be achieved will be found in **figs. 22** and **23**, the first two being touch switches and the second an oscillator which is momentarily switched on by touching one of the points shown. Some useful 'attack' values can be produced by the latter.

Before leaving the subject of pitch determination, some mention must be made of frequency divider systems.

So far, I have dealt only with independent oscillators which are non-operative until switched on by the pitch selection device. When a large number of separate frequencies is required, as in an electronic organ or other polyphonic instrument, an economy, both in cost and space, can be achieved by providing only twelve separate independent oscillators (one for each semitone in the octave) and connecting each to a chain of synchronised, divide-by-two circuits equal in number to the number of octaves of tones required. Many different types of circuit capable of giving an oscillatory output of frequency exactly half of the input frequency have been developed and most have been used in musical instruments. Two examples are given in **figs. 24** and **25**. The outputs from each divider stage are used both as basic signal currents and as a means of synchronising the stage below. These currents are usually of square or sawtooth form (but more of this in the section on tone quality).

While commercially of very great importance as a cheap means of constructing reasonable polyphonic musical instruments, frequency divider systems all suffer from the inherent disadvantage, *as polyphonic sources*, that all octavely-related notes are precisely in phase with each other. Furthermore, for any combination of notes to be available simultaneously, it is necessary that all the master-oscillators and all the divider stages should be operating continuously while the instrument is in use. The consequence of this is that *all* tones in the whole gamut are phase-related and much of the realism arising from the slight phase differences between discrete sources, however accurately tuned (which is the basis of our identification of them as individual sources), is lost.

This factor, which is a disadvantage in polyphonic instruments can, however, provide us with a most useful tool, in the synthesis of monophonic instrumental tone, if each master oscillator and its divider chain is regarded as a source of raw material for a single note. Phase-freedom is preserved and additional harmonic components made available for tonal synthesis. This is dealt with later.

Your Tape Dealer

So you want to be a recording engineer?

By Gerald Chevin

THE sound recording industry in and around London is currently expanding at a considerable rate to meet the growing demand for gramophone records. This expansion has created new opportunities for potential recording engineers and tape machine operators.

The progression from 'tape jockey' to engineer depends on several factors, which vary between studios, but it can happen purely by luck. Perhaps the engineer due to balance a session fails to arrive because of illness or a traffic jam. It may well be left to the assistant to take charge and, if things go well, that particular producer may ask for the assistant to engineer his next session.

Firstly it must be stated that absolutely no glamour is attached to the position of 'tape jockey'. In fact it is hard work with little reward, financial or otherwise, and it means working very long hours. But if you are prepared to face the initial period, the hard slog will prove useful in furthering a career as a sound recording engineer.

The question is often raised—what educational qualifications are required for the job? So far there is no formula for the perfect engineer and many studios simply choose applicants with a musical background, electronics background, or a mixture of the two. Recording engineers can be split fairly easily into two categories, concentrating respectively on small groups and large orchestras. Rather more musical experience, including the ability to follow a score, is desirable for a classical recording engineer. For group work, on the other hand, the ability to mix with young people, and an ear for their kinds of music, are important. It is only fair to mention that age plays a substantial part since many groups prefer to see a young engineer at the controls, even though an older person might do a better job.

Being able to operate the tape machines quickly and efficiently is the first task most studio people learn. From there you branch out to editing and dubbing tapes, setting up for a session, and the big one—working overtime. The job should not even be considered if you are not prepared to work overtime, nights and weekends.

Finally, one should apply for a position by letter, stating qualifications, age and present job. Who knows, in a year or so, you too could be a recording engineer.

BLACK LIST

A REPLY TO PETER BASTIN'S 'THE OTHER SIDE OF THE COIN'

By H. W. HELLYER*

HE came into our shop, patently timid, weighed down by a portmanteau-sized tape recorder the manufacturer had slyly labelled 'transportable' when it was put on the market, well over a decade ago. He left, ten minutes later, a sadder and wiser man, taking his unrepairable burden.

Long experience in the trade has revealed that some makes and models are beyond economic repair. As enthusiasts—and some of us carry our daily work over into this absorbing hobby so that the border-line between work and pleasure can hardly be defined—we would love to be able to rip another of the old-timers to bits, to turn up new spindles on the lathe, to refashion bearings, strip down motors to their essentials and clean the running surfaces, and finally to add some modern refinements to the circuitry so that the veteran emerges as a piece of equipment that could compete for quality with any of its modern counterparts. As so many of these older machines were built to last as long as a battleship, the refurbishing would be worthwhile—but time costs money. Such a job would be a labour of love, and needs a good technical knowledge. Which is why, to quote from the June Editorial, so many enthusiasts 'curtail their creativeness in favour of chasing the latest transistor amplifier, the latest IC tuner, and the latest 'Dolbyised' discs . . . who tolerate capstan sleeves and narrow tracks, plastic mics and miniature jacks, and then complain that their tape equipment is not as good as their gramophone'.

Which is why, also quoting the June issue, people like F. W. Sutherland can earn our approbation by an intelligent improvement to a standard machine (*Extending an Akai M8*, page 235). His handful of parts may have cost shillings, and the knowledge would be current in the average workshop, but the time involved in doing the job would undoubtedly cost more than a casual customer is likely to tolerate.

Even the normal servicing processes can run up a considerable bill, when one of these veteran machines has to be tackled. If the service establishment wants to guarantee its work—and most of us do—it becomes necessary to inspect an old-timer more critically, to clean more thoroughly, to relubricate throughout and often to replace small parts that the owner may not have been aware of, let alone noted their depreciation. Otherwise, sad to say, one does a swift service job on one part of the machine and has the distasteful task later of convincing the owner that the subsequent breakdown was in no way related to the original repair.

First consideration is the availability of spare parts. Many firms have folded, others have been taken over with their new masters completely disowning earlier products. Even when the makers are still in business the stockpile of replacements will have long since melted away. If we know, as soon as our little fellow drags his equipment through the door, that certain bits and bobs are unobtainable and that some of the jobs on his ageing pet will take almost as long as building anew, then, sirs, we must fain refuse.

We do, in fact, publish a Black List, which has a copy under glass upon the counter by the till. It causes some raised eyebrows among the aficionados: 'What, you can't repair the old Thundergut? Best machine they ever made. Never goes wrong.'

Stifling our obvious rejoinder 'Why have you brought it in?' we say that yes, we agree it *was* good—accent on the past tense—but that even the makers have brought out new models and, though we hardly hope to be able to resell, nevertheless we would take a *Mark One* in part exchange . . .

It must seem unfortunate for us that the disappointed owner of the veteran seldom comes back to us to replenish his home rig. Too often, he goes along to the discount store, buys reduced rubbish and forswears 'hi-fi' forever.

There is no solution to the contretemps. We must upset some in order to give good business to others. Our Black List remains, with many quite respectable names upon it: machines that have seen such good service that their owners can never accept their relegation to a scrapheap; others that came on the market like mayflies, to perish in a season, and a few, mostly foreign, whose agents and distributors have kept us waiting so long for spares that tape decks go rusty before they can be repaired.

There must be room in the fringe of the business for a service organisation willing to accept the audio jobs that nobody else is able to do. Our Editor could not have been thinking in these terms when he suggested in a leading trade magazine that audio service depots were an inevitable thing of the future. But among our readers we shall surely find one or two experts ready to have a go. What about it, lads?

*Technical Director, Bristol Tape Recorder Centre

PHILIPS FAMILY TAPE RECORDER

N 4305

Everything the family could want in a tape recorder. Record your children's first words, music lessons, etc. A lifetime's enjoyment. Superb quality won't let you down. Four tracks, two speeds. Excellent reproduction and many features of much more expensive recorders. Supplied complete with microphone, recording/playback lead, 5" reel of long play tape, 5" empty spool.

OUR PRICE 36 GNS!

List Price £46.13.11

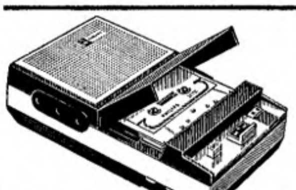
ALSO COMPLETE PHILIPS RANGE INCLUDING—

N 2200 CASSETTOPHONE—

Your choice of music anywhere. Trim, streamlined musicassette player. 76 hour batteries. All transistor amplifier. Our Price 9½ gns. List price 13 gns. Only a few left.

GL 559 Smart, attractive loudspeaker enclosure. 6 watt. Size 10½" x 7½" x 7½". List Price £11. Our Price 8½ gns.

EL 3575 Full stereo tape recorder. Duoplay and multiplay integrated. First class frequency response and reproduction with full tonal values. List Price approx. £101. Our Price 72 gns.



PHILIPS EL 3302 CASSETTE PORTABLE RECORDER

OUR PRICE **22 GNS.**

LIST PRICE £28 . 7 . 0

A real gem from Philips. Record or playback, anywhere, instantly. Just snap a Compact Cassette or Musicassette. Powered by five 1.5 Volt batteries — mains unit available. Lockable record control with playback, re-wind and fast wind. Microphone with remote stop/start control. External speaker sockets. Supplied with carrying case, blank and demonstration cassettes, library rack, etc.

DON'T MISS THESE VALUE FOR MONEY OFFERS . . .

Send coupon for INTEREST FREE Easy Terms

Ferrograph

FERROGRAPH MODEL 713

A mono system of tremendous potential. Vertical or horizontal operation. Silicon solid state electronics. 3 motors (no belts). Half track. Tape speeds 1⅞, 3¾, 7½. Output: 10 watts RMS. **OUR PRICE £153 . 6 . 3** List Price £174.13.6.

MODEL 702/4 A superb stereo system. Specification similar to 713 with no output stage. Damped tension arms for slur-free starting. Will mix four inputs into one channel. Half or quarter track. **OUR PRICE £173 . 8 . 5** List Price £194.15.8.

MODEL 722/4 A masterpiece in stereo equipment. Specification similar to 702/4 with an output of 2 x 10 watts. A speaker for each channel. Unit construction, etc., etc. Must be heard and compared. **OUR PRICE £194 . 3 . 1** List Price £204.14.9.

The above are pre-increased prices In extremely short supply — Preference given to REW customers!

Come along to either of our showrooms and you can see and hear the equipment of your choice. Rew are the only authorised Philips Audio Centre in South London. Our experienced staff will help you select from a comprehensive range of the biggest names in the sound business. Our amazing "Specials" and offers will delight you. Interest free easy terms are available. If you can't call, write or phone for details. Our rapid reply mail order system is very popular.

R.E.W. AUDIO VISUAL CO

HEADQUARTER SHOWROOMS AND MAIL ORDER: DEPT. TR, 266-8 UPPER TOOTING RD., LONDON, S.W.17. Tel. 01-672 4471/2 and 9175.

WEST END SHOWROOMS:
146 CHARING CROSS ROAD, LONDON, W.C.2.
Telephone: 01-836 3365 (opposite Astoria Cinema).

NAME ....
ADDRESS ....
....

BASF 30% OFF!

Fantastic offer of world-famous BASF magnetic recording tape at near wholesale price! Brand new, fully guaranteed. Each tape supplied in the superb BASF plastic swivel box. (*3" tapes in plastic mailing boxes.*)

STANDARD PLAY		*List Price*	*Our Price*
5" 600'	...	22/3	**15/-**
5¾" 900'	...	29/5	**20/6**
7" 1200'	...	36/7	**25/6**
LONG PLAY			
3" 210'	...	9/6	**6/9**
4" 450'	...	15/7	**10/9**
5" 900'	...	29/3	**20/6**
5¾" 1200'	...	36/5	**25/6**
7" 1800'	...	51/7	**36/-**
BASF LOW NOISE COMPACT CASSETTES			
C.60 ...	...	17/7	**12/3**
C.90 ...	...	25/1	**17/6**
C.120 ...	...	33/7	**23/6**

DOUBLE PLAY		*List Price*	*Our Price*
3" 300'	...	15/-	**10/6**
4" 600'	...	26/1	**18/3**
5" 1200'	...	43/3	**30/3**
5¾" 1800'	...	56/5	**39/6**
7" 2400'	...	79/7	**55/6**
TRIPLE PLAY			
3" 450'	...	23/-	**16/-**
4" 900'	...	40/1	**28/-**
5" 1800'	...	67/3	**47/3**
5¾" 2400'	...	91/5	**64/-**
7" 3600'	...	116/7	**81/6**

Post and Packing **2/6** *per order.*
Mail order only

LEDA TAPES (D) 17 LEIGH PARK ROAD, LEIGH-ON-SEA, ESSEX

London office: Tel.: 01-226 7004.

You take no chances when you purchase our brand new British Recording Tapes. Manufactured by reputable British firm. Fitted leaders, polythene bag and boxed (ex. 3"). These tapes are not to be confused with sub-standard imported or used taped. All 100% tested and fully guaranteed.

This month free coloured leaders with all tape orders

Standard Play			
3" 150'	...	...	**2/-**
4" 300'	...	...	**4/-**
5" 600'	...	...	**6/-**
5¾" 900'	...	...	**7/6**
7" 1200'	...	...	**9/-**
Double Play			
3" 350'	...	...	**4/-**
4" 600'	...	...	**6/-**
5" 1200'	...	...	**11/6**
5¾" 1800'	...	...	**16/-**
7" 2400'	...	...	**19/6**

Long Play			
3" 220'	...	...	**2/3**
4" 400'	...	...	**5/-**
5" 900'	...	...	**8/-**
5¾" 1200'	...	...	**10/-**
7" 1800'	...	...	**13/-**
Empty Spools			
3"	...	...	**8d**
4"	...	...	**1/8**
5"	...	...	**1/9**
5¾"	...	...	**2/-**
7"	...	...	**2/3**

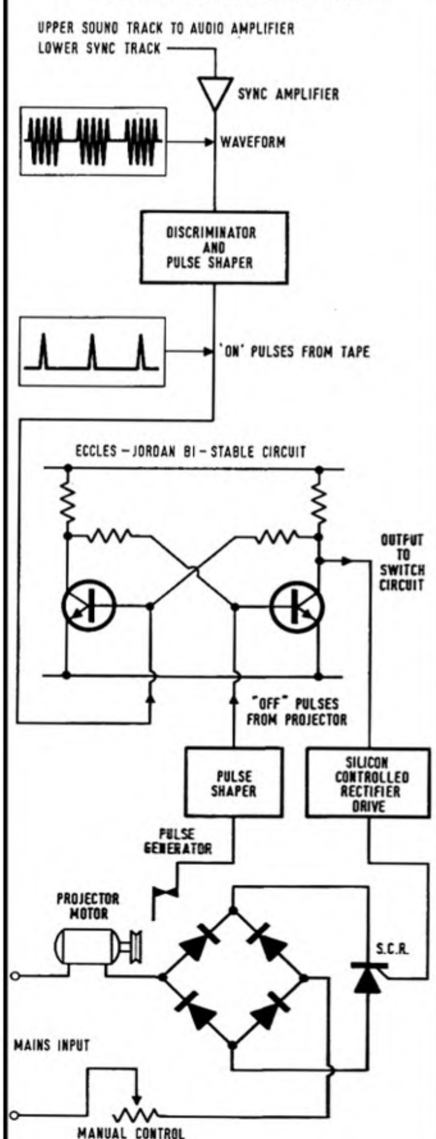
Compact tape cassettes. 100% perfect, fully guaranteed, not to be confused with Maxwell.
All supplied in plastic library cases.
C. 60 7/6, C. 90 10/-, C. 120 14/6. P & p 2/- per order.

N. WALKER TAPES

28 Linkscroft Avenue, Ashford, Middlesex.
Phone: 53020

The simple switching may be replaced by an Eccles Jordan bistable circuit. In this circuit the two transistors are connected in such a manner that when one is switched on the other must be off. The transistors may be switched by applying electrical pulses to their base connections, so that if one transistor is controlled by pulses from the tape recorder and the other with pulses from the projector, the time one transistor remains in any particular on or off state depends on the time ratio of the two sets of pulses. If the pulses from the tape are arranged to switch the motor on and the pulses from the projector to switch the motor off, should the motor try to go faster or slower it will alter the time between the on and off pulses and so alter the motor speed. For instance, if the motor tends to go faster *then the off pulses occur in a shorter time after the on pulses, and automatically correct the speed of the motor.* In this manner the motor is electronically locked to the pulses on the tape by what is known as the *mark space ratio* of the pulses and, therefore, the projector remains in precise sync to the tape.

FIG. 2 BLOCK DIAGRAM OF CONTRONICS P.I. TAPE/FILM SYNCHRONISER



The pulses originate from the camera which needs a simple contact to produce one pulse per frame. As we are recording, in the first instance, for a projection system, we should bear in mind that an electric motor has inertia and if a very rapid on/off control is applied to it, it cannot immediately respond to any slight variations in the control. It requires finite time to slow down or to speed up. Slower or faster pulses may be used, but in practice, one pulse per frame is ideal for most 8 mm projectors. These pulses are recorded either on a stereo tape recorder or a ¼-track machine that has been modified so that a feed can be taken from the bottom track, directly into the Cinesound without the necessity of additional amplifiers. The stereo machine could well be modified itself by adding an additional head between the sound tracks, thus allowing music and effects to occupy different tracks. The projector requires two small modifications, and these are fairly easy to carry out; the first is to fit a simple contact like a reed switch and a small magnet to the revolving shaft so that the reed relay makes and breaks once per frame when the magnet passes it; the second is to connect the synchroniser control leads into the motor circuit.

Primarily, the Cinesound is a pulse producing system ideal for 8 mm projection using a silent projector. The modifications needed are not difficult to effect, and full instructions are given in the very good handbook supplied by the manufacturers. The record unit *R1* which is attached to the camera is very small and light and costs £5 3s. 11d. The replay unit, *P1*, which is connected to the projector is again fairly small and costs £15 11s. 7d. Both electric and spring drive cameras may be used. There is a combined record/playback model *CS/1* available which costs £33 0s. 5d. This unit incorporates a frames-per-second indicator, auto start switch, and circuits to accept different rates of pulse input. The Cinesound system may be used with perforated tape. This greatly assists editing but an electric camera-drive must be used with modifications to the camera motor wiring. It has no special merit for transferring to magnetic stripe as it is not desirable to try to control a magnetic projector's speed from the pulses on the recorder.

If the record unit is adapted for use with a 16 mm camera for ultimate transfer to 16 mm optical film, it must be remembered that most laboratories will only accept pulse-sync tapes that have been recorded to Nagra or Perfectone standard (i.e. two-track tape with the pulse recorded on the bottom track at *two pulses per frame* (one pulse per half-frame interval) at sound speed or 48 pulses for 24 f/s or 50 pulses for 25 f/s). The 16 mm camera, therefore, must be fitted with commutator and generator that can produce this rate and, ideally, an electric motor.

The Cinesound is manufactured by *Contronics Ltd., Deepcut, Camberley, Surrey.*

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 1s. per word, minimum 15s., Box Nos. 2s. extra. Copy and remittance for advertisements in **DECEMBER 1969** issue must reach these offices by **20th OCTOBER** 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. quoted on the outside of the envelope. The district after Box No. indicates its locality.

SITUATIONS VACANT

Wanted: Recordist. Details S.A.E. Trans World Radio and Television Service, Fleet Street House, Great Wakering, Essex.

Sony (UK) Ltd. See pages 436/440.

Electronic Engineer specialised Tape Recorders. West End situation. Elegant job and prospects. Apply to Box 557 (London). Assistant to above position. Apply to Box No. 558 (London).

Repair Mechanic required having a basic knowledge of electronics. Some experience with transistors and transistorised amplifiers necessary. Interesting work in large, airy and very well equipped service department. High basic rate, 5-day (40-hour) week with overtime when necessary. Pension scheme, own canteen service. Apply Mr. S. Allard, Johnsons of Hendon Ltd., Service Department, 970 North Circular Road, London, N.W.2. Tel. 01-450 8671.

Magnetic Tapes Ltd. require young men to be trained in various processes of manufacturing tape recorders for both industrial and commercial use. Varied and interesting work. Genuine interest in the audio field essential. Please write for appointment giving details of any previous experience. Apply to S. E. L. Collings, Magnetic Tapes Ltd., Chilton Works, Garden Road, Richmond, Surrey.

FOR SALE—PRIVATE

Solid State Stereo Tape Recorder, Eagle TC450. Vertical or Horizontal operation, 4-track stereo and mono record/playback (as reviewed in *Tape Recorder* Sept. '68), in pristine condition. A few hours use only. Cost £69. Bargain at £40 Box No. 553 (Kent).

Hi-hat with 15 inch Krut cymbals £5. Bass drum pedal £2. Side drum stand £2. All Olympic, excellent condition. Phone 01-660 1386.

Philips EL6033/10 omni/cardioid studio moving-coil microphone, cost £26, excellent condition. Best offer above £11. Box 559 (Surrey).

Akai 1710W 4-track 3-speed, 2 extra SW50 Speakers, 2 microphones, tapes, reels, extras, almost unused, £85. Redhill 63681.

Tandberg Series 15 2-track mono. As new. 9000 ft. L.P tape. Cost £85. Accept £60. Lancaster 3968.

Fi-Cord 202 for sale £30, case, battery, charger, transformer. Cost over £100. 01-360 7755.

FOR SALE—TRADE

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

Pre-recorded American Stereo Tapes. 7½ ips. Cheap as records. Bernsteins, Mahler, Maazels, Sibelius, Karajan, Beethoven Symphonies. £15 per set of 5 tapes incl. PT and duty (any duty or purchase tax charged by the postman will be refunded—see instruction slip in tape box). £3 cheaper than records. PO 5s. for complete catalogue. Postereo Tapes, 9 Darley St., Harold's Cross, Dublin 6, Eire.

W.H.M. 8 transistor Audio Limiter/Compressor in modular form. Full frequency range. 20 db overload capacity. P.P.M. attack. Fast recovery . . . no 'hole'. Low distortion. £15 net (UK), 2 year guarantee. 35 Villiers Road, Watford WD1 4AL.

If quality matters consult first our 75-page photographically illustrated catalogue with technical specifications (6/6). Members enjoy unbiased advisory service, preferential terms. Membership 7/6. Our associates also manufacture records from your own tapes, or record the Master at our studios (Steinway Grand). Bulk terms for choirs, fund-raising. Please specify requirements. Audio Supply Association, 18 Blenheim Road, London W.4.

"Ampex" Tape—Brand New and Boxed 1,800 feet 7in. reel. Long play (list price 55/-). Our price 30/- each; two for 55/-; four for £5. P & P 1/9 per reel. 3/- for 2 reels, 4 or more Post Free. Limited quantity. E. C. Kingsley & Co., Dept. TO, 132 Tottenham Court Road, London, W.1. 01-387-6500.

UNIMIXER 4S

A new 4-channel stereo/mono mixing unit for the small professional user and enthusiast in the studio and on location. Any input impedance between 25-600 ohms, noise figure better than 2.5 dB above thermal noise. 2 indep. outputs on each channel. Robust construction. Fully guaranteed. Price £45. *Further details from*

Soundex Ltd., 18 Blenheim Rd., London, W.4. 01-995 1661

TAPE EXCHANGES

Contact the World through your Tape Recorder and Britain's largest Tape-X-change: Worldwide Tapetalk, 35 The Gardens, Harrow. Particulars 4d; sample magazine 1s. 4d. (stamps).

MISCELLANEOUS

Dictating and Audio Service Ltd., 5 Coptic Street, London, W.C.1. (Near the British Museum). Telephone: 636 6314/5. Authorised Service Agents. Grundig, Philips and other leading makes of Tape Recording equipment repaired to Manufacturers' Standards by skilled staff, using modern test equipment—audio generators, oscilloscopes, audio voltmeters, etc.

. . . an **AAU** from **M.A.C.** connects recorders . . . **INSTANTLY** ! Full details available from MAC Electronic Company, Ripley, Surrey. Telephone Dunsfold 310.

STUDIO FACILITIES

Studio Sound Recording Studios. Recording and disc transcription service. Latest high-level cutting techniques. Mono and stereo records. Exceptional quality obtained from amateur recordings. Members A.P.R.S., 31-36 Hermitage Road, Hitchin, Herts. Telephone Hitchin 4537.

Your tapes to disc. 7in. 45—25/-, 10in. L.P. —55/-, 12in, L.P.—65/-. 4-day postal service. Masters and Vinylite pressings. Top professional quality. S.A.E. photo leaflet: Deroy Studios, High Bank, Hawk Street, Carnforth, Lancs.

Your own tapes transferred on to discs. Send for details: R. J. Foley Tape to Disc Service, 112 Beach Road, Scratby, Great Yarmouth, Norfolk.

Graham Clark Records. Tape to disc pressings. 23 The Grove, Walton-on-Thames, Surrey. Tel. Walton 25627.

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

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

WANTED

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.

GOOD QUALITY TAPE RECORDERS PURCHASED FOR CASH. TELEPHONE 01-472-2185.

Please help me—I'm desperate to obtain copies of recordings of "The Goon Show" (other than those issued on L.P. records or recently re-broadcast). Details to Box No. 556 (Glasgow).

Old Records. Pre-war discs of opera singers on HMV Victor, Columbia, etc., labels, always wanted. Also continental makes, Polydor, Odeon, Fonotipia, Schallplatte, etc., of even greater interest. Lubbock, 303 Whitehorse Lane, London, S.E.25. Tel. 01-653 1695.

EMITAPE Afonic
low-noise recording tape

quiet as a mouse!

don't buy any tape – buy EMITAPE

THE RANGE OF EMITAPE AFONIC LOW-NOISE TAPE

88
STANDARD PLAY

The best general purpose tape, giving maximum durability at all professional speeds. Pre-stretched polyester base film of super strength.

99
LONG PLAY

50% longer recording time – specially designed for multi-track recorders – pre-stretched polyester base film of super strength.

100
DOUBLE PLAY

Twice the recording time for a given size of spool – the perfect film for low speed, multi-track recorders – superflex polyester base film.

300
TRIPLE PLAY

Maximum playing time on spools up to 5″ dia. – extended dynamic range – specially suitable for battery operated recorders – extra tensile polyester base.

EMITAPE IS AN EMI GROUP PRODUCT EMI

THE MAGNIFICENT WORLD

Model 4000D

4 TRACK STEREO TAPE DECK—4000D

*4 track stereo/monaural recording and playback *2 speeds, 3 heads *All silicon transistorized pre-amplifier *Automatic shut off, Instant stop control *Tape cleaner *ONE MICRON GAP HEAD *Magnificent oil-finished wooden cabinet *For increased stereo enjoyment, use the matching AA-6000, 120 watt solid state amplifier and the matching speaker SW130 (2 way, 25 watt input).

MIGNON STEREO TAPE RECORDER—1710L

*4 track stereo/monaural recording and playback *3 speeds *Automatic shut off *Pause lever *Tape cleaner *Tape lifter in fast forward/rewind operation *4 hours maximum stereo recording capacity with a 1,200 feet tape *Beautiful black vinyl leather cabinet *For increased stereo enjoyment, use the matching high compliance speaker SW-50.

CARTRIDGE/REEL-TO-REEL STEREO TAPE RECORDER —X-1800SD

*8 track stereo cartridge recording and playback *Transfer from open reel to cartridge *4 track stereo/monaural recording and playback *Wide frequency CROSS-FIELD HEAD *ONE MICRON GAP HEAD *Magnificent oil-finished wooden cabinet *For increased stereo enjoyment, use the matching speaker SW-130 (2 way, 25 watt input).

Model 1710L

Model X-1800SD

Prove it by the sound!
………… prove it with **AKAI**® CROSS-FIELD HEAD

Pullin Photographic Limited: Great West Road, Brentford, Middlesex Tel: 01 568-9222