JULY 1969 2s 6d

tape recorder

A SIMPLE TRANSISTOR LIMITER/COMPRESSOR

SERVICING THE REVOX 36

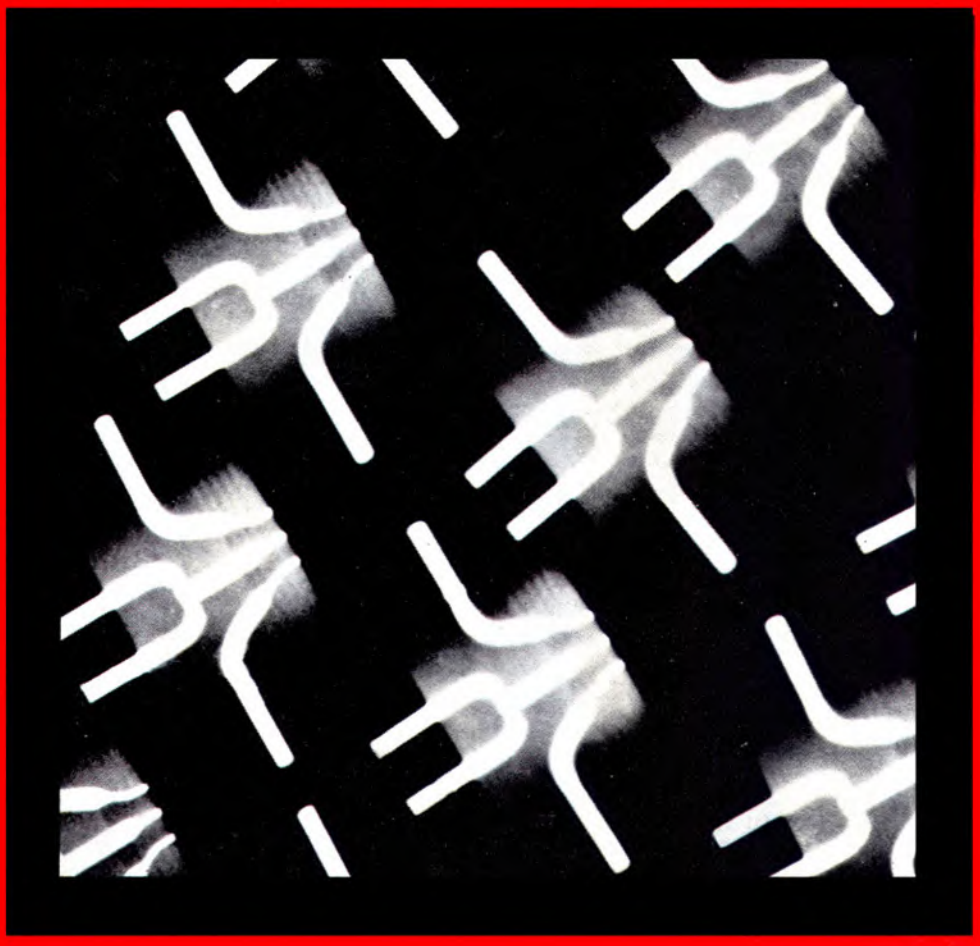
RECORDING LIVE MUSIC ON BATTERY EQUIPMENT

FADERS AND MIXERS

REVIEWS: SONY TC 355 & PHILIPS MICROPHONES

A STEREO SWITCH UNIT

SURVEY OF BATTERY TAPE RECORDERS



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BRANDED TAPES
20% OFF!
BASF—EMI—GRUNDIG—PHILIPS SCOTCH—AGFA

Brand new, Fully Guaranteed and in normal manufacturers pack.

		LIST PRICE	OUR PRICE
STANDARD PLAY			
5"	600'	22/2	18/-
5½"	900' Except Agfa	29/5	24/-
7"	1200'	36/7	29/6
LONG PLAY			
3"	210' Not Scotch	9/3	7/6
3"	300' Scotch only	9/7	7/9
4"	450'	14/9	12/-
4½"	600' BASF, Agfa only	22/-	18/-
*5"	900'	29/2	23/6
*5½"	1200'	36/5	29/6
*7"	1800'	51/7	41/6
8½"	2400' BASF, Scotch only	74/-	58/9
10"	3280' Agfa only	85/9	68/9
10"	3600' BASF only	96/6	77/6
10½"	4200' Agfa, BASF only	113/6	89/3
SCOTCH DYNARANGE (L/P)			
5"	900'	32/8	26/3
5½"	1200'	41/-	33/-
7"	1800'	58/1	46/6
8½"	2400' (Metal Reel)	84/3	67/6

GRUNDIG TAPE AVAILABLE ONLY WHERE MARKED WITH ASTERISK

		LIST PRICE	OUR PRICE
DOUBLE PLAY			
3"	300' Not Scotch	14/3	11/6
3"	400' Scotch only	16/7	13/3
4"	600'	26/-	21/-
4½"	900' Agfa, BASF only	31/-	25/-
5"	1200'	43/2	34/9
*5½"	1800'	56/11	46/-
*7"	2400'	79/-	63/6
10"	4600' Agfa only	140/9	112/9
TRIPLE PLAY			
3"	450' Not Scotch	22/3	18/-
3"	600' Scotch only	24/10	19/9
4"	900'	40/-	32/3
*4½"	1200' Agfa, BASF only	50/-	40/3
5"	1800' Not Scotch	67/2	54/-
5½"	2400' Agfa, BASF	91/4	73/6
7"	3600' only	116/6	93/6
COMPACT CASSETTES			
C.60		17/6	14/3
C.90		25/-	20/3
C.120		33/6	27/-

Postage and packing 2/6. Orders over £3 post free.

AMPEX TAPE—SAVE 30%

A special offer of top quality, premium grade, mylar (Polyster) base tape with Full Leader and Stop Foil. Boxed and Fully guaranteed.

TYPE	DESCRIPTION	LIST PRICE	ONE	THREE	SIX
541-12	1150' on 5½" reel Long Play ...	35/-	24/6	71/-	137/-
551-12	1200' on 5" reel Double Play ...	42/-	29/6	86/-	168/-
551-16	1650' on 5½" reel Double Play ...	55/-	33/6	97/6	189.-
551-24	2400' on 7" reel Double Play ...	77/6	49/6	145/6	285/-

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

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UP TO HALF PRICE

Compact Cassettes with £0, 90 and 120 minutes playing time. Brand New and packed in normal plastic library box. Available at this exceptional price.

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/-
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Must not be confused with cheaper American Overture Cassettes advertised elsewhere.

ILFORD—
ZONAL TAPE
40% OFF!

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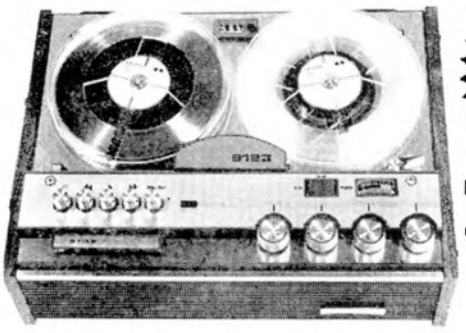
From the Motion Picture and Magnetic Products Division of **ILFORD LTD.** we are proud to present a New Stupendous **BARGAIN OFFER**! Never before have you been offered such a breathtaking opportunity. **ILFORD-ZONAL** premium grade magnetic tape (extensively used by the B.B.C.) at a terrific reduction 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 5½" 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 5½" 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 £3 post free

BARGAIN OF THE MONTH
PHILIPS/STELLA 4-TRACK TAPE RECORDER

Model 9123



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LIST PRICE £60-0-10

OUR PRICE

£48

Carriage 10/-

An attractively priced, high quality, reel-to-reel recorder. You will find that this machine, despite its many potentialities, is very simple to operate, thanks to the clear arrangement of its controls and connection sockets alike.

LOOK AT SOME OF ITS OUTSTANDING FEATURES

- *Mono recording and playback.*
- *Stereo playback, duoplay and multi-play with stereo amplifier and accessories.*
- *4 track, 2 speeds—3¾ and 1⅞ i.p.s. reels up to 7".*
- *Output 4 w.*
- *Tone control.*
- *Tape position indicator.*
- *All transistor amplifier.*
- *Suitable for use as amplifier.*
- *Facilities for mixing and for monitoring via its built-in loudspeaker.*
- *Supplied with omnidirectional moving coil microphone. 7" reel of tape, 7" empty spool, connecting lead and library rack.*
- *Magnificent wooden sided cabinet.*

K. J. ENTERPRISES (Dept TR7) 17 THE BRIDGE, WEALDSTONE, MIDDLESEX (Opposite Harrow and Wealdstone Station). 01-427 7758. Showroom hours: 9.30a.m. - 5.30p.m. Closed Lunch 12.30 - 1.30p.m. Close 1p.m. Saturday.

FREE Our New 100 page illustrated catalogue sent entirely FREE on request. Britain's most specialised comprehensive range of recording tape, Accessories and Audio equipment. 20,000 reels of tape always in stock with reductions ranging up to 50%

CHILTON

★ Provision for microphone, radio and low output magnetic cartridge.
★ As an amplifier only with Bass and Treble controls.
★ 10 watts R.M.S. per channel and fully protected by stabilised supply.
★ 4 Loudspeakers in rattle free cabinet.
★ Solenoid controlled mechanism.
★ Quiet running deck, very cool even with prolonged use.
★ Fully transistorised on 10 printed circuit boards.
★ 3 head system and three speeds—19, 9.5, 4.75 cm/s.

Portable Version 145 Gns.

Chassis version from 124 Gns.

Magnetic Tapes Ltd., Chilton Works, Garden Road, Richmond, Surrey

Telephone: 01-876-7957

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EVERYTHING IN RECORDERS AND HI-FI ON THE BEST OF TERMS

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★ **NO EXTRA FOR CREDIT UP TO 18 MONTHS**
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SPECIAL OFFER
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LONDON E.C.2
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Opposite Liverpool Street Station
Hours of Business:
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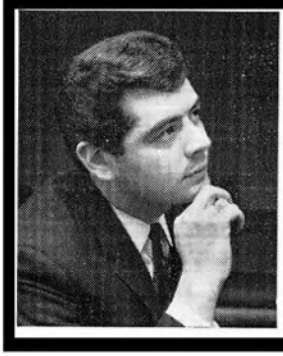
Closed all day Saturday

OPEN SUNDAY

10 a.m. to 2 p.m.

Part of the NuSound Organisation

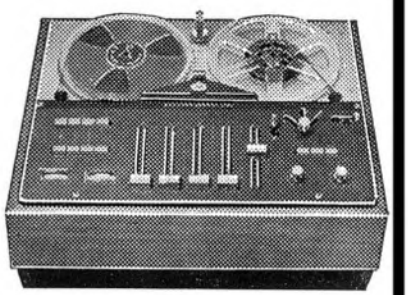


Our manager Bob Hookings is a keen tape recording enthusiast. Bang & Olufsen's are his speciality, having used B & O equipment for several years his knowledge of this wonderful range is second to none. He is able to give personal callers his expert advice (please avoid telephoning) not only on B & O but on any other recorder suitable to your individual requirements and pocket.

At the City Tape Recorder Centre you can see one of the finest selections of tape recorders on display in London. Every leading make and model from Akai to Vortexion.

We are easy to get to being almost opposite Liverpool St. Station and remember we are the only tape recorder specialists in Great Britain open on Sunday !

Do your weekly rush shopping on Saturday with your wife and visit us on Sunday at your leisure !



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The very latest B & O 2000K DE LUXE. Featuring semi-professional specification — a fully transistorised stereo/mono recorder with 4 track record and replay facilities and many more special features. Price £158.7.3.

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ONE WAY TO SATISFACTION

4-TRACK STEREO/MONO	Deposit	12 Monthly Payments	Cash Price
	£ s. d.	£ s. d.	£ s. d.
Philips EL3312...	16 19 10	4 3 4	66 19 10
Ferguson 3232	22 18 3	5 14 7	91 13 0
Sony TC200 ...	23 15 0	5 18 9	95 0 0
Sanyo MR929 ...	24 0 0	6 0 0	96 0 0
Philips EL3555...	25 19 4	6 5 8	101 19 4
Aiwa TP1012 ...	26 0 0	6 8 2	102 18 0
Akai 1710W ...	27 17 3	6 16 8	109 17 3
Sanyo MR939 ...	28 0 0	6 16 8	110 0 0
Sony TC260 ...	29 5 0	7 5 0	116 5 0
Tandberg 12/21/41	31 10 0	7 17 6	126 0 0
Philips EL4408...	33 16 8	8 6 8	133 16 8
Telefunken 204 'E'	34 12 5	8 10 0	136 12 5
Beocord 2000K	39 10 0	9 13 4	155 10 0
Beocord 2000T	40 10 0	10 2 6	162 0 0
Sony TC530 ...	41 10 0	10 6 3	165 5 0
Ferrograph 722/4	46 15 0	11 10 5	185 0 0
Akai M9 ...	49 3 5	12 3 4	195 3 5
STEREO TAPE UNITS			
Sanyo MR-801 ...	20 0 0	4 13 4	78 0 0
Sony TC250A ...	20 10 0	4 18 4	79 10 0
Akai 3000D ...	26 11 4	6 11 8	105 11 4
Sony TC350 ...	27 5 0	6 16 3	109 0 0
Beocord 1500 ...	31 10 0	7 11 8	122 10 0
Tandberg 62/64X	36 18 0	9 0 0	144 18 0
Ferrograph 702/70440	6 8	10 0 0	160 6 8
4-TRACK MONAURAL			
Grundig TK140	11 14 6	2 18 4	46 14 6
Philips EL4305...	11 17 9	2 16 8	45 17 9

4-TRACK MONAURAL	Deposit	12 Monthly Payments	Cash Price
	£ s. d.	£ s. d.	£ s. d.
Ferguson 3226...	11 10 0	2 16 8	45 10 0
Telefunken 201	11 18 9	2 19 7	47 13 9
Ferguson 3228...	11 19 0	3 0 0	47 19 0
Philips EL4306...	14 1 8	3 10 0	56 1 8
Ferguson 3230...	14 13 0	3 13 2	58 11 0
Ferguson 3216...	16 19 0	4 0 0	64 19 0
REPS M10 ...	18 18 0	4 14 6	75 12 0
Wyndsor Vanguard	18 18 0	4 14 6	75 12 0
Truvox R54 ...	18 18 3	4 14 11	75 17 3
Tandberg 1526...	20 19 0	5 3 4	82 19 0
Truvox R204 ...	31 14 2	7 15 0	124 14 2

SPECIAL OFFER! £10 OFF
SANYO MR400 PORTABLE
Mains/Battery Cassette Recorder

Takes Standard Philips cassettes
Automatic Recording Control
Cassette Ejector Button
Press Button operation including Fast Forward and Rewind. Leather carrying case
Superb quality
Supplied complete with Cassette and Dynamic Mic with remote control

Latest Model—New List £39 19s. 6d. **29½ gns.**
Full instructions. Makers Guarantee. Limited supply

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

SPECIAL OFFER!

TELEFUNKEN 300TS
★ Telefunken 300TS Battery/Portable. ★ 5" Tape capacity. ★ Volume and Stop/Start controls in handle. ★ Complete with microphone.
Reduced from 61 gns. **Our price 45gns.**
Deposit £15 15s. 12 monthly payments £2 12s. 6d.

TELEFUNKEN 302TS
★ 4-Track. ★ 2 speeds, 3¾ and 1⅞ i.p.s.
Reduced from £77 8s. 9d. **Our price 56gns.**
Deposit £19 16s. 12 monthly payments £3 5s.

TELEFUNKEN 203TS
★ Mono/Stereo. ★ 4-track. ★ Sound-on-Sound. ★ 2 speeds, 3¾ and 1⅞ i.p.s. ★ Complete with TD21 Microphone.
Reduced from 86 gns. **Our price 64gns.**
Deposit £22 8s. 12 monthly payments £3 16s. 4d.

this is the name

THE RECORDER CO

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

We are happy to announce that we can now supply

BRAND NEW BRITISH & GERMAN RECORDING TAPES

P.V.C. POLYESTER & MYLAR

Both manufactured by world reputable British and German firms. Fitted with leaders and stop foils. Not rejects or sub-standard in any way—tapes are splice free and are boxed. Remember: full refund plus postage should goods not meet with your full approval.

	Length	English price	German price
Standard Play			
3"	150'	2/6	2/-
4"	300'	4/-	3/6
5"	600'	9/-	6/6
5¾"	900'	11/6	8/-
7"	1200'	16/-	10/-
Long Play			
3"	220'	3/-	2/6
4"	450'	6/-	5/-
5"	900'	11/6	9/-
5¾"	1200'	16/-	10/6
7"	1800'	23/-	14/-
Double Play			
3"	400'	6/-	4/-
4"	600'	8/6	7/-
5"	1200'	21/-	13/-
5¾"	1800'	24/-	17/-
7"	2400'	39/-	22/-

EMPTY SPOOLS: 3" 9d. 5" 2/-. 5¾" 2/3. 7" 2/6.

Compact Tape Cassettes at half price. 60, 90 and 120 minutes playing time, in original plastic library cases. MC60 8/9, MC90 12/6, MC120 18/6.

N. WALKER Ltd.

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A couple of things for the record.

Everybody has heard of Grundig Tape recorders.

But not everyone is quite so wise about Grundig tapes and accessories.

But they're the best.

And we don't mind what machine you use them on.

You'll still notice the difference.

Then there's our mikes.

Superb quality studio standard. Moving-coil, omni or directional.

For reasonable prices.

If you're keen on your sound equipment, Grundig accessories will bring out the best in what you've got.

GRUNDIG

Write for the name and address of your nearest Grundig Accessories specialist.

Grundig (Great Britain) Ltd., London S.E.26.
A Member of the British Industrial Holdings Group

Life begins at 36¾.

Pounds.

The price of the new Grundig C200 de luxe battery operated casette recorder.

It's fantastic.

Never before has sound quality been so high in a recorder of this size.

And it has lots of sophisticated equipment packed into its easily portable case.

Like a moving coil recording level meter, an electronically stabilised motor, 12 transistors and 3 diodes.

It has separate recording level, volume and tone controls and a mains power pack is available.

The black and satin silver finish brings it right up in the looks department.

If you are interested in a portable cassette recorder, remember the Grundig C200 de luxe.

Because things start happening around 36¾.

GRUNDIG

For people who listen.

Grundig (Great Britain) Limited, London S.E.26. A member of the British Industrial Holdings Group.

tape recorder

JULY 1969 VOLUME 11 NUMBER 7

INCORPORATING
SOUND AND CINE

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COVER PICTURE

No stray solder, no broken or shorted leads. Supplied by Kodak, our cover photo is a radiograph of components to be found in every battery recorder currently on the market—transistors. Radiography offers manufacturers a safeguard against internal and external physical flaws.

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. $4.80 & $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.

WHEN YOU HAVE completed your fortieth specification, written your hundredth 'not specified' and ignored your thirtieth 'frequency range', you realise that manufacturers' data, where audio is concerned, are somewhat empty. The rot set in at least six years ago with the introduction of Class-B transistor amplifiers. In 1963 a 4 W stereo amplifier was assumed to be capable of delivering 4 W continuous sine-wave power per channel. Today this same amplifier may have its output power specified in eleven different ways. Our 4 W sustained sine-wave power might be doubled to give 8 W *peak power* or raised by a less extravagant factor to some 6 W *music power*. Some manufacturers combine both 'improvements' to achieve 12 W *peak music power* and, if the power ratings apply to an 8 ohm load, double the figure again by specifying 24 W for a 4 ohm load. Ours is a stereo amplifier, remember, and by adding the two channels we can double each figure in turn, stretching the original 4 W rating to a grand 48 W. This is temptingly easy to round off at 50 W.

There is nothing criminal in defining a 4 W amplifier as a 48 W device, *provided the measurement conditions are clearly stated*, but a bald wattage rating, with or without a quoted load impedance and distortion figure, serves only to mislead a half-educated public. We may yet see prosecutions under the Trade Descriptions Act.

A similar situation pertains to tape recorders, more through ignorance than dishonesty. Frequency response, signal-to-noise ratio and distortion are tied to each other by the magnetic characteristics of the recording tape and cannot be meaningfully quoted in isolation. Among the thirty-nine recorders in our page 284 survey, only the *Nagra 4* is specified by its manufacturer against a named tape. The remaining 34 specs are an approximate guide, not to the performance of the named recorder, but to the degree of liaison between the manufacturer's design and marketing teams.

A meaningful wow and flutter specification would name the meter employed, the speed, brand and thickness of tape, the supply reel diameter and the nature of the reading (RMS, peak or peak-to-peak). It should ideally be the worst reading of a 30-minute run since this allows for record/replay phase changes and for resonance at certain combinations of tape elasticity and drive tension. A meaningful specification would also treat wow and flutter as separate entities, showing the proportion of speed fluctuation within the ear's most sensitive 4 Hz region. But what are we given in reality? Simply a cheap and cheerful $n\%$.

Input sensitivities vary from no figure at all, through a specified level at an unspecified impedance (or vice versa) to a sensible a mV at b ohms for 0 dB peak recording level.

At least two recorders of near studio quality now accommodate DIN sockets throughout, the Philips *Pro 12* and the Uher *1000*. The latest specification from Philips, referring to a purely domestic machine, takes the trouble to give the input and output conditions at individual pins. This kind of information, given enough publicity, may help overcome the 'messing about in the dark' distaste many of us have for DIN. We are tired of hearing about vague 'standards' and 'exceptions' and particularly of 'revised standards'. Even the early Quad stereo tuner was wrongly wired, due to misunderstandings. We intend to poke the editorial nose inside every DIN socket currently being marketed on a tape recorder, plus a few tuners and amplifiers, and produce a pin-by-pin breakdown of the results, to be published within a few months.

FEATURE ARTICLES

REGULAR ITEMS

EQUIPMENT REVIEWS

'The Sony TC 800 represents better value than any other battery portable on the market and is worth every penny.'

D. K. Kirk, Tape Recorder

Recommended retail price £79:17:9

SPECIFICATIONS

Power requirements	DC 12V AC 110, 120, 220 or 240V, 50/60 Hz
Track	Dual
Reel	5 in. or smaller
Tape speed	3¾ ips (9.5 cm/s), 1⅞ ips (4.75 cm/s)
Recording time with 900 ft. (275m) tape	1.5 hours in total at 3¾ ips 3 hours in total at 1⅞ ips
Transistor	15
Diode	11
Frequency response	50 – 13,000 Hz at 3¾ ips 50 – 7,000 Hz at 1⅞ ips
Bias frequency	Approx. 55kHz
Motor	D-501F DC servo-motor
Speaker	3⅛ × 6¼ in. dynamic
Power output	Max. 1 watt
Jack	Microphone (1): sensitivity 0.195mV, impedance 600 ohms. Auxiliary (1): sensitivity 0.055V, impedance 100k ohms. Monitor (1): normal output 0.775V. Remote control (1). Speed control (1).
Power consumption	AC 6W
Battery life	10 hours recording with supplied batteries
Dimensions	12¼ in. (w) × 4⅓ in. (h) × 10¼ in. (d)
Weight	11 lbs. 13 ozs. with battery

Accessories	SONY Cardioid microphone F-85, 'D' size super batteries, 5 in. demonstration tape, 5 in. empty reel, power supply cord, connection cord, earphone
Optional accessories	Speed slow-down control RM-5, car battery cord DCC-2AW, carrying case

SONY
RESEARCH MAKES THE DIFFERENCE
Ascot Road, Bedfont, Feltham, Middlesex

'FILM' 69 CONFERENCE

AN INTERNATIONAL Film Technology Conference and Exhibition is being organised by the British Kinematograph, Sound and Television Society. It is scheduled for the Royal Lancaster Hotel from June 23 to 27 and is expected to bring together film-makers from 14 countries. A series of papers will be presented, including a description of the Moscow Tele-Centre by Vladimir Makoveev. Conference proceedings will be transmitted on colour CCTV and a daily TV report will be fed to 23 hotels. The National Film Theatre will run a supporting programme of films on cine technique. A series of factory and studio visits has also been arranged.

Copies of the provisional programme are available to BKSTS members and non-members from *Paul McGurk, 110-112 Victoria House, Vernon Place, London W.C.1.*

EVR DEMONSTRATED IN CARDIFF

THE FIRST PUBLIC demonstration of EVR (Electronic Video Recording) was held on April 10 at the Institute of Science & Technology, University of Wales. It was presented during a conference organised by the National Committee for Audio-Visual Aids in Education.

£80,000 ORDER FOR RCA

SOUND RECORDING equipment valued at £80,000 is being supplied by RCA for installation at Associated British-Pathe in Wardour Street. A total of £150,000 is being spent on recording, transfer and projection equipment.

US STANDARDS PANEL SUPPORTS METRIC

STRONG SUPPORT for the metric system was expressed recently at a meeting of the USA Standards Institute. Three members of an international four-member panel supported the system and the opposing member, H. E. Cheseborough of SIMCA, agreed that the US would eventually adopt metric. A British representative stated that adoption of metric in the UK had already cut design and drafting time and reduced trade barriers.

TAPE RECORDER PRODUCTION FIGURES

FIGURES PREPARED by the Ministry of Technology show that cassette recorders comprised 16% of total January deliveries, rising to 49% of deliveries in February. Collection of separate statistics for reel-to-reel and cassette recorders commenced in January but separate figures cannot be published in detail without revealing individual companies' output. This situation is expected to alter as the cassette market grows. Production of tape recorders in January was higher, at 16,236, than during the same month of 1968. The February figure was lower than last year, however, at 13,163.

Total UK deliveries during 1967 were 488,839, a further 49,239 recorders being exported. 262,799 were of British manufacture. 1968 deliveries were 408,357 (UK) plus 45,419 (exported). 262,799 were of British manufacture.

WESTEL NARROW-DRUM VTR

A NEW CONCEPT in videotape recorders has been developed by Westel. The *WRR-350* and battery-powered *WR-250* employ a 200° omega-wrap two-head helical scan system. Unlike most helical scan arrangements, where a complete field is recorded during each head cycle, the Westel employs a comparatively narrow drum (approximately 70 mm). One sixth of a field is recorded per head cycle at a 3200 cm/s writing speed on 25 mm tape transported at 38 cm/s. The system is said to operate equally well with horizontally and laterally oriented tape coatings. A dual-capstan drive is employed to maintain constant tape tension. Demonstrated recently at the NAB Convention in Washington, the *WRR-350* costs £13,900 (monochrome) and £25,000 (colour). Respective prices of the *WR-250* recording unit are £8,300 and £7,350.

NEW MANUFACTURER NAMED

PRELIMINARY DETAILS of a new studio equipment manufacturer appeared in this column last month. The company has now found a name and a home: *Unitrack Equipment Ltd., 590 Wandsworth Road, London S.W.8 (01-622-8620).*

RTRA EXHIBITION BURNT OUT

DAMAGE ESTIMATED at £150,000 was caused by fire at the Metropole Exhibition Hall, Brighton, during the RTRA Exhibition. The 30 stands were almost entirely destroyed and dealers have been asked to confirm orders made during the two days of the scheduled three-day exhibition.

1969-70 WILDLIFE RECORDING CONTEST

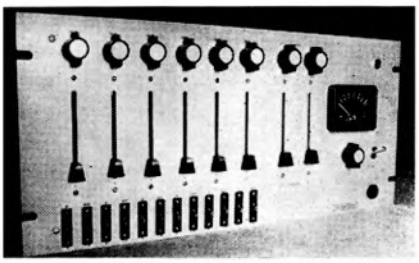
A BATTERY recorder and portable cassette machine are to be offered as prizes in the next Wildlife Recording Contest. The decision to organise a second contest was announced by L. B. Gehrke, managing director of 3M UK, when naturalist Peter Scott presented 1968-69 awards at the British Institute of Recorded Sound. As already reported, Class 1 (Birds) of the contest was won by Magnus Sinclair of Haroldswick, Shetland, for his recording of curlews (photo). The cassette recorder will be offered in a junior category for contributors up to 17 years of age.

Full details of the 1969-70 competition are available from *W. R. Bowles, 3M Company Ltd., 3M House, Wigmore Street, London W1A 1ET.*

WORLD OF TAPE

STUDIO MIXING EQUIPMENT

A COMPLETE RANGE of studio sound equipment is now being offered by Sounds Group, including low-noise microphone amplifiers, response selection amplifiers, line and mixing amplifiers and PPMs. Mixing desks can be built on a modular system or to customer's individual requirements. The six-channel unit illustrated



was designed for CCTV installations and is now available to order from Studio 99 Video Limited, 81 Fairfax Road, London N.W.6. *Manufacturer: Sounds Group, 9 Warren Street, London W1P 5DA.*

NEW STUDIO OPENED IN LEYTON

A NEW STUDIO opened during the last week of April, Progressive Sound of 593 High Road, Leyton, London E.10. Mixing and effects equipment were designed by Gerald Chevin of Advision and includes the compressor/limiter described on page 289. Rates are £5 per hour music studio hire (capacity for ten performers), and £12 for a complete wedding on disc. A Lyrec-Ortofon variable-groove disc cutter is being used and the basic charge for a 30.5 cm LP master disc is £7 15s.

NEXT MONTH

AN INVESTIGATION into the annoyance caused by gaps in recorded music on magnetic tape, dropout, will be described by G. Domburg and B. Lopes Cardozo of Philips Research Laboratories, Eindhoven. Henry Maxwell commences a short series on *VTR Circuitry* while M. G. Skeet describes a stereo conversion of the Fi-Cord *1A*. Alec Tutchings will review the *Dual TG 28.*

THE SOUND STUDIO

PART FOUR **FADERS AND MIXERS** BY K. R. WICKS

THE most common form of fader or variable attenuator is the potentiometer type volume control as found in domestic equipment (**fig. 1a**). For the control of signal level in a studio, such a device would not be suitable. One reason is that the variation of attenuation with rotation may not give ideal control over the desired range, and can vary from one control to another so that each would have to be individually calibrated. Another disadvantage is that the resistance between the slider and earthy end of the track is often sufficient to allow the source to be heard even though it is, in theory, faded out. Furthermore, the input and output resistances (R_{in} and R_{out}) will vary with rotation of the slider unless the load resistance (R_L) is high compared with the potentiometer resistance (R_P), as would be the case with a valve grid circuit. Then, variations in R_{out} would not matter, and R_{in} would be constant so that a source could be correctly terminated at all times.

For some professional purposes, where constant resistance is not essential, a high quality potentiometer type control is adequate, and this consists of separate resistances connected between metal studs, over which the moving contact passes. This is shown in **fig. 1b,** and the resistances are usually chosen so as to give 2 dB change in level between successive contacts over the normal working range of the control. The reason for steps of 2 dB being chosen is that it is about the maximum amount by which the volume of *normal programme material* may be altered without noticeable jumps in level. If pure tone is faded up on a control with 2 dB steps, however, the separate increments can easily be heard. This applies also to long drawn-out notes which occur in some pieces of music, so some discretion is clearly required in the use of a fader, although the times when the individual increments are detectable on music are, in fact, few and far between.

The design of a potentiometer type control is very simple and, as an example, I have taken the device shown in **fig. 2** which could be used to adjust level up to 6 dB about a normal setting. (In this article, decibels are used to relate voltage levels, ignoring impedance differences, and 0 dB is any arbitrary value.) This potentiometer is designed to have an input resistance (R_{in}) of 600 ohms, and the load resistance (R_L) is assumed to be high compared with R_P so that the shunting effect of the load on the potentiometer is negligible.

FIG. 1 POTENTIOMETER CONTROLS

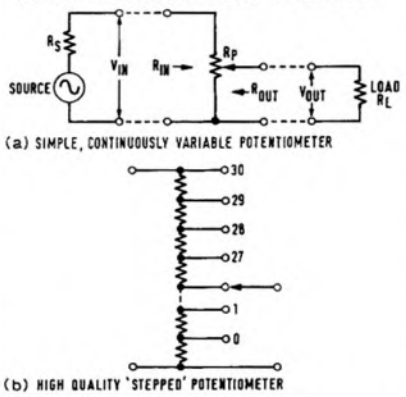


FIG. 2

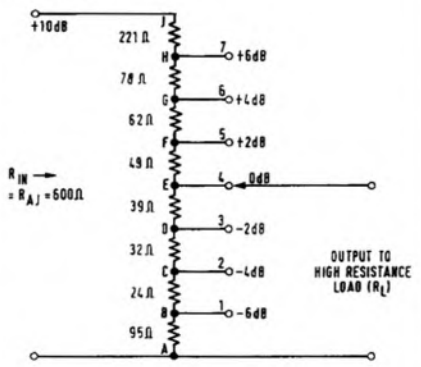
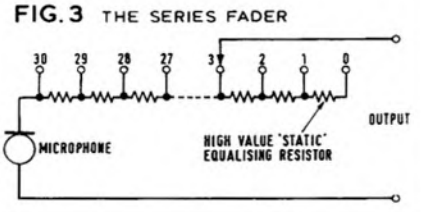


FIG. 3 THE SERIES FADER



Since the level at stop 7 of the control is to be 4 dB below the input level, it follows that

$$4 = 20 \log_{10} \frac{R_{AJ}}{R_{AH}}$$

$$\text{giving } \frac{R_{AJ}}{R_{AH}} = 1.59$$

Since R_{AJ} is 600 ohms, then

$$R_{AH} = \frac{600}{1.59} = 379 \text{ ohms,}$$

giving a value of 600−379=221 ohms for the top resistor, R_{HJ}.

Going from stop 7 to stop 6 involves a 2 dB drop which means that $\frac{R_{AH}}{R_{AG}} = 1.26$

$$\text{and } R_{AG} = \frac{379}{1.26} = 301 \text{ ohms.}$$

The second resistor, R_{GH}, is given by 379−301=78 ohms, and the other resistances may be calculated in a similar manner.

The range of the control can be extended by dividing R_{AB} into a number of separate components so that the volume can be decreased to a very low level in 2dB steps, and by providing an end stop connected to A, giving (ideally) infinite attenuation.

Another simple fader is the series type (**fig. 3**) which was used in the early days of broadcasting, and connected directly to the microphone. The stud for minimum volume was connected to the next stud by means of a resistor which was high enough to introduce sufficient attenuation to render signals inaudible but ensured that no static charge was allowed to build up. Without this static equalising resistor, it was found that the end stop would sometimes acquire a voltage with respect to the rest of the fader and, although this voltage was very small, it was not negligible compared with the signal level from the microphone, and a noticeable click would be heard when the wiper passed to or from the end stop. With a

(continued overleaf)

series fader, R_{in} and R_{out} vary with attenuation so that mismatching occurs, and results are poor.

Nowadays, in professional equipment, faders are inserted in a circuit at a point where the signal level is sufficiently high to prevent noise voltages generated by the fader being audible. These faders take many forms but, in general, they provide constant resistance in at least one direction and are therefore known as *constant resistance controls*. The variable components usually consist of separate wirewound resistors connected between the studs over which the wiper travels. Over most of the range, the attenuation is usually 2 dB per stop, increasing to about 8 dB per stop at the low level end of the scale where the signal is virtually inaudible, and fine control is not necessary. At the minimum setting, the attenuation provided should be at least 60 dB, and care has to be taken when wiring to minimise coupling between input and output circuits.

Fig. 4a shows an L-type attenuator designed to provide a constant input resistance (R_{in}) of 600 ohms, when loaded with 600 ohms. The amount of attenuation is determined by the ratio of R_1 to $R_2 \parallel R_L$ (R_2 in parallel with R_L) and $R_{in}=R_1+R_2 \parallel R_L$. Thus, with R_{in} and R_L fixed, R_1 and R_2 can be calculated for each value of attenuation required. Simple formulae can be obtained giving R_1 and R_2 in terms of R_L and N, the voltage ratio corresponding to the desired attenuation ($N>1$) Using the notation as in **fig. 4b**,

$$N = \frac{V_{in}}{V_{out}} = \frac{I_{in}}{I_{out}} = \frac{R_2+R_L}{R_2} \qquad (1)$$

$$R_{in} = R_1 + \frac{R_2 R_L}{R_2+R_L} = R_1 + \frac{R_L}{N}$$

$$\therefore R_1 = R_{in} - \frac{R_L}{N},$$

and since $R_{in}=R_L=R$,

$$\text{Then } R_1 = R\left(1-\frac{1}{N}\right) = \frac{R(N-1)}{N}$$

From equation (1),

$$R_2 N = R_2 + R_L$$

$$\therefore R_2(N-1) = R_L = R$$

$$\text{giving } R_2 = \frac{R}{N-1}$$

Although R_{in} is constant, R_{out}, which is given by $R_2 \parallel (R_1+R_S)$, varies with the attenuation setting and decreases as attenuation increases. This type of fader can be used to obtain either a constant input resistance *or* a constant output resistance, but not both.

The T-type fader is illustrated in **fig. 5** and it can be seen that it is basically an L fader with an additional variable which enables both R_{in} and R_{out} to be maintained constant at all settings of attenuation. If R_S, R_L, R_{in} and R_{out} are all to be equal, as is usually the case, then it follows that the attenuator will be symmetrical, i.e. $R_1=R_3$. By treatment similar to that applied to the L-pad above, the values of the components are found to be:

$$R_1=R_3=R\frac{(N-1)}{(N+1)}$$

$$R_2=\frac{2RN}{N^2-1}$$

The π-attenuator (**fig. 6**) is similar to the T-type in that it has three variables, and both R_{in} and R_{out} can be made constant. Resistance values are given by:

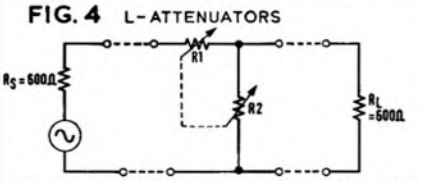
$$R_2=R_3=\frac{R(N+1)}{N-1}$$

$$R_1=\frac{R(N^2-1)}{2N}$$

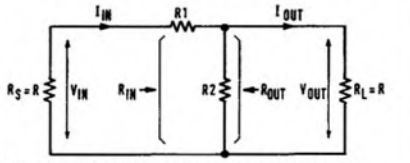
Constant resistance faders of the T and π types are widely used, but they are relatively expensive, having three high quality variable components. A more simple device which provides almost constant resistance is the *ladder attenuator*, one type of which is shown in **fig. 7a.** The resistive network may be regarded as a succession of π attenuators, and the values of R_1 and R_2 can be calculated as for a π network to obtain the required attenuation per stop. Resistors R_4 are equal to $\frac{R_2}{2}$ as they replace two resistors of separate π networks, each equal to R_2. Resistor R_5 is made equal to $R_2 \parallel R$, where $R=R_S=R_L$, and the ladder network and load are represented in **fig. 7b.** With this arrangement, the input resistance 'seen' by the slider at any stud is $\frac{R}{2}$, as each stud is connected to the junction of two matched impedances each equal to R. Since $R_6=\frac{R}{2}$, then R_{in} is equal to $\frac{R}{2}+\frac{R}{2}=R$ for all settings of the fader. The output resistance (R_{out}) will, however, vary with the fader setting, but the effect is small except at low values of attenuation. The equivalent circuit for a 600 ohm ladder fader with the slider in the minimum attenuation position as shown in **fig. 8.** It can be seen that $R_{out}=600 \parallel 900 = 360$ ohms. As attenuation is increased, the shunting effect of the source becomes progressively more *masked* and the value of R_{out} tends towards 600 ohms.

The condition for balance of the bridge

FIG. 4 L-ATTENUATORS



(a) L-ATTENUATOR CONNECTED BETWEEN 600Ω SOURCE AND LOAD



(b) CIRCUIT FOR THE GENERAL CASE OF AN L-ATTENUATOR BETWEEN EQUAL LOADS

FIG. 5 THE T-ATTENUATOR

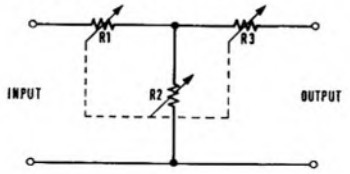


FIG. 6 THE π-ATTENUATOR

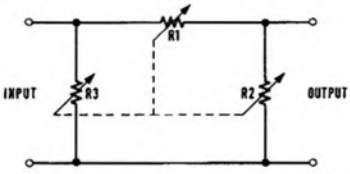
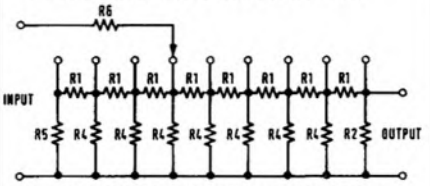
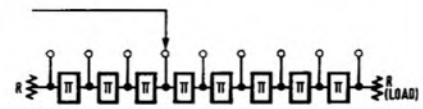


FIG. 7 THE LADDER ATTENUATOR



(a) SIMPLIFIED DIAGRAM WITH ONLY A FEW SECTIONS SHOWN



(b) THE LADDER NETWORK ANALYSED. (THE INPUT AND OUTPUT RESISTANCE OF EACH π SECTION IS EQUAL TO R).

FIG. 8 EQUIVALENT CIRCUIT FOR A 600 OHM LADDER FADER AT MINIMUM ATTENUATION SETTING

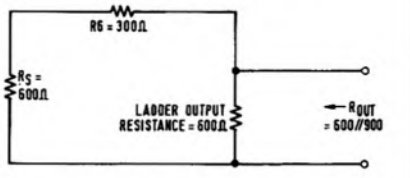
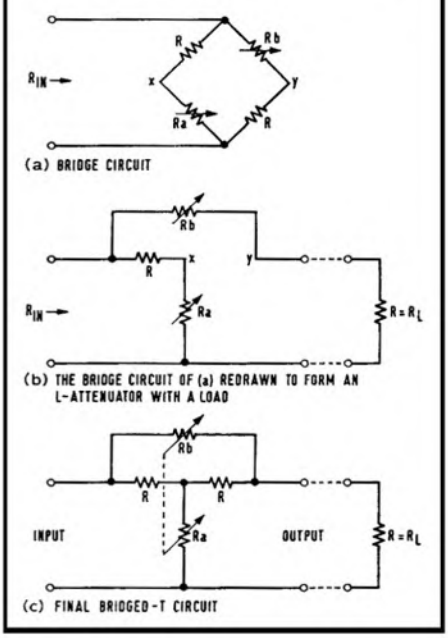


FIG. 9 DERIVATION OF THE BRIDGED-T FADER



shown in fig. 9a may be expressed as $R^2=Ra\,Rb$.

Now $R_{in}=(R+Ra) \parallel (R+Rb)$

$$=\frac{R^2+RaRb+R(Ra+Rb)}{2R+Ra+Rb}$$

If the bridge is balanced, $R^2=Ra\,Rb$.

Then $R_{in}=\frac{2R^2+R(Ra+Rb)}{2R+Ra+Rb}=R$

The bridge may be redrawn as in fig. 9b, and it can be seen that a modified L attenuator is formed, R_{in} being equal to R as long as $R^2=Ra\,Rb$.

The output resistance will, however, vary with the attenuator setting, so the circuit developed so far has no advantage over a normal L-attenuator. Since the bridge is balanced, no potential exists between the points x and y, so any component may be connected between these points without disturbing the balance and, in practice, a resistor of value R is chosen, giving the final bridged T circuit shown in fig. 9c. Since the whole circuit is symmetrical, and $R_{in}=R$, then R_{out} must also be equal to R, and so a fader is obtained with only two variables but with constant input and output resistances.

All the faders described so far have been of the unbalanced variety. Balanced versions are obtained by splitting the series resistors into two separate components, each inserted into one 'leg' of the circuit. As an example, a 600 ohm bridged-T attenuator and its corresponding balanced version, the bridged-H attenuator, are compared in fig. 10. Balanced faders can be used to reduce the likelihood of stray pick-up, but they are more expensive as they require extra variable components.

Most faders used by the BBC are of the bridged-T type although, a few years ago, the balanced-H type was used almost exclusively.

On studio faders it is normal to have switch contacts fitted which operate as soon as the source is faded up off the end stop. These contacts can be used to operate an indicator light showing that the source is faded up, or to mute the studio loudspeaker to prevent acoustic feedback occurring in the studio.

FIG. 10 COMPARISON OF A 600 OHM BRIDGED-T FADER (UNBALANCED) AND ITS BALANCED EQUIVALENT, THE BRIDGED H-FADER.

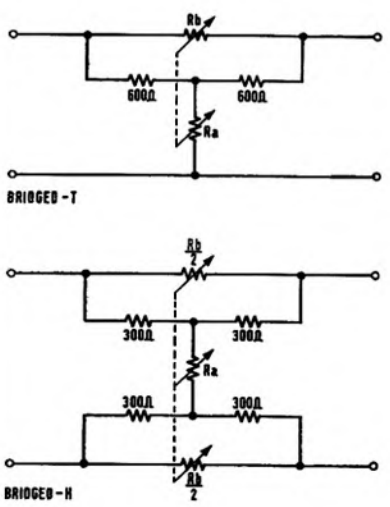


FIG. 11 SIMPLE POTENTIOMETER MIXING SYSTEM

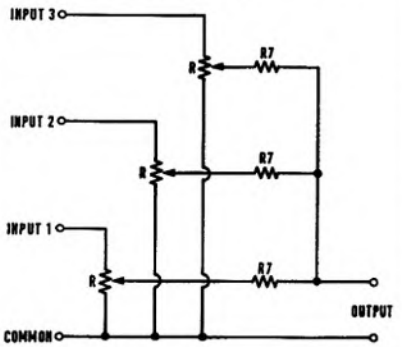


FIG. 12 CONSTANT RESISTANCE MIXING

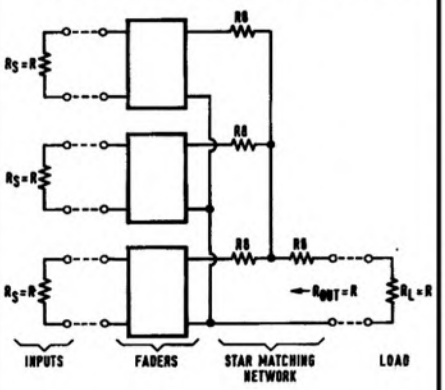


FIG. 13 EQUIVALENT CIRCUITS FOR CALCULATION OF THE MATCHING LOSS

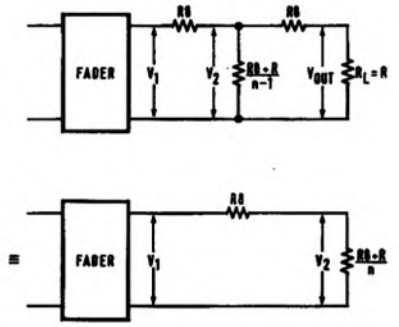
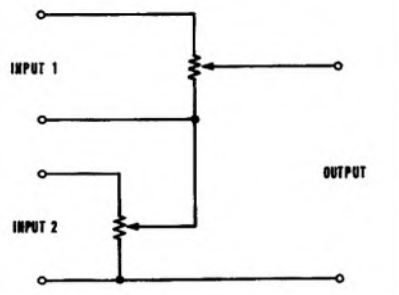


FIG. 14 SIMPLE SERIES MIXER



MIXERS

A mixer consists of a number of faders, the outputs of which are combined. It is essential that each channel is unaffected by the settings of the faders of other channels. With simple potentiometers, this can be achieved by using the circuit shown in fig. 11. Resistors R_7 are high compared with R, so that the load presented to each fader is substantially independent of the other fader settings.

A high quality mixing system is shown in fig. 12, and any faders with constant input and output resistances can be used. In order to maintain the correct loading on the fader outputs, and to make R_{out} equal to R, it is necessary to use resistors (R_7) to combine the channels and connect them to the output terminals. For a mixer with n channels, the resistance seen by the output of any fader will be equal to R_{out}, and is given by :

$$R=R_8+\frac{R_8+R}{n}$$

(assuming that $R_S=R_L=R_{in}=R_{out}=R$)

Thus $nR=nR_8+R_8+R$

Giving $R_8=\frac{R(n-1)}{n+1}$

The arrangement of resistors used to combine the faders and the output is known as a *star matching network*, and this introduces some attenuation. For an n channel mixer the equivalent circuit at the output of each fader is shown in fig. 13.

$$V_{out}=\frac{RV_2}{R+R_8}=\frac{R}{R+R_8}\times\frac{(R+R_8)\,V_1}{n\left(R_8+\frac{R+R_8}{n}\right)}$$

$$=\frac{RV_1}{nR_8+R+R_8}=\frac{RV_1}{R_8(n+1)+R}$$

But $R_8=\frac{R(n-1)}{n+1}$

$$\therefore V_{out}=\frac{RV_1(n+1)}{R(n-1)(n+1)+R}=\frac{V_1}{n}$$

Thus the voltage ratio $\frac{V_1}{V_{out}}$ is equal to the number of channels (n), and the attenuation introduced by the star network is equal to $20\ log_{10}\ n$ dB.

The number of channels will, therefore, determine the mixing loss and the subsequent amplification required. For a three-channel 600 ohm mixer, R_8 would be 300 ohms and the attenuation of the mixing pad would be 9.5 dB whilst, for a five-channel mixer, R. would be 400 ohms, and the attenuation 14 dE.

The two mixers described so far are known as *parallel* mixers since the channels are eventually paralleled together. It is possible to connect channels together in series (fig. 14) but this method is not very popular as stray pick-up can become a problem in channels which are not earthed, Also it is not usually convenient to have inputs with neither side earthy, such as input 1.

Basic mixing circuits have been discussed, but in practice more complex arrangements are usually adopted.

Fig. 15 shows a simplified studio mixer with seven faders. Two microphones, a record

(continued on page 301)

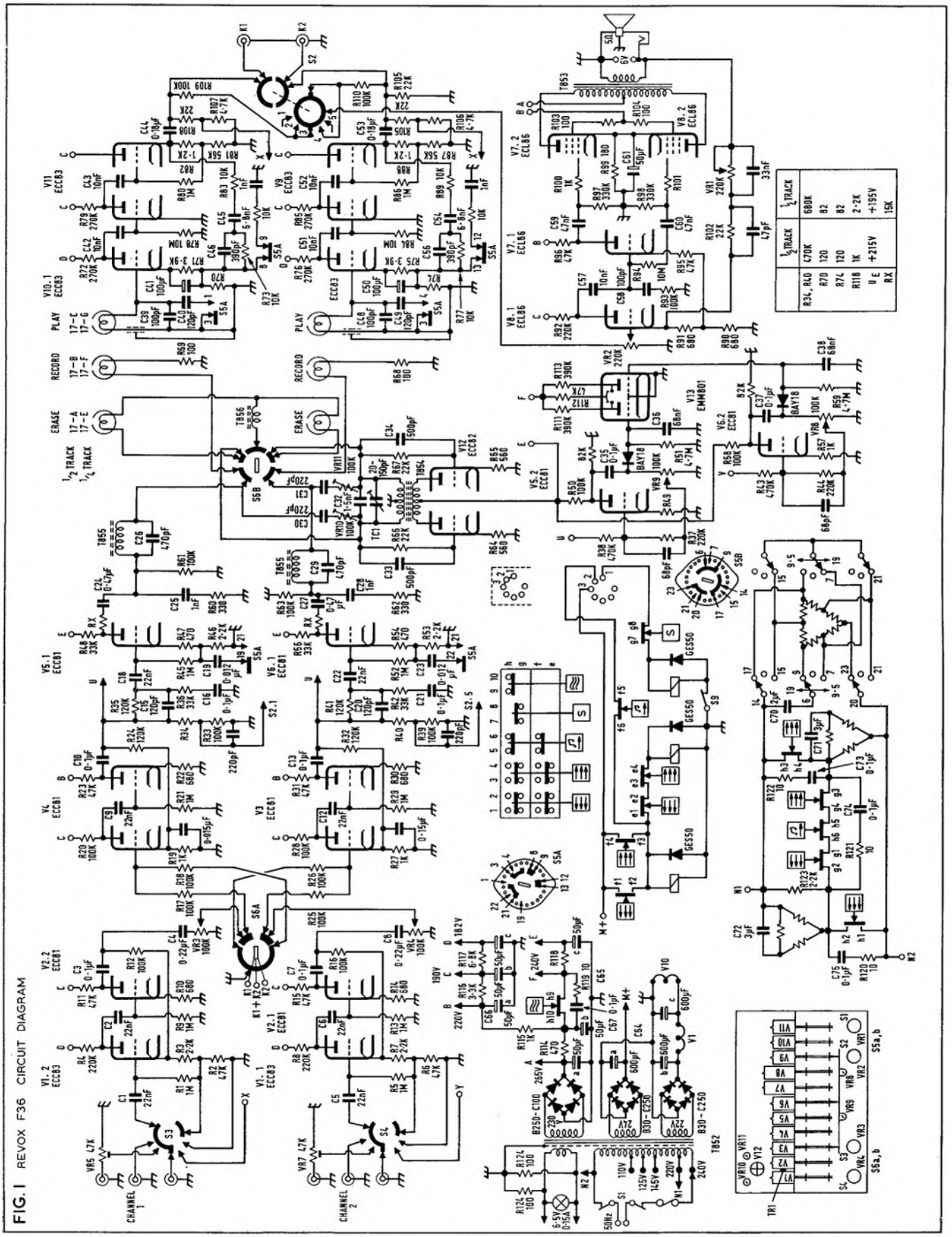


FIG. 1 REVOX F36 CIRCUIT DIAGRAM

REVOX SERIES 36

BY H. W. HELLYER

UNTIL last year it was safe to talk about 'the Revox' and be understood by professional and domestic users as meaning the *Series 36*. Like their studio counterparts, these machines, intended for the general market, were very fine pieces of construction, capable of superlative results. Now that 'the new Revox' has come along, it is safe to assume that a few more *36* models will be sculling around at bargain prices, for Revox owners do not usually change and the *77* offers all the facilities that they are likely to require. A few of the older models are bound to be traded in.

The trouble is that some of these, because of their rugged construction and above average performance, may have been run beyond the point that the professional engineer regards as normal. And any self-respecting service department is bound to charge a fairly stiff fee for overhauling equipment which needs testing to a high specification. The following notes are directed as much to new owners of second-hand Revox machines as to established owners wishing to dig a little deeper.

The ironic point about all this, in my humble opinion, is that many of the adjustments and tests I shall have to mention may never need doing. Like the old Ferrographs, the stalwart EMI designs, practically anything from the Leevers-Rich stable, and not a few older Truvox and Brenells, the decks are designed to go on for ever. With regular maintenance, they almost do. Many owners swear that the veterans improve with age.

The *36* range goes back to 1956, which is quite venerable for a tape recorder design. Different marques have been given successive letter designations. The *D* was the first stereo model, the *E* and *F* models being refinements. Our **fig. 1** is a circuit of the *F36*, with the modifications incorporated.

It was not until the *G* range came out on the international market seven years ago (1964 in this country according to my researches) that the major innovations were made. These consisted of a change of capstan motor from the previous pole-switched type to the hysteresis-synchronous version; VU meters instead of the *EM71* and *EMM801* magic-eye level indicators, and the tape tensioning switch which increased the spool handling capacity to 27 cm. The general features are the same, however, and we can use the *F36* as an example—even though **figs. 2, 3** and **4** are of a *G36* model.

Half and ¼-track versions have been marketed since the *D*.

It goes without saying that Revox have a three-motor philosophy. The reel motors are identical, and work in conjunction, as can be traced from the diagram. During fast winding in either direction, full torque is applied to the appropriate motor. For take-up, back tension is provided by feeding the left reel motor with part of the supply. In fact, on all versions, the reel motors are effectively in series via the selector switching, but there are marked differences in the way that this is done. Without the detail of the circuit diagram for the particular model, and some experience in tracing it, faults can lead to frustration. In my own experience, incorrect back tensioning during play or record is more often due to the limiting 2.2 K resistor across the LH motor (*F*), leaky suppressor capacitors (all models), the 3.3 K series resistor in the *G* versions, or the tape tensioning pin common to all types, than to the motor itself. There may be a little bother with the motor switching, and great care has to be taken when attempting to clean these spring blades. Be gentle, and avoid switch cleaners that leave a carbon deposit. Arcing is fatal to this type of switch. Squirting aerosol switch-cleaner willy-nilly into that inviting gap at the left of the assembly is asking for trouble. A gentle wipe with a soft pad, spirit-moistened, takes longer, but is more effective.

On later versions, part of the *G* series for example, there is the further complication that the feed for motor take-up is taken from a 125 V tapping on the main transformer. It has never given me any trouble, but is mentioned here to avoid panic lest anyone measures motor supply voltage and thinks he is being cheated!

Sluggish winding has been experienced at times—and these are really fast-winding machines, with very even torque, so that the fault becomes apparent in its early stages—and can be caused by the internal bearings of the motors themselves. Particularly if the fault is more apparent when cold. The wind motors are easily dismantled, and the felt lining can be oiled with light machine oil (for these Papst motors, Esso *Terresso 43* is recommended). The ball race should be cleaned and regreased and the outer rotor wiped over to remove any residual oil. As with all precision mechanisms, cleanliness is half the battle.

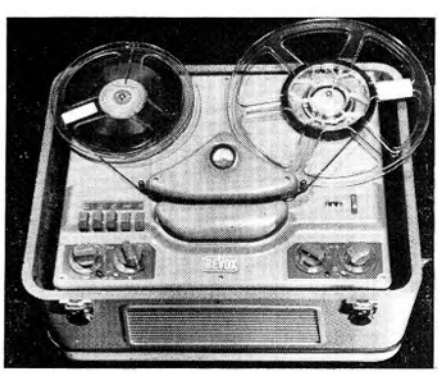
The capstan motor is not quite such an easy proposition. The two sections of the chassis must be separated, mechanics from electronics, by releasing four screws of the main top-plate, two at the front corners and two at the rear between the spools (the cross-headed screws near the back lip, not the two nuts which set the position of the brake solenoid).

Brakes, now that we have mentioned them, are particularly precise on these machines. They are steel band wrap types, giving a form of servo operation, and they must be balanced. The brake linings are fabric, secured to the drums, needing only a wipe over with methylated spirit. Avoid any more detailed cleaning which needs removal as it is almost impossible to get the old lining back on the drum smoothly. Avoid, too, the clumsy attempts at swinging the brake bands out of the way for spool height adjustment, done by releasing a very stiff set screw in the drum. It is better to use a short angled screwdriver from the inner side, holding off the brake lining with a flat blade while the screw is slackened.

The brake setting depends on the bend of the forward side of the arc and the spring between the arms. But of equal importance is the leaf-spring section, which must make the rear part of the bracket sit neatly against the chassis pin. The long coiled brake return spring (visible in **fig. 2**) can be adjusted into three holes and this, in conjunction with the solenoid throw, should allow sufficient adjustment to free the brake. The throw can be adjusted by slackening the two nuts previously mentioned and, if any further adjustment is needed, the front portion of the brake bracket can be bent. But this is a final resort. The action can be checked without loading the machine by pressing stop and play buttons together, which energises the solenoid.

Fig. 3 shows the left guide and the pin quite clearly and the menacing finger points to another pair of crucial adjustments, the nuts for the main pressure-arm solenoid. Again, these are last-ditch adjustments, and the correct procedure for testing inward pressure, as recommended by the makers, is to replay a constant tone tape and withdraw the roller with a pressure gauge hooked as near the spindle as you can get without interfering with the action. When the pitch changes, the gauge should read 1.5 kg. The fine adjustment is by the nut at the outer end of the compression spring on the linkage from the solenoid, under the deck. It is not easy to adjust correctly, and may need a little patient experimenting. The trick, if you have feeler gauges handy, is to check the clearance at the

(*continued overleaf*)



inner end of this linkage when the solenoid is de-energised. There should be between 0.5 and 1 mm If you cannot get this clearance (and as the roller has to go on very hard with these designs, it is not easy to adjust) then you may have to shift the solenoid. Be careful, the nuts are tight, and it is expensively easy to shear off a bolt head when tightening. On one or two machines I have found it advisable to change the washers for a thinner plain type and a shallow shakeproof, allowing the nut a greater length of thread to bite upon.

At the bottom of the pivot spindle of the pressure arm there is a bush, clamped by screws, and these should not be touched unless major dismantling has taken place. But just in case there is doubt, the position is for the arm to be parallel with the front of the chassis when the linkage is slack, i.e., solenoid not energised. It is remotely possible for the whole adjustment to be out if this is not so, as I well remember, having been led quite a dance by omitting to check this point after a Revox had been tackled by a local 'handyman'.

quite distinct types of switch and we shall have to leave the more delicate type for a later discussion.

The *D*, *E* and *F* models have the switch blade for the autostop at the left guide, while the *G* model, which will occupy us next month, has a different kind of switch and the blade is at the right guide.

Electrically, the autostop closes the return path for the push-button solenoid, in series with a pair of contacts closed when the stop key is up. This solenoid is mounted below the push-button unit, and the arrangement of trip-leaf and push-bar switching can be confusing to anyone new to Revox. If servicing to the assembly is needed, it is much easier to separate the electronics, remove the pressure solenoid and tackle the problem from the back. A little smear of silicone grease on the plated switch blades is recommended after cleaning, but two words of warning are necessary. Do not attempt to bend the blades to improve contact and, when reassembling, make sure the shunt diodes do not touch any adjacent metalwork.

Anent those diodes : I have once or twice had misleading solenoid faults because of poor shunting action—too good shunting, I should say ! Earlier models than the *F* used R-C shunting. Relays and solenoids give very light operation, and very positive action, but when things go wrong, tracing out the circuits and resetting contacts, etc., can be a source of headaches, as we used to find on some of the older Grundigs. Patience is an engineer's handiest tool. From the front, the view of the switches can be a deterrent to the home repairman. Unless the rocker-action swivel of the speed change switch controlling the pole selection of the capstan motor is accurately set and quite positive, arcing can occur. The switches are in two banks, wafer-type with fairly heavy wipers, but as there is considerable leverage from the loosely pivoted rocker bars, the mounting of the switch itself must be firm. Use of an additional shakeproof washer at the upper end is helpful.

Next to the switch is the outer concentric spindle of one of the gain controls. Three of these outer barrels can come off, and usually do when you try to remove the plastic selector knobs. It is important to put them back in the same alignment. The on-off switch assembly is an indirect type, with a forked clamp on the spindle actuating a toggle. But, unlike the counterparts on some British radiograms, which shall be nameless, these forks are sensibly made. The clamp thread cannot wear and work loose as a locking nut is used. If on/off switch action is pernickety, suspect the switch rather than the actuator in this design.

Third important point we have already touched upon, and here seen clearly, is the bush at the base of the roller arm spindle. It is easily accessible for that vital parallel adjustment.

Reverting to **fig. 4** we may note that the intrusive pointer indicates the upper capstan shield, a plastic protector. Any neglect will have meant oxide, tape parings, dust and dirt —especially, in my experience, mysterious lengths of hair !—getting into the cup, and demanding a clean-out. Now the Revox roller goes on with a wallop ; 1.5 kg is a lot of pressure and it is perhaps an advantage that the assembly cannot inadvertently be left engaged. When the power goes, the roller comes off ; with no tape loaded, the roller cannot go on. But the hard pressure sometimes masks ill effects due to this dirt and it is

(continued on page 301)

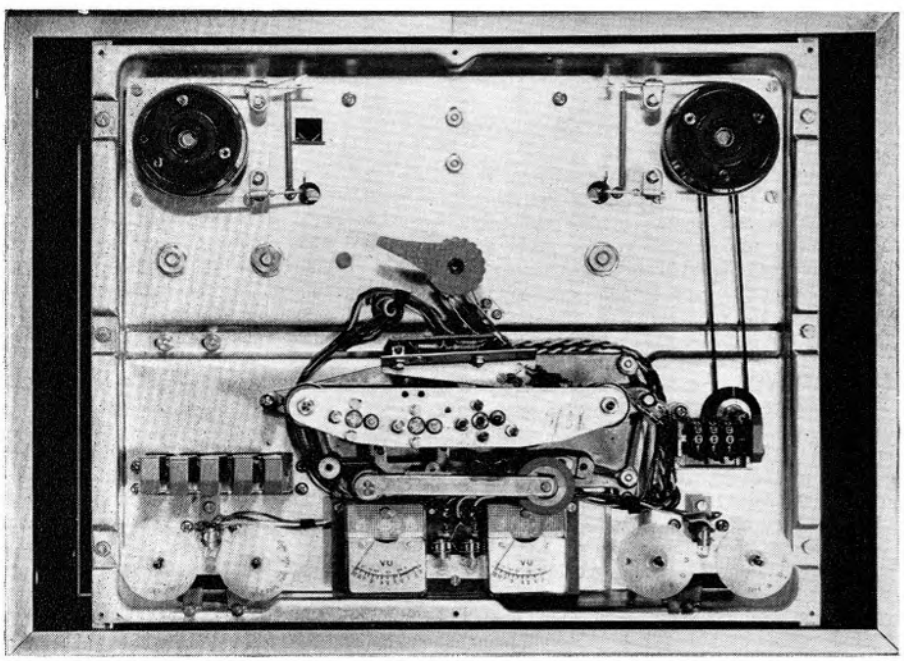


FIG. 2

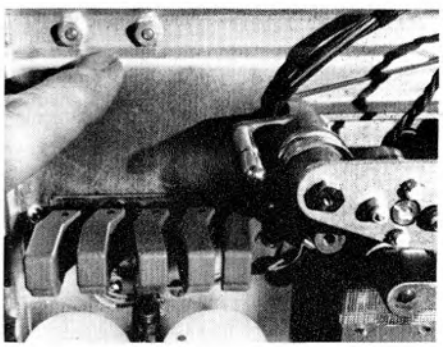


FIG. 3

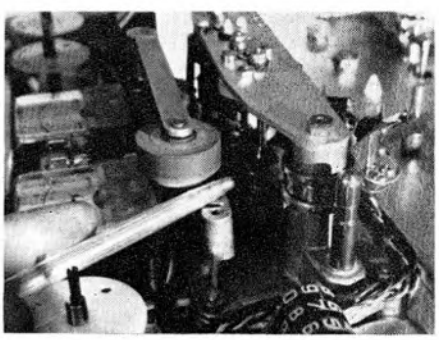


FIG. 4

If neglect is the basic cause of trouble, the solenoids may be sluggish, and more than once this has led to replacement when all that was needed was cleaning and thorough lubrication. The slug must slide freely, and can be removed, cleaned with spirit, with the barrel similarly treated, and then reassembled with a smear of Molyslip. As with all lubrication, a little in the right place is the secret, not liberal application.

At the other end of the head channel, seen in **fig. 4,** another of the guides can be seen, but this time with a polished runner against the barrel, whose movement actuates the autostop switch (also seen in this illustration at the rear of the head plate). There are two

A stereo switching network

By W. P. Copinger

THE time eventually comes, after using a tape recorder for a while, when one realises that a second tape recorder is a necessity. This is useful for editing, tape copying, special tape programme preparation, replying to tape correspondents, and building a tape library, to mention a few applications. With two good tape recorders properly interconnected it is possible to have copies almost as good as your original recordings.

Always use screened leads for your connecting cables or patch cords with screened plugs. Keep the leads as short as possible. The output from the playback machine 'A' (**fig. 1**) should come from the 'amplifier out' section. With screened lead this is plugged into the 'radio input' section of the machine for recording on 'B'. This is the simplest form of connecting two machines. The process is reversed if you wish to record on 'A' and play on 'B'. It would be preferable, if you have a good amplifier and loudspeaker, to play back over-run the tape. Take two tape recorders.

your tape recorder through this amplifier rather than through the recorder's own possibly fairly simple amplifier and speaker. To do this and to be able to copy and record from radio without having to disconnect wires or pull out plugs and plug in others with wires hanging around the place, it would be better to have a simple switching system leaving all plugs and sockets to tape recorders and amplifier connected.

The circuit of **fig. 2** shows a fairly simple switching system using a 4-way 3-pole rotary

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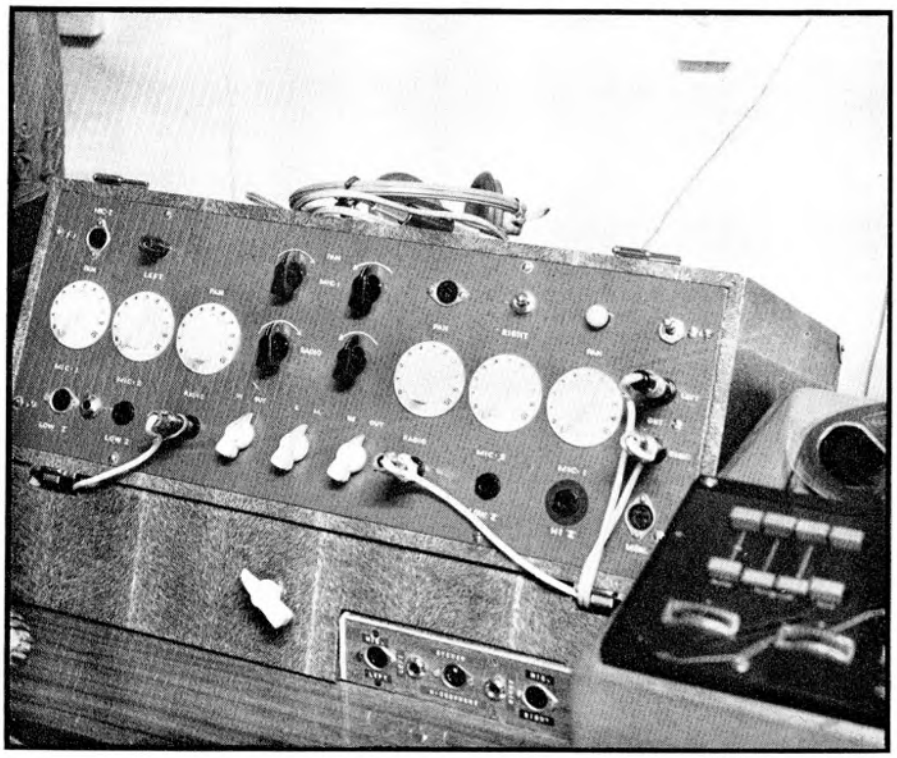
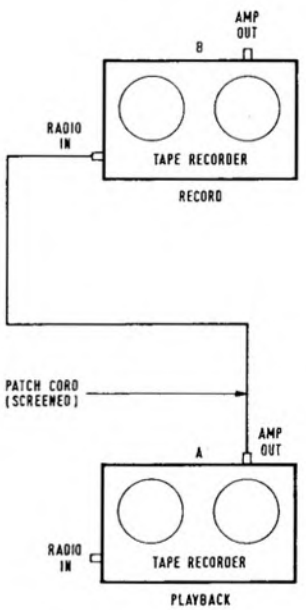


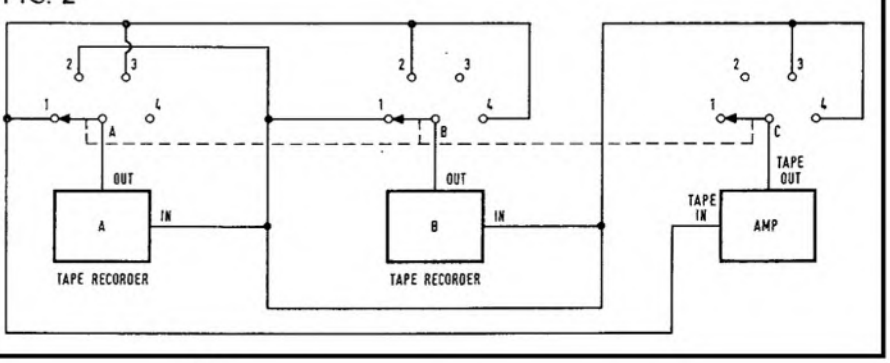
FIG. 1



It is always good practice to make original recordings at the fastest speed available and adjust later to a slower speed when copying for permanent retention in the tape library, if quality of recording is not the main consideration. This, of course conserves tape and space.

A further advantage of two tape recorders is the solution to the awful problem of running out of tape on the machine when recording an important radio programme you particularly wanted. With two machines properly connected, the second machine, loaded with tape, is ready to take over the recording if the first looks like running over time. This procedure, of course, can also be used when out on a recording session doing a long programme which may

FIG. 2



switch. This type of switch can be purchased from most radio accessory shops, but if difficulty is experienced it may be purchased from *Electroniques, Edinburgh Way, Harlow, Essex*. These firms can supply a great variety of parts from which it is possible to make up almost any type of rotary switch for radio work. This particular switch costs about £1 in parts which are very simple to assemble.

The switch has four positions which will switch the tape recorders input and output with the amplifier 'tape in' and 'tape out' as follows:—

Position 1. Record on 'A' tape recorder, play back 'B' with 'A' playing back on monitor through amplifier.

Position 2. Record on 'B' from playback 'A' with 'B' playing back on monitor through amplifier.

Position 3. Record on both 'A' and 'B' from amplifier with 'A' playing back through amplifier.

Position 4. Record on both 'A' and 'B' again from amplifier but this time with 'B' playing back through amplifier.

Positions 3 and 4 are only possible if the amplifier has a tape monitor switch between preamplifier and amplifier. The input gain control on the playback machine must be kept at a minimum to avoid any feedback.

The author's equipment consists of two ½-track and one ¼-track stereo tape recorders and a six channel stereo mixer. These are all interconnected with a Leak *Stereo 30* amplifier and controlled with one 10-pole 6-way rotary switch. **Fig. 3** shows the circuit diagram controlling this switching. The switch at Position 1 enables all recorders to record from amplifier tape output with one recorder 'C' playing back through its monitor head to the amplifier and 'B' playing back likewise to tape recorder 'A' line input. This recorder is complete with amplifier. Recorders 'B' and 'C' are both preamp only models with no main amplifier. Position 2 switches line output from 'A' to the inputs of all tape recorders with 'C' output off tape going to the amplifier for monitoring. Position 3 is similar but 'B' output goes to amplifier for tape monitoring. Position 4 switches 'C' output to all tape recorders to record with 'B' output to amplifier for monitor. If in this position we want to record on 'A' from 'C' then 'A' has its own monitor amplifier. Position 5 mixes output from one tape recorder 'C' left channel to right channel mixer input and 'A' left channel to left channel mixer input. It also switches mixer output to record channel for use on 'B' tape recorder, which plays back through amplifier. The mixer has a mono switch feeding all mixed inputs to left channel output, thus mixing a maximum of two tape recorders and four microphones in a 'mono mix'.

Position 6 is a stereo mix position mixing from output of amplifier which can include radio, disc or tape recorder ('C') through amplifier, monitoring off tape on amplifier.

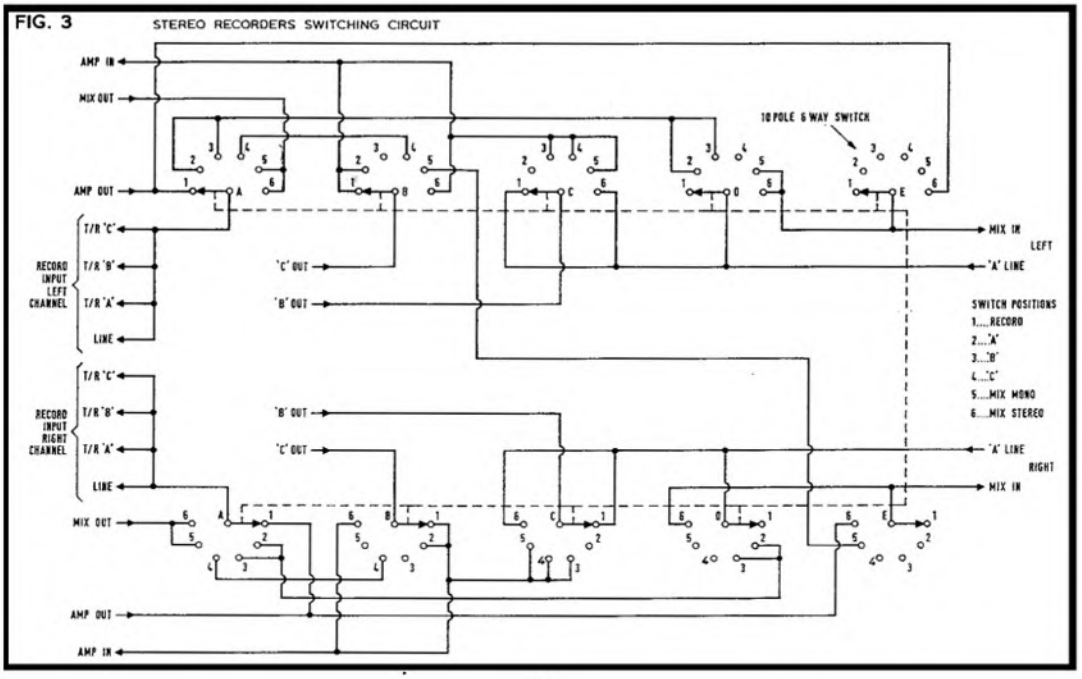
EARTH RETURN

The circuit diagrams of these switches do not indicate the earth return section of the circuit in order to simplify the drawing and clarify the circuitry. The stereo connecting leads to and from the recorders can be twin screened leads as used in microphone cables using the screening as the earth return or two separate screened cables such as co-ax cable (a bit heavy) as used in television aerial lead in. When wiring the switch take all screens to a single large tag screwed to the back of the panel on which the switch is mounted, or to a convenient point in the switch box. If, when stripping the wires for soldering to the tags on the switch, there is not enough twisted screening for the required distance to the earth tag, solder a bit of wire to the screen to lengthen it. Ensure that none of these earth wires contact any of the solder tags on the switch otherwise you may be in trouble. To avoid this risk use insulated earth wire and cover the screening near the solder point on the switch with insulating tape. This earthing procedure for each lead with one earth point will reduce the risk of hum being picked up on the inputs. A further precaution against hum loops is to ensure that only one piece of equipment has a mains earth. All earth returns from each tape recorder will be by means of the screened leads interconnecting the equipment.

This is a fairly complex switching system which could be adapted to differing uses, e.g. if no mixer available cut out this section or add other devices or tape recorders. The line connection shown in this circuit is a wandering screened lead with a screened jack plug on the end for connecting to additional tape recorders such as a mono machine, battery portables, electronic organ, or other equipment.

It might be asked why so many tape recorders? Two are ½-track stereo tape recorders ('A' and 'C'), one with four preamps only and a ¼-track stereo replay head; the other ½-track machine is complete with a stereo amplifier for outside recordings (with mains power) for concerts, choirs, etc. The third machine ('B') is a ¼-track stereo recorder, also with four preamps (no main amplifier) and off tape monitor. This is used for recording material for the ever increasing sound library. Four track mono or ¼-track stereo saves considerable storage space for tapes. The first 'C' machine is used largely for playing back ½-track or ¼-track tapes to be copied or edited. The second 'B' machine is used solely for recording, and from the circuit it will be seen that no provision is made for recordings to be played back to another machine for copying. In addition there are a couple of portables and two further moon mains recorders in use.

FIG. 3 STEREO RECORDERS SWITCHING CIRCUIT



FIRST IMPRESSIONS OF THE FERROGRAPH 7

A short pre-review report from **John Shuttleworth**

HAVING had many years' experience of Ferrograph tape recorders, and having used *Series 1*, *2*, *3*, *4*, *5* and *6*, I was naturally keen to try the new *Series 7* when it was announced.

I was fortunate in getting one of the first of these machines to come off the production line, and have since been able to try the *724* (¼-track stereo with 10 W power amplifiers), the *702H* (½-track stereo, 38, 19 and 9.5 cm/s without main amplifiers), and *713W* ½-track mono in natural wood case, with 10 W main amplifier.

I must admit that I was suspicious of the new series. The old machines right from *Series 1* to *Series 6* were built to last; many eight to twelve year old Ferrographs I have handled are basically still as good as new, and very few have shown any signs of age at all. It seemed to me a pity that 'progress' should demand the abandonment of a well tried, beautifully functional deck which was completely reliable, and it was sad to hear so often that the Ferrograph was 'old fashioned' when I knew from long personal experience that a second-hand Ferrograph would in general out-perform most 'modern' tape recorders.

As soon as I receive a machine, it goes on the test bench and is measured for wobble, signal-to-noise ratio, frequency response, and distortion. If it does not meet its specification, the manufacturer is consulted.

Ferrograph are obviously proud of their reputation and any faulty machine of theirs that I have handled, usually damaged by previous owners as the machines seem to survive neglect remarkably well, has been returned to me after servicing completely meeting its original specification.

On many occasions this has been done either free or for a purely nominal charge and in no case have I ever had a bill larger than £9.

I once purchased a *Stere-Add* unit (now unfortunately no longer obtainable) second-hand, which refused to function due to modifications by its previous owner. I returned it to Ferrograph expecting a fat bill for putting it right. It was returned a few days later, working perfectly and labelled 'Serviced—no charge'.

If the *Series 7* turned out to be as good an instrument as it seemed, and continued to be backed by this sort of service, it would be a most desirable machine to own. I was able to test the company's reaction to servicing reasonably quickly, as I unfortunately used a faulty tape for testing one of these machines. This was a new tape from a reputable manufacturer and I did not suspect it until after I had returned the Ferrograph. When I complained about the recorder thinking that the fault lay there, it was collected by the Ferrograph van and delivered again later with a label bearing a new legend 'adjusted—no charge'. My experience so far with the *Series 7* has shown that it will do all that Ferrograph claim, and that in the unlikely event that one should slip through the quality control tests at the factory and still be faulty, it is put right by the company quickly and without quibble or charge.

Since this is in no way a review of the *Series 7*, I will not give a detailed description of the recorder, or any test figures, except to say that the models I have handled met the manufacturer's specification, and that the *702H* (the high speed model) came well within the specified limits.

The recorders are simple to use, though readers familiar with the previous Ferrograph will find that it takes a little time to get used to the new facilities. I found at first that I had to remember to press the record button after loading the tape, setting the controls to pause and adjusting the record levels. In the older models the function switch would have been turned to 'record' straight away and the extra movement of pressing another button would not have been necessary. In the *Series 7*, the separate record button is needed to provide the facility of switching to and from 'record' while the tape is still running. I have found this invaluable and would now miss it if it were not provided.

VARIABLE REWIND SPEED

Another facility offered that I think is unique on a machine in this price range is the variable speed rewind. I do not use this a lot but I can see that many people would find it extremely useful.

In the stereo machines, signals recorded on one track can be transferred to another by moving a switch, and signals fed into the inputs for one channel can be recorded on both channels without the need for external connection. I find this extremely useful; the recorder can be used as its own four-channel mixer when in the mono mode, or as a stereo two-channel mixer when recording in stereo.

The 10 W power amplifiers in the mono and *722*/*724* models are of excellent quality and have independent bass and treble tone controls. I use them to drive a pair of Goodmans Maxim speakers as I find a Ferrograph *724*, Heathkit *FM4U* tuner (converted to stereo by Motion Electronics), and the two Maxims make an excellent high quality transportable system.

I have also tried the amplifiers through Tannoy and Lowther speakers and the quality obtainable should satisfy the most discerning listener.

Some people with large rooms, or who like to listen at a loud level, might find the Maxim too inefficient. Where portability is not a consideration I would recommend the larger and more efficient speakers.

In spite of being transistorised, the new Ferrograph still weighs upwards of 22 kg—and so I would class it as transportable rather than portable, though the new carrying handle allows it to be carried by two people quite easily and comfortably.

I would like to see the meters illuminated, at least in the record mode. I have been so used to this on the previous Ferrographs that I did not think to take a torch with me, when recording a pantomime over last Xmas, and found myself in a dark corner, unable to read the meters when the house lights were out. I would also like some form of editing block provided, perhaps on the underside of the head cover so that it is ready for use when the cover is open. This is the only place on the deck where an editing block can be conveniently stood at the moment, and those available commercially do not always fit there easily.

I also prefer the hinged lids on previous Ferrographs to the lift off type on the *Series 7*. I never know what to do with a lid once I have taken it off, but a hinged one can sit on the recorder and lean against the wall.

For the advanced and particular recordist the preset controls for adjusting bias and replay level, marked B and A on the control panel, are invaluable. The machine can be adjusted for different tapes to give optimum performance and since there are now tremendous variations in characteristics between one reputable brand of tape and another, not to mention the large numbers of 'cheap' tapes available, this is now to my mind an essential facility. The days when there was very little difference between different brands of high quality tape seem also to have passed and anyone using a machine with tape for which it is not adjusted could now get a serious loss in quality.

BATTERY TAPE RECORDERS

a survey of battery and mains / battery reel-to-reel and cassette equipment

We would like to thank the manufacturers and distributing agencies concerned in the preparation of this survey for forwarding specifications and for confirming each published entry. Several of the recorders listed are limited to scientific, industrial and professional applications. Prices can be obtained by applying to the relevant company.

AKAI X-5 STEREO (mains/battery)

Tape speeds: 19, 9.5, 4.75 and 2.375 cm/s.
Spool capacity: 13 cm. 18 cm arms available.
Wow and flutter (19 cm/s): 0.15% RMS.
Frequency response (19 cm/s): 40 Hz-20 kHz ±3 dB.
Signal-to-noise ratio (19 cm/s): 50 dB.
Heads: ¼-track stereo erase, record/play and bias.
Sockets: Jack and DIN.
Inputs: *Microphone* 0.1 mV at 4K
Line 60 mV at 4K
Outputs: *Line* Not specified.
Loudspeaker 2 W maximum per channel.
Features: AGC, cross-field bias, rechargeable battery, internal mains unit. Brushless DC motor.
Dimensions: 295 mm × 280 mm × 130 mm.
Weight: 6 kg.
Price: £180 including tax.
Distributor: Pullin Photographic Ltd., P.O. Box 70, Great West Road, Brentford, Middlesex.
●**Review:** February 1969.

ALBA R23 Cassette

Tape speed: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: 0.6% RMS.
Frequency response: Not specified.
Signal-to-noise ratio: 35 dB
Heads: ½-track mono erase and record/play.
Sockets: Miniature and subminiature jack.
Input: 1.2 K at unspecified level.
Output: *Loudspeaker* 300 mW.
Features: AC record bias, DC erase.
Dimensions: 205 mm × 128 mm × 61 mm.
Weight: 1.3 kg.
Price: £24 3s 6d including tax.
Distributor: Alba (Radio and TV) Ltd., 70 Tabernacle Street, London E.C.2.

AMPEX AG-20

Tape speeds: 38 and 19, or 19 and 9.5, or 9.5 and 4.75 cm/s, to order.
Spool capacity: 18 cm (open lid), 13 cm (closed).
Wow and flutter (38 cm/s): 0.15% RMS.
Frequency response (38 cm/s) : 50 Hz - 16 kHz ±1.5 dB.
Signal-to-noise ratio (38 cm/s) : 60 dB (full-track), 55 dB (½-track), peak record level to unweighted noise.
Heads: Full or ½-track mono erase, record and replay.
Sockets: Cannon XL or DIN, to order.
Inputs: *Microphone* 100 μV to 100 mV at 200 ohms.
Line −26 dBm at 100 K.
Outputs: *Line* −20 dBm into 600 (unbalanced).
Headphones 0 dBm into 200 ohms.
Features: AGC, calibrated VU meter. Supply tension servo. Loudspeaker monitor version available. Optional cinesync
Dimensions: 235 mm × 83 mm.
Weight: 6 kg.
Price: On application.
Manufacturer: Ampex Great Britain Ltd., Acre Road, Berkshire.

EMI L4

Tape speeds: 19 and 9.5 cm/s.
Spool capacity: 11 cm.
Wow and flutter (19 cm/s): 0.2% RMS.
Frequency response (19 cm/s): 50 Hz - 12 kHz ±2 dB.
Signal-to-noise ratio (19 cm/s): 50 dB for 0.2 mV microphone input at peak recording level.
Heads: full or ½-track mono erase, record and play.
Sockets: GPO jack and Cannon.
Inputs: *Microphone* 0.05 mV at 30 and 50 ohms.
Line 270 mV at 20 K.
Outputs: *Line* 0 dBm.
Headphones 50 ohms.
Loudspeaker 200 mW at 65 ohms.
Features: Input and off-tape monitoring. IEC or NAB recording characteristic. Pilot sync version available.
Dimensions: 180 mm × 300 mm × 145 mm.
Weight: 4.9 kg.
Price: On application.
Manufacturer: EMI Electronics Ltd., Audio Recording Equipment Division, Hayes, Middx.
●**Field Trial:** February 1967.
●**Review:** September 1967.

GRUNDIG C200 Cassette

Tape speed: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: 0.4% RMS.


Grundig C200

Frequency response: 80 Hz-8 kHz +2, −6dB
Signal-to-noise ratio: 45 dB.
Heads: ½-track erase and record/play.
Sockets: DIN.
Input: *Universal* 0.2 mV at 7 K. (*Microphone/line*)
Outputs: *Line* 600 mV at 18 K.
Headphones 1.8 K, unspecified level.
Loudspeaker 0.8 W at 5 ohms.
Features: Treble control.
Separate record and replay gain controls.
Dimensions: 153 mm × 242 mm × 64 mm.
Weight: 2 kg.
Price: £36 17s 6d including tax.
Distributor: Grundig (Great Britain) Ltd., London S.E.26.
●**Review:** December 1968.

GRUNDIG TK2200

Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 13 cm.
Wow and flutter (9.5 cm/s): 0.25% RMS.
Frequency response (9.5 cm/s): 60 Hz-9 kHz +3, −5dB
Signal-to-noise ratio (9.5 cm/s): 47dB
Heads: ½-track mono erase and record/play.
Sockets: DIN.
Inputs: *Universal* 0.25 mV at 7.5 K.
Output: *Loudspeaker* 2 W at unspecified impedance.
Features: Input monitoring through headphones or internal speaker.
Dimensions: 350 mm × 216 mm × 115 mm.
Weight: 4 kg.
Price: £97 19s. 8d

BATTERY TAPE RECORDERS

Distributor: Grundig (Great Britain) Ltd.
●Review: December 1968.

NAGRA 4

Tape speeds: 38, 19 and 9.5 cm/s basic.
Spool capacity: 18 cm (lid open), 13 cm (lid closed).
Wow and flutter (38 cm/s): ±0.08%, to DIN 45 507.
Frequency response (38 cm/s): 30 Hz - 20 kHz ±2 dB at −20 dB on Scotch *202*.
Signal-to-noise ratio (19 cm/s): 71 dB (Scotch *202*).
Heads: Erase, record and replay, full or ½-track, to order.
Sockets: Cannon and Continental.
Inputs: *Microphone* (Nagra 4D) 0.2-30 mV at 200 ohms (two inputs).
Line 0.37-120 V at 100 K.
Mixer 560 mV at 9 K (0 dB fixed level).
Outputs: *Line* 4.4 V into 600 ohms for 0 dB input.
Headphones 880 mV with no load. 20-800 mV at 50 ohms.
Mixer 560 mV at 100 K for 0 dB signal.
Loudspeaker 1.6 W (with external power supply).
Features: Neopilot synchronisation with crystal frequency standard and radio link with camera (to order). AGC, compression, mixing. Five different versions available.

Nagra 4-L

Dimensions: 318 mm × 222 mm × 110 mm.
Weight: 6 kg.
Price: On application.
Distributor: Hayden Laboratories Ltd., East House, Chiltern Avenue, Amersham, Bucks.
●Nagra 3 Review: September 1963.

NATIONAL RQ-1135

Tape speed: 9.5 and 4.75 cm/s.
Spool capacity: 8 cm.
Wow and flutter (9.5 cm/s): Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Input: Not specified.
Output: *Loudspeaker* 700 mW maximum.
Features: Auto/manual gain control, input monitoring.
Dimensions: 229 mm × 83 mm × 254 mm.
Weight: 2 kg.
Price: £22 18s 3d.
Distributor: Unamec Ltd., United Africa House, Blackfriars Road, London S.E.1.

NATIONAL RQ-203S Cassette

Tape speed: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track erase and record/play.
Sockets: Miniature jack.
Inputs: *Microphone* —60 dB at 20 K.
Line —5 dB at 100 K.
Output: *Loudspeaker* 2.5 W maximum at 8 ohms.
Features: Battery cutout on microphone.
Dimensions: 245 mm × 75 mm × 235 mm.
Weight: 2 kg.
Price: £35 5s 9d.
Distributor: Unamec Ltd.

NATIONAL RQ-204S Cassette

Tape speeds: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track erase and record/play.
Sockets: Miniature jack.
Input: *Microphone* 1 mV at 200 ohms.
Output: *Loudspeaker* 1.6 W.
Features: Battery cut-out on microphone. AGC.
Dimensions: 220 mm × 70 mm × 270 mm.
Weight: 2 kg.
Price: £26 5s.
Distributor: Unamec Ltd.

NATIONAL RQ-206 S Cassette

Tape speeds: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Input: 20 K at unspecified level.
Output: *Loudspeaker* 1.6 W 'music power' at 8 ohms.
Features: Battery cutout on microphone.
Dimensions: 226 mm × 102 mm × 235 mm.
Weight: 2 kg.

National RQ-401 S

Price: £33 2s 11d.
Distributor: Unamec Ltd.

NATIONAL RQ-401S

Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 10 cm.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase pair and record/play pair (four heads).
Sockets: Miniature jack.
Input: Not specified.
Output: *Loudspeaker* 700 mW maximum.
Features: Forward and reverse record/play back, AGC, input monitoring.

(continued overleaf)

Dimensions: 261 mm × 83 mm × 226 mm.
Weight: 3 kg.
Price: £40 11s 9d.
Distributor: Unamec Ltd.

NATIONAL RQ-501S

Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 13 cm.
Wow and flutter: Not specified.
Frequency response (9.5 cm/s): Not specified.
Signal-to-noise ratio (9.5 cm/s): Not specified.
Heads: ½-track mono erase pair and record/play pair (four heads).
Sockets: Miniature jack.
Inputs: *Microphone* —74 dB at 20 K.
Line —20 dB at 100 K.
Output: *Loudspeaker* 1.2 W at 8 ohms.
Features: Auto/manual gain control, forward and reverse record/playback, input monitoring.
Dimensions: 289 mm × 87 mm × 254 mm.
Weight: 3 kg.
Price: £52 7s 11d.
Distributor: Unamec Ltd.

NATIONAL RQ-504S (mains/battery)

Tape speeds: 9.5 and 4.75 cm/s ± 30%.
Spool capacity: 13 cm.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Inputs: *Microphone* —73 dB at 200 ohms.
Line — 20dB at 100 ohms.
Output: *Loudspeaker* 2.5 W maximum 'music power' at 8 ohms.
Features: Electronic variable speed control. Battery cutout on microphone.
Dimensions: 320 mm × 110 mm × 272 mm.
Weight: 3 kg.
Price: £77 15s.
Distributor: Unamec Ltd.

SANYO M26 Cassette

Tape speeds: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Input: Not specified.
Output: *Loudspeaker* 500 mW.
Features: Price includes shoulder case.
Dimensions: 223 mm × 128 mm × 58 mm.
Weight: 1.5 kg.
Price: £30 2s 5d including tax.
Distributor: Sanyo Service and Sales Ltd., 164 Clapham Park Road, London S.W.4.

SANYO M48M Cassette

Tape speeds: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Inputs: Not specified.
Outputs: *Loudspeaker* 300 mW.
Dimensions: 240 mm × 114 mm × 58 mm.
Weight: 1.3 kg.
Price: £23 18s 8d including tax.
Distributor: Sanyo Service and Sales Ltd.

SANYO M88 Cassette

Tape speeds: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Input: Not specified.
Output: *Loudspeaker* 1W.
Features: Price includes shoulder case.
Dimensions: 231 mm × 127 mm × 64 mm.
Weight: 1.5 kg.
Price: £30 2s 5d including tax.
Distributor: Sanyo Service and Sales Ltd.

SANYO MR115 (mains/battery)

Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 13 cm.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Inputs: Not specified.
Output: *Loudspeaker* 1.2 W.
Dimensions: 295 mm × 254 mm × 98 mm.
Weight: 4.5 kg.
Price: £41 18s 2d including tax.
Distributor: Sanyo Service and Sales Ltd.

SANYO MR120 (mains/battery)

Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 13 cm.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Input: Not specified.
Output: *Loudspeaker* 1.8 W.
Dimensions: 305 mm × 210 mm × 105 mm.
Weight: 4 kg.
Price: £50 17s including tax.
Distributor: Sanyo Service and Sales Ltd.

SANYO MR212

Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 8 cm.
Wow and flutter: Not specified.
Frequency response: Not specified.


Sanyo MR 212

Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Input: Not specified.
Output: *Loudspeaker* 600 mW.
Features: Capstan-sleeve speed change.
Dimensions: 248 mm × 200 mm × 80 mm.
Weight: 1.8 kg
Price: £24 17s 6d.
Distributor: Sanyo Service and Sales Ltd.

SANYO M138 Cassette

Tape speed: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Input: Not specified.
Output: *Loudspeaker* 1 W.
Dimensions: 231 mm × 127 mm × 58 mm.
Weight: 1.4 kg.
Price: £27 16s 1d including tax.
Distributor: Sanyo Service and Sales Ltd.

SANYO MR400 (mains/battery)

Tape speed: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature jack.
Input: Not specified.
Output: *Loudspeaker* 650 mW.
Features: Cassette ejector.
Dimensions: 246 mm × 142 mm × 70 mm.
Weight: 1.6 kg.
Price: £40 14s 2d including tax.
Distributor: Sanyo Service and Sales Ltd.

SHARP RD-303 (mains/battery)

Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 8 cm.
Wow and flutter (9.5 cm/s): 0.35% RMS.
Frequency response: Not specified.
Signal-to-noise ratio (9.5 cm/s): 40 dB.
Heads: ½-track mono erase and record/play.
Sockets: Miniature and sub-miniature jack.
Input: 200 ohm, unspecified level.
Output: *Loudspeaker* 1.1 W maximum.
Features: Input monitoring on headphones or internal speaker. Capstan sleeve speed change. AC record bias, DC erase.
Dimensions: 262 mm × 95 mm × 19 mm.
Weight: 2.5 kg.
Price: £29 8s including tax.
Distributor: Sharp Sales and Service, 16/18 Worsley Road, Swinton, Manchester.

SHARP RD-505 (mains/battery)

Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 13 cm.
Wow and flutter (9.5 cm/s): 0.4% RMS.
Frequency response (9.5 cm/s): Not specified.
Signal-to-noise ratio (9.5 cm/s): 40 dB.
Heads: ½-track mono erase and record/play.
Sockets: Miniature and subminiature jack.
Inputs: *Microphone* 200 ohms, unspecified level.
Line 500 K, unspecified level.
Output: *Loudspeaker* 1.3 W maximum at 8 ohms.

Features: AC record bias, DC erase.
Dimensions: 307 mm × 250 mm × 12 mm.
Weight: 4 kg.
Price: £40 12s 8d including tax.
Distributor: Sharp Sales and Service.

SONY TC-75 Cassette
Tape speed: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature and subminiature jack.
Inputs: Not specified.
Outputs: *Loudspeaker* 1 W.
Features: Battery cutout on microphone.
Dimensions: 130 mm × 238 mm × 60 mm.
Weight: 1.6 kg.
Price: £35 8s.
Distributor: Sony (U.K.) Ltd., Ascot Road, Bedfont, Feltham, Middlesex.

SONY TC-100 Cassette (mains/battery)
Tape speeds: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature and subminiature jack.
Input: Not specified.
Output: *Loudspeaker* 1 W.
Features: Cassette ejector.
Dimensions: 240 mm × 148 mm × 61 mm.
Weight: 1.5 kg.
Price: £42 9s. 6d.
Distributor: Sony (U.K.) Ltd.

SONY TC-210 (mains/battery)
Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 13 cm.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature and subminiature jack.
Inputs: *Microphone* 0.195 mV at 400 ohms.
Line 61.5 mV at 150 K.
Outputs: *Line* 0.775 V at 100 K.
Loudspeaker 1 W.
Features: Battery cutout on microphone. AGC. Input minitoring on headphones or internal speaker.
Dimensions: 294 mm × 118 mm × 302 mm.
Weight: 4 kg.
Price: £48
Distributor: Sony (U.K.) Ltd.

SONY TC-222 (mains/battery)
Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 13 cm.
Wow and flutter: Not specified.
Frequency response (9.5 cm/s): Not specified.
Signal-to-noise ratio (9.5 cm/s): 47 dB at peak recording level.
Heads: ½-track mono erase and record/play.
Sockets: Miniature and subminiature jack.
Inputs: *Microphone* 0.195 mV at 400 ohms.
Line 61.5 mV at 150 K.
Outputs: *Line* 0.775 V at 100 K.
Loudspeaker 1 W.
Features: Auto/manual gain control.
Dimensions: 303 mm × 296 mm × 118 mm.

Sony TC-560D

Weight: 4.5 kg.
Price: £54 12s.
Distributor: Sony (U.K.) Ltd.

SONY TC-560D (mains/battery Stereo Tape Unit)
Tape speeds: 19, 9.5 and 4.75 cm/s.
Spool capacity: 18 cm.
Wow and flutter (19 cm/s): 0.15% RMS.
Frequency response (19 cm/s): 50 Hz - 17 kHZ ± 3dB.
Signal-to-noise ratio (19 cm/s): 52 dB.
Heads: ¼-track stereo erase pair and record/play pair (four heads).
Sockets: DIN and miniature jack.
Inputs: *Microphone* 0.19 mV at 600 ohms (−72 dB).
Line 61 mV at 100 K (−22 dB).
Outputs: *Line* 0.775 V at 100 K (0 dB).
Headphones 28 or 10 mV at 8 ohms (switched).
Features: Forward and reverse record and playback, dual capstan system. Electronic speed stabiliser. Operates from car battery or mains.
Dimensions: 416 mm × 392 mm × 170 mm.
Weight: 13 kg.
Price: £175 19s. 3d.
Distributor: Sony (U.K.) Ltd.

SONY TC-800 (mains/battery)
Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 13 cm.
Wow and flutter: Not specified.
Frequency response: Not specified.
Signal-to-noise ratio: Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature and subminiature jack.
Inputs: *Microphone* 0.195 mV at 600 ohms.
Line 55 mV at 100 K.
Outputs: *Line* 0.775 V at 100 K.
Loudspeaker 1 W maximum.
Features: Auto/manual gain control. Electronic speed stabiliser. Speed slow-down control (RM-5) available.
Dimensions: 322 mm × 107 mm × 261 mm.
Weight: 5.4 kg.
Price: £79 17s. 9d.
Distributor: Sony (U.K.) Ltd.
●**Review and Field Trial:** August 1967.

SONY TC-900S (mains/battery)
Tape speeds: 9.5 and 4.75 cm/s.
Spool capacity: 8 cm.
Wow and flutter (9.5 cm/s): Not specified.
Frequency response (9.5 cm/s): Not specified.
Signal-to-noise ratio (9.5 cm/s): Not specified.
Heads: ½-track mono erase and record/play.
Sockets: Miniature and subminiature jack.
Input: Not specified.
Output: *Loudspeaker* 1 W maximum.
Features: AGC. Capstan-sleeve speed change.
Dimensions: 223 mm × 216 mm × 114 mm.
Weight: 3 kg.
Price: £35 18s.
Distributor: Sony (U.K.) Ltd.
●**Field Trial:** March 1967.

TANDBERG 11-2
Tape speeds: 19, 9.5 and 4.75 cm/s.
Spool capacity: 18 cm (open lid), 13 cm (closed).
Wow and flutter (19 cm/s): 0.1% RMS.
Frequency response (19 cm/s): 40 Hz - 16 kHz ±2 dB.
Signal-to-noise ratio (19 cm/s): 58 dB (¼-track).
Heads: ½-track erase, record and playback.
Sockets: Cannon, DIN and miniature jack.
Inputs: *Microphone* 0.15 mV at 200 ohms.
Line 5 mV at 10 K or 125 mV at 200 K.
Outputs: *Line* 1.55 V at 600 ohms or 1 V at 200 ohms.
Loudspeaker 0.25 W at 20 ohms.
Features: Tachometer-controlled motor. Input and off-tape monitoring. Professional pilot version and full-track available.
Dimensions: 330 mm × 100 mm × 255 mm.
Weight: 5.5 kg.
Price: £163.
Distributor: Elstone Electronics Ltd., Hereford House, North Court, Vicar Lane, Leeds 2.
●**Review:** January 1969.


Tandberg 11

TELEFUNKEN M300TS
Tape speed: 9.5 cm/s.
Spool capacity: 13 cm.
Wow and flutter: ±0.2%.
Frequency response: Not specified.
Signal-to-noise ratio: 46 dB.
Heads: ½-track mono erase and record/play.
Sockets: DIN.
Inputs: Not specified.
Outputs: *Loudspeaker* 1 W.
Features: Contra-rotating flywheels.
Dimensions: 273 mm × 277 mm × 77 mm.
Weight: 3 kg.
Price: £63 3s. 1d.
Distributor: AEG (G.B.) Ltd., 27 Chancery Lane, London W.C.2.
●**Review:** February 1965.
●**Field Trial:** April 1965.

TELEFUNKEN M302TS
Tape speeds: 9.5 and 4.75 cm/s.

(continued overleaf)

Spool capacity: 13 cm.
Wow and flutter (9.5 cm/s): ±0.3%.
Frequency response (9.5 cm/s): Not specified.
Signal-to-noise ratio (9.5 cm/s): 46 dB.
Heads: ¼-track erase and record/play heads.
Sockets: DIN.
Input: Not specified.
Output: *Loudspeaker* 1 W.
Features: Contra-rotating flywheels.
Dimensions: 273 mm × 277 mm × 77 mm.
Weight: 3 kg.
Price: £76 0s. 10d.
Distributor: AEG (G.B.) Ltd.

TELEFUNKEN M4001 Cassette

Tape speed: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: ±0.3%
Frequency response: Not specified.
Signal-to-noise ratio: 45 dB.
Heads: ½-track erase and record/play.
Sockets: DIN.
Input: Not specified.
Output: *Loudspeaker* 0.4 W.
Dimensions: 199 mm × 113 mm × 55 mm.
Weight: Not specified.
Price: £34 16s.
Distributor: AEG (G.B.) Ltd.

UHER 1000 Pilot

Tape speed: 19 cm/s.
Spool capacity: 13 cm.
Wow and flutter: ±0.2%.
Frequency response: Not specified.
Signal-to-noise ratio: 52 dB (CCIR equalisation).
Heads: Full-track erase, record, playback and pilot.
Sockets: DIN.
Inputs: *Microphone* 0.3 mV at 200 ohms, balanced transformer.
Outputs: *Line* 4.4 V at 600 ohms or 450 mV at 15 K.
Sync pulse 0.04 mV (DIN 15 575).
Loudspeaker 1 W.
Features: Switched CCIR/NARTB equalisation. Electronic speed control. Auto/manual AGC. Off-tape monitoring. Calibrated VU meter.
Dimensions: 270 mm × 215 mm × 85 mm.
Weight: 3 kg.
Price: On application.
Distributor: Bosch Ltd., Radlett Road, Watford, Hertfordshire.

UHER 4000L

Tape speeds: 19, 9.5, 4.75 and 2.375 cm/s.
Spool capacity: 13 cm.
Wow and flutter (19 cm/s): ±0.2%.
Frequency response (19 cm/s): Not specified.
Signal-to-noise ratio (19 cm/s): 52 dB.
Heads: ½-track erase and record/play.


Uher 1000


Uher 4200

Sockets: DIN.
Inputs: *Microphone* 0.1 mV at 2 K (25 mV maximum).
Line 2 mV at 47 K (500 mV maximum).
Outputs: *Line* 1 V at 15 K.
Loudspeaker 1 W.
Features: Input monitoring, switchable meter lamp. Calibrated VU meter.
Dimensions: 270 mm × 215 mm × 85 mm.
Weight: 3 kg.
Price: £127 1s.
Distributor: Bosch Ltd.
●**Review and Field Trial:** November 1966.

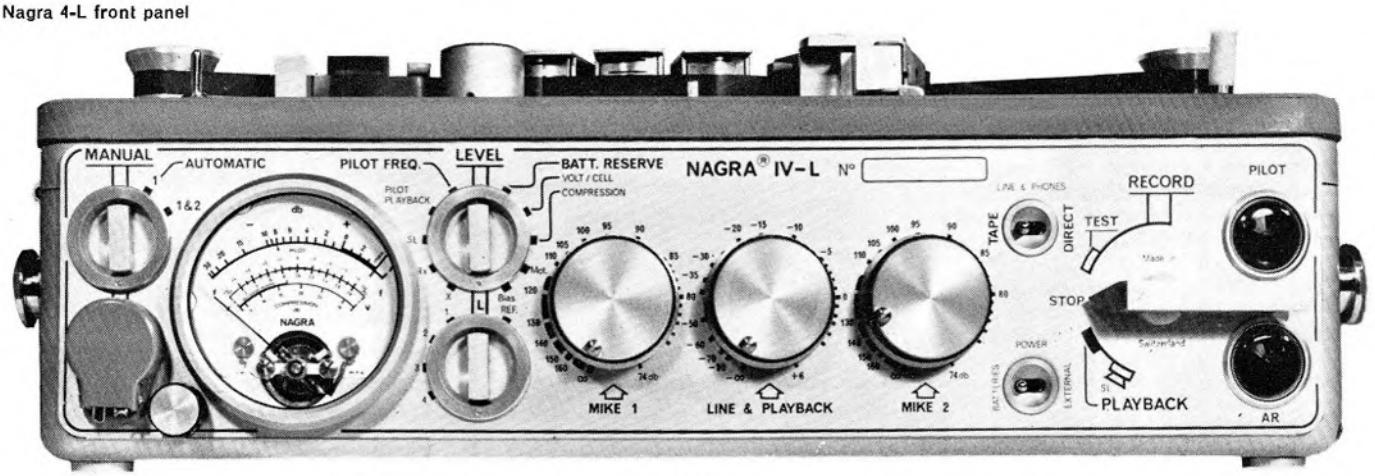
UHER 4200 STEREO

Tape speeds: 19, 9.5, 4.75 and 2.375 cm/s.
Spool capacity: 13 cm.
Wow and flutter (19 cm/s): ±0.2%.
Frequency response (19 cm/s): Not specified.
Signal-to-noise ratio (19 cm/s): 53 dB.
Heads: ½-track stereo erase and record/play (¼-track to order).
Sockets: DIN.
Inputs: *Microphone* 0.1 mV at 2 K (25 mV maximum).
Line 2 mV at 47 K (500 mV maximum).
Outputs: *Line* 1 V at 15 K.
Loudspeaker 1 W.
Features: Input monitoring, switchable meter lamp.
Dimensions: 270 mm × 215 mm × 95 mm.
Weight: 3 kg.
Price: £154 6s.
Distributor: Bosch Ltd.

VAN DER MOLEN SONIC EIGHT STEREO Cassette (mains/battery)

Tape speed: 4.75 cm/s.
Cassette system: Compact.
Wow and flutter: Not specified.
Frequency response: 100 Hz - 10 kHz ±3 dB.
Signal-to-noise ratio: 40 dB.
Heads: ¼-track stereo erase and record/play.
Sockets: DIN.
Inputs: *Microphone* 70 μV at 2 K.
Line 70 mV at 2 M.
Outputs: *Line* 100 mV at 10 K.
Loudspeaker 4 W per channel, 15 ohms.
Features: Detachable loudspeakers.
Dimensions: 534 mm × 128 mm × 178 mm.
Weight: 7 kg.
Price: £64 3s 1d.
Manufacturer: Van Der Molen Ltd., 42 Mawney Road, Romford, Essex.

Nagra 4-L front panel



A SIMPLE TRANSISTOR LIMITER-COMPRESSOR

BY GERALD CHEVIN *

IN the March issue of *Tape Recorder*, the theory and practice of peak limiters were discussed by W. H. Myall. This article is intended as a follow-up and describes a simple but efficient limiter which may be either completely portable or housed in existing equipment.

The object of a limiter is to suppress excursions of sound above predetermined levels, introducing as little change in programme quality as possible. The difference between limiting and compressing is just a question of ratios, i.e. a compression rate of 10:1 signifies that for a 10 dB rise of input signal the output will only rise 1 dB. When the rate becomes as severe as 30:1, it is termed as limiting.

One must, of course, remember that when limiting or compressing the dynamic range is squashed, even though the action of the limiter/compressor may not be audible, the results could sound rather odd.

Dynamic range is the difference between the loudest and softest passages in a programme measured in decibels. If this range is too high, the signal-to-noise ratio would be relatively low. Conversely if it is too low the quality may sound unnatural.

Two important factors govern the results obtained with all limiters and compressors, the *attack* and *release* times, the latter and sometimes the former being variable. The attack time is defined as the time after the signal has reached the input before the limiter acts at full efficiency. The release time is defined as the time the limiter takes to reset back to its normal no-signal condition.

There are a variety of ways one can control the gain of the sound source automatically. A very popular but somewhat 'old fashioned' method employs thermionic valves with a variable-mu characteristic, the gain of which varies in sympathy with the grid bias voltage, without distortion. **Fig. 1** depicts a block diagram of such a limiter/compressor. The signal is amplified by the AF amplifier, the output of which is fed into the next stage, namely the tape machine. The DC rectifier assembly converts the AC signal into a DC source. This is then applied back to the grid of the valve as a negative voltage, with respect to earth, causing the gain to be reduced automatically depending upon the setting of VR1. Several large companies have produced some excellent limiters along these lines, but it is now considered outmoded because of physical size and power requirements, in fact a similar method is used in ultra-modern designs, where one varies the channel width of a field effect transistor.

* *Advision Ltd.*

FIG. 1 BLOCK DIAGRAM OF VARIABLE-MU LIMITER-COMPRESSOR

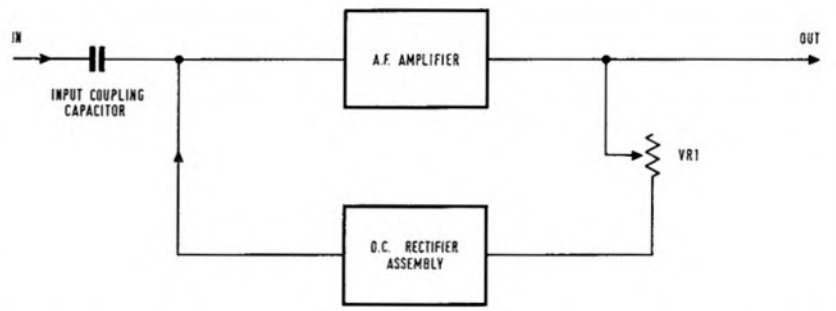
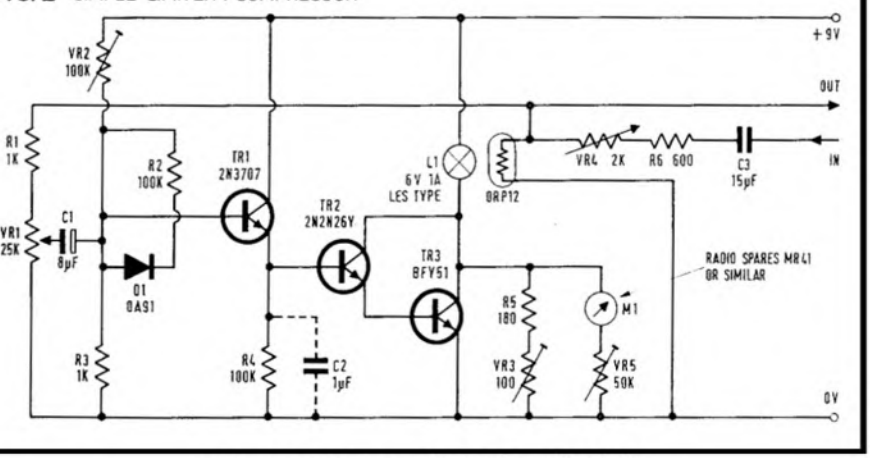


FIG. 2 SIMPLE LIMITER / COMPRESSOR



Author's Correction : C2=10 μF. C3=50 μF.

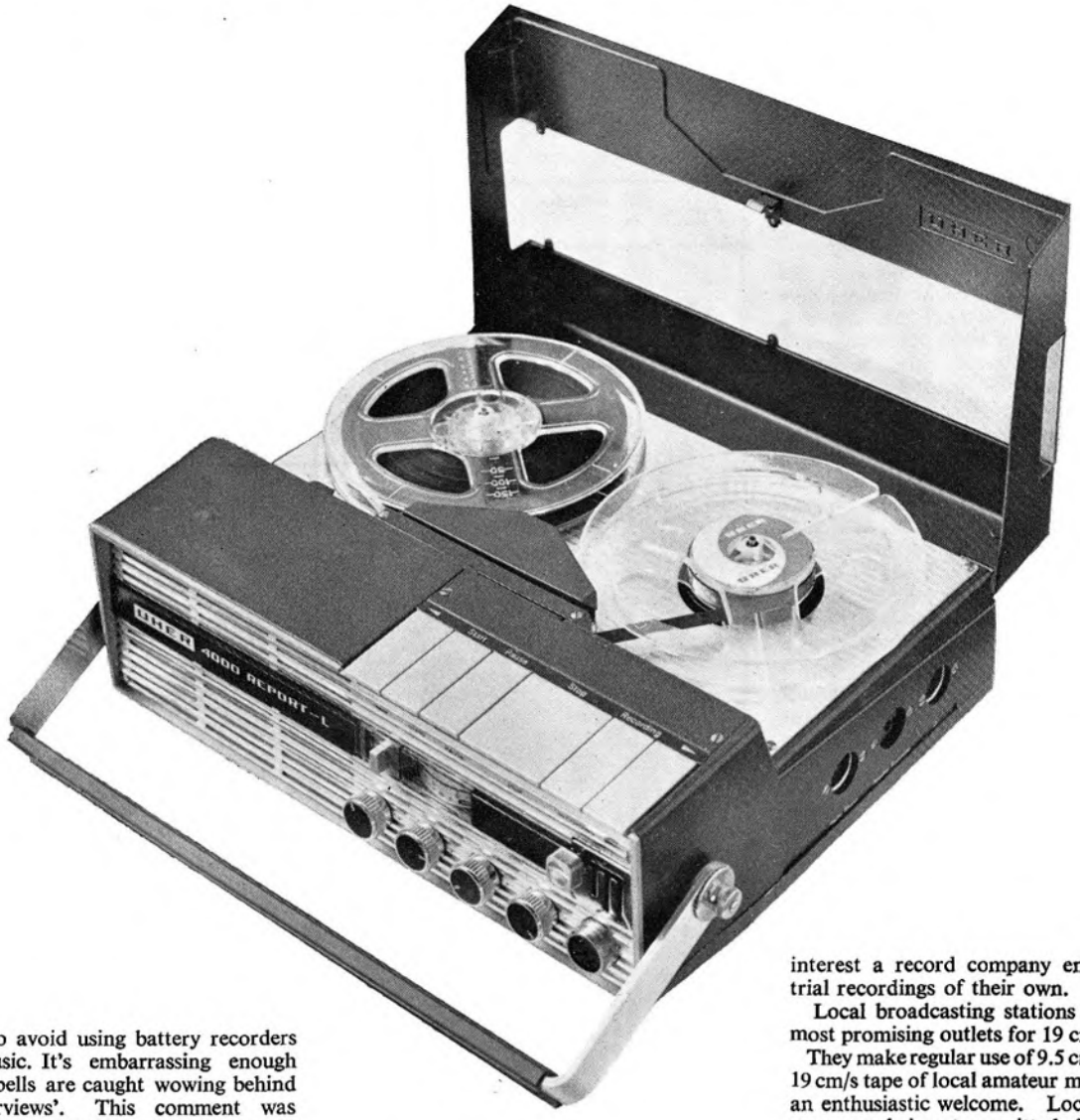
This brings us to a very simple **fig. 2** method that is quite successful, and the basis of this article.

The programme material is fed to the input via C3 and on to the base of Q1, which is at high impedance and gated to stand at the bottom of its conducting curve. The output from the emitter is then fed to the super alpha pair Q2 and Q3, which reacts as a DC amplifier. The standing voltage relies on the positions of VR1 and VR3 and should be set for minimum bulb illumination. If the setting is too high, Q3 will overheat. It may also be seen that the attack time depends upon this illumination point; too low a standing voltage will render the attack time quite slow. This adjustment is therefore quite critical. The release time may be adjusted by varying C2. I have found for most purposes that a fast release time is quite acceptable, by employing the formula T=C2 x R4, where T=time in seconds, C=capacitance in farads, and R=resistance in ohms.

A capacitor of 1 μF was found to give a release time of 0.1 seconds. A range from 1 μF to 10 μF could be connected to a switch for variable control. The *ORP12* cadmium sulphide cell has a high resistance when dark, and vice-versa. By placing this cell across the output, the gain of the DC amplifier may be adjusted by the 'threshold' control VR1. This in turn sets the illumination of the bulb

(continued on page 301)

RECORDING LIVE MUSIC ON BATTERY EQUIPMENT



By David Kirk

'WE try to avoid using battery recorders for music. It's embarrassing enough when church bells are caught wowing behind outdoor interviews'. This comment was made to me by a BBC engineer four years ago, at a time when almost every portable short of the Nagra relied on a centrifugal governor to hold the speed steady.

Battery recorders have improved since then and are now at the stage where electronic speed control is found even on middle-price domestics. Grundig's £96 *TK2200* and £49 *C200*, National's £66 *RQ504*, Sony's £80 *TC800*, the £127 Uher *4000L* and £180 Akai *X5* all employ oscillator-controlled electronic governors of one form or another. The £146 professional Tandberg *11* imitates the drive system of the old £330 Nagra *3B*. A series of teeth cut in the periphery of the Nagra capstan flywheel feed a tachometer circuit with a tone which is related in frequency to the ate of capstan rotation. This stabilises the speed of a motor directly coupled to the capstan. In the Tandberg design, the teeth are cut in the spindle of a motor which is linked by a belt to the capstan.

This new generation of battery portables has already proved its superiority over earlier designs, but are they now capable of decent live music recording? In my experience they are, depending upon what one means by 'decent'. No self-respecting record company, however small, is likely to accept 19 cm/s master tapes, whatever the recorder, though 38 cm/s tapes might be taken seriously. This rules out everything except the Nagra or battery Ampex, though neither is manufactured in stereo form. A 19 cm/s tape is an adequate medium for demonstrating the abilities of amateur musicians, however, and might interest a record company enough to make trial recordings of their own.

Local broadcasting stations are among the most promising outlets for 19 cm/s recordings. They make regular use of 9.5 cm/s and a good 19 cm/s tape of local amateur music can expect an enthusiastic welcome. Local programmes are now being transmitted from Brighton, Leicester, Merseyside, Nottingham, Durham, Sheffield, Leeds and Stoke-on-Trent. Radio Stoke is experimenting with stereo.

Like the record companies already mentioned, the BBC might be provoked by a 19 cm/s tape into making their own recording of the participant musicians. A 38 cm/s Nagra tape would stand a better chance of acceptance, though anything less than an AKG capacitor at the microphone end would probably bring the recording below their desired standard. Outstanding recordings are sometimes made with cheaper ribbon microphones, notably the £50 STC *4038*, and a full-track 19 cm/s battery recorder is at least capable of exceeding the quality of sub-normal broadcast discs.

Radio Free Europe have a demand for recordings which, as they put it, reflect the

FIG. 1 SINGLE FIGURE-OF-EIGHT MICROPHONE

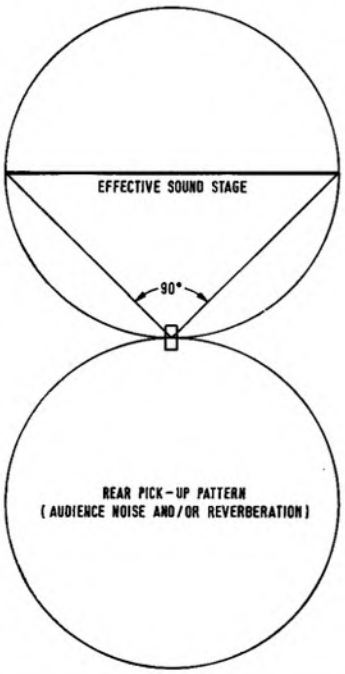
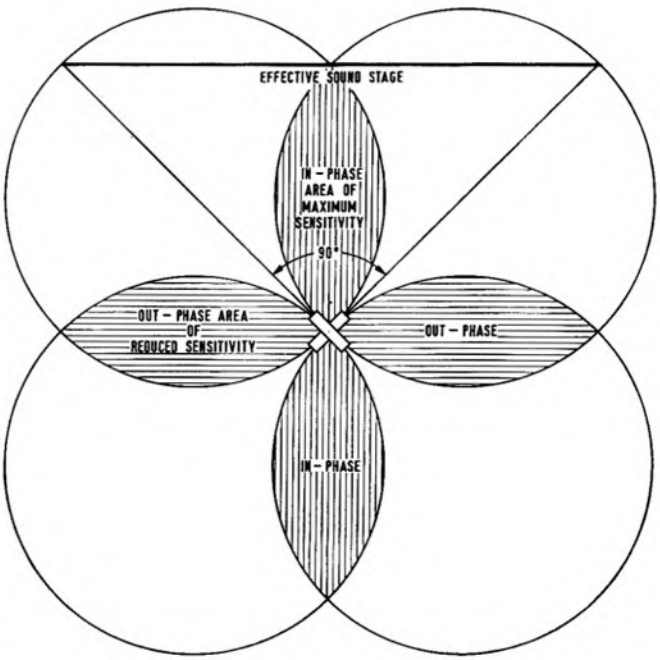


FIG. 2 FIGURE-OF-EIGHT STEREO PAIR



British way of life. This offers an excellent market for recordings of competent amateur orchestras. Radio Free Europe is represented in the UK at *135 Wardour Street, London W.1.* For addresses of record companies, it is necessary only to look at the nearest sleeve. The low-price labels are the most promising, typically Allegro, Music for Pleasure (EMI), Oryx and Saga.

Having considered the market for 'Music with Limitations', we go on to the practical business of getting the best out of battery equipment. Most manufacturers of battery recorders earn their living by catering for the impulse buyer, whose domestic needs include some sort of microphone. Hence the plastic-cased moving-coil microphone, worth perhaps two or three pounds, supplied with the majority of portables. The quality of this microphone and the length of the attached cable are the biggest limitations of electronically stabilised battery recorders. The cable is rarely more than 2 m long and usually feeds a medium-impedance (600-ohm to 3 K) transistor input stage. Neither the performers nor the audience want miniature recorders around their feet, to say nothing of a fidgeting engineer, so a 20 m extension cable is essential for recording public performances. This is usually sufficient to permit monitoring in the seclusion of a side-stage room. Working a medium-impedance microphone through such a length of cable is inviting RF trouble and hum. This noise can usually be eliminated by using a low-impedance (15-50 ohm) microphone and matching through a suitable transformer. The transformer needs to be connected close to the recorder, not at the microphone end of the cable. Though I have used a number of more expensive moving-coil microphones, my best results have been achieved with a Grampian *GR2* ribbon. This is capable of feeding anything through the appropriate *G7* transformer, or can be connected direct to the balanced low-impedance inputs of the Uher *1000* or Nagra. The Tandberg *11* takes a balanced 200-ohm microphone. Balanced inputs employ two signal conductors (usually with red and black insulation) plus a separate earth. They provide greater freedom from hum and RF than the more common unbalanced input comprising one conductor and an earth return. Whether balanced or unbalanced, screening should be exercised on all microphone cables, even when working at 15 ohms.

Studio capacitor microphones are superior even to the best ribbons, for most applications, but the £30-or-so capacitors developed in recent years have earned a reputation for inconsistency. Trapped moisture behind the diaphragm of a capacitor microphone can create noise difficulties even on the AKG *C24*, and is not easily extracted.

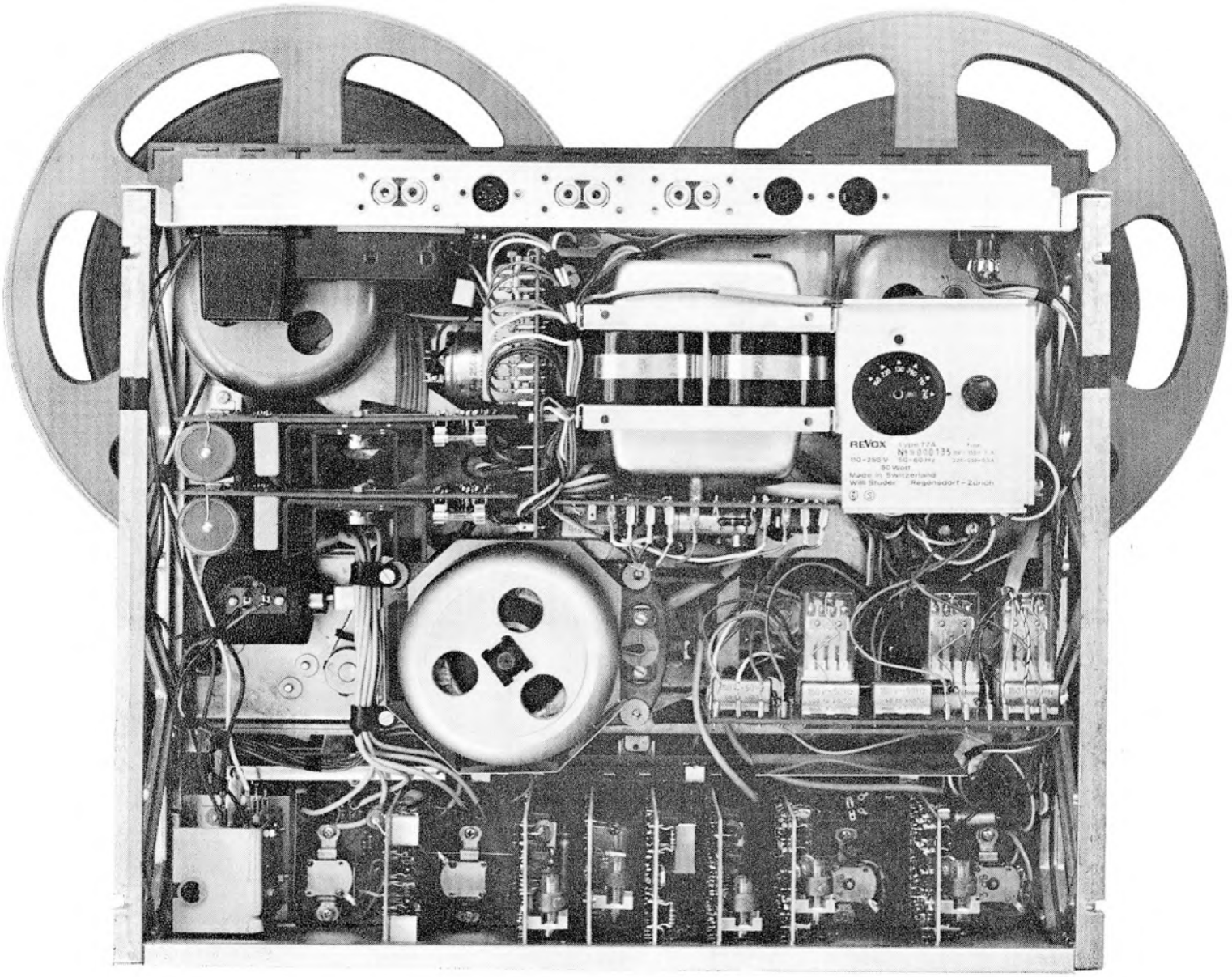
Demand for stereo recordings is limited at present, though the Radio Stoke experiments may pave the way for the eventual introduction of stereo local broadcasting. Stereo recording is a more interesting and more difficult business than mono, though the choice of stereo recorders is limited to the ¼-track Uher *4200* and the ¼-track Akai *X5*. (The *X5* is not available in ½-track form.)

Microphone technique can be as simple or as complex an art as the recordist cares to make it. The most consistently successful mono and stereo placements (**figs. 1** and **2**) are fortunately also the simplest. The advantage of figure-of-eight ribbons is that they pick up reverberation from the rear of the auditorium. This has a beneficial effect on choral and organ recordings. It can also enhance the performance of amateur violinists by rounding off some rough edges in their playing. Each unit of the coaxial *C24* capacitor can be switched electrically from figure-of-eight to a cardioid or omni-directional pick-up pattern, but a recordist able to afford £270 for a microphone will have had the gumption to exchange his battery recorder for a professional mains portable and a larger car. Figure-of-eight ribbons can be converted to unidirectional operation, poor man's cardioid, by mounting a small screen of absorbent material a few centimetres from the rear microphone face. Three or four layers of towelling and curtain over a 40 x 40 cm sheet of softboard will cut audience noise and echoes down to a more tolerable level.

All microphone stands should rest on sponge or rubber pads to provide isolation from foot-tappers and wandering soloists. Unprotected, a stand may transmit rumbles to the recorder, rivalling the noise of a howling wind. I was caught this way some months back, when a women's choir stood up and tromped off the stage in mid-song.

Two points to watch when using the **figs. 1** and **2** systems are the effective angle of the sound stage and the placement of each performer. A figure-of-eight ribbon should not be expected to encompass more than a 90° spread of sound. A stereo pair should ideally form an equilateral triangle relative to the extreme left and right performers. It is sometimes tempting to move the pair very much closer in order to raise the balance of quiet instruments. The soft plunk of a banjo, for example, can easily be drowned by the brass and percussion of a jazz band. The banjo could be raised in level by employing the **fig. 3** technique, but this will confuse the

(*continued overleaf*)



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outer images. in this case the trumpet and trombone. The situation can be improved by mixing in additional spaced cardioids at **A** and **B.** Neither the Uher *4200* nor the Akai *X5* have four-channel mixing facilities, however, and we become faced with the complication of external mixers. A 2 x 2 stereo microphone mixer might be built for £20 around the circuits given by John Fisher (*A High Quality Mixing Unit*, March, April and May 1967). Although multi-microphone technique offers considerable scope for experiment, it is prone to producing hole-in-the-middle stereo. The **fig. 4** situation is more reliable than **fig. 3,** with a single ribbon in place of the stereo pair. This will at least centralise the banjo, or shift it sideways if desired, but exaggerates the left/right location of other instruments. The percussion also tends to spread across the entire sound stage.

Fig. 5 shows the ideal solution to the problem of stereo balance. It also happens to be very much simpler than multi-microphone arrangements. Instead of moving the stereo pair towards the banjo to raise its level, as in **fig. 3,** the banjo is moved well forward of the other instruments in the direction of the arrows until the desired balance is reached. If the instrument becomes unnecessarily loud, it is simple enough to shift the performer back a metre or two towards the drums. The trumpet produces a greater sound level than the trombone and these instruments, too, can be moved forwards or backwards relative to each other. If total realism is required, the trumpet should remain in its distant position even when muted. Realism and recorded quality do not always go hand in hand, however, and it is up to the recordist to reposition the muted instrument if he so wishes.

A similar situation applies to modulation level. There are two schools of thought here : the recording level can either be adjusted to peak on a predetermined 'loudest passage' and left there for the entire session, or discreetly raised and lowered during the performance to minimise tape hiss and distortion. The fixed-gain technique keeps the performers' *fffs* and *ppps* intact, but musicians have little regard for meter needles and frequently exceed the loudness of their rehearsed performances. The 'human AGC' alternative, though technically incorrect, has a more immediate appeal to the average listener, who neither knows nor cares about *ppp* niceties. It is one rung down the ladder to Radio One constant-volume drabness, however, and should be exercised with prudence.

Before the subject of microphone positioning and sound balance is left, some attention must be given to the use of omni-directional microphones. There are so many moving-coil microphones of this pattern on the market that some recordists will undoubtedly attempt to use them for stereo. If two omni-directional microphones are arranged as a coincident stereo pair, the result will be scarcely better than double-mono. The spaced technique of **fig. 6** is the only one capable of giving any kind of stereo. The two microphones should be near enough to prevent a hole in the middle, yet sufficiently far from each other to retain reasonable stereo separation.

FIG. 3 FOUR – MICROPHONE STEREO – SEE TEXT

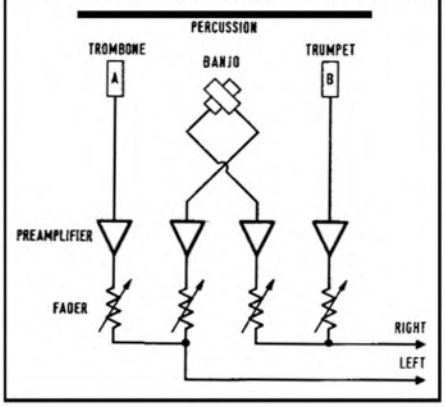


FIG. 4 THREE – MICROPHONE STEREO

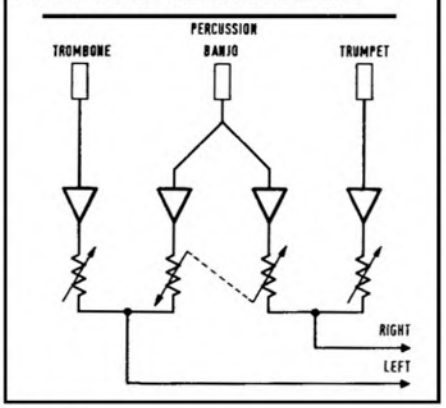


FIG. 5

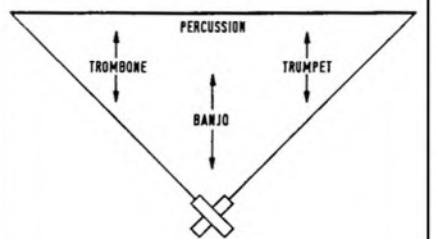
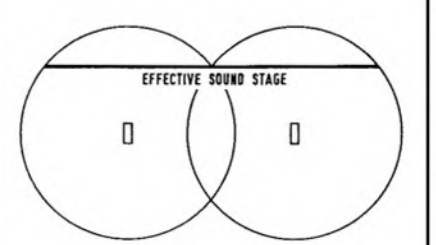


FIG. 6
SPACED OMNI – DIRECTIONAL MICROPHONES



The optimum height of a tripod-mounted stereo pair (**fig. 2** style) is usually around 1.5 m, on the same plain as a standing listener's ears. There is a good case for raising this to 2 or 3 m when the sound stage is relatively deep. The increased height improves pick-up from performers at the rear. Choral music is usually presented with the choir placed behind the orchestra and a high ribbon or stereo pair will catch sibilance that would otherwise have been absorbed in the body of the instrumentalists.

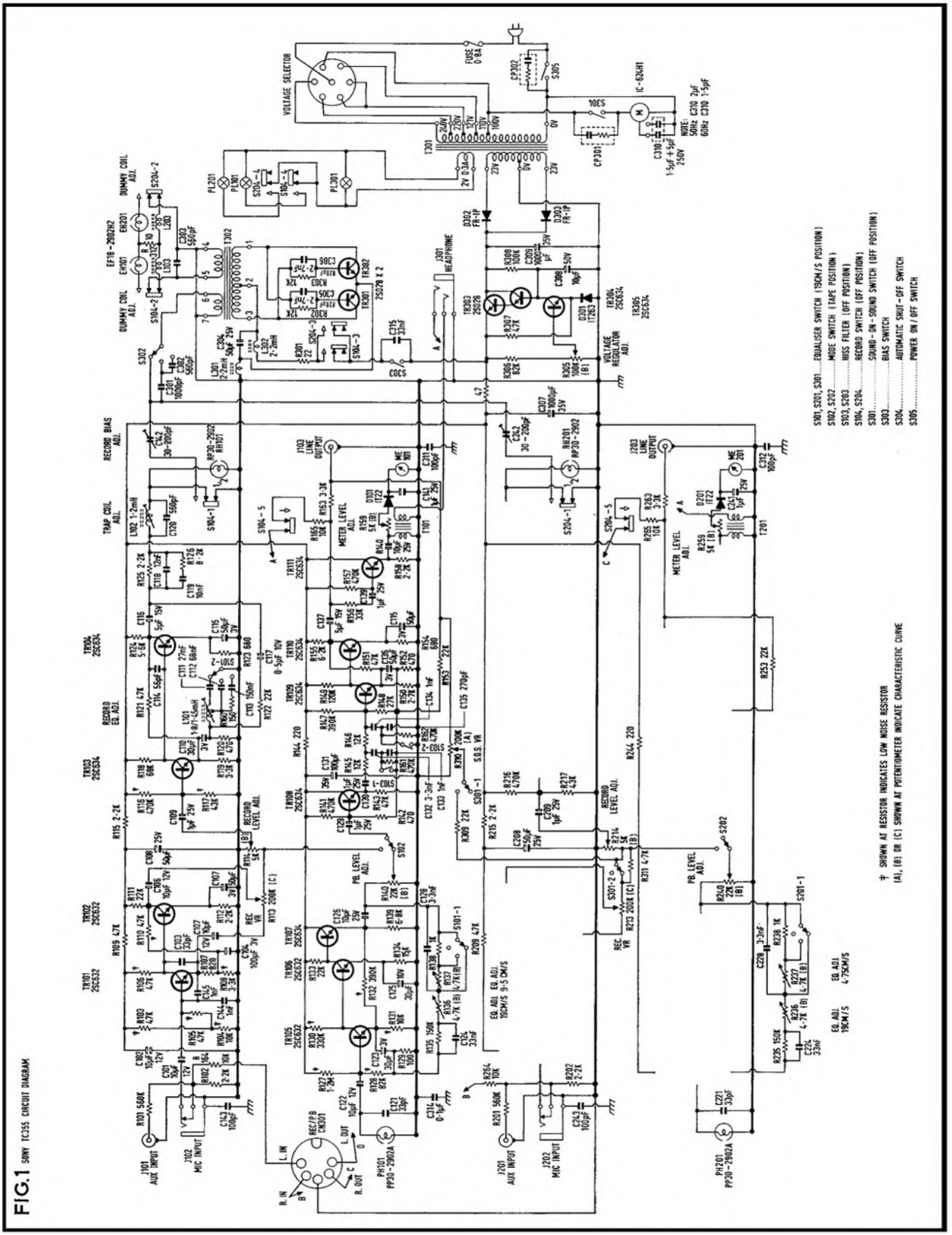
The Tandberg *11*, Uher *1000*, EMI *L4*, Ampex *AG-20* and Nagra models incorporate off-tape monitoring to keep the recordist continuously informed of the recording quality, including tape hiss, wow and flutter, and dropout. Neither the Uher *4200* nor the Akai *X5* stereo portables have this facility, though the *4200* at least permits monitoring of the incoming signal. Although not essential, monitoring facilities transform microphone balancing from a chore into a satisfying art. Off-tape monitoring is particularly valuable on recorders with VU meters, as these devices react less predictably than PPMs. Where it is possible at all, monitoring from battery equipment is best undertaken on headphones, not because they are superior to loudspeakers but because they absorb less power. Oxide flaking, base deformity and background noise are in fact easier to detect on good headphones than with loudspeakers. Few off-stage rooms are sealed completely from the sound of the main hall, and tape hiss, over speakers, can easily be drowned in room noise. Loudspeaker monitoring also presents the risk of echo and howlround, particularly if intervening doors are liable to be opened during a performance. A good pair of headphones, mono or stereo, places the recordist in an isolated world of his own. My own favourite, the £19 Sharpe *HA10* (S. G. Brown) were chosen more for their noise sealing properties than for their sound quality and even allow same-room monitoring of loud piano music.

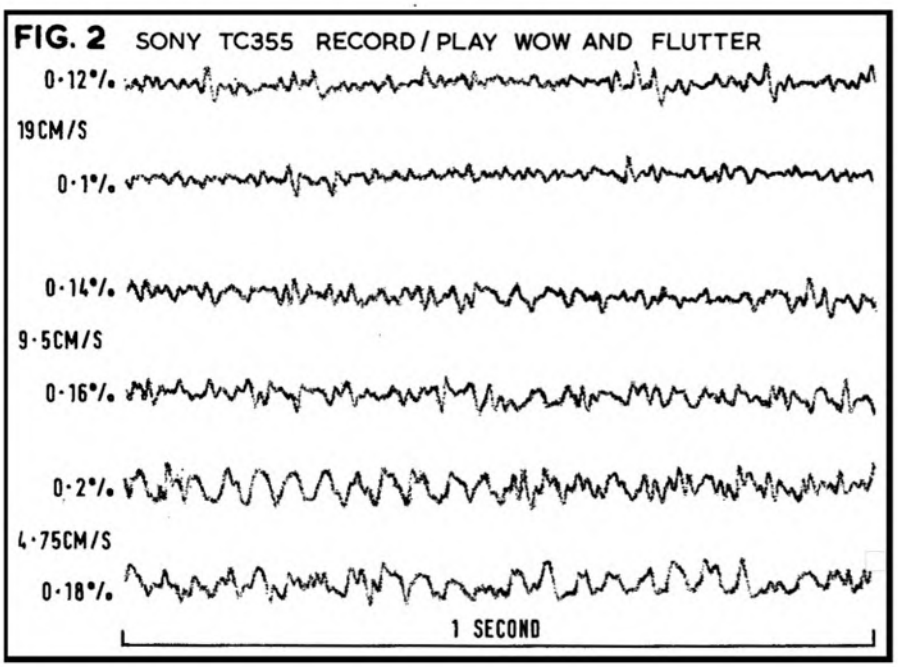
The small dimensions of battery recorders tempt some operators to use the equipment in their hands, across their knees, or suspended from their shoulders. Some portables tolerate this kind of operation, being designed primarily for location speech or effects recording. For music recording, however, a fixed horizontal base is essential if wow and flutter are to be kept at a minimum.

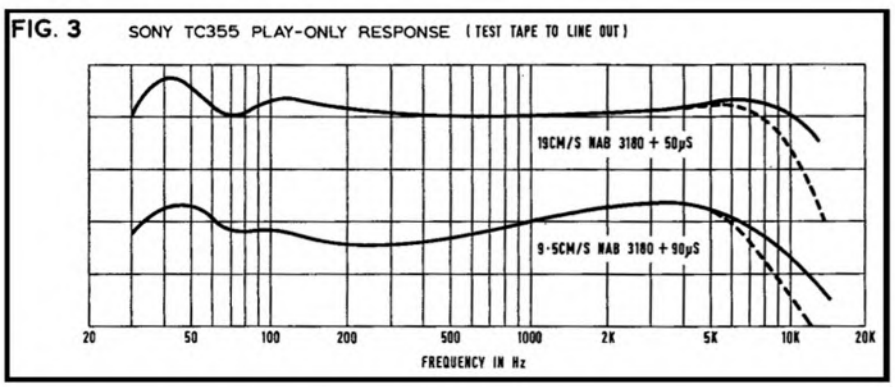
Working at 19 cm/s usually presents considerable expense in terms of battery replacement and three hours per half-dozen cells is relatively good going. Mains units can pay for themselves in as little as 40 working hours with recorders of this kind. Some mains units impart a small amount of audible hum to the tape and this should obviously be checked carefully before any payment is made. Rechargeable batteries are another method of economising, though they tend to become erratic after a few months.

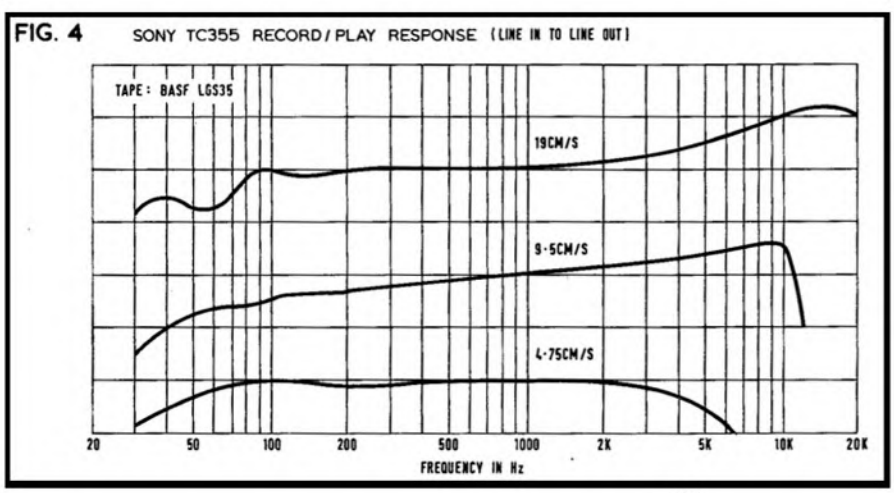
Finally, it should be remembered that not all composers and arrangers enjoy the affluence of the Beatles. A licence to record live performances of all musical works under MCPS control is available for 10s. from the Mechanical Copyright Protection Society Ltd., Licensing Department, Elgar House, 380 Streatham High Road, London, S.W.16

FIG.1 SONY TC355 CIRCUIT DIAGRAM









SONY TC355

MANUFACTURER'S SPECIFICATION

(19 cm/s). Quarter-track transistor stereo tape unit with stereo headphone monitor. **Wow and flutter:** 0.15% RMS at 19 cm/s. **Frequency response:** 20 Hz-25 kHz, unspecified limits. **Signal-to-noise ratio:** 52 dB. **Distortion:** 1.6%. **Bias frequency:** 160 kHz. **Spool capacity:** 18 cm. **Tape speeds:** 19, 9.5 and 4.75 cm/s. **Modulation indicators:** Twin meter. **Microphone input:** 0.19 mV at 600 ohms. **Line input:** 0.06 V at 560 K, or 7.75 mV at 10 K. **Line output:** 0.775 V at 100 K. **Headphone output:** 31 mV at 8 ohms. **Sockets:** Miniature jack (microphone). Phono and DIN (line), GPO jack (headphone). **Tape heads:** Erase, record and play. **Dimensions:** 386 x 180 x 355 mm. **Weight:** 10 kg. **Price:** £99.

Manufacturer: Sony Corporation, Tokyo, Japan.
Distributor: Sony (U.K.) Ltd., Ascot Road, Bedfont, Feltham, Middlesex.

THE Sony *TC355* is the successor to the *TC350* reviewed in June 1967. The controls and layout are similar to the *TC350*, with all recording controls hidden under a small sliding panel. A double VU meter with adjacent vertical meter scales makes stereo monitoring easier than with the original separate meters, and a noise suppressor switch curtails the extreme high note response on play to reduce high frequency tape hiss on poor recordings.

The positive HT line is stabilised at 25 V by a three-transistor and reference diode circuit so that noise, distortion and gain remain constant against variation of power source voltage.

The circuit of **fig. 1** shows that double and triple DC-coupled transistor groups are used for all amplifiers with both DC feedback for stability and AC feedback for control of equalisation or frequency characteristics. Single transistors are used only for impedance transformation where 100% feedback is provided in the emitter follower type of circuit. The record level controls (R.113 and R.213) alter the feedback over the microphone

(*continued overleaf*)

and line input preamplifier so that very large input signals cannot overload the input transistor. Note also that section S.302 of the equaliser switch alters the bias for each of the three tape speeds.

The mechanics of the deck are robust and powered from a heavy four-pole synchronous motor. Wind or rewind of an 18 cm reel of LP tape takes nearly four minutes. The four-digit tape position counter clocks up exactly one digit for each revolution of the supply spool.

Long term tape stability was well within 1% at all three speeds. Short-term speed stability was excellent on play only; a low wow and flutter test tape giving RMS readings of 0.07% and 0.08% for combined wow and flutter and 0.03% and 0.04% wow only at 19 and 9.5 cm/s respectively.

The cumulative record-play wow and flutter pen recordings of **fig. 2** show somewhat higher readings. This is because the flutter is higher on record, as the record head is further from the capstan than the play head, and also because the 25 Hz flutter from the four pole drive motor can either add or cancel periodically as illustrated by the top and bottom pen recordings at each speed. The 25 Hz flutter is only audible on sustained tones at the lowest speed of 4.75 cm/s.

The play-only responses of **fig. 3** were obtained by playing test tapes recorded to the NAB 50 μS and 90 μS time constants with 3180 μS bass lift. The dotted curves show the effect of operating the noise suppressor switch. System noise with no tape passing the heads was at the low level of 64 dB below peak recording level. Bulk erased tape gave a reading of −59 dB, and tape erased on the machine read −57 dB. All the above noise readings are unweighted.

Recording tests showed that 19 cm/s peak recording level of 32 mM/mm at 1 kHz gave a total distortion of 2.8%. This level was recorded with the VU meters just off the scale on constant tone. The dynamic behaviour of the VU meters was checked by recording speech and music, with peaks kicking into the red sector of the scales only occasionally, and then comparing the peaks with the steady tone peak recording signal amplitude on a CRO. All was well and the meters can be considered satisfactory for accurate monitoring of recording levels on or off the tape.

As no tape was supplied with the machine, I used BASF *LGS35* for the record-play tests shown in **fig. 4.** From previous experience I would guess that Sony tape would give a slightly more level response with less top rise and with a bass response nearer to that shown in **fig. 3.**

COMMENT

This is a three-head recorder with erase head, record head and play head assemblies for each of the stereo channels. This means that the record head can be specifically designed for recording only without having to double as a fine gap play head. The wider gap, larger track width and the 160 kHz bias frequency

gives optimum recording conditions for low recorded noise as shown by my signal-to-noise ratio tests above. An outstanding advantage of a three-head recorder and separate record and play amplifiers is the mode switching or A-B comparison of the incoming signal with that actually recorded on the tape.

The stereo headphone jack is designed to feed low impedance headsets but if 200-400 ohm units are preferred they can be fed from the line outputs instead.

This machine, unlike some recently reviewed models which are little more than playback devices, is actually capable of producing decent *recordings*. It is surprising, however, to see miniature jacks at the microphone inputs. For £99 I would expect to see standard jacks.

A. Tutchings.

PHILIPS MICROPHONES

EL6015 and EL6025

MANUFACTURER'S SPECIFICATION. Directional response: Cardioid. **Frequency response:** 125 Hz-17 kHz ±3 dB. **Front-to-rear ratio:** 16 dB. **Sensitivity:** 0.28 mV/μB at 500 ohms (—71 dB); 1.9 mV/μB at 25 K (—54 dB). **Cable length:** 3 m. **Switch:** On/off (short-circuiting, can easily be converted to interrupting). **Dimensions:** 40 mm dia x 155 mm (*6015*), 40 mm dia x 390 mm (*6025* with flexible shaft). **Price** £15 10s (*6015*); £20 (*6025*). **Distributor: Pye TVT Ltd., Addlestone Road, Weybridge, Surrey.**

THESE two microphones are part of a range of robust moving coil designs produced by Philips for public address, sound reinforcement and studio use. These particular units are intended for public address and sound reinforcement. The same insert is used in both the microphones under review, the major differences being mechanical.

The *EL6015*, the cheaper of the two, is a hand-held unit, approximately 15 cm long by 4 cm diameter. The works are contained in a capsule about 5 cm long, finished in satin chrome and black. They consist of a normal moving-coil transducer with an acoustic phase shifting network applied to the rear face of the diaphragm, this sound pressure being obtained via an open grille in the body of the head. By correct dimensioning of the network, a cardioid field can be obtained over the major portion of the acoustic spectrum. This inevitably results in a reduction of low frequency sensitivity because of the practical limit to the dimensions of the acoustic network. The coil is wound for a nominal impedance of 500 ohms. The handle proper is of black plastic. A mute switch operated by a rotating sleeve is fitted at the top of the handle and provision is made to lock the switch in the ON position should this be considered desirable. Approximately three metres of two-core screened cable, together with a plastic clip adaptor for fitting the unit to a microphone stand, are part of the accessories provided. The adaptor is fitted with three bushes of $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{5}{8}$ in diameter x 27 TPI Whitworth form, which suits the majority of microphone stands available in this country.

The head of the *EL6025* microphone is similar to that of the *6015*, but is connected to the base by a chromium plated steel flexible tube about 30 cm long, enabling the microphone to be adjusted to the optimum position relative to the speaker. Contained in the base is a transformer to match 500 ohms or high impedance (25 K and above). A mute switch (which also functions as the impedance switch) is fitted to the base, which is terminated with a universal adaptor similar to the *6015*, together with three metres of screened two-core cable.

As is to be expected, the electrical sensitivity and performance figures of the two microphones are substantially identical, and **fig. 1,** shows the free field response, this being related to 500 ohms in each case. In common with most cardioid moving coil microphones, the response drops at frequencies less than 150 Hz. Above this frequency the response has a rising characteristic and the usable response can be considered from 100 Hz to 15 kHz. The increased sensitivity in the 3 to 8 kHz region gives a 'forwardness' to speech and the overall effect with vocalists is very good. The back to front sensitivity is approximately 20 dB from 150 Hz to 1.5 kHz, decreasing to about 10 dB at 3 kHz, the system resonance, and then improving at higher frequencies. When compared with an omni-directional microphone, the sound level can be increased by up to 10 dB before feedback occurs.

The claimed sensitivity of 0.26 mV per μB for low impedance (500 ohms) is met, as is the

(*continued overleaf*)

FIG. 1 PHILIPS EL6015 AND EL6025 (500 OHMS)

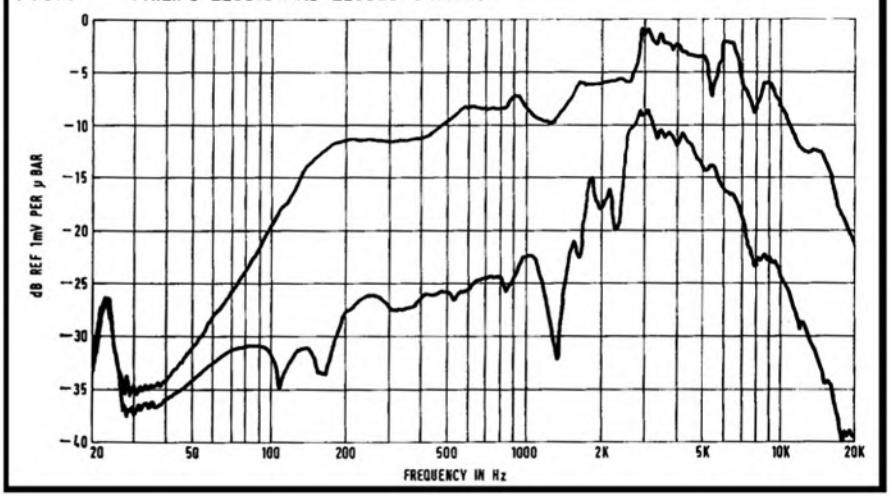
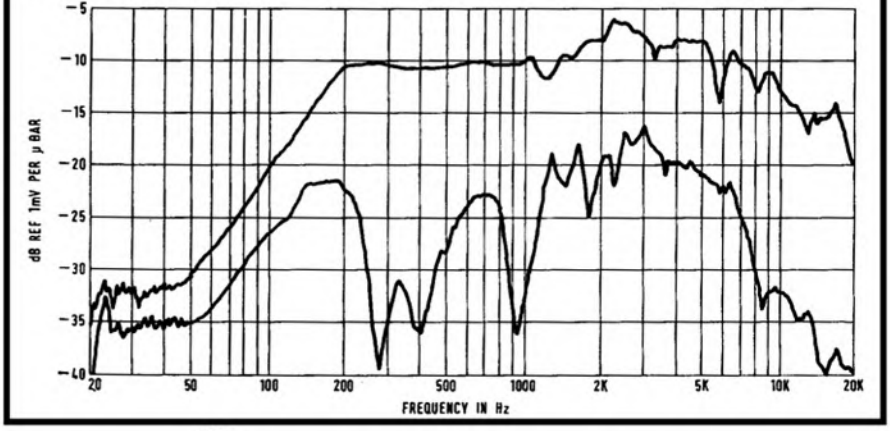


FIG. 2 PHILIPS EL6035 (500 OHMS)



6035

6037

sensitivity figure of 1.9 mV per μB for the high impedance 25 K.

The *6015* microphone was loaned to the teenaged leader of a local school pop group, who was most enthusiastic about its performance. Unfortunately, during one of the more exuberant sessions, the microphone was subjected to shock treatment of several hundred G's. Nevertheless, although the sensitivity was somewhat impaired, it survived as a functional unit.

Priced at £15 10s for the *6015*, and £20 for the *6025*, these microphones represent very good vale for money. They are robust; they meet their specification; and the performance is more than adequate for their intended purpose. In particular, the service sheet can be held as an example to other manufacturers on providing the requisite detailed information for the maintenance of this product.

EL6035 and EL6037

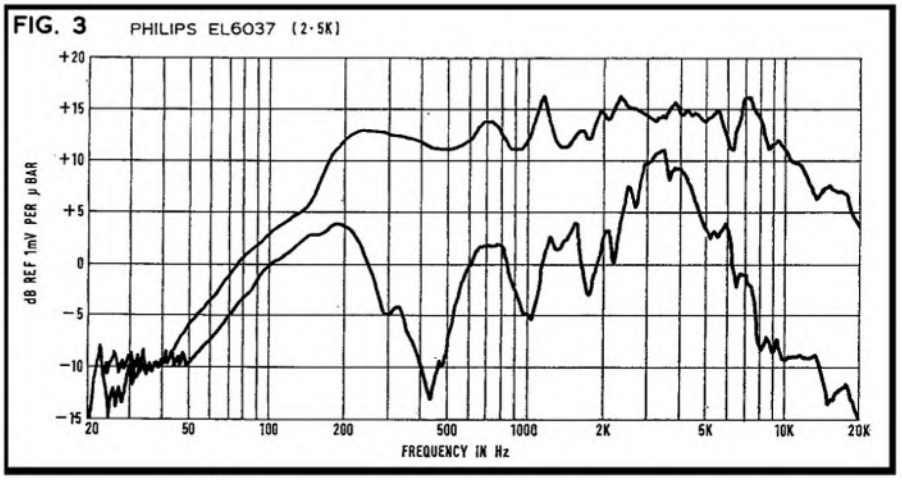
MANUFACTURER'S SPECIFICATION. Directional response: Cardioid. **Frequency response:** 60 Hz-15 kHz ±3 dB. **Front-to-rear ratio:** 20 dB. **Sensitivity:** 0.27 mV/μB at 500 ohms (—71 dB ref 1V/μB). Model *6037* also 1.9 mV/μB at 25 K (—54 dB ref 1V/μB). **Switch:** On/off interruptor (*6035*). **Dimensions:** 40 mm dia x 195 mm including DIN plug (*6035*); 40 mm dia x 170 mm (*6037*). Price : £26 (*6035*), £28 (*6037*).

These microphones, in the medium price range, are basically identical and apparently a development of the *EL6015* series. The mode of operation is similar but the acoustic parameters have been modified to give a more extended frequency response: this is, of course, reflected in the increased price.

The microphone heads are finished in satin brush stainless steel. The *6035* has a plastic handle and is fitted with a locking ring switch and a three-pole DIN plug at the base. The *6037* handle has a rosewood finish and has five metres of cable attached. A quick-release holder is supplied with each microphone. The holders have bushes to accommodate $\frac{3}{8}$ and $\frac{1}{2}$ inch 26 TPI Whitworth, and $\frac{5}{8}$ 27 UNF thread.

The output impedance of the *6035* is 500 ohms, and the *6037* has a transformer for either 500 ohms or 25 K. Rated sensitivities are 0.27 mV per μB low impedance, and 1.9 mV per μB at high impedance. **Figs 2** and **3**

FIG. 3 PHILIPS EL6037 (2·5K)



show the free field sensitivities of both these microphones. They are substantially similar, the differences in the back response of the two microphones being due to normal manufacturing tolerances. The response is flat from 200 Hz to 10 kHz, and the usable response is from 100 Hz to 20 kHz.

These microphones are intended for use with soloists (instrumental or vocal) in combo's and dance bands. Performance-wise, they easily meet their specification. They appear to be robust and the finish, in the Philips tradition, is excellent. They are supplied in a plastic fitted case giving maximum protection to the instrument in transit during their service life.

Priced at £26 and £28 respectively, these microphones are good value for money and can be recommended to small groups who are prepared to pay a little more than minimal.

EL6042

MANUFACTURER'S SPECIFICATION: Directional response: Omni. **Frequency response:** 60 Hz-16 kHz ±1.5 dB. **Sensitivity** at 1 kHz: 0.21 mV/μB at 200 ohms (—79 dB ref 1V/μB). **Dimensions:** 18 mm dia x 134 mm. **Price:** £32.

This beautiful, slim, pencil-like microphone is amongst the best moving coil units I have used for a long period of time. It is less than 2 cm in diameter by approximately 13 cm long. The finish is in matt chrome and the base is terminated in a matching DIN three-pin plug. It is supplied with a quick release swivelling adaptor and is contained in a robust transit case. Because of the small size (the diaphragm is barely 15 mm in diameter) the transducer requires a minimum of acoustic correction to give a uniform response, whilst diffraction effects below 10 kHz are negligible.

The performance is exemplary. Frequency response, shown in **fig. 4,** is flat and smooth from below 100 Hz to 20 kHz. The LF response is not as extensive as the best capacitor microphones, but is better than the majority of moving coil microphones, irrespective of price. The impedance is 200 ohms and the sensitivity of 0.12 mV per μB gives a good signal-to-noise ratio. The 'deafness' of the microphone (sensitivity limited by self-generated noise) is approximately 20 phons, giving a useful dynamic range in excess of 80 dB. At a sound pressure level of +125 dB reference zero level, the distortion was less than 2% at 1 kHz and, after being subjected to a sound level of 140 dB,

the microphone sensitivity and overall frequency response were unchanged. It should be noted that the sound level of 120 dB is approximately 15 dB higher than the crescendo of a symphony orchestra at a distance of six metres, and 20 dB louder than a pop group vocalist at his best !

This is an excellent microphone and, at £32 represents exceptional value for money.

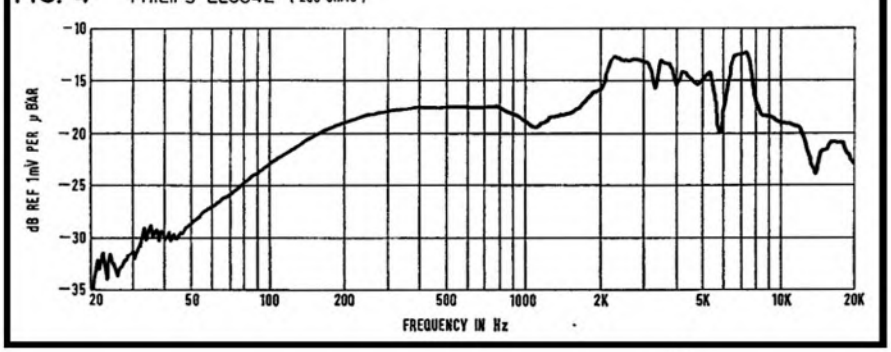
SUMMARY

These microphones are representative of the new Philips range, and have been in use under laboratory and service conditions for approximately six months. They have been subjected to more abuse than they would normally incur during their economic life and have all come through with flying colours. The design and workmanship are of the standard one would expect from this major engineering complex. The microphones are functionally designed and this is reflected in the decor which suggests a strictly engineering approach. Indeed, the severity of the lines of the *6042* gives it a beauty of its own.

All the microphones easily meet their claimed specifications and, between them, cover the majority of public address, dance band, and vocalist requirements. In the price range of £15 10s to £32, they offer very good value indeed.

Stanley Kelly

FIG. 4 PHILIPS EL6042 (200 OHMS)



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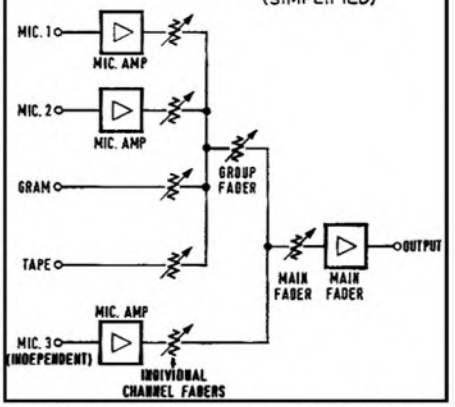
THE SOUND STUDIO CONTINUED

player and a tape reproducer can be mixed in the normal manner, and the combination of these sources is controlled by a group fader. The third microphone channel is not affected by the group fader as it is directly connected to the main fader which controls all sources together.

An arrangement such as this would be used in the production of a play with narrative. The narrator would use microphone three and, at the end of one part of the play, the group control would be used to fade out all the other sources simultaneously. This method allows individual faders to be left at particular settings, and removes the problem of having to fade three channels simultaneously with two hands. The main fader is often used only to adjust the output level of the mixer during the 'lining-up' procedure before a recording or broadcast, but it can be used to fade all inputs together when necessary.

In some large studios more than one group fader may be used, switches being employed to allow each source to be controlled by any group fader.

FIG. 15 PRACTICAL STUDIO MIXER (SIMPLIFIED)



This facility is commonly adopted in broadcast studios and enables the equipment to be used for many different types of production.

Next month's article will cover monitoring facilities, both aural and visual.

TAPE RECORDER SERVICE CONTINUED

only when testing to laboratory standards that the discrepancies show up.

Cleaning completely requires removal of the head plate but for general maintenance there is no need to go to this length. We can raise the cup (gently, with a lift action at two sides), swab out the inside from below with a pipe-cleaner moistened in spirit and bent to shape, and relubricate with a thin smear of medium grease. Not too much here as capillary action can cause the lubricant to creep up the spindle; and do not use machine oil, for the same reason.

For more detailed dismantling, the whole capstan assembly, motor, flywheel, flexible coupling *et al*, can be dropped downwards simply by removing four screws. Then the motor can be removed by taking off its holding nuts. It is very easy, and worth doing when a major overhaul is carried out, as the very fine running performance of this machine deserves a little extra trouble being taken. The bottom bearing is grease-packed and the spindle runs on a ball (don't lose it when cleaning out the grease!). A fairly stiff grease is used and a decent warm-up is advisable.

TRANSISTOR LIMITER/COMPRESSOR CONTINUED

(which should be in very close proximity to the face of the cell). A large signal will therefore cause the bulb to glow brightly, decreasing the resistance of the *ORP12* to a few ohms and causing a drop in output again, as the normal output impedance is 2 K. It can be seen that, providing the preset voltage on the bulb is correct, the gain reduction should be inaudible.

When setting up, first turn VR2 to maximum resistance, then adjust VR3 for the slightest hint of illumination in a dark room. Then set VR2, until the glow is slightly more visible. This should be the correct operating point, and need not be adjusted again. VR4 will control to a small extent the signal input voltage and reduce any 'thump' that may be experienced. The threshold control is then adjusted for the desired reduction of dynamic range, and I have found it quite helpful to insert a 1 mA meter in series with a 50 K preset potentiometer in the collector of Q3 down to earth. The preset pot should be adjusted for full scale deflection under no signal conditions, and the meter will swing backwards as limiting compressing takes place. Due to slight drifting, the preset should be mounted in an accessible position.

The limiter itself, as can be seen from **fig. 2**, will not introduce any noise into the programme material as the signal only flows through the passive network containing C1, R6 and VR4.

A minimum level of about −10 dB is required to operate the limiter efficiently. The maximum level is +8 dB (0 dB being 1 mW across 600 ohms).

The input impedance is 600 ohms but can be modified via an emitter follower for higher impedance. The current consumption is 90 mA at full illumination of L1 so a small mains power supply would be ideal. Two *PP9* batteries in parallel (and two diodes to prevent their internal resistance reflecting on each other) would suffice.

The actual construction is left to the reader as the limiter compressor may be used for a number of applications. The author's limiter/compressor was constructed on a 50 x 50 mm piece of Veroboard and housed in a small Eddystone box. An in/out switch is desirable to switch the HT positive and compare the effect of the limiter/compressor.

The unit is now being used by West of England Sound, Torquay, and Progressive Sound Service, Leyton. Tony Walden of the former and Bob Bloomfield of Progressive both report good results.

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 **AUGUST 1969** issue must reach these offices by **20th JUNE** addressed to: The Advertisement Manager, Tape Recorder, Link House, Dingwall Avenue, Croydon CR9 2TA.

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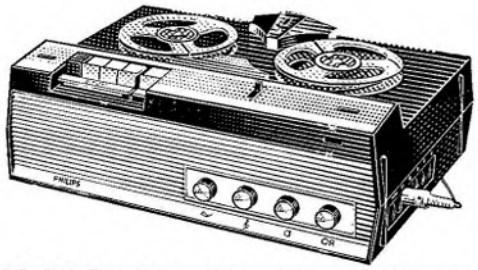

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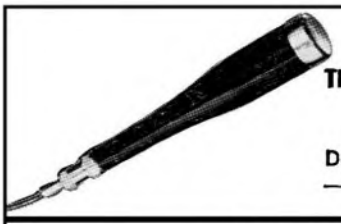

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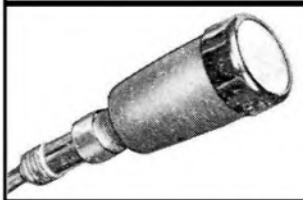

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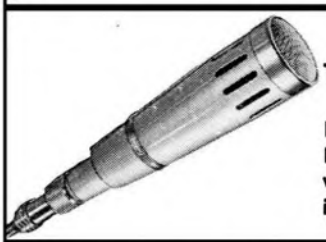

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