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tape recorder

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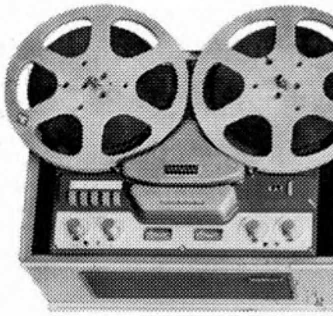
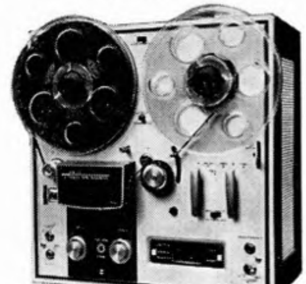
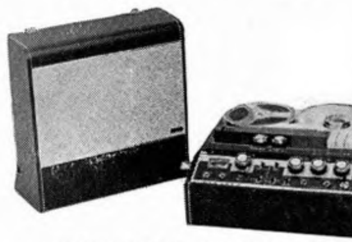


REVOX 736



AKAI 1710



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WYNDSOR VANGUARD The newest model to the famous WYNDSOR stable. 3 heads. Before and after record/replay facilities. 3 speeds. 4 tracks. 7" tapes. Freq. 40-15,000. 6 watts output. Detachable 8" Hi-Fi speaker unit giving superb reproduction. A wonderful value for money recorder at **59 gns.**

B & O 2000 The most comprehensive fully transistorised stereo recorder available. Its facilities are too numerous to list. Available in 2 or 4 track and suitcase or table model versions. A recorder for those wishing to purchase the finest available. **119 gns.**

BRENELL Mk 5M The most comprehensive and finest mono recorder made by this famous British company. 3 heads, 4 speeds. Up to 10¼" tapes. Bass, treble controls. Mixing. Before and after record comparison facilities. V.U. Meter. 6 watts output. Separate record/replay amplifiers. **93 gns.**

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AKAI M7 Stereo	As new 82 gns.
PHILIPS 3549	Inc. accs. As new 39 gns.
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SONY TC260 A brilliant new 4 track stereo model. Separate record and playback volume controls. Bass and treble controls. V.U. meters. Automatic tape stops. 7" Tape. 2 speeds. Superb Hi-Fi quality. Complete incl. 2 dynamic microphones, fantastic value at **97 gns.**

TANDBERG 6 One of the most technically perfect record/replay tape units available. Every possible facility provided. Sound on Sound. Freq. 30-20,000. 3 Speeds. 2 or 4 track models. 7" Tapes. Auto tape stops. A perfect unit for use with the best hi-fi equipment. **110 gns.**

GRUNDIG TK6 A handsome high quality battery/mains portable by the world famous company. 2 tracks. 2 speeds. Freq. 50-13,000. 4¼" tapes. Meter for recording and battery level. Includes superb dynamic microphone. A portable recorder with big machine performance and quality. **69 gns.**

REVOX 736 The stereo tape recorder that sells by reputation alone. One of Switzerland's finest products. Full professional record/replay facilities. 4 Preamplifiers. 3 heads. 2 V.U. Meters. Track to track facilities. Freq. 30-18,000. For the perfectionist. **127 gns.**

AKAI M8 Japan's finest. Complete stereo. 4 speeds. Unique Akai Cross Field recording. Freq. 30-25,000. 2 V.U. Meters. 10 watts output. Auto tape stops. Bass, treble controls. 4 tracks. 7" tapes, etc. Fantastic Hi-Fi performance. **136 gns.**

UHER 4000 L A superb 4 track all transistorised battery/mains portable. Unbelievable performance. Freq. 40-20,000. 1 watt output, 4 speeds. 5" tapes. Ultra lightweight only 6lb. Capable of recording to the highest standards and used extensively by profesionals. **103 gns.**

AKAI X4 Completely fully transistorised battery/mains portable. Superb performance. 3 speeds. 5" tapes. V.U. meters. 4 tracks. Operates from mains or rechargeable batteries. Has own power amplifiers. Freq. 40-20,000. Excluding microphones. **99 gns.**

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VORTEXION WVB One of the most tried and tested models available. This latest model has the new Wright & Weaire 3 speed deck. 3 motors. 3 heads. Separate record/replay amplifiers. Before and after record. Monitoring facilities. 4 watts. Variable bias. 8¼" tapes, etc. **£115.10.0.**

SONY TC200 This is the lowest priced hi-fidelity complete stereo recorder available. 2 separate speakers. 2 speeds. 4 tracks. Meters. 2 microphones inc. 7" tapes. Track to track facilities. We have yet to see a recorder offering so much at such a price. **72 gns.**

TELEFUNKEN 300 A truly remarkable battery/mains portable tape recorder. Available in both 2 or 4 track models. Extremely portable and a delight to use. Easy to operate push buttons and controls. High quality dynamic microphone incl. Freq. 40-14,000. Wonderful quality. **49 gns.**

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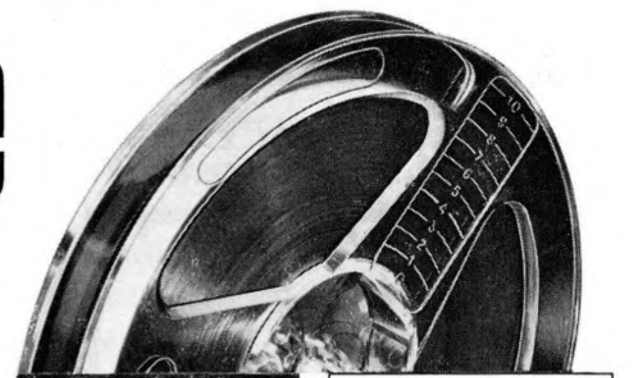

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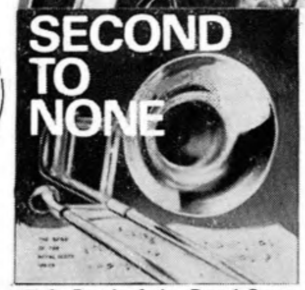


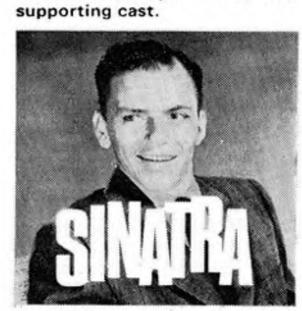
70 Band of the Royal Scots Greys plays regimental music. 12 items include Colonel Bogey; Semper Fidelis; El Capitan.

22 The Moonlight, Pathetique and Appassionata . . . world's three greatest sonatas played by famous TV pianist.

285 Ideal party disc! Swinging dance arrangements of Z Cars; Maigret; Coronation St.; Kildare; other famous themes.

151 As Long As He Needs Me, Consider Yourself, all the famous tunes with Ian Carmichael, Joyce Blair, full supporting cast.

302 Vintage collection of ballads by the Big Daddy of folk-singers. Tracks inc. Early One Morning, The Irish Rover.



***81** The fabulous Sinatra swings and sings 12 top songs. Don't Worry About Me; Melody of Love; Look over your Shoulder; White Christmas; etc.

*202 One of Nat's greatest discs! Walkin'; Because You're Mine; You'll Never Grow Old and nine others.

31 John Hollingsworth conducts the Sinfonia of London in a thrilling performance of this famous ballet music.

196 Steam team! George Shearing and Dakota Staton team up in Cuban Carnival; Yesterdays; Blues in My Heart; 8 more.

*219 Ornadel/Westminster Festival Orch. in all the hit numbers: Street Where You Live; Little Bit; Ascot Gavotte.

14 Sinfonia of London under Muir Mathieson give scintillating performances of Bizet's two delightful suites.

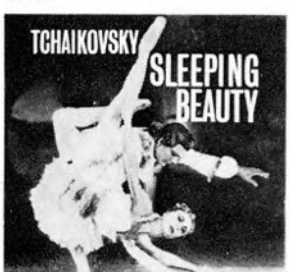
239 Virtuoso performance by Yuri Boukoff with L'Orchestre des Concerts de Colonne under maestro Pierre Dervaux.

61 Fidelio Overture; Brahms St. Anthony Vars; Mendelssohn Hebrides Overt; Siegfried Idyll—exciting interpretations.

30 Memorable playing by Endre Wolf with Sinfonia of London under Anthony Collins.

11 Thrill to Surrey With The Fringe, Oh What a Beautiful Morning and all the hits of this classic show.

* Indicates Mono LP's—reprocessed for stereo reproduction.



44 Covent Garden Ballet, conductor the late John Hollingsworth, in a sparklingly fresh rendering of this lovely ballet.

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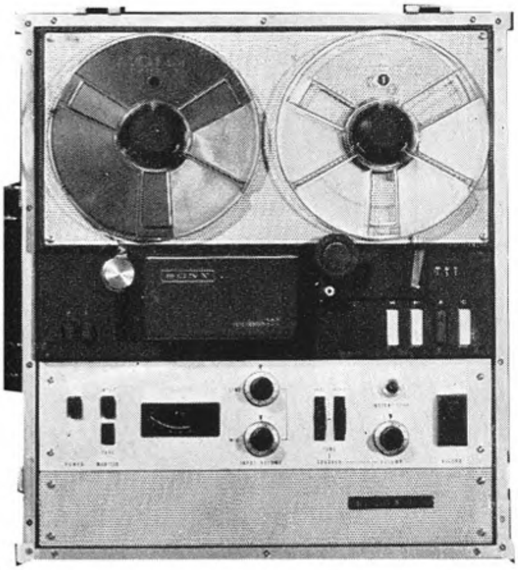

MODEL TC 777 4J (left) and M (right). FEATURES ■ Fully transistorised ■ 3 head, 3 motor system ■ Separate record and playback amplifiers ■ Individual Mic/Line level controls for mixed recordings ■ Sound-on-sound and sound-with-sound recording ■ Electro-magnetic controls, duplicated in remote control unit ■ Flywheel balanced tape guide ■ Integral Record/replay head ■ Price TC 777M – 195 gns. TC 777 4J – 297 gns.

SPECIFICATIONS:

Power requirements:	90 watts. 100, 110, 117, 220 or 240 volts, 50/60 cycles.
Tape speeds:	Instantaneous selection $7\frac{1}{2}$ ips or $3\frac{3}{4}$ ips.
Recording track:	$\frac{1}{2}$ track.
Operating angle position:	Horizontal or Vertical.
Frequency response:	30–17,000 cps at $7\frac{1}{2}$ ips. 30–10,000 cps at $3\frac{3}{4}$ ips.
Signal-to-noise ratio	Better than 50 dB.
Harmonic distortion	Less than 1% when recorded at normal max. recording level. (12 dB below saturation of tape).
Recording level indicator:	VU meter.
Monitor:	From input or off the tape while recording.
Erasing effect:	Better than 65 dB.
Flutter and wow:	Less than 0.15% RMS at $7\frac{1}{2}$ ips.
Fast forward and rewind time:	Within 105 seconds using a 1,800 ft. tape.
Bias frequency:	92 kc $\pm$ 10%.
Inputs:	Microphone x 2 low impedance 600 ohms unbalanced. High impedance 100 K ohms unbalanced.
Outputs:	External speaker monitor 3 watts RMS into 8 ohms external amplifier load impedance not less than 10 K ohms earpiece monitoring.
Motors:	Capstan motor—4 pole Hysteresis synchronous. Reel spindle motor—2, 4 pole induction motor.
Dimensions:	$16\frac{1}{4}$" (W) x $10\frac{1}{4}$" (H) x $18\frac{3}{4}$" (D).
Weight:	Approx. 42 lb. Accessories approx. 10 lb.

The following specifications apply to the 777 4J only:

Power requirements:	85 watts. 100/240 VAC. 50/60 cycles.
Recording track:	$\frac{1}{4}$ track record playback plus $\frac{1}{2}$ track playback only.
Frequency response:	40–15 Kcs$\pm$2 dB at $7\frac{1}{2}$ ips.
Inputs:	Microphone –65 dB (0.44 mv). 600 ohms unbalanced. Line –12 dB (0.2v). 100K ohms unbalanced. Rec/PB connector (DIN).
Outputs:	Line output (switched) 0 dB (0.775v). 600 ohms unbalanced. 0 dB (0.775v). 100K ohms unbalanced. Binaural monitor –3 dB (0.55v). 100 ohms unbalanced.
Fast forward and rewind:	Within 90 seconds (1,800 ft. of tape).
Dimensions:	17.5" (W) x 8.7" (H) x 17.9" (D).
Weight:	Recorder unit approx. 42 lb. Accessories approx. 11 lb.

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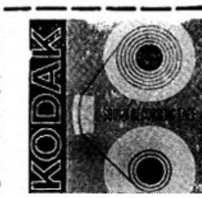
But you be the judge. Try Kodak P.300 Triple Play Tape for your next recording and hear for yourself.



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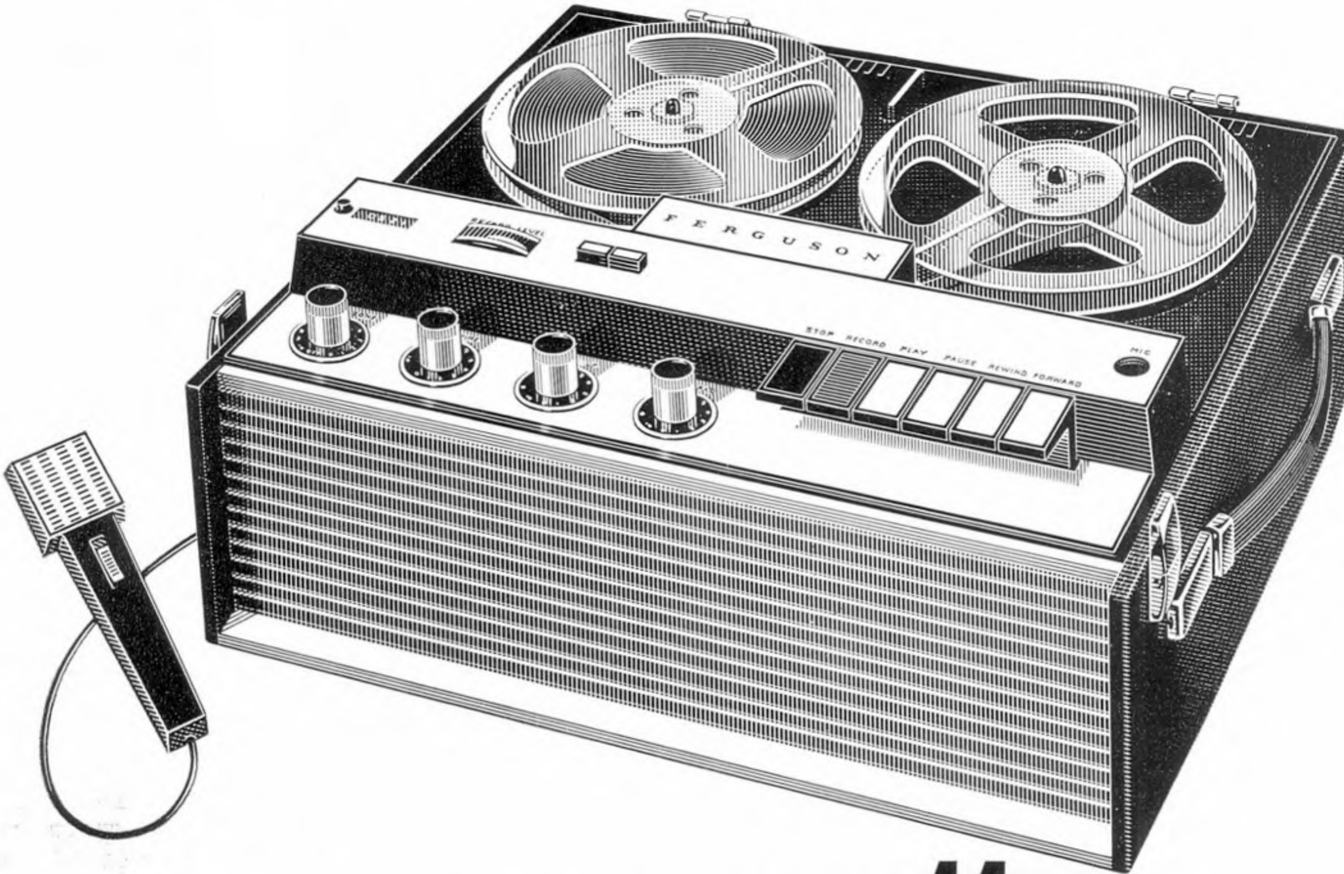

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Exceptional value for the enthusiast – that's Ferguson's new 3214 tape recorder! It has every feature needed to make top quality recordings – just look at this list!
• 7″ spools giving 17 hours' playing time on double-play tape (8½ hours on tape supplied). Plays any tape any speed – including stereo with accessory amplifier. • Four tracks, three speeds – 7½, 3¾ and 1⅞ i.p.s. • Remote pause control on microphone. • World-proven Thorn tape deck. • Automatic end-of-tape stopping. • Fully interlocked piano-key controls to avoid accidental erasure. • Double-track replay for special effects. • Two-way tape inching – controlled movement of tape for precise positioning. • Tape editing index – exact editing made easy. • Wood cabinet for purer sound reproduction. • Monitoring during recording. The **3214** is beautifully finished in handsome black leathercloth with silver-finish "instrument look" controls and fittings, and features useful storage space for mike, connecting lead and mains lead. Output is 3 Watts feeding into the highly sensitive 7″ x 4″ elliptical speaker. Overall frequency range is 40 c/s to 7 Kc/s at 1⅞ i.p.s., 40 c/s to 14 Kc/s at 3¾ i.p.s. and 40 c/s to 18 Kc/s at 7½ i.p.s. The 3214 has an electronic record lever indicator, graduated volume and tone controls, comprehensive input and output sockets. Supplied complete with superior stick-type microphone, 900 ft. of free Long Play tape, spools and connecting leads.

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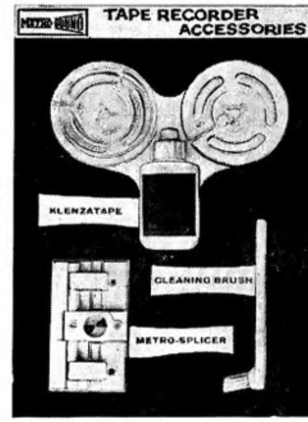
- **Tape Recorder** Mechanical Maintenance Kit 36/- Available from dealers everywhere.



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Loewe Opta 416 ... ... 51 gns.
Loewe Opta 408 ... ... 39 gns.
Loewe Opta Cassette ... 39 gns.
Philips EL3301 ... ... 27 gns.
Philips 3586 ... ... 27 gns.
Stella 472 ... ... 27 gns.
Sanyo Auto ... ... 22 gns.
Sanyo Batt/Mains ... ... 36 gns.
Telefunken 300 ... ... 49 gns.
Telefunken 301 ... ... 54 gns.
Uher 4000L ... ... 103 gns.
•Van der Molen VR4 ... 59 gns.
•Van der Molen VR7 ... 39 gns.

•Microphone extra

MAINS POWER PACKS

Philips, Stella or Cossor ... £5.12.0
Telefunken 300 with cell ... £15.17.0
Uher 4000, with cell ... 16 gns.

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Grampian Reflector ... £6.10.0
Grampian Ribbon £11.10.0
Grampian DP/4 Dynamic... £8.5.0
Reslo Ribbon £12.2.0
AKG D.119 ... ... £20.0.0
AKG D.14S £10.0.0
AKG D.19C £17.10.0
Eagle Mixer ... ... 3 gns.
Grundig Mixer Stereo ... 18 gns.
AKG K.50 Headphones ... £7.10.0
Philips Pre-amp £6.10.0

Also microphones by ACOS, FILM INDUSTRIES TELEFUNKEN, BEYER, etc.

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Standard, Long, Double, Triple Play in all sizes by all leading makers.

● DEFLUXERS BY WEARITE, WALGAIN

● *Pre-recorded Tapes by Columbia, H.M.V. and all E.M.I. Labels, Crown, Phonoband Eagle, etc.*

Bib, Bond and E.M.I. splicers. Matching transformers. Plugs, sockets, etc.
Prices subject to alteration as announced by manufacturers.

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HI-FI DEPT.

● **STEREO AND MONO AMPLIFIERS**
Quad Pye Rogers Cadet Mk. III Leak Armstrong Tripletone Scott B & O Truvox

● **TUNERS**
Quad Rogers Pye Leak Armstrong B & O Tripletone

● **LOUDSPEAKERS**
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● **MOTORS, PICKUPS**
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Connoisseur Ronette
DECCA incl. Sonotone
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Deram, etc. SME Mk. II
Philips ADC BSR
Ortofon Pickering
Acos Transcriptor

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

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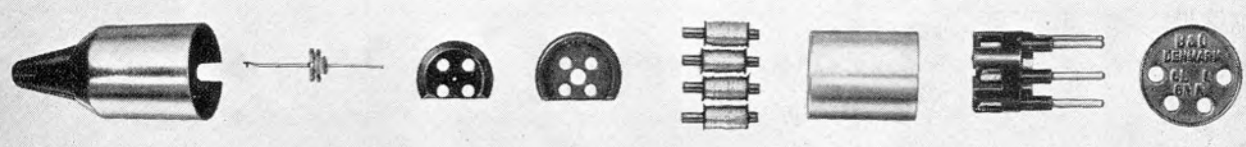
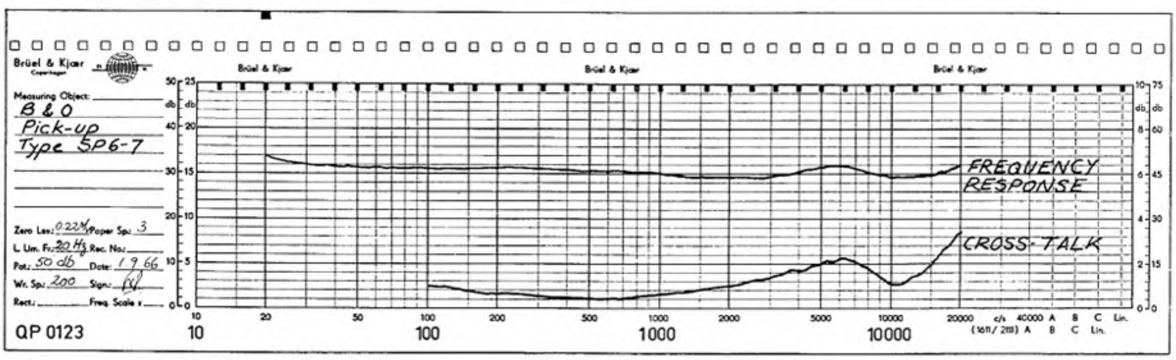
B & O-for those who consider design and quality before price



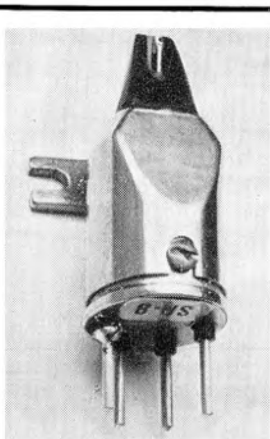
A B C D E F G H

These components make the B & O Cartridge the accepted leader in its field.

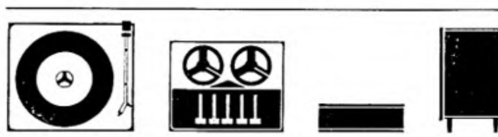
A Main housing
B Stylus assembly with cross armature
C Armature mounting
D Front coil bearer
E Four coils
F Anti hum shield
G Rear coil mounting and socket assembly
H Rear cover



This graph proves it.



The B & O SP6 magnetic cartridge has been designed to provide as nearly as possible the perfect link between the gramophone record and the main amplifier. The diamond stylus is set at the B & O pioneered and now accepted standard of 15° from the vertical. Type SP8 is available with elliptical stylus. It employs a symmetrical micro-cross armature for excellent stereo separation with minimum cross-talk. Push-pull design reduces harmonic distortion to a minimum. Result: A superb instrument capable of the highest fidelity.
Frequency response: 20 c/s – 20 kc/s±2·5 dB. Output: 7 mv per channel at 5 cm/sec. Channel separation: better than 28 dB at 500 c/s. Stylus pressure: 1-3 gms. Compliance: 12 – 15 x 10 – 6 cm/dyne. Moving mass: approx. 1.5 mgms. Load: 47K ohms. Mounting: standard ½″ centres (SP6 and 8) or Plug in fitting for B & O arm (SP7 and 9). Weight: approx. 10 gms. Stylus diameter: ·0007″ Elliptical: ·0007″ x ·0002″.
Price SP6 and 7 £8.8.0d. SP8 and 9 £14.14.0d.
A graph showing the response characteristics is packed with every SP8 cartridge.



B & O also make the Beogram transcription deck, the Beocord range of Tape Recorders, Beomaster integrated Tuner amplifiers and high quality Beovox pressure chamber loudspeakers.
Write or telephone today for comprehensive colour catalogue to:—

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PHILIPS CASSETTE RECORDERS
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Famous recordings to play anywhere!

Get a Philips Cassette Recorder now and you have both a recorder *and* music player . . . to use at home, on holiday, in your car, wherever you go – *even as you walk along!* Snap in a normal Compact Cassette to record any sound. Snap in a Musicassette to play your favourite music. It's a great new entertainment idea! All kinds of music are available on Musicassettes – and nobody can wipe the recordings off by mistake!

See your Philips Dealer. Find out for yourself just how light and easy-to-use-anywhere Philips Cassette Recorder really is, how wonderfully it records your favourite sounds . . . how excitingly it now plays your favourite music. Be one of the first to get in on this big new idea.

Model EL 3301T 27 gns

Complete with free Musicassette, Compact Cassette library rack, remote stop/start control, microphone with stand, direct recording/playback lead and handsome carrying case. Musicassettes 40/-. Compact Cassettes (for use when recording) C60 (60 mins) 19/6 & C90 (90 mins) 27/6.

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Jazz Vocals

Strings

Folk

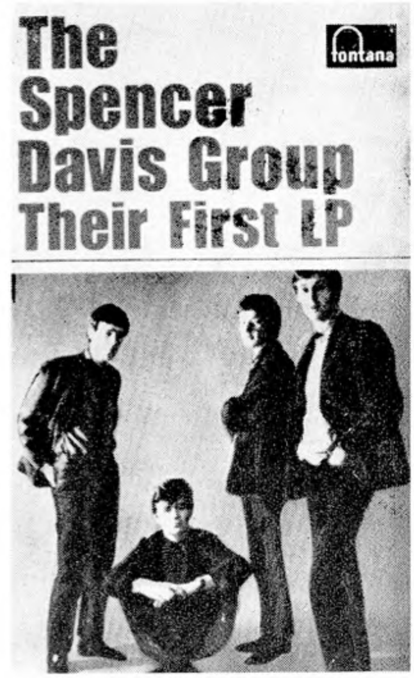
Marches

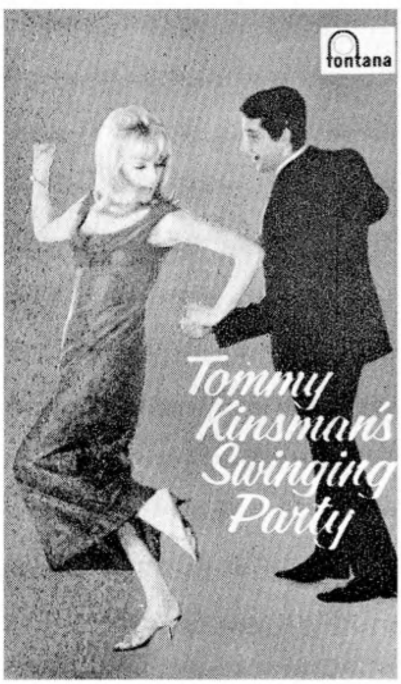
Shows

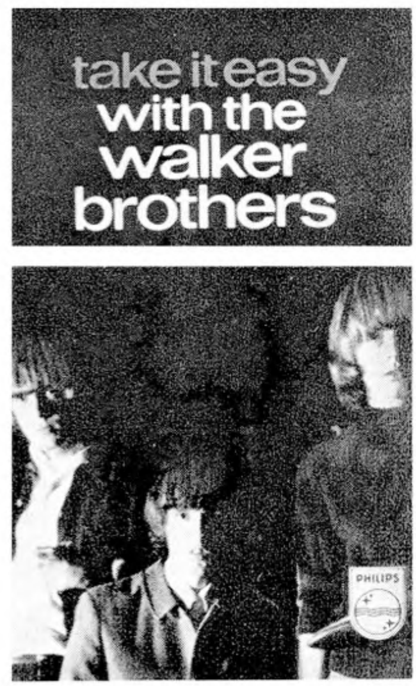
Dances

Concerts

Artistes







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POST TODAY! To: Philips Electrical Ltd., Century House, Shaftesbury Avenue, London W.C.2.

Please send me details of Philips Cassette Recorders and Musicassettes.

Name ....

Address ....

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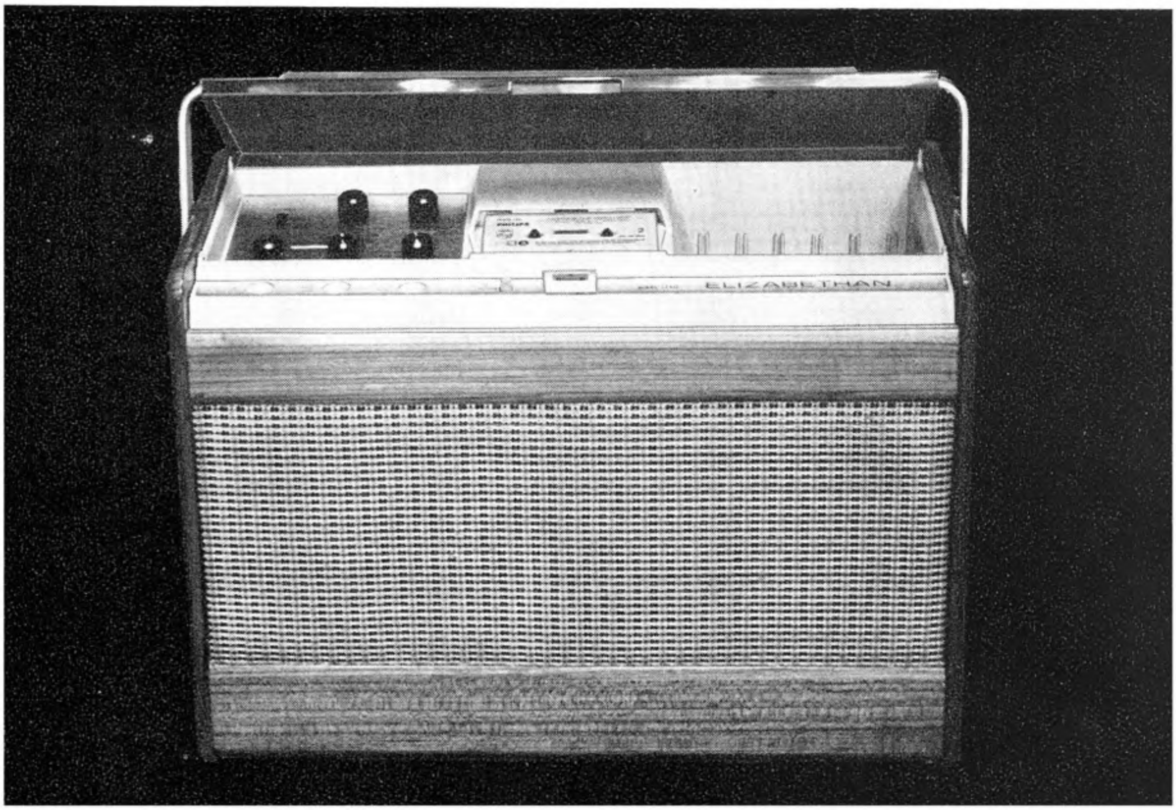


NEVER in the history of tape recorders a machine that looks and sounds like this!

Tall and handsome, cassette loaded and with a wonderful depth of sound (it has a *10 inch round Hi Fidelity speaker*). And *only* the fabulous new Elizabethan LZ 612 allows you to slip a 90-minute programme from the top pocket of your jacket—or your handbag—and be listening to it at over 5 watts output, literally in the next second. No wonder this unique machine was the sensation of the Radio Show. Just study its advanced features . . . but better still, go to your Elizabethan dealer . . . hear it . . . and judge for yourself!

- *Completely portable, mains/battery and car supply operated.*
- *Furniture style solid teak acoustic cabinet.*
- *Specially developed 10 inch round Hi Fidelity speaker.*
- *Separate bass and treble controls.*
- *Full mixing facilities via independently controlled inputs.*
- *Straight through amplifier monitoring providing 'listen while you record'.*
- *Separate mic, radio and gram inputs.*
- *Record/battery level indicator meter.*
- *90 minutes per cassette playing time.*
- *5½ watts output* ■ *Supplied complete with microphone, tape cassette and leads.* **LZ 612 45gns.**

the Sound alone tells you it's

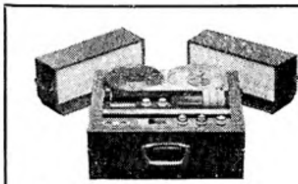
elizabethan

SEE AND HEAR THESE OTHER ELIZABETHAN MODELS, TOO!

LZ 9102T 27 gns
Compact portable battery operated cassette loaded tape recorder weighing only 3 lb.

LZ 32 (twin track) 32 gns
LZ 34 (four track) 34 gns
Brilliant 3-speed mains operated 2 and 4 track recorders.

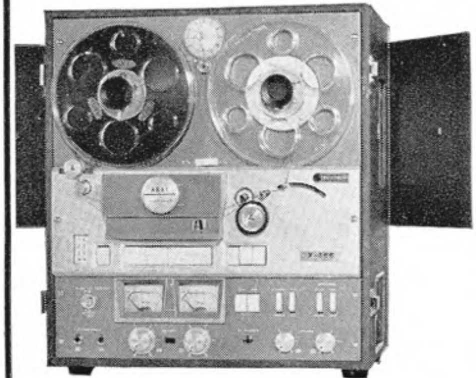
LZ 102 49 gns
Fully transistorised 4 track 3-speed mains operated recorder with outstanding performance.



LZ 711 75 gns
Complete portable mains operated stereophonic tape recording system for the creation of professional quality tapes.

Hear & handle

AKAI at the R·E·W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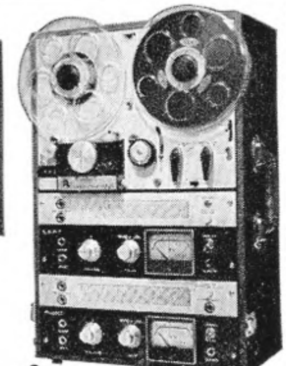
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2

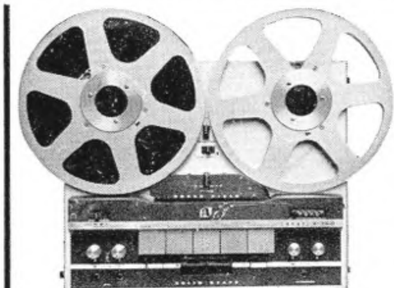

4

special demonstration centre

R.E.W. are proud to offer the fabulous Akai range of tape recorders as examples of first class contemporary audio engineering. Specially comprehensive demonstration facilities of these superb machines are now a star feature of the R.E.W. Service. Skilled demonstrators are available with all the facts and figures on AKAI at their finger-tips—ready to give you technical advice if you need this. You will find their enthusiasm infectious. We carry the full range, all on display and all readily available for comparative demonstration, if so desired, with any other make of tape recorder. Visit our show-room now*, see, hear and buy the model of your choice with all the advantages of dealing with Britain's Largest Hi-Fi and Tape Specialists. INTEREST FREE H.P. terms over 12 months, one-third deposit, generous part exchange allowances on your old equipment in sound condition and full after sales facilities.

If you are unable to call, use our fast and friendly mail order service with absolute confidence. **Post the coupon NOW** ! for full details of the AKAI range and choose in the comfort of your own home.

** We're easy to get to—only 20 minutes from Charing X to Tooting Broadway (Northern Line)*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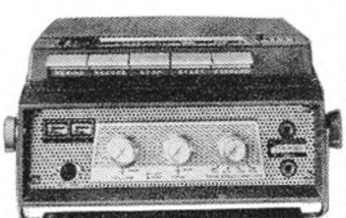
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R.E.W. (Earlsfield) Ltd., Dept. TR, 266-268 Upper Tooting Road, London S.W.17.

1 AKAI X355

For the advanced amateur or professional, featuring 3 motors, 3 speeds, 4 heads (including Cross Field bias) and 20w. per channel output. Built-in echo chamber effect. Full A.B. monitoring. Remote control facilities, etc., etc.

239 gns. *Deposit £83 19 0.*
12 monthly payments of £13 18 4.

2 AKAI 910

A mono recorder, available in four or two track form. Clean practical styling ; two speeds ; 3.2 watts out-put. Built in P.A. system and mixing facilities.

62 gns. *Deposit £22 2 0.*
12 monthly payments of £3 11 8.

3 AKAI M8

High quality 4-speed, 4-track stereo/mono recorder featuring Cross Field head. Vertical or horizontal operation. 4 hours' stereo recording on 1200ft. standard tape. 2 stereo fill-in speakers. Sound-on-sound. 6 watts per channel.

136 gns. *Deposit £52 16 0.*
12 monthly payments of £7 10 0.

4 AKAI 1710

A completely self-contained, 3 speed, 4 track stereo/mono recorder. Two 7in. x 5in. built-in speakers, 3 watts per channel. Attractive styling and AKAI precision finish. Takes up to 7in. reels.

79 gns. *Deposit £27 19 0.*
12 monthly payments of £4 11 8.

5 AKAI X300

A studio type 3-speed 4 track stereo/mono recorder of professional quality. Fully solid state, 20 watts per channel amplifier ; Cross Field heads; 10½in. reels ; keyboard controls, and many other features.

190 gns. *Deposit £66 10 0.*
12 monthly payments of £11 1 8.

6 AKAI X4

Fully transistorised stereo/mono, battery mains portable recorder. 4 track; 4 speeds; Cross Field heads ; superb low-speed frequency response. Mains-rechargeable battery. 5in. reels. Weighs only 11.21lb.

131 gns. *Deposit £47 11 0.*
12 monthly payments of £7 10 0.

99

Emitape 99–the long play tape formulated for 4-track recorders

Emitape 99 has been created by E.M.I., the original and largest British manufacturers of magnetic recording tape, in co-operation with I.C.I. who have produced a special 'Melinex' film base material for this new production.

Emitape 99 has greater strength—perfect tracking at all speeds—and outstanding hi-fi performance has been achieved by the most up-to-date coating techniques.

Three other high quality grades are in the Emitape range: **Standard Play 88** for use at professional tape speeds; **Double Play 100** for more recording time; **Triple Play 300** for maximum playing time on battery portables.

Emitape is supplied in a free transparent two-piece library case originally designed for computer tapes. It gives compact dust-free storage and easy indexing.

Emitape is used nine times out of ten by the B.B.C.

All the best dealers are Emitape stockists.

EMITAPE

THE MOST ADVANCED MAGNETIC RECORDING TAPE IN THE WORLD

EMI

AN E.M.I. GROUP PRODUCT

E.M.I. TAPE LIMITED,
HAYES, MIDDLESEX

tape recorder

DECEMBER 1966 VOLUME 8 NUMBER 11

INCORPORATING SOUND AND CINE

Editorial and Advertising Offices:
LINK HOUSE,
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COVER PICTURE

Owners of *Philips EL3536* stereo machines will know that the model in our picture has its PLAY and 3¾ i/s buttons depressed, while the operator—finger poised above the STOP key—is studying Part 3 of Mr. Matthews' Magnetic Sound Recording series. This picture, emphasising the domestic rather than technical side of tape recording, was used at this year's *Do It Yourself Exhibition* to show that our hobby can—for those who so choose—be a comfortable and leisurely pastime.

SUBSCRIPTION RATES

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

TAPE RECORDER WAS FIRST PUBLISHED in February 1959, thus putting our 'volume year' one month out of step with the calendar year. The annual indpx has therefore always run from February to January, for the past two years appearing as part of the magazine itself. This practice has caused a certain amount of calendaric cacophony, so we have decided to put up with the anomaly of one eleven-month year for the sake of common sense. Thus readers will find an index at the back of this issue despite an indication at the top of the page that this is only No. 11 of Vol. 8. We apologise to those who store their copies in binders, as there will now be an unused string in Vol. 8 ; but eventually it should be useful to know that each binder represents a normal calendar year.

As future years tick by there will undoubtedly be changes in the marketing of tape recorders and associated equipment. The Resale Prices Act, which became law in July 1964 and parts of which were promulgated by a Commencement Order in April 1965, undoubtedly has some bearing on such changes. For the present, manufacturers are able to enforce RPM (resale price maintenance) on tape recorders and many other audio items simply because of a blanket application for exemption from the requirements of the Act, made by BREMA (British Radio Equipment Manufacturers' Association). Eventually, this and other such applications must be defended before the Restrictive Practices Court, and as some firms have not taken advantage of the current temporary 'cover', and others appear not to be aware of it (one importer actually had his guarantee cards reprinted, removing the list price sale conditions), it seems very unlikely that tape recorder manufacturers will succeed in defending their right to impose resale conditions. We are not taking sides in this complex RPM controversy, merely looking at the present facts and probable future.

The particular part of the future of immediate concern to us here is *servicing*. RPM is already on a dwindling course, and as price competition becomes fiercer, as A vies with B and B with C in reducing the margin between what the customer pays and what the manufacturer or wholesaler charges, we are likely to see a drastic reduction in the number of dealers able to afford effective service after sale. Some readers may feel that service is not very effective even from retailers (some, at least) with a full 33⅓% mark-up ; but at present one can at least 'shop around' for the likelihood of good service, whereas the time may come when the only shopping around will be for the lowest price—perhaps in a Discount House and not a shop anyway.

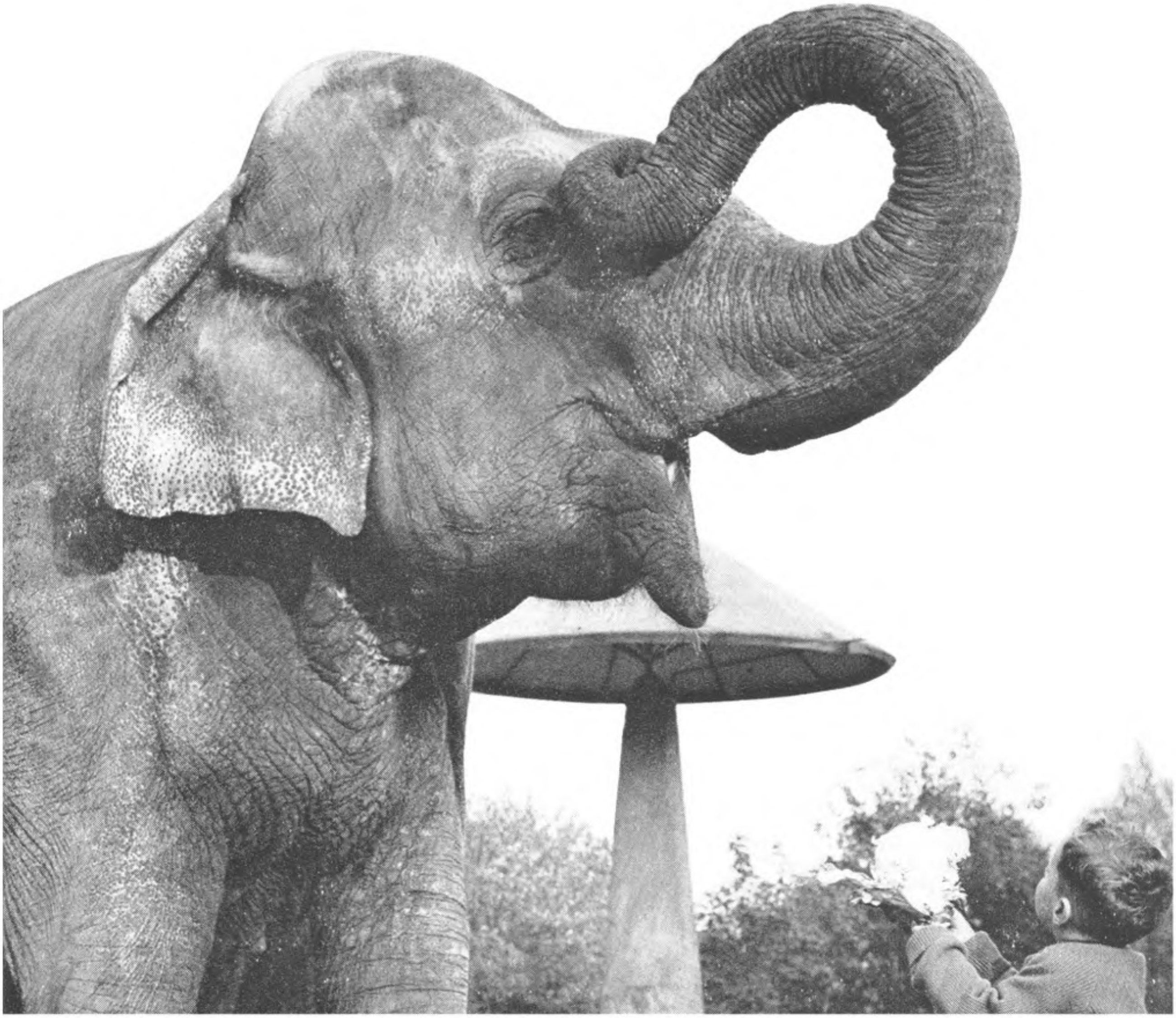
What, then, will happen to tape recorder service—apart from increasing the demand for Mr. Hellyer's articles and books? On page 459 we report on a visit to a manufacturer's service department ; expansion here is, perhaps, one pointer to the future, Also, following the North American pattern there will probably be an increase in the number of specialist firms who make a business of servicing and repair as such, charging economic prices in order to make a normal business profit. A consolation here, particularly in the case of manufacturers—who might be expected to know their own machines inside out—is that service as such will be the whole point and not just something done in spare moments when the shop is empty.

The best of present day retailers run separate service workshops and give their customers every satisfaction. We must all hope that such establishments will manage to survive by maintaining their reputations and keeping those customers who feel that a higher price is a good investment in personal attention. But the market is changing and new practices will emerge. Perhaps readers have interesting views on what is likely to happen or what is desirable ; if so, please write and let us (and other readers) know.

FEATURE ARTICLES

REGULAR ITEMS

EQUIPMENT REVIEWS



Bring home an elephant

in this handy container:

Get out on location with the fantastic Grundig TK6L portable tape recorder! Mains or battery operated, this machine is ready for action any time, any place. With the specially designed auto accessory, even a car or boat power supply can be used. The TK6L captures living sound—wherever you are. Superb Grundig engineering means a professional performance—with a dynamic range of 50dB, and a frequency response of 50-13,000 c/s at $3\frac{3}{4}$ i.p.s. The 6" x 4" speaker punches out a big life-size sound, with precise clarity.

Twin track, two speed ($1\frac{7}{8}$, $3\frac{3}{4}$ i.p.s.), the TK6L has sockets for radio, record player, second tape recorder and extension speaker. Other features? Six smooth piano-key controls, temporary stop, digital position indicator, and monitoring while recording. A newly developed Grundig DC motor, fully electrically controlled and stabilized, provides excellent reliability and freedom from noise. All this for 73 gns. The Grundig TK6L—portable high fidelity.

GRUNDIG

the Grundig TK6L

Please tell me more about the Grundig TK6L, and send your 32-page colour catalogue illustrating new Grundig recorders, radios and stereograms.

Name ....
(Block letters, please)

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Post to Grundig (GB) Limited, London, S.E.26 TR 2

WORLD OF TAPE

STUDIO AUTOMATION

TAKE one studio tape recorder, marry it to a domestic record changer, and the result is likely to be an automatic tape changer studio playback system. Just such a machine is now being produced by the Japanese *Nippon Columbia Company* and is designed to eliminate manual handling of tapes. The *DN 150P*, which costs £5,500 in Japan, takes up to 42 reels of 10in., 7in. and 5in. diameter, selection of stereo or mono reproduction being performed by a 1 Kc/s switching signal. Choice of 15 or $7\frac{1}{2}$ i/s playing speed is also decided in this manner.

EIGHT SHILLINGS EACH

THE potential market for background music equipment in Britain is around twenty million pounds, estimated the managing director of 3M at the recent launching of the *Cantata 700* music system. This optimistic forecast amounts to some 8s. for every man, woman and child in the country. One could build a good missile for less ! It is, however, only one fifth of the figure estimated for the USA.

Believed to be the first background music system ever offered for retail sale, the Cantata may be purchased outright, or hired in the conventional manner. Price of the player unit, of similar size to a domestic tape recorder, is £160. Pre-recorded tapes are similarly 'rather dear', a 24-hour cartridge (recorded on four tracks of $\frac{1}{4}$in. tape at $1\frac{7}{8}$ i/s) costing £40. The range of available tapes is considerable, however, a total of 37,000 items having been recorded over the past five years.

Encouraged by the success of the system in the USA, 3M are now marketing a smaller home model.

TAPE TRANSCRIPTION IN COURT

THE findings of a committee into the practicability of tape recorded transcription of court proceedings, under the chairmanship of Mr. Justice Baker, recently based a very favourable report on experiences with recorders supplied by *Peto-Scott* at London Sessions and the Strand. The system centred on *Philips* multi-channel equipment, capable of transcribing up to 31 channels simultaneously. Multi-track recording eliminates almost every possibility of tampering with, or editing, tapes. A seven-channel installation in the Strand recorded the activities of six separate courtrooms, the seventh channel being fed by a TIM timing signal. Cost of a typical system is in the region of £1,000.

CBS DEVELOP NEW VIDEO RECORDER

A COMPLETELY new approach to television recording is adopted in a system developed recently by *CBS Laboratories.* Exact details are not yet available but, from a tangle of speculation, there emerges a "non-photographic" film storage medium, totally housed in an evacuated cartridge. The technique is being likened to an experimental thermoplastic recorder, demonstrated by *General Electric* in 1960, which recorded television pictures on plastic tape $\frac{1}{10}$in. wide, transported at 5 i/s.

PRE-RECORDED VIDEO TAPES

GREATER clarity than broadcast programmes and freedom from outside interference ; these are the claimed advantages of commercially-recorded video tapes now available to American owners of *Sony* television equipment. Produced by *Audio Fidelity Records* the tapes have, at present, a very limited market. Of the 3,000 Sony video recorders currently being used, only 300 are being employed for home entertainment. The majority are in industrial use.

Audio Fidelity are awaiting the introduction by Sony of a video player—a rotating head machine designed to feed a conventional television receiver. The absence of recording facilities will render prices of under £200 feasible—plus £6 to £10 for converting the receiver. *General Electric* also plan to produce a player at some £280.

NEXT MONTH

TO BE PUBLISHED on Wednesday, 14th December, the January issue of *Tape Recorder* will feature a visit to the *Revox* and *Studer* factories in Germany and Switzerland. An epic amateur recording of a Gilbert and Sullivan performance will be described by a group of Cambridge students and enthusiasts, under the collective nom-de-plume of 'Jack Point'. Alec Tutchings will review the *Philips EL3556*.

SERVICE WITH 260 SMILES

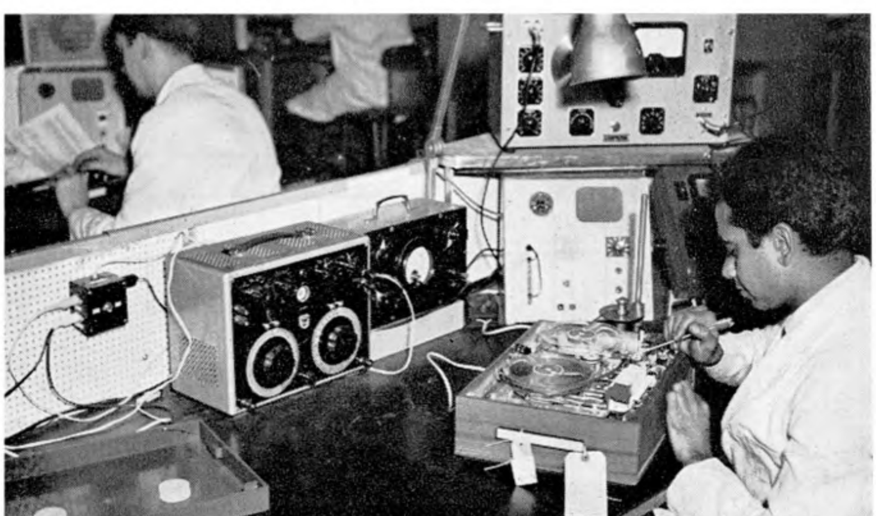
TWELVE men service an average of 260 tape recorders a week at the Croydon branch of *Amalgamated Electric Services Ltd.*, servicing subsidiary of the *Philips group*. On a recent visit we saw a large organisational machine engaged in handling some 7,000 orders per week (1,500 placed by phone) for about 50,000 spares, apart from dealing with a thousand actual equipment repairs each day (third of a million a year !). The repairs and spares service covers all types of appliance

"No, I haven't been here long. Just transferred from curtaining".

and equipment, from washing machines to hair driers and transistor radios to electronic organs.

We were naturally interested in the tape recorder side of the business, and it was pleasing to discover that men do not 'graduate' to this type of repair or to the more complicated television receivers until after some experience on radio servicing. The engineer in charge of the tape recorder repair shop told us that these days there is an approximate balance between mechanical and electrical faults, though at one time about 90% of all faults on recorders were mechanical.

About half of the total of 900 AES employees are based on the recently expanded Croydon premises, the remainder being shared between eight other branches. 'On site' repair work is done by a Field Service Force of 150 engineers. The bulk of AES's 20,000 customers are retailers, though members of the public may if they choose, deal directly with one of the nine branches. A 'Trade Shop' caters for retail callers at Croydon, though when one contemplates the total of 20,000 possible component part numbers and looks at the vast stores—complete with moving belt—it would seem a miracle that any sort of caller service could be operated. However, AES is apparently now the largest service organisation of its kind in the UK, and while recorders play only a small part in its activities, we were certainly impressed by its efficiency.



NO NEED TO THINK

PART ONE

WILLIAM HENRY INVESTIGATES METHODS OF AUTOMATIC GAIN CONTROL

FIG. 1

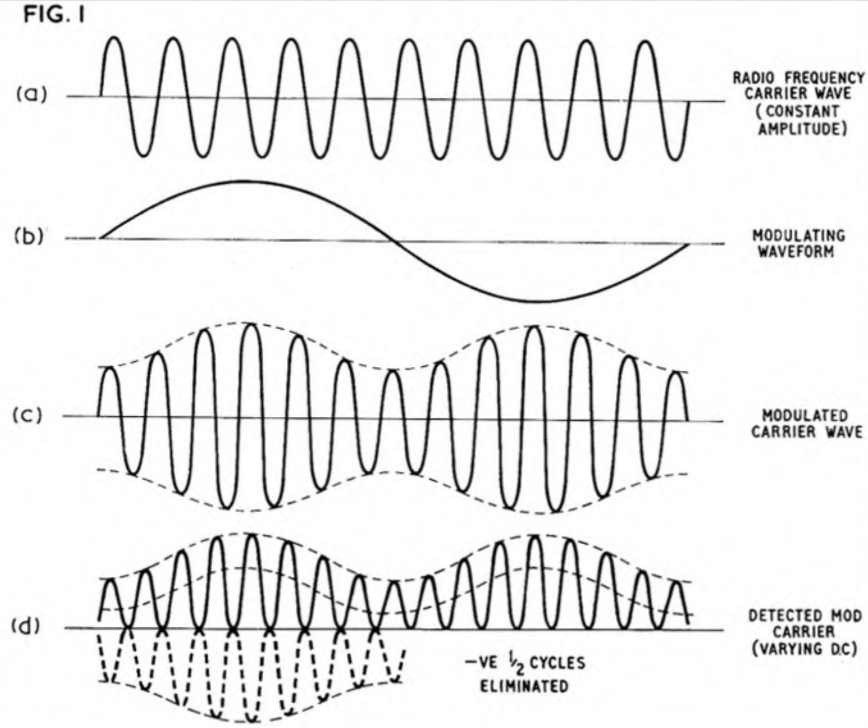
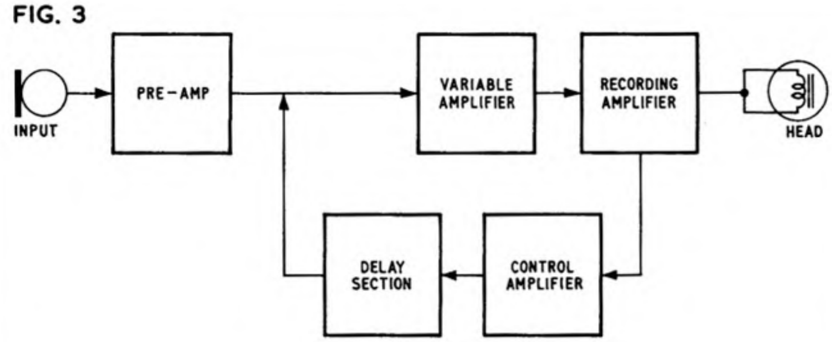


FIG. 3



IT is usually the simplest thing, in theory, that is hardest to do in practice. Take tape recording : what could be easier? An audio signal is made to drive a current through the coils of an electromagnet, changing the magnetic pattern on a prepared tape. All we need to do to reproduce this pattern as sound is to reverse the process—or so it would seem to the innocent who has not dug a little deeper beneath the surface of the subject. Who has not, for example, studied David Kirk's *ABC* series, or Gordon J. King's excellent articles *Towards Better Taping*.

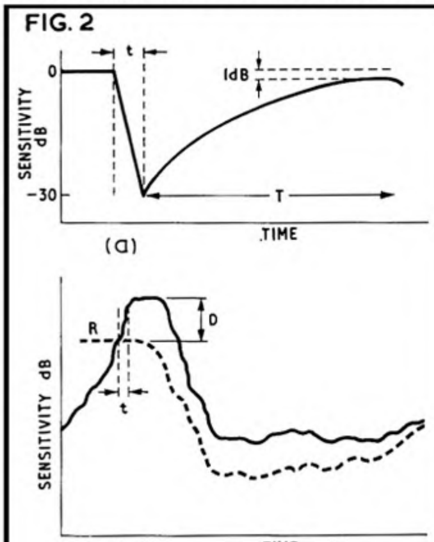
A similar train of misconceptions applies in the case of automatic recording level. The true-blue enthusiast will have none of it. He wants to be in full control of his machine, like the sporting motorist in charge of a throbbing gear lever. But the average chap will recognise certain advantages : one less factor to worry about while the drama group trundles around the stage ; both eyes concentrating on the milling crowd when the subject of an interview is besieged ; or an opportunity to pretend that the whirring sound beneath one's raincoat in the concert hall is no more than an extra-noisy wrist-watch. An obvious advantage—then why is it not a standard facility ?

The answer is twofold, First, the system is not quite so straightforward as at first appears, and second, the added facility costs a few shillings more in production, and ideally needs an over-riding switch to cut it out, affording full control when necessary. Automatic recording level control has been advertised in an unfortunate way as something of a gimmick. To understand it better, we need to consider what it is, what it does, and what extra circuitry is needed.

First : the title 'Automatic' must not be generally assumed to mean Automatic record level. A careful look at the sales brochure is necessary to ensure that this magic word does not mean that the machine is button-operated, or has a tape-end cut-out, or other such desirable attributes.

Next : the technique requires a little more finesse than the AGC or AVC employed in general radio and television practice. Which is one reason why the term 'AGC' is not entirely valid for tape. 'ALC' would be more to the

FIG. 2



point, as we shall see. But before that, it is helpful to take a brief look at the way a regulation of gain to prevent overload is obtained in current electronic circuits.

AVC in a radio set is a means of ensuring that the amplifier circuits prior to the demodulator are working in their most favourable state. Weak signals are given full amplification to obtain the best signal-to-noise ratio, and stronger signals made to apply a certain amount of feedback. This biases the amplifier stages prior to demodulation, so that a fairly constant radio frequency (RF) level is obtained.

Now consider just what this modulation is: the audio signal has been employed at the transmitting end to vary either the amplitude or the frequency of the radio frequency signal that carries it. This carrier can be amplified to apply a stronger signal at the demodulator of the receiver—i.e., the detector. And AGC may be used to ensure that the gain of the RF stages is reasonably constant, permitting more efficient design, and giving a better signal-to-noise ratio. But the modulation amplitude varies about a mean level to give changes in loudness. Provided the relative changes in modulation swing are maintained, the RF signal can be arranged to produce a constant level at the demodulator. Thus, a fading station will give a constant output.

Taking simple figures, supposing a receiver has been designed to accept anything above 50μV of RF input and produce 1V at the demodulator. In other words, with the minimum 50μV input at the aerial the RF and intermediate frequency (IF) amplifiers are working at full gain and capable of delivering a volt of modulated signal. A signal ten times as great will cause the AGC to come into operation and reduce the gain of the controlled stages so that there is still a volt at the demodulator.

However, from this volt of signal we extract the information we require, which is an audio signal varying about its mean level—which is now exactly what we need, a constant percentage of the carrier signal, regardless of the fading of the station. The variations of the audio signal which give us relative changes in loudness are not affected by the fading of the input signal—unless, of course, it fades beneath the input sensitivity figure of the receiver. **Fig. 1** illustrates the principle of detection, and shows that the amplitude modulation AM of an RF carrier varies in the way we have discussed and, when detected, becomes a separate waveform. As the percentage modulation is strictly controlled at the transmitter end, we do not have to worry about regulation of the audio signal—except where normal biasing and feedback is employed to get the best out of amplifier circuits and maintain the quality of the sound.

Frequency modulation (FM), although using a different propagation technique, gives us precisely the same thing after detection, i.e., an audio signal relative to its own, constant, mean level. (Purists will argue about a conflict of terms, but this is the least complicated way of explaining the process.)

However, the radio fraternity gets away with such straightforward methods of signal control—a kind of servo-system with bias proportional to the applied signal. But consider what would happen if we did the same thing for the recording amplifier of a tape recorder, with the amplifier circuits adjusted to give full modulation level for a given input and an arrangement whereby bias is applied in proportion to the loudness of the signal. We should end up with the *1812 Overture* reduced to a roll of muffled drums and poor old Haydn completely robbed of his *Surprise*. Everything would come out like that horrible canned noise that lulls us around the supermarket—musical mush.

Before we consider what is actually done in practice, having demolished our innocent theory, let us think what happens when we control our recording manually. First, we set up the gear and use either a meter or a magic-eye to indicate the signal level. Regardless of whether the device shows us an average level, or follows each change in loudness faithfully and gives us an honest warning of peaks, we

(continued on page 463)

FIG. 4 PHILIPS EL3552 AUTOGAIN CIRCUIT

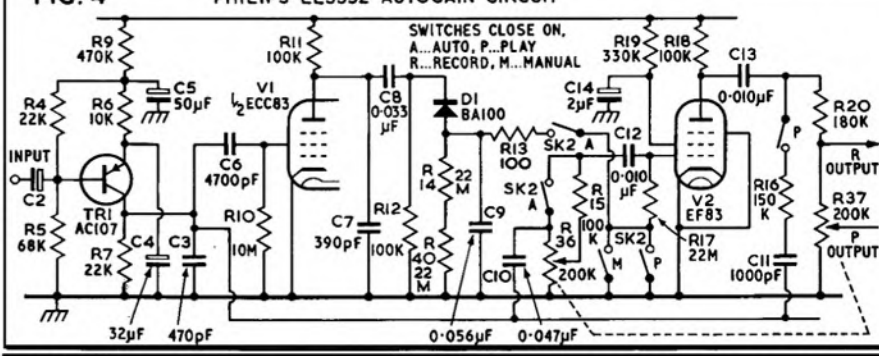


FIG. 5

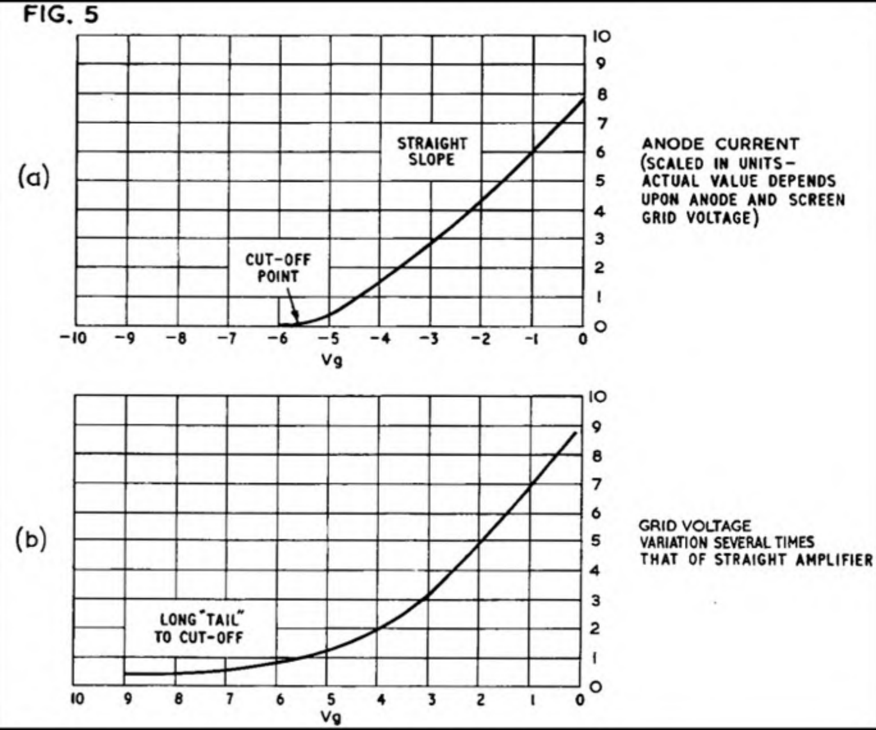
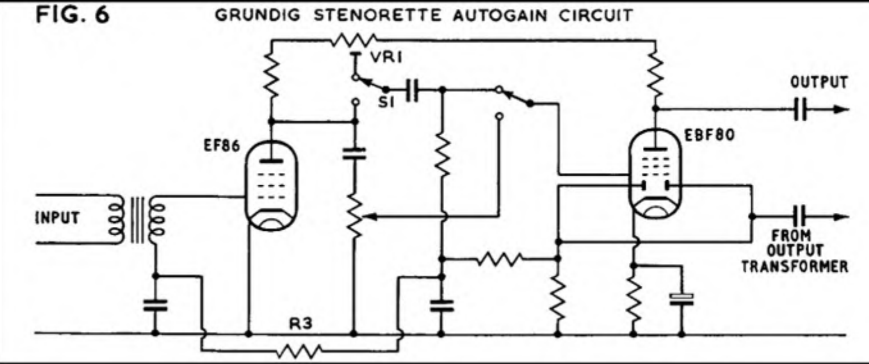


FIG. 6 GRUNDIG STENORETTE AUTOGAIN CIRCUIT



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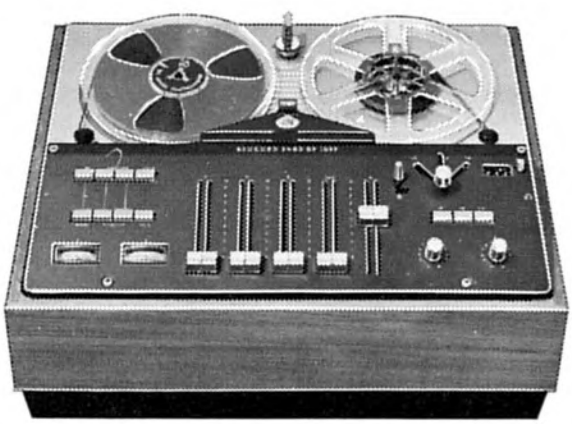

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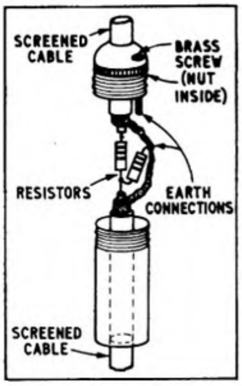

From: R. H. Coates Palgrave, P.O. Box 8232, Causeway, Rhodesia.

DEAR SIR, For some time I have been meaning to write to describe a 'gadget', and now do so on the off-chance that there may be someone who would find it useful.

To house neatly, and screen effectively, matching resistors incorporated in leads used for connecting pieces of equipment, I have found the small aluminium screw-top tins used for packing small high-speed twist drills very handy.

A hole to take the screened cable is made in both the bottom and in the lid of the tin (these tins are 2in. long by $\frac{1}{2}$in.). The resistor connections are then made so that they are housed inside the tin. To get earth continuity and screening, a small hole is drilled beside that which takes the cable, in the lid, and a very small BA brass screw placed through it, with the nut end protruding $\frac{1}{4}$in. inside. The ends of the earth brading and/or resistor can then be easily soldered to this protruding portion. The body of the tin is loose on the cable and after making the necessary resistor connections, the body can be screwed back into the lid (see drawing).

My equipment comprises *Quad, Garrard 301, SME-Pickering 381, Revox* and *Uher 4000*, and I now have a complete set of connecting/matching leads for record, replay and dubbing. I have found the tins easily procurable from hardware stores, who are quite willing to hand over their empties. *Yours faithfully,*

. . . about the Boys' Brigade

From: Kim C. Washbourne, 23 Wymans Road, Cheltenham, Gloucestershire.

DEAR SIR, Can you please assist me by publishing an appeal letter?

Through tape-corresponding abroad, I have received three requests for feature tapes concerning youth organisations in Britain. If I can obtain appropriate material I hope to do a series on the *Boys' Brigade*, concerning its history and activities. If any reader could loan recorded material on this subject, it would be greatly appreciated. Care will be taken with all recordings, and all correspondents will receive a reply. *Yours faithfully,*

. . . about the October cover

From: A. J. Walsh, Managing Director, AEG (Great Britain) Ltd., Lonsdale Chambers, 27 Chancery Lane, London, W.C.2.

DEAR SIR, I was intrigued to read your interpretation of the picture shown on the cover of the October 1966 issue of *Tape Recorder*.

I must admit that I had not tried to put any interpretation on this picture, which was issued by the *Telefunken* Publicity Department. Nevertheless, I felt confident that our colleagues in Hanover had intended to give quite a different impression when taking this photograph.

I asked them what they had in mind and they now tell me that they wanted to convey the idea that modern Telefunken equipment is purchased by intellectual people (witness the books) with a keen interest in world affairs (witness the globe), who nevertheless appreciate the advantages of a comfortable 'retreat' (witness the rocking chair, etc.).

I also asked about the origin of the rocking chair and understand that it is a mass-produced German model !

Needless to say, the Telefunken photographer is rather disappointed at the fact that he has not got his message home on this occasion. Perhaps we will have to ask our Public Relations man to provide a short caption in future press releases to give a lead as to the 'story behind the picture'. *Yours faithfully,*

. . . about Aneurin Bevan

From: W. Carr, Department of Modern History, The University, Sheffield 10.

DEAR SIR, The *Society for the Study of Labour History*, President Professor Asa Briggs, and *The Trade Union, Labour, Co-operative-Democratic History Society*, President George Woodcock, are conducting an exploratory survey to try and establish the whereabouts of any recordings of speeches by the late Aneurin Bevan, M.P. On behalf of these societies, I would like to appeal, through the columns of your journal, to readers who have such material in their possession, or who know of the whereabouts of such material, to get in touch with me. If possible, I would also like to know whether individuals or organisations possessing recorded material would be willing to let us examine it. I can assure readers that every care would be taken of material loaned to us for the purpose of our investigation.

Yours faithfully,

NO NEED TO THINK CONTINUED

set the gain of the amplifier by turning the Record Level control so that the input does not overload. If a peak subsequently catches us unawares, we reach out quickly for the knob and turn it down a notch. Our reflexes being what they are, it is then too late and the overload has introduced a temporary distortion.

All that the manufacturer is trying to do, when he fits Automatic Record Level to his product, is save us the embarrassment of slavishly watching a flickering needle or fluourescent beam, with one hand nervously poised over the knob. He arranges his control circuits so that a given level of signal will bring the bias circuit into operation exactly as if we had ourselves turned down the gain. At the same time, to avoid the lower level signals being biased out of existence, he permits the gain of the amplifier to recover slowly, keeping the relative intensity of the sounds the same. The dynamic range has to be maintained—and this is the snag that requires special circuits to avoid the distortion which would occur if a simple peak-clipping bias circuit were used.

To illustrate this, **fig. 2** shows first the control range **(a)** and second the effect of this control on the waveform which may be a passage of music **(b)**. Both illustrations are borrowed from Messrs. *Philips* and apply to the *EL3552*, which was one of the early examples of modern automatic technique. We stress 'modern' here, because forms of gain control have been used in a number of tape recorders, principally dictating machines; but these were generally of the simple 'bias in proportion to signal' method, with no refinement of delay and recovery.

A study of **fig. 2** shows that the control range is 30dB, the signal level dropping this amount in a short period of time when a loud sound triggers off the bias. Then, if no further sounds loud enough to instigate the control should occur, the delay circuits **(fig. 3)** allow the bias to reduce gradually, the overall gain of the amplifier rising slowly until it is within 1dB of the original level after 60 seconds.

Naturally, the curve shown relates to a constant level of signal, after the original triggering loud noise. But the second curve **(b)** gives a more realistic impression—though an impression it has to be, for the page is not wide enough for us to show the sort of waveform that even a simple musical signal would trace out in 60 seconds. The important point to note is that the hard line, which is the waveform that would be traced out by an uncontrolled signal, is repeated faithfully by the dotted line, which is the gradually recovering controlled signal. The time limits of the recovery period are deliberately chosen so that they can have no distorting effect on an audio signal. The level **R** is chosen to simulate a normal modulation level for a properly recorded tape.

This point is also important. Modulation indicating devices vary from the sluggish 'average' indication that tells us too late when we are bouncing up into the red, to the flickering peak indicator that defies the operator's reflexes. A correctly modulated tape should have an average level that gets the best signal-to-noise ratio from the machine and its ancillary equipment, while ensuring that peaks do not cause clipping and audible distortion. Undermodulation introduces noise, hum, tape hiss and other like evils; overmodulation results in a constant distortion that cannot be removed on playback, no matter how low we wind back the gain control.

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(continued on page 488)

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MAGNETIC SOUND RECORDING

PART EIGHT

BASIC THEORY OF EQUALISERS

BY C. N. G. MATTHEWS

IN earlier articles we saw that both recording and reproduction introduce problems of frequency response—the equipment behaves differently at different frequencies. It was mentioned that these shortcomings are countered by equalising networks incorporated in the amplifiers. Now we must decide what these networks are and how they operate. This is about as far as we can hope to go at present, because a full mathematical treatment would be well beyond the scope of a single article.

All equalisers, simple or complex, use resistive and reactive components. Reactive components — capacitors and inductors — change their opposition to current flow as we change the frequency, but, over the audio range at least, the opposition to current flow offered by a resistor is independent of frequency. Further, the opposition offered by a capacitor decreases with frequency, whereas that offered by an inductor increases. So by using a combination of resistive and reactive components we can get pretty well any kind of frequency response we please.

Let us first consider what happens when we use an inductor at varying frequencies. The opposition to current flow is called the inductive reactance X_L and we can substitute this quantity for R in Ohm's law.

$$V=IX_L$$

But X_L is not so simple a parameter as resistance. It is given by $X_L=2\pi fL$, where f is the frequency in cycles per second, L is the inductance in Henries, and π, to three significant figures, is of course 3.14.

Now we go back one step further to consider the nature of inductance itself. We know that a magnetic field is set up around any conductor while it is carrying a current. To set up this field requires energy, which must be supplied by the battery or other generator. Once the field is in being, it requires no additional energy, so the opposition offered to direct current is high when circuit is first made but no greater than that offered by the resistance of the wire when the magnetic field has been established.

Any *change* in current brings a change in magnetic field. If the current increases the field increases, so extra energy must be supplied. If the current decreases the field decreases and its excess energy is returned to the circuit. Either way, the effect is to oppose current changes. This means that the voltage change which produced the current change is opposed. Since the only thing which can oppose a voltage is another voltage, we say that a *back-EMF* has been set up. We call it the back-EMF of self induction. If, when the current is changing at the rate of one ampere per second, the back-EMF is one volt, then the inductance of the circuit is one Henry.

In DC circuits inductance has little effect except at the moments when the circuit is made or broken. But in an AC circuit the current is changing continuously at a rate $2\pi f$. So the inductive reactance, X_L is $2\pi fL$. An important feature to note is that X_L varies *directly* with frequency. In other words, if we double the frequency we double the reactance.

A capacitor does not set up a back-EMF in the same way as an inductor, but in an AC circuit it successively charges, discharges, recharges in the opposite direction and discharges again in time with the variations of the applied EMF. An AC meter connected in series will seem to indicate an alternating current flowing through the capacitor, but in fact no true conduction takes place. What the meter indicates is the alternate charge and discharge currents. But we need not be too pedantic about this because in AC circuits the *effect* produced by a capacitor is that of a conductor whose opposition to current flow varies with both frequency and capacitance. This opposition is called capacitive reactance and is given by

$$X_C=\frac{1}{2\pi fC}$$

Like inductive reactance, it can be substituted for R in Ohm's law.

$$V=IX_C$$

In the expression

$$X_C=\frac{1}{2\pi fC}$$

the capacitance is expressed in farads, *not* microfarads. The vital fact from our point of view is that X_C is *inversely* proportional to frequency. So if we double the frequency we *halve* the reactance.

Now we have three types of component. In one the opposition to current flow is constant over the whole of the frequency range in which we are interested. In another, the opposition *increases* in direct proportion to signal frequency, while in the third the opposition *decreases* in direct proportion to frequency. It seems then that by using these components in combination we can within reason produce any kind of frequency response.

The opposition offered to current flow by a circuit comprising resistance and reactance is called its *impedance* (Z). For a series circuit of two elements only the impedance is given by $Z=\sqrt{R^2+X^2}$. For a parallel circuit of two elements,

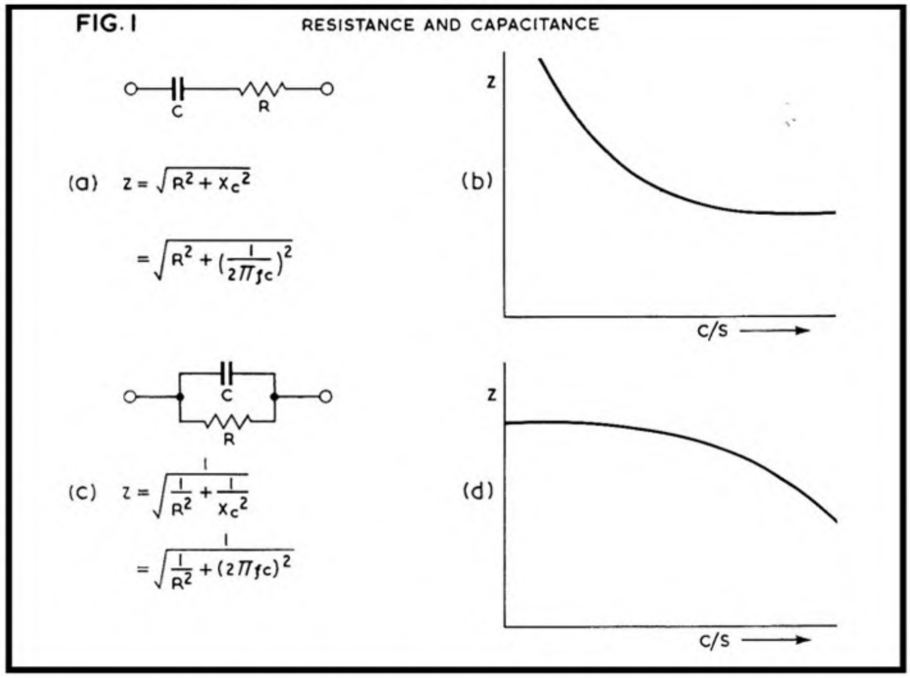
$$Z=\sqrt{\frac{1}{\frac{1}{R^2}+\frac{1}{X^2}}}$$

The equations are precisely the same as those for resistances in series and parallel, except that the quantities are added in quadrature.

In **fig. 1(a)** we show a series circuit of resistance and capacitance. At very low frequencies, X_C will be so high that it constitutes virtually the entire opposition to current flow. As we increase signal frequency X_C will fall but R will remain constant. Consequently the impedance will fall rapidly at first, then more slowly as R plays an increasingly important part in the opposition to current flow.

As we approach the higher end of the frequency range we reach a state of affairs in

(*continued on page 467*)



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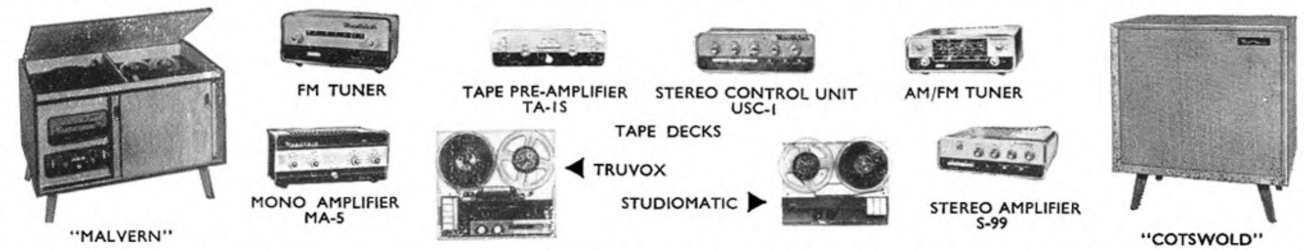

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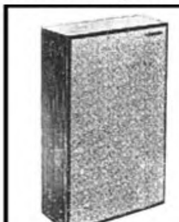

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FIG. 2 RESISTANCE AND INDUCTANCE

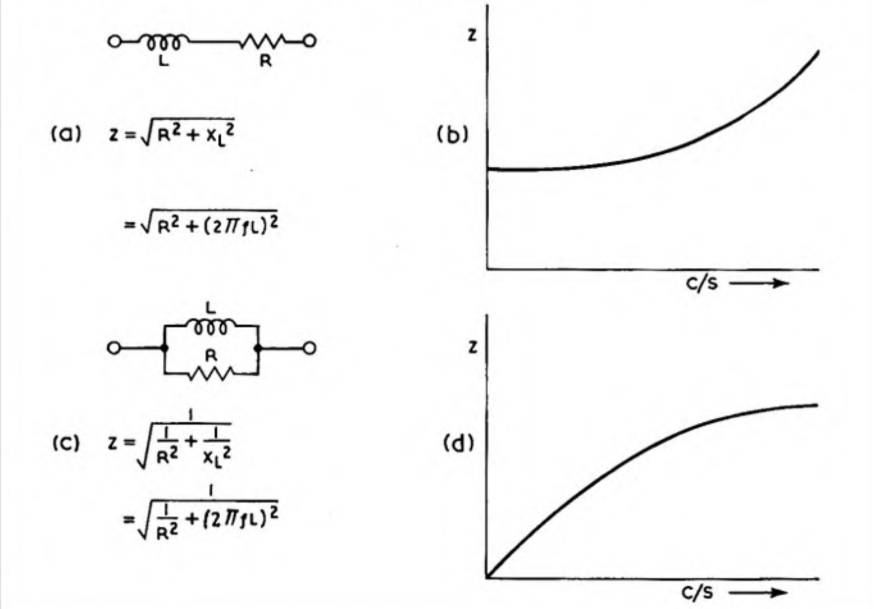
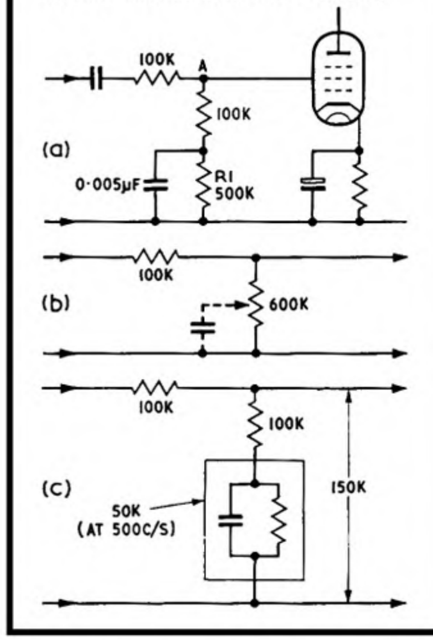


FIG. 3 SIMPLE BASS LIFT CIRCUIT



which Xc is negligible in comparison with R. Since R is constant and Xc has no real effect under such circumstances, the impedance now remains constant if we increase the frequency further So we get a frequency response curve of the shape shown in **fig. 1(b)**, in which the impedance is very high at the low frequency end of the range. It falls rapidly at first, but then with decreasing steepness till it levels off into a horizontal line. In this kind of circuit the impedance is infinity at zero frequency and can never fall below the value of the series resistance. The frequency at which resistance takes over from reactance is called the turnover frequency. Naturally, it is determined by the relationship between the values of resistance and capacitance.

Now consider **fig. 1(c)**. Here the circuit consists of resistance and capacitance in parallel. At low frequencies Xc is so high that the capacitor might just as well not be present. All the current flows through the resistance, so the effective impedance of the circuit is R. As we increase signal frequency, Xc falls so that an increasing current flows through the capacitive arm of the circuit. Thus the impedance falls at an increasing rate as Xc becomes steadily smaller in comparison with R.

So we get the kind of response curve shown in **fig. 1(d)**. Now the initial impedance is equal to the value of the resistance and it remains constant till Xc becomes low enough for the capacitive branch of the circuit to conduct appreciably. After this, the opposition to current flow falls with increasing swiftness. In this circuit, the impedance can never rise above the value of the resistance, but it can fall to a very low value at the upper end of the frequency range.

Fig. 2(a) shows a circuit consisting of resistance and inductance in series. At low frequencies the inductance offers virtually no opposition to current flow, so the impedance of the circuit is equal to its resistance and will remain constant till the value of XL becomes an appreciable fraction of R. Then the impedance will rise with increasing rapidity to give the frequency response shown in **fig. 2(b)**. Here again the impedance can never fall below the value of the series resistance, but in contrast to the series circuit of resistance and capacitance, the impedance increases at the high frequency end of the range.

Finally, we see in **fig. 2(c)** a circuit comprising resistance and inductance in parallel. At low frequencies inductive reactance is not far off zero. Thus the resistance is virtually short-circuited by the inductance and the impedance is very low. An increase in frequency brings an increase in XL so that the impedance rises towards the value of the parallel resistance, which it can never exceed. Again we have a contrast to a similar circuit comprising resistance and capacitance, because now the impedance rises towards R instead of falling away as the frequency is increased. This gives us a response curve of the shape shown in **fig. 2(d)**.

All of the curves we have been examining have two important features in common. The first is that at one end of the frequency spectrum they indicate that the circuit impedance is constant over a range of frequencies. By choice of components and circuit configuration we can have this constant portion of the curve at either high or low frequencies, and when the response begins to turn over we can make the impedance either rise or fall. The second important feature is that when virtually all the impedance is due to the reactive component the circuit has a rising or falling characteristic of 6dB-per-octave. In other words, when we double the frequency we either double or halve the impedance. This means that we can use any of these circuits, suitably incorporated into an amplifier, to compensate for the 6dB-per-octave rising frequency characteristic of the reproducing head.

The phrase "suitably incorporated into an amplifier" covers a multitude of problems which it would not be possible to discuss at present. A properly designed equaliser must take into account the impedance of the circuit from which it is being fed and the impedance of the circuit which it is feeding. Thus the mathematics tend to become a little complicated, especially as circuits so simple as those we have been examining are only a basis of design. But as a very simple example consider the circuit of **fig. 3(a)**.

Here the grid leak of an audio amplifier has been split into two unequal parts and a small capacitor has been shunted across one. A series resistor has been added between the grid of the valve and the coupling capacitor from the preceding stage. We can look upon this combination as a potential divider from which the signal is tapped off at a point A. Now at 20 c/s, 0.005μF has a reactance of approximately 1.5M. This is so large in comparison with R1 that we can neglect it. So the potential divider consists of 100K in series with 600K, as shown in **fig. 3(b)**. Six-sevenths of the signal is applied to the valve. If we increase the frequency even to as little as 500 c/s, Xc falls to 60K, which almost short-circuits R1 so that the effective grid leak valve is now only about 150K. This transforms our potential divider into that shown in **fig. 1(c)**, which will apply only just over half of the signal to the valve. Since the capacitive reactance at 500 c/s is already low, a further increase in frequency will have little effect, so this circuit will give a so-called bass lift. What it really produces, of course, is a treble cut.

This is about as far as we can go on the subject of equalisers. In practice they are considerably more complex than the simple circuits shown, but at least we have covered the basic principles.

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SOUND AND CINE

LOOPING THE LOOP

BY ANTHONY WIGENS

IDEALLY, I would like my sound film, *The Country Lovers* to proceed with smooth efficiency. However, I console myself with the thought that I will learn more if things go wrong; so will you, the reader. On that score, we can all be re-assured. We are having plenty of downs to balance out the ups.

One of the ups appears with Kay in a photograph this month. His name is Jess, and he is going to be just fine for the male part in the film. He came along to watch Kay work on our first post-sync session, using the test film taken at her screen test. And things went wrong.

I could have done with help during the screen test. I was reading the part that is now Jess's while filming Kay. Division of interest resulted in my forgetting to mark the start point of the screen test in any way. A board will be used at the start of each shot on location, and it will be a clapper board if we attempt to use location sound. Not only had I no board to mark the point in the script where Kay began, but I had no wild recording taken at the same time. We recorded her sound test separately. So if she had fluffed her lines or missed out a word, there was no way now of knowing, through checking up on the tape.

Full of confidence, however, I set up the *Eumig Mark S* projector and cut the test length of film from the whole reel. When it came back from the processing laboratories I had sent it straight off to *Zonal*, and it was back in a little over a week, with a neat magnetic stripe down the side and a bill for 13s. 7d. This was made up of 5s. for 30ft. of stripe at 2d. a foot, a 6s. minimum charge for *Permafilm* treatment, which Zonal carry out routinely before striping, and postage and packing of 2s. 7d. When you consider how little the post-and-packing charge would rise on a longer reel of film, and note that the Permafilm charge would be the same for 400ft. of film, you will realise that it is uneconomical to send 30ft. away for striping. However, I was in a hurry to carry out these loop post-sync tests, as this may be the only way I can achieve lip sync with my apparatus.

Having spliced the test film into a loop I searched around for a make-shift loop absorber. I found one in the shape of a standard lamp. With its reflector tilted horizontally and a pencil Sellotaped inside, projecting to form a spindle, I was able to suspend a film reel at just the right height above the projector. It all worked splendidly (see photo).

We watched the scene once through in awe, then turned to our scripts to spot Kay's first words at the start of the loop. Lip-reading proved none too easy. Almost simultaneously we spotted her saying, "Why didn't he stop?" and again we all managed to recognise, "You must be joking." After the third run through we were still no nearer identifying the first sentence. So I waited until "Why didn't he stop?" came on the screen, and stopped the projector. Then I ran it backwards, with Jess and Kay reading off the previous lines in the script consecutively. Of course they couldn't match it to Kay's lip movements, because these were back to front. However, painfully we checked back until we had identified in reverse the opening sentence. Then I switched to forward run, depressed the record button, and Kay spoke the first sentence, and the second, and the third.

To our dismay, they didn't match the lip movements at all. Despondency seemed endless, but after some time Jess shouted, "That line comes up twice. You know, 'Why didn't he stop?' Look, it's here too!" And it was. I only wrote it, so how could I have been expected to notice that?

Kay had to read her script, as she had not yet learnt it by heart. This meant that in looking down at the words, she missed dubbing lines accurately to the picture. However, it should be all right on the night. I believe that Jess, whose work is rooted in technology, was thinking he had volunteered for Fred Karno's army, although the prospect did not seem to dismay him. However, the lesson was not wasted on me. I recognised that if people volunteer their time, the organiser is duty bound not to waste it. Future work sessions must be organised far more efficiently.

The actors prepared for their first post-sync recording session. Note 'lash-up' loop absorber with pencil, spool, and clothes peg.

The ultimate construction of the film, should we use post-sync sound throughout, will work like this: the whole film will be broken into loops, according to the pattern of the sound track. When the sound has eventually been dubbed on all the loops, they can be opened up and joined together. The advantage of the loop is that it doesn't have to be constantly rewound and re-threaded in the projector; you simply let it run on and on. When you are ready to record, you do so, stopping the projector at the end of the loop. It can be re-started at once for playback and a check on the effectiveness of the sound recorded. Try again? Well, the film is all ready for you to do so.

Snag is that the sound is recorded 56 frames ahead of the picture, so there has to be silence on the film for at least the first 56 frames.

Meanwhile there are other ups and downs. Up is the news that *Ilford* have made great forward strides in colour film processing, and I have a hefty investment in Ilford stock in my film cupboard. I was convinced last summer that this film was now really good, but I met too many doubters for comfort. Now a letter from Ilford's technical press relations man reminds me that the firm has done 'smashing things' to the processing, with improvements in colour saturation, especially in reds. As *The Country Lovers* is an all-outdoor movie it does not matter to me that there is no Ilford *Colourcine* balanced for tungsten light yet.

Balancing this 'up' is another 'down'. Prepared for the chance that I may be attempting to construct a sound track on tape, as an alternative to post-sync, I have been trying out the *Philips EL 3534*. All went well until I played back a speech passage and could hear shadow voices in the background. The tape had been well-used, so I cursed the erase head, and wondered idly about things like print-through, while I broke out an unused reel of Ilfotape. I threaded it up and carried out some more vocal doodlings, then did a fast rewind and prodded the playback key.

To my horror, after a few minutes of perfectly good voice reproduction, an alien sound crept into hearing. Unmistakably, the strains of something like a German drinking song were marring the recording. The door of the room was closed, there was no radio or television on in the house, and in fact I was all alone save for sleeping children.

Fortunately, I don't believe in ghosts. I have read the news story about the man whose teeth fillings picked up police messages, and I own a *Gramdeck* which has to be played with the operator's index finger in electrical contact with the gramophone spindle to stop it picking up the *Light Programme*. So I know about these things.

But where do I have to stick my finger in the EL 3534 to quell German drinking songs? Or are there little Black Forest gnomes left inside by a manufacturer who needs to pull *his* finger out?

A JAPANESE MIRACLE

Gordon King analyses the Sony TVC 2000 domestic video tape recorder

MANUFACTURER'S SPECIFICATION. Integrated domestic video tape recorder and 405-line television receiver. **Tape Speed:** 7½ i/s ±0.2% **Tracking:** Two-head helical video reproduction (single head recording). Fixed-head sound and control tracks at opposite tape edges. **Tape width:** ½in. **Spool Capacity:** 7in. **Recording Time:** 60 minutes per 7in. reel (£12). **Rewind Time:** 7 minutes. **Start Time:** 6 seconds. **Motor:** Single phase, hysteresis synchronous. **Video Recording:** Double sideband FM. **Video Input:** 1.4V p-p composite signal, negative-going sync. **Signal-to-Noise Ratio:** 40dB (audio and video). **Audio Input:** Microphone: 600 ohms unbalanced, —60dB. Line: 10K unbalanced, —20dB. **Audio Output:** 5K unbalanced 0dB. **Frequency Response:** 80 c/s-10 Kc/s ±6dB. **Distortion:** 5%. **Wow and Flutter:** 0.25% RMS. **Semiconductors:** 50 transistors, 28 diodes and one thermistor. **Price:** £365 (Camera, lens, tripod and case available at extra £131). **Distributor:** **Sony U.K. Sales Division, Mercia Road, Gloucester.**

A RELATIVELY inexpensive way of recording vision signals produced by a television camera would appear to be by running the tape linearly past the heads at a velocity many times greater than that required for the best quality audio recordings. This is because the component sine-wave signals of sound extend in frequency to a little above 15 Kc/s, while those of vision go up to about 3 Mc/s and sometimes above, depending on the required picture definition.

Major fast-running disadvantages are the need for a vast amount of spooled tape to provide a reasonable, continuous programme time, and the problems involved in maintaining a very constant tape velocity past the heads to keep the reproduced picture steady on the display screen.

There have been several attempts at overcoming the problems involved in creating a linear video tape recorder at a tape velocity below the basic theoretical requirements. A form of cross-field biasing may eventually be adopted in this context provided a signal-to-noise ratio at least as good as 40dB can be attained, for a lower ratio can add very disconcerting grain to the reproduced picture, rather like working an ordinary television receiver on a weak aerial signal.

Engineers Michael Turner and Norman Rutherford pioneered linear video tape recording in this country, and some time ago we heard about (or saw) the results of this in the original *Telcan* and the *Wesgrove* home video tape recorders. These engineers are still concerned with this mode of recording and have taken out patents on some of their ideas. An interesting one (No. 1,041,632) relates to recording the signal of the highest definition at or near the un-recorded level of the tape, near the level of maximum tape remanence. Peak-white signal is arranged to correspond to the un-recorded level, while black is arranged to correspond to the start of the non-linear part of the tape magnetisation characteristic. The sync pulses are added on the characteristic between the two video signal levels. A special kind of recording head is employed to compensate for backward spread of the tape magnetism in conjunction with the recording of compensating pulses with the video signal.

At the present state of the art, however, linear video tape recording cannot be considered as being really successful.

Professional video tape recorders use the transverse-scan recording system. Here, 2in. wide tape passes through the deck at a velocity of 7½ to 15 i/s, while, at the same time, video heads are scanning the tape across its *width*. Four heads are mounted equidistant round the periphery of a drum which is driven by a synchronised motor at a speed of about 15,000 r.p.m. This results in side-by-side tracks being recorded across the tape at an angle deviating only by a small amount from 90° to the direction of the tape. A sound track is recorded along the top edge of the tape and a synchronising track (to correct the speed of the head-drive motor should this tend to wander) along the bottom edge.

The effective head-to-tape velocity of this scheme is around 1,500 i/s, which with head gaps no narrower than conventional ones can record up to about 10 Mc/s. The video signals in this type of machine are recorded within the protection of an FM carrier, and this results in a useable video bandwidth of about 6 Mc/s, adequate for monochrome and colour signals of very high definition. These machines, of course, cost many thousands of pounds and are used essentially by broadcasting authorities, a well-known professional version being that by *Ampex* (i.e., the *VR2000*, suitable for wideband colour).

A compromise between the linear and transverse techniques is an arrangement whereby diagonal side-by-side video tracks are recorded on the tape. This is known as the *helical scanning system*, since the tape is passed in the nature of a helix round the periphery of a fairly large drum, along the middle of which is a slot through which appear the poles of the video head. The head (or heads) is fixed to a rotating arm driven from a constant-speed motor system.

The *Sony* recorder, submitted to us recently for test, uses this system in conjunction with two video heads and ½in. tape, as shown in **fig. 1.** The tape can be seen passing round the drum, while inside can be seen the rotating arms, each end carrying a head. The two head windings are connected on one terminal board, so that only three lead-outs are needed for the two heads, and these are extended into the machine via slider rings and brushes, seen in the centre of the head assembly.

The heads themselves cannot be seen in this picture, neither can the slot in which their poles operate, but the head adjusting screws are just about visible at the ends of the rotating arm. The heads are adjusted along the arm so that the poles are only lightly in contact with the tape oxide. The small winding in the six-o'clock position is for synchronising the head speed, and will be referred to later. The heads rotate at 25 r.p.s. (for the British TV system) and this is arranged by a servo motor drive system.

The tape is driven through the deck and round the drum at 7½ i/s in the usual way, and **fig. 2** shows the capstan and pinch-roller. The head shown in this picture is a stacked arrangement for recording top-edge sync signals (for locking the speed of the head-drive motor) and bottom-edge sound signals. A part of the take-up spool can also be seen.

Fig. 3 shows the detail of the other side of the deck, and the head here is for erasing the tape in the ordinary way before it arrives at the video drum. Full-width erasure is used, so that sound, vision and sync are all erased at the same time. This picture also shows the tape guides. Since the tape passes round a helix, the take-up spool is above the level of the supply spool and the tape is fed into and out of the helix by tapered tape-to-drum guides. One such guide can be seen in **fig. 3** (bottom right), this tapering towards the top.

The tape is in contact with the drum over about half its circumference and, because the heads are rotating at 25 r.p.s., each head pole is in contact with the tape for one-fiftieth of a second. Each diagonal scan on the tape therefore, corresponds to a period of time equal to one-fiftieth of a second.

Now, a television picture is made up of *two fields* each having half the number of scanning lines of a complete picture. Thus, a 405-line picture has 202½ lines per field. The lines of one field fall in the spaces between the lines of the partnering field. The lines are thus interlaced, and this is what is meant by an interlaced picture. The technical term for a picture is *frame*. Remember, two fields interlaced make up one frame.

A television frame is produced in one-twenty-fifth of a second, and a field in one fiftieth of a second. It follows, therefore, that each diagonal scan on the tape records all the information of one complete field.

When the Sony is recording pictures, only one of the heads is used. The other is switched out of circuit. The head in operation is fed with video information and it starts the diagonal scan on the tape at the instant that a picture field starts. This is ensured by the synchronising (see later). Thus, it records one field, misses the next one, records the next and so on, recording every other field only. Each diagonal track is of a width that it virtually contacts its neighbour, as shown in **fig. 4.**

When the recording is played back, *both* heads are switched into circuit. This means that information is fed out of the head system every fiftieth of a second, yet information is fed in when recording only *every other* fiftieth of a second. In effect, only half the picture information is recorded, while each field is played back twice so as to make complete, full-line frames. In a real television picture, the information contained in interlaced pairs of adjacent lines differs slightly, but on the

Sony TVC 2000 domestic video tape recorder

Fig. 3 (right): full-track erase head and angled guide.

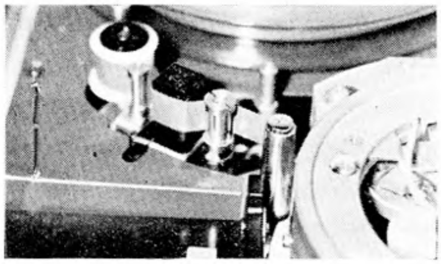


Fig. 7 (below): The complete *TVC 2000* recorder and receiver.

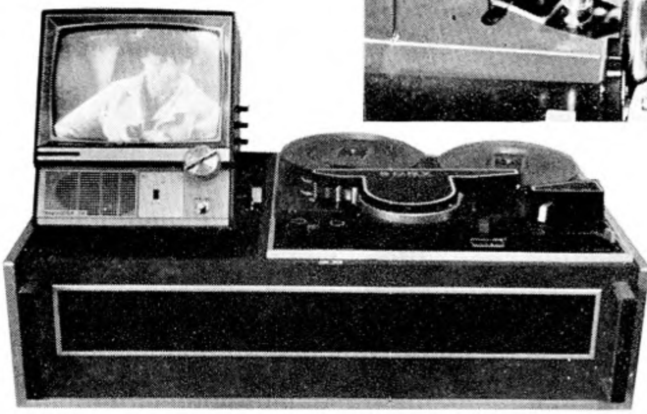


Fig. 2 (right): Stacked sound/control head. Capstan and pinch-wheel are also visible.

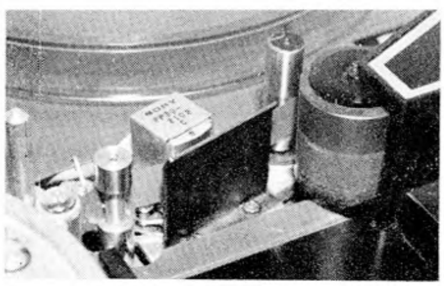


Fig. 8 (below): Camera and tripod available for the *TVC 2000*.

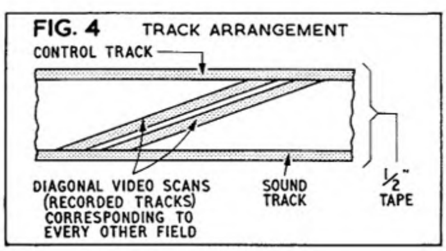
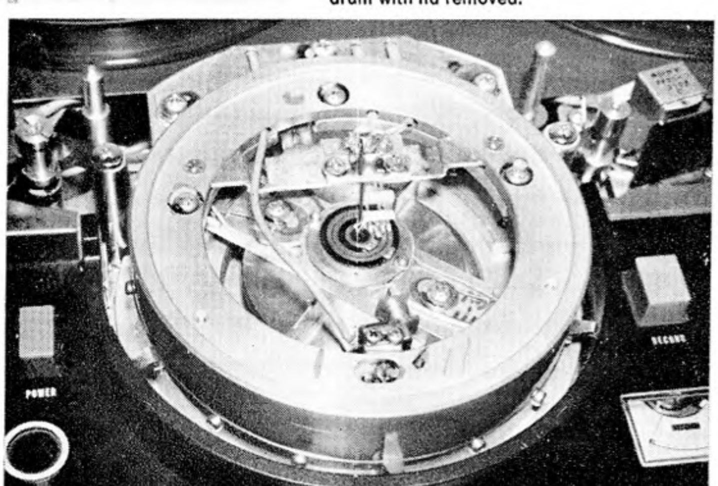


Fig. 1 (below): Video head drum with lid removed.



Sony playback the information is exactly the same in each interlaced pair of lines.

Thus, instead of the picture being made up of 405 lines of different information, it is composed of 202½ lines of different information, but occupying 405 lines on the screen. In an average picture, there is very little difference between the information of interlaced line pairs, so the fact that the same information is presented twice, occupying two lines, has little impairment effect on the picture as a whole.

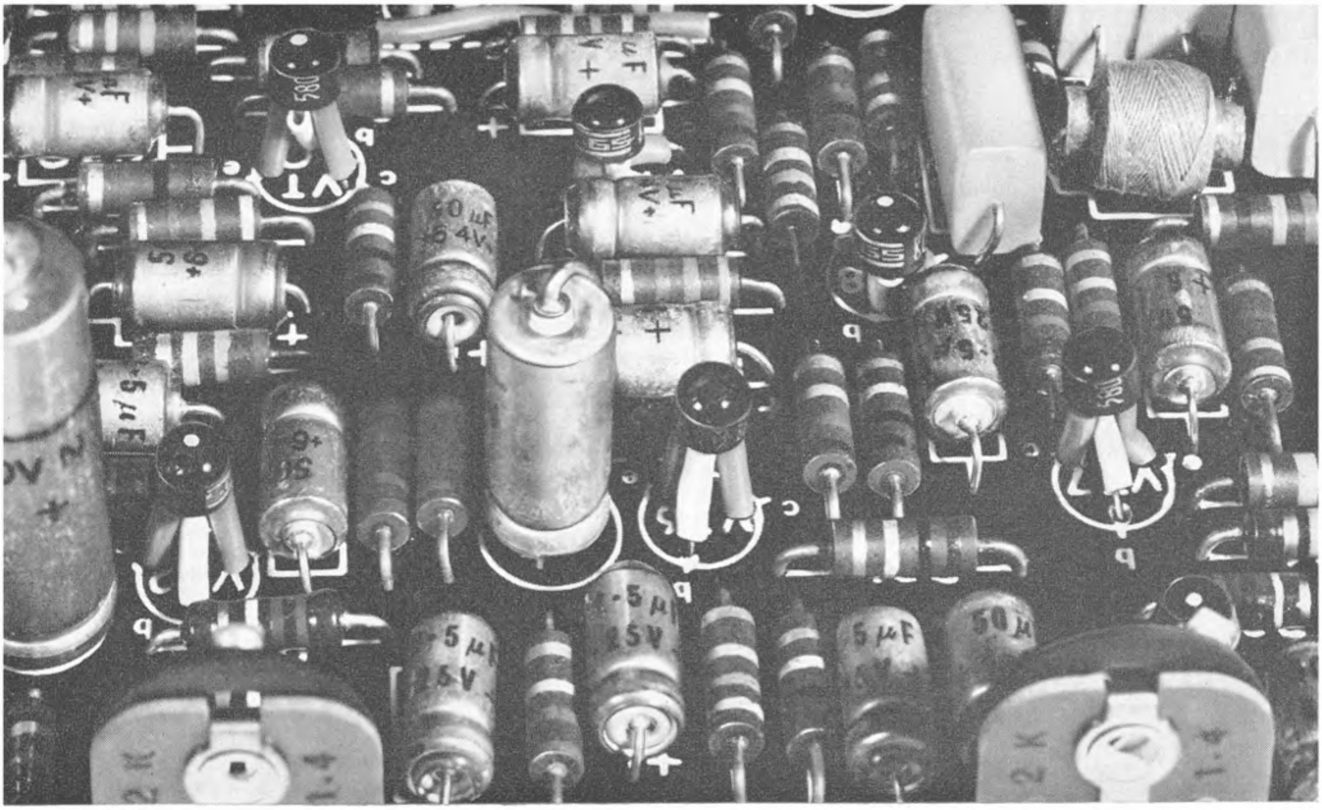
We have been talking about pictures of 405 lines. This is not really correct, for no television picture uses all the lines. Some of them in each field are blacked out during the field synchronising period, and these can be seen on any television set by carefully adjusting the *vertical hold control* until the picture just starts to roll (up or down the screen). A black space can then be seen between the frames of picture, and here is where the blacked-out lines reside ; they become visible if the brightness control is turned up a little above normal. There are fewer than 400 active lines in a 405-line picture.

The video bandwidth required for a television picture is related to the number of lines to provide a balance between the vertical and horizontal definition. The vertical definition, of course, is fixed by the number of lines and a 405-line picture needs a video bandwidth approaching 3 Mc/s to obtain correct horizontal definition balance. A 625-line picture, on the other hand, requires a video bandwidth above 5 Mc/s for correct definition balance.

Now, since the Sony has a vertical definition corresponding to about 200 lines, the horizontal definition does not need to be as high as for a true 405-line picture. The overall record/playback frequency response extends over a spectrum of 1.8 Mc/s to the −3dB points, and this provides a horizontal definition which about equals the vertical, giving a picture of fair overall definition, but somewhat below that of an off-the-air television picture.

A very revealing video test is given by Test Card 'D', radiated by the BBC and ITV for picture quality assessment and adjustment. **Fig. 5** shows an untouched photo of this Test Card as received by the monitor receiver of the Sony VTR at a distance of about 40 miles from a Channel 9 ITV transmitter, using an attic-type aerial. The picture quality is extremely good, lacking overshoot or ringing (i.e., black-after-white and white-after-black and multiple reflections of vertical picture elements), and the bandwidth embraces 3 Mc/s, since on the picture the 3 Mc/s frequency gratings were resolved at fair contrast. These gratings can also be seen on the photo, but the printing block may fail to record them. The 2.75 Mc/s gratings, however, are displayed at full contrast. Incidentally, for readers not conversant with Test Card 'D', the frequency gratings are enclosed in the circle and reading from left to right and from top to bottom they correspond to frequencies of 1, 1.5, 2, 2.5, 2.75 and 3 Mc/s.

(continued on page 473)



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TRUVOX LIMITED · NEASDEN LANE · LONDON NW10 · TELEPHONE: DOLlis Hill 8011 tape and then played back on the monitor; the result is shown in fig. 6. On the screen the 2 Mc/s frequency gratings were just visible, and the 1.5 Mc/s gratings at full contrast; the photo barely defines the 2 Mc/s gratings, but clearly shows the 1.5 Mc/s gratings. This test of video bandwidth corresponds closely to the bandwidth tests made by other means.

So much, then, for the overall video bandwidth and the picture definition; what of the machine generally? The complete system consists of three units: the video tape recorder proper, the monitor television unit, and the camera unit. The television monitor is a slightly modified transistor 9in. receiver which operates normally on all 405-line BBC and ITV channels. This is (and has been) available from Sony agents purely as a TV set of portable, mains/battery design.

In the Sony VTR system this receiver, with a front-panel switch changing from off-the-air operation to VTR operation, is fitted in a substantial carrying case along with the recorder, as shown in fig. 7. The monitor is set-up on a pivot arrangement so that it can be folded right down into the case, operated vertically or between the two positions. This intermediate position is shown in the photo, and the picture on the screen is a tape recording being played back.

The camera on the top of the tripod (supplied) is shown in fig. 8. This takes any C-mounting 16mm. lens system, and the standard lens fitted is f1.9 25mm., with iris stopping down to f22. Focus goes from a foot or so to infinity, while the depth of focus depends on the f-setting, as with any ordinary film camera.

The camera has an electronic focus control on the rear panel (to focus the electron beam on to the camera tube target) and a pre-set beam current adjustment. This latter, once set automatically, caters for a wide range of light intensities. This avoids having to make frequent adjustments to the optical iris to suit the prevailing light conditions.

The camera contains transistor electronics and 50-field video signals are supplied to the tape recording unit through a fairly long length of DIN-terminated multi-conductor cable. The camera is also powered from the tape unit through a separate cable.

The tripod is a light-weight metal type with telescopic legs and axial, vertical and horizontal shifts with appropriate locking arrangements. The picture 'seen' by the camera is usually viewed and set up from the monitor screen, but once the electronic and optical controls have been set, viewing is handled by the pull-up frames shown on the top of the camera in fig. 8.

The complete Sony system does four things: (i) It acts as an ordinary television set on BBC1 and the ITV channels. The large control at the right is the channel selector and fine tuner, and the volume control is directly below. The purpose of the switch has already been explained. (ii) It can record and play back the sound and vision of any television programme. (iii) It can serve as a closed-circuit television system on both sound and vision so that the monitor screen displays whatever the camera

(continued on page 488)

Fig. 5

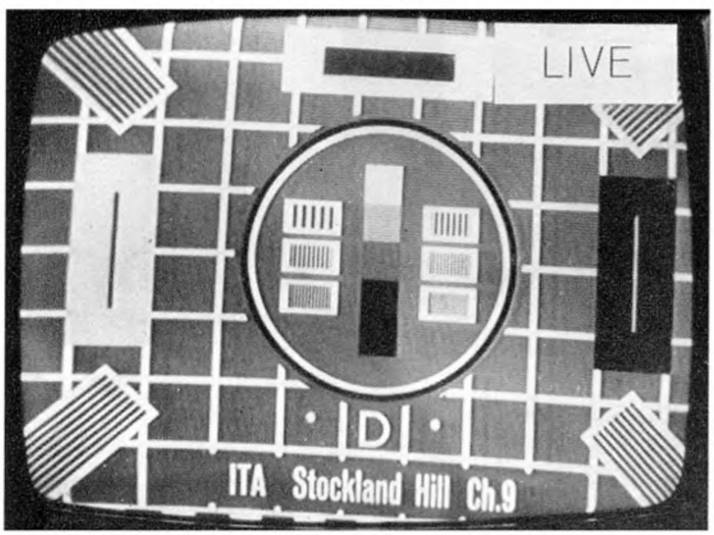

Fig. 6

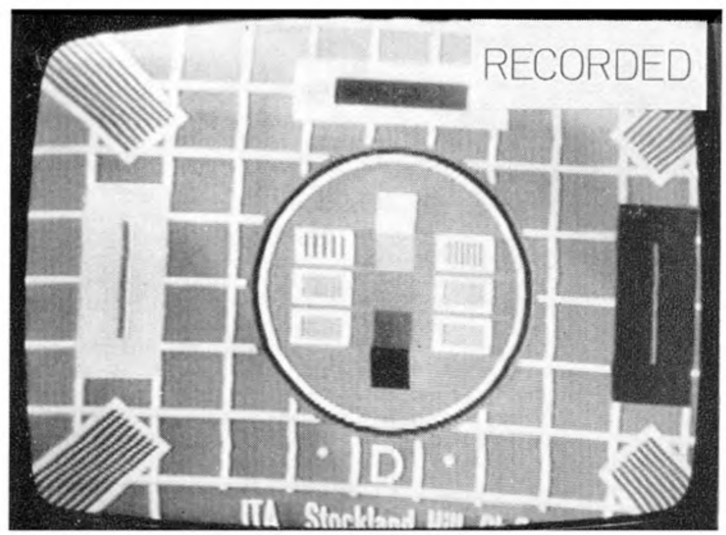

Fig. 9

Fig. 10

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BATTERY POWERED TAPE RECORDERS

PART 13: THE TRANSISTOR EFFECT

BY MICHAEL GORDON

IF we take a transistor and bias the emitter junction for forward conduction and the collector junction for reverse conduction, the information that we have gleaned from past discussions on diode junctions would lead us to suspect that we should obtain a relatively high current in the emitter/base circuit and a relatively low current in the collector/base circuit.

We may, however, be very surprised to find that we do, in fact, have our normal forward current in the emitter/base circuit, and not a low current in the collector circuit, as we would expect, but a high current here also ! We would probably think that something is amiss with the transistor or that we have got the collector voltage polarity reversed (putting this junction also into forward current).

Changing the transistor and checking the collector potential would give the same results, so then we may start a bit of head scratching. Eventually, having no other knowledge, we would discover that the high collector current drops almost to zero, registering just collector junction leakage current, when the emitter/base forward current is switched off. Moreover, we would discover that the collector current has some relationship to the amount of forward current flowing in the emitter/base junction.

Our meters would show that as the emitter/base current is increased in the forward direction from zero, so the collector current rises to a saturation value when further increase in emitter/base forward current fails to evoke any further rise in collector current. In other words, we would have discovered the transistor effect.

Fig. 1 shows respectively at **(a)** and **(b)** the 'on/off' conditions, at **(i)** for a *p-n-p* transistor and at **(ii)** for an *n.p.n* transistor. The only difference lies in the polarity of the potentials applied to the junctions. This was considered last month, but let us recapitulate on this important aspect again. The collector junction in a *p-n-p* transistor for forward conduction requires to be biased so that the collector electrode is positive with respect to the base. In an *n-p-n* transistor this is reversed, and the collector electrode requires to be biased negatively with respect to the base for forward conduction.

The emitter junction is the same, so that for forward current the emitter electrode relative to the base has to be positive on a *p-n-p* transistor and negative on an *n-p-n* transistor. We can look at the emitter junction from base relative to the emitter, so that for forward conduction the base of a *p-n-p* transistor needs to be negative with respect to the emitter and positive with respect to the emitter for an *n-p-n* transistor.

It is best to look at the emitter junction biasing in this way because the emitter/base potential is generally known as the *base bias*.

At **(a)** in **(i)** and **(a)** in **(ii)** in **fig. 1,** the base bias is for forward conduction, thereby giving rise to the relatively high collector current due to the transistor effect. The transistor effect is also revealed at **(b)** in **(i)** and **(ii),** since here the base bias is switched off, thereby causing the collector current to collapse to a very low value, equal to the collector leakage current (that is, the current flowing when the collector junction is biased for reverse current).

It should again be stressed that under normal operating conditions both *p-n-p* and *n-p-n* transistors have a base bias for forward conduction while the collector junction is biased for *reverse* conduction (*not* for forward conduction). The relatively high current in the reverse-biased collector junction when the base bias is for forward conduction is given by the transistor effect alone.

To sum up, then, the greater the bias in the forward direction applied to the base, the greater will be the flow of collector current. The junction currents, of course, are limited by the ratings of the transistor, and in practice the base bias represents a very small value of forward current, while the collector current is considerably greater, to some extent promoted by a higher potential at the collector junction than at the base.

In **fig. 1** the resistors marked Rb limit the base current, while those marked Rc limit the collector current so that the ratings of the transistors are not exceeded. A prime rating is junction power dissipation, this being the product of the potential across the junction and the current through it.

A full explanation of the transistor effect would demand a discourse into the realms of physical science, which is well outside the scope of this series of articles. Nevertheless, some explanation is needed to satisfy the enquiring mind, and from first principles we can reason as follows.

Let us first consider an *n-p-n* transistor, in which the emitter, being of n-type semiconducting material, produces negative current carriers (i.e., electrons). Now, owing to the base being biased for forward conduction, the emitter electrons flow into the base, and many of them diffuse across it and come under the influence of the collector potential. This is positive on an *n-p-n* transistor, as will be recalled, so the negative electrons are thus attracted towards it and eventually flow into it, thereby creating the collector current.

Almost all the negative current carriers delivered by the emitter arrive at the base and only a few combine with the holes in the base layer. This effect does result in a small loss of charge, but this is countered by the continued flow of forward current in the emitter/base junction. The voltage developed across the emitter junction is dependent on the junction current (usually called the *base current*). Thus, an alteration in base current alters the current flow in the collector-emitter circuit, as already explained.

It is interesting at this stage to compare the operation of an *n-p-n* transistor with that of a valve. It is the heated cathode in a valve that produces the electrons, and these are emitted into the vacuum of the valve's envelope. The valve's anode is subjected to a positive potential (relative to the cathode) which attracts the electrons towards it, and anode current flows. Between the cathode and the anode is located the control grid, which is biased negatively with respect to the cathode. The grid, however, is of a mesh construction so electrons can pass through it to the anode. The quantity of electrons flowing (constituting the magnitude of anode current) is controlled by the negative bias applied to the grid.

With the grid very heavily negative, the negative electrons are repelled and none get through to the anode. This is the condition of anode current cut-off. As the grid is made less negative, so more and more electrons manage to get through the mesh, and the anode current rises.

The cathode, grid and anode of a thermionic valve, then, can be likened to the emitter, base and collector of a transistor ; but this analogy cannot be taken too far. A valve operates in a vacuum while a transistor operates in a pure crystal with the controlled addition of impurities (to add the current carriers—these are given in a valve by the heated cathode).

A very important difference, however, is that while the anode current of a valve is controlled by a *voltage* at the control grid, the collector current of a transistor is controlled by a forward *current* in the base circuit. The control circuit of a valve is thus at high impedance (no current flowing), while the base or control circuit of a transistor is at low impedance (current flowing). It is for this reason that a valve is often called a voltage-operated device and a transistor a current-

(*continued on page 477*)

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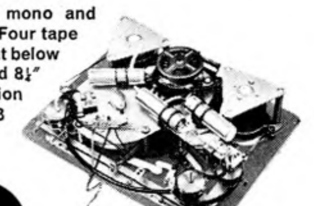

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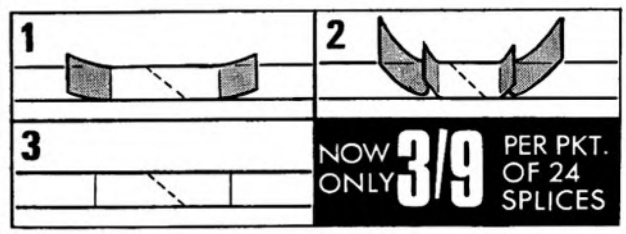

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operated device. To keep the record straight, however, it should be mentioned that there is a type of transistor (called a field-effect transistor —F.E.T.) that has a very high input impedance, but this is not yet employed in tape recorders, though at the time of writing is finding application in the housing of very low-level microphones.

Having now a basic idea of how the *n-p-n* transistor operates, the same mode of illustration should be applied to the *p-n-p* type. Here, because the emitter is *p*-type semiconducting material, the emitter passes *holes* to the base when base current is flowing, and these diffuse through the base layer, and are attracted to the negatively charged collector, thereby giving the collector current, which is a function of the base current, as in the *n-p-n* transistor.

From the aspect of the use of transistors in tape recorders, the most important point to remember about the two types of transistor is the polarity of the electrodes. If a transistor is connected with the incorrect polarity (i.e., by inadvertently connecting the supply source or battery round backwards) it will almost certainly change its characteristics permanently for the worse; that is, if it is not completely destroyed.

Since a transistor is basically similar to a valve in the aspects just considered, it follows that it can be connected in circuit in a similar manner to a valve. This is, indeed, true and it is sometimes possible to substitute a transistor for a valve provided due consideration is given to component values, supply potentials, polarities and so forth.

FIG. 1

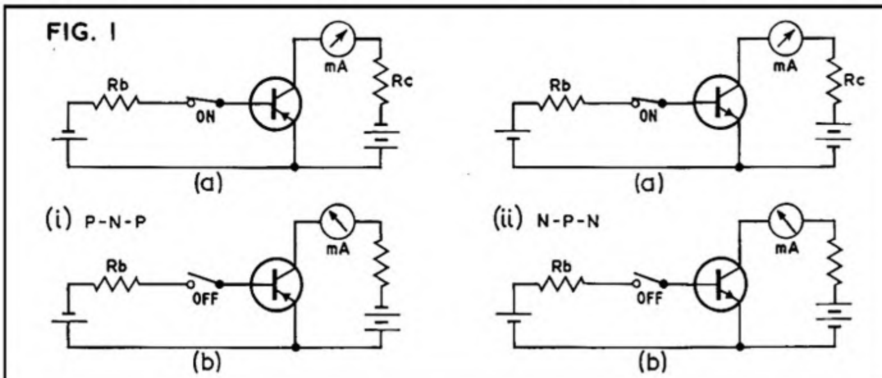
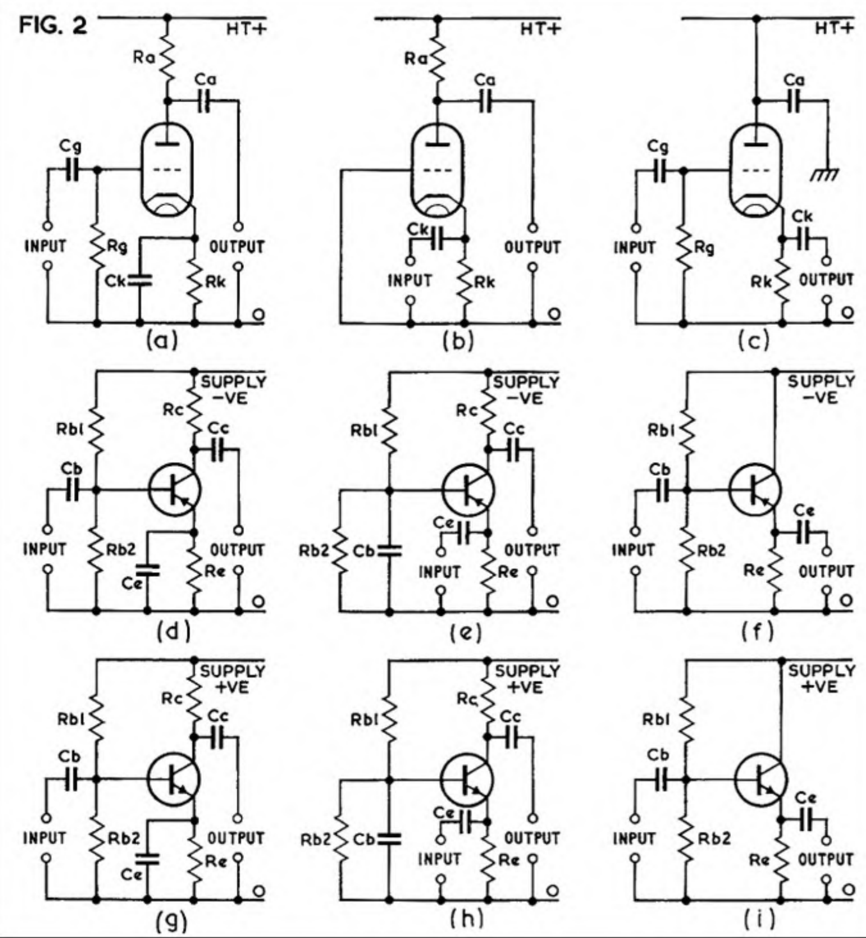


FIG. 2



Most of the transistors used in battery-powered tape recorders are arranged as signal amplifiers and impedance matching devices, and it is from these aspects that we shall commence our discussion on transistor circuits, absorbing the necessary basic theory as we proceed, but always keeping as practical as possible.

Fig. 2 shows the three chief valve configurations at (a), (b) and (c). These are respectively the grounded-cathode circuit, the grounded-grid circuit and the grounded-anode circuit. At (a) the input signal is applied at the grid and taken from the anode, at (b) the input is applied to the cathode and taken from the anode and at (c) the input is applied at the grid and taken from the cathode. The most well known circuit is that at (a). Circuit (b), sometimes called the cathode input circuit, has a low input impedance and a high output impedance, while circuit (c), sometimes called the cathode-follower, has a very high input impedance and a low output impedance.

The input and output impedances of (a) are both high, and this represents the basic amplifier.

In all the valve circuits, Rg is the grid resistor, Rk the cathode resistor and Ra the anode load resistor. In (a) the input signal is fed through capacitor Cg and extracted through Ca, these capacitors passing the signal while isolating the connected circuits from the DC. In (b) the input signal is applied through Ck and extracted through Ca, while in (d) the input signal is applied through Cg and extracted through Ck.

For a valve to work correctly, its control grid must be biased a little negatively so that the positive and negative half cycles of input signal will swing the anode current up and down the characteristic curve with the minimum of distortion. A battery is rarely—if ever—used nowadays, and the bias is provided by the volts drop across the cathode resistor due to the anode cathode current flowing through it.

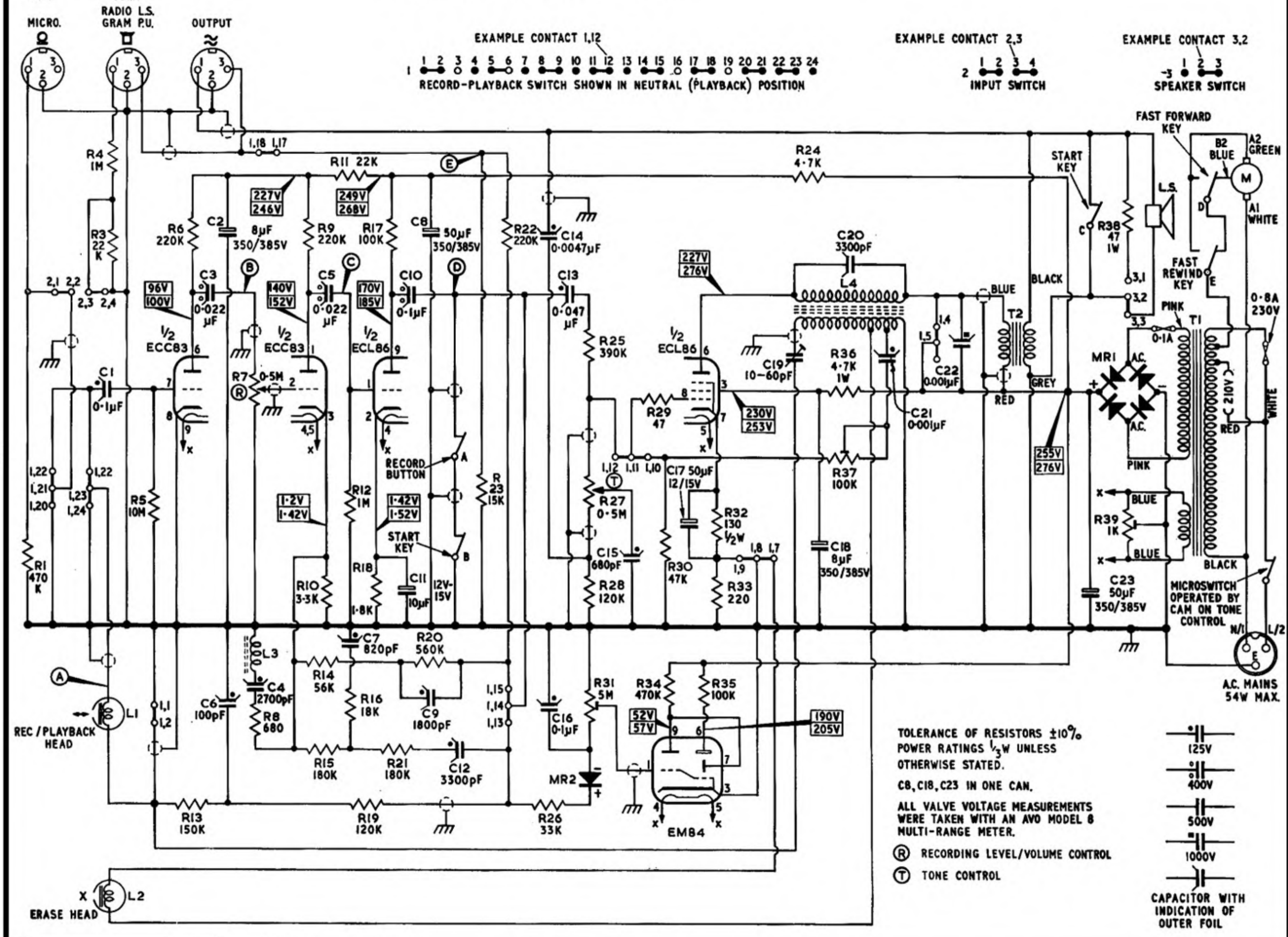
Consider circuit (a). Here anode current flows through Ra and Rk. The latter is usually of a lower value than the former, and a small voltage is developed across it, making the cathode positive with respect to supply zero (i.e., HT negative). A typical volts drop here may well be 3V. Thus, the cathode is three volts positive with respect to the HT negative line. Now, since the control grid is connected to HT negative through Rg, the cathode is also 3V positive with respect to the control grid, which is exactly the same as the grid being 3V negative with respect to the cathode. Hence, the control grid is automatically biased negatively, as required.

The same applies to Rk in all circuit configurations. Ck in (a) shunts Rk simply to bypass any signal voltage across the resistor, the presence of which acts as negative feedback and reduces the stage sensitivity.

We *need* signal across Rk in (b), of course, so Ck here is the coupler. The same applies to circuit (c), again Ck being the coupler, as we have seen. Ca in (c) holds the anode at earth line potential signal-wise, which is a requirement of this circuit.

(*continued on page 488*)

FIG. 1 GRUNDIG TK14 CIRCUIT DIAGRAM



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BY H. W. HELLYER

GREAT firms like *Grundig* make so many tape recorders that choosing a particular model to discuss is rather like judging a beauty contest. As always, there are a few choice contenders, scoring on this or that professional point; and one or two who seem to have strayed by accident from the knobbly knees line across the way. The safe way of avoiding having one's eyes scratched out is to select a 'typical' model.

The Grundig stable can be divided into the earlier 'solenoid' models, the *Reporter* range, and the scarifying relay-laden types such as the *820* and *830*, then the 'single-control' group, such as the *TK20*, *25*, *35*, etc., and the later abrupt change of style that brought us the *TK14*, *23*, *40*, and now the *17*, *18*, *120*, *400* and the *L* variations. This is a very broad division, taking no account of the *TK6*, and the stereo models of the *TK41*, *46* category, which have some very striking differences in both deck and electronics. Nor does it embrace the tiny *EN3*, which I hope to be allowed to deal with later.

For the present, let us take a middle course and look at the first of the key-operated group, the TK14, whose circuit appears on the facing page. The deceptively simple two-valve amplifier shows what can be done with some clever mechanical switching, while the deck mechanism is basically similar to the later, more ambitious models. It thus gives us a good descriptive talking point.

This machine is a good deal easier to service than its predecessors. Removal of the top cover and the base allows access to most of the 'vitals', and releasing the amplifier printed-circuit board to the extent of its connecting leads lets one carry out the majority of tests with the machine in a working mode—a facility which some other manufacturers would have done well to copy !

The top plate is removed by releasing the four fixing screws (noting that the short one comes from the position near the start key—at front right), then pressing down slightly on all six keys to let the lips clear the cutaway of the plastic. A gentle upward pressure with the thumbs then raises the moulding enough to let one lift it forward and up, clear of the recessed clamps at the rear. Head assembly, spool carriers, belts, levers and keys are all then accessible.

When re-assembling, it is easier to fit the rear edge into its recess first, with the plate resting just above the keys at the front, then depress the outer key on one side slightly, press the plate down and do the same on the other edge, finally applying even pressure at the sides to allow it to seat firmly all round. Take care with the positioning of the edge-controls, milled plastic wheels for the volume and tone controls, to ensure that they do not foul the side of each cutaway.

A point to check when the plate is off: the on/off switch attached to the volume control. This is a simple device, depending on the rotation of the control spindle, but as it is held in place by a small screw, which can work loose, intermittent action, occasional arcing or a completely dead machine may originate from this minor fault.

The base is held by four screws through the rubber feet. When this is removed, the lower part of the circuit board can be seen, with its metal screen mounted on spacers fitted to the four holding screws. Slackening these screws slightly renders the screen plate loose enough to be slid down until the screw heads are clear of the eyelet shape of the retaining holes, and it may then be lifted away. This gives access to the solder-point side of the printed board, but to get at the components it is necessary to take out the screws completely and release the crank arm of the record switch from a slot in the Paxolin slider. This can be reached from the side without much trouble—and it is vital to remember not to overlook replacing this lever in its slot when re-assembling, or you may damage the switch.

The board swings down, hinged by its connector leads which all approach from harnesses at the rear (the bottom when the machine is stood up for easy servicing). Some hum and perhaps a measure of instability may be noted if the machine is operated in this position with the screened plate removed, but this presents little difficulty except with the very rare distortion or noise fault.

In the main, the faults that may lead to removal of the board are loss of gain, severe distortion or oscillator failure. The first two faults should lead one immediately to the two coupling capacitors, 0.022μF, between the successive triode amplifiers, and the last may be a breakdown of the 3,300pF capacitor which tunes the oscillator coil, or a leak across the bias trimmer. (On the later ¼-track models of similar design, there may be a tendency for trackswitch faults to give misleading symptoms, and this should be checked before dismantling. The track switch on these machines is on the rear top deck.) One cause of oscillator failure, or apparent weakness, is a worn or damaged erase head. If a good recording can be made on 'clean' tape with the erase head disconnected, but erase is weak and recordings distorted when this is replaced, suspect the erase head itself.

The connections to the oscillator coil are very easy to get at, being taken to tags adjacent to the coil itself, and tests are easily made for continuity and relevant voltages (given on the diagram). One possible trouble that has been noted is the off-tuning of the oscillator by the iron-dust core dropping down in its former. Look for the base of the slug resting against the strip of transparent adhesive at the hole in the printed circuit board.

Note that the amplitude of the oscillator signal is determined by the amount of feedback from the transformer secondary to the ECL86 pentode grid. The weak link here is the 100K preset resistor, again accessible through a hole in the printed board, and too easily damaged by over-eager pressure. This lifts the rotating part of the slider and makes for bad contacts. Quite tantalising faults can occur from such trivial causes.

A small cause with a disturbing effect is that other favourite, the erratic switch. In this case, crackles and odd noises during Play, but apparently good recording, or good play with intermittent recorded bursts of distortion may have their origin in nothing more serious than a slightly loosened or offset screw in the swivel bracket of the Record push-button. The amount of movement of the lever that engages the switch slide is determined by a screw

(continued on page 481)

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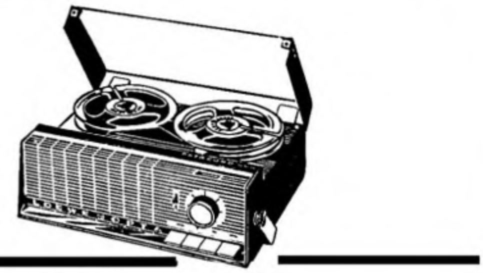

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Ferguson 3222	12	5	0	2	0	10	35
Grundig TK140 ...	13	6	0	2	4	4	38
Philips EL3558	14	14	0	2	9	0	42
Ferguson 3224	15	8	0	2	11	4	44
Wyndsor Vanguard ...	20	13	0	3	8	10	59
Philips EL3556	21	14	0	3	12	4	62
MAINS 2-TRACK							
Ferguson 3220	8	15	0	1	9	2	25
Grundig TK120 ...	10	6	6	1	14	5	29½
Tandberg 823	18	18	0	3	3	0	54
Brenell Mk. 5/3 ...	25	18	0	4	6	4	74
Brenell Mk. 5/3 'M' ...	32	11	0	5	8	6	93
Ferrograph 631	33	5	0	5	10	10	95
Ferrograph 633 Connoisseur	42	0	0	7	0	0	120
STEREO/MONO							
Philips EL3312	16	16	0	2	16	0	48
Sony TC250A	19	19	0	3	6	6	57
Philips EL3555	26	5	0	4	7	6	75
Akai 1710	27	13	0	4	12	2	79
Sony TC260	33	19	0	5	13	2	97
Tandberg Series 12 ...	36	15	0	6	2	6	105
Truvox PD104	36	15	0	6	2	6	105
Beocord 1500	36	15	0	6	2	6	105
Revox 736	44	9	0	7	8	2	127
Beocord 2000K	47	5	0	7	17	6	135
Beocord 2000T De Luxe	48	13	0	8	2	2	139
Akai X-350	66	10	0	11	1	8	190
Akai X355	83	6	4	13	17	9	239
BATTERY							
Philips EL3301	9	9	0	1	11	6	27
Telefunken 301 4-T ...	18	18	0	3	3	0	54
Akai X-4 Stereo ...	34	13	0	5	15	6	99
Uher 4000L ...	36	1	0	6	0	2	103

Just released :

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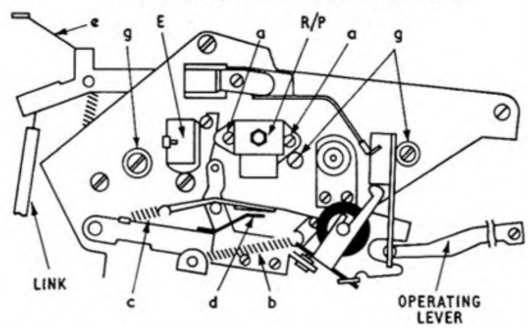
TAPE RECORDER SERVICE CONTINUED

FIG. 2

GRUNDIG TK14
AZIMUTH AND PINCH PRESSURE ADJUSTMENTS



R/P—record play/head. **E**—erase head. **g**—guides **a**—azimuth adjusting screws. **b**—pressure roller bracket tension spring. **c**—pressure sling tension sping. **d**—head shield plate on leaf spring. **e**—auxiliary brake lever.

adjuster and a small grub-screw limiter in the portion of lever that is pushed by the bottom of the push-button. There is no need to dismantle the printed board to check the engagement of the lever with the slide, as the makers have kindly provided a peep-hole for our benefit.

Belt changing on this model is very easy—a great improvement over earlier models. All that is necessary is the removal of the head mounting plate, shown in **fig. 2**, and the three belts are immediately accessible. Removing this plate is quite simple, but there are one or two small points to watch for. First, slacken the fixing screw and withdraw the EM84 complete with base and clip. Next, slide the small brass dust-cover up and off the capstan spindle. The easiest way to do this is with the spindle turning. While this important little joker is off, clean the nylon bush with methylated spirit and remove any foreign matter from around the inner surface. The upper bush of the flywheel can be cleaned when the plate is removed.

Release the holding screws of the plate and take care to retain the clip under the right one. This clip is used to provide a mounting hole for the top-plate fixing screw.

Once the plate is loose, move it slightly until the operating lever at the right is free of the fork of the pressure roller arm. Both slide in a cutaway bracket, and as the roller arm is strongly spring-loaded, refitting will need a little patience and juggling. Another point is the link at the left which fits in a small slot of the pause button lever, middle of the left-hand three. This needs a bit of finesse when refitting, and care should be taken that it is linked on the auxiliary brake lever (e in **fig. 2**), the correct way up. Never apply force when refitting. It is so easy to bend small levers.

If the tape position indicator belt is slipped off first, it is easier to release the head plate, without fouling the auxiliary brake lever. The whole plate can then be swung away to the right, hinging on its leads. The motor pulley to flywheel belt is taken off first, pulling it carefully between the motor pulley and idler wheel used for fast forward movement, while rotating the parts by hand. Always use this method when removing or fitting belts to prevent unnecessary strain. The principle is the same as getting the chain on a bicycle or a fan-belt on a motor-car, i.e., letting the periphery of the larger wheel do the work of pulling the belt into place. (On some Philips machines, for example, this is the *only* way of fitting the rather tight belt, and on the *Ampex* deck the width of the pulley flanges is such that the first time one replaces a drive belt one offers up a fervent prayer.

The take-up belt, which is usually the one that needs changing, giving the symptoms of poor take-up toward the end of the spool, is looped over a pulley section at the base of the flywheel. Do not try to remove the flywheel, but loop the belt over it carefully and hold in place with slight tension before slipping it gently over and round the clutch drum. A twist or two of the flywheel by hand will then run it into place. Before re-assembling, check that neither belt is fouling any of the deck assembly and clean any oil or grease from the belts with methylated spirit. The motor pulley is a thrust fit on the motor spindle, and there is a possibility this may have been compressed slightly on the torsion spring. A pair of claw pliers is a great help in positioning this at the correct level, with belt 14.5mm. above the chassis. Watch out for distorted fan blades on the models with top-mounted plastic or metal fans ; these can soon chop and ruin a new belt. If there is a slight metallic noise, in some cases like a varying motor hum, make sure the blades have not worked loose at the roots, and the bush is a good fit on the spindle. Some models in the TK14 and TK23 series have fans at the base of the motor, which can also work loose and cause odd noises.

The brakes on this model seldom need attention, but care should be taken to ensure that the two long curving rods are free. With each brake engaged, its appropriate rod should have at least a millimetre play, and the brake bracket must be able to move fully to clear the pad from the edge of the spool carrier. Note the positioning and arrangement of the brakes, which ensure that the correct tension is applied according to the direction of rotation.

One final point worth mentioning here is the tendency for guide wear. This can cause wow and is not always an obvious fault. A bright light shone across the head channel soon reveals flats on the cylindrical barrel sections. Apart from replacement, the initial cure is to slacken the guide slightly, turn the barrel section and retighten, making sure that the height of the guides is correct—a malfunction also revealed by wear marks. It is surprising the amount of abrasive action tape oxide can have !

Before refitting the top plate, run the machine. A scraping noise may indicate that the two clip brackets holding the head cables are slightly offset and intermittently fouling the flywheel upper rim. Check the clear running of the pressure roller, which is spring-loaded and, to a certain extent, self-adjusting. Note the tension of the pressure sling which takes the place of pads. Beware of cleaning the heads and running the machine before the cleaning fluid is completely evaporated ; this takes the flock surface from the sling and can cause curious squeaking noises. Note the head face plate, intended to prevent hum and noise pickup, and which should sit flat and true across the head shielding when the machine is switched to play.

Much of the foregoing applies also to the TK23, except that this model has the track switch, and an autostop, the lead to which has to be unsoldered before removing the headplate.

JAPANESE MIRACLE CONTINUED

The picture in **fig. 5** was recorded on the 'sees' without the recording system being operated. The sound accompaniment in this case emanates from the monitor's own speaker (only a small one, of course). And (iv), it can record and playback the sound and vision of any closed-circuit set-up as in (iii). To show how well these functions work, two sets of off-the-screen photos were processed, one set using a TV card as already discussed, and the other using the camera.

Fig. 9 shows a monitor picture of a girl televised by the camera at f1.9, 8ft. and illuminated by a 375W floodlight. This same sequence is shown again in **fig. 10** but this time played back from the tape after being recorded. There is little difference in definition between the two pictures. Better pictures can be obtained at close-up distances and in bright daylight, but the exercise was to see how the system operated under lighting conditions that could be obtained in the home during a winter's night and at medium distance from the camera.

There is some loss in definition as would be expected from the Test Card experiment, but the quality of the system is perfectly acceptable and corresponds to an *average quality* television picture found in most homes.

The contrast range on playback is extremely good, as can be seen in **fig. 6** (note the vertical contrast squares in the middle of the circle). Both line and field synchronising are also excellent. This was tested by recording several thirty-minute TV programmes on tape and then playing them back. At no time was there serious loss of sync.

As mentioned earlier, synchronising is a function of the head speed, and this is locked to field sync pulses recorded on the control track. These pulses are picked up on playback and compared in rate with those produced by rotation of the head, and this is where the small winding comes in (see at the six-o'clock position on the head assembly in **fig. 1**). A discriminator circuit is connected to both pulse sources and, provided the pulses coincide, the head motor is running at the correct speed. However, should the motor tend to run fast or slow, the pulses no longer coincide and the discriminator produces a correction voltage which is fed to the head servo-system, thereby bringing the motor back into step with the field pulses.

(*continued on page 488*)

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"Love is Forever"
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TC-SCX 3563

Joe Loss
"Go Latin with Loss"
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THE AWKWARD CUSTOMER

a tape sketch for two characters

BY DAVID HAINES

THIS SHORT PLAY must not be taken amiss. Its only purpose is to illustrate a vital aspect of drama-on-tape.

Recorded dialogue must always sound natural and spontaneous—much more so than dialogue on the stage. The only real way of achieving this high standard is by improvising some dialogue beforehand—and on a topic of controversial interest. Generally, of course, the topic should relate to the play or scene in question; the voices are thus effectively 'loosened up' in readiness for recording.

Accordingly, this play deliberately introduces the topic of creative recording—about which many amateurs hold strong views.

It should be easy, therefore, for any two enthusiasts to enact a similar (but less eccentric) customer-and-salesman situation. What (for example) should an efficient salesman tell a prospective customer? Perhaps a salesman should *not* be expected to give 'creative' advice.

Issues of this kind are soon clarified by dramatic improvisation—and frequently some useful criticisms and ideas are thrown up. For example, it might occur to the 'customer' to say: "Why is the tape supplied with the machine left blank? Why don't the manufacturers provide a demonstration tape with every machine?".

And the 'salesman' must genuinely try to give the answer on behalf of the trade.

After a period of improvisation, almost any play can be tackled with increased fluency and confidence—which will surprise all those newcomers who still imagine themselves incapable of acting.

ANNOUNCER: We present a snort play entitled *The Awkward Customer*.

SALESMAN: Good afternoon, Sir. Welcome to the Audio Emporium.

CUSTOMER: Thank you. I'm interested in buying a tape recorder, but I've never owned one before.

SALESMAN: Allow me to show you our range. This is a de-luxe model...

CUSTOMER: It's very elegant.

SALESMAN: It's also of the strongest possible construction.

CUSTOMER: And what exactly is the purpose of the machine?

SALESMAN: (*patiently*) I am about to tell you, Sir. On this machine, Sir, you can record on eight different tracks—and at any one of seven different speeds.

CUSTOMER: But what can I record?

SALESMAN: You can record for a total of 86 hours on one spool.

CUSTOMER: You're not answering my question. What sort of sounds can I actually record?

SALESMAN: You can record any sound between twenty cycles and fifty kilocycles.

CUSTOMER: I'm afraid you misunderstand me. I simply want to know the creative purpose of the machine.

SALESMAN: And I'm trying to tell you. The purpose of the machine is to provide every conceivable facility. See those knobs? They give you independent mixing on ten channels.

CUSTOMER: But for what reason?

SALESMAN: For combining ten separate sources of sound. Believe me, Sir, this machine represents a considerable technical advance.

CUSTOMER: All right—let's assume I've bought it. What type of recording activity can I now undertake?

SALESMAN: That's *your* business—not mine. You can always record the baby or something.

CUSTOMER: I haven't got a baby. I'm a bachelor.

SALESMAN: How about recording all your gramophone records on a single tape? It saves putting on and taking off.

CUSTOMER: (*haughtily*) Well, really! I envisaged something a little more artistic — something to which I can devote my powers of concentration and self-denial. I want a hobby worthy of the highest ideals.

SALESMAN: How about recording people blowing their noses?

CUSTOMER: Blowing their noses?

SALESMAN: (*earnestly*) You can easily make a collection of different types of nose-blowing. You might even win a prize—it's been done, Sir, it really has.

CUSTOMER: I'm afraid I live too lonely a life. Who would come and blow their noses for me?

SALESMAN: If it's friendship you're looking for, why not join a drama tape society?

CUSTOMER: I loathe and detest all forms of amateur theatricals.

SALESMAN: But think of the advantages of drama-on-tape. No learning of lines, for instance.

CUSTOMER: Are you implying that I have a bad memory?

SALESMAN: Of course not, Sir—I'm just pointing out the advantages of acting for the microphone. For instance, you don't even have to look the part. Even the ugliest person can play the hero.

CUSTOMER: (*angrily*) So I'm ugly, am I?

SALESMAN: (*hastily*) No, Sir—of course not—

CUSTOMER: I didn't come here to be insulted! I admit I've got bags under my eyes—but they are due entirely to overwork. (*wildly*) That's why I'm looking for a constructive hobby—something to help me relax!

SALESMAN: (*nervously*) Take it easy, Sir—

CUSTOMER: I've got to release my inhibitions! I'm all pent up!

SALESMAN: What are you doing with that chopper?

CUSTOMER: You said this recorder was of sound mechanical construction. Let's test it!

(*Rapid sound of smashing, followed by customer's maniacal laughter. Door slams, car engine starts and accelerates into distance.*)

SALESMAN: (*loudly*) Would you come up, Mac? We've got a little service job.

A MODIFIED MIXER

A. D. Marsh describes a studio installation based on the Robinson mixer

KNOWING the interest shown, by amateurs and professionals alike, in the 'other man's' equipment, and also to show how the professionals are willing to accept advice and ideas from amateurs and technical 'backroom' boys, it was thought that a peep into a small professional control room of a well-known recording firm situated in North Lancashire would be of interest to readers of *Tape Recorder*.

Dozens of records and masters are cut weekly at *Deroy Sound Service* for distribution in England and all over the world, both from professionally recorded tapes and from amateur tape recordings of weddings, choirs, groups, talks, etc.

The necessity of keeping abreast, or indeed ahead if possible, of competitors, means constant replacement of costly equipment as each new advancement is made. About a year ago, it was decided that new additions would have to be made in order to meet the demand for high level, high quality discs, cut from customers' own tapes or from tapes recorded in our own studios.

First essential was a new *Neumann* cutting lathe with its 150W feedback system to supplement the three less sophisticated lathes already in use. Then the latest American limiting installation, with its very rapid action (1μS) essential to keep the dangerous amplitude peaks from damaging the delicate and expensive cutterhead on high modulation.

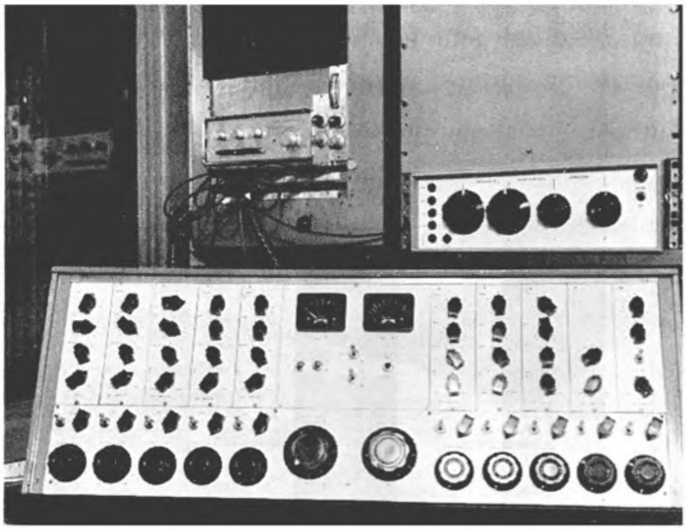
With the additional *AKG* and other high quality capacitor microphones to supplement others in use in the studio, it became apparent that a new microphone mixer was the next essential step forward. Leading makers in the U.K., Denmark and Germany quoted several thousand pounds for one 'made to measure' and it was decided to obtain the circuits and data to manufacture our own, incorporating all the needs of the present and forseeable future.

After much discussion and midnight oil-burning, getting circuits together, reading all procurable material on the subject, a rough idea took shape. The mixer would have to use transistors, with their many inherent advantages ; the latest types of transistors are capable, when used with correct circuitry, of very low noise and distortion figures, and their low impedance and small size make them eminently suitable for microphone mixers. The decision was also made to construct on the module principle ; being of flexible design, this would accept changes reflected on it from alterations or additions in other equipment.

At this stage we recalled having read in *Tape Recorder* an excellent series of articles by D. P. Robinson, and after re-reading the series it was thought that, with a few modifications, here was the very thing. We wrote to Mr. Robinson asking his opinion on the professional changes, and he replied promptly with circuit suggestions for new transistors and modifications to other parts of the mixer which he had carried out since the original articles were published a couple of years ago.

The mixer has ten channels and five microphone preamps (600/60 ohms) for use with dynamic microphones. Three line amps (600/60) are for use with high output capacitor microphones, and two auxilliary channels, one with high impedance module, accept inputs from valve equipment used for copying—*Radford* on disc, *Revox* on tape, etc. The other is a 600-ohm line preamp which is fed from upper or lower track playback amps (600 ohms) for track-to-track recording or flutter-echo.

Most of the live recording done in the studio is of the popular type which demands 'gimmicky' sound, therefore it is essential to be able to alter the response curves of each individual mike channel. This curve bender is inserted after each mike channel pre-amp and is the one described in *BBC Monograph No. 46* **(fig. 1).** It is essentially a low impedance



Above: Acoustically damped recording studio, with control rocm visible in backgrourrd.

Left: Modified version of the Robinson mixing unit.

Far Left: General view of the control room

version of the *Baxandall* tone control, giving a rising or falling characteristic at either end of the audio frequency range with a maximum excursion of 14dB at 60 c/s and 10 Kc/s.

The gain at 700 c/s remains constant to ±1dB. It also includes a 'presence' control which gives a peak at 2.8 Kc/s with an amplitude of 3dB or 6dB.

All input channels are switched so that they can be coupled to the upper or lower bus mixer amplifier. Each input is also fed via an echo-send pot. to echo mixer amps. All three mixer amps are standard as described in Mr. Robinson's articles.

The upper and lower track buses feed modified separate amplifiers and peak programme meters (**fig. 2**), and also feed the main channel gain controls and output amplifiers.

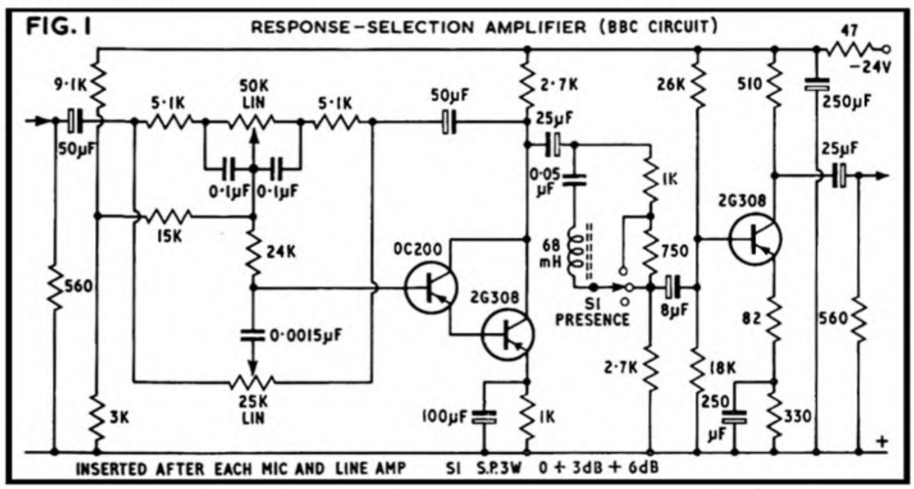
Each module is constructed on a punched board with turrets inserted in the appropriate places for each component. They are inserted in the mixer from the front with the connecting leads plugged in at the rear, these plugs and sockets comprising a 9-pin noval valve holder and plug. The centre portion of the mixer contains the bus amps, mixer amps and PPM amplifiers, channel routing switches, and a push-to-talk switch which operates a 12V relay. This relay mutes the play-back speakers and removes a short on the talk-back microphone placed on the mixer ; these precautions prevent feedback from studio to control room.

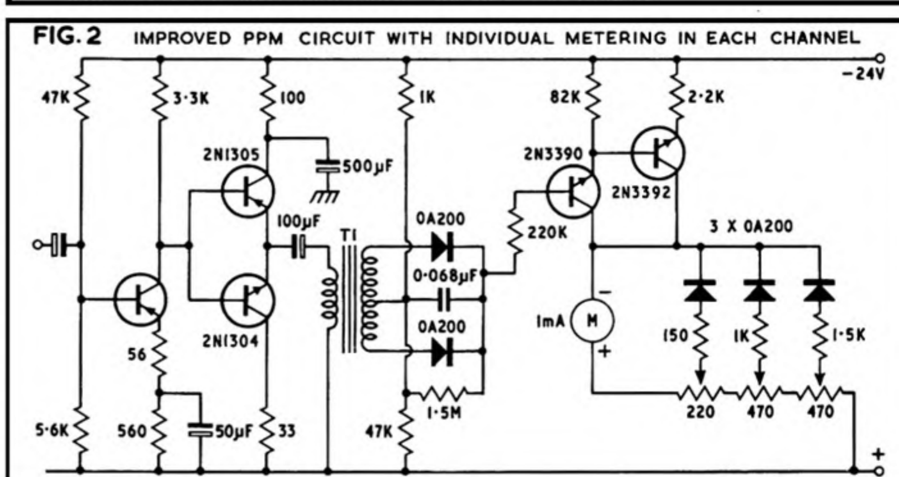
The cabinet was constructed from ¾in. aluminium alloy angle, bolted together, with two end cheeks and a top of ⅜in. plywood. The woodwork is grey to match the studio equipment and the front panels are matt white formica (handy for pencilled notes) with black *Lettraset* lettering.

On pop groups, the twin meters allow the vocals to be on one track and meter, with the accompaniment on other. With choral works, we split the choir up into sections so that those overloading can easily be seen on the PPM's in each section. At the time of writing the mixer has been in use each day for eight months, and distortion figures are well down to professional standards. We not only enjoyed planning and building the mixer, but saved a great deal of money, to be spent on a reverberation plate.

The mixer contains 85 transistors, 55 potentiometers and 40 switches and cost, with additional facilities, nearly £400.

Modifications to allow connection to *Fairchild* compressors and limiters have just been made. Most transistors are the more-expensive *Texas*. For fellow-builders we would mention that delivery on the PPM is from six to twelve months !





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GEORGE GOODALL
TONY FARSKY

BEN WEBSTER MEETS OSCAR PETERSON Seven items by Ben Webster (tenor), Oscar Peterson (piano), Ray Brown (bass) and Ed Thigpen (drums). **World Record Club TT495.** 3¾ i/s twin-track mono. 29s. 6d.

FOR AT LEAST a fortnight following the arrival of this tape it was hardly ever off my machine. Here is Ben Webster in great form with near perfect backing by the Oscar Peterson trio.

It is more than a quarter of a century since Webster joined the Ellington orchestra. But it is only in the past ten years that he has been widely heard as a result of numerous recording sessions, and is now acclaimed as one of the really great tenor men.

In a programme that, apart from *Sunday* which is taken at too fast a tempo, maintains a very high standard, *The Touch Of Your Lips* and *Bye Bye Blackbird* are my favourites. Blackbird begins with a chorus from Webster played with extreme economy of notes; after a solo by Peterson, Webster takes off on a series of improvisations that build and build to the end, which comes all too soon. The routine is similar for the other medium tempo items. The ballads *When Your Lover Has Gone* and *In The Wee Small Hours* are rendered with great feeling and the breathy vibrato that my wife calls the sexiest sound in jazz.

Oscar Peterson's piano solos are adequate but not outstanding, but his backing for Webster leaves no room for criticism. Although I like much of Peterson's solo work, it is as an accompanist that, in my opinion, he really excells.

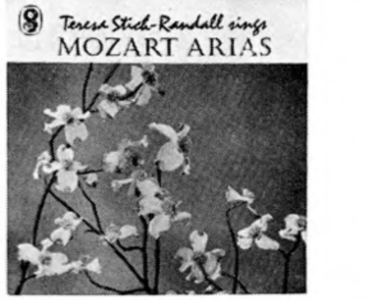
The jazz on this tape has the kind of direct appeal which should be enjoyed not only by the converted, but also by many who say they don't like jazz. **T.F.**

BRITTEN/DOHNANYI Young Person's Guide to the Orchestra (Britten), Variations on a Nursery Theme (Dohnanyi). Concert Arts Symphony Orchestra conducted by Felix Slatkin. **World Record Club TT506.** 3¾ i/s twin-track mono. 29s. 6d.

A FILM WAS PRODUCED in 1946 called *The Instruments of the Orchestra*, an educational film, and Benjamin Britten was asked to write the accompanying music for it. Such is Britten's craftsmanship that, to perform this task he composed a fine set of variations and a fugue on a theme of Purcell's, and this work has since found its place in the regular concert repertoire.

The Dohnanyi variations are based on a tune well known throughout Europe. We know it as *Baa Baa Black Sheep* and it has been used as a theme for a set of variations by a number of composers, one being no less a person than Mozart.

The performances given here of both works are satisfying, and there is some lively piano playing in the Dohnanyi variations, but the recording leaves much to be desired. On the review copy there was a hard edge noticable particularly on string tone severe enough to be noticed on even the smaller replay machines. The Britten variations especially demand a better recording than this. **G.G.**



TERESA STICH-RANDALL SINGS MOZART ARIAS Vienna Orchestra conducted by Laszlo Somogyi. **World Record Club TT425.** 3¾ i/s twin-track mono. 29s. 6d.

TERESA STICH-RANDALL'S quality of voice was the main item of interest for me on this tape. The arias, selected from the four best known of Mozart's operas, are of course lovely in themselves, but the soprano voice that sings them seems to command special attention. A very closely confined vibrato—almost no vibrato at all—gives her a pure sounding tone which in places sounds almost like a boy's. Her tone remains very firm at both extremes of its range, but there is a feeling of detachment from the characters of the arias that may not appeal to some. Personally, I like my Mozart on the cool side. Whatever one's taste, however, we are left in no doubt that Teresa Stich-Randall is a very fine technician.

The four operas covered by the selection are *Don Giovanni*, *The Marriage of Figaro Cosi Fan Tutte*, and *The Magic Flute* (to give the title that is best known, regardless of language). Although they are in the main well known, a comprehensive booklet gives the text and context of each aria.

The recording quality is not of the best. The frequency range sounds restricted and there is some slight edgy distortion here and there. Wide-range speaker users take note. **G.G.**

THE SHEARING TOUCH Twelve items by George Shearing (piano) and others. **World Record Club TT 466.** 3¾ i/s twin-track mono. 29s. 6d.

THE SHEARING SOUND, which was such a great commercial success in the 50's, is very much on the fringe of jazz. It is, however, worth recalling that thirty years ago Battersea born George Shearing was one of Britain's brightest jazz stars. In those days his forceful two-handed playing showed influences as diverse as Hines, Waller and Wilson, quite apart from that of the boogie pianists. For seven years in succession he was voted Britain's top jazz pianist in the *Melody Maker* polls.

It was only after Shearing left Britain for the U.S. that he came under the bop influence which lead to the unique sounds produced by the Quintet.

The music on this tape is a mixture of items by the Quintet and solo piano, which show, on the whole, less creativeness than much of the original Quintet's work of 15 years ago. **T.F.**

PERSONAL APPEARANCE Eleven items by Sonny Stitt (alto and tenor saxophones), Bobby Timmons (piano), Edgar Willis (bass) and Kenny Dennis (drums). **World Record Club TT441.** 3¾ i/s twin-track mono. 29s. 6d.

IF SONNY STITT has won less recognition than he deserves it is because his style so closely resembles that of Charlie Parker; but as Arthur Horwood points out in the thoughtful notes issued with this tape, the similarity of styles apparent at first is deceiving. Stitt, who became a jazzman during the Parker era, switched from alto to tenor to avoid being so closely identified with the master. Although I like much of Stitt's work on alto, I think his tenor playing featured here is even better.

Unlike the previous WRC Stitt release, *Only The Blues*, which I did not rate very highly, on this recording he plays superbly throughout, despite lack of support from the rest of the group. Both the drummer and the bass player unknown to me, fail miserably to get with Stitt and give him backing. Bobby Timmons's piano playing is also very disappointing. It is a great tribute to Stitt that he comes over so well despite the lumbering lack of support.

The programme is mostly 'standards'. On the slow ones, *Easy Living* and *Autumn In New York*, he stays close to the melody and plays with great feeling. On the medium tempo and fast numbers *Easy To Love, You'd Be So Nice To Come Home To, I Never Knew, Between The Devil And The Deep Blue Sea*, etc., he generates a powerful swing, inventing new melodies as he goes. Stitt himself says about his playing that you should "Tell something with prettiness into it", and it is this concern for melody that places him nearer to Lester Young than Charlie Parker. **T.F.**

JAN PEERCE SINGS FAMOUS HANDEL ARIAS Jan Peerce (tenor) and Vienna State Orchestra conducted by Hans Schweiger. **World Record Club TCM62.** 3¾ i/s twin-track mono. 29s. 6d.

HANDEL composed a number of operas and oratorios which are now only seldom staged. However, many of the arias from these works are well known as solos and one or two, such as *Where'er You Walk* from *Semele* have become popular entertainment over the years. Strictly speaking *Semele* is neither an opera nor an oratorio but a masque, a popular form of musical entertainment of the period.

Throughout this selection of ten arias, Jan Peerce maintains a stylised operatic type of voice which tends occasionally to be swamped by the orchestra His diction is not of the clearest on this tape, final consonants often being indistinct, and one needs the text, kindly supplied by World Record Club, to follow the words.

Apart from the balance between voice and orchestra, the quality of the recording is fair. Edgy distortion tends to appear in some louder passages, but is not severe. **G.G.**

A test was made, to see just how much the head speed relied upon the sync pulses, by shorting out the control head winding while a tape was being played back. The picture did not immediately lose lock, but after a few seconds a very slow field roll started, which almost immediately ceased when the short from the control head winding was removed. This tells of the high inherent stability standard of the mechanism. In practice, the machine takes about six seconds to stabilise itself from first starting the motor and tape transport.

The capstan is driven by a powerful, single-phase hysteresis motor, synchronised to the mains supply frequency. A heavy flywheel irons out most wow and flutter effects on the ordinary motion of the tape. A pull-up/push-down type switch allows the head motor to be operated with the tape stationary. This action tends to produce a still of a single field, but not very successfully, as under this condition the picture takes on a disconcerting vertical judder. Nevertheless, it does allow one to see what is on the tape at a particular point without the tape passing through the deck. Apparently, though, this is not a good thing to do for any length of time for fear of wearing the oxide off the section of tape exposed to the rotating heads.

This leads to head life questions. It is one of the big problems with any video tape recorder that, owing to the high tape/head velocity, the video heads quickly wear out and lose definition. On the Sony, however, it is understood that the head poles are composed of a very hard ferrite produced by a special technique that gives the heads a life of about ten times that of those produced by more conventional methods.

A remarkable feature of the Sony is its ease of operation. It is truly no more difficult to work than any audio recorder and TV set. Main deck controls are to the right of the video drum. The mains is switched on by a push-switch (shown in **fig. 1**), and the head motor is started by the switch referred to above. The capstan is started by the main lever visible in the right-hand 'control box' in **fig. 7**, which also gives fast rewind. For recording, the *record* button is depressed while the lever is pushed to *play*. The video and audio going into the heads is indicated on the meter the function being selected by the switch to its right. This switch also allows the AC mains supply to be checked on the meter.

AUTO SHUT-DOWN

Both vision and sound can be monitored on the TV set while a recording is being made, irrespective of the programme medium. An auto shut-down feature comes into operation at the end of the tape.

The TV monitor has sockets (miniature jack) for audio recorder and earphone, while the recorder proper has rear sockets for 'line in', 'aux in', 'camera' and 'microphone'. The microphone supplied with the system could be a wee bit more sensitive for comfort.

The switch on the front of the monitor unit allows instantaneous change between an ordinary TV broadcast and a taped programme, while a slide-switch on the tape deck changes from TV to camera.

The price of the whole system is just about

£500, made up of £365 for the tape unit and the TV (£180 in Japan) and £131 for the camera system complete with lens, tripod and carrying case. No price has been suggested for the tape unit alone, but assuming £100 for the TV monitor and about £50 for the monitor/recorder housing, the price of the deck minus the camera would be in the region of £215. Not all that costly when one comes to think of it, especially if the domestic TV could be used instead of the monitor. So far, this does not appear to be possible, but it is understood that the importers are investigating the possibility of an RF generator/modulator which could be connected direct to the aerial socket of any TV set and the set tuned to an unused channel for the VTR. What about tape? Well, this costs £12 per spool, giving an hour's programme time.

NO NEED TO THINK CONTINUED

or in a locale that requires distant effects as well as immediate sounds to be captured; taping a stage show without the advantage of a comprehensive microphone system; working in remote areas where the machine must perforce be left out of reach or sight while the microphone is either manipulated in one shaky hand or clipped, lavalier-fashion, to some convenient button; all these are conditions where manual setting of recording level is bound to be a hit-or-miss affair. Many a potentially good tape has been spoilt by a hasty twitch at the controls.

This should not be read as an unequivocal championing of a 'look-no-hands!' technique. Under studio conditions, or in favourable circumstances where the relative levels can be anticipated and a manual setting made, the author would always plump for 'manual' record level control.

Manufacturers recognise this foible, and in many of the Auto machines we now find an over-riding switch inserted. This converts the machine to a 'normal' manually-controlled device. In the model which we are at present considering, the *Philips EL3552*, this consists of a simple push-button between the two front control knobs, and is a very effective selling point, in conjunction with the usual magic eye. It is as well to conclude this first article with a look at the whole circuit, given in **fig. 4**.

The input stage is formed around an AC107 transistor, but this does not affect our study and is only included for interest. From the collector of this stage, the signal is coupled to a triode amplifier stage, half of an ECC83, and thence via the diode D1 as a rectified bias control to the EF83. This is a vari-mu valve, i.e., its gain depends on the amount of bias with which it is being fed. Whereas a normal valve amplifier has a straight curve of anode current plotted against grid voltage, the vari-mu valve has a curve which flattens and tails off at the bottom end so that instead of cutting off the anode current when the bias reaches a slightly negative value, the gain is gradually reduced. **Fig. 5** shows comparative curves, **(a)** straight and **(b)** vari-mu.

Selection of 'Auto' puts the signal from the input stage, via C10, SK2 and C12 to the grid of the EF83. The gain of this vari-mu valve is regulated by the negative voltage from the rectifier circuit, and the exact choice of components determines the amount of recovery time. A very high value of grid load for the controlled valve is selected during Auto operation, consisting of two 22M resistors in series, a total of 44M.

In this particular circuit, the ECC83 triode is used to amplify the signal and apply the control voltage. This frees the amplifier circuit from the varying load—and possible distortion—that would be caused by tapping off a higher control voltage from a later stage. But where control of recording level is a paramount consideration, and the quality of the waveform less exacting, as in a machine employed principally for speech, this device can be adopted. It is, in fact, used in a very early version, the *Grundig Stenorette*.

BATTERY TAPE RECORDER CONTINUED

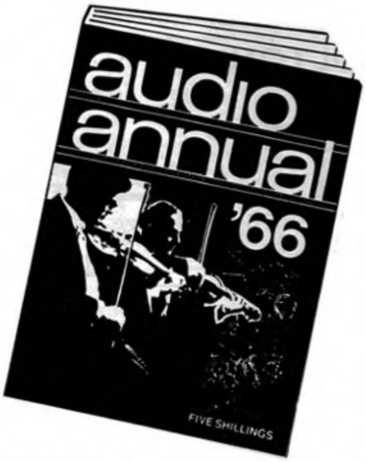
In the *p-n-p* transistor configurations at **(d)**, **(e)** and **(f)**, the base bias is supplied by the potential-divider composed of Rb1 and Rb2. This is across the supply and the resistor values are arranged so that a small negative voltage is applied to the transistor base, relative to the emitter. The collector is connected to supply negative in each circuit and at **(d)** and **(e)** Rc represent the collector load, across which the amplified signal is developed (equivalent to the valve anode load Ra).

In circuits **(d)** and **(f)** the signal is applied to the base through Cb, and in **(d)** and **(e)** extracted from the collector through Cc. In **(e)** the input signal is applied through Ce and extracted through this same capacitor in **(f)**. Capacitor Cb in circuit **(e)** grounds (or earths) the base signal-wise, for a direct connection as in **(b)** would short-circuit the bottom arm of the base potential-divider and destroy the base bias. The collector in circuit **(f)** is earthed signal-wise through the low impedance of the supply circuit.

Comparing series **(a)**, **(b)** with series **(d)**, **(e)**, **(f)** may lead one to believe that the emitter resistor (Re) is equivalent to the cathode resistor (Rk) in the valve circuits. This is not really true, though, for although collector current flows through Re, thereby causing a volts drop across it, this is not sufficient solely to bias the transistor in most circuits. Hence the need for the base potential-divider. Re, however, has another purpose, that of stabilising the transistor from the DC point of view, as we shall see in a later article. Ce across Re in circuit **(d)** serves the same purpose as Ck in the valve circuit **(a)**.

Series **(g)**, **(h)**, **(i)** are exactly equivalent to series **(d)**, **(e)**, **(f)** apart from the type of transistor and the polarity of the supply voltage. The circuits have purposely been shown side-by-side to highlight (a) the nature of the transistor symbol and (b) the difference in supply polarity related to the symbol.

The transistor circuits in **fig. 2** should be studied and committed to memory, for they form the essential building bricks of all battery-powered tape recorders. Next month we shall look more closely at these circuits and study how the transistor amplifies an audio signal.



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equipment reviews

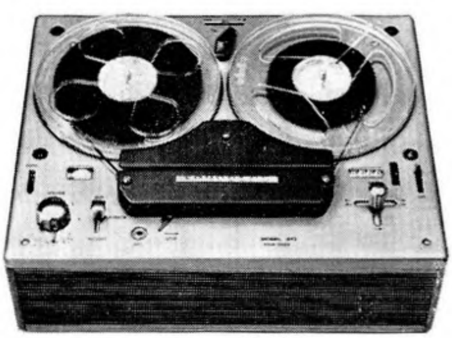
ONE of the first *Tandberg* recorders sent to me for review was the *Model 3B*, which was similar to this machine in many respects. I remember being very impressed by the cleanness of reproduction on both internal and external wide-range speakers, and by the excellent frequency balance on the internal speaker with the carefully designed switch bass-lift equalisation.

The *Model 84* has the same clean sound on an external speaker, but the internal speaker sounds 'tubby' with the switch on the 'bass' position, and lacking in body with a level frequency response. **Fig. 4** shows the overall electro-acoustic responses and reveals that the bass rise starts far too early at 2 Kc/s and acts in fact more nearly as a high note depressor; a sharp bass rise commencing at 300 c/s is needed with this speaker-cabinet combination.

The specified wow and flutter limits seem to be high by modern standards and the fluttergrams of **fig. 1** confirm that the short-term speed fluctuations are indeed higher than is usual in a machine of this class. The cumulative wow and flutter, when record and play imperfections add, are 0.19% RMS at $3\frac{3}{4}$ i/s and 0.2% RMS at $1\frac{7}{8}$ i/s. The lower limits, during partial cancellation, are 0.12% and 0.18% respectively. The 50 c/s motor flutter is barely audible, but the 5 and $2\frac{1}{2}$ c/s wow can be clearly heard on a sustained tone or chord.

The play-only responses to line output correspond closely to the test-tape characteristics of 140 and 280µS, **fig. 2**.

Record-play tests gave the responses of **fig. 3** which were identical on top and bottom tracks. The fall in bass response below 100 c/s would seem to be an amplifier effect or lack of full equalisation at very low frequencies, which will only be audible on external wide-range speakers and will certainly not be noticeable on the internal speaker.



500 c/s overload tests showed that a level 13dB above test-tape level could be recorded without distortion and that the magic-eye record level indicator beams just closed at this level. The time-constants of the magic-eye rectifier circuits have been nicely chosen so that the beams close sharply on the shortest transient and return to zero relatively slowly so that it is possible to monitor the mean recording level very accurately without missing (*continued on page 493*)

FIG. 1
TANDBURG 84
WOW AND FLUTTER

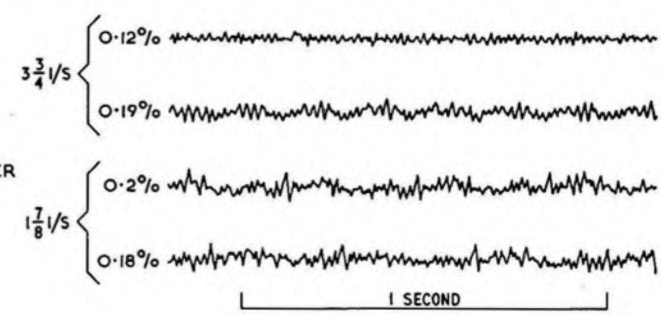


FIG. 2 TANDBERG 84 PLAY-ONLY RESPONSE (TEST-TAPE TO LINE OUT)

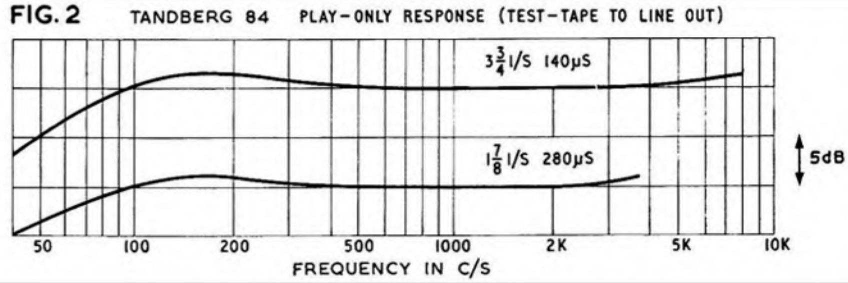
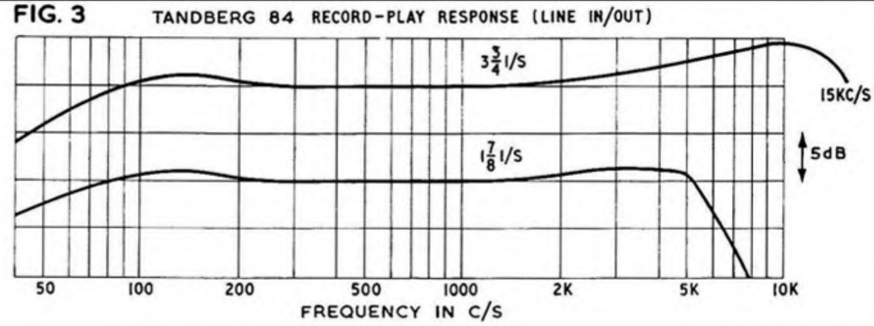


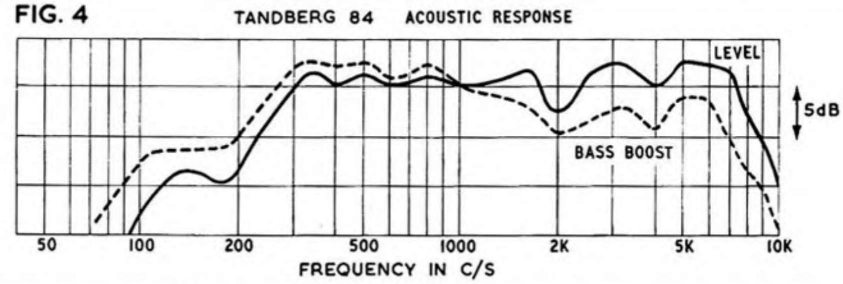
FIG. 3 TANDBERG 84 RECORD-PLAY RESPONSE (LINE IN/OUT)



MANUFACTURER'S SPECIFICATION. Quarter-track mono tape recorder. **Speeds:** $3\frac{3}{4}$ and $1\frac{7}{8}$ i/s. **Wow and Flutter** (respective): 0.2% RMS and 0.3% RMS. **Frequency Responses** (respective): 40 c/s-10 K c/s ±2dB; 40 c/s-4.5 Kc/s ±2dB. **Noise Level:** 50dB below maximum modulation. **Inputs:** Microphone: 1.5-7.5mV at 1M. Gram: 1.5-7.5mV at 0.5M. **Output:** 3W (3.5V across 4 ohms). **Dimensions:** 15 x $11\frac{1}{2}$ x $6\frac{3}{4}$in. **Weight:** 20 lb. **Price:** £61 19s. **Distributor:** **Elstone Electronics Ltd., 81 Kirkstall Road, Leeds 3.**

TANDBERG
MODEL 84

FIG. 4 TANDBERG 84 ACOUSTIC RESPONSE



a momentary overload due to a sharp peak.

System noise with no tape passing the heads was 35dB below test-tape level and erase and bias noise was 33dB below test-tape level, so that the unweighted signal-to-noise ratio was 46dB.

So much for the technical objective tests—but how does it handle and what does it sound like? As mentioned earlier, the switched bass rise is slightly wrong and, to my ear, should only be used for restoring the balance of programmes which suffer from excess treble.

Styling is excellent, with all controls on the deck panel. The bright nickel-plated metal knobs and control levers, together with the metal head covers, are a welcome change from the usual brittle plastic and give an air of solidity to the machine. Mechanical noise is low, but not quite so low as some of the earlier Tandberg recorders. A jack socket is provided for microphone input and inserting the microphone switches the input from the rear line input socket; the microphone must be removed for radio or gram recording.

I am a bit disturbed about the poor wow and flutter performance of this review sample. It is difficult to decide whether this is a low limit one which has slipped past the final inspection or whether it is the result of deliberate trimming of such luxuries as a *Papst* motor, to get down to a lower price bracket. We are so used to the near-perfection of Tandberg recorders that we are slightly shocked when we encounter one that barely meets the very conservative specification. Let us hope that this is 'the exception that proves the rule'.

A. Tutchings.

NO NEED TO THINK CONTINUED

A circuit of the very popular valved version of this machine is given in **Fig. 6.** This illustrates how the principle of AGC as used in the common radio receiver can be adapted to the recording amplifier with very little alteration. A signal is tapped off the output stage, actually from the secondary of the output transformer, rectified in a diode section of the multiple valve EBF80 and applied as bias to the grid of the pentode section of the same valve, and, via R3, to the input stage. A two-position 'Sensitivity' switch is provided, with a preset, allowing a variation of the original signal level applied to the controlled amplifier, at the operator's disposal. This circuit worked very well, and although the physical layout of these machines presented a little difficulty to the serviceman who was not experienced in handling them, the Stenorette gave sterling service for years before the Auto system was applied to tape recorders in the domestic entertainment market.

In the second part of this look at Auto circuits, we shall consider its application to the transistorised versions of the dictating machines, and outline in detail the popular auto circuits that have now become an accepted part of tape recording. Among these are the Grundig *TK18*, the *Telefunken* design, the *Ficord 202*, whose Auto circuit was introduced quite early, then omitted, and the *Elizabethan* variations on this theme.

READERS' PROBLEMS

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

RECORDED 'PLONKS'

Dear Sir, Could you please advise me on how to get rid of a very disturbing 'plonk' that is recorded on the tape every time the record button is pressed or released on my *Stella ST458*. This is particularly annoying when one is endeavouring to dub from one recorder to another. *Yours faithfully*, **A.R.K., Brixham.**

For some time we have been investigating the problem of recorded clicks and have had very little satisfaction from manufacturers. Almost unanimously they say it should not happen. You know, and we know, that it does.

You may simply be recording an acoustic click though this can be checked by operating the pause control before neutralising the switching.

Insertion of a component is unlikely to help. The trouble could be a sudden build-up of charge at the oscillator, and this can only be circumvented by arranging that the oscillator comes into operation slightly after the record circuits and drops out of action slightly before the recorder is neutralised. This can be quite a complicated matter. One or other of these conditions can be arranged by circuit modification—though not so easily on the 458, where the erase head, being shunt-fed across the main part of the oscillator coil winding, is virtually part of the tuning circuit; but for both conditions to apply, a relay change-over switch is needed. We think a deeper investigation of causes is needed before getting too involved with possible cures.

Check whether the 'plonk' happens as much at different gain settings. Check whether the pause control has any effect, and check the Mu-metal cover of the record/playback head for good chassis return. Note whether the leads have gone astray—their routing is important.

LONG MICROPHONE LINES

Dear Sir, I should be most grateful if you could advise me on cable lengths and impedance. I shall be working with a 75ft. microphone cable and am informed by my dealer that a 200-ohm microphone will be all right, though I was thinking of a 25-ohm balanced to earth set-up. Which would you recommend?

Could I feed a common-base preamplifier with high output impedance into a lower-impedance mixer input by loading the preamp with a suitable resistor and taking the signal off this?

Yours faithfully, **J.A.N., London, S.W.1.**

A fairly long line for a microphone in the order of 200 ohms impedance is perfectly satisfactory (the BBC use 500 ohms). For minimum noise and hum pickup any long line should be balanced, but this can only be achieved by a balanced output from the signal source and a balanced input at the amplifier programme circuit. For many ordinary applications an unbalanced line is suitable. The lower impedance (25 ohms) would not contribute much to signal coupling. In either case, however, the source and amplifier input impedances must (or should) be matched for the best results.

The output of a common-base amplifier could be connected more-or-less direct to the mixer input without trouble. There would be no need for the suggested load resistor.

PLAYING THROUGH A RADIO

Dear Sir, Is it possible to connect a tape deck to a radio receiver, using the latter as the amplifying unit? I do not wish to record from the set, merely to play a number of pre-recorded tapes. *Yours faithfully*, **J.A.B., London, S.E.9.**

It is possible to employ the audio section of a radio receiver as part of a tape recorder replay system. The 'PU' terminals can be used as inputs for this purpose. Results would be very poor indeed, however, if the tape head was connected direct to these terminals, due to the low level of the head output and need for equalisation. A small transistor equalised amplifier was given in fig. 4 of the July 1965 issue on page 253. Connected between tape-head and radio, the device should give perfectly satisfactory results.

ADDING A METER

Dear Sir, I have a tape recorder fitted with a miniature VU-meter which is about 1¼in. long. However, this is really only good enough to avoid overload distortion, as the needle deflection at normal sound levels is so small as to be quite useless.

Can I use the line output rated at 0.75V ±4dB, 47K, to feed a large diameter meter? If so, what type and rating of meter would be necessary to magnify the lower range of my present meter, and would it be necessary to protect the meter in some way when the volume level exceeds the range?

I would prefer to use the line output rather than the speaker socket as my tape recorder is fitted with separate input and output volume controls. I will then be able to record at a standard volume level while leaving the speaker volume setting untouched.

Yours faithfully, **J.E.S., London, S.W.20.**

The necessary circuits to operate a meter such as you describe can be taken from the 'Studio Mixer' series of articles in October and November 1964. It is not simply a matter of connecting a meter to the line output socket, but also of rectifying the signal and applying correctly averaged voltage to the meter. The type of meter stipulated is the Ernest Turner 100µA unit, available for about £1. If you cannot get this directly from a local retailer, write to Ernest Turner Instruments Ltd., High Wycombe, Bucks.

SOUND STUDIO MAGIC EYE ADJUSTMENT

Dear Sir, Please could you tell me if there is any way of altering the action of the magic-eye level indicator on my *Sound Studio De Luxe* ¼-track tape recorder. To obtain a strong recording, the level needs to be set such that the eye is fully closed. The eye operates on playback, but with a much weaker reaction.

Yours faithfully, **R.J.M., Guernsey, C.I.**

There is no facility on the Sound Studio for adjustment of the magic-eye, component values being chosen during design to give closure at peak modulation. Providing the valve itself is not at fault, the cause of this deterioration is probably the small rectifier which is in series with the signal feed from the output of the triode section of the ECL82 to the magic-eye input. This can be replaced with an OA70 and will probably cure the fault. If it does not, we would advise your experimenting with the 220K series feed resistor. Do not reduce it below 100K, or you will find the magic-eye circuit loading the head circuit and causing HF losses. There is a 680pF capacitor decoupling this 22K resistor, and this must also be checked, in case a slight leak has developed.

STATIC ON THE STELLA 455

Dear Sir, I have encountered a problem with background noise on my *Stella ST455* recorder. The noise is heard as a constant high frequency crackling which can be completely eliminated by the top-cut control. I ruled out the possibility of its being caused by fragments of oxide on the moving parts by a thorough clean-out with carbon tetrachloride, and eventually traced it to a static build-up on a pulley. There is only one motor in this machine, with a belt driving the take-up spools. This belt runs all the time the motor rotates, with clutch devices being operated for fast-winding.

I discovered the crackle was completely eliminated by touching a flexible wire between a convenient chassis point and the reservoir spool pulley. However this is not very satisfactory as a permanent solution since the wire would wear and, in any case, generates a certain amount of frictional (mechanical) noise. The static voltage generated does not appear to be high enough to be discharged by a fine point mounted as close as I could get it to the pulley. And why, incidentally, is the pulley not earthed through its bearings?

Yours faithfully, **C.F.P.H., Henley-on-Thames.**

It should not happen, of course, and the best solution is to ensure—as you suggest—that the bearing is earthed, the best way of doing this being to smear the bearing surface with molybdenum graphite grease. Then powder the drive belt with French chalk to stop the mechanical friction (static being the result of belt slip, which to some extent must be inevitable with a common drive system such as this).

CLASSIFIED ADVERTISEMENTS

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

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

SITUATIONS VACANT

Laboratory Stewards required at Ealing Technical College, St. Mary's Road, Ealing, W.5 for language/recording laboratories. Duties include maintenance of tape recorders and associated equipment, preparation of duplicate recordings, care and supervision of tape library. Salary Miscellaneous Grade IV £780-£880 per annum including London Weighting. Apply immediately to the Registrar at the College (Tel. No. GEO 4111).

FOR SALE—PRIVATE

Grundig T.K.6 battery/mains portable recorder complete with microphone, new, very little used, £40. Box No. 508 (Glasgow).

Brenell MK5 type 'M' recorder with matching Grampian DP 4 microphone, new, little used, £60. Box No. 507 (Glasgow).

FOR SALE—TRADE

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

A unique tape buy! Top brand 7in. 2,400ft. 25/-, 5¾in. 1,200ft. 15/-; p/p 1 at 2/-, 2 at 2/9, 3-6 at 3/6. Bargains in all sizes. S.a.e. for list. E. C. Kingsley & Co. Ltd., 93 Tottenham Court Road, London, W.1. EUSton 6500.

E.M.I. Professional unused tape, long play, 3,600ft. Highchute Ltd., 359 Oxford Street, W.1. (GRO 7288.)

Cash discount on most famous makes of tape recorders, Hi-Fi equipment, Cameras and Typewriters, to Club Members. Join England's largest Mail Order Club now and enjoy the advantage of bulk buying. Send 5/- for membership card, catalogues, price lists and ask for quotation on any item. C.B.A. (Dept. A1), 370 St. Albans Road, Watford, Herts.

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

Your sole U.K. agent for "Saja" spares and service. We carry many spares for the M40/M5 Export and M50. C. Braddock Ltd., 266 Waterloo Road, Blackpool. Tel. 45049, 24 hours answering service.

Grundig tape recorders—display models at greatly reduced prices: model TK17 de luxe, model TK18L and also model TK6 portable. One only of each type at greatly reduced prices to personal callers. Lancashire Hi Fi, 8 Deansgate, Manchester.

Akai X355 ex-professional studio model, hardly used. £200. Mocam Management Co. Ltd., 12a Moscow Road, Queensway, London W.2.

Amazing quality recording tape at bargain prices. Maximum satisfaction guaranteed. Special offer—with every 2 reels sold 1 free spool any size. Send s.a.e. for price list to Tape Sales Division, 100 Greatfield Road, Kidderminster, Worcestershire.

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Have you had details of my inexpensive RMS Fluttermeter? Also available on hire. Leaflet on request. W.H.M., 35 Villiers Road, Watford.

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

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MISCELLANEOUS

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Sleep Learning and Therapy. Two revolutionary techniques in their respective fields of Academic Learning and Mental Health which have been rendered possible by the invention of the tape recorder. Learn difficult lessons, memorise new data at short notice, master foreign languages, parts in plays or improve your mental powers. Send **now** for FREE details of our Sleep-Learning Recorder, Time Switch, Pillow Speakers, Cassettes, Induction and Language Tapes and general information about these vital subjects. The Institute of Sleep-Learning (TR), 16 King's College Road, London N.W.3. PRImrose 3314.

PERSONAL

Get 1966 AUDIO ANNUAL. An approach to tape recorder servicing; Whither stereo?; Tape prospects and problems; the hi-fi revolution. Plus a selection of the more important equipment reviews that appeared in HI-FI NEWS and TAPE RECORDER during 1965. 5/- from newsagents or 6/- (pp) from Link House, Dingwall Avenue, Croydon, Surrey.

Can anyone tape me occasional T.V. and radio items? Taped Stanley Baker material wanted. Box No. 506 (London).

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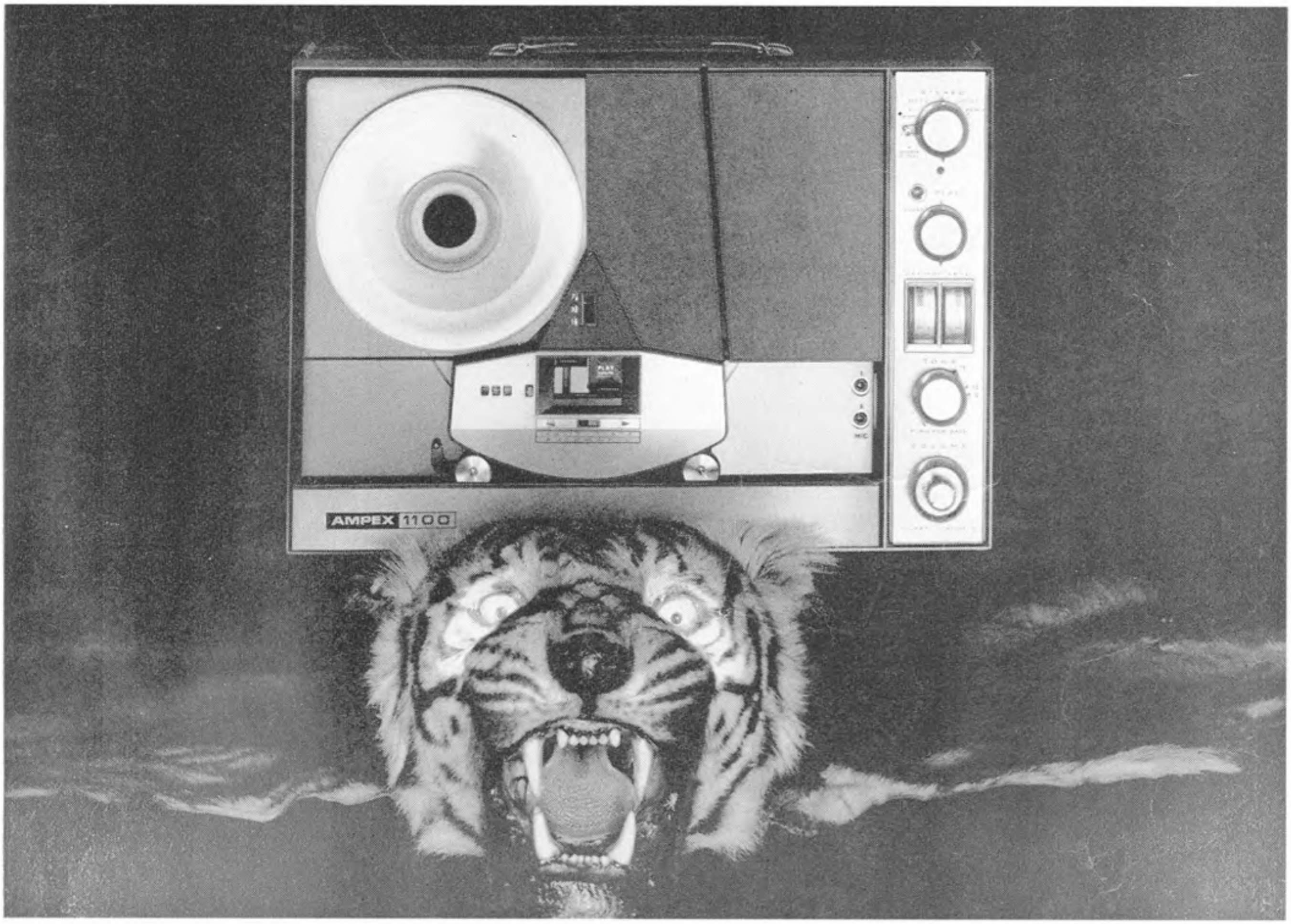

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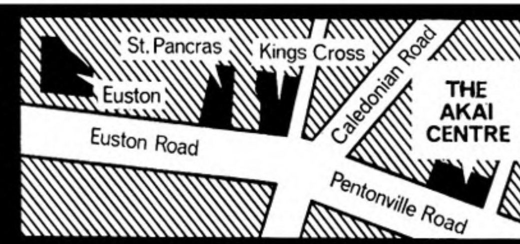
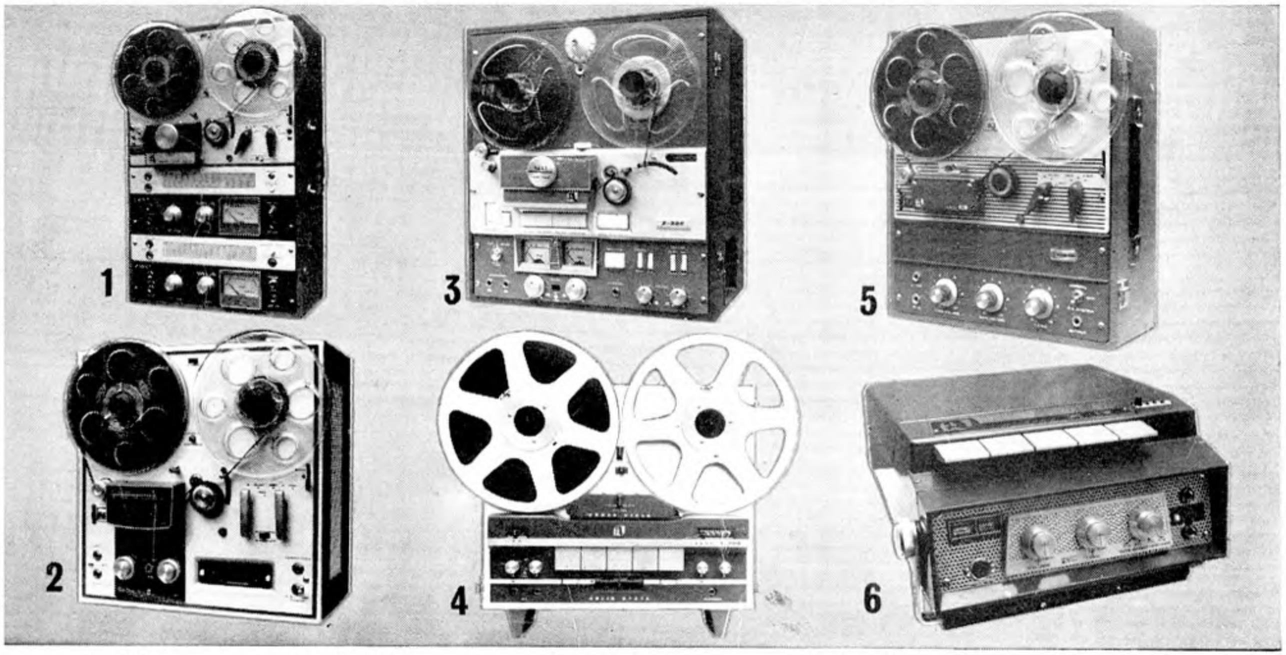
Ampex sales and service facilities are conveniently located throughout Europe and the Middle East. For more information write to: Ampex Great Britain Ltd., Acre Road, Reading, Berkshire, England. Telephone: Reading 84411. Ampex S.A., Via Berna 2, Lugano, Switzerland. Telephone 091/3.81.12. Ampex Europa, G.m.b.H., 6 Frankfurt/Main, Düsseldorfer Strasse 24, Germany. Telephone: 252001-5. Ampex, 41 Avenue Bosquet, Paris 7e France. Telephone: 705.38.10.

THE AKAI CENTRE





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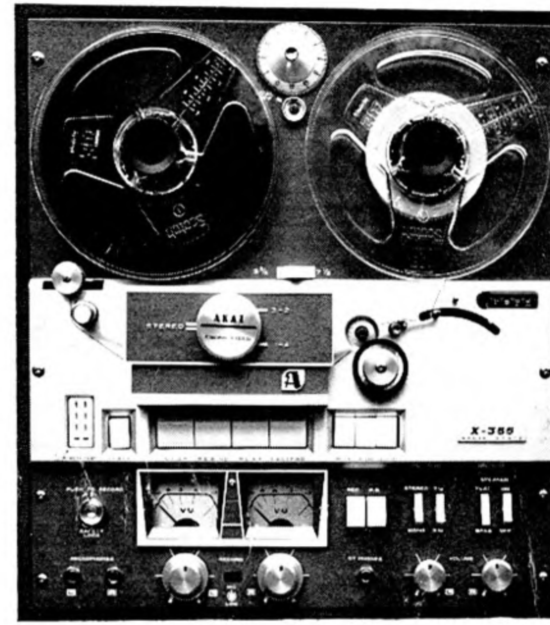

3. AKAI X355
A machine for the advanced amateur or professional, with 3 motors, 3 speeds, 4 heads (including Crossfield bias) and 20 watts per channel out-put. Fully solid state; push button solenoid operated controls, automatic reverse, repeat and shut-off functions. Built-in echo chamber effect. Full A.B. monitoring. Remote control facilities, etc., etc. **239 gns.**

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