FEBRUARY 1969 2/6d

# tape recorder

A LOW NOISE TAPE REPLAY AMPLIFIER

TRUVOX TRANSFORMATION

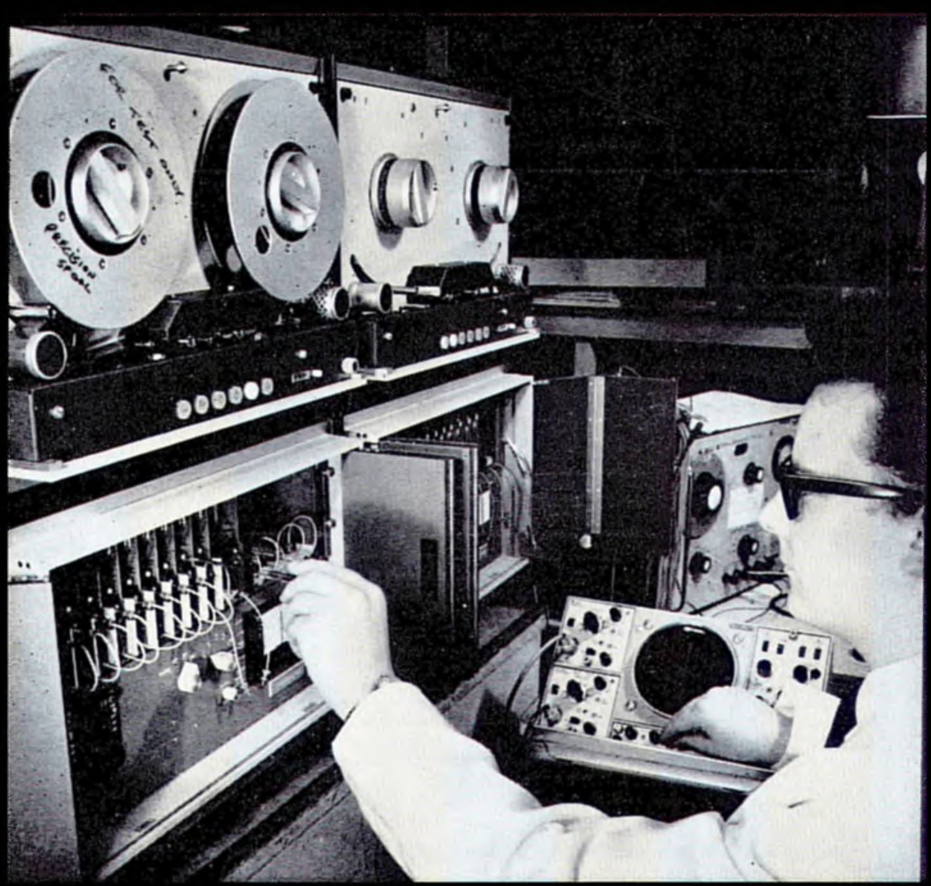
THE ART OF GOOD MICROPHONE MATCHING

AKAI X-5 REVIEW

AN INEXPENSIVE MICROPHONE BOOM

ANALYSIS OF AN AMATEUR

TAPE AT THE BBC MONITORING UNIT



# Ferrograph New Generation Series 7 -

# not a year old and already a classic

Ferrograph Tape Recorders, Series 1 to 6, have been famous since 1949, and although Series 7 was introduced only a year ago it is already acknowledged as a classic. No other recorder to-day gives you quality like this, reliability like this, and offers so many desirable facilities.

It has the finest specification—and when Ferrograph gives you a figure, it is a conservative minimum. Ferrograph guarantees it. Every instrument is individually tested. With Ferrograph you know where you are—exactly.

Available in Mono, and in Stereo with and without end amplifiers; with this unique range of 30 facilities:

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

U.K. Retail prices from £150 incl. P.T.
See and hear Ferrograph Series 7 recorders at your local Ferrograph stockist, or post coupon for details and address of nearest Ferrograph specialist (or ring 01-589 4485)

*Ideal for rack mounting*

*Elegant hardwood case*

*Grey vinyl case*


# FERROGRAPH

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

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

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

NAME ..........................................................................

ADDRESS ..........................................................................

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# K. J. ENTERPRISES

BRITAIN'S PREMIER MAIL-ORDER AUDIO SPECIALISTS

*Immediate despatch on Advertised Lines.*

Send Cash with Order.

DISCOUNT BARGAINS ★ VAST STOCKS OF TAPE & EQUIPMENT ★ REFUND GUARANTEE.

## BRANDED TAPES

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### BASF—EMI—GRUNDIG PHILIPS—SCOTCH—AGFA

***Brand new, Fully Guaranteed and in normal manufacturer's pack***

| | LIST PRICE | OUR PRICE |
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| **STANDARD PLAY** | | |
| 5" 600' Except Agfa | 22/2 | 18/- |
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| 7" 1200' Except Agfa | 36/7 | 29/6 |
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| 3" 210' Not Scotch | 9/3 | 7/6 |
| 3" 300' Scotch only | 9/7 | 7/9 |
| 4" 450' | 14/9 | 12/- |
| 4¼" 600' BASF, Agfa only | 22/- | 18/- |
| *5" 900' | 29/2 | 23/9 |
| *5¾" 1200' | 36/5 | 29/6 |
| *7" 1800' | 51/7 | 41/9 |
| 8¼" 2400' BASF, Scotch | 74/- | 59/6 |
| 10" 3280' Agfa only | 85/9 | 68/9 |
| 10" 3600' BASF only | 96/6 | 77/6 |
| 10½" 4200' Agfa, BASF only | 113/6 | 91/6 |
| **SCOTCH DYNARANGE (L/P)** | | |
| 5" 900' | 32/8 | 26/3 |
| 5¾" 1200' | 41/- | 33/- |
| 7" 1800' | 58/1 | 46/6 |
| 8¼" 2400' (Metal Reel) | 84/3 | 67/6 |
| **BASF PES.35 L/P Low Noise** | | |
| 5" 900' | 36/10 | 29/9 |
| 5¾" 1200' | 45/6 | 35/6 |
| 7" 1800' | 63/- | 50/9 |
| 10" 3600' | 115/- | 91/- |

| | LIST PRICE | OUR PRICE |
|---|---|---|
| **DOUBLE PLAY** | | |
| 3" 300' Not Scotch | 14/3 | 11/6 |
| 3" 400' Scotch only | 16/7 | 13/3 |
| 4" 600' | 26/- | 21/- |
| 4¼" 900' Agfa, BASF only | 31/- | 25/- |
| 5" 1200' | 43/2 | 35/- |
| *5¾" 1800' | 56/11 | 46/- |
| *7" 2400' | 79/- | 63/6 |
| 10" 4600' Agfa, only | 140/9 | 112/9 |
| **TRIPLE PLAY** | | |
| 3" 450' Not Scotch | 22/3 | 18/- |
| 3" 600' Scotch only | 24/10 | 19/9 |
| 4" 900' | 40/- | 32/3 |
| *4¼" 1200' Agfa, BASF only | 50/- | 40/3 |
| 5" 1800' Not Scotch | 67/2 | 54/- |
| 5¾" 2400' Agfa, BASF -only | 91/4 | 73/6 |
| 7" 3600' Agfa, BASF -only | 116/6 | 93/6 |
| **QUADRUPLE PLAY** | | |
| 3" 600' Kodak only | 37/- | 29/6 |
| 3¼" 800' Kodak only | 46/3 | 37/- |
| 4" 1200' Kodak only | 64/6 | 51/6 |
| **COMPACT CASSETTES** | | |
| C.60 | 17/6 | 14/3 |
| C.90 | 25/- | 20/3 |
| C.120 | 33/6 | 27/- |

GRUNDIG TAPE AVAILABLE ONLY WHERE MARKED WITH ASTERISK

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

## AMPEX TAPE—SAVE 30%

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

| TYPE | DESCRIPTION | LIST PRICE | ONE | THREE | SIX |
|---|---|---|---|---|---|
| 541-12 | 1150' on 5¾" reel Long Play | 35/- | 24/6 | 71/- | 137/- |
| 551-12 | 1200' on 5" reel Double Play | 42/- | 29/6 | 86/- | 166/- |
| 551-16 | 1650' on 5¾" reel Double Play | 55/- | 33/6 | 97/6 | 189/- |
| 551-24 | 2400' on 7" reel Double Play | 77/6 | 49/6 | 145/6 | 285/- |

POST & PACKING 2/6. ORDERS OVER £3 POST FREE.

## FERROGRAPH TAPE — 20% OFF

**Brand New. Fully guaranteed and in normal manufacturer's pack.**

| | LIST PRICE | ONE | THREE | SIX |
|---|---|---|---|---|
| BN7 1,200' on 7" reel (Dynarange) | 50/- | 40/- | 117/6 | 230/- |
| BN8 1,800' on 8¼" reel (Dynarange) | 71/- | 57/- | 168/- | 330/- |
| BL7 1,800' on 7" reel (Dynarange) | 70/- | 56/- | 165/- | 324/- |
| BL8 2,400' on 8¼" reel (Dynarange) | 90/- | 72/- | 213/- | 420/- |

Post and Packing 2/6. ORDERS OVER £3 POST FREE

## SENSATIONAL NEW HALF PRICE OFFER!

A bulk purchase of top quality Recording Tape manufactured by one of the Country's leading makers. A polyester based tape with superlife black coating. Polythene wrapped and fully guaranteed. Available while stocks last in one size only.

| | NORMAL VALUE | ONE | THREE | SIX |
|---|---|---|---|---|
| 1800' on 7" reel Long Play | 50/- | 26/6 | 78/- | 150/- |

POST & PACKING 2/6. ORDERS OVER £3 POST FREE

## ILFORD - ZONAL TAPE

### 40% OFF!

SOUND VALUE GUARANTEE

### NEW KJ SPECTACULAR

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

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

Post and Packing 2/6 Orders over £3 post free

**SPECIALISTS in PHILIPS, GRUNDIG, FERGUSON, SANYO & EAGLE EQUIPMENT**

## BARGAINS OF THE MONTH

## PHILIPS-STELLA

PHILIPS

***PORTABLE CASSETTE RECORDER***

**MAINS or BATTERY**

*SAVE 12 guineas*

**LIST PRICE £42** **OUR PRICE 28 gns.!** *Carriage 10/-*

**SPECIFICATION**

**Tape Speed:** 1⅞" *sec. using compact cassette system.*
**Playing Times:** *Up to* 120 *minutes using* C120 *cassette.*
**Freq. Range:** 80-10,000 *c/s.*
**Signal to Noise:** *Better than 45 dB.*
**Wow and flutter:** ±0.4%.
**Output Power:** 750 *m.w.*
**Inputs:** *Microphone (with remote control), Radio, Record player, etc.*
**Outputs:** *Diode (HZ) or Ext. Speaker (5-8 ohms).*
**Power supply:** *9v battery (6 × U.2) or 100-130 v or 200-240 v ac Mains.*
**Dimensions:** 12½" × 8⅛" × 2¼".
**Wt:** *(with batteries) approx. 6lbs.*
**Finish:** *Black and Silver.*

**MODEL ST9112**

*Full manufacturer's guarantee.*

Supplied complete with microphone, Recording lead and cassette.

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

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

## CHILTON

### This month we give details of the Chilton Stereo Portable Recorder, which can be the basis of a Hi-Fi set-up

- ★ Provision for microphone, radio and low output magnetic cartridge.
- ★ As an amplifier only with Baxandall Bass and Treble controls.
- ★ 10 watts R.M.S. per channel and fully protected by stabilised supply.
- ★ 4 Loudspeakers in rattle free cabinet (2 each side).
- ★ Solenoid controlled mechanism.
- ★ Quiet running deck, very cool even with prolonged use.
- ★ Fully transistorised on 10 printed circuit boards.
- ★ 3 head system and three speeds—19, 9.5, 4.75 cm/s

We respectfully suggest you have a demonstration, as volume and quality of reproduction are both impressive.

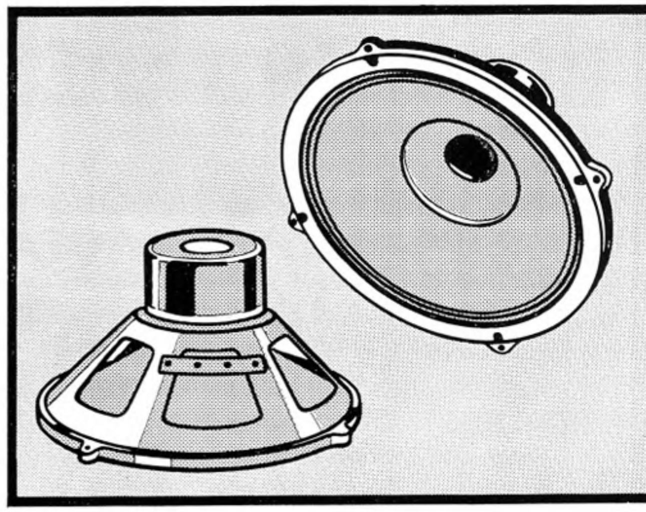
Finish—Charcoal grey with stainless steel trim.

Weight—38 lb.

Recommended price: 141 Gns. incl. pt.
Chassis version from 124 Gns. incl pt.

**Magnetic Tapes Ltd., Chilton Works, Garden Road, Richmond, Surrey**
**Telephone : 01-876-7957**

# Faithful Reproduction



## with the Grampian TC12 loudspeaker

The Grampian TC12 loudspeaker is a high quality twin cone unit at a reasonable price. The loudspeaker is built of high quality materials to a rigid specification and is eminently suitable for good quality sound reproduction. Let us send you full details or better still go and hear one at your local dealers now.

Design for suitable cabinet available.

**Grampian manufacture high grade microphones, parabolic reflectors, windshields and accessories, also mixers and amplifiers.**

**Grampian SOUND EQUIPMENT**
Integrity that you hear

Send for leaflet giving full details

**GRAMPIAN REPRODUCERS LTD**
Hanworth Trading Estate, Feltham, Middlesex
Tel: 01-894 9141/3 Cables REAMP, FELTHAM


# This is a page of hi-fi news.

Into the world of Hi-Fi, now and again there comes a product that represents terrific value to the enthusiast.

Such a product is the Grundig TK247 de luxe Stereo tape recorder.

Never before have so many professional features been incorporated in a machine at a price the amateur enthusiast can afford.

Permit us to dangle the specifications in front of you.

Four track, full stereo record and playback to Hi-Fi standard.

Independent record/playback controls and tone control.

Facilities for in-put mixing, super-imposition, multiplay and echo effects. Also monitoring via ear-phones, automatic tape-stop, parallel track operation, tape inching, and a tape joining channel.

More?

Right. Plated steel chassis and frame ensure perfect mechanical alignment.

Tape pressure band prevents drop-outs.

Double-action safety clutch. Easily modified for 60Hz mains operation. Amplifier hinges for easy servicing.

Two tape speeds give up to eight hours playing time.

Less than 0.15% wow and flutter.

Twin-edged illuminated VU level meter.

Two $6\frac{3}{4} \times 3\frac{3}{4}$" high-quality elliptical speakers with two-inch tweeters.

It is $17\frac{1}{2} \times 13 \times 7\frac{3}{4}$" and weighs 30 lbs.

Quite a tape recorder for anybody.

Please send me details of the Grundig TK 247 de luxe.

Name ....................

Address ....................

....................

....................

GRUNDIG

Dept. T.R.1 Grundig (Great Britain) Ltd., Sydenham, S.E.26.

# tape recorder

FEBRUARY 1969 VOLUME 11 NUMBER 2

INCORPORATING
SOUND AND CINE



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**COVER PICTURE**

Testing the performance of a Thermionic T8000 14-channel instrumentation recorder. Each system is assembled to individual customers' requirements, this unit being destined for an overseas university. A visit to Thermionic and their sister companies Truvox and Vectron is described on page 66.


**SUBSCRIPTION RATES**

Annual home and overseas subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 36s and 47s respectively. USA $4.30 & $5.60. Six-month subscriptions are 18s (*Tape Recorder*) and 24s (*Hi-Fi News*), from Link House Publications Ltd., Dingwall Avenue, Croydon CR9 2TA.

*Tape Recorder* is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.


IN NOVEMBER 1967 we published details of an Electronic Video Recording and Reproduction (EVR) system being developed by CBS. Revolutionary recording systems have suffered a high mortality rate in the half-decade since Telcan but, as did the latter, EVR has now achieved the stage of a public debut. The December 1968 unveiling, widely reported in the daily press and on television, is now being followed by a year of gestation before, in 1970, EVR is unleashed upon the world.

There were strings attached to Telcan. It worked, as a low-cost re-useable recording system, but was clumsy to operate, unreliable and inflexible. EVR on the other hand. is self-threading, technically elegant and extremely versatile. Vision is recorded by a scanning electron beam on 'photo-sensitive tape' (our definition of film!) at 12.7 cm/s, two tracks being recorded across 8.75 mm with magnetic sound strips at each edge.

The electronics involved in EVR are ingenious, if not entirely original, but the recording medium itself has all the hall-marks of once-only expose-and-dispose cine film. EVR offers the luxury of canned Telefilms which we shall purchase for a mere £20 view, view again, and . . .? Except as a rich man's plaything, the system can surely only survive through a low-cost library service; could *you* stomach *Dr. Zhivago* more than once a month?

Although EVR offers little in the way of domestic and educational recording facilities, it will channel demand away from video until the £350 price barrier is reduced to £200 or less. We doubt the feasibility of making helical scan equipment significantly lower in price than the Sony, but confidently await a price-cutting breakthrough in laser technology. Another five years?

The irony of modern television is that the 4 MHz bandwidth, though technically essential, is far wider than it need be in terms of information. Only a fraction of a typical television frame is significantly different from the preceding one and in the specialised conditions of a video telephone 'head and shoulders', this change represents an exceedingly small part of the overall bandwidth. Bell Laboratories have developed a method of capitalising on this phenomenon with the aid of pulse code modulation.

Another American concern, the UMC Facsimile Corporation, is experimenting with variable-velocity scanning to eliminate signal redundancies in a television system capable of transmitting a full size newspaper page per minute on an FM audio transmitter subcarrier. An entire newspaper could be transmitted each night and stored on 19 cm/s tape equipment in the viewer's home. An index would enable the recipient to select, by fast winding, the columns he wished to read. One step up, or down, from recording the BBC news on a time-switched audio recorder.

Sony recently developed a single-gun colour television display tube which is expected to undercut the price of conventional three-gun tubes. At the front end of the video chain, RCA have announced a single-gun NTSC camera which will shortly be marketed here at half the price of a conventional colour unit.

With such active research taking place across the oceans, it comes as no surprise to learn that an English branch of the American Audio Engineering Society is being formed by disgruntled BKSTS members. The AES Journal is in our opinion the ultimate in audio journalism (how modest can you get?) and we welcome any move to extend its influence.

**FEATURE ARTICLES**



**REGULAR ITEMS**



**EQUIPMENT REVIEWS**


# Ever Ready pack the performance! into battery operated tape recorders

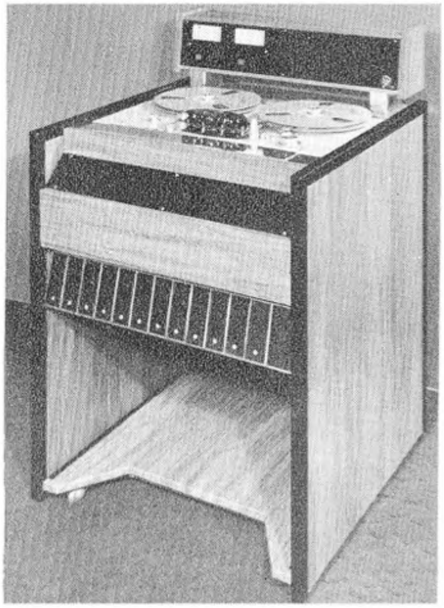
Ever Ready is the power that performs best in today's cordless record players and tape recorders. Ever Ready High Power Batteries pack in bright sound, crisp reproduction and much, much longer playing time!

Load up with Ever Ready Power – your customers will be expecting it.

The Ever Ready Co (GB) Ltd · Ever Ready House
1255 High Rd · Whetstone · London N20 · 01-445 8877


**Ever Ready pack the power in**

# WORLD OF TAPE



### £70,000 ORDER FOR LEEVERS-RICH

AN ORDER for a £70,000 multi-track tape installation has been secured by Leevers-Rich from Ross-Ace Recording Studios in the USA. Negotiations are currently progressing with major US studios for the sale of Leevers-Rich equipment valued at a further £305,000. The recent announcement of a new range of studio recorders has aroused great interest among overseas customers and export contracts now under negotiation total £750,000. Sales to EEC, Middle and Far East countries increased rapidly last year.

Production of *Type E Mark 6* recorders for Ross-Ace commences in January. The prototype pictured employs conventional 6.25 mm tape though the bulk of the order comprises eight 8-channel 25.4 mm consoles and eight 4-channel models.

### MICROPHONE NOTES

DETAILS OF Fi-Cord and Beyer microphones are merged with practical advice in a set of notes now available from *Fi-Cord International, Charlwoods Road, East Grinstead, Sussex.* Entitled 'Microphone Techniques and Applications', the notes are sensibly written for the tape recording and PA markets.

### VTR BOOKLET

A 44-PAGE booklet for users of videotape equipment has been produced by 3M. Entitled the 'Electography Producers Manual', it explains the virtues of videotape over other mediums and covers general handling matters, storage, lighting and colour recording. A technical glossary is included. Further details are obtainable from *Minnesota Mining and Manufacturing Company, Magnetic Products Division, P.O. Box 3388, St. Paul, Minn. 55101, USA.*

### AUDIO AND DESIGN DISC PRICES

PRICES OF Audio & Design discs in the December *Tape to Disc* survey were quoted incorrectly. 18 cm 45 r.p.m. SP pressings cost 16s. 6d. (25), 10s. 2d. (50) and 7s. 1d. (100). 18 cm 45 r.p.m. EP Varigroove discs are 20s. (25), 12s. (50) and 8s. (100). 30.5 cm LP Standard discs are 50s. (12), 30s. (25), 21s. (50) and 16s. 4d. (100). Prices of 30.5 cm LP Varigroove discs—60s. (12), 34s. (25), 23s. (50) and 17s. 4d. (100). Single-side direct-cut 18 cm discs are 22s. (SP), 24s. (EP) and 28s (EP Varigroove). Double-side prices are 28s., 30s. and 36s. respectively. All the company's discs are now cut to the current BSI standard with a deep run-in and run-out groove. Since adopting this, they have received no reports of difficulty with autochangers.

### CARSTON AUDIO HIRE SERVICE

A NEW DIVISION of Carston Electronics has been formed to supply various forms of audio equipment on long or short term hire. Nagra Neopilot recorders are immediately available at £25 per week. A full list of microphones and electronic equipment is available on request from *Carston Electronics Ltd., 71 Oakley Road, Chinnor, Oxfordshire.*

### PETER CLIFFORD ON METRICATION

'THE IMPACT of Metrication on the Film, Sound and Television Industries'—title of a talk to be given on January 29 at the Royal Overseas League, Park Place, St. James Street, London S.W.1. Commencing at 7.30 p.m., it has been prepared by P. M. Clifford of Hawker Siddeley Dynamics and forms part of the spring BKSTS lecture programme. Other talks in the series include 'Recent Research in the Development of High Quality Loudspeakers' (by R. E. Cooke and L. R. Fincham of KEF, April 16) and 'Some Transistor Amplifier Problems and Their Practical Solutions' (by P. J. Baxandall of the RRE Malvern, April 23).

### AUDIO ANNUAL '69

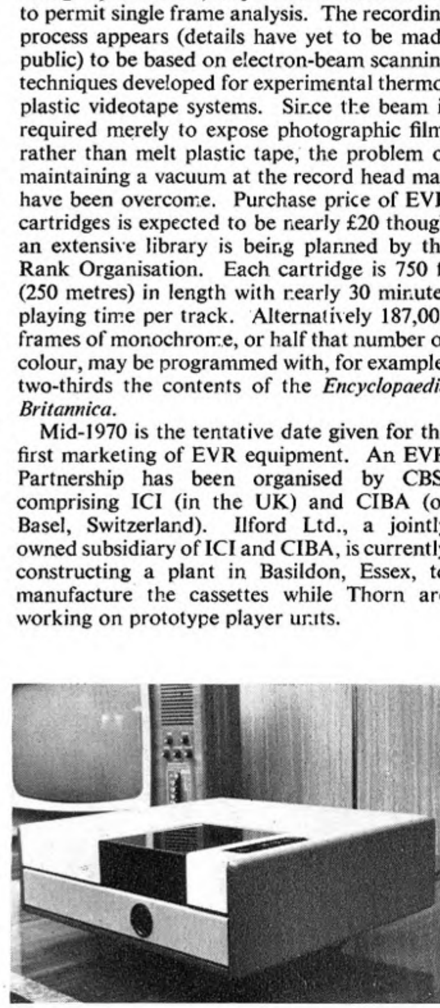
THE FOURTH AUDIO ANNUAL is now available at 7s. 6d. from bookstalls or 9s. by post from Link House Publications. Raymond Cooke, James Moir and Stanley Kelly are among the contributors, respectively covering 'Monitoring Loudspeakers', 'Waveform Distortion and Musical Quality', and 'Replay Stylus Compensation'. Some 30 *Tape Recorder* and *Hi-Fi News* reviews are reprinted in the Annual.

### EVR DEMONSTRATED IN LONDON

THE ELECTRONIC VIDEO RECORDING system reported in our November 1967 issue made its London press debut at the end of 1968. EVR is in several respects similar to 8 mm photographic film, carrying sound on magnetic edge stripe, though a flying spot technique is employed to permit reproduction through conventional television equipment. Invented by Peter Goldmark, President of CBS Laboratories and pioneer of LP gramophone records, EVR is being aimed at the educational equipment market and will not be marketed domestically until colour television becomes more popular. A broadcast-quality version has been developed which may compete with, or replace, conventional telecine and videotape.

EVR is primarily a reproduction system, requiring a £200 player (illustrated) to convert pre-recorded cartridges into monochrome or colour television programmes. The 8.75 mm film medium is transported at 12.7 cm/s and, though sprocketless, may be halted indefinitely to permit single frame analysis. The recording process appears (details have yet to be made public) to be based on electron-beam scanning techniques developed for experimental thermoplastic videotape systems. Since the beam is required merely to expose photographic film, rather than melt plastic tape, the problem of maintaining a vacuum at the record head may have been overcome. Purchase price of EVR cartridges is expected to be nearly £20 though an extensive library is being planned by the Rank Organisation. Each cartridge is 750 ft (250 metres) in length with nearly 30 minutes playing time per track. Alternatively 187,000 frames of monochrome, or half that number of colour, may be programmed with, for example, two-thirds the contents of the *Encyclopaedia Britannica*.

Mid-1970 is the tentative date given for the first marketing of EVR equipment. An EVR Partnership has been organised by CBS, comprising ICI (in the UK) and CIBA (of Basel, Switzerland). Ilford Ltd., a jointly owned subsidiary of ICI and CIBA, is currently constructing a plant in Basildon, Essex, to manufacture the cassettes while Thorn are working on prototype player units.



**NEXT MONTH**

**ONE OF THE most popular columns in the early years of this journal, *Tape Recorder Workbench*, is being revived in March by F. C. Judd under the monthly title *Sound Workshop*. W. H. Myall investigates peak limiters while Gordon King describes a new method of tape-controled slide changing. The King system requires no separate pulse track. Alec Tutchings will review the Truvox *PD202*.**

# Brief case for the Telefunken M 302

We're not going to give you a load of verbage about the marvellous features of the M 302.

It's a portable. Light. Compact. Handy, and easy to use tape recorder.

Words can't do justice to the sound quality. How can words explain what only ears appreciate.

There's just one factor we should like you to note. The M 302 has a frequency response of 40-14,000 c/s.

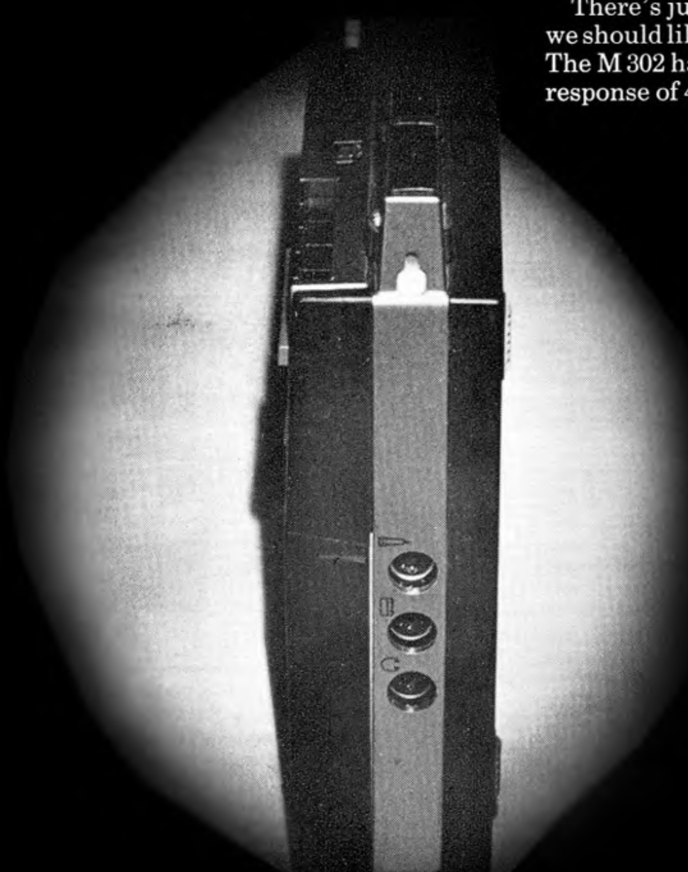
That's something many big mains models would be happy to claim.

So, if you're looking for a portable, make sure you hear the M 302.

It's another splendid example of Telefunken's philosophy, dedication to faithful reproduction.

See your dealer. Or write for full specification.

AEG/Telefunken
27 Chancery Lane
London WC2.



# Analysis of an amateur

## BY PETER BASTIN

AMATEUR: one who cultivates a particular study or art for the love of it and not professionally. So says my dictionary. It is unfortunate that the word 'amateur' has such a corny ring, redolent of pale-faced young men who make rugs and old men who think that they can paint like Churchill. It is allied to stamp-collecting, fretwork and brass-rubbing and has become a word associated with whims more than dedicated intent.

In our world of tape recording, the word has possibly a little more depth. To us, but not necessarily to the general public. An amateur tape recordist, to the man in the street, is the fellow who pokes a microphone up passing nostrils and asks what is thought of the last by-election.

It is an odd reflection that if the amateur recordist displayed a notice round his neck proclaiming that he was a *ferromagnetist*, he would in all probability receive considerably more respect from the man in the street. This form of bluffing is common in most walks of life. People who are not clever enough to pass the examinations of professional bodies sometimes join 'institutes' which exist solely for these misfits. Members can then use letters after their names which mean absolutely nothing to the professionals yet cut considerable ice with the unwary general public. The use of ponderous descriptions often hides insignificant ability and indifferent interests. For example, would you believe that a *physharmonicist* is someone who is interested in early harmoniums?

I have been recording as an amateur for some 15 years and, I suppose, have heard many hundreds of amateur offerings. I have heard tapes which have been so good as to make one wonder whether or not they have been recorded in a professional studio. I have heard tapes so bad that I have wanted to give up the whole business and become a layabout. And I have heard tapes which have been neither; indifferent tapes with bad scripts, bad voices, overlong and boring, yet with a high degree of recording quality. Somehow, somewhere, these tapes miss the boat and it is a great pity, for they form, by far, the majority class. What is wrong? It is rarely the equipment or the tape. Therefore, it must be the recordist himself.

I speak to tape-recording clubs on various occasions and find that these organisations are useful observation points in the study of the amateur. Most clubs have their quota of square pegs looking for square holes to fit into. You'll recognise them; strange-looking characters with slightly vacant faces, milling round listening yet doing nothing. Camera clubs and other clubs have the same sort of thing. At the other end of the scale you have a nucleus of bright characters who provide the driving force and, in between, the middleman quota—the people who listen, and learn, and try, but do not always succeed. Consequently, when the tape-club attempts a communal tape, the majority of the work is done by the nucleus of bright characters, the rest humping along, doing the labouring jobs. This is not meant in the nature of criticism; it is merely an attempt to analyse the role of the amateur in club affairs. I believe that the best amateur recordists are those who are lone-wolves. They can concentrate on their efforts and not be outvoted by others who may think that they are not working on the right lines; they can work at their own speed, outside the dictates of time. Whereas I believe in the lone-wolf policy, I do not by any means condemn people who belong, or want to belong to tape clubs. A willing member can learn a vast amount from his colleagues, especially if they are experienced amateurs and the fact that people of similar interests get together to talk about their interests can do nothing but good.

The amateur is not really liked by the professional and it is easy to understand why. The professional makes his living with a tape-recorder and he must, therefore, be very good at it. The amateur does not need to make his living at it and there is therefore no desperate incentive to be perfect. The professional feels that only he has the right to make recordings for professional purposes and jealously guards his rights in this respect. I understand this, for no one likes it when some amateur comes along and tries to undercut you as a professional whatever-you-may-be. But, surely, there must be some point at which the amateur and professional can meet amicably. On the assumption that the professional *is* good and on the assumption that the amateur is equally as good, it seems to me that the only interest to be served is the receiver's—ie. the client, the BBC, etc. In point of fact, the BBC are very good in this respect. They never ask you if you are a professional; so long as the material is good and of interest to them, they will take it.

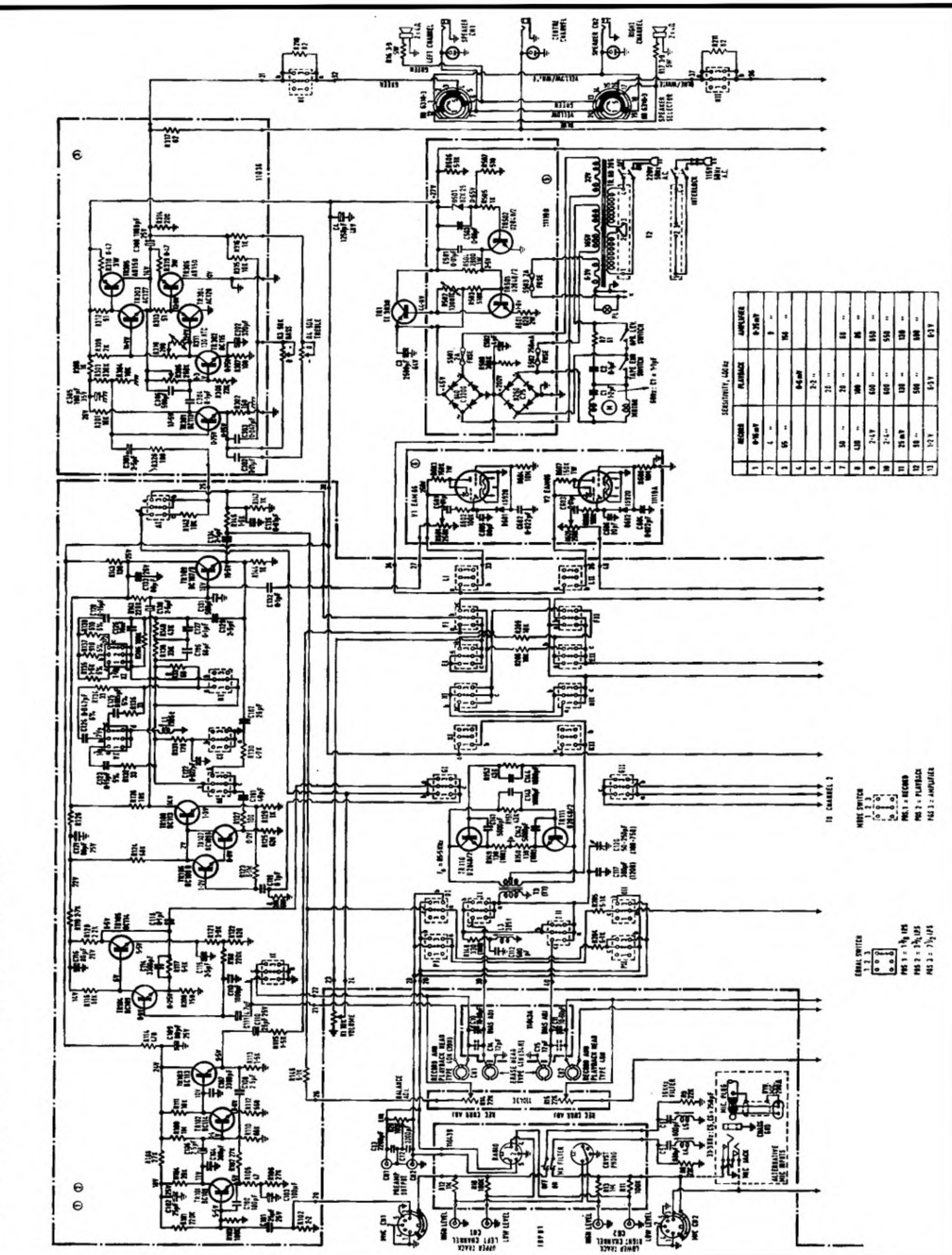
What then, is the amateur's goal? What standards must he achieve to provide real and serious competition to the professional? Firstly, he must make sure that he has the right equipment. A fifteen guinea Nip recorder and a crystal microphone will get him nowhere at all, although I have known excellent recordings taken on inexpensive machines. John Bradley's winning contest tape, a chat with a public convenience attendant, was one of the best actuality recordings I have ever heard and it was recorded at 4.75 cm/s on a battered Philips *EL3585* battery portable. Luck entered into it, as I am sure John Bradley will admit, for you can sometimes do a recording which turns out to be a gem. Try to repeat it and you will never succeed in reaching the same target. Even if you do intend to operate with an inexpensive battery recorder, you must have another machine to produce the edited master. No professional recordings are ever made at less than 19 cm/s for reasons of quality. So it would appear that an important requisite to bring the amateur up to professional standards is the provision of two tape recorders. And it goes without saying that he should have microphones to match in quality.

Then there is the attitude to the job in hand. It must be entirely dedicated. No artist ever produces a masterpiece if he's got his mind on a pint of *Brew Eleven*. If you are going to produce a tape on the vicar's garden-party, think of nothing else but the vicar's garden-party. Live it, think it, dream it; this is the stuff of professionalism. If you listen to amateur tapes you will be patently aware of a discrepancy in this direction. Emphasis is frequently in the wrong direction; concentration upon quality may be evident to the detriment of entertainment value. What is the point of a smashing-quality interview in Oxford Street if it goes on too long and is (a) very nearly drowned by traffic and (b) dominated by an interviewer with an appalling accent? The amateur should learn from the professional if he wants to compete with him and the best advice in this direction is to listen to the BBC.

Although I have heard some very good amateur tapes (nearly all of them contest winners) there are a number of inevitable marks of the amateur which appear in almost every tape. Let's examine them. Firstly, there is poor technique—clicks and bad splices. Then there is the too-rapid fade, the too-rapid cut-in, badly-balanced level between commentary and insert and, of course, mains hum. All these, except hum, can be overcome by thinking and trying a bit harder. Hum can probably be overcome by consulting a recorder surgeon. But make sure that he *is* a surgeon and not a stretcher-bearer. Then there is the biggest fault of all—overlong programmes, programmes meandering on and on, either devastating the subject or making a mountain out of a molehill. Almost any subject should be cut down to its very minimum at the outset. If, for any reason, it still appears to be too minimal, it is easier to add than prune. Interest in a subject stems from what is being *said*, not from a lot of waffle. Voices are important and more than one promising tape has been ruined by an adenoidal voice, uncultured and unlovely, snuffling its way through an otherwise acceptable narrative. Regional accents and brogues should *not* be excluded. A good regional accent can be most attractive, *so long as the speaker talks*

*(continued on page 74)*

FIG. 1 TANDBERG SERIES 12 CIRCUIT DIAGRAM (CHANNEL 1)




# TANDBERG SERIES 12

BY H. W. HELLYER

MY first encounter with the Tandberg *12* was an unhappy one. An influential customer, an architect, had bought the first one we had in the shop and installed it himself. A devil for concealment, he had mounted it behind heavy sliding doors in a rosewood cabinet, slung along one wall of a vast lounge. Two *Model 14* speakers were tucked in similar boxes, where they nestled inconspicuously in the corners of these converted wardrobes and must have made a string quartet sound like a gathering on the blasted heath. Shortly after installation, and luckily before the family had moved in, we had an urgent call to see to a 'complete breakdown'. The *12* being what it is, we thought first of fuses, realised that fuse-changing was a job for the engineer (and more about *that* subject later) and rushed off fully armed. But the cause of the fuse blowing spree was the method of mounting, which completely nullified ventilation. *AD150* output stages in Class B push-pull do not run unduly hot, but certainly need a bit of airflow over the collector cases to maintain correct operating temperature. And the complementary driver stage will easily over-drive when the ambient temperature increases.

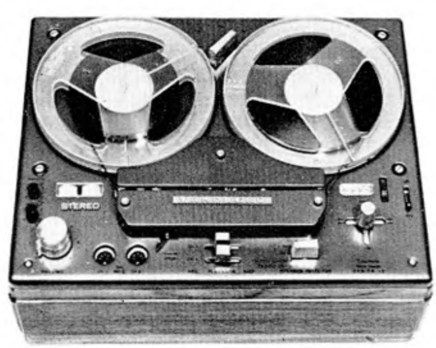
We insisted on raising the tape recorder on two blocks and bringing it slightly forward in the cabinet. Grudgingly, the owner permitted this challenge to his styling. And then, within a week, howled again. Complete failure!

We scurried back to find that he had suffered another of his many changes of mind and instructed his workmen to move the large cabinets in which the loudspeakers were concealed. Unfortunately, he had not told them that hefty woodscrews through the loudspeaker cables spelt death to transistorised output stages. It was—or, had Messrs. Elstone not been very kind to us, it could have been—an extremely expensive error. The internal loudspeakers are protected with a series resistor, as a safeguard against the output stages pumping full power into the small monitors in their own basic *Model 12* cabinet. The resistors are an incidental safety device for the output stages, when 'external' is selected, and the feed from the J21 sockets is taken to an external pair, but there is no remaining protection against a short-circuit.

Dismantling the deck offers no problems. Removal of the four main screws *through* the top plate allows the complete machine to be lifted from the cabinet, leaving only the loudspeakers. The flyleads are hardly long enough for much work to be done under these circumstances, unless both deck and cabinet are propped vertically. So extension leads are helpful, or J21 plugs with flyleads to external units. But, I beg of you, please protect the outputs when making tests. In our workshop we have small connector boards carrying linked jack and J21 sockets and these are taken to a pair of 4-ohm speakers with 10-ohm, 10 W resistors in series. The resistors can be switched out for quality tests, but we find that the practice of protective damping takes many worries away when working on transistorised equipment that may be of quite different ratings, as well as giving us a series test connection if we want it. The reduction in output is not significant for preliminary tests, and it is useful also to be able to monitor the test signal quietly while measuring across a correct load by having a series-damped loudspeaker.

The other precaution that must be taken here is the reconnection of the output leads from the main part of the machine to the loudspeakers after test. The speakers have three tags, with the 3.9-ohm wirewound resistors across two of them, and connection must be to the outer end of the resistor, and the opposite side of the speaker coil. Again, the tags are encased in plastic, and not always easy to fiddle into place. I find it easier to reconnect with both deck and cabinet vertical, as previously described, place the deck as nearly as possible in place, fit the rubber mounts on the fixing screws, and then tilt the whole assembly to the horizontal position, aligning finally before tightening up. This is easier than juggling with the rubbers while re-inserting—they always scuttle to the bottom of the cabinet, anyway!

On the subject of alignment, do not forget that the horizontal alignment of the top plate depends on the tightening of the two screws



at the top corners, i.e., beneath the spools. The plate has two rubber mounts beneath these screws (the reassembling secret is a touch of wax), and the compression of these rubbers gives the last adjustment for deck level.

There is a rule that those items which are most accessible are least likely to need attention. Tandberg are no exception. The fuses are mounted on a panel at the side of the bottom deck, necessitating removal from the cabinet for a fuse replacement. And, in earlier marks, the 2 A fuse for the 6.3 V winding that feeds the *EAM86* heaters and the pilot lamp was wire-ended and soldered into place, which is very naughty as the solder points are by no means easy to get at. I notice that fuse holders are now fitted, so complaints must have filtered back to Mr Nodtvedt, or somebody. Fortunately, one can make a temporary fitment, given the right fuse, by soldering to the first and third tags of the group along the top of this printed circuit board (tags 1 and 9).

I should like to add to the complaints my plea for accessibility of fuses on *any* piece of electronic apparatus. Quite often, in the field, one has to change a fuse in a hurry, and one cannot afford to miss the important parts of a recital while the innards are unscrewed and removed. I speak with feeling, having recently had the bitter experience of having to force apart the cabinet of a Sony *9-90* portable television to change a fuse—to the dismay of a customer, and the loss of a few more grey hairs on my part, for the sides of the rear shell were glued—yes, *glued*—to their supports. Fuses should always be available with no more than the removal of a small panel required.

Accessibility of the main printed panels is a little better, true. The panels can be removed fairly easily—just so long as one takes particular note of the colour-coded wires from each tag. This is mentioned because it is so easy to plunge into the job before dramatically realising that there are some close relatives in the colour scale, and the shiny insulation of Tandberg wires (another of the breed that curls away in disdain from the soldering iron, I fear), can make identification difficult. For the benefit of those who like information that may, like Grandma's extra combinations, come in handy one day, I add the colour code sequence of the connections on the edge of the panel from top to bottom. The right channel panel is to the 'inside' of the machine, by the way, nearer the motor. Colour code includes tracer wires, with a white basic colour and a tracer of identifying colour. Top tag, red. Next, inner of screened cable, and third, screen. On the right board the screened cable is green; yellow for the left channel. In sequence downwards after this: white/blue, white/grey, white/brown, white/yellow, white/green, white/red and finally, mauve. On the left panel, the colours may be lone, namely not white with the tracer.

There are some important differences in the layout of these panels between earlier production runs and those currently being sold. These differences include the return line from the emitters of the driver pair, joined by their 51-ohm resistor. A link from the positive end of the 1,000 μF speaker coupling electrolytic is taken to the emitter of the upper (emitter of *AC127*) of the pair, and the emitter resistor

(*continued on page 70*)

# THE ART OF GOOD MATCHING

## PART 1 MICROPHONES

**BY ANTHONY EDEN**

IN this article we shall be considering the problems that arise when matching a microphone to a tape recorder or some form of mixing unit.

First let us examine the meaning of the following data: Microphone: Impedance 600 ohms; Sensitivity (or Output Level) —72 dB ref. 1 volt/dyne/cm².

Primarily, microphones are voltage sources and voltage is the necessary form of drive for the input stage of a tape recorder. The voltage generated by the microphone is thus the first consideration. A microphone will generate a voltage at its output terminals only if sound pressure waves act upon the transducer. If the output voltages of various microphones are to be compared easily, there needs to be some kind of standard reference pressure level. In recent years the reference level that has become most widely used is 1 dyne/cm². This is equivalent to 0.1 N/m² (Newtons per square metre) which again is equivalent to 1 μB (microbar). The *Newton* and *dyne* are both units of force, the Newton being a part of the newer system of units known as the Metre Kilogram Second (MKS) system and the dyne forms part of the Centimetres Gram Second (CGS) system of units.

Pressure is defined as force per unit area and this is the dimension in which sound waves are measured. The Bar was originally used in meteorology for measuring atmospheric pressure and is derived from the CGS system of units. The reference level of 1 dyne/cm² refers to the pressure acting on the diaphragm of a microphone and in physical terms it is equivalent to the peak level of a normal voice at a distance of 1 metre from the microphone. Thus, this reference level is very useful for assessing whether the output from a microphone is sufficient to load the input of a tape recorder or mixer fully under average sound conditions. The voltage so generated at the output terminals of the microphone is quoted in one of two ways; either directly in millivolts or in decibels relative to 1 V. For those who are not used to dealing in decibels, **fig. 1** has been included to convert any reference to decibels relative to 1 V directly into volts.

Returning to our original data for a microphone, we now have the following equivalents:

—72 dB ref. 1 V/dyne/cm² which is equivalent to —72 dB ref. 10 V/Newton/m² which from **fig. 1**, is equivalent to 0.29 mV/μB and (as we have seen, 1 μB is 0.1 N/m²). This is equivalent to 2.9/N/m².

The various forms of the above data, are used by different manufacturers. It is unfortunate that the majority of microphone manufacturers quote output levels in terms of decibels while most tape equipment manufacturers refer to the maximum sensitivity of the microphone input in terms of millivolts. However, with the help of **fig. 1** it should now be possible to see if a particular microphone can provide sufficient voltage to feed a particular tape recorder.

It is important to remember that such a voltage output should be regarded as the minimum necessary for adequate input loading and any voltage less than this value may well result in 'under-recording' and hence undesirable tape and amplifier noise will be introduced into the recording. At the other extreme, most microphone amplifiers will not stand overloads greater than about 40 dB. This should also be borne in mind if the microphone is to be used for, say, close-up singing where the vocalist tends to sing very loudly. Under normal conditions of use, overload of the microphone amplifier does not present any problem.

Closely associated with the output voltage generated by the microphone is its *impedance*. We stated at the beginning of the article that we are primarily interested in voltage to drive the input of the tape recorder; power matching (i.e. exact impedance matching between units) is thus not very important. However, all dynamic and ribbon microphones are basically low impedance output devices, as well as being low voltage output devices. This voltage is often too low to conduct along great lengths of cable satisfactorily. Transformers of the step-up variety are used to increase the voltage and the voltage is stepped up in the same ratio as the turns ratio. Thus, a 1:10 transformer will step up the voltage 10 times from the input to the output terminals. In turn, it can be easily demonstrated that the impedance ratio will be stepped up as the square of the turns ratio. With a turns ratio of 1:10, the impedance ratio will then be $(1)^2:(10)^2$ or 1:100.

Ribbon microphones are basically very low impedance devices and require a transformer, situated in the microphone housing, to step up the impedance to some standard level, for example 30/50 ohms, 200/300 ohms, 600 ohms or 50 K. Dynamic microphones have a higher basic impedance, and models with an impedance of about 30 ohms will not have any transformer in the housing, but any higher impedance will require a step-up transformer. From the foregoing it can be seen that the voltage output level will be increased as the impedance increases. We should thus expect a dynamic microphone, for example the Grampian *DP4/L* with a basic impedance of 25 ohms and an output level of —86 dB ref. 1 V/dyne/cm² to be stepped up in the ratios of the **Table.**

| Microphone Output Impedance | Transformer Turns Ratio | Voltage Magnification | Output/ Level |
|---|---|---|---|
| 25 | basic value | 0 dB | —86 dB |
| 200 | 1 : 2.83 | 9 dB | —77 dB |
| 600 | 1 : 4.90 | 14 dB | —72 dB |
| 50k | 1 : 44.8 | 33 dB | —53 dB |

A reference to the manufacturer's specification soon shows that this is indeed the case.

To sum up, tape recorder input circuits require voltage to drive the input and thus we are primarily concerned with the problem of obtaining adequate voltage output from the microphone. Impedance matching is important only to obtain sufficient voltage to drive the tape recorder input, so long as the microphone impedance is lower than that of the tape recorder. The last point is important because the quoted sensitivity level of the microphone will not be obtained and, further, on certain microphones the frequency response will be impaired.

Let us now take a more detailed look at the voltage output generated by a microphone. First of all, the voltage generated by a microphone under standard pressure conditions is normally measured under open circuit conditions (i.e. no resistive load is applied across the terminals). This means that the microphone is generating its maximum voltage, and is the value normally quoted by microphone manufacturers as it is the most optimistic. However, a piece of simple mathematics soon reveals that under conditions of matched impedance (i.e. a 600-ohm microphone is fed into a 600-ohm load) the sensitivity may drop by as much as 6 dB in the worst case. Thus, it is not advisable to match a microphone directly, a problem that becomes more apparent with low impedance transistor input stages. It is for this reason that AKG, in their microphone literature, quote a minimum actual input impedance of 2 to 3 times the nominal impedance of the microphone. It is normal practice to feed a 600-ohm microphone into a load of approximately 2 K, when one can safely use the manufacturer's figure for voltage output.

One would only consider using a higher impedance microphone if the output voltage were not sufficient fully to load the tape recorder input. For example, consider the case where we wished to match the Grampian *DP4* microphone to the Revox *A77*. The manufacturer's data for the *A77* states: microphone input 0.15 mV at 6 K. We have three microphone impedances we could use which would meet the impedance conditions: those of 25 ohms, 200 ohms and 600 ohms. Using **fig. 1** we find that the output voltages are respectively 50 μV, 140 μV and 250 μV (approx.). Thus 140 μV output will be barely adequate for the 150 μV (0.15 mV) input to the *A77*, whereas the 250 μV output level provides an adequate safety margin and would be the preferred choice. If we consider the impedance of the microphone with reference to the *A77* input impedance we find that there is an adequate margin of safety with no danger of the full microphone output not being available under operating conditions.

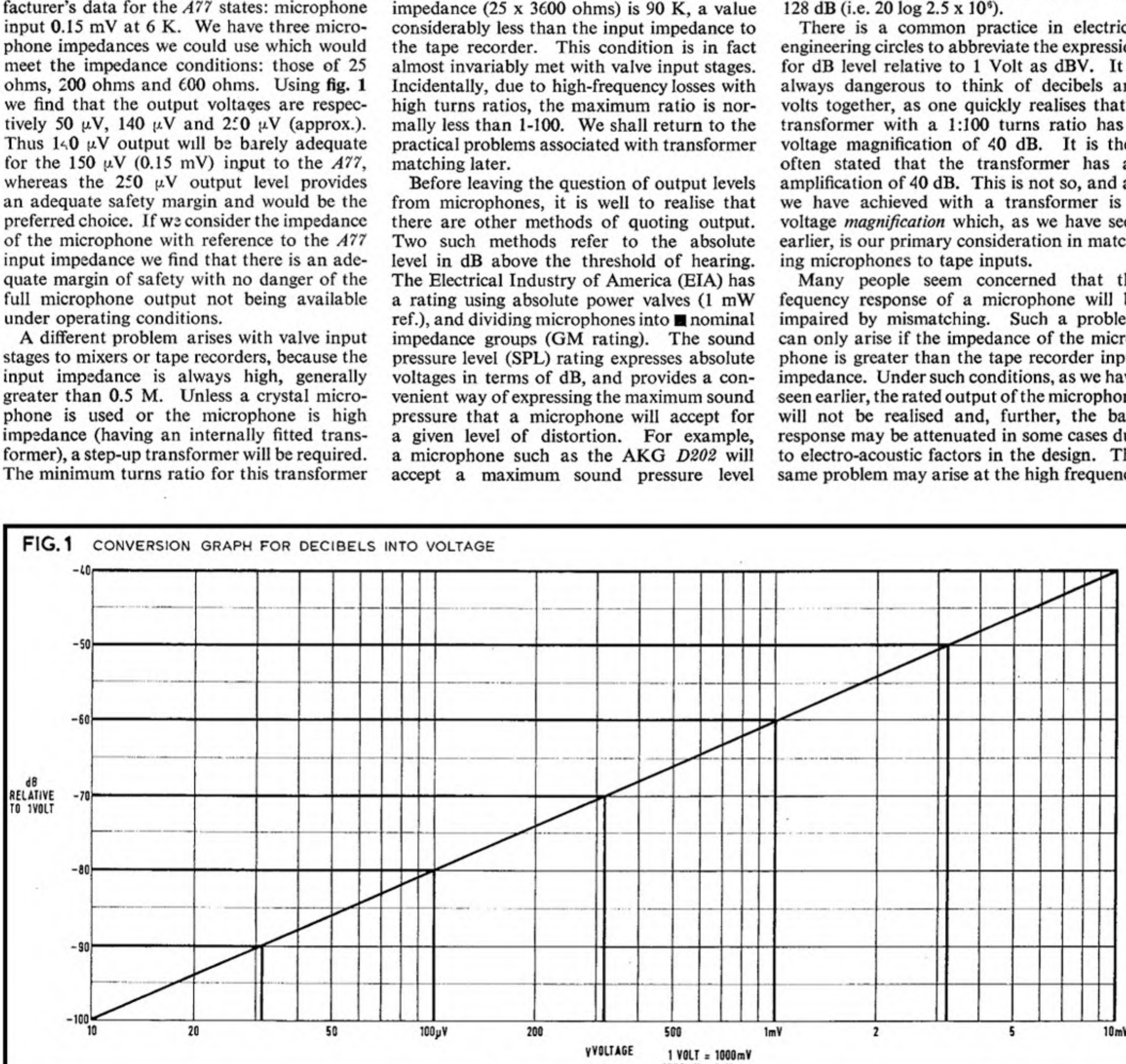
A different problem arises with valve input stages to mixers or tape recorders, because the input impedance is always high, generally greater than 0.5 M. Unless a crystal microphone is used or the microphone is high impedance (having an internally fitted transformer), a step-up transformer will be required. The minimum turns ratio for this transformer can be readily calculated as shown earlier. If we consider a 25-ohm Grampian *DP4/L* with an output level of —86 dB relative to 1 V/dyne/cm$^2$, this value in volts can be seen from **fig. 1** to be 50 μV. If we wish to feed this microphone into a tape recorder of maximum sensitivity 3 mV at 0.5 M input impedance, we then require a 1:60 transformer. With this turns ratio we find that we have an impedance ratio of 1:3600 and since our microphone input impedance is 25-ohms the output impedance (25 x 3600 ohms) is 90 K, a value considerably less than the input impedance to the tape recorder. This condition is in fact almost invariably met with valve input stages. Incidentally, due to high-frequency losses with high turns ratios, the maximum ratio is normally less than 1-100. We shall return to the practical problems associated with transformer matching later.

Before leaving the question of output levels from microphones, it is well to realise that there are other methods of quoting output. Two such methods refer to the absolute level in dB above the threshold of hearing. The Electrical Industry of America (EIA) has a rating using absolute power valves (1 mW ref.), and dividing microphones into ■ nominal impedance groups (GM rating). The sound pressure level (SPL) rating expresses absolute voltages in terms of dB, and provides a convenient way of expressing the maximum sound pressure that a microphone will accept for a given level of distortion. For example, a microphone such as the AKG *D202* will accept a maximum sound pressure level figure of 128 dB SPL (or 500 μB) for a distortion of 0.5% at 1 kHz. 0 dB on the SPL rating is equivalent to a sound pressure of .0002 μB (or dynes/cm$^2$), which is the accepted figure for the threshold of hearing (the ear will not respond to any stimulus below this pressure). It can be readily seen that 500 μB is 2.5 x $10^6$ times greater than .0002 μB. Accepting a linear relationship between pressure and voltage, a ratio of 2.5 x $10^6$:1 on the voltage scale is equivalent to 128 dB (i.e. 20 log 2.5 x $10^6$).

There is a common practice in electrical engineering circles to abbreviate the expression for dB level relative to 1 Volt as dBV. It is always dangerous to think of decibels and volts together, as one quickly realises that a transformer with a 1:100 turns ratio has a voltage magnification of 40 dB. It is then often stated that the transformer has an amplification of 40 dB. This is not so, and all we have achieved with a transformer is a voltage *magnification* which, as we have seen earlier, is our primary consideration in matching microphones to tape inputs.

Many people seem concerned that the fequency response of a microphone will be impaired by mismatching. Such a problem can only arise if the impedance of the microphone is greater than the tape recorder input impedance. Under such conditions, as we have seen earlier, the rated output of the microphone will not be realised and, further, the bass response may be attenuated in some cases due to electro-acoustic factors in the design. The same problem may arise at the high frequency

**FIG. 1** CONVERSION GRAPH FOR DECIBELS INTO VOLTAGE



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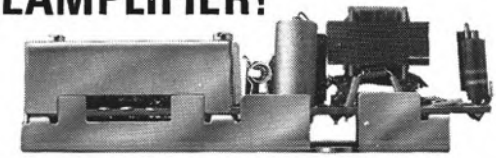

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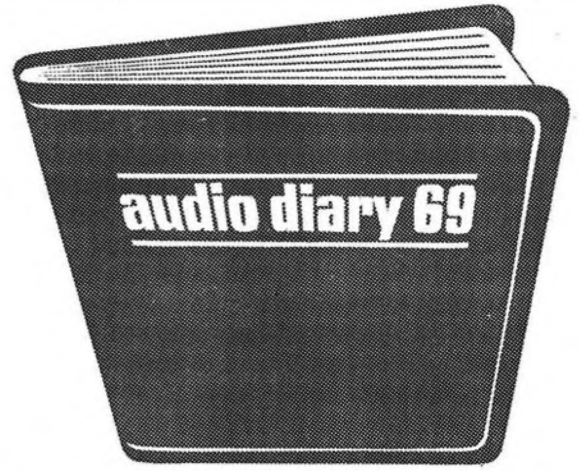


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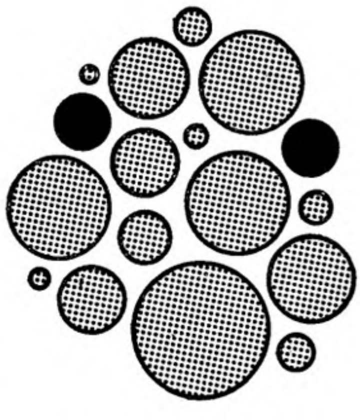


end as, in order to obtain a fairly flat response over a wide range, certain electro-acoustic corrections are required at the extremes of the frequency range. Also, due to inductance in moving-coil types, a lower than optimum load value may result in a simple high frequency roll-off.

A good general guide when comparing one dynamic microphone with another is to look at the quoted frequency response and the output level; for in order to obtain a wide flat frequency response the output level must be reduced. If the frequency response is very wide and flat and the output level high, one or both of the manufacturer's specifications may be suspect! Of course, there are ways to obtain a reasonable frequency response and high output level, and this is all part of the art of designing microphones. There is precious little point in taking any notice of manufacturers' frequency response claims unless a typical response curve is shown, the levels are quoted between which the response is measured or if the statement 'conforms to DIN 45-500' is included.

One type of microphone requiring special consideration is the little-used crystal. Crystal microphones require loading into an input impedance of at least 2 M to obtain the full frequency response. If the microphone is loaded into any value less than this, the bass response will be curtailed. **Fig. 2** shows the circuit diagram of a suitable circuit which has an input impedance of 3.6 M and low (250-ohm) output impedance. The voltage gain is unity and the noise produced at the output terminals for a 2 M source is about 10μV. This means that an average crystal microphone of sensitivity —40 dB ref. 1 V/dyne/cm² will yield a signal-to-noise ratio at this reference level of 60 dB. Frequency response is flat from 20 Hz to 20 kHz and distortion at this level is less than 0.05%. The circuit is based on a design published by Mullard and comes from a most useful publication *Audio Circuits using 'Lockfit' AF Transistors* published in January 1968.

If much use of a crystal microphone is envisaged, it is worth making this buffer amplifier, near the microphone with as short a piece of screened lead between the two units as practicable. If a small 22.5 V battery is used to keep size to a minimum, a 2.2 K series resistor will be required to maintain correct operating currents. Since the output may well be too large for certain transistor inputs, a potentiometer, which could be a preset if so desired, has been incorporated.

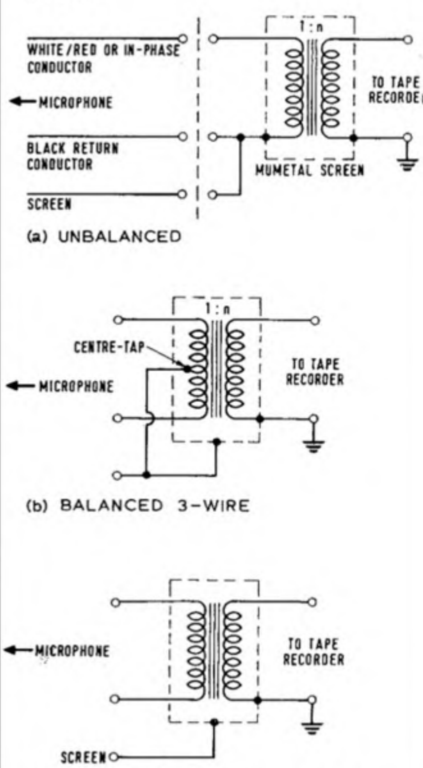
There is another method in fairly common use of quoting microphone output levels. This method uses the reference pressure level of 10 μB but, instead of referring voltages to this level, power values are used instead and we obtain a reference value of 1 mW per 10 μB. This does not present serious problems, since power and voltage are related ($P = \frac{V^2}{Z}$) and an example should show that meaningful comparisons can be made between one expression and another. Consider the Beyer *M88* microphone. This has an output level of —49 dBM ref. 1 mW per 10 μB (dBM is the dB level relative to 1 mW in 600 ohms, although the microphone impedance may not be 600 ohms). A level of —49 dB is equal to $10 \log^{10}$ of $\frac{1}{Pn}$, where Pn is the effective power of the microphone. From this Pn has a value of $1.26 \times 10^{-8}$ W but we know this is equal to $\frac{V^2}{600}$ (as this is a 600 ohm reference). Thus V = 2.8 mV per 10μB or 0.28 mV per μB, and this value is also confirmed by the specification data.

Let us now consider the various methods of connecting the input terminals of a transformer to a microphone cable. The only restriction on the following information is that, if a high impedance (50 K) microphone is to be used, cable lengths are restricted to about six or seven yards. Otherwise unlimited cable lengths may be used to connect the microphone to mixer or tape recorder. If a high impedance microphone is to be used with long cables, an impedance conversion unit may be used as shown in **fig. 2**. Again, the unit should be placed near the microphone and then an unlimited cable length may be used to connect to the tape recorder.

It is general practice with microphone cables to have two conductors twisted together and carrying the signal from the microphone. These conductors are then enclosed in a flexible braiding to shield the inner conductors from stray fields. This braiding is usually connected to the microphone housing and hence the microphone connector will normally carry a two-pin socket and a screw type connector, to which the braiding is connected. At the far end of the cable the connections may be made in one of three ways as shown in **fig. 3a, b** and **c**.

*(continued on page 70)*

FIG. 3

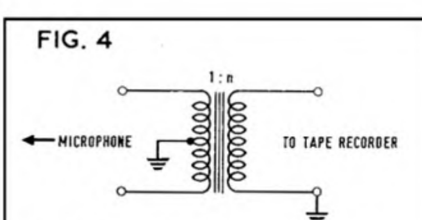



(a) UNBALANCED

(b) BALANCED 3-WIRE

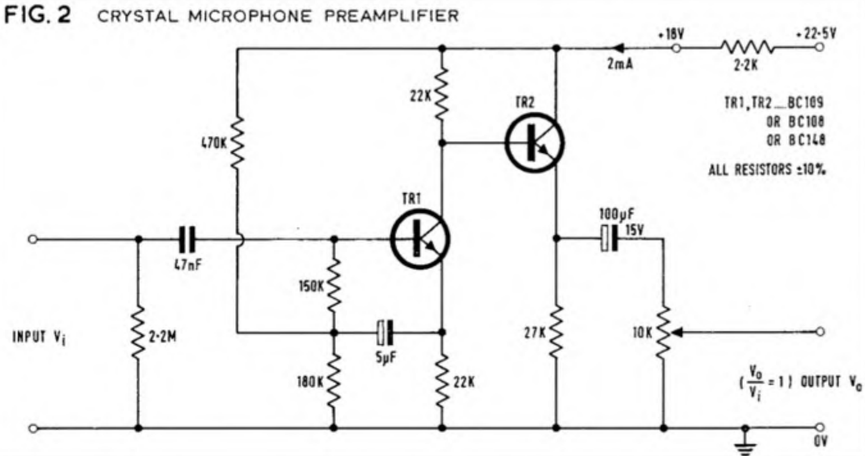
(c) BALANCED 2-WIRE AND EARTH

FIG. 4

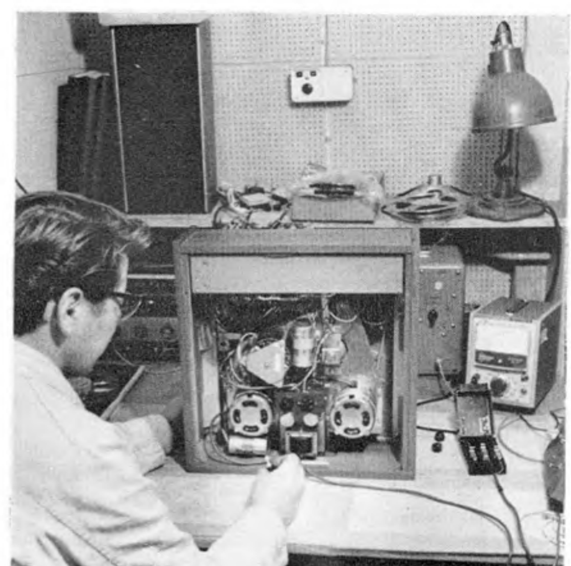



(d) BALANCED 2-WIRE

FIG. 2 CRYSTAL MICROPHONE PREAMPLIFIER



# THE TRUVOX TRANSFORMATION

# RICHARD GOLDING VISITS THE CONTROLS AND COMMUNICATIONS GROUP

A FEW miles from Southampton in a single establishment at Hythe are the Truvox, Thermionic, and Vectron companies of the Controls and Communications Group. Behind the factory, running down to the Solent, is a wide slipway offering excellent sailing facilities. The factory itself has a badminton club with a regular team match once a week, and fields a strong football team captained by an ex-Saints player—Pat Parker, the Dispatch Manager. There is a first-class works canteen with good food at low prices. Local accommodation is comparatively easy to find, and the area is predominantly rural, with the glades of the New Forest in easy reach.

But it is not altogether this pleasant atmosphere which has enticed electronics development engineers away from the tensions of city life into the laboratory team at Hythe. Under the new leadership of L. B. Whittaker, the Managing Director, many exciting things are happening, not the least of which is the transformation of Truvox itself.

Eighteen months ago the Truvox company, then at Neasden, was independently ploughing its own particular furrow. But due to problems such as staffing in the London area, Truvox was acquired by the Controls and Communications Group, who took the wise but traumatic step of transferring it lock, stock and barrel to Hythe.

The senior company at Hythe is Thermionic Products (Electronics) Ltd, a long-standing member of the C & C Group which has occupied part of the premises for years. Thermionic's main business is the manufacture of professional recording equipment for communications, scientific and industrial applications, including a substantial slice of custom built equipment for airports, military, police and other large-scale users. Next is Truvox, specialising in domestic and educational equipment, then Vectron, now specialising in tape heads and automatic announcing machines. In addition, the Hythe establishment represents the Japanese Shibaden range

**Top left:** Despite a restricted frontage, the premises housing Thermionic, Truvox and Vectron has expanded into adjacent accommodation since the arrival of Truvox. Thermionic, the senior company, retains its name over the door.

**Top right:** Azimuth grinding of a Vectron head for use in a Thermionic industrial recorder.

**Centre left:** Checking azimuth and mechanical tolerances of complete head assembly.

**Centre right:** Soldering components into the partly assembled preamplifiers of a Truvox *PD202*.

**Bottom left:** Part of the main Truvox production department. A line of *Series 200* recorders are being assembled in the foreground while racks of *Series 50* models are being soak tested at the rear.

**Bottom right:** Quality control engineer testing a partly-assembled Truvox *R202*.

of video tape recording equipment in Britain, and manufactures Agavox office dictating equipment.

Taken together, these activities amount to the largest and most diverse tape recorder manufacturing complex in Britain, with a unique (but entirely logical) spread of interests. The demand for recorders, after all, embraces every one of these fields, and the manufacturing disciplines are similar; it is lack of marketing strength rather than manufacturing ability which causes most other companies to limit their activities to particular sectors.

As Truvox manufacture tuners among their audio equipment, it may be of interest to know that other parts of the group manufacture professional wireless communications equipment (British Communications Corporation), aerials (Modern Aerials), numerical control and electronic test equipment (Airmec and Airmec-AEI Ltd). In particular, BCC walkie-talkie and long-range wireless sets are standard equipment for several armies in many parts of the world.

The first task at Hythe was the creation of space and facilities for producing the Truvox range, made up of recorders, tuners, speakers and amplifiers. The combined weight and technical know-how of Truvox, Thermionic and Vectron was brought to bear on the problems, first of getting production moving, then of matching Truvox products, plans and overall philosophy with those of its new industrial sister companies. To understand the difficulty of this, and the effect that the new overlap with industrial recording equipment has had on Truvox itself, a digression into the activities of Thermionic and Vectron is neccessary.

Thermionic, which has been producing industrial magnetic recording equipment for nearly 20 years, is now the leading British manufacturer of multi-channel communications monitoring recorders, primarily for air traffic control (ATC) work. It also manufactures industrial analogue and digital recorders.

The Thermionic *Series 4* multi-channel communications recorder alone accounts for a third of the world's ATC market and since all countries signing the international ATC agreements must use approved communications recording equipment, the *Series 4* is exported for use in very many different climates and conditions.

The recording system is based on a precision three-motor tape transport, together with modular electronics and control gear. Standard variations include 6-, 12- and 24-channel multiples of a basic 6-channel 6.25 mm tape unit, and a 24-channel recorder using a single 25.4 mm transport, but installations of greater or lesser complexity are assembled to order.

In the case of the *Series 4*, the deck is fitted with two interlaced three-track heads, giving the six channels in one direction across the ¼-inch tape, which is recorded in one direction only. Spooling is controlled by a simple system of interlocking pushbuttons, and there is a tape-driven, real-time-calibrated position indicator. The electronics are solid-state, based largely on integrated circuits, and offer such refinements as immediate monitoring of all channels and automatic switching to empty channels or standby deck. The original *Series 4* has now progressed to the *Mark 5*.

At home the recorders are used not only for ATC but increasingly by police, fire and ambulance services, law courts and commercial users for whom the monitoring of communications can save time, trouble and paperwork. The Kent County Constabulary, for example, recently installed a 12-channel system in one of the most modern police control rooms in the country. Every phone call, including 999 calls and conversations between the control room and patrol cars or policemen on the beat is automatically recorded on the *Series 4*, one track of which continuously records time signals. A monitoring system enables senior officers to listen in to any channel to save time in an emergency, and the whole tape, which cannot be tampered with, can be produced as evidence in court. The Staffordshire Police recently installed a similar system.

The main function of Vectron nowadays is to produce heads for Thermionic recorders, and Ted Read, the chief of Thermionic's Development Department, showed me round the head production area. Following the recent installation of new equipment, the laminations for the magnetic circuits of the tape heads are produced by photo-etching instead of being blanked mechanically by means of hard tooling. This prevents the burring of edges and resultant poor stacking of the laminations, which is liable to occur when tooling is used. As each lamination is only 50 to 100 $\mu$ thick, and the magnetic circuit for each tape track normally consists of up to ten laminations giving a nominal stack (and track) width of 0.5 to 1mm, proper stacking is most important.

After stacking, bonding and winding, the lamination assemblies are inserted into the half head shells, which are machined in pairs to an accuracy of $\pm 7.5\mu$. The interfaces are then lapped (fine ground) with diamond paste, first by machine and finally by hand, before the two halves of the head are assembled face to face to give the microscopic gaps characteristic of professional recorders. The head is further machined and faces are polished before the head is finally mounted. Having seen the manufacturing process, I was not surprised to learn that finished heads for 24-channel 25.4 mm communications recorders cost several hundred pounds, and the complete head assembly well over a thousand pounds, which compares with a very few pounds allocated to heads in the average domestic recorder.

Another recorder which is rapidly gaining world-wide recognition is the Thermionic seismic recording system, *Type T8100*, designed to be operated unattended, for example, on some remote mountain in Peru, and to provide long-duration recordings on 25.4 mm tape with a minimum of power consumption. The

(*continued on page 69*)

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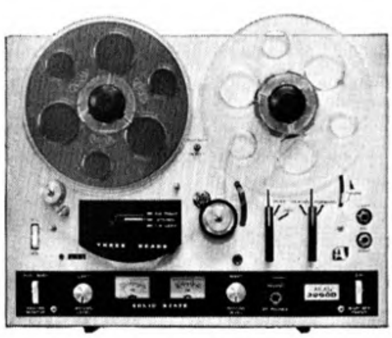
**AKAI M9 High Fidelity Stereo Tape Recorder** (right) **Cross-field Head. All Silicon Transistor Amplifier.** 4-track stereo/monaural recording and playback. 3 speeds (1⅞, 3¾ and 7½ ips) plus 15 ips with 15 ips adaptor kit. Hysteresis synchronous 2-speed motor. Wide Cross-field frequency response. All silicon transistor amplifier. Sound on sound. Automatic shut off, Automatic stop. Automatic pinch wheel release, Automatic lever release. Recording mode switch. Bass switch. Tape shifter in fast forward rewind operation. DIN jack, stereo headphone jacks. Four digit index counter with reset button, VU meters. Finely oil-finished wooden cabinet or vinyl leather wooden cabinet. **£195—PLUS —SENSATIONAL OFFER to every purchaser of the M9, a FREE pair of Wharfedale Super Lynton Speakers currently valued at no less than £41 4s. 0d.!**

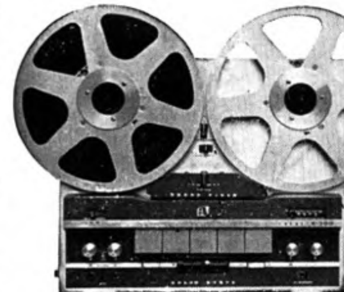
M9

**AKAI 1710W Stereo Tape Recorder** (left) **The Shield Type Head for High S/N Ratio.** 4-track stereo/monaural recording and playback. 3 speeds (1⅞, 3¾ and 7½ ips (15ips optional)). Automatic shut off. Pause lever. Tape cleaner. Tape shifter in fast forward/rewind operation. 4 hours maximum stereo recording capacity with a 1,200ft. tape. DIN jack, Stereo headphone jack. 3-digit index counter with reset button, VU meters. Finely oil-finished wooden cabinet. **£109—PLUS—SPECIAL OFFER with each machine—FREE ACCESSORY KIT (value £12 18s.) PLUS FREE pair of Stereo Headphones value £6 10s.**

**AKAI 3000D 4-track Stereo Tape Deck** (left) **High Quality Three Heads System.** 4-track stereo/monaural recording and playback. For playback, the 3000D requires external power amplifier and speakers. 2 speeds (3¾ and 7½ ips). Three heads (erase, recording and playback heads). All silicon transistor pre-amplifier. Automatic shut off, pause lever. Tape cleaner. DIN jack. Stereo headphone jack. 3-digit index counter with reset button. VU meters. Beautifully grained wooden cabinet. **£99 10s. PLUS—SPECIAL OFFER with every deck FREE pair of Stereo Headphones listed at £6 10s. PLUS FREE COVER—PLUS TWO FREE MICROPHONES listed at 6 gns.**



3000D



X300

**AKAI X-300. 10½in. Reel Studio Type Stereo Tape Recorder** (right) **(No Belts . . . Direct Driven Capstan).** Crossfield Head. Solid State Amplifier. 4-track stereo/monaural recording and playback. 2 speeds (3¾, 7½ and 15 ips optional). 4-heads (erase, recording, playback/monitor plus bias heads), 3 outer-rotor motors (Hysteresis synchronous 2-speed motor for direct driven capstan, two torque motors for fast forward and rewind). 50 watts solid state amplifier. Unitized amplifier circuit cards. Sound over sound. Automatic stop, Automatic shut off. Specially 90kc biased for recording of FM multiplex. Reel accommodation up to 10½in. Piano key controls. Tape cleaner. 4-digit index counter with reset button. **List price £263.18.3. OUR PRICE only 179 gns.!**

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Checking Truvox IC FM tuner printed circuit board with a master board by means of a comparascope.

original system was designed in 1962 by Dr P. L. Willmore, then of the Royal Observatory and latterly of the Institute of Geological Sciences, Edinburgh, around a standard Thermionic *TDR4* deck, modified to reduce the speed and power consumption, but there has been extensive subsequent development.

There are two versions of this machine, 12- and 24-channel, employing the same tape transport, which uses a small Mullard synchronous 'pancake'-type motor driving the capstan through a double reduction belt to give a tape speed of 0.297 cm/s, or 51 hours recording time on 1800 ft of instrumentation tape. There is only one spooling motor, driving the take-up spool, with a brake on the payout spool. Constant tape tension is ensured by servo systems controlled through transient arms. The whole is housed in an aluminium cabinet, sealed for protection against the weather but not too massively constructed, since it may be necessary for the field workers to contend with a total absence of adequate transport.

On the industrial front proper, Thermionic manufactures a substantial range of analogue and digital recorders including a portable four-channel analogue recorder, *Type T3000*, based on the same deck as the *Series 200* and its predecessors which was found, with some modification, to be eminently suitable for a small industrial machine.

As fitted to the *T3000*, the Truvox deck has larger motors and upgraded electronics designed for four-channel FM recording, either as an accessory to or as a replacement for a strip chart or other graphic type of recorder. The result is particularly suitable for use in medical field work, such as in cardiographic research. The *T3000* is very popular on the American market, and has been sold in countries all over the world in the last few months.

Comparing the *T3000* with its nearest domestic equivalent, the Truvox *R200*, the industrial machine is finally soak-tested for at least five days, compared with a normal four hours for the domestic recorder. Rigorous testing of the more elaborate electronics accounts for the price differential—over £600 for the *T3000* compared with £125 for the *R200*.

The first figure would be unthinkable for any domestic recorder, yet the *T3000* is a low-cost industrial machine. The more advanced industrial refinements such as vacuum tape hold (common on computer peripheral tape transports) simply cannot be considered for domestic recorders; nevertheless, since its association with Thermionic, there has been a wide and growing area of overlap where the principles and practice of the industrial company are employed by the domestic equipment manufacturer.

The Truvox *Series 50*, introduced soon after the move, was in all essentials a product of the old Truvox company, while the Truvox *Series 200* range, introduced at the last Audio Fair, was an unashamed rethink of the *Series 100*, redesigned and restyled by the Hythe team to bring it back into line with current trends.

The design and development departments of the three companies (including Vectron) have been integrated, under Tony Crosse, the technical director, though the production lines remain separate. Thermionic experience has been applied to the Truvox production lines, as was apparent the moment I entered the Truvox electronic sub-assembly shop. Here about 40 women were working on sub-assemblies for the *Series 50* and *Series 200* tape recorders, amplifiers and tuners, in four neat production lines. At the head of the lines was a comparascope and, further on, a long inspection bench loaded with test gear.

The women are drawn from the local area and, after an initial four-week training period, are placed in groups according to aptitude. Each group does more or less the same sort of work each day, some assembling printed circuit boards and others soldering potentiometers, or working on specific units such as the amplifier of the Truvox *R50* recorder. The actual tasks change in detail from time to time, as the work is carried out in batches, but the type of work remains the same. The women seemed very pleased with the arrangement—once they have mastered a particular process they gain confidence from the acquired skill and show little desire to chop and change.

Immediately a girl has finished a particular task, the work is sent forward for testing. Printed circuit sub-assemblies are placed under the comparascope alongside a 'master' board which is known to be correct. The comparascope superimposes the images of the two boards, switching from one image to the other in rapid succession, so that any discrepancies are immediately apparent.

Complete sub-assemblies are tested at the inspection bench using various items of equipment, and male inspectors are continuously checking and troubleshooting. Like the products of its industrial sister companies, and unlike most domestic recorders, every sub-assembly of every recorder is inspected and tested at each stage of manufacture.

About 800 different types of electronic components are used in the sub-assembly room, of which 150 are used in the *Series 200* Stereo Tape Unit. Being a stereo unit, many components are duplicated, making a total of 350 parts—and this model has no output amplifiers. Before any electronic sub-assembly leaves this room, it is subjected to a simulated load test using special instruments and test gear. On acceptance, the sub-assemblies are passed to the main assembly shop.

On the day of my visit, the *R50* tape recorder was in production, travelling in batches three abreast down the assembly lines. Each deck was mounted in a cradle, a normal procedure with products of this nature, and the early stages of assembly were carried out by women, many of whom had worked on Thermionic recorders for years. The later stages of adjustment were taken over by a team of men whom the chief Truvox designer, Henry Howitt, described as extremely skilled.

These stages consist of wow and flutter

(*continued overleaf*)

**Upper left:** Truvox *Series 50*. **Lower middle:** *Series 200* stereo tape unit. **Bottom:** Thermionic *T3000* four-channel analogue recorder based on the *200* mechanism.

tests, sync and speed tests, and mechanical checks, after which the recorders are placed on the soak rack for a four-hour continuous run. This runs the recorder in—both mechanically and electrically—before the quality control engineer subjects it to a final series of thorough tests. The QC engineer puts himself in the position of the customer and works through a full schedule of tests contained in a written specification which in the case of the *R50* runs to six foolscap sheets of close typing.

While I was there the *R50s* were coming off the soak rack and into the QC cubicles, and the testing was seen to be most stringent. The first inspection was visual and included checking for correct assembly, wrong or damaged components, neat connections, and general workmanlike finish. All controls and switching were then examined for smooth and positive operation, and the correct positioning and routeing of the various cable forms and their associated attachment points were also checked. This was followed by hum/noise testing, head alignment, wobble check, replay sensitivity, input sensitivity, distortion checking on an oscilloscope, erase, and frequency response with test tapes on both tracks at all speeds.

In all there were 42 separate operations, but the testing was not finished there for in addition there are regular spot checks on machines with additional soak runs before packing.

Comparing the present Truvox products with those of their predecessors, the greatest change is the very much higher standard of quality control, though the product range is outwardly similar. Of course, the bulk of the present products derive directly from the old Truvox company, but all have been face-lifted outwardly and, I am told, considerably improved internally.

Another result of the association of Thermionic and Truvox is the improved performance of the Truvox Servicing Department, which was not helped by the dislocation of service on the move to Hythe. Normal service has now been resumed, and the Truvox Servicing Department endeavours to send an acknowledgement and estimate within 48 hours of receipt of a machine, with an average turn-round of seven-ten days. Truvox would like to cut this even further and they seem to be pretty confident that they can do it. I hope they can, for it is this kind of customer-oriented approach that British industry needs most.

Considerable thought is being devoted to the long-term future of Truvox and some interesting products are under wraps. Truvox, in common with every other domestic recorder manufacturer, must also face up to purchase tax; how this will affect sales and ultimately future policy is a question neither Truvox nor any other manufacturer is yet able to answer with certainty.

Where there are ways of incorporating industrial expertise into domestic recorders without raising their price unrealistically, the Hythe management will certainly find them. The incentive is there with such things as advanced training for selected employees. The whole management team, for example, recently took a 13-week advanced course in electronics at Southampton College of Technology.

The notion of management as a career in itself, merely incidentally related to the business in hand, must be killed off if full exploitation of technical development is to be made. The Hythe management team, right up to the managing director himself, have shown themselves ready to study the practical realities of the equipment their company produces. Adopted nationally, this attitude may feasibly rescue the British economy. Truvox, certainly, have been transformed.



of the lower *AD150* is joined to the same point. On the later version, this link is absent, the positive of the coupler goes directly to the *AD150* emitter and the other end of the 0.47-ohm emitter resistor. There is, in fact, quite a list of alterations involved, and some care must be taken if a replacement panel is needed at any time, to stipulate the serial number of the machine, or quite serious problems can arise.

This is quite apart from the modifications involved when changing from ½-track to ¼-track operation. Apart from heads and oscillator transformer, there are four capacitors and three resistors to alter. Most of these are concerned with the oscillator, and it is this section of the circuit with which we should really bother ourselves.

The importance of correct bias has been stressed in several articles that have appeared either as individual contributions directly on the subject or as parts of general series dealing with the art of tape recording. My own view of the situation is that too many people take bias for granted. This is an error, compounded by the makers of cheaper machines, who allow little or no adjustment of bias and certainly not by the user. Indeed, one notorious series of models has a bias preset whose 'optimum' position works almost like an 'on-off' switch. Get it in the right position and you will have bias; anywhere else and you can whistle in vain ! But the amplifier of those machines is so poor that improvements in recording characteristic which might be affected by bias alteration would be completely masked by noise and distortion from other sources. Perhaps their philosophy is understandable.

Note the way the bias is fed from the secondary of the oscillator transformer, taking the maximum output which supplies the erase head, and applying it via a series adjustable capacitor, across which a 'damping' fixed capacity is arranged to flatten out the adjustment, and also the way that a dummy load of a series 330-ohm resistor with a tuned circuit of a 500 pF capacitor across a small coil is inserted to maintain exact oscillator output while recording monophonically. The actual tolerance between mono and stereo is $\pm 10\%$, for bias and for erase volts. Measuring bias across a 100-ohm resistor in series with the record head (red wire top track, blue wire lower track), one should get 65 mV, ¼-track and 95 mV, ½-track. The erase head voltage, measured across the winding, should be between 80 and 110 V. A valve voltmeter is needed for these measurements, of course, and before making them the frequency should be checked. This should be 85.5 kHz and the tolerance is $\pm 2$ kHz. If in doubt, err on the high side. The core of the inductor is the adjustment for this test, between mono and stereo, after the basic frequency has been set by the 50-250 pF trimmer, and a bit of juggling is sometimes needed to get a balance between upper track record and lower track play and vice versa.

From the foregoing, it is obvious that the machine is adaptable for multiplay, sound-on-sound and all the other attributes one gains from a completely parallel record and playback pair of channels with individual switching. There is a chance of some magnetic coupling between the windings of the stacked heads, and a warning is given that care in setting up is needed for sound-on-sound operation to avoid instability, but I have never found this much of a problem, and a little time taken with the setting of controls, plus the device of switching in the multiplex filters on the recording channel to damp things down a little, and winding back the treble on the playback channel, produces very good and trustworthy results.

Mention of the multiplex filters leads us to say again that the problem of pilot tone interference is by no means a problem admitting of an easy solution. And when the despoilers get to work on disc pilot tone as well, we shall find hi-fi-minded amateurs 'doing a Dolby' in reverse to eliminate the unwanted signals and retain the broadcast and disc-recorded programmes. The point about filters is not their notching efficiency, but the fact that one must compromise in the amount of roll-off one can tolerate without robbing the frequency response of its upper end. This is not the place to go into the technical argument, or to quote the physics of filters, but my own experiments have shown that the simple trap across the tape recorder input will always result in some high frequency loss when the original broadcast is a direct one, and not one already degraded by landline connections or re-recording, or some other of the foul devices with which we have to live these days. That's the trouble with going to concerts—I *know* that little fellow at the back has to 'ting' his triangle just there—I have watched him do it !

If you want to get the best out of the *12*, the output stage must be correctly balanced. Easily said, not always so easy to achieve. The output is a six-transistor block, with a pair of common emitter audio preamps driving a complementary inverter stage, which in turn switches on the push-pull pair, operating, of course, in Class B.

In particular, one must get the quiescent current setting just right, and this is done by balancing the drive to the output pair, by regulating the input to the inverter pair. The 200-ohm preset does this job, with the negative temperature co-efficient resistor helping it. (Note—the physical position of such a component can be a vital part of any adjustment, so avoid moving it once the initial setting up has been done.) Adjustment for correct quiescent current should be done with no

(*continued on page 72*)

# THE WORLD ON RECORD

**The Application of magnetic tape recording at the BBC Monitoring service**

**BY JOHN FISHER**

"IN a short while we shall broadcast extraordinarily important news. I repeat, this is the Czechoslovak Radio, Prague. Esteemed listeners, stay at your receivers, in a short while we shall broadcast extraordinarily important news." The news was, of course, the invasion of Czechoslovakia by forces of the Warsaw Treaty countries. The time was just before 2 a.m. on August 21, 1968. These few words, which were to herald the tragic and momentous events of the next few days, were heard and recorded at the BBC Monitoring Service. Minutes later it was monitoring and recording all audible broadcasts out of Czechoslovakia on the invasion, as off-duty Czech monitors were summoned back to listen through the night and the news bureau settled down to a hectic and tiring night for the skeleton staff. In the hours and days that followed, the story of the invasion was written through monitored broadcasts, no mean task as the studios and transmitter went on the air (initially independently, but within a few days in an emergency national network) to keep the voice of the nation and the Czechoslovak Government on the air, addressing the people, encouraging them, calming them and urging them to passive resistance. The nerve and courage of the broadcasters and news agency operators was immense: as invasion troops surrounded a building, more than once was heard: " . . . until we are pushed away from our microphones we shall continue . . . ", and last reports of tanks with their guns trained on the radio building came from many of the radio stations. The pathos of some of the reports is hard to convey.

For a short while the Monitoring Service became the first, and often only source of news of the crisis. History was being made and taken down in writing as it happened, and attention was focused through the news, current affairs programmes, and the press, on the place from which the news was supplied.

What, then, is the BBC Monitoring Service? It exists to provide at speed an accurate account of news and comment from broadcasting stations in all corners of the world. It is a national service and, in addition to supplying information to the rest of the BBC, it provides material for government departments, the press and other bodies concerned with international affairs. Working in collaboration with the US counterpart under an exchange agreement, it provides virtually

**Close-up of the monitors' positions showing switched feed to the IBMs.**
***Copyright BBC.***

worldwide coverage by receiving in exchange for its own output monitored material from stations in countries which it is impractical to cover from Britain—mainly the Far East and Latin America.

Because it would be economically impractical to listen to every broadcast from every country, and because of the continually expanding volume of material broadcast by all countries of the world, the Monitoring Service has to be flexible and continually adapt itself to the needs of the moment, listening to broadcasts likely to yield material of interest at the time in question and selecting the essence of what is monitored for use by news desks and as background information. The reporting of major events, official statements, comment and propaganda from the Soviet Union and other communist countries are among its main tasks. Frequently, as in the case of China, monitoring proves to be one of the few ways of obtaining information at all.

But the Monitoring Service is not concerned solely with communist states. Any crisis which develops rapidly produces a demand for the latest information, and monitoring of radio reports can give a blow-by-blow account of how the situation changes. An example of this happening outside the socialist bloc was the Arab-Israeli conflict in June 1967, the Six Days' War. Before the outbreak of fighting, the course of propaganda broadcasts gave some idea of how feelings and pressures were building up. From the moment fighting started, the radios became organs of encouragement, command, propaganda and instruction to occupied territories. The watch on the Middle East became of prime importance as world attention focused on the warring area, and in the early stages much of what appeared in the press came straight from monitoring transcripts. Monitoring also provided a guide to the way the countries were feeling towards the UK, and provided for newsreels the recording of President Nasser's abdication speech.

The Monitoring Service is set in an old country house near Reading, and has its aerials in nearby parkland away from sources of electrical interference. The service is divided into two main parts, which are responsible respectively for the actual processes of reception/translation, and for output via teleprinter or printed documents. The output department reads the monitors' transcripts and selects and edits the material for transmission by teleprinter to the Foreign Office, BBC news desks and subscribing news agencies, while the same material is separately assessed by other editors for publication as documents covering the broadcast news, comment, propaganda and economics of the countries involved; there is a distinction because the news bureau will be interested in 'hot' items — the launching of the first Sputnik, for instance, or the first news of a coup—while the published material will be used for reference and background and therefore will include items of more lasting interest, perhaps documenting in detail the course of the same coup as seen through broadcasts from the country and transmitters elsewhere. The published material is supplied to other departments of the BBC, Government departments, the libraries of the Houses of Parliament, four of the copyright libraries, and to a limited number of subscribers including the press, academic institutions and commercial organisations. The BBC itself makes considerable use of the monitored material as background for broadcasts in its external services to the countries from which these broadcasts have originated; monitoring their broadcasts sets the stage for material broadcast back to them.

In the reception unit, the broadcasts are listened to live by expert translators who must be familiar with much of the technical jargon of the language, with the political and economic climate of the country concerned, and also be able in the light of their background knowledge to exercise primary selection of the material. But it is not enough for the monitor to simply report what he has heard—or thinks he has heard: reception may be difficult, he may be under strain,

*(continued on page 73)*

signal. Though the makers of the Tandberg, as with many other sources, simply advise turning volume controls to minimum, I much prefer to ensure there is no input either of signal or noise by removing the signal and loading the inputs correctly. This is normal practice for assessing the noise figure of a high fidelity amplifier, for example. Then a milli-Amp meter is connected in series with the 27 V positive feed to the output section, i.e. the red wire of the board, and the preset adjusted for a 35 mA reading. This preset is the inner one of the two on the panel, near the top.

The outer preset is used for setting the correct output level, and the procedure here is to use a scope and valve voltmeter and a good, calibrated signal generator. Do not try and do it, I beg of you, by trial and error. The ear is just not good enough to determine the point at which clipping begins to occur, and it can take a long period of listener's fatigue to confirm that you were wrong after all. By then you will have forgotten you moved the preset and will probably blame something else ! Correct method is to feed a 1 kHz signal into the high level input socket, with volume controls in maximum position and the selector at AMP. Set the speaker switch to EXT for undamped output and fit a 15-ohm wirewound resistor across the outputs (not just the channel being measured, but both please—this is commonsense safety practice). Measure across the resistors with TVM and oscilloscope and increase the output from the signal generator until clipping of the sine wave just begins. Then adjust the outer preset (R305 left and R405, right) until the clipping is symmetrical for both positive and negative excursions of the sinewave. Take care not to overdo the clip to try for a better shape. Make the adjustment with the amount of clip just enough to be obvious, no more. Then decrease the input until this squaring off just disappears, when the transistor voltmeter should read 6.3 V, and this should be the same on each channel. This corresponds to 10 Watts to a 4-ohm inductive load. A 2 dB difference between channels is allowed in the specifications, but it is no great trouble to approach closer than this, and is advisable anyway.

The magic-eye adjustments have not been mentioned for one reason—they seldom need alteration, and there is always a tendency to peak up to answer a signal rather than measure the signal and then adjust the indication—bad practice, but too common. Main trouble I have found is getting at the small panels. Not because of the inaccessibility—though I do wish Tandberg would use screws with a more definite head to receive the jaws of a small spanner, or the slot a good screwdriver could engage—these are neither one thing nor the other. The trouble is that the valves are clipped in a bronze spring and not so easy to remove as they appear to be. Once they are out, and the panel can be removed by unclipping the tagged wires, no soldering needed, any necessary servicing can be done. A bit of care is needed for the replacement of the rubber mounts when refitting the screws but, like all else to do with Tandberg, it is worth that extra little bit of trouble.



Method **a** is very commonly used and is satisfactory with long cables on the condition that a good earth is provided at the tape recorder. Method **b** is also commonly used and in this condition the two halves of the transformer winding are balanced via a centre-tapped earth point. Great care must be taken with such a method of connection to ensure that the centre tap is not accidentally connected to one of the signal conductors. If this should happen there will be a dramatic reduction in microphone signal as half of the input turns have been shorted out. Under such a condition it is not very important for the tape recorder to be earthed, although of course this is always a wise precaution.

Method **c** is the preferred choice of recording studios and is also the most expensive method of winding transformers. The windings are arranged such that they are balanced to earth, but if one of the signal conductors is earthed, the windings become unbalanced and since there is no actual earth centre-tap, the transformer still operates with the same turns ratio, primary to secondary. In circuit analysis it is considered that under normal operating conditions the primary has a 'virtual earth' at the centre point of the winding. It is useful to connect up the screen connection because otherwise the microphone casing can be a source of hum if it is handled.

There is a fourth method of connecting microphones which is not recommended because of the danger of touching the plug whilst connected to the transformer. This method uses two wires only as **fig. 4.** If a two-pin jack plug is used, the screen of the plug is also carrying the microphone signal and touching the plug can be disastrous.

Since the generally accepted method of connecting the microphone lead to the input of the transformer is via jack plugs and sockets, method **a** is the cheapest as it requires 2-pin jack plugs and sockets. Methods **b** and **c** both require the 3-pin jack plug and socket method of connection. It is then normal to connect the secondary of the transformer to the tape recorder or mixer unit by means of a short piece of coaxial cable. A number of manufacturers such as Grampian, Ferrograph and AKG make up microphones to meet every matching requirement using methods **a** and **b**.

In conclusion I should like to express my grateful thanks to the following organizations for providing valuable assistance: The Research Department of the BBC, Politechna, Grampian Reproducers, KEF Electronics, and to a number of colleagues within the Post Office Telecommunication Headquarters.

# OUR READERS *write*

### *. . . about public address*

**From : Gordon Holton (APAE), Beacon Edge, Summerfield Road, Lansdown, Bath.**

*Dear Sir*, I feel that I must raise my pen in defence of the public address fraternity. Your contributor Peter Bastin, in his December article 'Recording Outdoors', states that 'Recording speech from a PA system is usually a failure, due to the normal (!) deafening mains hum from these things.'

No self-respecting PA engineer would use equipment in this condition ; certainly our own amplifiers are checked frequently by me and if they are not up to standard remedial action is taken immediately. We have frequently to provide tape recording facilities direct from my amplifiers for various functions and feel sure that any 'deafening mains hum' from our equipment would soon result in a drop of engagements. As a large proportion of our engagements are in public buildings in Bath, such as the Guildhall and Pump Rooms, we have to ensure good quality reproduction. **Yours faithfully**

### *. . . and public address*

**From : K. Gover (Trader Member APAE), 4 Pinfold Hill, Shenstone, Lichfield, Staffordshire.**

*Dear Sir*, Your contributor Mr. Bastin makes sweeping condemnation of public address in his December issue article. Deafening mains hum is not normal.

There is no excuse for bad PA, for modern equipment operated by competent engineers is reliable and gives high quality sound. Readers should complain to the organisers at any function where the sound is faulty. Members of the Association of Public Address Engineers all over the country have the equipment and knowledge to provide first class results at a fair price. **Yours faithfully**

### *. . . about the Grand Duke*

**From : Douglas H. Cooper, 'Olden Lodge', 37 Hill Road, Clevedon, Somerset.**

*Dear Sir*, For some years I have been a keen tape recordist, music being perhaps the main pleasure. As a Gilbert & Sullivan fan, I seized the chance to record all the operas which were put out on Radio Three. I was particularly interested to secure two which were unfamiliar—the last two—*Utopia Limited* and the *Grand Duke*. All went well until, at the time of the latter, we had to cope with visitors. The VHF tuner and the tape recorder were left to look after themselves and the recording was defective. It may well be that the BBC's commercial activities in selling recordings will expand to include G & S. Meanwhile, I should like to contact someone who made a recording of the *Grand Duke* on September 22 so that it could be borrowed or copied. **Yours faithfully** and the meaning may be ambiguous. There must obviously be a check on what he has heard, he must be able to go back over the material, repeatedly if necessary, to make quite sure. And obviously in a speech lasting several hours it would require superhuman effort for one monitor to transcribe every word faultlessly and with complete accuracy.

If you doubt this, try taking down a British politician's speech at a party conference, or a radio commentator, and see how many gaps there are after five minutes. Then consider several hours in another language!

This is where magnetic tape comes in. Magnetic tape provides a semi-permanent, convenient means of recording, replaying and storing the original broadcasts as they were received, and for subsequent reference if a summarised translation is required to be expanded. Without a recording medium such as this, the broadcast once heard is lost for ever.

While tape in the familiar 6.25 mm form is used by the Monitoring Service, mainly for recording broadcasts which may be replayed in a newsreel programme, a more convenient form (for this purpose) is generally used for transcribing broadcasts. While originally wax was used as the recording medium, the present system, designed to BBC specification and produced by IBM, uses a magnetic belt, like a wide endless-loop tape. This revolves slowly at constant speed between two tensioning rollers, while the tape is helically scanned by moving the head slowly across the belt width on a principle not unlike the transport of a disc-cutter head.

This system gives just over a quarter of an hour's playing time, and allows a high storage density of information on the tape as the bandwidth required is narrow (speech, by AM radio remember), and also a high storage density of complete recordings by comparison with conventional tape. But by far the most important reasons for using what at first seems a way-out method of recording is the utter simplicity of operation and loading—the belts just slide on from the end, and tension is taken up automatically as the mechanism starts up—and the relative speed with which a single sentence or word can be found on the belt, as the head transport mechanism can be manually over-ridden to scan between the first and last lines on the belt in a matter of a second or so, compared with a much longer period on spool-to-spool tapes or cassettes and the increasing difficulty of pinpointing a particular passage as one shuttles backwards and forwards. The system has no hi-fi pretensions, but it works well for what is intended and the quality obtained is adequate for high intelligibility.

AC bias is used for low distortion and background noise, but by normal standards the bias frequency would be alarmingly low, between 20 and 30 kHz. However, with the very limited frequency range fed to the recorders, this raises few problems of whistles and mush from beats between the higher input frequencies and the bias which can cause trouble in normal audio work. In any case there is normally a fair background of atmospheric noises, whistles and monkey chatter, even with the complex receivers used-due to overlapping of stations and overcrowding of the frequency bands.

On record, an AGC circuit is used which also provides a visual flashing-lamp indication that the tape is reaching peak level. Adjustment of volume and tone on the headphone output is also included for replay, and monitors are provided with extra machines away from the radios for replay and transcription of the belts. In addition to the normal monitoring positions, there is a control console manned by an engineer from which monitor's signals can be checked, from which the engineer can feed a signal from more sensitive receivers to a monitor's position, and at which there are additional belt recorders which can be remotely controlled and are equipped with automatic changeover from one machine to the next—normally monitors can select one of several machines to feed their signal, but must do the change-over manually near the end of a belt, and visual warning is provided when the belt is nearing its end.

In addition to these belt recorders, there are conventional tape machines which produce tapes for inclusion in programmes or for archive purposes. The machines used are normally Ferrographs, but in local parlance a 'Ferrograph' can be the tape recording made on that machine, which can be somewhat confusing to the uninitiated! In another department Brenell recorders, modified for balanced line operation and equipped with a slightly crude remote stop-start arrangement are used to record occasional morse transmissions. David Kirk would have kittens if he saw the way the machines are halted on remote stop with their pinch wheels locked on the capstan, but wow is not of prime importance here and in fact the machines stand up remarkably to the treatment! A rack mounted Ferrograph is also available for recording morse, Hellschreiber or teletype signals where necessary though teletype

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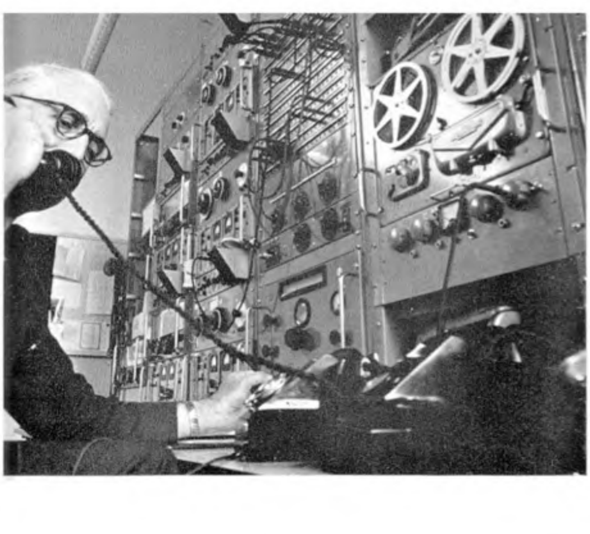



## book reviews

**HI-FI IN THE HOME.** By John Crabbe. 328 pages, 94 line and half-tone illustrations. Price 40s. Published by *Blandford Press Ltd.*, 167 High Holborn, London W.C.1.

I APPROACH this particular review with some trepidation! I see the cynics eagerly scanning these lines for the merest trace of bias. So I must state straight away that I have examined this book critically and without prejudice, and now, having read it, assert the critic's right to give praise where praise is due. For it is due here. *Hi-Fi in the Home* is by far the most successful book of its kind that I have read. I was invited to examine it in the context of tape recording, but inevitably I dipped further into the book and read on, so perhaps I may also be allowed a few words to deal briefly with the book as a whole.

One's first impressions are that the book is going to be worth its 40s. It has a nice feel to it: the paper is good quality, the hard binding is well finished and has a laminated dust cover. The print is clear and well spaced for reading without strain (which is a lot more than can be said for many books). Drawings and photographs abound and are well presented. There is an adequate index and a glossary of terms used.

Within this 'music lover's guide to high quality sound reproduction', John Crabbe introduces the concepts of and need for 'hi-fi', and in 10 chapters describes the nature of musical sounds and the ear's response as related to recording and reproduction, the basic components for the reproduction of music, the various individual items of audio equipment, stereophony and acoustics, how to choose equipment, installation, listening room acoustics, choice and care of records and the organisation of record concerts. The book ends with an interesting speculation on future audio developments, recorded music and music in the concert hall.

Tape recording and tape machines are dealt with in proportion to their importance in relation to domestic sound reproduction. There is no practical treatment of circuits or the theory involved in magnetic recording, but a clear non-mathematical exposition in layman's terms of the principles and components. Where a technical term is needed, it is explained and may be referred to in the glossary. The basic ideas of recording, equalising, HF bias, track configuration, mixing and balancing are among the aspects dealt with.

Some advice is given on how to set about choosing equipment, including a tape recorder, and here there was just one point on which I would have been inclined to disagree: it is suggested that, if the machine is to be used primarily for the replay of pre-recorded stereo material, a $\frac{1}{4}$-track machine should be chosen because of the prevalence of pre-recorded $\frac{1}{4}$-track tapes in stereo. I would have thought it better to suggest the purchase of one of the $\frac{1}{2}$-track machines fitted with an auxiliary $\frac{1}{4}$-track head for replay purposes, which would allow the replay of $\frac{1}{4}$-track tapes while also permitting the user the superior quality from pre-recorded two-track tapes or two-track tapes of his own recording. Admittedly the choice of such recorders is very limited!

The book reads well and is neither hopelessly complex for the novice nor boringly elementary, the extremes at which many hi-fi books lie. I have in the past wondered whether a generalised book on a wide subject such as this can really be successful and worthwhile: John Crabbe's book has shown clearly that it can, and his treatment can only be described as masterly. Some of the general audio material one is already familiar with from excerpts in *Hi-Fi News*, of course.

A musician venturing into audio reproduction would find this book of great interest and help in finding out what it is all about and in choosing his equipment; those who 'know it all' and have forgotten the original purpose of the exercise in the technicalities of the subject would enjoy borrowing a copy, and I would not be surprised if they ended up with one of their own! Well worth reading.

**J.H.F.**

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**THE WORLD ON RECORD** CONTINUED

signals are normally fed direct to teleprinter machines.

'The World on Record'—the title sounds rather pompous. But this is precisely what the BBC Monitoring Service is doing—putting the world on record. Twenty-four hours a day, round the clock, the Monitoring Service is listening to some part of the world: to the part that is awake, to the part that is troubled, to the part calling to others in the night when the radio waves travel farthest. 'Listening to the world' it has been called, but it is more than that, it is taking down in writing what the world says, to be used as evidence for or against it when future historians assess the history that is now being made. People forget, and memories are short when it is convenient to forget, and it is often convenient to forget what you said last year or to pretend that you did not really say it after all. The monitored transcript, backed by that small black belt of magnetically coated film, may even be the only key to what really happened. As the Warsaw Treaty forces invaded Czechoslovakia, the radio stations went on telling the people and the listening world what was happening, confident that they were being heard and the events recorded. One Czech announcer said 'The world is awakening to an unusually sad morning, but it is watching us and will continue to watch us at this critical time. Let us be courageous, dignified and calm at our place of work, everywhere where we belong and where we must defend our positions. History must one day be able to use those historic words about us: this was their finest hour'.

I would like to thank the British Broadcasting Corporation for permission to publish this article.

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**ANALYSIS OF AN AMATEUR** CONTINUED

*properly.* Slurred, snuffling and indistinct speech from narrators is inexcusable and if the recordist's voice is unsuitable, he should obtain the services of someone else. An indistinct voice coupled with another common fault, undermodulation, makes the tape sound as if it is being shoved through a bale of cotton wool. It is a strange paradox that most inferior tapes are undermodulated rather than overmodulated. I suppose it is because overmodulated tapes are obvious by their distortion and undermodulated tapes can always be 'corrected' by shoving up the volume!

Quite recently I listened to two documentary tapes on subjects of topical interest. The first one was well-conceived, well recorded and well-balanced apart from one thing. All the interviews were too long, too boring and too complicated. The mind boggled at all the facts and opinions hurtling out of the speaker and one felt like saying belt up. The tape was spoiled by the over-use of interviews. It was also spoiled by an extremely poor narrative voice. The other tape, which wasn't really a documentary at all, was so good that I suspected it immediately. Which is exactly as it should be. If you suspect that an amateur tape is not an amateur tape at all, the recordist has done the perfect job. Unfortunately, very few tapes fall into this category. The overall lack of success is not only due to bad voices, bad scripts and bad techniques but also to over-ambition. I have heard winning tapes in contests which, to my way of thinking, have been grossly over-ambitious; lots of people, lots of effects, lots of noise. The best of anything is always simple. John Bradley's loo interview, the tape about washbowl noises, the voice speaking backwards, were all good tapes based on a simple idea, carried out simply and without fuss. A deplorable observation on this is the pathetic tendency of people to try repeating the idea. It very rarely works and I feel that once you have exploited a particular theme or technique and had some success with it, you should leave it alone. This, I admit, is theory and cannot apply if you are a dedicated documentary man. But if you are the sort of chap who likes experimenting with new ideas I really feel that when you hit on a winner of an idea, do it once and try something else next time. How often have you said, at the end of a

*(continued on page 85)*

# closed circuit

## Supermarionation on Videotape

BY RICHARD GOLDING

VIDEOTAPE recording is being used to save both time and money for the *Century 21* organisation, whose popular puppet films such as *Stingray*, *Thunderbirds* and *Captain Scarlet* are seen in over sixty countries, including America where they are widely syndicated.

At their studios in Slough, Century 21 use an Ampex *VR-7003* helical-scan VTR to record their filmed takes for review and selection and to ensure that sound and vision are perfectly matched. The film cameras on the sets are fitted with *Plumbicon* cameras which take television pictures from a beam splitter positioned in the Angenieux lens of the film camera. This enables the staff of the entire unit to watch the scene being filmed on monitors situated both in the immediate environment of the set and also in executives' offices. Everyone therefore has a camera-eye-view of the subject and one can judge if the situation is 'right' before filming. When filming begins, the takes are recorded on videotape which acts as a check for the action.

When the director considers that he has a satisfactory take he can request playback, and within 30 seconds he can watch the scene being replayed from videotape with synchronous picture and sound. In this way he can check the quality of the take and ensure, for instance, that the lip synchronisation of the puppets is of the desired standard, because the dialogue has already been recorded before filming. Later, all the takes are replayed on the *VR-7003* and selected for editing to produce the finished film. The videotapes are then stored, forming a very useful library of takes which can be referred to when similar problems occur in later projects.

Century 21 now have three Ampex *VR-7003* machines in use, one of these at Pinewood Studios in connection with the production of a science-fiction thriller feature film, and another in the new TV series *Joe 90*.

The system is rather similar to that outlined in my article on the Arriflex Electronic Cam system (*Tape Recorder* August 1968) but does not go quite as far for the simple reason that the programme sound is pre-recorded, as with most types of film animation, and therefore the production as a whole is simplified.

The *VR-7003* is the middle-priced model in the Ampex range of educational and industrial VTRs and costs around £1500 (the TV Broadcast range, as readers will know, operate with a different format—transverse-scan with 50.8 mm width tape, and can cost many thousands of pounds). It first appeared about a year ago and took the place of the *VR-7000* which was then discontinued. While similar in many ways to the *VR-7000* (which incidentally was a very fine machine) and using the Ampex-invented air-film single head helical-scan recording system on 25.4 mm tape, the *VR-7003* incorporates improvements and additional features that add to its versatility. These advancements include a full 3.5 MHz bandwidth; rotary head transformer; automatic tension release around the scanning drum—

*(continued overleaf)*

Control unit of the Ampex *HS-100* instant replay slow motion disc recorder.

Ampex *HS-200* disc recording and computer-controlled editing system.

permitting indefinite standby; five minute forward wind time; wider tension adjustment range; improved differential gain and transient response, plus optional variable slow-motion from two to 20 fields per second, and a second audio (cue) track. The tape speed of 24 cm/s and the writing speed of 2230 cm/s was the same as the old model, allowing full compatibility between all *VR-7003* and all *VR-7000* models, and also between all these and all *VR-5103*, the very newest Ampex helican-scan VTR.

Whereas the *VR-7003* weighs about 100 lb, the *VR-5103* (the lowest priced in the Ampex range) weighs only 63 lb, and at ££00 it may be very interesting to CCTV operators in this country. To recap, we have four machines around £400—Sony, Shibaden, Nivico and National. Then, going up to around £1000, about half-a-dozen including two Ikegami models, two Loewe Opta and the new Philips *EL 3402* model. The Sony Professional VTR and the Ampex *VR-7003* one around £1500 with the Ampex *VR-7800* topping the scale at about £4500. Out of all these only the Loewe Opta models on the one hand, and the three Ampex models on the other hand are compatible from one model to another. All the other VTRs claim compatibility with machines of the same manufacture and model number but only Ampex have seemed to make any attempt at standardisation. I have made this point before, and it is worth making again particularly as so many colleges now are aiming for videotape exchange. There are four main areas in which compatibility can fail: tape speed, tape width, Head drum construction/tape-wrap, and number of heads in use. It is interesting to see that apparently Ampex hit upon a successful format from the start while others are still in the stages of experimentation.

Some details of the *VR-5103*: video response is 30 Hz to 3 MHz + 2, —6dB; horizontal resolution is 300 lines limiting visual resolution on monoscope test pattern, with 330 lines limiting visual resolution when playing back a *VR-7800* recording (this is the low-carrier monochrome recording that can be made on the *VR-7800* as an alternative to high-carrier). Rewind and fast-forward times, four minutes each for 3000 ft of tape. Remote control facilities for play, record and stop, at back-panel for use with remote control device or the Ampex *CC-6455* TV camera. Rotary head life: 500 hours minimum when used with Ampex videotape. Uses a single plug-in head. Recording time: 1 hour on 25 cm reel. Size: 59 x 26 x 31 cm modulator output: video-modulated RF. UHF connector tunable through channels two to five for use with standard TV receiver, recorder pre-set to channel. Nominal output 30 mV into 75-ohm load. Connects to TV receiver antenna terminals.

The third and last VTR in the Ampex helical-scan range is the *VR-7800*. This is quite a machine and just about the most versatile CCTV recorder ever offered—at over £4500 it needs to be. This machine incorporates such features as electronic editing; drum and capstan servos; automatic tension servo; 4.2 MHz bandwidth; forward or reverse slow-motion, variable from 1 to 120 fields per second; automatic tension release around scanning drum; two audio tracks (one a cue channel with a built-in panel mounted retractable microphone); three-minute forward and rewind times; and end-of-tape sensor providing automatic stop. Primary controls are conveniently grouped together for ease of operation, and secondary controls are readily accessible through a folding front panel. By merely turning a switch, the *VR-7800* will play both American and European format tapes. This makes it especially valuable for those users who regularly exchange tapes with American associates.

Options available include a colour system which supplies the circuitry required to record and playback colour and affect the necessary time base correction. The electronic editing permits the assembly on to one master tape of sequences taken from a number of different tapes while eliminating all picture rolls and transients that would result from mechanical splicing. In addition the electronic editor permits the insertion of new video and audio material on a tape that has been previously recorded, so allowing corrections to be made to an otherwise perfect tape without having to re-record the entire programme. The weight of the VTR is 140 lb.

Moving away from the helical-scan for the moment, I have at last been able to obtain some details of the new Ampex *HS-100* High-band Disc Video Recorder and Reproducer. This is a completely new advance in television technology and provides *instant* normal or slow motion replay, forward or reverse, stop-frame or frame-by-frame of any action programme in monochrome or colour with special effects, namely superimposing or video mixing. It uses a precision metal disc to record and erase video information continuously, with the last 30 seconds—equivalent to 750 frames or 1500 fields—always available in storage for replay (a system not unlike the repeater machine in a language laboratory with an endless loop running continuously, recording and erasing the last few phrases of a student's recording).

The *HS-100*, fully compatible with standard NTSC, PAL and SECAM colour or monochrome video signals, is designed to complement rather than replace videotape equipment currently in the field. It is for use where fast access time and variable playback speeds are more important than long playing time. The compact table-top control unit is the nerve-centre of a system made up of four separate units (disc servo unit, output processing unit, and electronics unit stand together in a free-standing case approx 5 x 2 x 2 ft and weigh around $4\frac{1}{2}$ cwt), and its dimensions are: 41 x 28 x 20 cm; weight 15 lb. The fingertip push-button controls are within easy reach at all times. There are three slow-motion modes, all operating in forward or reverse. Position one provides a 2:1 speed reduction, position two a 5:1 speed reduction, and position three activates the variable speed control lever allowing the operator to vary the speed continually from Normal to Freeze. The operator can switch from forward to reverse slow motion at will. In the Freeze mode a single frame is continually repeated. While in Freeze, the operator can push the Frame Advance button and move along one frame at a time, forward or backward.

The Control Unit has a time indicator clock, with cue pointer, and is calibrated from 0 to 30 seconds. The *white* time pointer gives the relative position of the record heads on the video disc, and permits the operator to find any recorded passage in the 30 second segment recorded on the disc. A *red* cue pointer, which normally rotates with the time pointer, is released when the cue button is pressed. It marks a specific event. Pressing the cue button a second time causes the *red* cue pointer to return to its normal position under the *white* time pointer.

I should imagine that the price of the *HS-100* would put it beyond any normal CCTV organisation at the moment, but videotape recording in general was out of the question before the cheaper helical-scan method was developed, and it is quite possible that somewhere, in Ampex's vast development programme a repeater for CCTV operation is being discussed.

The effect that videotape has had on broadcast television in the past few years is amazing, and you have only to take a quick look at the BBC television Centre at Shepherds Bush to see how important the invention of transverse-scan has been. The BBC Television Centre was opened in 1960. It has eight teleproduction studios, three of which are primarily for colour productions and can be used on 625-line PAL or 525-line NTSC standards. In addition, there are two presentation studios—used for the smaller discussion type of programme, or for small musical combinations. Mobile colour videotape facilities are also available. A routeing room has 14 duplex playback lines and one hexaplex line for sports. The routeing for recording includes inputs from over 100 separate stations, videotape recorders, film cameras, telecine chains, or microphones. From this routeing room, programming is sent out over Post Office circuits to BBC 1 and BBC 2 transmitters for broadcast.

The Centre also contains eight high-band Ampex *VR-2000* video recorders of the 14 *VR-2000s* used by the BBC) and four *VR-1000C* VTRs (of the seven VR-1000s used by the corporation). Several of the machines are equipped with an Electronic Editor. The total complement of VTRs in the Television Centre at my last count was 27 but it may well have gone up in the past few months. The VTRs are arranged in separate cubicles or recorder stations each containing two recorders. The stations have remote control facilities and waveforms for the recorders on their control console. More than half the non-live programmes produced for the BBC are on videotape.

BBC technical standards are considered among the highest in the world. In fact, the new concept of high-band recording and the *VR-2000* (which has now become the industry standard) was originally developed by Ampex for the BBC. During the development phase-Ampex delivered for evaluation two *VR, 1000C* recorders specially modified with a high-band modulation/demodulation system and Nuvistor preamps. Then in 1964 the BBC received the first *VR-2000s* to leave the factory. The two *VR-1000Cs* are still in use.


# a low noise tape replay amplifier

BY REGINALD WILLIAMSON

FROM the sales of the printed circuit board alone, it is obvious that the modest little 'front-end' preamplifier published in the April 1966 issue of our sister *Hi-Fi News* continues to fill a particular need amongst the do-it-yourself members of the hi-fi fraternity. But it does come as a surprise to discover that almost as many purchase the board with intention of using it as a tape replay preamp compared with those who construct it for its original purpose, that of a disc replay 'front-end' for low output pick-ups. My fellow contributor Alan Watling and I added the facility of being able to use it as a microphone or tape replay amplifier virtually as an afterthought and yet, as such, it apparently meets the needs of its users quite well.

But, it must be admitted that in this particular application it is not entirely suitable if one has maximum quality in mind. There are a number of reasons why the results one would obtain might be far from optimum. The requirement, in terms signal-to-noise ratio alone are very much more demanding for tape replay, particularly considering the matching of the signal source (replay head to the input stage). The degree of post equalisation necessary for tape replay is far greater than that specified for disc, especially at the higher speeds.

So it was decided to examine the whole question of tape replay and the special problems involved, applying the results to another front-end specially designed for the tape enthusiast.

The main area of investigation was to determine the optimum signal-to-noise ratio that could be achieved using currently available bipolar transistors and the results of this preliminary work led to a number of interesting conclusions. It is well known already amongst designers that, using bipolar transistors, the s/n ratio is primarily a direct function of (a) the source resistance 'seen' at the input of the

*(continued overleaf)*

FIG. 1

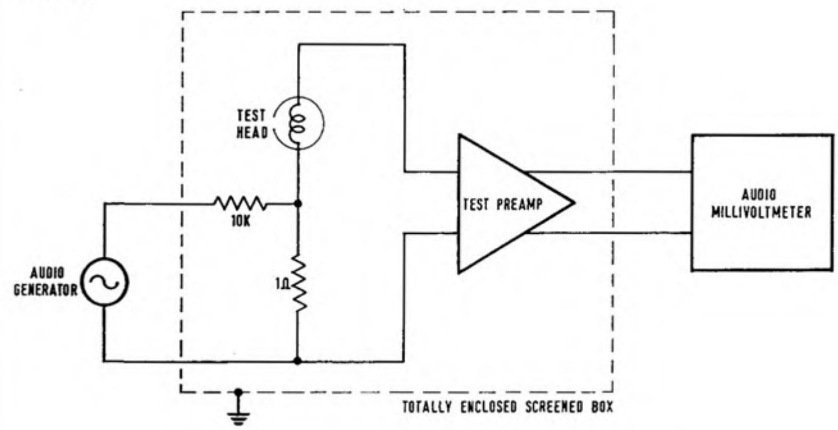
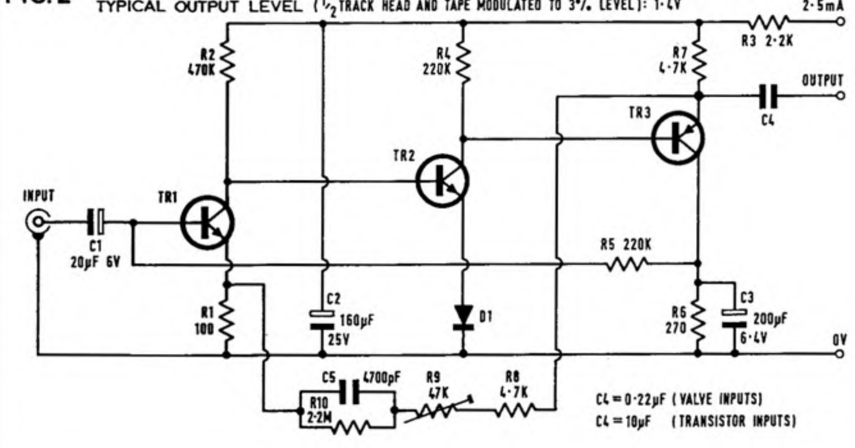



FIG. 2 MAXIMUM OUTPUT LEVEL: 6V RMS
TYPICAL OUTPUT LEVEL ($\frac{1}{2}$ TRACK HEAD AND TAPE MODULATED TO 3%. LEVEL): 1·4V



transistor and (b) the $I_{ce}$ of the transistor. These basic factors are kept in mind when designing small signal amplifiers of all kinds and, since the circuit designer has direct control over (b), it has been the practice to keep the $I_{ce}$ of the first stage in any small signal preamp as low as practicable. In the original 'front-end' for example, the $I_{ce}$ of the first stage was of the order of 150 $\mu$A and this is typical for this type of circuit. Some further improvement in terms of s/n ratio might have been achieved if it had been possible to lower the $I_{ce}$ even further but, with the transistors obtainable at that time, the $h_{fe}$ also fell sharply with lower values of $I_{ce}$, the loss in gain cancelling out any possible advantage. In this respect, the position has much improved, since there is now a large range of ultra high $h_{fe}$ small signal transistors, not only with clearly specified noise factors, but capable of maintaining a substantial small signal AC gain down to very low values of $I_{ce}$. Data is freely available on these transistors and usually includes noise factor contours for given values of $I_{ce}$ and $R_s$ (or source resistance). Equipped with this information, any designer is able to calculate optimum DC working conditions for a specified source resistance and so obtain the maximum s/n ratio for a single-stage amplifier.

Matters grow rather complicated when we consider a multi-stage equalising feedback amplifier with a substantially inductive generator source at the input. It is certainly possible to get very close to optimising circuit values for an amplifier of this type on paper—but the arithmetic would be 'interesting' to say the least. Since the results would have to be verified anyway by practical tests—and I am no great lover of complicated sums—it was decided to set up a sample circuit and carry out noise tests whilst altering all those parameters that were variable, and recording the results. Because of the high amount of equalisation required and the intention to try and produce an equalised output level of 0 VU or higher, the preamp was tailored basically to produce the highest possible forward gain. A 500 mH replay head was chosen as a standard signal source, since this was also regarded as typical. To avoid masking effects when using a modulated tape as the signal source, a generator was connected directly in to the head circuit in the manner shown in **fig. 1.** Finally, the equalisation was accurately adjusted in the feedback loop to produce a standard 70 $\mu$S replay curve.

The main adjustments made during the tests were to the $I_{ce}$ of both the first and second stages of the test amplifier and, from this, one interesting fact emerged, that the $I_{ce}$ of the second stage also influenced quite strongly the s/n ratio of the preamplifier. From the data obtained in these tests, the $I_{ce}$ for the first and second stages was optimised at 50 $\mu$A and 100 $\mu$A respectively; the reader will also note the rather high values of collector load in both stages. Although the noise figures obtained were wideband, weighting the output to limit the bandwidth from 1 kHz to 5 kHz—the 'sensitive' noise area—yielded optimum $I_{ce}$ values only marginally less; the results following tests with head impedances differing from that of the test head, indicated that inductance values up to 50% lower or 100% higher did not materially affect the performance of the preamplifier.

It was whilst discussing these results with a fellow worker in this field, that he mentioned some earlier work had been published along these lines, and on checking the reference it was gratifying to discover that essentially the same conclusions had been reached.*

The performance of a working prototype confirmed that, in terms of signal-to-noise ratio, it would be difficult to improve upon the figures obtained using currently available bipolar transistors, unless one had complete control over all the factors involved, including the design of the head. The high forward gain not only permits complete equalisation even at 38 cm/s but there is sufficient closed loop gain to deliver an output of 1.4 V (or ±6 dB over 0 VU) from a typical ½-track replay head scanning a tape modulated to the 3% distortion level; the output from the preamp presents a source impedance of 100 ohms or so. The inherent wideband noise is extremely low and never worse than 8 dB below virgin tape noise from a ½-track head; similarly, the wideband noise was measured using the 0.5 H test head and it was better than –72 dB below the signal of a tape modulated to the 3% THD level. Again, the noise level is well below that generated by a virgin tape. Weighting the output signal to a 1 kHz-5 kHz bandwidth improved these figures by another –13 dB.

The circuit consists of two common emitter stages directly coupled in cascade and both have very high values of collector load. An additional common collector stage has been added to act as a matching device and buffer for the feedback network. The whole amplifier is a closed DC and AC loop, with the base bias for the first stage being derived from a small value of resistor in the collector circuit of the emitter follower output stage. This helps to minimise the effects of any variation in individual transistor characteristics. The equalisation elements are of course, within a separate overall AC feedback loop, with one variable resistive element to permit a wide range of adjustment to any specified replay curve.

It is essential to use a printed circuit board and this is currently available from *Walsall Timing Developments, Hall Lane, Walsall Wood, Staffs.* This company have also undertaken to supply most of the other components, although if any constructor runs in to any special difficulty over the low noise transistors specified for the first and second stages, I have a small quantity for exclusive supply to readers of this magazine.

*'Low Noise Transistorised Tape Playback Amplifier' by James Davidson. Journal of the *Audio Engineering Society*, January 1965. (Published in the USA.)
Since this article was prepared, two excellent essays on the whole subject of noise in transistor circuits have been published in November and December 1968 *Wireless World*. These originally formed the basis of a lecture by the author, Peter Baxandall, delivered to the Royal Radar Establishment, Great Malvern.

**COMPONENT LIST**

| | |
|---|---|
| **R1** | 100 |
| **R2** | 470K carbon film or metal film |
| **R3** | 2.2K |
| **R4** | 220K carbon film or metal film |
| **R5** | 220K |
| **R6** | 270 |
| **R7** | 4.7K |
| **R8** | 4.7K |
| **R9** | 50K preset sub. min. |
| **R10** | 2.2M |

All resistors should be 5% tol. or better.

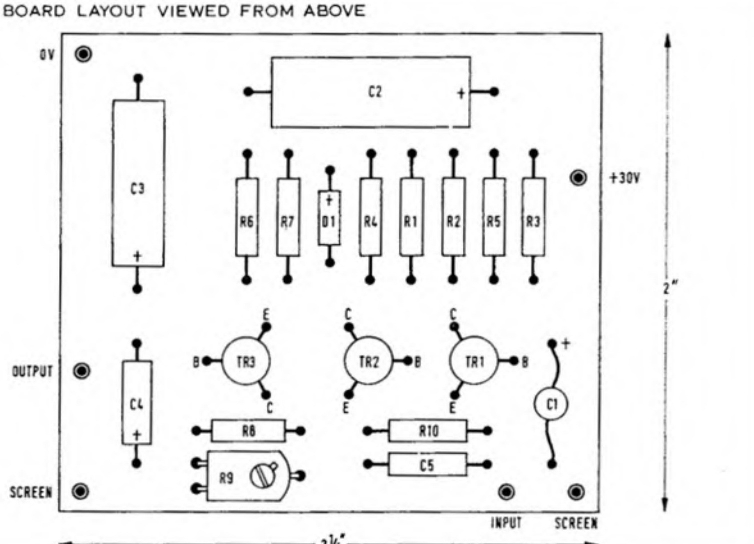
| | |
|---|---|
| **C1** | 20$\mu$F 6v. bead tantalum |
| **C2** | 160$\mu$F 25v. elec. min. |
| **C3** | 200$\mu$F 6.4v. elec. min. |
| **C4** | 0.22$\mu$F for valve inputs or 10 15v. for transistor inputs |
| **C5** | 4700 pF. polyester foil or SM |

**Semiconductors:**

| | |
|---|---|
| **Q1** | 2N3391A, BC150 or equivalent |
| **Q2** | 2N3391A, BC150 or equivalent |
| **Q3** | V561, MPS6533 or equivalent |
| **D1** | Silicon diode 1N914 or equivalent |

**Printed circuit board:** Walsall Timing Developments, Hall Lane, Walsall Wood, Staffs.

FIG. 3 BOARD LAYOUT VIEWED FROM ABOVE



## AKAI X-5
## STEREO PORTABLE

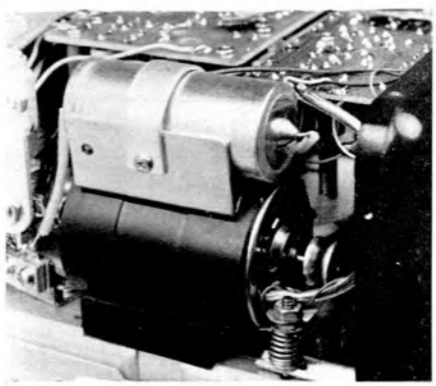
**MANUFACTURER'S SPECIFICATION** (19 cm/s). Quarter-track stereo tape recorder with internal mains unit/charger. **Wow and flutter:** 0.15%. **Frequency response:** 40 Hz-20 kHz ±3 dB. **Signal-to-noise ratio:** 50 dB (battery), 45 dB (mains). **Inputs:** 0.1 mV (microphone), 60 mV (line). **Output Power:** 2W per channel. **Fast wind speed:** 600 ft in 90 seconds. **Dimensions:** 29.5 x 28 x 13cm (w x l x h). **Weight:** 12 lb. **Price:** £180 including purchase tax. **Manufacturer:** Akai Electric Co. Ltd, 12, 2-chome, Higashi-Kojiyam, Ohta-ku, Tokyo, Japan. **Distributor:** **Pullin Photographic Ltd, 11 Aintree Road, Perivale, Greenford, Middlesex.**

THE price of this machine is £180, and I would guess that about 180 pounds pull is required to unhook the very high tension coiled springs which suspend it in its rectangular wooden transit frame! Packing and repacking this recorder once a week can be recommended as a course of muscle development.

Unpacked, its weight of approximately 14 lb with rechargeable battery, is almost equally divided between electronics, including mains transformer and battery charging circuits, and machinery. A lot of the head switching is done by physically moving the erase, and cross-field bias heads relative to the tape so that unwanted heads are at times moved above or below the tape path.

The brushless motor is unique in that its three fixed coils are switched sequentially by three pairs of transistors connected in a ring circuit so that, as one pair is switched off, the next pair is switched on after a short time interval fixed by the series and shunt 10 μF capacitors and associated charging resistors. Operation is rather like a three state multivibrator where each state energises one coil. The voltage induced in the non-switched coils is proportional to motor speed and is rectified to produce a control voltage which alters the charging time of each circuit to maintain constant motor speed.

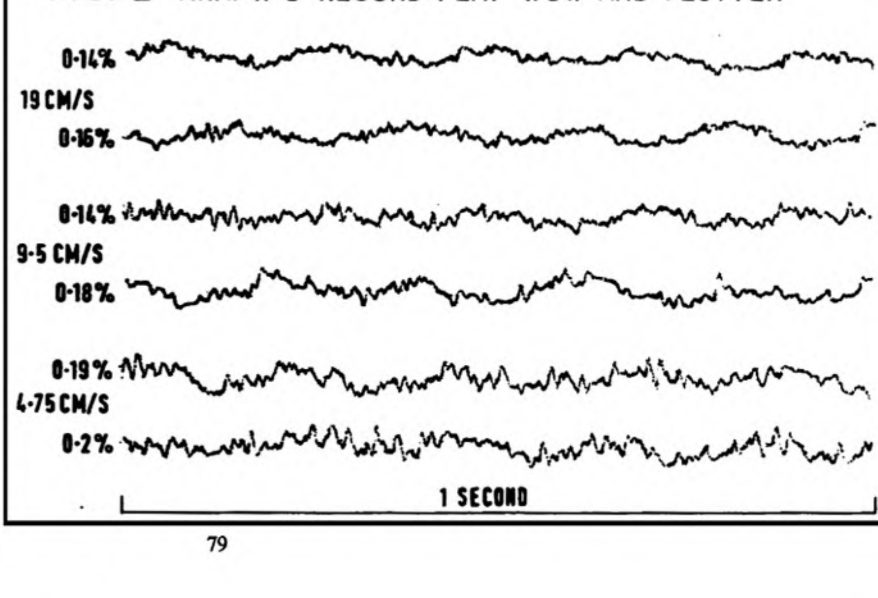
The motor shaft carries two pulleys; one drives a high speed drum of relatively large mass but small diameter which is stepped at one end to provide four drive speeds to the capstan wheel, which has little mass and acts mainly as part of the speed reduction system; the other pulley drives a lay shaft which provides wind and rewind facilities as well as a light take up tension during record or play. This shaft rotates at 5 Hz and the fluttergrams



of **fig. 2** show that it is responsible for the 5 Hz wow at each of the four tape speeds. It is this shaft wow, coming in and out of step on record and play, which accounts for the variation in wobble at any one tape speed. On a low wow and flutter test tape, wow remained constant at 0.1% at all speeds with wow and flutter readings of 0.14%, 0.16% and 0.19% at 19, 9.5 and 4.75 cm/s respectively. The flutter seemed to be quite random in nature and was almost certainly due to tape friction effects. In other words we have a near perfect tape transport spoiled by the varying load of a secondary drive system. If the specification wow and flutter figures are any guide, it would

*(continued overleaf)*

**FIG. 2** AKAI X-5 RECORD PLAY WOW AND FLUTTER



seem that the unwanted loading wow can be even worse under certain conditions.

**Fig. 3** shows the responses obtained at line output when playing 70 and 140 μS test tapes at 19 and 9.5 cm/s. The level responses show that the playback equalisation is nearer to the CCIR characteristics than the specified NAB curves.

The record-play curves of **fig. 4,** show over pre-emphasis of the high note response during recording at 19 cm/s, correct pre-emphasis at 9.5 cm/s, and inadequate HF pre-emphasis at the two lowest tape speeds.

The tone controls only affect the loudspeaker outputs; the combined amplifier and loudspeaker response is shown by **fig. 5**. The top tilted acoustic response is of some help when playing recordings made at the two lowest speeds, but the tone controls have to be turned nearly fully anticlockwise for 19 and 9.5 cm/s recordings.

Nominal peak recording level of 32 mM per mm tape width (32 mM/mm) was obtained at 1 kHz with the VU needles just beyond the red sector of the scale. Distortion at 19 cm/s

was 2.5% at this level with 5% third harmonic distortion, due to tape, at 3 dB above 32 mM/mm level.

Unweighted tape noise, after erasing 1 kHz peak recording level, was 49 dB below peak. System noise, with no tape passing the heads was extremely low at —53 dB. Both these tests were made on battery operation. On mains, hum was evident on the CRT and measured 5 dB up on the battery figures, but listening tests on wide range external speakers showed that the hum was almost inaudible under the slight tape hiss, and that any form of motor noise was conspicuous by its absence.

The tape position counter clocked 8 digits for 10 revolutions of the right-hand take-up reel.

Wind and rewind were adequately powered with a winding time of 3 minutes 45 seconds

*(continued on page 82)*

**FIG. 3** AKAI X-5 PLAY-ONLY RESPONSE (TEST TAPES TO LINE OUTPUT)

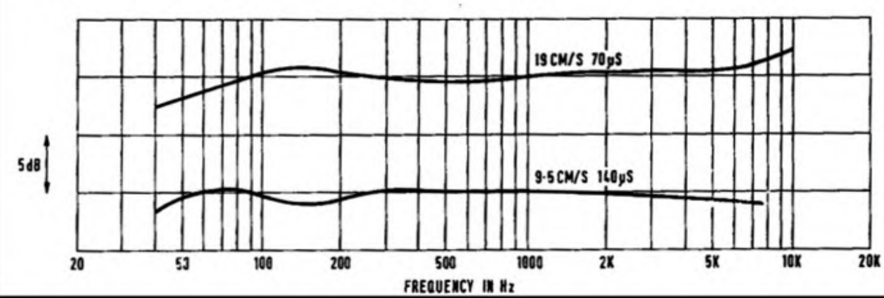



**FIG. 4** AKAI X-5 RECORD/PLAY RESPONSE (LINE IN TO LINE OUTPUT)

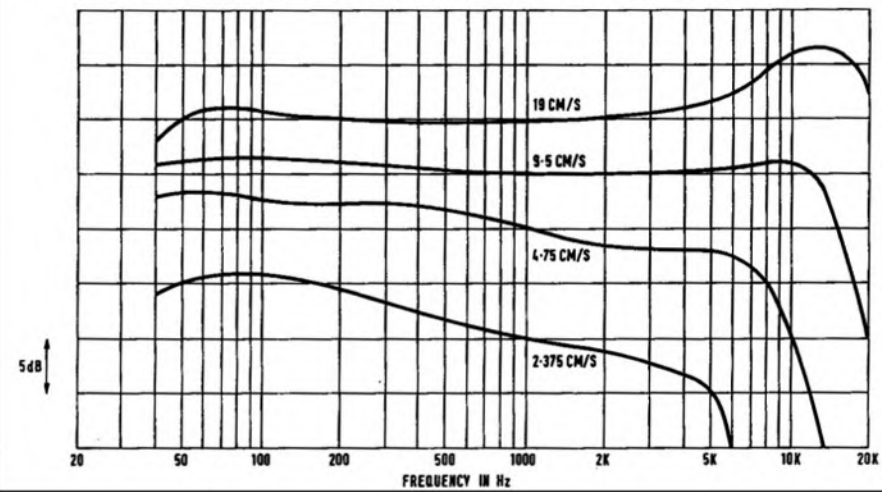



**FIG. 5** AKAI X-5 ACOUSTIC RESPONSE (WHITE NOISE TEST TAPE TO SPEAKER OUTPUT)

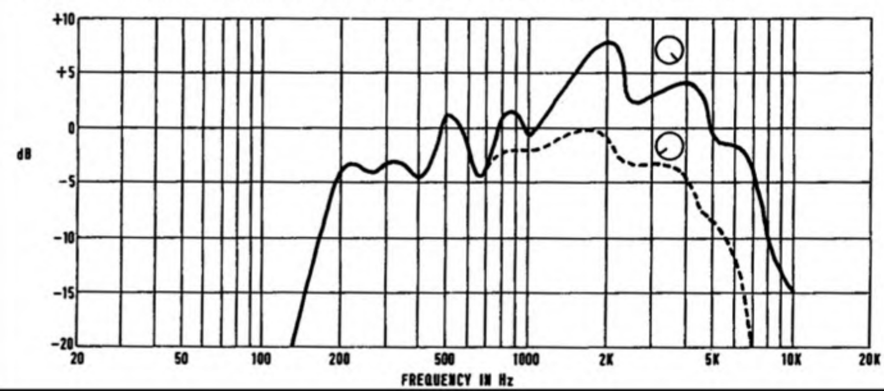
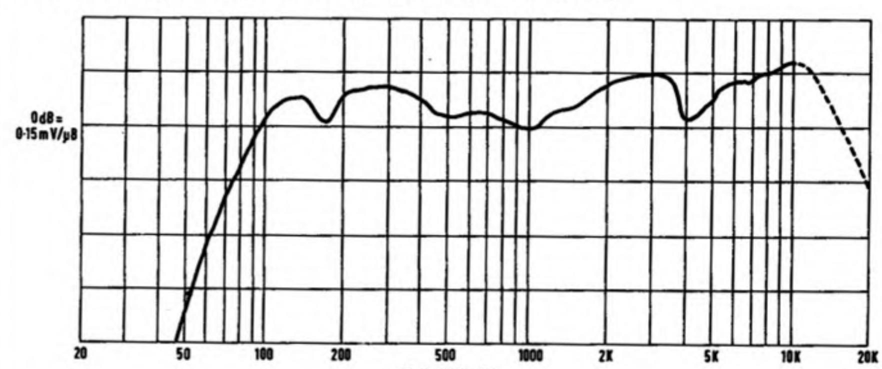



**FIG. 6** AKAI X-5 MICROPHONE RESPONSE (700 OHMS IMPEDANCE)



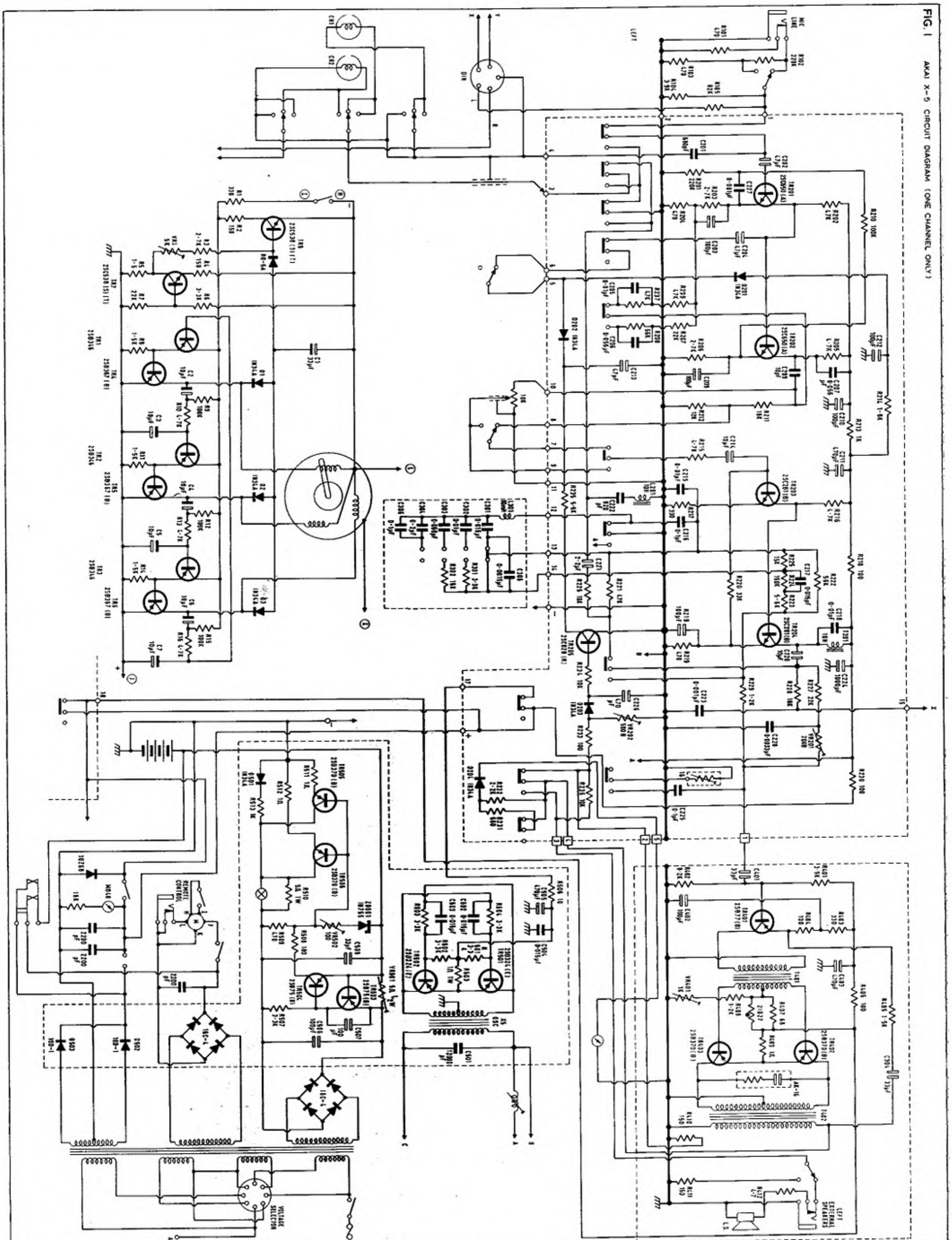
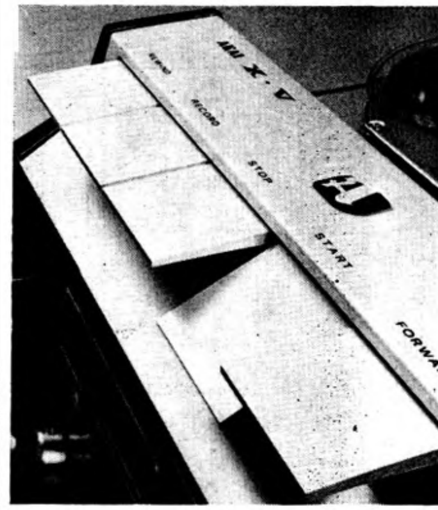
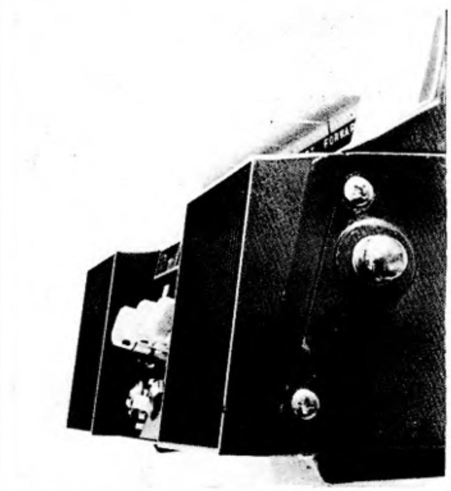


FIG. I AKAI X-5 CIRCUIT DIAGRAM (ONE CHANNEL ONLY) in either direction for a 900 ft reel of LP tape.

AGC recording seemed to be commendably free of distortion and examination of the circuit in **fig. 1**, shows that two diodes (D201 and D202) act as variable resistors to shunt the signal from the input transistor Tr201. The resistance of the diodes is altered by the current drawn through Tr205 which in turn is biased by a rectified signal from the secondary of the power amplifier output transformer.

The internal — almost external — speakers were almost pitifully inadequate for stereo monitoring, indeed the only way I could find of obtaining any reasonable stereo effect was





to wrap the recorder around my face by using it as a kind of super mouth organ. From this and previous reviews—not excepting the Revox *A77*—I think the time has come for manufacturers to consider the provision of a good quality pair of stereo headphones with any portable stereo recorder. The space and money saved by eliminating internal speakers should go some way to make this possible without any increase in overall price. If the headphones could provide monitoring whilst recording, then so much the better.

**A. Tutchings.**

# An Inexpensive Microphone Boom

BY J. S. FROST

MANY amateur recordists must at some stage have needed a microphone boom. Perhaps to raise the microphone higher than usual, to reach across a table, to move out of the way of people's feet. When an urgent need arose and the budget would not stretch to a commercial variety, it was decided to look into the possibility of constructing one. It had to be inexpensive, be made of readily available components and require the minimum of engineering—the author does not have a precision workshop at the bottom of his garden! The solution was to utilise chemical laboratory scaffolding.

**Fig. 1** shows the complete system and **fig. 2** the components. These are **A** a Reslo adaptor *AR220*, **B** a short length of rod, 13mm, **C** a crossover *45-2*, **D** a pivot *525-2*, **E** a universal half boss *526-2* and a microphone plug **F**. The rubber ring **G** drops into the microphone adaptor so that as **E** is screwed in, the microphone ean be properly aligned. **H** is a length of 13 mm alloy rod which makes up the boom and **I** is the Allen key for adjusting the crosshead assembled as in **fig. 3.**

Items **B** and **E** were threaded using an 0.5 in x 26 tpi BSB die. The main shaft is aluminium alloy though, for those wishing to be more extravagant, the more durable and less easily marked stainless steel or chromed brass tube may be used. If a long boom is being constructed a counterweight is necessary. This was made by drilling centrally through a brass cylinder 5 cm in diameter and 8 cm long. This weighed almost 3 lb and is adequate for all but the heaviest microphones. One word of warning: a really stable stand is an absolute must when a boom is used.

*Jecons (Scientific) Ltd., Mark Road, Hemel Hempstead* will supply the laboratory scaffolding. Current prices are as follows:

Main crossover *45-2*: 2s. 8d.
Pivot *525-2*: 2s. 5d.
Universal half boss: 526-2: 5s. 6d.
Allen key *99-2*: 8d.

0.5 in. alloy rod: 2s. 3d. per foot.
0.5 in. stainless steel rod: 4s. 6d. per foot.

Assembly is simplicity itself (fig. 3). The short threaded rod is screwed into the Reslo adaptor mounted on the stand. The crossover is dropped over the rod and tightened. The pivot is fitted into the crossover and temporarily tightened. The arm is slid through, the arm locking screw tightened and the universal half boss and microphone adaptor fitted at one end of the arm with the counterweight at the other. The microphone can now be screwed in and adjustments made to the angles. After use, the crosshand can be left on the tube and the stand unscrewed.

Fig. 1

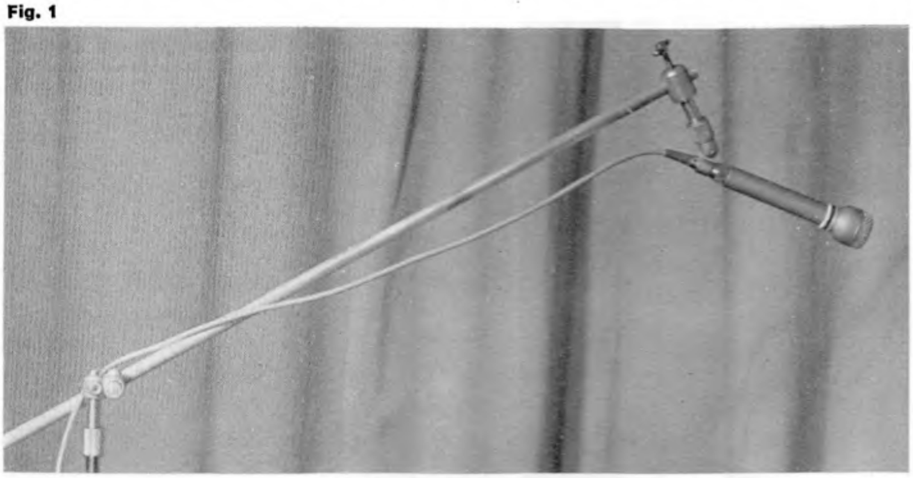


Fig. 2

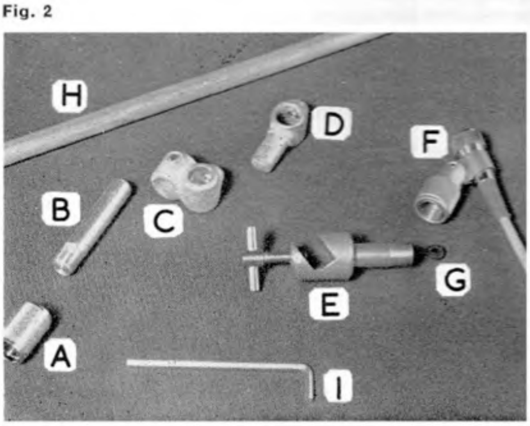
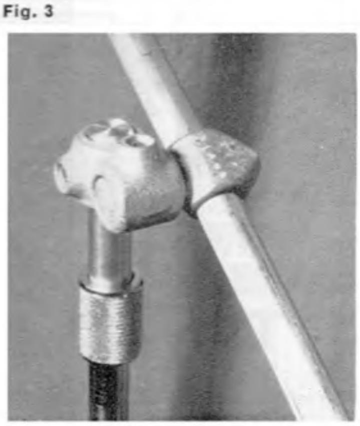



Fig. 3




BY CYRIL GRANGE

A FEW years ago when I was mayor of my borough, I came home after a function about 1 a.m. and, walking from my garage to my back door, heard a nightingale singing quite remarkably in a low elm hedge at the top of my garden.

Excitement bid me hurry, so in my 'white tie and tails' I gathered up a battery tape recorder and parabolic reflector and was lucky enough to get a position about 20ft away from the singing bird. The resultant tape, I say it and shouldn't, was really marvellous, being completely free from audible hum, flutter and background noise.

Mark this well—it is *most difficult* to make a tape which, while giving the song clearly, has not picked up such unwanted sound as that from cars, aeroplanes, diesel locomotives, people talking, children shouting and, most of all, wind.

The early professionally made tapes of bird song (and some of the latest ones !) were spoiled by dreadful unwanted noise sometimes louder than that of the song itself. So a good deal of satisfaction certainly comes from the making of a perfect tape. The hobby offers a great challenge to patience, experience and ingenuity. Conditions are usually adverse and there are so many unknowns which can ruin a recording and not be heard until the tape is played back.

I am going to explain ways in which these stray sounds can be, at least, mitigated but it is far better to choose a day or night when there is no wind and few road noises (Sunday, early morning or late evening.)

It will be a great help if the singing bird is static, preferably partly hidden so that you can get fairly near. *The closer the microphone to the bird* the better the signal-to-noise ratio. If the bird is rare, then this closeness is vital for the recording will have to be made anyhow and if the song is recorded as loudly as possible (because of the nearness of the microphone and not because the recording level knob is turned up excessively), then on playback the unwanted noises will stay muted in the background. We hope ! It is well to beware of too great amplification or there may be bad distortion on playback or much background mush.

Birds usually sing in one chosen position and if this is noted the microphone can be placed to collect most of the song sound. It can be tied up to a tree branch, bush, or outbuilding so that it will stay somewhere near the singer.

Many popular recorders are supplied with a crystal microphone having a high impedance up to 2 M or so and an extension cable can only be used to a maximum length of 20 ft. If the length is increased above this distance HF response will fall and this is fatal for recording such song as from a mistle thrush, wren or blackcap. The high frequency loss makes the song woolly. If a low impedance moving coil microphone is available, this can be used over long distances if connected to the high impedance input through a suitable transformer. The Grampian *DP4/L* is very good for long distance outdoor work but I find that a windshield has to be fitted.

Bird 'conversation' at close up range is most interesting and possibly rarely heard by humans.

Contrary to usual belief, February is the month when bird song starts up in earnest. It is July when the singers take their rest.

The robin is our most regular exponent and fortunately is fairly easy to find and to coax. A few spadefuls of earth dug from the garden will soon have it investigating and you should be ready to record, for it is likely to fly up into a nearby bush to sing.

Jealous of his territory for most of the year, we can assume that his song is linked with the holding of his area, for you can sense an expression of vigour and definance. It is a quick, gay, melodious song of short duration but soon repeated.

Bird songs are difficult to describe on paper and it is thus important to see the singing bird, and to describe it along with important details.

The presence of a robin is often heralded by a sharp warning 'tick' rapidly repeated but as soon as he accepts you so he may well burst into song. If he is still on his guard he may signal this with a long-drawn plaintive 'tzee-ee', easily recognised.

A common February note is the 'tzip-tzip', believed to be used to explain to other robins the boundaries of his territory.

Listen for these noises as well as for his song; an interesting record can become particularly valuable if your careful observations are included. To record song only is unsatisfactory, for it is so easy to forget details. A concise commentary is important.

February songsters may be residents such as starlings, nuthatch and thrush; or the winter migrants—fieldfares, brambling and waxwing (lots of these last March at the hawthorn berries).

The fieldfare can easily be attracted to your garden by over-ripe apples and the main note producing a warning will probably be a sharp 'tschak', I *have* heard their song, which is a pleasant warble but quite low in intensity. So the mistake must not be made of turning up replay volume in the belief that the power of the fieldfare's song is as powerful as that of our song thrust. To do that will not only give a wrong impression but will bring in all sorts of annoying noises.

These birds are rather shy, quick to alarm but speedy to return and probably one will have to use a parabolic reflector or a 30 ft extension cable and keep well out of sight. With skill and patience, the result will be truly surprising.

The redwing is another winter visitor allied to the thrust-like fieldfare and also quite willing to feed on 'bad' apples. His murmurings are well worth recording because they are so varied and are best heard in the evening at roost—which can well be in your garden.

The song has been described as a rippling soliloquy but what I suggest you try for is the low sub-song best heard at the end of this month.

These resident song birds can be recorded this month : owl, woodpecker, tree creeper, mistle thrush, blackbird, dunnock, goldfinch, skylark, wren, heron, mallard, grebe, lapwing and pheasant.

Let me know how you are getting on !

**ANALYSIS OF AN AMATEUR CONTINUED**

television show, well, it was all right, but too much like the thing last week that so-and-so did'.

The amateur tape-recordist should be an enthusiast. He should aim at the highest possible quality, combined with the highest possible entertainment content. It really doesn't matter whether he's a music man, a multi-tracker or a documentist of other people. Listen to the music recordings of Phillip Towell, the nature recordings of Richard Margoschis; listen to the work of the amateur specialists. There aren't many and there's room for very many more.

# 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 MARCH 1969 issue must reach these offices by 17th JANUARY addressed to: The Advertisement Manager, Tape Recorder, Link House, Dingwall Avenue, Croydon CR9 2TA.**

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

## SITUATIONS VACANT

**Hi-Fi and Tape Recorder salesman** required by R.E.W. (Earlsfield) Ltd., at their Tooting branch. Good pay and conditions. Apply the Manager, 266 Upper Tooting Road, London S.W.17. Tel. 01-672 9175 or 672 8267.

## MISCELLANEOUS

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

**Skilled** tape recorder repairs carried out by expert personnel of many years' experience backed by extensive test equipment: Wow and flutter meter, audio valve voltmeter, audio generator, oscilloscope, etc., with final test performance figures quoted if required—Ferrograph specialists. Tape Recorder Centre, Tel-Lee-Radio, 220 The Broadway, Wimbledon, S.W.19. 01-542-4946.

**Early flutter** spoils Recording . . . A fact well known to many. Send 6d in stamps for important information on how to deal with this and many other problems connected with wow and flutter. Music Tapes, 36 High Street, Salisbury, Wilts.

## FOR SALE—PRIVATE

**Leaving Country.** Professional equipment for sale. Akai X355 Recorder, four months months old, list price £331, accept £200 o.n.o. Vox Organ Guitar immaculate, cost new £200 accept £80 o.n.o. Ring 01-734 5933, Hewson, (9 a.m.-6 p.m.) or write. Box No. 545 (London).

**Custom-Built six channel** stereophonic microphone mixer (31 transistors) with stabilised mains power unit. Features per channel: BBC-Design pre-amp; Transformer (balanced) input switchable 30/600 ohms; preset attenuator; phase reversal; indicator lamp; each channel switchable to left/right mixer or "panpot". Outputs can feed five stereo recorders simultaneously. Only eight months old—genuine reason for sale. £70 o.n.o. Enquiries: 01-274 1717 evenings or weekends.

## FOR SALE—TRADE

**Absolutely free,** huge catalogue listing prerecorded mono and stereo tapes. Many carrying a discount of as much as 30%. Don't buy another tape until you've seen this new list. Send 4d stamp to BCM/tapes unlimited, London, W.C.1.

**Always be careful** (and money-wise) before buying quality equipment. Send your requirement list to Audio Supply Association for evaluation and quotation. See below . . .

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

**If quality matters** consult first our 70-page photographically illustrated catalogue (5/6) and equipment housing guide (1/6). Members enjoy unbiased advisory service, preferential terms. Membership 7/6. Our associates also manufacture records from your own tapes, or record the Master at our studios (Steinway Grand). Bulk terms for choirs, fund-raising. Please specify requirements. Audio Supply Association, 18 Blenheim Road, London, W.4.

**Absolutely genuine.** Up to 50% off retail prices of Recording Tape. Up to 25% off prerecorded tapes including cassettes. Up to 25% off Hi-Fi equipment. Send 6d stamp for full details to: BCM/tape unlimited, London, W.C.1.

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Limited quantities available ex-stock.

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## TAPE EXCHANGE

**Tapeworm's Stereo International.** This is for the stereo and hi-fi people. S.A.E. for details. 4 Queens Road, Maidstone, Kent.

**Open up the New Year** by opening up a "Tape Station" with Worldwide Tapetalk, 35 The Gardens, Harrow. Particulars: 4d stamp.

**Tapeworm's International Club.** The Club that offers so much for so little. Established 10 years now. S.A.E. for details. 4 Queens Road, Maidstone, Kent.

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**Mature Opera Enthusiast** and acoustic engineer invites correspondence from other collector enthusiasts able to share performances of live opera from British sources for private study. Overseas correspondence not precluded. Box No. 544 (Yorks.).

## STUDIO FACILITIES

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

**Your tapes to disc.** 7in. 45—22/-, 10in. L.P. —55/-, 12in. L.P.—65/-. 4-day postal service Masters and Vinylite pressings. Top professional quality. S.A.E. photo leaflet: Deroy Studios, High Bank, Hawk Street, Carnforth, Lancs.

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**Rapid Recording Service.** L.Ps from your own tapes. Master discs and pressings. Demo discs. Mobile recordings. Multichannel facilities for transfer to 8 and 16 mm film tracks. Sound effects library on discs. Brochure on request from:—Rapid Recording Service, 21 Bishop's Close, London, E.17.

**Graham Clark Records.** Tape to disc—pressings. Top quality yet lowest prices in country. 7in. 45 from 12/6. Small studio available. S.A.E. leaflet. 23 The Grove, Walton-on-Thames, Surrey. Tel. WT 25627.

## WANTED

**Truvox Series 80** Tape Unit in good condition. Please contact: E. Kennet, 17 Oakpark, Avenue, Torquay.

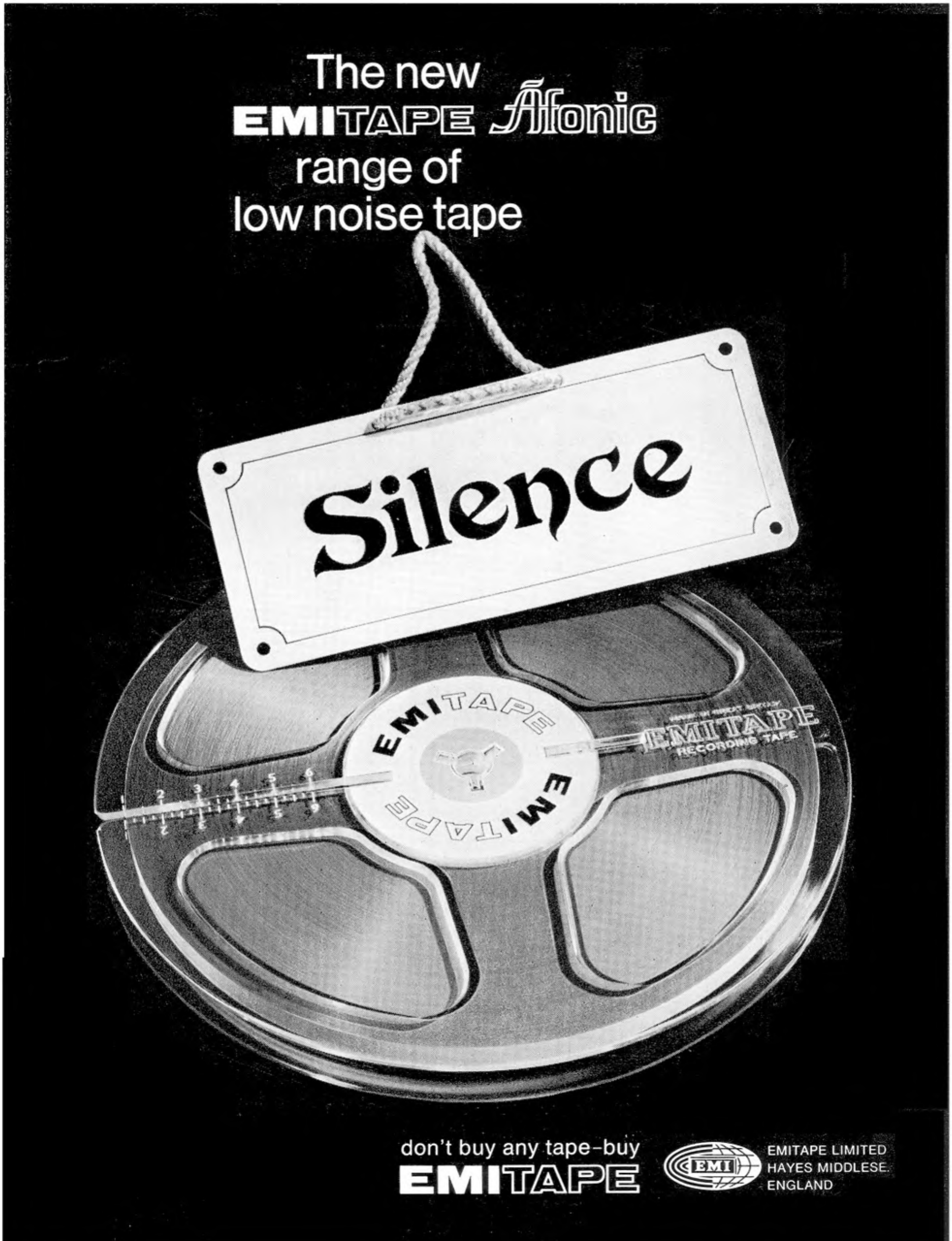
**Ferrograph Tape Recorder,** reasonable condition, please state price, etc. Box No. 546 (Surrey).

**Harting HM8** circuit and/or service manual urgently required. Neal, 145 Chester Road, Childer Thornton, Wirral, Cheshire (Hooton 3150).

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

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

**Good Quality Tape Recorders purchased for cash. Telephone 01-472 2185.**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