STUDIO SOUND

JANUARY 1971 3s (15p)

TELEFUNKEN

£600

BUT IT'S THE BEST

MAGNETOPHON M28A professional tape recorder by Telefunken, the company who made the world's *first* tape recorder.

● **Three-motor tape transport** at 3¾ and 7½ ips ensuring maximum speed constancy.

Fully comprehensive mixing facilities.

● **Solid state electronics** are used throughout. Modular construction ensures trouble-free maintenance and replacement of parts.

● **Relay operated transport control** operated by illuminated push buttons requiring only fingertip operation.

● **Interchangeable head assembly** comprising half-track, stereo, erase, record and playback heads, is mounted on a single rigid plate fixed to the main chassis. It is normally not necessary to replace or adjust heads during the normal life of the machine.

● **Two channel monitoring and VU-meter amplifier** can be switched to two modes. In the 'before-tape' mode the amplifier is connected to the output of the mixer, while in the 'off-tape' mode it is connected to the output of the replay amplifier. Two large VU-meters calibrated to international standard are provided.

Broadcast-studio versions Models 28B and 28C are provided with tape speeds of 15 and 7½ ips, but have no mixing or monitoring and VU-meter amplifier. Model 28B is equipped with full-track heads. Model 28C has two-track heads and track selector switch.

CONTACT: BRIAN ENGLISH

A.E.G. Telefunken, A.E.G. House, Chichester Rents, Chancery Lane, London WC2
Tel: 01-242 9944

NEW EMITAPE 815

in close touch with the best heads in the business

Our new professional audio tapes, EMITAPE 815 and 825 have won the approval of broadcasting and recording studios after rigorous evaluation on a wide range of tape transport units. EMITAPE 815 is standard-play. EMITAPE 825, the long play version, is ideal for portable and low tension recorders. Both have a polyester base with a specially treated coating and a new formulation that results in low modulation noise. Other advantages are exceptionally good dynamic range and signal-to-print ratio. EMITAPE quality is something you can prove to yourself now. If you are a professional recording engineer and haven't heard our new tape, send us your name and we'll send you a sample.

not just any tape - **EMITAPE**

EMI

EMI TAPE LIMITED · HAYES · MIDDLESEX · Telephone: 01-573 3888

Studio Sound

AND TAPE RECORDER

JANUARY 1971 VOLUME 13 NUMBER 1

INCORPORATING
SOUND AND CINE

EDITOR
JOHN CRABBE

DEPUTY EDITOR
DAVID KIRK

ADVERTISEMENT MANAGER
ROBIN WELLS

ASSISTANT ADVERTISEMENT MANAGER
TONY NEWMAN

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

COVER PICTURE

Dudley Moore contributing to a *Private Eye* recording made during Keith Wicks' visit to Marquee.

SUBSCRIPTION RATES

Annual UK subscription rate for *Studio Sound* is 36s. (overseas 42s., $5 or equivalent). Our associate publication *Hi-Fi News* costs 50s. (overseas 53s., $6.30 or equivalent). Six-month home subscriptions are 18s. *(Studio Sound)* and 25s. *(Hi-Fi News).*

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

WHAT DO STUDIOS look for in a master tape recorder? The unhappy Unitrack affair begs the question and suggests that, for Morgan Studios, Sutton Sound (almost), and the Rolling Stones, a long-standing good reputation didn't count for much. Someone always has to be first to purchase from a new manufacturer, of course, and one must at least admire their confidence.

Most engineers have preferences for one design or one manufacturer, though their desires are often deflected by long delivery dates towards more prolific companies. Not that a delivery date can be considered a promise. One British manufacturer recently lost a customer by quoting six weeks delivery. The customer placed his order with another maker promising faster delivery; months later he was still waiting for his machine.

If any one manufacturer holds the lion's share of goodwill among engineers it is Studer. The *J37*, despite its valves, its scissors and its apparently flimsy plastic pushbuttons, is still generally considered one of the finest recorders in production. Its smaller companion, the *A62*, suffices for many institutions as a robust transportable unit, despite being dubiously tagged 'the big Revox'. Latterly the *A80* with its swivelling deck and modular electronics—not to mention 25 ICs, 77 transistors and 73 diodes in the transport control circuitry alone—has been developed for the multitrack market. The complex deck circuitry may attract engineers who derive pride from the sophistication of their equipment, but may repel the larger proportion insisting on plain reliability.

Quality (of the measurable signal-handling kind) is important to the engineer though it takes fourth place behind three practical considerations: (1) Is the delivery date convenient? (2) Will the recorder seize up after a full day's use? and (3) How easily can it be lined up and serviced? None of these factors appears in the average specification. The figures that do appear are often suspect, traditionally so conservative that any machine actually meeting, but only just within, its spec would be considered useless. Remember all the ±2 dB margins quoted in our May 1970 survey of professional recorders? These against bandwidths which, after routine setting up, should be flat within 0.5 dB. Wow and flutter are too often front-of-reel figures, disguising the high end-of-reel wow present on many servoless tensioned supply turntable designs.

It is arguable that the studio automation so fervently advocated (by makers of automated systems) at the IBC will lead to an increase in maintenance problems over the next few years, rather than a simplification. One large London studio is boasting a 'replace it when it fails' philosophy which seems perfectly appropriate to automated systems in the present healthy state of the UK recording industry. When (or if!) expansion eventually turns through saturation into contraction, the outmoded philosophy will present a few headaches for whoever has to service recalcitrant ICs. The disreputable state of many disc cutting studios indicates an apathetic attitude to maintaining, let alone replacing, ageing equipment. Ancient rumbling Ampexes, switches that sometimes don't, racks of control equipment handed down from early film studios, and stark staring holes from where antedeluvian limiters have departed for a Lisle Street grave. Such studios not only exist, they enjoy high reputations, perhaps because the cutting engineers restrain from smoking in front of their more valued customers. If the move to cassettes presents no other advantage, it may at least eliminate the poorer disc-cutting emporiums from the audio chain.

FEATURE ARTICLES

REGULAR COLUMNS

EQUIPMENT REVIEWS

studio diary

RCA DEVELOP CAMERA TUBE WITH MEMORY

A SLOW-ACTION television camera tube has been developed by RCA. A still picture can be held as long as a month before read-out, or relayed at rates of up to 200 different frames per minute. A silicon wafer vidicon target some 25 mm in diameter is isolated into 600 000 photosensitive diodes. A silicon dioxide lattice is coated on the target to achieve this isolation. The target is initially scanned with a high voltage electron beam to erase the previous picture. The new picture is then placed on the target by conventional scanning. Repeated lower voltage scanning builds up the electron charge to store the picture. A light bulb outside the tube illuminates the target on read-out, which involves still lower voltage electron scan. The current flowing through each diode during read-out is dependent on the charge recorded at each point. A stored picture may be screened for several minutes before the read beam gradually erases the picture.

AUDIO AND VIDEO RENTALS

CLOSED CIRCUIT television and videotape equipment is being offered for hire by Audio & Video Rentals Ltd, 27 to 29 Whitfield Street, London W1E 4Q7. Hire contracts can be arranged to cover periods from one day to a maximum of three years, daily charge decreasing for long hire terms. Long term charges are assessed on a basic costing of 4.5% of capital expenditure per month (three year contract). Pulse generators, distribution amplifiers, vision mixers, effects generators, sound equipment and microwave links are available in addition to helical and quadruplex VTRs. If required, a full television studio may be hired.

LOW PRICE L4

EMI ARE now offering their *L4* battery tape recorder for £59. Previously restricted to the scientific and industrial market, it is now available to any interested purchaser. The *L4*, which has now ceased production, operates at 19 and 9.5 cm/s and includes two microphone inputs, line in and line out sockets, AB monitoring and HF bias. Full, half-track and pilot sync models may be ordered. Details from EMI Electronics Ltd, Hayes, Middlesex.

SAFEGUARDING PA EQUIPMENT

THE DANGER of electrocution, ever present among users of stage amplification equipment, has been overcome by an audio engineer and former guitarist John Reid of Boston Avenue, Newcastle on Tyne. In partnership with Chris Hayes, he has formed Sound Electronics (Newcastle) Ltd to manufacture the *Playsafe*, a circuit breaker designed to connect between a microphone or guitar and the amplifier. The fuses are mounted in a 75 mm long high-impact PVC tube and are expected to retail at £3. Some five groups in the North East are currently using the device and Equity has requested a demonstration.

STUDIO OPENS IN NOTTINGHAM

UP TO 40 performers can be accommodated in the Nottingham studio newly opened by Banner Productions, entertainment promotion consultants. Main purpose of the studio will be to provide groups under the Banner wing with experimental recording facilities. Four and two channel tape equipment is being used, with a 15-channel mixer and AKG/Calrec microphones. The Banner Recorded Sound studio may be hired at £7 per hour.

W. H. SMITH JOINS VIDEO CONSORTIUM

W. H. SMITH & SON have formed an international consortium to distribute video cassettes and video discs on a wholesale and retail basis. Other companies involved are Librairie Hachette (France), Schmidt Agence AG (Switzerland), Hermann Montanus (Germany) and A. S. Nord Cassette. The latter is jointly owned by Narvesens (Norway), Pressbyran (Sweden) and Rautatiekirja (Finland).

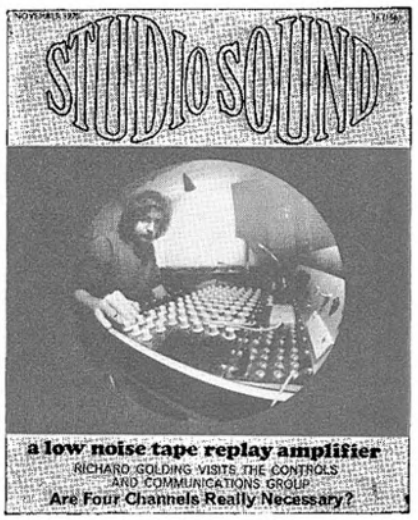
The new concern is to be registered as Cassettes International S.A. with offices at Boulevard Adolphe Max 71, Brussels.

LONDON OFFICE FOR CARSTON

SALES AND SERVICE divisions of Carston Electronics moved in November to new offices in Camden Town. Their new address is Shirley House, 27 Camden Road, London N.W.1. (Tel. 01-267 2748).

NEXT MONTH

A CHANGE IN cover design with our February issue. An impression is reproduced below with mock titles. Tony Waldron looks at headphones, their design and use, and Eric Robjohns asks Why so Many Tape Recording Characteristics? Video tape recorders are surveyed, Angus McKenzie reviews the Weircliffe bulk eraser and John Shuttleworth visits the BBC's Maida Vale 1.

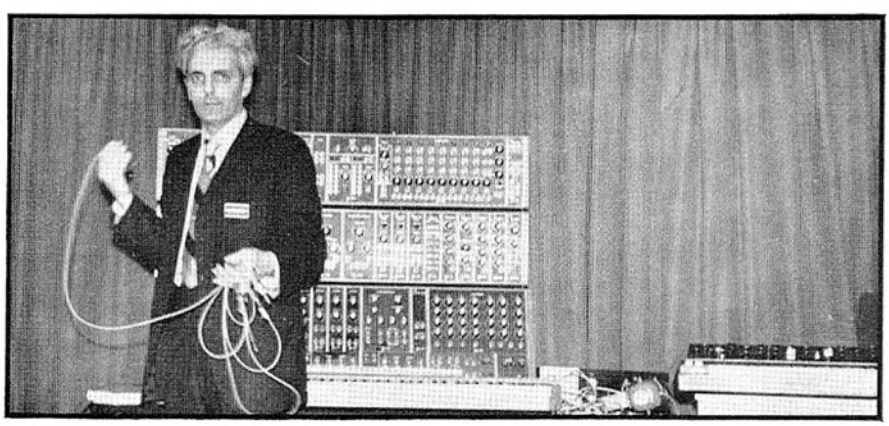


UK AES

THE Audio Engineering Society was formed 22 years ago in the United States to encourage higher standards in disc and magnetic tape recording, and the general art of sound recording and reproduction. It very quickly became regarded, initially in the States and later throughout the World, as a most important body in its field for the dissemination of technical knowledge. In the early 1950s it started publication of the more or less quarterly *AES Journal*.

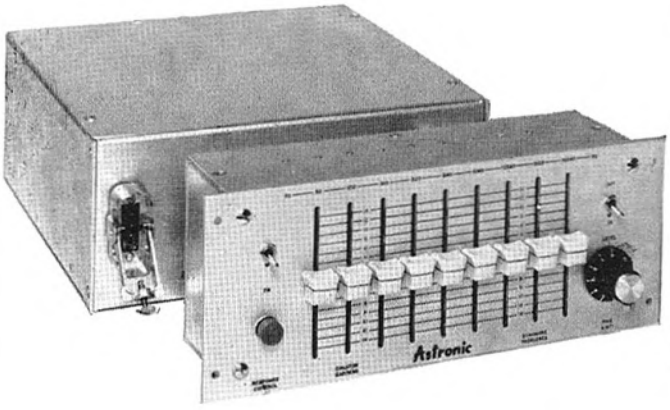
There are three grades of membership. Full membership applies to those engineers having a degree or its equivalent in experience. Associate membership, which does not carry voting powers or the right to hold office, can be granted to anybody interested in the objectives

(continued on page 9)



Dr R. A. Moog demonstrating his electronic music synthesiser to an Audio Fair audience.

ENGLAND, SCOTLAND, IRELAND, FRANCE, BELGIUM, HOLLAND, GERMANY, ITALY, GREECE, AMERICA, SOUTH AFRICA, AUSTRALIA, NEW ZEALAND



IN STUDIOS THROUGHOUT THE WORLD YOU WILL FIND

"Astronic"

AUDIO RESPONSE CONTROL UNITS
TYPE A1671

The MK11 version now available embodies complete printed circuit board construction of main unit improved control panel and changes in switch design.

Send for full details from **ASTRONIC LTD.**

DALSTON GARDENS, STANMORE, MIDDLESEX, HA7 IBL

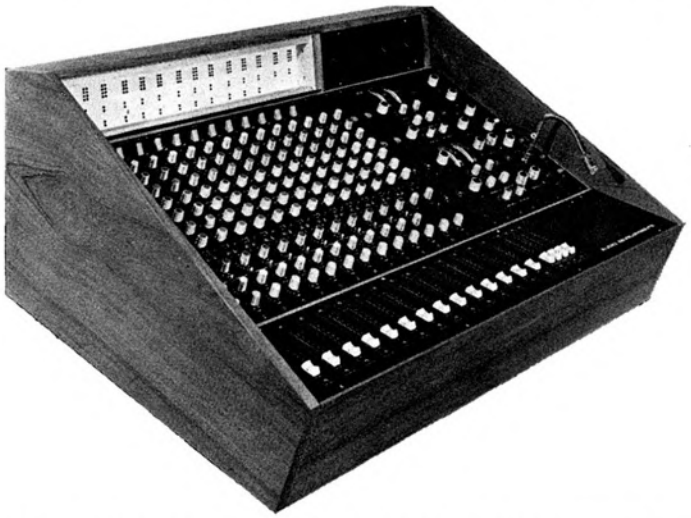
Grams. Astronic Stanmore **Phone : 01-204-2125**

AUDIO DEVELOPMENTS

A PORTABLE MIXING CONSOLE BUILT ON THE MODULAR SYSTEM

SPECIFICATION :

INPUTS:	12 input channels each having 600 ohm microphone input, switched attenuator and 10K ohm line input. 2 echo return channels.
EQUALISATION	All input channels have Baxendall H.F. and L.F. controls, HI and LO pass filters, and presence lift of up to 10 db. at: 150, 300 and 600 Hz 2, 3, 5 and 8 kHz
GAINS:	Maximum gain of unit in standard form 80 dB.
NOISE:	Microphone input unit with all equalisers set flat, better than −125 dB.
OUTPUT and DISTORTION:	Maximum output +20 dBm. Distortion 0.05%
MONITORING:	Built in 20w. per channel stereo amplifiers. 4 PPMs and PPM for echo send.
COMPRESSOR/ LIMITERS:	4 Compressor limiter amplifiers provided, may be inserted in any group or channel.
OUTPUTS:	4 Groups 600 ohm Balanced 2 Echo send 600 ohm Balanced 2 Fold-back 600 ohm Unbalanced 2 Monitor Speakers 8 or 15 ohm 1 Talk back Speaker 8 or 15 ohm
FADERS:	All faders are Penny & Giles slide type.
TALK-BACK:	Built-in microphone and talk-back amplifier.
ROUTING:	By unique matrix system.



PRICES AND DETAILS ON REQUEST TO

AUDIO DEVELOPMENTS, HALL LANE, WALSALL WOOD, STAFFS. BROWNHILLS 4605

of the AES. Student membership is open to those who are studying allied subjects to audio engineering at a recognised college or institution, and carries the same restrictions as Associate membership, although the student may serve on local student committees. Students are given a preferential annual subscription of $6. Associates pay $10 and full members $12.50.

For some time several British members of the AES have been planning, with the co-operation of the main body in the States, to open a British Branch. A limited company has been formed, known as Audio Engineering Society Ltd, which will control the finances of the British Branch. It exists purely as a means for subscriptions to be collected in Britain and paid en bloc to the US each year.

A business meeting was held on September 29 at EMI House in Manchester Square, London, where the Articles of Association were explained and slightly modified to suit the situation in Britain. A committee was elected and Percy Wilson has been asked to be Chairman. John Borwick, technical editor of *The Gramophone*, was elected Secretary and John Gilbert, head of the Telecommunications Department at London's Northern Polytechnic, was elected Vice Chairman. Sufficient committee members were elected to ensure a quorum of five, so three members will hold office for one year and three for two years. Those elected to date are John Maunder, James Moir and Rex Baldock, one year; Donald Aldous, Raymond Cook and Norman Leevers, two years.

It was suggested that the Society might arrange visits to research establishments and manufacturers connected with audio engineering.

The audience at this inaugural meeting included some of the best known personalities in the audio world, and many manufacturers present stated that they would give financial support to the new branch. The membership fee of about £6 5s. per annum will entitle members to attend meetings and also to receive the American Journal which is now being published monthly. Membership forms and details are available from John Borwick, 47 Wattendon Road, Kenley, Surrey.

CRAIGHALL INSTALL 16-CHANNEL NEVE

A 16-CHANNEL four output group mixing console has been installed at Craighall Studios in Edinburgh by Rupert Neve & Co. With Studer and Ampex tape equipment plus a four-track recording van Craighall claim to be, and intend to remain, the best equipped studio north of the Tyne. Dennis Chapman (left) of Neve is pictured discussing the installation with studio manager Robert Sibbald.

book reviews

TAPE RECORDER SERVICING GUIDE. By R. G. Middleton. 96 pages, with line and tone illustrations. Price 35s. Published by W. Foulsham & Co. Ltd, Slough, Bucks.

FIRST question to be asked is 'Who is going to fork out 35 bob for a work on tape recorder servicing which skims very lightly over the general principles, which assumes the possession of a reasonable amount of test equipment and the know-how to use it, and which is nowhere specific about makes and models or particular designs?'

The answer is—not the average service engineer, who may be presumed to have most of the information in Mr Middleton's 'Guide' already at his fingertips, or within easy reach. Nor, for that matter, the chap who owns a *Humbox Hi-Fi* and needs to be told how to take it to bits.

Mr Middleton is no slouch at the art of communication. I feel sure our own Gordon King would not be insulted by a comparison. One of the elite of full-time writers on electronics, with a pretty comprehensively furnished laboratory for his den (just like Gordon) and with an unending passion for detail, RGM has a pack of good books to his credit.

After the inevitable foreword from W. Oliver, which includes a useful bit of drum-beating for Heathkits, we find Mr Middleton commencing his preface with the suggestion that servicing tape recorders may be a substantial source of supplementary income. I could tell him that there is more to it than knowing how the blighters work. If one is to cost one's time economically, the vital need is for specific information. Circuits and a few drawings and photographs of mechanical layouts are worth a wealth of heady prose.

Nevertheless, the information we are given is valid and interesting. Commencing with a chapter on general principles that leans heavily toward a better understanding of magnetism, and spends a good while talking about HF bias and tape modulation, with adequate illustrations, Mr Middleton tries to cover the whole field in one leap.

Chapter Two is headed 'Preventive Maintenance and Evaluation' and deals with tools and test gear and a few brief checks. There is one error where an exploded diagram of clutches is captioned 'Typical brake assembly' and his list of 'basic requirements' for a tape transport falls far short of, for example, Paul Spring's list (Grundig) or for that matter, our own.

Chapter Three, on 'Adjustments and Minor Repairs', is exactly the sort of information the 'home mechanic' wants to know and a lot of the test gear techniques are practical—obviously the work of a chap who has gone through the mill himself. Similarly, the next chapter which concentrates on the transport, has a lot of horse sense about it. But it annoys me to see parts lists and layout photos of tape recorders printed with nowhere a mention of their make and model.

Chapters Five and Six deal with recording and replay troubles separately and in the latter we find another statement with which we might argue. Underlining the need for a loudspeaker substitute, RGM says: 'It is possible for an amplifier to be seriously damaged if operated without a load. This is especially true of solid-state amplifiers.'

The final chapter is an unusual but welcome one headed 'Recorder Test Equipment Troubles'. Here we have not only good advice on the limitations and choice of specific equipment for the job but also a few hints on its use and maintenance. Full marks.

Although I cannot go all the way with the blurb-writer who says this will be an invaluable reference for the workshop, I must applaud Mr Middleton's motives in writing it. Well aware of the labour it involves and glad that it covers slightly different country than my own, soon to appear! I can heartily recommend this book to the amateur tape recorder enthusiast interested not only in what the machine can do but also a few reasons why. All very readable and without any serious blunders. Typical Middleton, in fact.

HWH

AROUND the STUDIOS

BY KEITH WICKS

MARQUEE

IN 1964, the Marquee Jazz Club moved from Oxford Street to Wardour Street. The new premises were much larger and left ample room for a recording studio.

The studio, entered from Richmond Mews (off Dean Street), started in a modest way. Like most studios in those days, Marquee provided only mono facilities. They initially concentrated on making demonstration discs, although the great success of the Moody Blues' first single *Go Now* proved the studio's ability to produce first-rate recordings. By 1966 the recording industry was expanding and Marquee went four track. The control room was very small, and monitoring was provided by two speakers, each fed by a 12 W amplifier. The studio itself was unimpressive, with chicken wire and padding on the walls, but this state of affairs did not last long. Redecorations were carried out the following year and new equipment installed, including a more comprehensive mixing desk. After this, the business flourished and in the spring of 1969 an eight track Ampex recorder was purchased. Since then, the studio has been extremely busy recording such people as Johnny Dankworth, Cleo Laine, Françoise Hardy, Manfred Mann, and the Nice. At the end of July this year Marquee closed for further modernisation. One month (and over £50 000) later, the studio reopened, and I can report that the money has been well spent.

Gerry Collins, the studio director, showed me the new set-up. Then Gerry and studio manager Colin Caldwell took control of a session featuring Peter Cook and Dudley Moore. With the aid of producer Barry Fantoni, William Rushton, and others from *Private Eye*, that magazine's Christmas record was eventually taped. It is a pity the end product will be a low quality flexible disc, as the recorded material is worthy of something better.

After the session, I talked to Gerry Collins about the studio and the equipment they now have. I first asked him about the mixing desk:

G.C. The desk erganomics were designed by ourselves, using channel modules by Helios Electronics. The bulk of the circuitry apart from the main channels was our own design. We have two foldback rings, and three EMT stereo echo plated. We also have lines to the Marquee Club, facilitating live recording. CCTV and talkback link us with the club.

K.W. *I notice you use VU meters on the desk. Any particular reason against PPMs?*

G.C. All our engineers have been used to working with VUs so we stuck to them, but we are going to incorporate two PPMs. They are projection display units which will be mounted on the wall some distance from the desk.

K.W. *What sort of monitoring amplifiers do you use?*

G.C. We're just changing over actually, to Spectra Sonics.

K.W. *From what did you change, and why?*

G.C. We've changed from 50 W *Quads*. Instead of feeding one amplifier into a cross-over unit in the speaker, we are going to use two amplifiers. All the bass signals will be sent to one amplifier, and will be fed to the bass section of the speaker. There will be a completely separate amplifier for the middle and top range.

K.W. *Is this to prevent intermodulation distortion?*

G.C. Yes. You can go further and use three amplifiers but I don't think there would be much more improvement.

K.W. *What speakers will these amplifiers feed?*

G.C. The new J.B. Lansings. They've just started being imported into this country and we've got the first pair. Advision studios are also installing them.

K.W. *They used to have Altec Lansings didn't they?*

G.C. Yes. We were the same. The new speakers can stand 120 W continuous rating which is fantastic. There is no chance of blowing the things up. Also, you can adjust the tonal characteristics of the speakers to the acoustics of the room.

K.W. *How is this achieved?*

G.C. By various crossover units in the speaker. There is a large bass unit, a middle unit, the usual sort of top speaker, and a special HF unit that brings in all the really highs that make a hell of a difference to the sound.

K.W. *How many speakers will there be altogether?*

G.C. Four amplifiers feeding two speakers. We've always used two speakers.

K.W. *You wouldn't consider using four speakers as many studios do?*

G.C. No. There's a tendency towards using just two in the States now. I think everyone gets a little carried away with the studio sound they hear. So many people are really knocked out by the tape they hear in studio control rooms but they take it away knocked down into final stereo form and find it's not quite so hot. Using a two-speaker system, we never escape from reality. You haven't got bass coming from one, strings from another, a voice from another, and so on, giving a barrage of sound. Anything sounds good if you play it loud enough. With our system, everything is kept in perspective from the original session right through to the final reduction. On our desk, you can pan all the monitoring to wherever you want it, so you can get the effect you want without losing reality.

K.W. *The studio is now rather luxurious. Who designed it?*

G.C. Well, I did. We've changed the acoustic only slightly, as it was already rather good. The control room was doubled in size, and that was done by Eddie Veale of Acoustic Consultants. During the month we were closed we pulled out all the cable ducts, had walls down, and then rebuilt, most of the work being done by ourselves.

K.W. *I know the floor area of the studio is nearly* 100 m². *How big is the control room?*

G.C. About 6 x 7 m. As well as the control desk, there is a cabinet housing extra equalisers, plus all our limiters. We use four Astronics, two Belcomans, one Altec and a Fairchild. In addition we have two equaliser-limiters which were built for us with features from several existing units. We are also adding two Audio & Design limiters.

K.W. *I see you prefer to keep the tape machines out of the control room.*

G.C. Yes. This is to keep distractions away from the control area. We're also putting in a complete remote control system for the rare event of having no tape operator. You can punch up any combination of machines, then press the final button, and the whole thing comes into action. These buttons are situated on the control desk in a separate remote box. The system was designed by Roger Pharo, our technical chief.

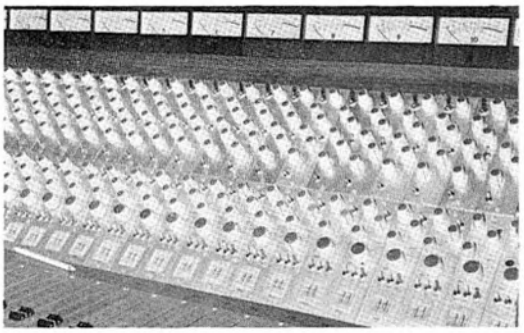
K.W. *What recorders do you use at the moment?*

G.C. There's a bench housing two *A62* Studers plus one four track Ampex. Our main recorder is an Ampex *MM-1000*. This is used as a dual purpose machine covering us for 16 track and eight track work. It is also adaptable to 24 track should that become necessary. With all Ampex equipment now you can build a mono machine up to a maximum of four tracks and, with the *MM-1000*, you can go from eight right up to 24.

K.W. *When do you use your Dolbys—all the time?*

Gerry Collins at the Marquee control desk.

Control desk close-up.



G.C. Yes, unless the client particularly doesn't want them to be used. We've got nine *A301* units—two noise reduction systems in each.

K.W. *Presumably most of the work you do here is pop?*

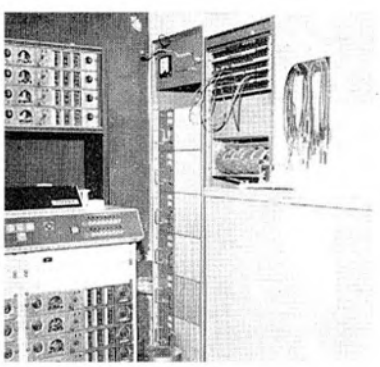
G.C. Yes, like any studio, but this encompasses small groups right up to 35-piece orchestras. We've just finished doing an LP for Byg Records of France featuring the group *Alice*. We did quite a lot of work on the Tremeloes' last single as well. We've just done two *Disco-2* from the club, and we've got another coming up very soon for *Tangerine Peel*. We are also going to do a 16-track session live from the club for the Small Faces. We do other things, for example this *Private Eye* record.

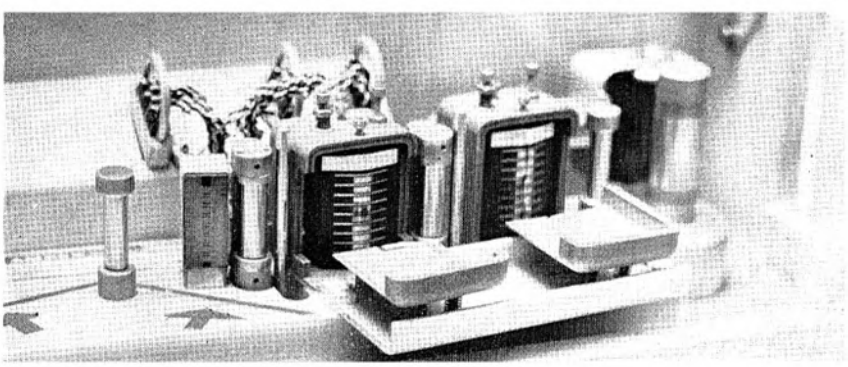
K.W. *What microphones were you using on this session?*

G.C. For piano a Neumann *87* and a *4038* ribbon. On the organ there was an AKG *D190* for the top and another AKG, a *C12A* for the bass. We didn't use a microphone for the rhythm guitar—it was injected directly into the mixer. For the vocals we had a Calrec capacitor microphone over the piano, and an AKG *D25* over the organ. The other microphone used for vocal was a Neumann *67*.

The hourly charges at Marquee are as follows:

16 track recording:	£26	Reduction: £20
Eight track:	£23	Reduction: £16
Four track:	£18	Reduction: £12
Stereo:	£15	Editing, dubbing
Mono:	£12	and playback: £5.





Top left: Four-channel Ampex and two *A62* Studers.

Bottom left: Ampex *MM-1000* and Dolbys.

Top centre: STC *4038* ribbon on electronic organ.

Top right: Peter Cook and John Wells using Neumann *U67*.

Bottom right: Close-up of *MM-1000* headblock.

5 good reasons to use an Ampex MM-1000 recorder.

1. It's expandable,
Our 8-channel MM-1000 Master Recorder costs only moderately more than other 8-channel recorders. But with the MM-1000 you can readily expand to 16 or 24 channels. Add-on 'kits' enable you to add channels as you need them. Or you can buy the MM-1000—16 or 24 channels completely checked out and ready-to-go.

2. It's designed to handle wide tape.
The MM-1000 tape transport is designed to handle 1" and 2" tape. It's the same transport that's now in use on over 3000 Ampex video tape recorders. When you go from 1" and 2" tape, you just change the tape guides and the plug-in head assembly. Lets you quickly change from 1" for 8-channels to 2" for 16 or 24 channels,

3. It's versatile.
The MM-1000 offers more standard and optional features than any other master recorder. Tape Motion Sensing for instance. Allows you to change modes without going into stop and without stretching or breaking tape. Automatic Tape Lifters? Yes, and with manual override Ping Ponging? Sure, Sel-Sync? Naturally. Also remote Sel-Sync. How about Variable Speed Motor Drive Amplifier? Yes again, plus an Electronic Timer with up to 4 remote read-outs for pinpoint accuracy. Versatile? You bet!

4. It's promotable.
"New Generation" recording capability is built into the MM-1000. The new groups demand this capability and record at the studios that offer it. The MM-1000 is capturing the imagination of these groups, and challenging their creativity. With the MM-1000 you'll have a promotable edge over studios with past generation equipment.

5. Its applications are totally unrestricted.
The wide range of applications for the MM-1000 mean its cost is amortized over a very short time. The MM-1000 may typically be used for Pop music recording, master Classic recordings, multi-language synchronised with videotape recordings, multi-channel sound source for film transcriptions. Or simply as a 'soul mate' in the search for innovation in music.

AMPEX

For further information on the Ampex MM-1000 recorder, send this coupon today.

Name _____

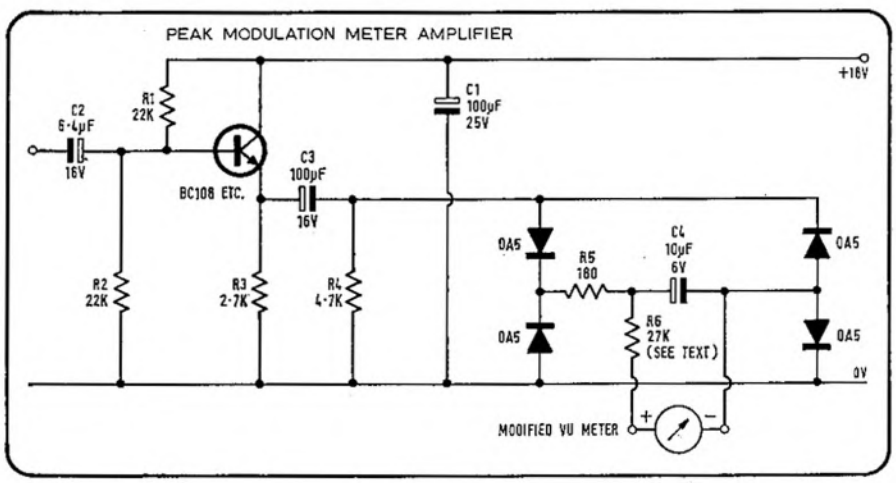
Company _____

Address _____

SS.1

Ampex Great Britain Ltd.,
72 Berkeley Avenue, Reading, Berkshire. Tel: 84411

Building a povum



*Michael Naylor * describes an inexpensive alternative to the PPM, a peak-oriented VU meter.*

FOR those who would prefer a PPM to a VU meter but cannot afford their taste, this circuit may be the answer. The object of metering is to know the peak voltage being sent down the line and on to the tape. As only the maximum peak is of crucial interest, it is not essential that the meter be logarithmic. This meter utilises the scale of a VU but registers both positive and negative peaks with the attack and decay associated with a PPM.

I developed this circuit to use in an eight channel four group mixer I have built and all four meters have functioned for more than a year without trouble of any kind. They are in use nearly every day and their sensitivity and calibration have not drifted at all.

A *Sew* VU meter is used but must be modified as follows. The clear plastic front cover is prized off very carefully. It is a push fit and can easily crack.

I learned the hard way—one of my four did crack. Having done this, the screws that hold the movement in the case must then be removed. They are sealed with a soft white material and located on the back of the case next to the terminals. This allows the movement to be withdrawn. A diode can now be seen in series with the movement, and a resistor across the terminals. These have to be extracted and the movement resoldered directly to the terminals. This has the effect of increasing the current sensitivity and over-coming the diode's non-linear characteristic which is duplicated in the circuit.

The transistor is merely an emitter-follower presenting a bridging impedance to the line and a very low AC charge path to the following circuitry. Virtually any high-gain device capable of peak collector currents up to 100 mA peak can be used. I hasten to add that the circuit takes only about 3.5 mA and that these peak currents come from the 100 μF capacitor, C1, across the supply. For this reason, C1 should be close to the transistor and diodes or clicks may be induced in the supply.

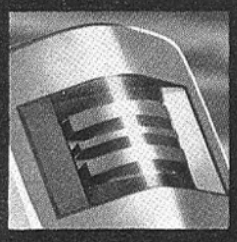
R4 provides a DC leakage path for the coupling capacitor C3 and thus prevents a static reading building up on the meter. The four diodes form a full-wave bridge rectifier so that the meter equally registers negative and positive peaks. This, via R5, charges the storage capacitor C4. The value of R5 is so chosen as not to impede the natural attack time of the meter and to restrict the peak current through the transistor to a safe limit.

R6 determines, together with the internal resistance of the meter, the decay time and also the sensitivity. The 27 K value shown gives a sensitivity of nearly +8 dBm for a 0 VU 100% reading, and thus corresponds to a PPM reading of 6. If an absolute calibration is required, a 50 K skeleton preset could be substituted for R6 and then adjusted on test.

The VU scale of decibels is accurate and can be relied upon to remain so. As can be seen, there is no 'set zero' to drift and the circuit is even independent of supply fluctuations. All in all, this is a reliable and stable unit that needs no setting up or adjustment and which, above all, is cheap and easy to build.

* *Sound balancer, Yorkshire Television.*

glass & x'tal ferrite head



Model GX-365

150,000 hours service life!

Dust Free / Wear Free / Preeminent Recording

AKAI has again developed a world's first. It's the GLASS and X'TAL (crystal) FERRITE HEAD. We call it the GX-Head. The core of this head is made of pure crystal ferrite, and the inner circumference of the head shield is mounted and set in glass. The GX-Head is "dust free". Thus, sound quality is not affected by magnetic tape dust even under hot and humid conditions. It's "wear free" and guaranteed for over 150,000 hours of use. It incorporates AKAI's unique "focused field" recording system which completely eliminates distortion in recording/playback of high frequency signals. This revolutionary head is incorporated in our **GX-365 Stereo Tape Recorder** which also features automatic continuous reverse, automatic volume control, magnetic brake, and 3 motors.

Audio & Video

AKAI®

AKAI ELECTRIC CO., LTD.
Ohta-ku, Tokyo, Japan

Rank Aldis-Audio Products, Rank Audio Visual Ltd. : P.O. Box 70, Great West Road, Brentford, Middlesex Tel: 01 568-9222

The Quiet Accompanist

John Fisher discusses the merits of tape as a musician's tool

OFTEN one becomes so involved with the technicalities and complexities of recording and reproduction, of building and buying equipment that comes a step closer to the original sound—or the sound one thinks should have been the original—that one forgets why one bought that first simple and subsequently unsatisfying tape recorder: to record music, to record live performances in which one was participating or in which friends and relatives were taking part. Recording, in all its complexities, develops alongside and away from the music that brought it to one's notice. It may even get to the stage of taking precedence over the older art. A sad reflection but so often true.

I do not intend to dwell on this sorry state of affairs. Instead I propose to look at tape as a tool for the musician, a tool that is required to be near perfection but which is displaced when the performance is ready to take over. Perhaps the market research departments of one or two reputable manufacturers might read on to see whether there is not a market for a simple, high quality machine at reasonable price for those to whom tape is a tool, not a god.

From time to time I get letters or personal enquiries from friends as to the best machine for their purposes. One of these, about a year ago, came from a young music student at the Guildhall School of Music, doing double first studies in piano and singing. She had realised how invaluable tape could be in developing her performances and technique, as well as being a medium to record live and broadcast performances. She had also realised, from listening to friends' machines, just how unsatisfactory most of them were for the purpose for which they had been bought, despite the oily assurances of the salesman, the winning claims of the glossy coloured brochures, the superlatives of the copy writers, and the glib suggestions of the instruction book. Contrary to the claims of the copy writers, a £30 domestic recorder will *not* turn you into an artist of international calibre in a fortnight. Nor will a machine costing £300. There is no substitute for hard work and good teachers. But a good machine *can* be a great help, it *can* illustrate and clarify points, can show up flaws to which the performer's ear is not tuned. It can also be a great help in broadening one's repertoire and knowledge of works.

Piano rehearsals

So to the particular requirements in this student's case. The machine was to be used to record piano, both during performances and more particularly in rehearsal, to help with phrasing, the application of technique, to show up unevenness and to help in producing a unified performance. One's ear compensates, with the help of one's brain and the 'inner performance', for the deficiencies in what one hears oneself playing. After a concert performance, a tape recording is a far better basis for a constructive post mortem than any self-appointed critic.

The second use of the machine was as a means of helping correct voice production, good phrasing and intonation, showing up unhappy passages and showing how well others are coming off, comparing interpretations and speeds (so often one feels one speed when singing and quite another when listening), and gauging the development of the voice and depth of interpretation over a period of time—an audio scrapbook. Taken to a music lesson, it is also an automatic notebook that will repeat points brought out by the teacher during a performance.

The third use of the machine was as a tame accompanist. When learning an unfamiliar or particularly tricky piece, it is enormously valuable, as a time saver, to hear other people's performances and, on the other hand, to have an electronic accompaniment on tap without trying the patience and good nature of a live accompanist. It is far happier to meet one's accompanist with a piece firmly learned and then go on jointly to produce a free performance, than to bash away from square one together when neither knows the piece well enough to begin interpreting.

So the machine was required to record piano and female voice—perhaps two of the hardest things to tape well. It had also to reproduce them satisfactorily, with all that implies in the reproducing chain. Above all, the machine had to be used by someone a musician first and last, with little technical knowledge and no wish to spend more than the barest minimum of time on the mechanics of recording. The following specification was drawn up:

(1) Should be able to record on one channel, replay that channel while recording on a second, and be capable of replaying the second without, and possibly also with, the first track.

(2) The quality in terms of hiss, distortion, dropout and frequency response should be beyond reproach.

(3) The wow and flutter should be negligible at one speed at least—nothing is more irritating than a wowing piano. It is hopeless listening for undue vibrato or roughness in the voice when a cheap machine is wobbling all over the place.

(4) To eliminate unnecessary and tedious connections, the machine should have built-in power amplifier(s) and speaker(s), ideally two.

(5) The machine should be fairly small and light, to enable it to be easily carried.

There was one more requirement, alas all too common. It should be cheap, under £60 with one decent mike and a reel of good tape. I hear you laugh? After six months I began to wish I'd kept my mouth shut, particularly as an important examination loomed up and one by one items of my own equipment migrated. Most dealers who know me were polite and decided I was just a little farther off the rails than usual; some politely said they'd keep their eyes open. Others just took a tea break when I entered their shop, or were permanently away on business when I phoned. It had to be secondhand—I defy you to find a machine that would really meet that spec new under £60.

So we took to scouring the second-hand equipment columns of the audio journals, *Exchange & Mart*, and the like. Many a frustrating dash to farthest extremes of London and the home counties found an 'as new' machine that turned out to be the first of a series of 12 made over a period of 15 years or more, the capstan rusty and slow, wobbling at least 10% RMS, the frequency response and background comparable with a GPO local line (somehow, in Berkshire, trunk lines are much better than those to the nearest town or village). Many, many such trips. We revised specs, tried compromises, but to no avail.

Curiously reluctant

A Revox *736 would* have done–except that it is a bit heavy to carry about, to and from college, even if you do use a trolley about the house—and owners seem curiously reluctant to part with them for enough under £60. A Bang & Olufsen would have been nice enough *if* anyone would part with a working one, though it was a little bigger than ideal. Nagras and Uher *4000s* come a bit expensive, even second-hand, and one could hardly call the internal facilities adequate for serious listening. I did waste one evening hovering hopefully over a £20 FiCord *202*. Okay, I should have known better, but by then I was desperate! Its owner coaxed it into life and gave a convincing demonstration of how badly a machine can deteriorate: it sounded worse than those £5 jobs at Woolworths. Ferrographs and Brenells were too heavy, though one can get them within the price range. No, the only ideal machine seemed to be a Tandberg, and the only real possibility within the price range, one of the good old *Series 7* machines. Tried getting one?

(*continued overleaf*)

I did eventually. I was away for the weekend, tired after a long drive and settling down to a pleasant meal when I was passed the local evening paper. There, tucked away between geysers and prams, was a Tandberg 7. Some 20 minutes later, my meal still warm (just) I had signed away £40 and had a mint condition ¼-track machine with me. I would have preferred a ½-track version but at the price did not hesitate. When it's out of use for a week or so I shall fit 2/2 track heads. Until then, it's doing a grand job.

The stereo Tandberg met the bill perfectly. It is compact and, in a small carrying case, easily and safely transported. Quality through its internal speakers is quite pleasing and, if available, external speakers can be plugged in or the machine connected to external power amplifiers. Simple selector switches, spring-biased to play, select record and amplifier conditions for the two channels. A separate single switch routes the two speakers to Channel One, Two and Stereo, both channels connected to internal plus external speakers, or both channels connected to external speakers (muted if they are not connected). Twin peak-reading magic eyes are provided (much easier to use than VUs when one's attention is mainly on the music) and the joy-stick-controlled tape transport is simple to use and kind to tape. One sometimes hears of oxide rubbing off at the erase head and in the guides, but routine cleaning overcomes this. There is a simple and effective locking pause control which enables the capstan to get up to speed before record or play starts. At 19 cm/s, the overall frequency response, with correct tape and bias setting, would do credit to many professional and semi-professional masses of hardware. Wow and flutter are low if the mechanism is kept clean. The automatic stop has been immobilised for being more a nuisance than a help. The mirror finish on the heads makes for good contact without wear, and has made me take back much that I have said about ¼-track recording. I would still prefer 2/2 track, but the machine is remarkably good.

Naturally, this machine is not the only one that would do, if a little more money were available. The Revox *A77* with built-in amplifiers and speakers would be my ideal choice, but as a smaller machine one of the Chilton or current Tandbergs would fit the bill.

As microphone we chose a Film Industries *M8* ribbon with matching transformer, which provides excellent performance for about £12 total, or a little less for a high-impedance-only mike. A music stand plus adapter usually doubles as a mike stand, and about 15 m of cable seems to be a useful length.

As others hear

A short time ago we received a letter from a reader asking for advice which, although only indirectly concerned with tape recorders, illustrated some of the dangers in using modern electronic aids. He too was a singer, and was concerned with the problem of hearing himself as others hear him, rather than that very different sound of one's own voice coloured by head resonances and all sorts of psychological factors. I do a certain amount of singing myself and know exactly what he means. Most people have been surprised at the sound of their recorded voice the first time it is reproduced to them, and I think in singing one never quite gets over the shock! A piano changes character as you move back from the piano stool and round to the side facing the audience. Recording organs, I have often found that the instrumentalist having heard the replay of the first take, will go back and re-register. How many organists consider the very different sound mixture reaching the audience, compared with that at the console? But to return to the letter: the reader wondered about using a microphone, amplifier and headphones to give him the sound as the audience would hear.

There are of course several snags. Whatever level one puts through the earphones, one would hear a mixture of direct and indirect sound with added coloration from the transducers. Also, fed at high level, the sound would be much fuller in tone than the audience would ever hear, and this in itself would be a deception, probably an unjustified flattery. Going back on stage without the phones would be very discouraging! At a level where the sound transmitted through the head becomes negligible, the ears would probably be in danger of suffering damage from the signal fed by the phones. I am pretty sure he would have been wasting his time with the system he outlined, and in danger of harming his voice, his ears and his confidence.

The problem of applying what the music student is taught while away from the teacher's supervision is a very real one. No electronic aid is a substitute for proper training and coaching. A good tape recorder, microphone (ribbon or capacitor) and speakers (Quad electrostatic, KEF *Concord* or Goodmans *Maxim*) plus decent external power amplifier if necessary (beware too much use of the tone controls) will, with the proper tape, give a fair idea of what one sounded like, *after* singing, and this can be invaluable to the musician.

There are still dangers. Using a recorder may encourage one to produce a quality one likes at first hearing but which is not essentially one's *true* voice, just as too much listening to commercial records (and particularly singing with them) can do. A tenor, for instance, may be thrilled by the effect of carrying his chest register up to very high notes instead of letting them float easily—he already sees himself in Wagner roles—but with this kind of treatment his voice is unlikely to last long in its prime. He may be initially discouraged by the smaller sound he produces when singing up there properly — but that is the quality he must nurture until it is as thrilling and exhilarating as the other, because that is the quality he can go on singing with for years without literally wearing out his voice in a short space of time.

One danger we have found is that the student, having once got over singing or playing in front of a microphone, may end up by singing *to* the microphone, even when it is not there, causing an unnatural inhibition and restraint on the voice. The microphone, a metre or two away, has become an intimate listener, and the audience much farther away is disregarded even when the mike is left at home. It is no good practising with the mike farther away, as this usually raises reverberation problems and the like: it is just a new factor that has to be recognised and overcome. In just the same way, so many choirs sing to their conductor—and don't the audience know it! Put a microphone in front of most choirs at a recording session and, unless they are used to such sessions, the whole tone becomes more intimate and introverted, with people singing to the mike and not to the imaginary audience beyond. The quality can be amazingly different—particularly if they adopt the traditionally miserable 'microphone face' that afflicts such self-conscious singers. The only answer is often to have a small body of suitably silent friends and relations of the choir as an 'audience' half way down the hall, and put up with one or two inevitable retakes because of audience noises. Miserable faces sound miserable, and no electronic controls can compensate.

Stereo separation

Talking of choirs, the tape recorder can be invaluable to a conductor, both in recording concerts for study afterwards and during rehearsal. Stereo is essential, giving some separation of the voices (or instruments if it is an orchestra), and the equipment needs to be of very high quality, installed and operated with the minimum of fuss unless it happens to be a professional recording session. For normal recordings of concerts and playback, after or during rehearsal, I would suggest something along the lines of the following:

(1) A single stereo mike. Being practical, this means almost certainly either the Lustraphone or B & O ribbons. Pairs of others can be used, but it is complicating things; most integrated moving-coil stereo mikes are just not good enough and a stereo capacitor is beyond most student musicians.

(2) A single long lead, avoiding matching transformers if possible.

(3) A high quality tape recorder, taking large enough spools to allow long runs at 19 cm/s at least, silent running in case it has to be used near the choir, with built-in power amps and preferably monitor speakers as well for the occasion when extension speakers get left behind.

(4) A pair of small and reasonably sensitive loudspeakers, something like the Wharfedale *Denton* which are a little more sensitive than the *Maxim* without being too large to carry around easily.

(5) A mike stand. (6) Decent tape—the brand for which the machine is adjusted. It's amazing how often a potentially excellent recording is ruined by being done on a 15 bob reel of reject acetate, just because someone told the person concerned that all tapes are alike!

Quite apart from being a tool in improving performance and a means of recapturing past performances, tape can be helpful as a publicity medium. Many amateur and semi-professional choirs send recordings round casually to an influential member of a music society to get the chance of a booking, and in the same way a recording of highlights from a season's performances can be useful ammunition in angling for a broadcast or when approaching a record company. Finally, even if these bodies are not co-operative, a tape of the year's best performances often makes a very acceptable private-release fund-raising disc for the choir to sell to members, friends and relations, and provides an annual record of achievements. Which perhaps brings us full circle.

impressions

BY JOHN SHUTTLEWORTH

EVER BEEN CONNED?

EVER since I was old enough to own a cheque book, I have paid bills and purchased things with it and have never been questioned or refused. In turn I have always taken other people's cheques but now, I am afraid, no more.

Some time ago I advertised a Ferrograph *704* for £165 in the *Exchange & Mart* and on the Thursday received a telephone call from a man who said his name was Ford ; could he call to see the recorder on Friday during the day ? We made an appointment for 10.30 a.m. At that time I had another call from a man who said that he was telephoning on behalf of Mr Ford who had some unexpected overseas visitors and had been up all night. Mr Ford was having a couple of hours sleep before going to the conference room that afternoon and could his appointment with me be moved to 4 p.m. Sunday ? I agreed and, at 4.30 p.m. on the Sunday, two men arrived in a chauffeur driven Humber.

One who introduced himself as Mr Ford was about 5 feet 6 inches in height [*167 cm if we do our job.*—**Ed.**] with black hair and sharp angular features. He was slim, wore a smart blue suit and spoke with a cultured accent. His companion was about the same age but taller, perhaps 5 feet 10 inches, heavily built and with lighter hair. He wore a brown tweed sports jacket, brown suede shoes, sports shirt and brightly coloured tie in rather bad taste ; he also spoke with a cultured accent. A friend of mine was visiting me at the time and the four of us had tea together, after which I demonstrated the recorder.

We agreed on a price of £174 10s for the recorder and some matching transformers and I agreed to give advice if necessary on how to use it in conjunction with Mr Ford's Sansui and Wharfedale equipment. I accepted Ford's cheque and wrote his 'address' on the back. I then helped load the recorder into the luggage boot of the Humber and it was driven off.

Three hours later I had a telephone call from the chauffeur asking if I could give him any information regarding Mr Ford's companion. It seems he had driven them to a London rail terminal where Ford had left with the recorder, then took the other man to a London hotel, where he was asked to wait 15 minutes.

Seeing no sign of the man after a couple of hours, he made enquiries at the hotel, and also at the hotel from which he had earlier collected Ford—neither man was known.

As I could not offer any further information, I suggested to the chauffeur that he ring back in 10 minutes ; meanwhile I would try to contact Ford at his home. I obtained the number from Directory Enquiries but could get no reply. The chauffeur phoned again and said that if I wanted to help I could contact him at one of two telephone numbers. He also told me the name of the firm for which he worked. I telephoned the office of the firm and asked if they could give me any information about Ford. I was told that, the law of libel being what it is, nothing could be said over the telephone except that they would be starting their own enquiries on Monday. I telephoned the police at Scotland Yard and was put through to the information room. They told me that no action could be taken as, until the cheque bounced, we had no proof that an offence had been committed. This was fair enough, but I still felt I ought to try to make sure.

I telephoned the police at Ford's claimed home town and asked if the name on the cheque was real or fictitious. I was informed that Mr Ford did indeed live at that address, was a highly respected citizen, but was out of town for a month. When I told them of the driver's experience, I was passed to another officer. He informed me that Mr Ford's house had been burgled and, among the things stolen had been a cheque book. I was asked to describe the man who had called himself Ford. It transpired that he was nothing like the real Mr Ford and that the cheque I had was one of the stolen ones.

It seemed to me that the fictitious Ford had either taken the recorder to the town he claimed to live in, as the break-in there might have been a local job, or more likely would have deposited it in one of the left station luggage lockers, to collect it on Monday morning and sell to one of the secondhand shops in the neighbourhood. If the latter was the case, a search of the lockers would find the recorder, and a watch kept on it would catch the thief on his return to collect it. I telephoned Scotland Yard again and was told by someone in the information room that they had other things to do than look for stolen tape recorders. I then telephoned the relevant station master and was put through to a gentleman who sounded like an aged porter; he said it was all very confusing as it might be parcels or lost property or police or anything but he would make some enquiries and ring me back. After waiting some time I telephoned the police at Mr Ford's home town and suggested that, as they were anxious to catch the housebreaker, they might like to try what I had suggested.

I was told the CID had gone home and was asked to phone at 9 the following morning when they would be back. As it was now about 1 a.m. I retired to bed feeling very frustrated. I woke at 6 on the Monday morning and it occurred to me that I might have had more help from the Railway Police than from the aged porter.

I telephoned the Railway Police, who had in fact heard from the police at Mr Ford's town but, having been told by them that the recorder was nearly a metre high, had only searched the large lockers. I asked if it was possible for them to look in the smaller ones but they told me there were hundreds of these.

At 9 a.m. I phoned the CID as requested and said it was likely that the recorder was about to be sold in the area of the rail terminal and that from my knowledge of the area (I lived near there at one time) there were two shops that were likely to be tried. One a second hand shop that handled tape recorders and the other an audio dealer shop that advertised 'Highest prices paid for good quality equipment'.

I was told that I should contact my local police as the offence had been committed in their area.

I went to the local police station taking a Ferrograph *Seven* with me. I felt that if this was shown to the porters at the railway station, one of them might remember seeing one like it the night before.

The policeman I spoke to did not show any interest in this idea, asked for another description of the man and told me the CID would call on me the following day.

Another friend came to visit me that evening and, after hearing my tale, told me I was mad to sit and wait for the police to find the recorder, and that I should be scouring the shops looking for it myself. A sergeant from the CID came to interview me on the Tuesday, asked for yet another detailed description of the men, but declined to contact the shops I had suggested, on the grounds that we had no proof that the recorder was there.

I was able to get away at 4 p.m. Tuesday and drive to the station myself. I went to the first of the two shops that might have bought the Ferrograph and said I was looking for a high quality stereo recorder. I was offered a Cossor, but said I wanted a better one than that. I was told a Sony would be ready next week and a Ferrograph in about a month, but not before, as all recorders sold were checked by an engineer who was then away sick. I asked if the Ferrograph was a recent model and was told it was not the latest, so I thanked the assistant and left.

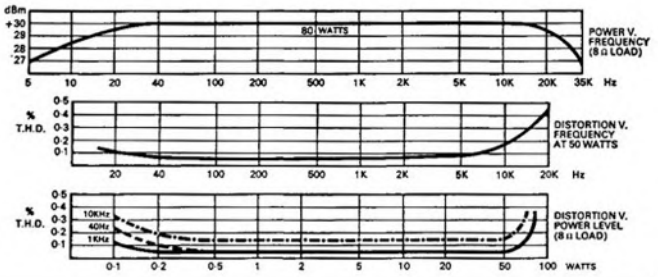
I then drove down to the second shop which was closed but had a notice on the door saying 'Back in 5 minutes'. Through the glass door of the shop I could see a Ferrograph on the corner of the counter, and immediately had the feeling that I had found mine as I expected. When the salesman returned I went with him to look at the recorder and checked the serial number. It was my recorder. I told the salesman that I was sorry to say that he had bought a stolen recorder and suggested that we should telephone the local police. Two CID officers arrived in a remarkably short time, took statements from both of us, and said they would have to take the recorder back to the

(*continued on page* 20)

audix

"Studio 80" amplifier

POWER OUTPUT:	Max 80W into 8 ohm.
POWER BANDWIDTH:	5 Hz to 35 KHz at 80 W.
FREQUENCY RESPONSE:	+ 0 dB / – .5 dB 20 Hz to 20 KHz.
TOTAL DISTORTION:	Less than 0.05 at 1 KHz.
SIGNAL TO NOISE RATIO:	Better than–95 dB below maximum output.
POWER SUPPLY:	100/120–200/250 A/C 50-60 Hz.



The "Studio 80" Power Amplifier has been produced to high performance standards for Studio and Laboratory applications.

Its proven characteristics puts it in a class beyond anything yet available in power, performance, and price, and is the ultimate in economic functional engineering design – Write for full details of guaranteed performance specification.

audix SOUND SYSTEMS

AUDIX B.B. LIMITED
STANSTED · ESSEX
Tel: STANSTED 3132/3437
(STD 027-971)

ALICE BUILDS QUIET MIXERS—

Our new professional modular system will not improve our noise figures—but it will provide a desk that an engineer can operate more quickly and efficiently than ever before.
The illuminated routing matrix and linear controls give constant visual mode reference.
Write for details of the BD range.

Of course we still make a remarkably compact 6- or 8-channel stereo desk if you wish to make masters on a mixer 27 inches long!

ALICE (STANCOIL LTD.)
WINDSOR 61308
15 SHEET STREET
WINDSOR · BERKS

LEVEL CONTROL EQUIPMENT

Superb Performance—moderate cost

E800
Line/Channel
Equaliser

A versatile equaliser divided into three independently operating ranges. Each range has nine frequencies, any one of which may be selected to PEAK or DIP up to 20dB. The range covering the Mid-frequencies overlaps the ranges either side providing optional broad or sharp peaking. 12dB/octave LF filter and 6dB/octave HF Boost is also included. Noise—85dBm. Normal operating level—10 to+10dBm.

also available

F600 & F700 Compressor/Limiters.

Audio & Design (Recording) Ltd.
10 Lower Rd., Cookham Rise, Maidenhead, Berks.
Tel: Bourne End 22231 (STD. 06285-22231)

A HIGH QUALITY MIXER

David Robinson

PART EIGHT
HEADPHONE AMPLIFIERS

BEFORE starting on the remaining monitoring and checking circuits, three pieces of information for constructors. Firstly, by the time this article is published, the final production problems on printed circuit boards will have been overcome and all outstanding orders will be progressing normally with deliveries being two or three weeks from the receipt of an order.

I have received a few letters from users of the printed card querying small differences between the cards and the published circuits. In all cases the 'errors' are intentional and there is no difference in performance; changes have been made to simplify the circuits, or to make the layout of components on the board easier.

Finally, good news for people still having problems in obtaining the Fortiphone transformer. I have had a replacement designed by E. A. Sowter Ltd which is available ex-stock. It has the added advantage of being a better transformer in all respects, allowing an even better noise figure to be obtained from the microphone amplifier, and a higher predistortion input to the line amplifier. The low frequency performance is considerably improved; in fact C2 (fig. 22) must be increased from 1 μF to 10 μF, 6 V tantalum. (By keeping C2 low, the AC feedback was reduced at low frequencies, producing a rise in low frequency amplifier gain to compensate for the drop caused by the input transformer.) The transformer ratio has been increased slightly to present a better impedance match to the silicon input transistor and this in turn raises the gain from 52 to 56 dB. Both these factors contribute to the better noise figure.

The size is slightly larger than the Fortiphone version, but it will still just fit the standard module. The printed circuit must be as close as possible to the front of the module, with the preset gain pot RV1 over the space provided on the card. Colour coding of the leads is identical and, apart from C2, no changes need be made to the circuit. A further bonus is that the small quantity prices are lower than for the Fortiphone and there is no minimum order charge.

A useful addition to any mixer is a calibration oscillator. This serves two purposes. Firstly, a short section of 1 kHz can be recorded at O VU or PPM 6 at the start of a tape to act as a reference level for subsequent editing or disc cutting—be sure to label the box NAB or DIN reference level (better still, 18.5 or 32 mM/mm) to avoid certain confusion by the studio receiving the tape! Secondly, if the oscillator works at 10 or 15 kHz, it can be used to check high frequency equalisation.

The original 1964 mixer design used a conventional twin-T feedback circuit; this suffered from a varying amplitude/frequency characteristic, and also from a fairly high distortion level. This new circuit avoids these disadvantages, and provides an elegant remarkably simple solution to many of the oscillator design problems. The circuit was originally published in *Design Electronics* (October 1970), and is the work of P. Howden and M. Ridgeway of Molins Machine Tool Ltd. **Fig. 47** shows the circuit. It relies on the property of certain circuits to produce an output signal, inverted with respect to the input signal but with zero phaseshift. It is easily shown that if, in such a network, the input and common terminals are interchanged, the output will give a voltage gain greater than unity. These are the necessary conditions for oscillation. If the circuit is redrawn, it will resolve into our old friend the twin-T network, in asymmetric form.

The output of the circuit is coupled to the input of the filter by an emitter follower, which provides the necessary power gain—no perpetual motion here! The gain of the feedback loop is stabilised by a 24 V 40 mA bulb, which passes an extremely low current—and hence does not light. It will, however, last for a very long time. Typical bulbs are the Post Office type, widely available.

The circuit is simple to set up. Resistor R is made variable in the first instance, and adjusted to give about 1 Volt RMS out of the circuit at Tr1 emitter. This can be done with the PPM

(*continued on page 20*)

FIG. 47 OSCILLATOR

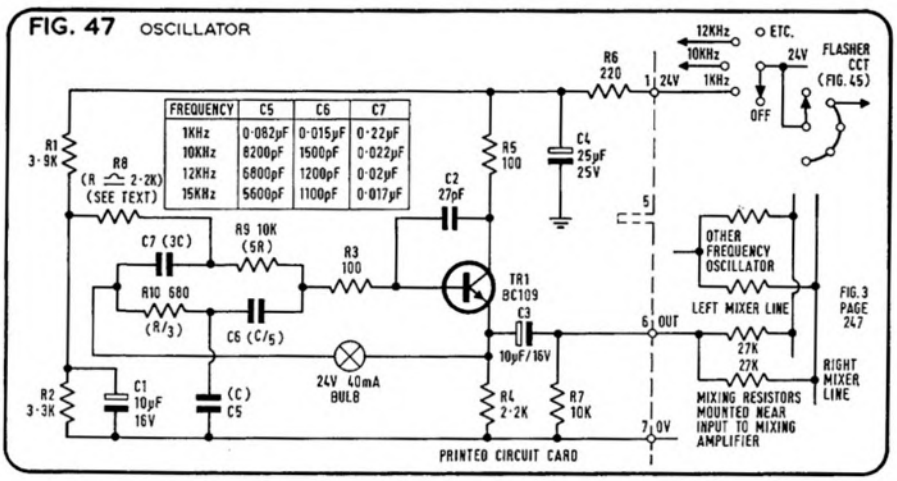
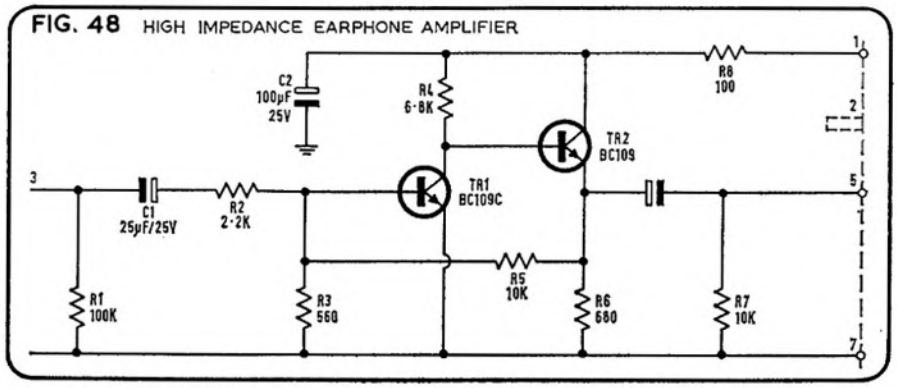


FIG. 48 HIGH IMPEDANCE EARPHONE AMPLIFIER



circuit if necessary. With the master fader at maximum, adjust R roughly to give PPM 6, or 0 VU: then back off the master fader by 6 dB. (PPM 4.5, or −6 VU.) This represents the normal operating position of the fader. Finally, adjust R to give a reading of PPM 6, or 0 VU. This completes the alignment. Under these conditions, the distortion is about 0.5%. For other frequencies, use the formula $f = 1/2\pi RC$. For low frequencies, C1 (which must present a short-circuit to the signal) may have to be increased. If printed circuits are used, then each frequency uses a separate board; all the outputs are connected permanently to the left and right mixer lines via mixing resistors.

The oscillator is turned on and off by switching the power supply voltage; a separate pole on this switch also works the flashing indicator circuit described last month, which ensures the circuit is not left inadvertently in the operating condition for longer than necessary or while a recording is attempted.

professional location recording engineers prefer to use earphones, since they maintain the earphones are so clinical they show up the slightest errors—also the monitor conditions are always constant and the different monitoring rooms found on location do not colour the balance engineer's judgement. A quick survey of the high quality earphones available shows that there are two main types in general use. One is a 15-ohm-per-earpiece version, which is intended as a substitute for the main speakers and, while being much more sensitive than the speakers, still requires a fairly large signal. The other types are smaller and lighter to wear, and in the order of 500 ohms each requiring a very small power indeed to drive them to full output.

Fig. 48 shows an amplifier designed to feed to one of the latter type, and in particular the AKG *K50* earphones. In the manufacturers' technical data these are listed as 400-ohms per earpiece and as requiring a normal input level of 250 mV, although the maximum that can be applied to the units without serious distortion is 6 V. The amplifier shown will produce 2 V at full drive which gives an uncomfortably loud sound and it will be recognised as being similar in design to the output amplifiers used in the earpieces have different sensitivities. This is achieved with VR2; both these two potentiometers are mounted on the fader rack in the central portion. **Fig. 49** shows how the earphone monitoring scheme fits into the mixer block diagram.

For those who have low impedance earphones, the circuit of **fig. 50** is more suitable. By using an output transformer, correct matching to 15 ohms can be realised and thus more power can be delivered to the load. The AKG phones need 2.5 mW typically, while low impedance phones need 60 mW for the same intensity at the ear. The first circuit, while having a very low output impedance, will not drive into a low impedance. The circuit used is very similar to those used in complementary-symmetry power amplifiers, with a single amplifying stage followed by the push-pull output pair.

Diodes D1, D2 and resistor R4 provide sufficient voltage drop between Tr2 and Tr3 bases to cause about 10 mA to flow in the output pair which reduces the cross-over distortion to low levels.

This circuit gives a good quality sound to the earphones, but to provide a top quality signal to low impedance earphones needs more power than this simple design can give. Using a small power amplifier taking its supply from the mixer would drain too much current from the power supply, and in such cases a separate amplifier must be used.

FIG. 49 CONNECTION OF EARPHONE AMPLIFIER (TAKEN FROM FIG. 36)

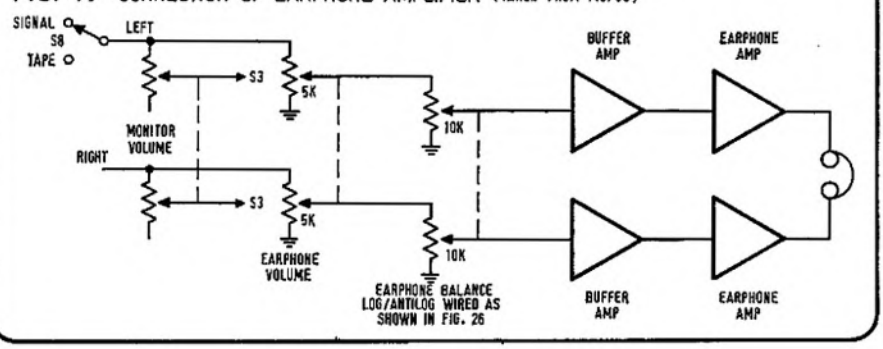
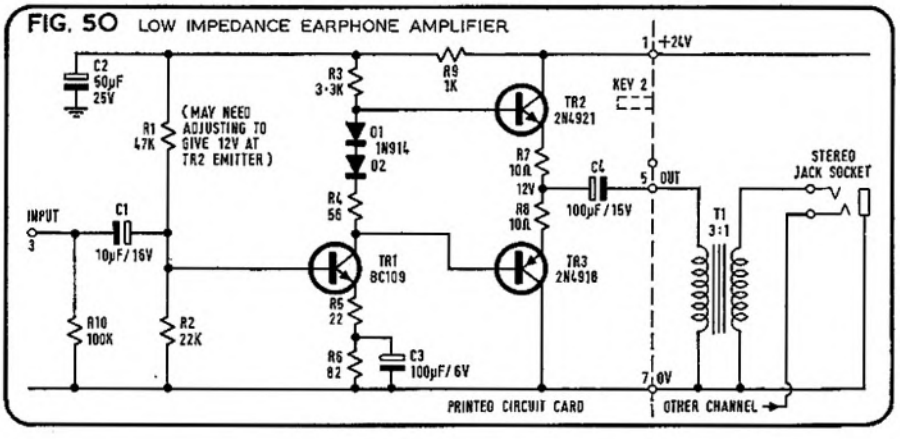


FIG. 50 LOW IMPEDANCE EARPHONE AMPLIFIER



There are sometimes recording situations where it is not possible to set up all the equipment and monitor loudspeakers in a room separate from the performers. For monitoring in these situations an earphone socket was provided. While earphones are certainly no substitute for good quality speakers, it is a case of something being better than nothing. 'Blind' recordings have a habit of going wrong. Many main part of the mixer (the same printed circuit can be used). The volume control VR1 is ganged to both channels, and is fed from the top or 'hot' end of the monitor volume control which is in the recessed panel on the front of the mixer so that the two controls are independent. The gain of the right channel can be varied by ±6 dB over the left channel to adjust the balance between the two earphones should the two

Component suppliers

Microphone transformer, replacing MSC 1829: Sowter Type 3128, from
E. A. Sowter Ltd,
7 Dedham Place,
Fore Street,
Ipswich,
Suffolk.
Prices (including post and packing) 1-25 £2.10
25 £1.80
Printed circuit cards from the author, c/o *Studio Sound*, at 30p each.
Ref. 219 Oscillator
220 Low impedance earphone amplifier.
106 Output amplifier, used for high impedance earphones.
Earphone Transformer T1
Henry's Radio Type TT11, from Henry's Radio, 303 Edgware Road, London W.2.

station with them, apologising to me that they could not let me take it back yet.

This was fair enough as they did not know me from Adam and, as far as they or the shopkeeper were concerned, my tale could have been false. I pointed out that I didn't know them from Adam either, whereupon one of them produced his identity card.

That evening I had a telephone call from a slightly embarrassed sergeant who had learned that I had found the recorder by doing what he had declined to do. I am still helping the police to try and trace the men concerned and will be visiting them to look at photographs.

Meanwhile, if you have a valuable piece of equipment for sale and you are offered a cheque, don't rely on the purchaser's honesty. Insist on cash or hold the equipment until the cheque has been cleared.

Constructing a TAPE CASSETTE/ SLIDE SYNCHRONISER

By P. J. HILL
AND B. HOWE

IT is fairly generally recognised that any showing of colour slides can be enhanced by using a tape recorder to provide a sound commentary.

This can be achieved very simply by deciding the order in which the slides are to be shown and writing a short script which is then recorded on tape. When the slides are shown, the tape recorder is set in motion and you can concentrate on changing the slides to synchronise with your spoken commentary.

If you already possess a reel-to-reel tape recorder and suitable automatic slide projector, then you are probably aware that suitable slide synchronisers exist. These work on the principle of recording a sound pulse on one track of the tape so that, when played back, the pulse activates a slide-change solenoid. The commentary is recorded on another track in the usual way.

To record and play back the synchronising pulses, the tape is run over the head of the synchroniser unit (usually in the form of a small box placed to the right of the recorder) and is then fed to the takeup spool.

We set out with the intention of producing a tape/slide presentation using a cassette recorder.

We reasoned that, since we could not take the tape to the sync head, then the simplest solution involved taking the head to the tape. Once the basic problem of head size had been overcome, and with the adjustments described below, this proved very satisfactory.

The following equipment was used:

Philips cassette recorder, Type *EL 3302*
Philips slide synchroniser
Kodak *Carousel* automatic slide projector

The recorder was first removed from its case and the erase head detached to make room for the new head. Connecting wires to the erase head were insulated with tape. The record button spring and nylon lever were then removed to clear space for the new head.

The lost erase facility is unimportant if new tapes are used for recording. It is also possible to buy a bulk eraser for clearing old tapes quite cheaply. In any event, since no part of the machine is damaged by this conversion, it can readily be converted back to its original state.

The head was then removed from the pillar on the synchronising unit. The head in its original state is far too big for the recorder, and was therefore removed from its metal casing. This was a simple matter since the head is only held in the casing by metal tags which can easily be bent back. A small portion of the head was filed away on each side until it fitted tightly between the two brass stands which normally support the erase head. Very little of the epoxy resin casing had to be removed to achieve this.

It is important to position the head correctly so that the top of the upper head is level with the top of the tape and just touches the tape in the play position. The upper track was used for the synchronising pulse as the lower track carries the commentary. To ensure the correct height of the head, sheet metal in the order of 3 mm thick was placed beneath it. A metal band was strapped over the head and screwed to the brass posts, thus holding the head securely

The tape recorder case was then cut to accommodate the head. This involved removing the slide top just above the heads, pushing it firmly to the left and pulling it off. After a section had been cut from the case, a thin shaving was taken from the top of the slide. A small slot was cut in the case to clear the head terminals in the stop position. When the top is back in position, the small slot is the only visible evidence of any alteration to the tape recorder. The only other cut necessary was a recess in the deck of the case to clear the head when it is in the play position.

In our particular conversion we were not interested in using the machine to record as we had a second machine for this purpose. Therefore, for neatness, the wires from the new head were taken to the microphone socket, removing and insulating the white wire (see **fig. 1**). Wires could equally well have been taken to a new socket mounted on the case. The casing was then replaced.

The old connecting wires from the pillar of the synchronising unit were extended, led out of the bottom of the unit and connected to a three-pin DIN plug to join the head via the microphone socket of the recorder. It was now possible to use the synchroniser in accordance with the instruction sheet supplied with it.

The only other modification is to the tape cassette itself. As the new head projects forward slightly in the play position, it is necessary to cut the plastic back (**fig. 2**). This does not impair the playing of the cassette in any way and both tracks can be used for conventional recordings if required.

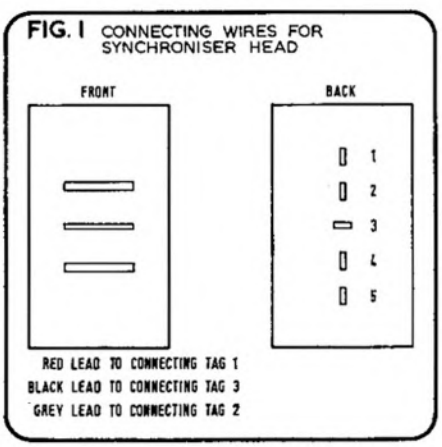


FIG. 1 CONNECTING WIRES FOR SYNCHRONISER HEAD

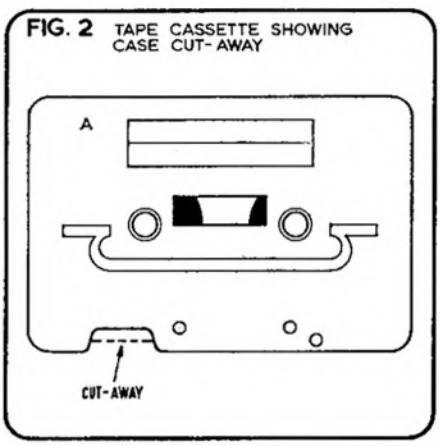


FIG. 2 TAPE CASSETTE SHOWING CASE CUT-AWAY

inside COMMAND

OPENED for business on November 2 1970, Command Studios occupy the former BBC premises known as Piccadilly One, 201 Piccadilly, where, so the story goes, Glenn Miller made his last ever recording. GPO land lines still run to Broadcasting House and in the physical structure of the studios can be seen the high standards of the Corporation's basic engineering.

Having seen so many studios making do with aged, improvised and ill-matched equipment, it was a pleasure to visit a concern where everything but the brickwork is new, matched and integrated. Much advanced thinking has gone into planning which provides almost infinite flexibility, even to the extent of being able to record a session on tape and on disc, and make a tape copy, all three simultaneously.

The premises extend from Piccadilly right through to Jermyn Street. Three studios are housed in the buildings, each with its own control room and each capable of operating independently or in any combination with the other two. Largest is Studio One occupying most of the floor area on Piccadilly level. This is big enough to hold a full symphony orchestra and has acoustics which can be varied from concert hall to very dry, the preferred decay time being 1.5 seconds. Forty tip-up theatre seats occupy one end of the studio and theatre-style spot lights and battens controlled from a Strand Electric dimmer panel are installed extra to normal studio lighting.

Control Room One looks out through a triple-glazed window over the studio from first floor level. Next door is Master Control housing all cable terminations, both audio and the fat 100-way cables which feed the control and selsync relays on the 8/16 (24) track recorders. Here we find rack-mounted Hewlett-Packard static test gear, meters and switches monitoring the battery banks supplying pure DC to relays and control desks, a crystal controlled oscillator feeding a precise oboe-like A-tone into the studios for tuning up, a CCTV monitor screen, and a rack of 24 *A360* Dolby units.

All three control rooms are acoustically, electrically and mechanically identical; the only difference is colour scheme. Each contains a 24 channel, 24 output control console custom built by Automated Processes Inc. of Farmingdale, New York, and based on IC components.

Miniature VU meters in each channel indicate level and a built in test tone generator provides line up tone for both console and recorders. Initial channel input level is adjusted by trimmer with the channel fader set at –12 dB and the channel VU meter peaking to +4 dBm (NAB standard). Four large VU meters to the engineers' left can be switched to read out any channel. Two of the VU's can be switched to read sum and difference levels when checking a stereo master tape for disc cutting or when recording MS stereo instead of XY stereo. An oscilloscope gives the recorded waveform pattern and metering is completed with a twin light-spot PPM. A comprehensive routing network feeds the 8/16 (24) track machine and two 1/2/4 track machines housed in a single console (one to each control room) complete with spare record/replay amplifiers, vari-speed device and power amplifiers. The small machines can be run in parallel for classical recordings.

The monitoring system comprises three independent miniature 24 channel mixers controlled by colour coded illuminated push buttons and rotary attenuators. Echo and other effects can be added to monitor signal without affecting recorded signal and it is standard practice at Command to monitor line out rather than use the popular but risky method of listening to line in.

Command's policy is to standardise on makes and types of equipment so all loudspeakers, even for talkback, are Altecs. All tape machines are Scully and all microphones AKG, the capacitor mikes phantom powered so any type of mike can safely be plugged in to the same socket. The most important factors when choosing equipment were considered to be performance, reliability and ease of servicing. Cost is to be worried about some other time for, if quality suffers because costs are cut, the chances of re-couping the investment are correspondingly reduced.

Planning and installation has taken into account possible developments over the next three to five years. The most obvious is quadraphonics and the control consoles are fitted with four quadraphonic panning controls which can pan any combination of channels through 360°. In addition to the usual complement of four monitor speakers, two extra Altecs are provided, one in each rear corner of the control room. In fact, it was interesting to note at Command that everything comes in minimum groups of four channels.

Beneath Studio One, and isolated from it and each other, are Studios Two and Three on the Jermyn Street level.

Studio Two has quite a different character from the spaciousness of Studio One. Its proportions make it seem smaller than its 48 m², though it is large enough for a chamber orchestra. *Bread*, *Emerson Lake*, *Anno Domini* and the late lamented *Taste* have all rehearsed in this studio while construction work was concentrated on Studio One. During my visit the floor was a maze of cables

inside COMMAND

DAVID KIRK VISITS COMMAND RECORDING STUDIOS

creeping down from Master Control two floors above to feed Control Rooms Two and Three, and to enable any combination of Studios and Control Rooms to be linked and monitored over the CCTV channels. Throughout the building, AC cables are trunked at ceiling height and audio cables at floor level.

Between Studios Two and Three is an isolation booth which can be used by either or both studios and either control room, or by Studio One. It is large enough to be used as a small studio on its own.

Studio Three is different again. Still large by normal standards, it is the smallest of the three totalling only 37 m³. Room enough for some 30 musicians. Two adjacent walls will have a total of six brick-built acoustically-treated isolated booths. The remaining floor area will remain clear. This is the studio for the heavies. The fold back system (common to Studios One and Two) provides each performer with a pair of cans attached to a simple 4 x 4 mixer with left and right channel rotary attenuators which will, in Studio Three, be built in to the booth walls.

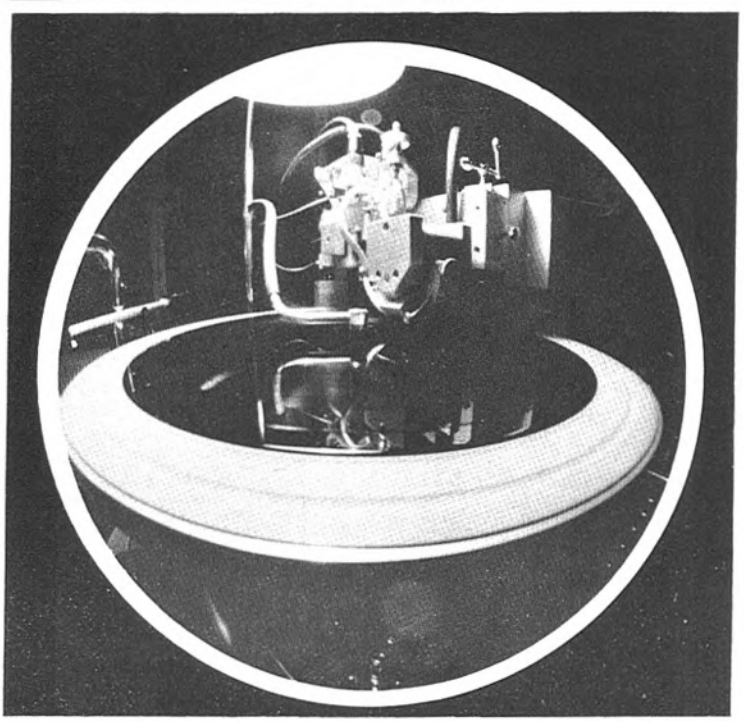
Tucked away beneath the pavement of Jermyn Street is a well-equipped workshop with pillar drill, lathe, engraving machine, and machine saw employed in making patch panel identity strips, engraved rack panels, foldback mixers, quadraphonic mike mounts and the elaborate disc cutting monitor system.

A large ventilating and filtration plant was inherited from the BBC. Two ducted fans serve one floor, moving filtered, warmed (or cooled), humidified air to and from control rooms and studios in ducts big enough to crawl through. The importance of this plant is much greater than to supply fresh clean air; temperature and humidity are vital influences on the performance of instrument and singer alike.

The rule at Command is that the engineer balancing the session should also cut the disc, thus overcoming the too regular complaint that the disc doesn't sound like the tape. Based on the Scully lathe fitted with a Westrex *3DII* cutter head (the only one in Europe at the time of writing) the system is completely automatic—if the tape is properly prepared to international standards. If I have a criticism of the layout of the cutting channel, it would be the position of the rack mounted tape machine, perhaps too easily touched by the engineer's coat sleeve.

Will British studios ever decentralise from London? The Command staff didn't think so. They consider their unique position, literally a stone's throw from Piccadilly Circus to be a major advantage. Two take-over approaches from international record companies while the studios are still being equipped would seem to support their view.

Above: Automated Processes mixer in Control Room One.
Top left: Studio One.
Centre left: Scully lathe and control equipment in Cutting Room.
Bottom left: Copy/edit room with two/four channel Scully in foreground.
Below: Westrex *3DII* cutter head.



MICROPHONES & ACCESSORIES

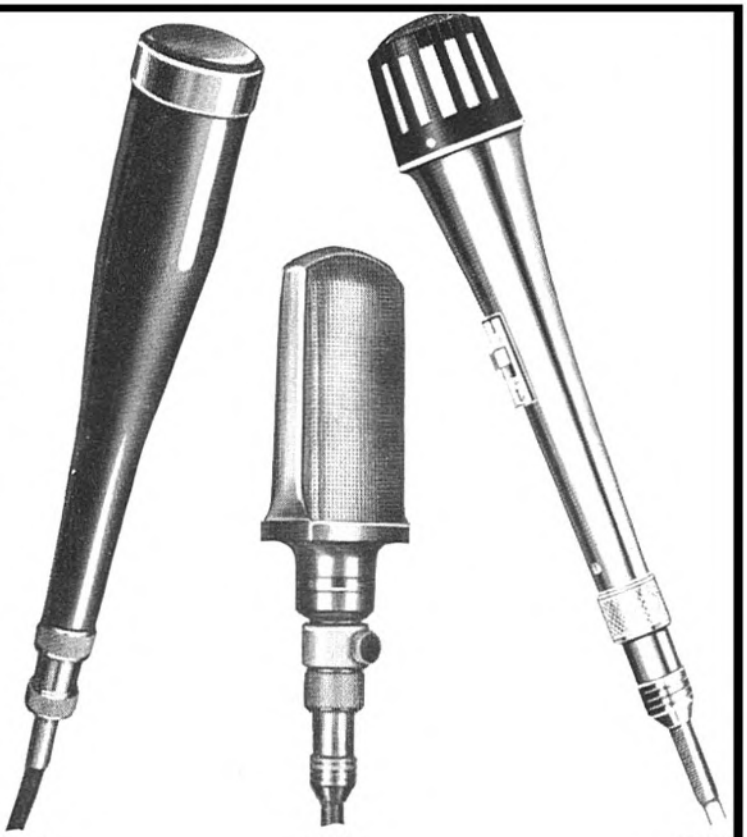
Our range of microphones includes all types, ribbon, omni-directional and cardioid, with or without switches, for hand or stand use. All microphones are manufactured in a special section of our works, under strictly controlled conditions with stringent test and inspection at every stage. Each and every microphone is individually tested both aurally and on Bruel & Kjoer visual and graphic recording test equipment for conformity to a prescribed performance. Accessories such as desk or floor stands, wind shields and parabolic reflectors are also well catered for.

Besides microphones every need of Public Address is met by a wide range of amplifiers, both mains and battery operated, mixers and amblophonic units, loudspeakers and associated equipment, disc recorder amplifiers and cutter heads.

Send for comprehensive list of over ***120*** *standard items to the firm who back you with* ***SERVICE***

Grampian
SOUND EQUIPMENT

GRAMPIAN REPRODUCERS LTD
HANWORTH TRADING ESTATE,
FELTHAM, MIDDLESEX.
TELEPHONE 01-894 9141



DP4 GRI GC2

This is not a misprint.

Brand new

EMITAPE

AT LESS THAN HALF PRICE
Polyester and PVC

For once in a lifetime an offer is made of this nature, you know the quality, you know the retail price, now read ours.

5" 600' **8/-**, 5¾" 900' **10/-**, 7" 1200' **13/6**
Also a few Long Play 5" **11/6**, 5¾" **15/-**, 7" **18/-**
Also SCOTCH BLACK. Long Play only 5" **11/-**, 5¾" **14/-**, 7" **17/-**

All of the above are guaranteed in every way possible.

CASSETTES C60s **7/-** each, C90s **10/-**, C120s **13/6** all cassettes supplied in presentation cases and first quality tape. All orders 2/6 p/p.

Order now while stocks last.

WALKERS
16 Woodthorpe Rd., Ashford, Middx.
Ash. 52136

AUDIO TEST EQUIPMENT HIRE

BROADCAST, RECORDING and FILM
AUDIO SYSTEMS CONSULTANTS

T. B. TECHNICAL LTD.
38 HEREFORD ROAD, LONDON W.2
01-229 8054

MINIFLUX

MANUAL VOL. I

A complete set of Laboratory Application Reports on the replay of audio magnetic recordings. Packed with hitherto unpublished information.
Full constructional details are included for several high quality pre-amplifiers of advanced design as well as multi-channel integrated circuit modules. Each design step is thoroughly discussed and supported by detailed test measurements and calculations.
". . . contains a very full treatment of equalisation Standards—the only detailed consideration of replay head magnetization that I have seen—the Manual is worthwhile on this score alone—a very worthwhile publication that gives answers to many important questions"—*Studio Sound review Dec. 1970.*
Price 32s 6d incl. U.K. postage.
Direct from the Publishers:
MINIFLUX ELECTRONICS LTD.
8 Hale Lane, London, N.W.7, ENGLAND

RECORDING STUDIO TECHNIQUES

PART THIRTEEN

TEST TAPES IN SERVICING

BY ANGUS McKENZIE

(Roundabout Records)

IN a past article I described the different types of test tapes and their use in day to day alignment. I did not, however, discuss the various fault conditions which can arise and which can best be shown up by using test tapes.

The importance of demagging heads and cleaning the deck prior to using a test tape is self-evident. It is usually difficult to ascertain whether or not a particular test tape has been affected by continual use. I would here like to recommend test tapes made in the BASF pattern which incorporate repetition bands of frequencies. An explanation of their best use might be helpful.

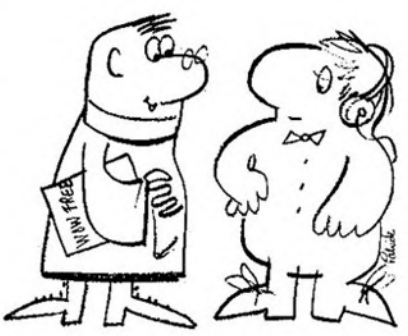
Since higher frequencies tend to be recorded more on the surface of the tape than lower frequencies (i.e. longer wavelengths), slight magging up of a tape usually causes an HF loss considerably more marked than any LF loss. It is usual on BASF test tapes for frequencies above 1 kHz to be repeated after the normal run at least once and in the case of some of their tapes up to three times. I have always made it a cast iron rule never under any circumstances to play more than the first repetition and if possible not even that. If at any time I suspect the test tape in any way, I check the final bands of the first test frequency run with the repetition bands and in particular the last repetition run which should never be played other than for checking the earlier bands on the best available machine.

After some years of very careful use, I had occasion to check my own 38 cm/s tape and noticed the 16 kHz band 1 dB down, while the 18 kHz band was nearly 1.5 dB down — with respect to the final repetition band.

In another instance it was necessary to check the performance of 18 Tandberg *62X* recorders used for tape duplication. Despite the careful demagging of each machine before testing, after all the machines had been tested for playback response the test tape made was rechecked and losses varying from 0.5 dB at 3 kHz up to 3 dB at 15 kHz were noticed on all bands with the exception of the final repetition bands. It will be seen, therefore, how important these repetition bands are. Furthermore some test tapes commence at the bass end first, others starting at high frequencies. Surprisingly BASF do not supply any repetition bands on their 9.5 cm/s test tapes, where the effect is most noticeable, though they used to charge the same as for a 38 cm/s test tape—£16.

The loss of extreme top on replay usually means that the replay head should be replaced, if this loss cannot be equalised. It should be noted that many replay amplifiers cut off above 16 kHz. Often a shelf up or down in mid and HF response is noticed. If this shelf seems to commence near the nominal turnover frequency of the replay time constant network, the actual time constant should be checked. I have found that in emergencies an engineer has used a 20% tolerance component to replace a 5% one in a network, causing just such a shelf. An incorrect time constant can also lead to a dip of up to 1.5 dB in the region of 4 kHz, with a gradual rise up to say 15 kHz in an attempt to flatten this dip out by over-equalisation. This would be a typical symptom of an incorrect time constant.

It may have occurred to the reader that the DIN standard time constants for 19 and 38 cm/s are useful in that they allow a 19 cm/s test tape to be played double speed, thus becoming a 38 cm/s recorded test tape with all frequencies doubled. Playing back a test tape at double speed effectively shifts the time constant by an octave. This technique can be further extended to 76 cm/s, provided a characteristic of 17.5 μS is acceptable, the more usual one being 35 μS. I prefer 17.5 μS in that it allows double speed copying to be done, making 19 cm/s copies from 38 cm/s masters. When recording frequencies as high as 30 kHz a high bias frequency is advisable, theoretically in the order of 150 kHz or higher, thus avoiding third and fifth harmonic beats. Surprisingly successful results can nevertheless be obtained with an oscillator frequency as low as 100 kHz.



Like to buy a *perfect* test tape?

It may occasionally be necessary to use an NAB test tape to line up a DIN standard machine, and vice versa. A 38 cm/s NAB tape will have a shelf down in response of 3 dB from 10 kHz upwards, whereas its bass end played back on a DIN machine will show a boost of 3 dB at 50 Hz and approximately 5.5 dB at 30 Hz. Similarly a DIN 38 cm/s test tape played back on an NAB characteristic machine will show a 3 dB top boost at 10 kHz and above, and a 3 dB cut at 50 Hz. It is very much simpler to compensate for these differences by switching the time constant in the replay amplifier than by correcting it externally. It should be remembered that the time constant resistor should be altered, rather than the capacitor, thus not disturbing the 1 kHz level seriously on replay. Some recorders incorporate a variable resistor allowing the time constant to be changed at will.

Many machines now produced do not have adjustable replay equalisers, the best known example being the Revox *77*. With replay heads having gaps of 3.5 μm, no top peaking on replay should be necessary at 19 cm/s. Revox replay heads having a gap of 2.5 μm, their replay response extends to at least 16 kHz at 9.5 cm/s, the only peaking used being introduced by resonating the replay head at the slower speed. It is sometimes desirable to ascertain the effective electrical gap of a head and an approximate value for this in the case of ferrite heads can be computed from the fact that, at 19 cm/s, a 4 μm head will be approximately 1.5 to 2 dB down at 18 kHz when the resonance of the head is damped and only the normal time constant equalisation is used. In this way I have proved that some ferrite heads, alleged to possess a gap of 3 to 4 μm, had effective gaps of up to 7.5 μm, it being quite difficult to find any with gaps below 4 μm.

I understand that BASF test tapes are available in up to 50 mm widths recorded across the entire tape. Ampex can supply tapes having the specified number of tracks independently recorded with guard bands in between each track to facilitate head height alignment, in addition to full-track tapes. It is utterly ridiculous that Customs and Excise should apply purchase tax to such tapes. They are test instruments, not prerecorded tapes for home entertainment! Because of this, BASF have to charge £16 for a test tape, of which nearly £5 is purchase tax.

Incidentally, Ampex charge £75 for a 25 mm test tape and £135 for a 50 mm. Their charge for a 6.25 mm test tape is £12 including tax.

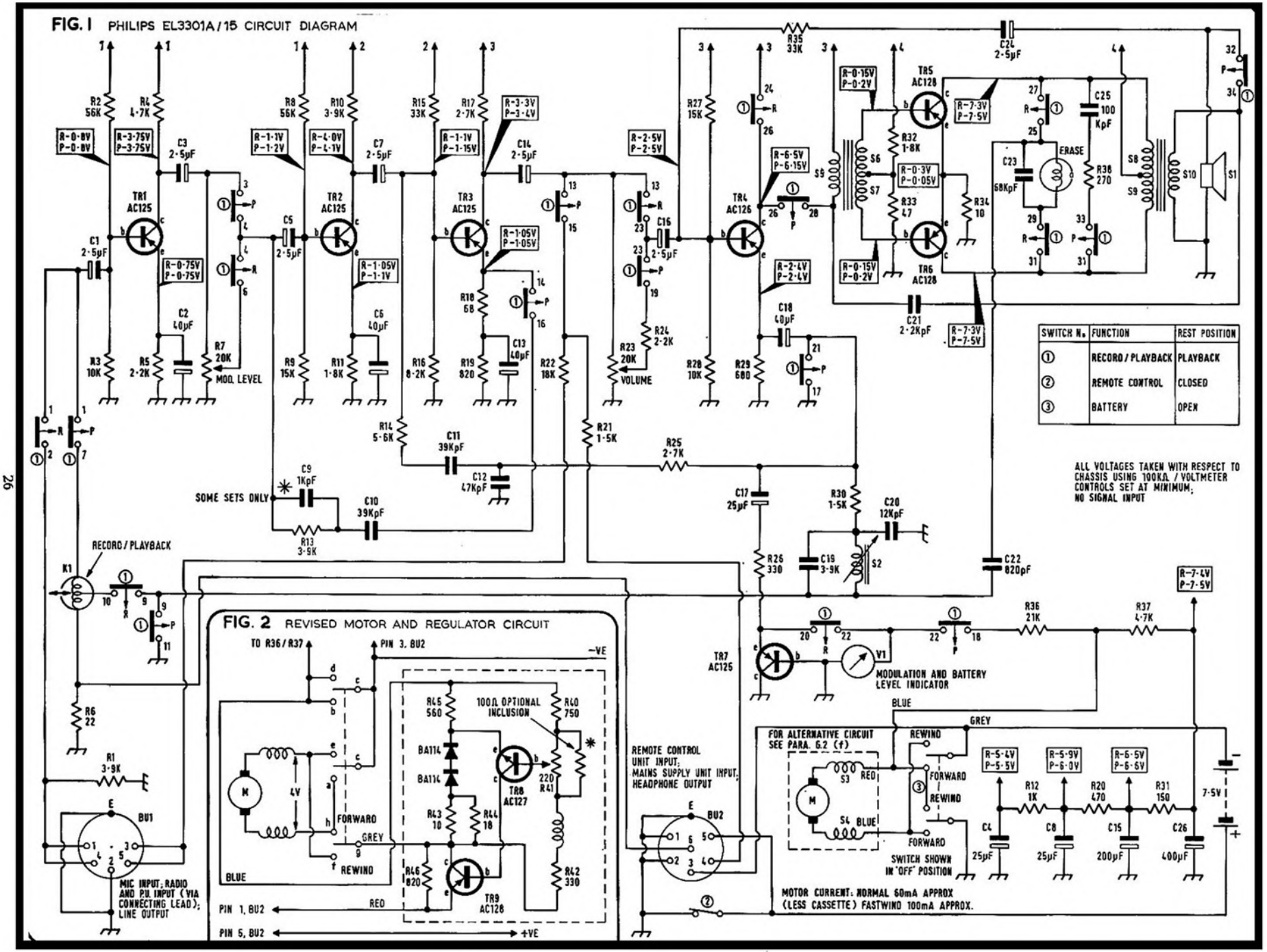


FIG. 1 PHILIPS EL3301A/15 CIRCUIT DIAGRAM
TR1 AC125
TR2 AC125
TR3 AC125
TR4 AC126
TR5 AC128
TR6 AC128
TR7 AC125
TR8 AC127
TR9 AC128
R-0·8V P-0·8V
R-3·75V P-3·75V
R-0·75V P-0·75V
R-1·1V P-1·2V
R-4·0V P-4·1V
R-1·05V P-1·1V
R-1·1V P-1·15V
R-3·3V P-3·4V
R-1·05V P-1·05V
R-2·5V P-2·5V
R-6·5V P-6·15V
R-2·4V P-2·4V
R-0·15V P-0·2V
R-0·3V P-0·05V
R-7·3V P-7·5V
R-7·4V P-7·5V
R-5·4V P-5·5V
R-5·9V P-6·0V
R-6·5V P-6·6V
MOD. LEVEL
VOLUME
ERASE
SOME SETS ONLY
RECORD / PLAYBACK
MODULATION AND BATTERY LEVEL INDICATOR
MIC INPUT; RADIO AND P.U. INPUT (VIA CONNECTING LEAD); LINE OUTPUT
REMOTE CONTROL UNIT INPUT; MAINS SUPPLY UNIT INPUT; HEADPHONE OUTPUT
FORWARD
REWIND
BLUE
GREY
RED
4V
7·5V
100Ω OPTIONAL INCLUSION
FOR ALTERNATIVE CIRCUIT SEE PARA. 6.2 (f)
SWITCH SHOWN IN 'OFF' POSITION
MOTOR CURRENT: NORMAL 60mA APPROX (LESS CASSETTE) FASTWIND 100mA APPROX.
ALL VOLTAGES TAKEN WITH RESPECT TO CHASSIS USING 100KΩ / VOLTMETER CONTROLS SET AT MINIMUM; NO SIGNAL INPUT
SWITCH No. | FUNCTION | REST POSITION
① | RECORD / PLAYBACK | PLAYBACK
② | REMOTE CONTROL | CLOSED
③ | BATTERY | OPEN
FIG. 2 REVISED MOTOR AND REGULATOR CIRCUIT
TO R36 / R37
PIN 3, BU2
PIN 1, BU2
PIN 5, BU2
-VE
+VE

PHILIPS EL3301

BY H. W. HELLYER

DO not despise the humble cassette. True, there is little you can do to upgrade a cassette recorder that you cannot also do with greater benefit to a normal reel-to-reel machine. Low-noise tape, better amplifiers and Dolby B notwithstanding, the cassette tape recorder has only convenience to offer, nothing more. If I offend one or two makers by saying this—so be it. I am used to sticking my neck out.

Having said that, let me redress the balance by admitting that for several years I have used a Philips *EL3300*, now modified into *3301*-plus, and have been very happy with its performance. My secretary uses it, in conjunction with a foot-switch, to read off dictation given on another cassette machine, the vastly superior Sony *TC100*, which has become my field machine and has never let me down. (We can't afford those snazzy office-type dictating machines—and besides, it gives me the chance to breathe down her neck occasionally while I change the batteries!)

The basic design of cassette recorders can be laid squarely at the door of Philips. Before they brought out the Compact Cassette, seven years ago, there had been several attempts to package a tape effectively. Our old friends at Garrard had a large magazine containing spools of 6.25 mm tape. I was concerned for longer than I care to remember in servicing Pamphonic and other equipment in pubs and supermarkets which made use of this quite reasonable device.

Economics sounded the deathknell, just as it eventually did for Grundig-Telefunken's 'DC International' design, using 3 mm tape at the non-standard speed of 5 cm/s. In my own opinion, again based on having serviced both designs, this latter method is far superior to the Philips. Certainly the mechanisms driving DCI tapes were more rugged, more stable, and very much more reliable.

Very many of the cassette models we meet nowadays (most of them, whatever the labels say, being Japanese) have been fashioned by a single specialist firm. One of my contacts names them as Nakamichi, but I am unable to confirm this. The notable exceptions to the rule are the American Wollensak model, which enjoys a high reputation, and of course Philips and Grundig, who are largely self-sufficient.

At the Olympia hi-fi jamboree, there were at least two cassette machines with a slightly different deck, the Harman Kardon *CAD-5* and the Kellar. Any upgrading of the machinery was overshadowed by the inclusion of Dolby B circuitry. Your indefatigable scribe has acquired a *CAD-5* (no, not the one that disappeared from the Lansing stand prior to the Audio Fair) and will have more to say about this later.

Our circuit (**fig. 1**) shows the second string of Philips machines, the *EL3301A/15*. It is very similar to the *EL3300* which preceded it and, apart from transistor changes from *AC126* to *AC125*, and one or two component changes, the circuit is substantially the same. We are not concerned here with styling. Facilities and connections, however, are important. I once came across a tape recorder user who had never, in three years, realised he had a monitoring facility on his machine, having never thought to push a certain switch while recording.

One of the major changes, which happened during the production run of the *EL3301* but which reflects back to the earlier models, was replacement of the motor with a completely different type. Models thus changed were given the suffix 'T'. It is essential when talking about Philips models to quote the whole model number.

The snag for the user is the high cost of this change. Instead of a straight motor replacement, taking ten minutes and costing, say, a fiver, we now have a different motor of changed dimensions, a regulator board, a switch alteration, and nine steps to be observed.

The revised circuit of this portion of the machine is given in **fig. 2.** Actual changes to the main circuit are provision of a new motor, a control switch SK3, and the regulator panel enclosed in dotted lines.

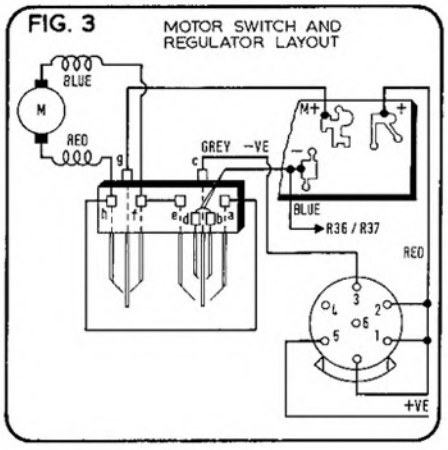
Study of the circuit shows nothing outstanding, simply a 4 V DC motor in series with a controlled transistor across the normal DC supply. The transistor, *TS9*, acts as a variable resistor, the voltage change on the base of TS8 altering conductivity of the pair, which are directly coupled, and so controlling the potential applied to the motor, whose alteration in demand affected the TS8 base. The emitter voltage of TS8 is controlled by the two diodes. By fitting a preset in the base bias circuit, we can limit the voltage at which the circuit operates. This is determined by the current drawn through R43/44 as the motor load alters (or the supply voltage, for that matter), reflected back as a voltage change to the TS8 base. When the motor is behaving, the circuit is inoperative.

Fitting is a bit of a fiddle. The motor has different dimensions and should come complete with a rubber spacer for the bottom of the motor well, to maintain correct level of belt run between motor and flywheel. This is essential. But the main part of the problem arises from the fitting of the panel and switch. Two holes have to be drilled to take the panel and these must be in the right position. This is under the place where the meter is sprung, so we first take off that mounting, enlarging the hole in the deck and the spring. The panel mounts by the flywheel; a little juggling will show the hole positions to be equidistant from the spring mounting hole we have just enlarged.

The switch is supplied with two plastics pips. These prevent correct mounting so we carefully chop them off. It should also be supplied with a new screw, as the original will no longer be suitable. The new screw is 12 mm long, 2 mm thread. Wiring up motor switch and panel is made easier by referring to the layout diagram in **fig. 3.** Note that one wire (the red from SK3 and pin 2 of the six-pin socket) has been deleted and instead a line is taken from this pin to the appropriate place on the printed panel. The grey and blue leads which were previously disconnected now go back as shown. I have marked in their colours on the main diagram to avoid confusion.

(*continued on page 30*)

FIG. 3 MOTOR SWITCH AND REGULATOR LAYOUT



Inputs				
Function	*Impedance*	*Sensitivity*	*Pins*	*Plug*
Microphone	2 K	300 μV	1/4-2	180° DIN
Radio	1.5 M	225 mV	as Mic, via *EL3768/03*	
Outputs				
Ext Amp	20 K	500 mV	3/5-2	180° DIN
Headphones	1.5 K	200 mV	4-1/2	240° DIN (6-pin)
Auxiliaries				
External Mains Unit		7.5 V	3-1/2	240° DIN (6-pin)
Remote stop/start			5-1/2	240° DIN (6-pin)

The Grundig TK147 is a hush-hush job

The TK 147, a four-track, fully automatic stereo machine, is one of Grundig's silent breed of tape recorders. The one sound we don't want you to hear out of the TK 147 is the TK 147. So we've designed it with that in mind. Because at Grundig we like to be at least several jumps ahead of the rest of the crowd. The TK 147 is built to an exclusive Grundig design with an elaborate electronic circuit that keeps noise to a minimum.

But that's just the start. This superior design also keeps the distortion level low and frequency response and dynamic range high, whatever the conditions, the composition or the volume of the recording.
And how d'you like the sound of that?
You can get superb stereo playback results by connecting it to a Grundig Stereogram or external stereo power amplifier and loudspeaker.

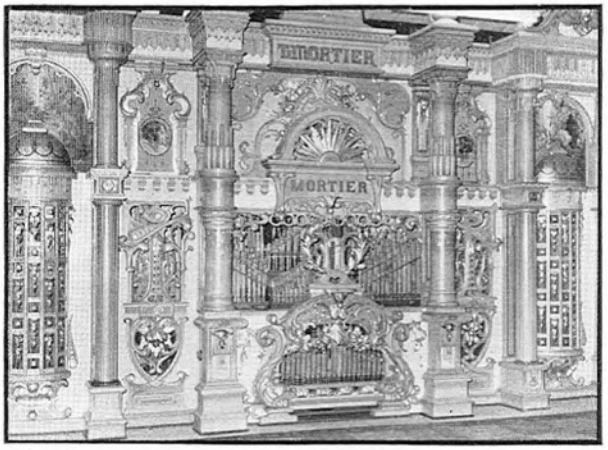
Wherever you look, you'll find clear evidence of Grundig's superb craftsmanship and attention to detail which results in a sound quality that is unmistakably better.

Listen to the hush-hush TK 147 soon - it's something to make a noise about. TK 147 - £96.4.0.

GRUNDIG
Made Better to Sound Better
Grundig (Great Britain) Ltd., London, S.E.26.

recording those mighty fairground ORGANS

BY ERNEST WALKER



98-key Mortier organ.

Edward Hine with a music book.

I CALLED at my local music shop for some batteries for a Uher portable tape recorder. Before leaving, Mr King, the manager of the department, asked if I intended entering a tape for the annual British Amateur Tape Recording Contest. I told him I did, but that the only idea which had so far occurred to me was to make a recording of some of the steam organs I anticipated would be coming with the Fair the following month. One of his colleagues, Peter Stanger, an expert on organs of the electronic variety, told me it was very doubtful if there would be a single organ travelling with the Fair this year, they cost too much to operate and maintain, and that I should think of something else. Well I just had no other ideas: had he?

He thought for a few moments, then asked: "Would you really like to record some fairground music?". I replied that I most certainly would. Then he told me about a Mr Edward Hine of Shaftesbury, who owned a collection of old fairground organs. He could give me no details, and suggested I wrote and asked for an appointment. We looked in the telephone book for Mr Hine's address, but Shaftesbury subscribers were not included so I had to pay a visit to the post office and consult the appropriate directory.

On returning home, I wrote to Mr Hine, saying that I had been told of his collection of organs, and asking if he would allow me to record their music when next there was a demonstration. I also told him that with his permission I should like to enter recordings of some of the music for the BATR Contest.

By return of post I received a reply. Though he did not have any fixed dates for demonstrations, we finally fixed on October 15, which was a little less than a fortnight away.

Though I was reasonably certain there would be a mains supply of electricity available, I had no knowledge of the method used to operate the organs. It could be steam, compressed air or electricity. In case it turned out to be some strange and antiquated electric system which generated interference on the mains, I decided to take a Uher *4000S* battery portable and Sony *777A*. I cleaned and demagnetised the heads of both recorders, then gave the machines a short run to ensure they were in good order.

Came October 15. We left home at 1.30 p.m. expecting to be in Shaftesbury within the hour. My wife, who was accompanying us because she also was keen to see and hear the organs, was tucked safely in the back seat, together with both recorders and the two zippers. A loudspeaker was packed away in the boot of the car: this so that I could play back the recordings to Mr Hine and demonstrate, should it be necessary, the recording standard I could manage.

We arrived at Shaftesbury, known as the Saxon hill-top town of North Dorset, just before 3 o'clock. The house and its extensive grounds were on the outskirts of the town. We went up a driveway, then into what might have been a large car-park. But there were no cars, only some big pantechnicons. I began to wonder if we were at the right address.

Inside the building, right in front of us, stood the largest steam-traction engine I had ever seen. Its paint gleamed, its brasswork glistened, and it gave the impression of having been delivered new from the engineering works that very morning. Apart from being used for haulage, it also drove a large dynamo which was fixed high up over the front of the boiler. An inscription plate indicated that the engine was built in 1922 by Burrells, of Thetford, Norfolk.

I looked around. Excepting that part occupied by the traction engine, the rest was taken up by three massive organs, each filling one side of the building. Their measurements were approximately 8 m long, 2 m wide, and 5 m high. Mr. Hine told me they were originally built for use in large dance halls on the Continent but that occasionally they could be seen at fairs. Certainly they are extremely handsome, and it seems a pity so few are still in existence.

No table was available so I put the Uher on

(continued overleaf)

a chair close to the entrance. Then I glanced around for a suitable place for the microphone. As I thought it likely the music would be fairly loud, I decided to place the stand as far away from the organ as possible, so set it up about 2 m to one side of the recorder. After sliding in the mike, I plugged the headphones into the machine and did a brief test. Just as I decided all was in order and switched off, music from the organ suddenly blasted forth—and I mean blasted! I switched on again, but the sound was so loud that I could not monitor it through the earphones—it penetrated the thick rubber padding and completely drowned the signal from the recorder.

The organ was so erected that there was a space of about 60 cm between it and the wall. It was here the operator stood when attending to the mechanism. I walked along to Mr Hine and touched his arm. 'Can you turn it down a bit?' I shouted. He leaned towards me and shook his head. 'No, there is no volume control.' 'Well it's terribly loud!' I shouted. 'Can nothing at all be done about it?' 'Nothing,' he said, smiling. I shrugged my shoulders in despair, then went back to the recorder. Judging by the VU meter, the tape was not being over-cooked so I left the machine running.

The first two tunes were run through in just over five minutes. Then came the *Swedish Rhapsody* which we all knew and, despite the loudness, thoroughly enjoyed. Our ears quickly became accustomed to the terrific volume of noise but it remained impossible to make oneself heard without shouting directly into the ear.

Ideal piece

The *Swedish Rhapsody* seemed an ideal piece of music to enter for the BATR Contest, so I asked Mr Hine if he would play it again. He shook his head. 'If I can find it!' he said, walking off in the direction of the organ.

When I had previously been at the back of the organ, the sound had dulled my wits to such an extent that I failed to notice what an interesting place it was. Now all was quiet, it seemed very different indeed, and Mr Hine told me all about the organ and how it worked.

This particular model was built in 1928 by Thomas Mortier in Belgium. Though it had been completely renovated by Grymonprez & Zoon, it was still exactly as it was when it had been first built 40 years ago. It had 98 keys, nearly 700 music pipes, and was fitted with drums, clappers, cymbals, triangle, bells and other solo instruments. All three organs worked on a similar principle to that of the pianola or player-piano but, instead of using rolls of paper in which slots were cut, very tough cardboard was used, which was folded into 'books' resembling giant seaside picture-card folders. The books measured about 36 by 18 cm and varied in thickness between 7 and 14 cm, depending on the duration of the tune and whether they contained more than one piece of music. They were made in Belgium, their titles being printed in German or Flemish. One organ will seldom accept a book made for another organ because of some slight difference in measurements, and great care is taken to keep the books separate.

Reading mechanism

To operate the organ, the book is placed alongside the 'reading' mechanism, with page one unfolded and lying across what resembles the platen of a small hand press. The upper part is brought down, locked into position, and the mechanism set into motion by an electric motor—which gives out a rather loud hum. Thereafter, the pages are drawn through automatically, re-folding themselves as they emerge at the other side of the platen. Under the platen are the keys which operate the valves that allow air to be blown into the music pipes, and which operate the various solo instruments. The organ has electric bellows, and the pipes work at about 7 kg cm^2 of air pressure.

During the next two hours, Mr Hine played music on the other two organs, both Mortiers and built between 1920 and 1928. It was unfortunate that because of the very wet summer some of the keys had been affected and were continually sticking, with the result that when the corresponding music pipe was played, it just went on playing, thus completely spoiling the music. Rectifying these faults is apparently easy enough; the difficulty is finding the particular key that is sticking. There are only about two people in the whole country capable of dealing with this kind of trouble, and they each have a waiting list.

Apart from the music and beautiful lights, one of the organs gave us particular pleasure. It had a piano accordion mounted against a black velvet background, high up and in the centre of the ornamented woodwork. And it was played most realistically—by a pair of invisible hands! It was this organ which was to be exhibited—and played—at the London Coliseum during the Twelfth London Film Festival in mid-November.

Eventually the time came for us to pack up the equipment and start for home. Before leaving, Mr Hine led us to another building which housed a second steam traction-engine, then being renovated. He told us about the organs stored in the pantechnicons which he hoped soon to set up in a permanent building. One was a Gavioli, made in Germany; a second, a Limmonaire, was made in France; and a third, a sort of 'composite' organ, was built from parts of various old organs by the London firm of Chiappia. All three had been in use with Fairs on the Continent.

It had been a most enjoyable, indeed exciting, afternoon, and I had captured on tape music from organs that had once given pleasure to tens of thousands of people, young and old, throughout the whole of Europe. Such organs can now seldom be seen or heard—'canned' music is accepted [*hardly an appropriate reference!*—Ed.], and is doubtless much cheaper to provide. But so long as there are men of such vision and generosity as Edward Hine, we shall still be able to see and hear some of the wonderful organs that were once regarded as an essential and important part of every fairground and large dance hall in Europe.

Final task is to set up the regulator for the correct speed. Although Philips give instructions on the setting of R41 with stroboscope, I have found the best way is to use a good test tape and beat the played note with a frequency reference. The twiddle takes seconds then. It is not a bad idea to make and keep one's own frequency reference tape, like the 400 Hz tone between television test transmissions, or some other note made when the machine is new and (presumably) fairly accurate.

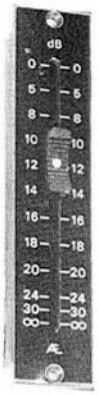
Now a few points of dismantling and repair that may help someone tackling this machine for the first time. The battery cover unclips or comes away with the bottom casing after removal of a central screw. This reveals the mechanism snugly cocooned in its upper case. Much servicing can be done without further dismantling. If the upper case needs to come off, first remove the single screw in the cassette compartment, then the long countersunk in the battery space and the three other cheesehead screws in the corners—*not* the two securing the printed board.

The upper case can be lifted away after the function knob is pulled off. Watch the flat spring that tensions this knob, and also a small red knob which depresses the limiting spring for record action. This will have rolled away under the sink unit by now! While you are looking for it, the two control knobs will fall off. Luckily they are easily refitted: not so on later models where spring tensioning is employed and reassembly becomes a juggling feat.

All parts are now get-at-able, except the component side of the printed circuit board which, it is to be devoutly hoped, you will never need to touch. There are, regrettably, one or two faults that can make this necessary, so let us leave the mechanical gubbins until next month and mention the electrical problems.

Some of the problems encountered include rough recording and intermittent record and play. Check first the connections to the heads. These should not be movable as the cable is clamped and flexes beyond the slide point. Several times we have had fractures at the head pins, held together by the sealing varnish to give tantalising intermittent symptoms. Next point to check is the other end of the R/P head cable, where it is connected to the slide switch upper tags. Difficult though it may be to get at this place, I nowadays waste no time fiddling around but replace this cable run completely when such intermittent faults have been traced to this area. If you look at the circuit you will note that the head winding is tapped. It is possible to have a shorted portion, or even an open circuit, and not lose recording completely; this could lead you to think the cable was quite in order.

Check also the power supply cable that runs adjacent to the battery springs, and the six-pin socket connections. These are particularly vulnerable to chemical attack when ageing batteries start to 'sweat'. Check the loudspeaker leads, too, which are rather short on the earlier models, superseded by contact connection in later models, which also have a better speaker unit.

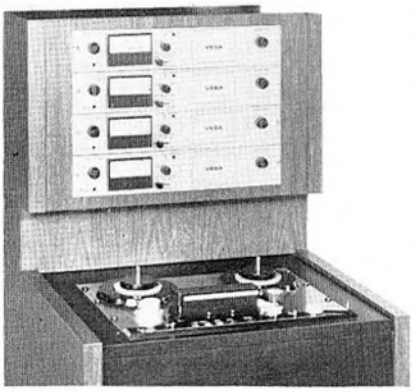


NEW equipment

GENERAL-PURPOSE CCTV

UP TO THREE remote cameras may be connected to the *WV-4KN* desk-top monitor developed by National. The system was conceived for general industrial supervision and requires no warm-up time. Dimensions of the monitor unit are 272 x 130 x 230 mm deep, camera size being 180 x 92 x 59 mm. Audio facilities may be added in the form of a *VN-154* intercom and the available accessories includes a remote panning unit, wide angle and telephoto lenses. Basic price of the 625 line random-interlace system is £250.

Distributor : Teletronics Ltd, 9 Connaught Street, London W.2.



VEGA 800 RECORDERS

VEGA 800 master tape machines are now available by direct order from the company's European headquarters. Basic variants are *800-1* (full-track single channel 6.25 mm), *800-4* (four channel 12.5 mm) and *800-8* (eight channel 25 mm). All models operate at 38 and 19 cm/s with 100 mS start time and ±0.2% playback speed accuracy. Signal-to-noise ratio is 60 dB (eight channel), specified frequency response being 35 Hz to 18 kHz at 38 cm/s. All versions other than the eight channel are available in portable versions in addition to the console format.

Distributor : Vega Electronics, 56 Queens Road, Basingstoke, Hampshire.

All statements on this page are manufacturers' claims only. They do not constitute a review.

LOW COST FADER

A LOW-COST slide potentiometer has been added to the Argo range of electronic components. Model *AF.100* has a 76 mm stroke and overall dimensions of 112 mm x 22 mm wide. Resistance range is between 100 ohms and 25 K with either JB calibrated log (as photo) or linear law (0 to 10 anodised aluminium scale). Long life and low noise are claimed.

Manufacturer : Argo Electronic Components Ltd, 54 Lemonfield Drive, Garston, Watford, Herts.

AUDIO TEST UNIT

THE RTS1 tape recorder test unit announced by Ferrograph embodies a variable frequency audio generator, millivoltmeter, wow and flutter meter and distortion measuring network in a single 440 x 254 x 142 mm cabinet. The sine generator covers 15 Hz to 150 kHz in four ranges (+0.2 dB) with less than 0.025% 1 kHz distortion, 0.08% 100 Hz to 20 kHz. Maximum output level is +5.5 dBm into 600 ohm load, attenuated in six 10 dB steps with a 15 dB fine control. Millivoltmeter input impedance is 1 M (1 mV to 100 mV), 2 M (300 mV to 100 V). Eleven ranges rise in 10 dB steps from 1 mV to 100 V FSD.

Wow and flutter measurement employs a 3.15 kHz internal oscillator and is weighted to DIN 45 507. FSD ranges are 0.3% and 1% peak. The distortion section rejects any fundamental between 500 Hz and 1.5 kHz and includes an oscilloscope output connector. The *RTS1* is mains powered (UK or US standard) and is supplied complete with an azimuth/response test tape.

Manufacturer : The Ferrograph Company Ltd, The Hyde, Edgware Road, Colindale, London N.W.9.

L4 BATTERY UNIT

WITH EMI approval, K. J. Grinsell is now manufacturing a dry battery unit to suit the *L4* portable tape recorder. This is identical in shape to the rechargeable battery originally supplied by EMI but incorporates 12 HP7 cells or their equivalent. The pack may be opened to fit replacement cells.

Manufacturer : K. J. Grinsell Productions, 180 Burbury Street, Lozells, Birmingham BI9 1TR.

PLUG-IN AUDIO MODULES

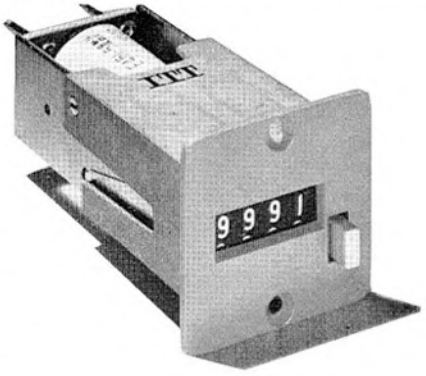
A RANGE OF audio modules on plug-in boards is being manufactured by Rugby Automation Consultants. Based on Mullard circuits, they are constructed on 63 mm square 3 mm thick fibreglass boards. Current range comprises the *MAI.1* microphone/line amplifier (adjustable gain) at £2.25, *MAI.2* mic/line/balance amplifier at £2.12½, *MAI.3* buffer amplifier at £2, and *MAI.4* emitter follower at £1.75. The *EI.1* equaliser amplifier costs £2.25 while *EI.2* to *5* cost £2.50. The latter comprise magnetic pickup, ceramic pickup, 9.5 cm/s tape head and 19 cm/s tape head equalisers. A *TI.1* tone control unit is offered at £2.25 and PI.1 power supply unit at £3.50.

Manufacturer : Rugby Automation Consultants, Rugby, Warwickshire.

PULSE COUNTERS

TWO MINIATURE pulse counters have been added to the range marketed by ITT, models *E350* and *E451*. They are respectively three-digit and four-digit, push button zeroing and capable of up to 1 000 counts per minute. Conservative life estimation is 10 000 000 counts. Both counters can be supplied to suit 12 V, 24 V or 48 V DC or 100 V, 120 V or 240 V AC. Model *E451* is illustrated.

Distributor : ITT Components Group Europe, Trading Services, Edinburgh Way, Harlow, Essex.



F CAVE

TOP DISCOUNTS

5 BRIDGE STREET
RICHMOND
SURREY

Tel. 01-948 1441 up to 8pm

DEMONSTRATIONS
MANY SYSTEMS AND INDIVIDUAL HI FI UNITS CAN BE HEARD AND COMPARED AT OUR SHOWROOMS
Please quote ref. Dept. SS/1

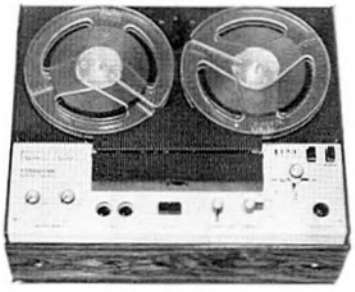
Special offers for Tape Recorder enthusiasts

TAPE RECORDERS AT BRITAIN'S BEST DISCOUNTS!

TANDBERG Series 3000

Take a close look at the outstanding features and facilities incorporated in this new model: 1. 4 heads. 2. Tandberg cross-field recording technique. 3. Mixing in mono. 4. AB-test switch. 5. Sound-on-sound and echo. 2 recording controls and indicators. 6. 3 speeds. 7. Listening during fast and rewind. 8. Pause button. Instant start/stop. 9. Automatic end stop.

Features like these and Tandberg's usual high quality and attention to detail continue through the range of Hi-fi equipment. Ask for details and special discount prices.



FERROGRAPH Series 7

Available in mono or stereo, Ferrograph Tape Recorders incorporate an unrivalled range of facilities including two inputs per channel with independent mixing, independent tone controls, and signal level meters for each channel for playback and record. They are available in elegant hardwood or in vinyl case to suit any interior or requirement.

FOLLOW THE PROFESSIONALS, RELY ON FERROGRAPH

TELETON FBX510 D

The quality of recording on this amazing stereo tape deck has to be heard to be believed. Features include two vu meters for record level and adjustable record level, three speeds, provisions for seven inch spools, two microphone inputs, and a very attractive walnut finished case. List price £62 0. 0. **Cash price £52 15.**

GRUNDIG

High quality sound recording without fuss is the keynote of the Grundig range. With concise easy to operate controls and at Cave's low prices a Grundig gives you real value for money. Compare our prices before you buy. Take these examples:

	List Price	Cash Price
Grundig TK120 ...	£39 5 0	£28 18 0
Grundig TK149 ...	£57 12 9	£46 19 0
Grundig TK146 ...	£68 2 10	£57 3 0

8 Track Stereo Cassette Players and Recorders

Are now in stock at Caves and available for demonstration. The equivalent of 2 LP records playing time in full stereo is now possible even in your car. Find out more about these fascinating units. Ask for details and Cave's bargain prices.

AKAI TAPE DECKS & RECORDERS

Prove for yourself the outstanding merits of the Akai 4000D. Having all the essential functional facilities, it also has many extras normally found on more expensive machines. The Akai 4000, the full tape recorder version of this excellent deck adds playback amplifiers and a pair of fine built-in speakers for stereo monitoring or just listening. And the Akai 1710 is surely one of the best complete tape recorder buys on the market today, combining all the best features of Akai engineering and construction. The above three models and the whole Akai range are available from Caves at very low prices.

TAPE RECORDERS	List Price	Cash Price
Revox Tape Recorders		*Special prices on application*
Ferrograph 713	£188 10	£166 0
Ferrograph 702/704	£207 7	£180 10
Ferrograph 722/724	£242 10	£202 19
Ferrograph Cover	£6 5	£5 16
Akai 4000D	£89 19	£72 19
Akai 1710L	£89 0	£77 12
Akai 4000	£124 18	£102 19
Akai X5000L	£177 19	£156 13
Akai X5000W	£177 19	£156 13
Akai M10L	£245 1	£215 13
Tandberg Tape Recorders		*Special prices on application*
Philips 4302	£35 17	£29 19
Philips 4307	£49 10	£42 10
Philips 4308	£60 10	£51 19
Philips 4404	£83 0	£71 5
Philips 4407	£105 0	£90 2
Philips 4408	£139 0	£119 6
Philips 2502	£49 10	£42 11
Philips 2200	£14 18	£12 5
Philips EL3302	£28 7	£21 10
Philips 2400	£69 0	£60 13
Philips 2400 inc. speakers	£86 0	£75 13
Philips 2401 inc. speakers	£99 0	£87 0
Philips N2202	£29 18	£26 18
Philips N2602	£42 0	£29 19
Uher 4000L	£145 10	£130 18
Uher 4200	£187 5	£168 10
Uher 4400	£187 5	£168 10
Uher 714L...	£55 10	£49 18
Sanyo Cassette	... ...	£20 19
Telefunken M501	£43 11	£38 8
Telefunken M204TS	£124 19	£109 18
Grundig TK120	£39 5	£28 18
Grundig TK124	£44 18	£35 7
Grundig TK144	£49 19	£42 5
Grundig TK149	£57 12	£46 19
Grundig TK121	£54 15	£45 19
Grundig TK141	£59 4	£49 14
Grundig TK146	£68 2	£57 3
Truvox R44	... ...	£45 10
Teleton T710	£34 15	£30 10
Teleton SL40	£37 10	£32 19
Teleton FXB 510D	£62 0	£52 15
Crown CTR8750	£32 11	£24 19

8 TRACK STEREO

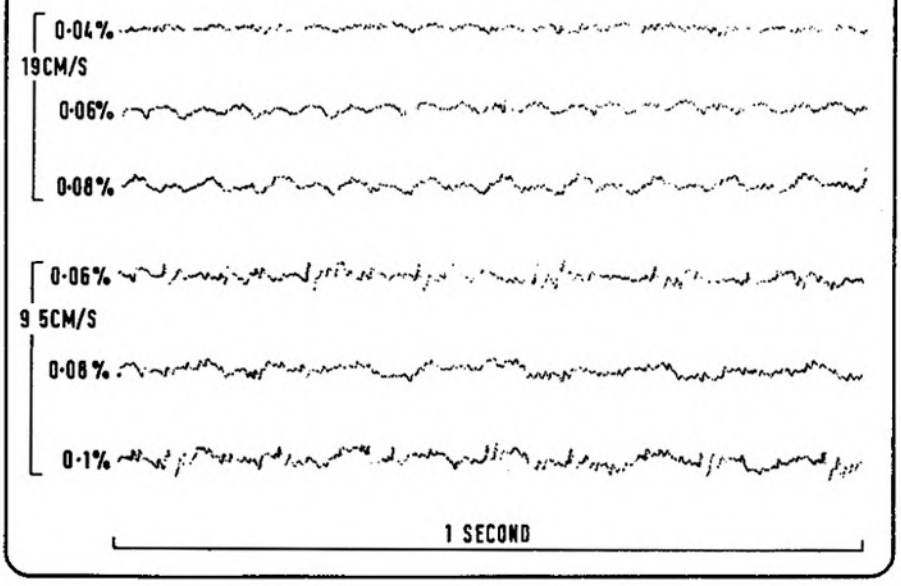
Akai CR 80	£115 0 6	£101 5
Akai CR 80D	£95 0 0	£83 12
Pioneer TP 83 8-track car stereo unit	£39 14 0	£33 4
Pioneer TP 85 8-track stereo unit with FM stereo radio	£84 5 3	£70 7
Pioneer HP. 82 8-track stereo home unit. Record and Playback	£90 17 8	£75 17
Motorola 8-track car stereo player ...	... ...	£41 0
Teleton STP 800 8-track stereo cartridge player/speakers	£52 5 0	£43 15

IT MAKES SOUND SENSE BUY FROM CAVES

SONY TC630D STEREO TAPE UNIT

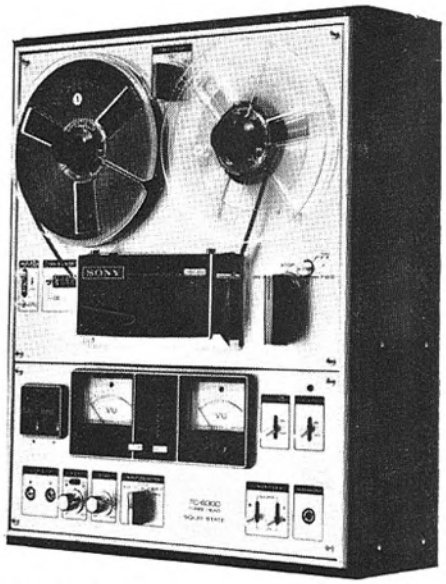
MANUFACTURER'S SPECIFICATION (19 cm/s). Quarter-track stereo tape unit operating at 19, 9.5 and 4.75 cm/s. **Wow and flutter:** 0.09% RMS. **Signal-to-noise-ratio:** 52 dB. **Frequency range:** 20 Hz to 22 kHz (unspecified limits). **Harmonic distortion:** 1.2% at rated output. **Inputs:** 190 μV at 600 ohms (microphone), 60 mV at 100 K (auxiliary 1 and 1) 60 mV at 560 K (auxiliary 3). **Outputs:** 0.775 V at 100 K (line). Eight-ohm headphone socket. **Oscillator frequency:** 160 kHz. **Dimensions:** 480 x 400 x 200 mm. **Weight:** 11 kg. **Price:** £164 15s. **Distributor: Sony UK Ltd, Pyrene House, Sunbury Cross, Sunbury-on-Thames, Middlesex.**

FIG.1 SONY TC630D WOW AND FLUTTER



THE Sony *TC630D* has fixed level outputs designed to feed an external control unit. The fixed gain also allows the VU meters to be switched to line output on play or monitor to measure the actual recording level on the tape. This facility is not often available on domestic machines.

The two slider controls between the meters are for left and right record level only. An input selector switch is placed below and slightly to the left of the sliders. To the left we find 'echo' and 'Sound on sound' controls, with microphone input jacks on the extreme left. The record keys are immediately above the microphone sockets. To the right of centre are the channel monitor keys which switch line, headphone and VU meters to input signal or tape output.



The power switch and noise reduction switch are placed to the right, in line with the meters.

Tape control is by the now familiar Sony three-position rotary lever with a push button to convert the normal playing speed to fast forward wind.

A four-digit tape position counter is driven from the supply reel at one digit per revolution.

Tape speeds were checked with a lightweight

(continued on page 35)

FIG. 2 SONY TC630D PLAY-ONLY FREQUENCY RESPONSE (NAB TEST TAPE TO LINE OUT)

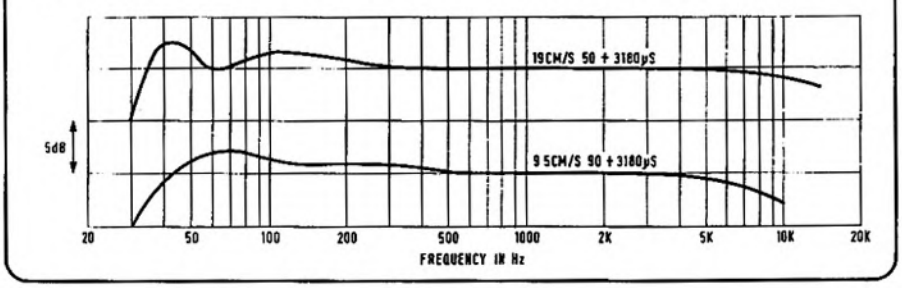
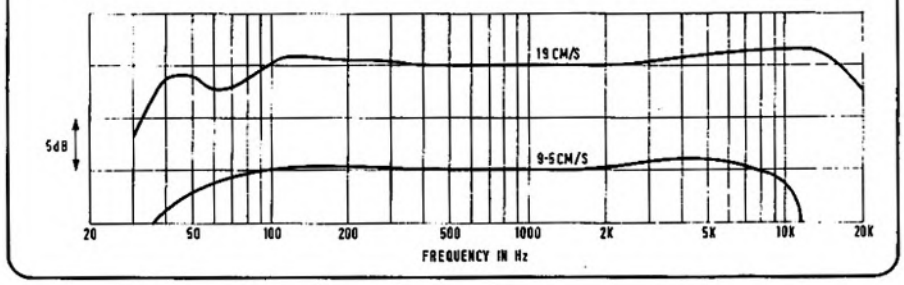


FIG. 3 SONY TC630D RECORD-PLAY FREQUENCY RESPONSE (−20dB REF 32mW/mm)



FRANCIS OF STREATHAM

Members of the Hi Fi Dealers Association

LONDON'S FOREMOST TANDBERG STOCKISTS

DECKS WITH PRE-AMPS
(Microphone extra)
Akai 4000D, Stereo
Revox 1102/4
Sanyo 801, 3 sp. 4 Tr. Stereo
Sony 355 3 sp. 4 Tr. Stereo
Sony 255 Stereo
Sony TC630 3 sp. 4 Tr. Stereo
Tandberg 6000X 3 sp. 2/4 Tr. Stereo
TANDBERG 3000X
Tandberg 1600X
Telefunken 205 3 sp. 4 Tr. Stereo
Telefunken 203 Studio
Philips N.4505 3 sp. Tr. Stereo
Philips PRO 12 2 sp. 2 Tr. Stereo

COMPLETE TAPE RECORDERS
Ampex 1100 Stereo
Ampex 2100 Stereo
*Akai 1710W Stereo
*Akai N.9 Stereo
*Akai 1800 Dual-purpose stereo 8 track cartridge and tape recorder
*Brenell Mk. 5/M Series III Mono
*Brenell Mk. 5 Series III Mono
*Brenell ST200 2 Tr. Stereo
*Brenell ST400 4 Tr. Stereo
*Ferrograph 713
*Ferrograph 702/4
*Ferrograph 722/4
Grundig 124 2 Tr. Mono
Grundig 144 4 Tr. Mono
Grundig 149 4 Tr. Mono Auto
*Grundig TK320 3 sp. 2/4 Tr. Stereo
Philips 4307 4 Tr. Single Speed Mono
Philips 4308 2 sp. 4 Tr. Mono
*Philips Professional PRO.12
Philips Stereo 4404 2 sp. 4 Tr.
Philips Stereo Cassette 2400
Philips 4407 3 sp. 4 Tr. Stereo
*Philips 4408 Prof. 3 sp. 3 Tr. Stereo
*Revox 77 Stereo Transistor
*Sanyo 990 3 sp. 4 Tr. Stereo
*Sony 252 4 Tr. 3 sp. Stereo
*Tandberg 15 2 or 4 Tr./3 sp./Mono
*Tandberg Series 12X 3 sp. 2/4 Tr. St.
Telefunken 204 T.S.
*Telefunken M207 2 sp. 4 Tr. Stereo
Telefunken 501 4 Tr.
Telefunken 203 Stereo/Mono 2sp. 4 Tr.
Telefunken 201 Mono 4 Tr.
*Uher 714 4 Tr. Mono
*Uher Royal de luxe 4 Tr. 4 sp. Stereo
*Uher Varicord 263 Stereo

BATTERY PORTABLE & CASSETTE
Philips EL3302 Cassette
Philips RR482 Cassette/AM FM Radio
Philips RR290 Cassette/AM Radio
Tandberg Series 11-2
Ferguson Cassette 3240
Grundig Cassette C.200
Aiwa Cassette Batt./Mains
Philips 2205 Batt./Mains Cassette
Pye Cassette
Sharp 505 2 Tr.2 sp./BM
National 4 Tr./2 sp./Batt. Mains
Telefunken 302 4 Tr. 2 sp. Mono
*Uher 4000L 4 Tr. 2 sp. Mono
*Uher 4200/4400 2/4 Tr. 4 sp. Stereo
*Sony TC800

POWER PACKS, BY Philips, Stella, Telefunken and Uher

● **MIXERS by**
Uher, Eagle, Telefunken, D.J., etc.

● **MICROPHONES by**
AKG, Grampian, Reslo, Acos, Telefunken, Beyer, Sennheiser, etc.

* Microphones extra

FOR A FAIR AND DEPENDABLE DEAL IN

TAPE and HI-FI

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

AMPEX TAPE SPECIAL OFFER

Guaranteed Brand New 500 Series
(P—Polyester: A—Acetate)

7" L.P. 1800 ft. (P)	... ...	21/-
7" Standard 1200 ft. (P)		15/-
7" Standard 1200 ft. (A)...	...	12/-
5½" L.P. 1150 ft. (P)	... ...	17/6
5½" L.P. 1150 ft. (A)	... ...	15/-
5½" Standard 850 ft. (A)	...	12/6
5" D.P. 1200 ft. (P)	... ...	17/6
5" L.P. 900 ft. (P) ...	... ...	12/6
5" Standard 600 ft. (P) ...	...	10/-

SPECIAL BARGAIN OFFER
3" reel, 600' polystrene tape, only 5/-

Postage 2/- on orders up to £3.0.0. Over sent post free in U.K.

Bib and E.M.I. splicers, Matching transformers, Defluxers, Bulk Erasers, etc.
Stands, booms, fittings.
Pre-recorded tapes and cassettes, etc.
Tapes in all grades and lengths by: B.A.S.F., Scotch, Philips, E.M.I., etc.
Cassettes by Philips, etc.

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

HI-FI DEPT.

● **AMPLIFIERS**
Quad, Rogers, Arena, Philips, Goodman, Nikko, Decca, Leak, Rotel, Armstrong Tripletone, Tandberg, Teleton.

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

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

● **MOTORS, PICKUPS**
GARRARD S.P.25 Mk. II less cartridge, post free U.K. £11.15.0 (p/p in U.K. 5/-).

Goldring	Thorens
Connoisseur	Shure
Audiotec	Sonotone
Neat	SME
Acos	Pickering
Duel	BSR

Diamond styli, Microlifts, Pressure Gauges, Cleaning Accessories, Cabinets, etc.

169-173 STREATHAM HIGH ROAD, LONDON, S.W.16
Between St. Leonard's Church and Streatham Station
01-769 0466: 01-769 0192

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

HERTS HI-FI

166 ST ALBANS RD, WATFORD
Telephone: WATFORD 34644

● TAPE RECORDERS — OUR PRICE	
Revox 1102/4	£179 0 0
Revox 1122/4	£203 0 0
Revox 1222/4	£215 0 0
Revox 1102 HS ...	£222 0 0
Revox 1122 HS ...	£253 0 0
Revox 1222 HS ...	£255 0 0
Akai XV	£160 0 0
Akai 1800SD	£166 0 0
Akai X360	£320 0 0
Akai 4000D	£71 0 0
Akai 4000	£98 0 0
Akai X330	£280 0 0
Akai X330D	£250 0 0
Akai 1710L	£72 0 0
Akai X-5000 L & W ...	£135 0 0
Akai M 10L	£198 0 0
Akai X-360DS ...	£243 0 0
Akai 2000SD	£255 0 0
Ferguson-Marconi	
3245/4245	£33 0 0
3246/4246	£36 10 0
3247/4247	£39 15 0
3248/4248	£45 10 0
3249	£49 0 0

Teleton FXB 510D ...	£53 10 0
Pye 9106	£29 19 0
Pye 9123	£49 10 0
Pye 9137	£83 0 0
Philips 4302	£30 10 0
Philips 4307	£39 19 0
Philips 4308	£49 19 0
Philips 4404	£69 5 0
Philips 4407	£87 0 0
Philips 4408	£111 0 0
Philips 4500	£104 0 0
Philips PRO 12... ...	£219 0 0
Uher 714	£47 10 0
Uher 2325	£99 10 0
Uher 2345	£107 0 0
Uher 2527	£110 0 0
Uher 2547	£118 0 0
Uher 2825	£138 0 0
Uher 2845	£138 0 0
Uher Royal 2 ...	£229 0 0
Uher Royal 4 ...	£229 0 0
Uher Royal C2... ...	£208 0 0
Uher Royal C4... ...	£208 0 0
Uher 4000L	£120 0 0
Uher 4200	£149 0 0
Uher 4400	£149 0 0

P. & P. 2/6 up to £5 of tape

	STANDARD PLAY				LONG PLAY			
Reel	4"	5"	5½"	7"	4"	5"	5½"	7"
ft.	300	600	900	1200	450	900	1200	1800
BASF	—	20/-	26/-	31/-	17/6	25/-	28/6	41/-
BASF round pack	8/9	15/3	20/3	23/6	13/6	20/3	23/6	34/9
BASF low noise	—	—	—	—	—	29/-	33/-	47/-
EMI	9/6	18/-	24/6	30/-	12/6	24/6	30/6	42/-
PHILIPS	—	18/6	24/6	28/-	13/6	20/6	26/-	36/6
SCOTCH	—	16/-	21/-	26/6	11/-	21/-	26/6	38/-
SCOTCH Dynarange	—	19/6	26/-	33/-	—	25/6	32/3	45/3

	DOUBLE PLAY					TRIPLE PLAY				
Reel	3"	4"	5"	5½"	7"	3"	4"	5"	5½"	7"
ft.	300	600	1200	1800	2400	450	900	1800	2400	3600
BASF	10/9	20/-	28/-	40/6	49/-	17/-	24/-	40/-	49/-	61/-
BASF round pack	8/6	15/3	23/6	34/9	43/6	13/6	20/3	34/9	43/6	55/9
BASF low noise	—	—	42/-	60/-	93/-	—	—	—	—	—
EMI	12/6	21/6	36/-	48/-	66/-	19/6	32/6	56/-	—	—
PHILIPS	10/6	19/-	29/6	42/6	59/6	17/-	30/6	50/-	—	—
SCOTCH	12/9	19/-	31/8	42/-	58/6	18/6	30/-	—	—	—
Dynarange	14/-	22/6	36/-	47/3	66/10	—	—	—	—	—

To **Studio Sound Classifieds, Link House, Dingwall Avenue, Croydon, CR9 2TA.**

Please publish the advertisement indicated below for

.....Insertion/s under the heading .....

Name .....

Address .....

.....

.....

Cheque P.O. enclosed £ ...

.....

Is Box No. required Yes/No. If no, please include remittance to cover name and address and or Tel. No.

Please write in block capitals.

strobe wheel and found to be within 1% limits at all parts of an 18 cm reel of LP tape.

Fig. 1 shows the pen traces and RMS readings of total cumulative wow and flutter at 19 and 9.5 cm/s. The 20 and 10 Hz speed fluctuations proved to be due to the idler wheel and not to the capstan sleeve as at first suspected. High frequency flutter is low due to the inclusion of a 'scrape filter' or rotating tape guide between the erase head and the record head.

NAB test tapes were played at 19 and 9.5 cm/s to give the responses of **fig. 2.** These are within 2 dB limits from 40 Hz to 15 kHz and 10 kHz respectively. Unweighted system noise with no tape was 50 dB below 32 mM/mm reference tape playback level and −55 dB when weighted to the IEC 'A' characteristic.

Reference tape level was recorded with the VU meters at full scale. The measured total harmonic distortion at 1 kHz 32 mM/mm 19 cm/s was 1.5%. Bulk erased tape noise was −54 dB and peak recording level erased on the machine gave a weighted reading of −53 dB.

The record-play responses of **fig. 3** at 20 dB below 32 mM/mm recording level are very satisfactory with 19 cm/s response within 2 dB limits from 40 Hz to 20 kHz and 9.5 cm/s within the same limits from 50 Hz to 11 kHz.

Comment

The above measurements show that the tape transport, frequency response and signal-to-noise ratios are adequate without being sensational, but the engineering is to a high standard and my impression is that the *TC630D* would maintain its measured performance for a long and useful life.

The controls have a satisfactory solid feel about them and the less frequently used knobs and switches come to hand when required without getting in the way of the day to day working controls. This is partly a matter of careful layout, but mainly a result of very clear labelling which also extends to the two side panels containing input, output and mains sockets, etc. A novel feature is the provision of a robust earth or 'ground' terminal so that the recorder can be firmly earthed to the main amplifier equipment to eliminate hum loops.

A. Tutchings

SOUNDEX UNIMIXER PORTABLE MIXING UNIT

MANUFACTURER'S SPECIFICATION. Four-input, two-output stereo mixer accepting 50 or 200 ohm balanced microphones (switched impedance). **Controls:** Stereo pair faders feeding group fader, two spot microphone faders, each with pan potentiometer, all four channels feeding master fader. All faders rotary. **Inputs:** 30 μV at 25 to 60 ohms, or 75 μV at 150 to 600 ohms. **Signal-to-noise ratio:** 55 dB for 20 kHz bandwidth and 70 μV at 30 ohms or 180 μV at 200 ohms input. **Distortion:** less than 0.25% (40 dB above rated input, 1 kHz). **Overload:** greater than 45 dB above rated input. **Frequency response:** 20 Hz to 20 kHz ±2.5 dB, 200 ohm input. **Outputs for rated inputs:** 250 mV stereo, 125 mV mono, 100 mV pan. **Output impedance:** 1 K to feed 10 K load or greater. **Output overload:** 4.7 V RMS (5% distortion). **Internal battery or external supply:** 18 V DC, 25 mA. **Price:** £45. **Manufacturer: Soundex Ltd, 18 Blenheim Road, London W.4.**

APART from providing the necessary operating facilities, any professional or semi-professional microphone mixer must meet certain well defined requirements regarding harmonic distortion and noise.

Noise should be within a few dB of thermal noise at the source, and total harmonic distortion should be negligible at all practical input levels and line output requirements.

Fig. 1 shows the circuit of one of the four microphone amplifiers and one of the two line output amplifiers. The resistive mixing and pan pot elements work at such a level that they contribute little or no extra noise, harmonic distortion or changes in frequency response.

Responses were measured on all four channels, and at various settings of the controls, and found to be well within the specified ±2.5 dB. Typical readings were −2 dB at 20 Hz and 20 kHz falling to −3 dB at 40 kHz.

Before starting harmonic distortion measurements, the inherent distortion of my B & K oscillator was measured directly on the harmonic distortion meter and found to be about 0.1% at 1 kHz. A 1 kHz one-octave band-pass filter reduced this low distortion to vanishing

point, together with any low level noise or hum from the oscillator.

Distortion with 75 μV into the 200 ohm input, output set to 250 mV, could not be measured accurately as it was well below 0.1% (one meter division on my harmonic distortion meter).

Increasing the input signal by 40 dB (100:1) to 7.5 mV brought the total harmonic distortion to just 0.1%. The output level was maintained by using the main gain control at 250 mV. At 10 mV input, the distortion increased to 0.25%. At 20 mV input (48.5 dB above rated input) it rose to 2.0%.

As the output was fixed at 250 mV for all these tests, the above readings show the harmonic distortion and overload characteristic of the microphone amplifier only. Next, the input was set to 7.5 mV (0.1%) and the main gain control increased to measure the line amplifier overload. THD was 0.1% at 1 V output, 0.25% at 3 V and 0.5% at 4 V. Distortion increased sharply at 5 V output, indicating the onset of waveform clipping. Safe maximum RMS signal would thus be about 3 V to allow for battery run down.

Signal-to-noise ratio can be measured in many ways, each one giving a different answer: unweighted using a quasi-RMS meter; unweighted using quasi-peak measuring instrument to DIN 45519; weighted to IEC 'A' curve to approximate to the ear's response at low listening levels; or weighted using filter and quasi-peak measuring meter in accordance with DIN 45405. It can also be expressed as a noise factor of so many dB above thermal noise.

I must also stress the obvious and state that it depends entirely on the signal level chosen for the test. The test signal suggested in the second line of the specification is 180 μV into the 200 ohm microphone input from a 200 ohm source. This is very realistic as it proves to be the average output from good quality 200 ohm moving-coil microphones for a sound pressure of 1 μB (140 μV for *MD211* Sennheiser, 250 μV for Grampian *DP4*).

Using the specified 180 μV 1 kHz signal and a low-noise, well screened 200 ohm resistor for the noise, the unweighted RMS s/n ratio was 50 dB and the IEC 'A' weighted s/n ratio was 55 dB.

The calculated thermal noise from the 200 ohm resistor at room temperature and with a bandwidth of 20 kHz is 0.25 μV or 58 dB below the test signal.

The measured unweighted signal-to-noise ratio is pessimistic, as the testing bandwidth is certainly wider than the specified 20 kHz. As the measured frequency response showed the 3 dB down point at 40 kHz, it would seem to be permissible to increase the ratio by 3 dB to allow for a reduction of the effective bandwidth to 20 kHz, giving a modified ratio of 53 dB. The IEC 'A' curve is already 3 dB down at 10 kHz so that no further improvement can be allowed.

A further complication is that the mixer noise differs significantly from pure thermal (white) noise. A one-octave analysis shows a 1 dB per octave rise with falling frequency compared with white noise, together with a sharp increase in very low noise below 100 Hz.

Thus the weighted RMS noise measurement would seem to be the most realistic at −55 dB, giving an effective noise factor of 3 dB.

A further advantage of accepting the IEC weighting is that it can be related to the sensitivity of the microphone to measure the 'deafness' of the microphone-mixer combination as the minimum sound level which can just be heard above the noise. If we take the microphone sensitivity to be 180 μV at 200 ohms impedance for a sound level of 1 μB, or 74 dB above hearing threshold, then the unwanted mixer noise will mask all sounds below 19 dB above threshold (74 dB minus 55 dB). As the noise is IEC weighted, the lower working limit can be expressed as 19 phons.

The internally generated noise of most pro-

(continued overleaf)

fessional capacitor microphones is in the range 18 to 22 phons, so that the performance of the mixer with the average moving coil microphone is really excellent.

In the same way it can be shown that, with our average microphone, the mixer will show a total harmonic distortion of 2% for a sound level of 115 dB. The Soundex instruction sheets are careful to point out that high output microphones, such as some capacitor microphones with internal amplifiers, should be attenuated before feeding the mixer to avoid overload of the mixer preamplifiers.

Comment

I have limited this review to a discussion of the all-important signal-to-noise ratio and harmonic distortion measurements as a slightly improved version of the Unimixer *4S* will shortly be the subject of an operational field test.

I was very impressed by the attention to detail, both in the construction and choice of components of the mixer itself and also in the preparation of the very comprehensive instruction sheets issued with the unit. These should be read carefully before putting the mixer into service.

A. Tutchings

BANG & OLUFSEN STEREO RIBBON MICROPHONE

MANUFACTURER'S SPECIFICATION. Figure-of-eight stereo ribbon microphone, coaxial to 90°. **Frequency response:** 30 Hz to 13 kHz ±2 dB. **Sensitivity:** 85 dB below 1 V/μB. Bass attenuator and phase-change switches. **Output:** 200 ohms at 1 kHz via 3 m lead and five-pin DIN plug. Supplied in rosewood case with table stand. **Price:** £30 9s. **Manufacturer:** Bang & Olufsen A/S, Struer, Denmark. **Distributor: Bang & Olufsen UK Division, Eastbrook Road, Gloucester.**

THIS technical review should be read in conjunction with the Field Trial by John Fisher which appeared in the August 1970 issue. I am always interested to compare my objective measurements with the subjective impressions of a skilled observer, as it is well known that acoustic measuring techniques lack the extreme subtlety of the human ear.

In this case however we seem to agree very closely on the good and bad characteristics of this microphone.

Test equipment

A B & K sound level meter feeds a compressor circuit in a B & K sine/random noise generator to maintain a constant sound level at a point in space on the axis of a small sound source (*Maxim* speaker) within 1 dB over the range 20 Hz to 20 kHz. A B & K level recorder drives the generator at a constant sweep speed and at the same time records the output of the microphone under test on a paper chart. A pure sine wave or narrow band of white noise can be used. For these tests, in a well damped but not anechoic room, a 30 Hz band of white noise was used as the test signal to break up standing waves due to reflection from the room boundaries.

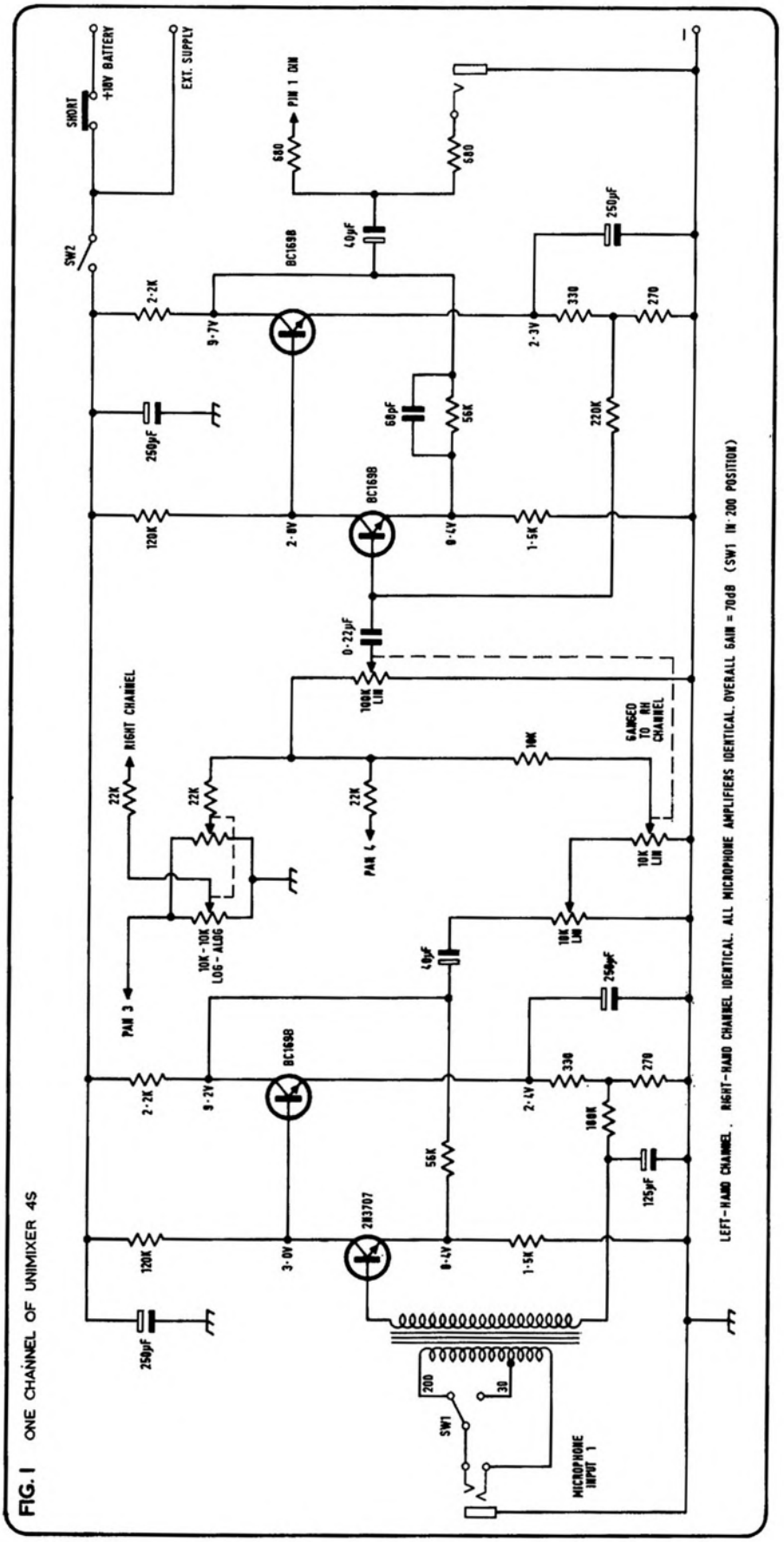
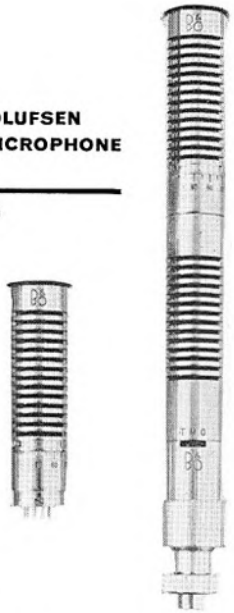
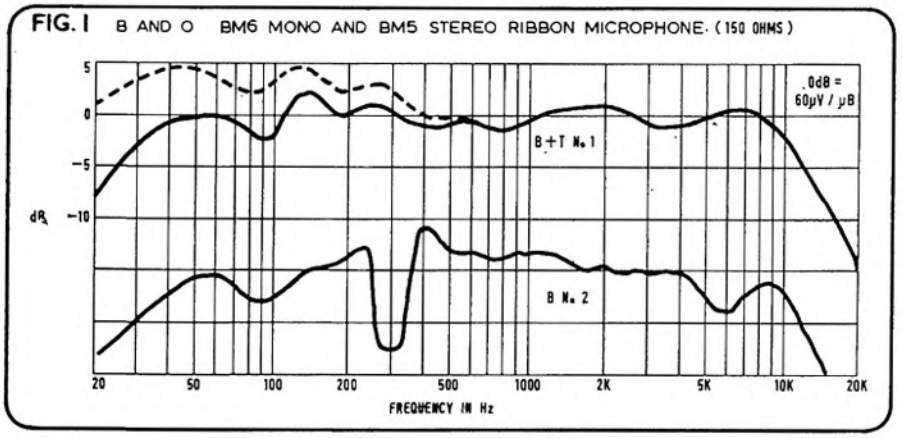


FIG. 1 ONE CHANNEL OF UNIMIXER 4S

BANG & OLUFSEN RIBBON MICROPHONE REVIEW

CONTINUED





Sensitivity

The generator frequency was set to 1 kHz and the reading on the sound level meter to 74 dB above sound threshold, which corresponds to a sound pressure of 1 dyne per cm², or 1 μB. The open circuit signal from the *BM5* microphone was 60 μV. This is a low sensitivity, even for a ribbon microphone, and great care should be taken in the design of a preamplifier or mixer for use with it if noise and hum are not to be obvious at very low sound levels.

The impedance of the microphone was measured at 1 kHz and found to be 150 ohms instead of the specified 200 ohms. Altering the ratio of the internal transformer to put this right would only increase the gain by a little over 1 dB.

Frequency response

The top solid curve of **fig. 1** is the mean response of three of the ribbon units 60 cm from the sound source. The dotted curve is at 30 cm range. The lower solid curve was obtained from the bottom unit of microphone number two. The sharp dip at 300 Hz is probably due to one edge of the ribbon fouling a pole piece.

The bass cut switch drops the response at 100 Hz by 10 dB so that a level response is obtained under close talking conditions at a distance of 15 cm or less.

The HF response of the *BM5* is extremely smooth to 10 kHz and identical on either side of the microphone. The polar diagram is a true cosine curve at LF but the lobes narrow slightly at HF to give a 4 dB loss at 10 kHz, 45° off axis.

The mid-low frequency response is very slightly coloured by the harmonics of the main ribbon resonance at 150 and 250 Hz.

Comment

A two-fold improvement in the efficiency of the magnetic circuit would remove my technical criticisms of this unit by increasing the electromagnetic damping of the ribbon and by raising the output to a reasonable level. If, at the same time, it could be made more mechanically robust, it would become a microphone of the highest class. Such improvements cost money however, and, in its price class it is certainly a microphone to be considered for single unit stereo sound pick up where the sound level is sufficiently high to overcome its sensitivity limitations.

A. Tutchings

field trials

PHILIPS PRO 12

THE Philips *PRO 12* first appeared in the UK in mid 1968, bridging the gap between the company's professional and domestic recorders. It is designed to the DIN 45 511 standards laid down for studio equipment. I saw a number of *PRO 12s* being used at Bush House (BBC Overseas Service) recently, so this looks like being a true 'semi-professional'.

Control Layout

Sprung turntable clasps lock the cine spools to the deck, which is capable of rattle-free vertical operation in addition to normal horizontal use. Viewed in a vertical position, all amplifier controls occupy a sub-chassis right of the deck. Two VU meters at the top are wired to a sensitivity switch capable of raising −10 dB signals to the 0 dB calibration to assist in lining up. Three push switches route either or both channels to the internal (mono) monitor amplifier and loudspeaker. An AB switch permits the usual After/Before comparison, affecting both the meters and the monitors. A rotary control below the AB switch governs internal monitor amplifier gain and is used in conjunction with the playback level controls. The latter vary the output signals from the rear connecting socket.

Two record level controls are seated above coaxial input selector skirts. Line, microphone, radio or opposite-track inputs may be chosen, independent of the other channel. Record push switches at the bottom of the sub-chassis operate in conjunction with a red record-select button grouped with the start selector in the lower right corner of the recorder. From left to right, these five controls select start, stop, record, rewind and forward wind.

A four-digit counter left of the start button reads nearly 13 for 10 turns of the take-up reel. It is pleasing to find counting devices consis-

(continued on page 39)

MANUFACTURER'S SPECIFICATION (19 cm/s): Half-track stereo tape unit. **Tape speed deviation:** 0.8%. **Wow and flutter:** 0.08% (to DIN 45507, measured with EMT 420). **Starting time:** 1 second. **Equalisation:** 70 μS (CCIR). **Frequency response:** 60 Hz to 12 kHz within 1.5 dB, 40 Hz to 18 kHz within 2.5 dB, to DIN 45511. **Signal-to-noise ratio:** −56 dB weighted, to DIN 45405. **Total harmonic distortion** (+6 dB at full modulation : 0.5% (record amplifier); 0.5% (replay amplifier). **Crosstalk:** −52 dB (at 1 kHz to 3% third-harmonic distortion, full level on adjacent track, both tracks biased). **Tape speeds:** 19 and 9.5 cm/s. **Line input:** 100 mV at 100 K. **Microphone input:** 1 mV (unbalanced) from 50 ohms to 2 K. **Diode input:** 2 to 40 mV at 20 K. **Optional inputs:** 200 μV at 50 ohms balanced (microphone transformer); 400 μV at 200 and 500 ohms (taps); 0.775 V or 1.55 V at 600 ohms line input transformer available. **Line and monitor outputs:** 0.775 V to 4 V with 10 K load (600 ohm line transformer available). Internal monitor speaker. **Weight:** 23 kg. **Dimensions:** 520 x 340 x 240 mm. Price: £249.50. (including £49.43 purchase tax). **Distributor: Philips Electrical Ltd, Century House, Shaftesbury Avenue, London WC2.**

Your Local Dealer

LONDON AREA

HAVEN HI-FI
196-198 SOUTH EALING RD.
LONDON W.5
Tel. 01-560 0194

Laskys
Stockists for all the leading makes of Tape Equipment
207 EDGWARE ROAD, W.2. *Tel.* 01-723 3271
33 TOTTENHAM CT. RD, W1P 9RB *Tel.* 01-636 2605
109 FLEET STREET, E.C.4 *Tel.* 01-353 5812
152/3 FLEET STREET, E.C.4 *Tel.* 01-353 2833
HIGH FIDELITY AUDIO CENTRES
42-45 TOTTENHAM CT. RD, W1P 9RD *Tel.* 01-580 2573
118 EDGWARE ROAD, W.2. *Tel.* 01-723 9789
MAIL ORDERS AND CORRESPONDENCE TO:
3-15 CAVELL ST., LONDON, E.1 2BN *Tel.* 01-790 4821

TAPE RECORDER HI-FI CENTRE (SHEEN) LTD
SPECIALISTS IN TAPE RECORDERS, ACCESSORIES, HI-FI EQUIPMENT
YOUR CENTRE FOR FRIENDLY HELP, SALES AND SERVICE
3 & 4 STATION PARADE, SHEEN LANE, SHEEN, LONDON, S.W.14
Open until 8 p.m. on Fridays
PROSPECT 0985
Opposite Mortlake Station, S.R.

CHESHIRE

Charlesworths HI-FI CENTRES
112 FOREGATE STREET, CHESTER. Tel. 25075
and 28 HIGHTOWN, CREWE. Tel. 56342
For all leading makes of Audio equipment
★ Spacious demonstration studio
★ Easy Parking

the hi-fi & Tape Recorder Centre . . .
Main **BANG & OLUFSEN** dealer—**SONY** centre. Also Ferrograph, Tandberg, Revox, Akai, Sanyo, National, Telefunken, Grundig, Uher, Philips. Also every other good make.
● Expert staff ● Advice ● Part exchange ● Home Dems ● Comparator Dems ● Car park ● New hi-fi Studio ● Best range in the North ● Many used bargains
the hi-fi Centre . . .
GREEN LANE, WILMSLOW, CHESHIRE
For personal attention ring Wilmslow 22112 or 24766 and ask for Mr. Bird or write or call for free INTRODUCTORY VOUCHER. Closed Wednesday 1 p.m.

DEVON

THE SOUTH WEST
Tom Molland Ltd.
Invite you to visit their well-equipped Demonstration Theatre and compare all the leading makes of Hi-Fi and Tape Equipment at
110 CORNWALL STREET, PLYMOUTH
Telephone **69285**
Immediate delivery to ALL Areas

Your Local Dealer

HAMPSHIRE

High Fidelity Specialists
Hamilton Electronics
Hamilton Electronics (Southampton) Ltd.
35 London Road, Southampton. Phone: 28622 3 Lines

FORRESTER'S
NATIONAL RADIO SUPPLIES LTD.
70-72 HOLDENHURST ROAD
BOURNEMOUTH HANTS
Largest hi-fi and radio component store in the south Tel: 25232

HERTFORDSHIRE

WATFORD
High Fidelity Centre
at RADIOLUX Ltd.
36 WOODLANDS PARADE, HIGH ST.
WATFORD (opposite the pond)
WATFORD 29734, 41029
IF IT'S GOOD—WE STOCK IT !
Demonstrations in our Stereo Theatre. Also home demonstrations with no obligation.

LANCASHIRE

STOCKPORT AUDIO CENTRE
FINEST IN NORTH WEST
FERROGRAPH REVOX B&O GRUNDIG TANDBERG
AKAI SONY TRUVOX PHILIPS
TELEFUNKEN SIMON UHER BRENELL FICORD
★ ALL MODELS ON COMPARISON DEMONSTRATION
★ EVENING DEMONSTRATIONS BY APPOINTMENT
FAIRBOTHAM & CO. LTD.,
58-62 Lower Hillgate, STO 4872

BOLTON
Specialists in High Fidelity Sound
H. D. KIRK Stereolectrics LIMITED
203 St. George's Road
Phone 23093
BOLTON

THE STEREO CENTRE
Recorders of Excellence
Tandberg Professional Agent
CONSULT GEORGE WEST — TAPE SPECIALIST
HFDA MEMBER · CAR PARK AT REAR · CLOSED TUESDAY
J. SMITH & SON
184 THE ROCK, BURY. 061-764-1242

Your Local Dealer

LANCASHIRE (continued)

ST. HELENS'
Harold Stott Ltd
Audio Engineers
Stockists of all leading makes of Hi-Fi Equipment. Appointed sole agents for: Revox, KEF, B & O, Quad, Sanyo, Sony, Sansui, Dynatron, Hacker, Tandberg, Armstrong, B. & W., etc., etc.

SURREY

FARNHAM SURREY
★ Stockists of all good Hi-Fi apparatus.
★ Comparative demonstrations.
★ We offer a real after sales service.
★ Easiest of terms
★ No parking problems.
Lloyd & Keyworth Ltd.
THE RECORD SHOP
26-27 DOWNING STREET, FARNHAM SURREY Telephone : Farnham 5534
SURREY AND HAMPSHIRE'S HI-FI SPECIALISTS

CROYDON'S
TAPE RECORDER CENTRE
All leading makes in stock, Hi-Fi equipment, cabinets, etc. Service agents for AKAI Tape Recorders
SPALDING ELECTRICAL LTD., 352/354 Lower Addiscombe Road, CROYDON.
ADDiscombe **1231/2040**

SUSSEX

A UNIQUE HI-FI SERVICE
BOWERS & WILKINS LTD.
Becket Buildings, Littlehampton Rd.
WORTHING Tel. 64141

WARWICKSHIRE

BIRMINGHAM — SOLIHULL
For the best in equipment visit
C.H. (HIGH FIDELITY) LTD
Hi-Fidelity Centre
167-169 Bromsgrove St., BIRMINGHAM 5
021-692-1487
12 Drury Lane, SOLIHULL WARWICKSHIRE
021-705-7999
Demonstrations by appointment

GRIFFIN RADIO LTD
(the high fidelity people)
Fully comprehensive stocks and advisory service for
Monaural and Stereophonic High Fidelity, Radio, Tape and Disc Equipment
64 BRISTOL STREET
BIRMINGHAM 5 *Telephone MID 1359*

tently right of the capstan; in earlier days these were often applied to a left-hand guide or feed spool where they introduced measurable tape speed fluctuations.

Left of the counter is a cue lever, overriding the tape lifters on fast wind to permit rapid searching and (no ferrites) equally rapid head wear. Normally the tape winds clear of the capstan and heads. Further left are the on/off switch, mains indicator lamp and pause control. Pause, rewind and forward wind controls all function through solenoids though most of the playback engagement is achieved manually. Though there is no danger of deforming the pinch wheel (a solenoid pulls the last 2 mm to the capstan).

A 'last resort' superimposition device is mounted in the lower left corner; this lifts the tape from the erase head during recording. If you wished to place a speech insert, for example, in a music passage already on the tape, slow movement of the control would fade the existing music slowly out and in.

Finally the tape speed selector at the top of the deck between the two spools alters the belt drive ratio between motor and capstan.

Mechanical design

The deck and control panel surfaces are mainly of thin (i.e. flexible) metal. This is nothing to complain about as the surface carries no mechanical load. Control knobs, head path covers, and spool turntables are plastic. From the left spool, the tape runs above (still viewing the *PRO 12* vertically) an indented lightweight rotating guide, then below a rotating bearing mounted on the left pillar of the head bracket. Erase, record and play heads form a crescent path, tape-to-head contact depending on the back tension from the reverse powered supply turntable. There are no pressure pads or pins but a substantial Mu-metal plate faces the play head. Both record and play heads are encased in 2 mm thick Mu-metal cans.

The play head shield is stuck to plastic foam, in turn glued to a bracket coupled to the pinch wheel arm. The pinch wheel and tape lifter mechanism is rather more complicated than usual, involving three different hinges to provide the insert facility. The heads are suspended from a single bracket and adjusting height, azimuth and forward angle, when necessary, should be quite easy. Record and play heads are of the 'butterfly' type for minimal crosstalk. Similarly the 1.7 mm record and play track spacing is aimed at minimal crosstalk rather than maximum signal-to-noise ratio. Twisted logic here if the recorder is intended primarily for stereo, though it conforms with the domestic standard.

Leaving the head gate, the tape passes over a fixed guide and round an autostop pin. The autostop retracts the mechanism completely. Removing the speed, cue and insert knobs, plus four Philips screws, frees the metal deck cover and front panel for routine cleaning. Eight larger screws hold the main chassis casting to the wooden cabinet, again quite easy to remove (flexible plastic handles are fitted to the casting) provided you remember to remove the red/grey loudspeaker leads first.

The view below deck is unusual, a 110 mm diameter capstan surrounded by a 165 mm diameter copper wheel, 45 mm thick. This wheel runs between two permanent magnets forming an eddy-current brake and thus providing a constant load to the induction motor driving the capstan. The Garrard *301* and *401* turntables use much the same principle. Increasing the tape speed from 9.5 to 19 cm/s pushes the magnetic brake slightly further across the disc. (A more elaborate version of this system is used in the new Philips *PRO 36*). A strobe wheel may be switched into action to check the precise speed. Despite the belt transmission (or perhaps due to it) this system gave remarkably good results in the late Terence Long's review (May 1970): 0.06 RMS wow and flutter at 19 cm/s.

Two separate motors are provided for spooling, switched to provide high forward tension with light reverse tension for fast wind and medium tension for normal record or playback. The *PRO 12* fast wound an 18 cm reel of standard play Dynarange in 52 seconds.

Connections

If you can get on with DIN sockets, this is really your machine: it has 10. All but the headphone socket are located at the rear, when the recorder is horizontal. These are Monitor, Mic 1, Mic 2, Line in 1, Line in 2, Diode in/out, Line out 1, Line out 2 (all five-pin), and a six-pin Remote control. I have already advertised my dislike of domestic DIN connectors; life is too short to deal with the countless combinations offered by 50 or so pins. Philips are good enough to supply a set of metal DIN plugs with the recorder.

Nominal input/output levels are given in the specification. For studio applications, Philips can supply transformers to match true 600 ohm 0 dBm line input and output. Balanced transformers can also be added for 50 ohm (200 μV sensitivity) or 200/500 ohm (400 μV) microphones.

Performance

Wow and flutter proved remarkably low, the *PRO 12* being very steady even at 9.5 cm/s when reproducing sine tones. In this respect the recorder is superior at its lowest speed to many aged professional recorders still being used in less well-off studios at 38 cm/s. Modulation noise, dropout and distortion are not low enough to make 38 cm/s redundant, however, and one wonders why Philips didn't go the whole hog to 27 cm spools.

Mechanical running noise is low enough to permit same-room recording, thick rubber feet reducing the possible transmission of vibration to resonant benches or cabinets. This is an excellent form of protection which I would like to see in more common use.

Handling

Despite its rapid braking, the *PRO 12* never snapped, tangled or noticeably stretched a tape during the several months it was used. The autostop functioned efficiently and there was no sign of vertical tape weave at the heads.

The mechanical mode selectors were less pleasant to use than the similarly priced Revox and Ferrograph, requiring exceptional force and snapping down noisily. A plastic flap over the pinch wheel hinges down to simplify editing. If I owned a *PRO 12*, I would remove the cover altogether as it tends to foul the pinch wheel when down.

Conclusion

I concur with Terry's comment that the *PRO 12* is an excellent machine except for the crashing solenoids which are reminiscent of 'snap, crackle and pop' domestics. Attention to the control design, an increase in spool capacity and tape speed, clearly labelled line-up presets and a more accessible head channel would make this a very fine recorder.

David Kirk

by Peter Bastin

WHEN IN India many years ago, I was interested to note how many English words were incorporated in the local language. This is true nowadays, not only in the orient but in Europe as well. It seems that it is impossible to translate much present-day jargon into other languages. *High Fidelity* (USA) comments upon this, with a choice selection of borrowed words. From Germany, probably the most generous borrower: *Habe ich jedoch den do-it-yourself fimmel.* From Italy: *Un nuova mid-range ad un nuovo tweeter ed a nuove caratterische del crossover. Aux jazzmen de l'ecole parkerinne* probably refers Frogilly to Charlie Parker. Dutchmen talk about *hifi low-noise ontwikkeld* and *play-back toets*, while the Swedes have *sex diskjockeys* and *tonvikten i soulmusik*. Even the English borrow. From the Welsh: *switched-on Bach.*

LARGE YOUNG son, devoted collector of Beatlemania, came home with the latest shining black disc of plug-into-the-wall music. Ignoring the music, which in parts is originally refreshing, I turned to the thick booklet accompanying the record, a largely-pictorial souvenir of the making of the film. Excellent photographs, sometimes repetitive, accompanied by verbatim (?) conversations between the Beatles. The most interesting features of the booklet are the photographs which illustrate the confusion of cables etcetera associated with a major professional recording Do. Polythene bags over microphones and lumps of sticky tape holding things in place. Sound engineers Glyn Johns and Malcolm Evans used so much equipment that it would take a page of this journal to list it all. An interesting booklet, but perhaps a pity that all the photographs were captionless. It is impossible to know who the people without beards and Fu Manchu moustaches might be. They could be engineers, inland revenue or just plain A and R men.

IN AMERICA, you can, if you are loaded, choose between 22 different models of video recorder, ranging in price from £300 to £4 400. Ampex, Concord, Panasonic, Roberts and Sony market playback units, time-lapse recorders, colour recorders and battery-operated recorders. Tape speeds vary. The Concord *VTR2000* has slow-motion facilities for £1 650, and Concord, Panasonic, Roberts and Sony all make battery-portable models. The cheapest model, a real smash bargain, is only £300. It's the Sony *CV2600*. On the other hand, a contemporary American audio journal advertises the GBC Complete Videotape System, which employs a Sony-made helical recorder, operating on 12.5 mm tape, a 1.8 vidicon camera and a Sony 20 cm monitor/receiver. The 'regular' price of this lot is £625; the special offer reduces it to £250. Isn't it time that someone in this country thought on the same lines?

A FEW YEARS ago, I wrote an article and review on a British domestic video recorder which operated on standard 6.25 mm tape. This was the Wesgrove *VKR 500*, a machine which recorded in a fixed-head linear fashion on (even) triple-play tape. The reels held about 4 500 m of tape and were 30 cm in diameter. Tape speed could be 19, 25 or 31 cm/s. The manufacturers painted a rosy picture of immediate and potential world-wide sales: a video replay unit was to be produced to play a ready-to-go market of cassettes, etc. And what had happened to all these pipe-dreams? Where is the Wesgrove *VKR 500?* Where is the Telcan? Where is Britain's contribution to the VTR scene? Sony and Philips have put domestic VTRs on the world market (you can get a Philips in Holland for under £200) and are likely to be followed in double-quick time by the Germans, the Danes, the Norwegians and so on. Not forgetting the Americans. But, apparently, forgetting the British. An incident of a few years ago springs out of the mental mist. A friend of mine applied to Philips for a job in the audio field and was offered a position as representative for a new battery-portable VTR. He's still waiting, presumably.

THE STEREOPHILE is a neat little small-circulation magazine produced in Washington, USA. J. Gordon Holt describes himself as 'editor, publisher, staff writer, chief tester and drudge'. Mary Holt is 'circulation manager, assistant editor, spouse and drudge'. The magazine is published four times a year at a subscription rate of about £2. It is, so it says, 'printed in the USA despite taxes and inflation'. This is the general humorous tone of the magazine which in no way puts humour above technical information. There are reviews of audio shows and technical equipment, letters and things for sale. No advertisements.

QUOTE ONE: *Daily News*, February 1923. 'The word selected by the *Daily News* as the prize-winner of their competition to suggest an alternative word to *listener-in* was *broadcatcher.*' Other words suggested were *radiolist*, *auditor*, *harker* and *Noah*, the last being because they 'ark'.

QUOTE TWO: March 1923. 'An improved amplifier is claimed to have been invented which will amplify the tone of the wireless voice, but not its imperfections.' It would appear that very little progress has been made in the last 47 years!

COMMENT IN American *High Fidelity* from a reader writing to the editor '. . . and why would anyone want a ½-track machine, even if it were available?' The editor points out that in Europe and England people still like to hear half-track stereo on half-track machines. Anyway, the man must be a nut.

CLASSIFIED ADVERTISEMENTS

Advertisements for this section must be pre-paid. The rate is 4p per word (private), minimum 35½p. Box Nos. 15p extra. Trade rates 6p per word; minimum 60p, Box Nos. 10p extra. Copy and remittance for advertisements in **FEBRUARY 1971** issue must reach these offices by **17th DECEMBER 1970** addressed to: The Advertisement Manager, **Studio Sound,** Link House, Dingwall Avenue, Croydon CR9 2TA.
NOTE: Advertisement copy must be clearly printed in block capitals or typewritten.
Replies to Box Nos. should be addressed to the Advertisement Manager, Studio Sound, 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

ELECTRONIC VIDEO RECORDING

EVR is being jointly developed by a consortium of CIBA, the international chemical group, ICI and CBS of America; Ilford is a member of the CIBA group, and we now require the following additional staff for this project at Basildon in Essex.

SENIOR AUDIO ENGINEER

and

AUDIO ENGINEER

for the operation and maintenance of high quality magnetic and optical sound equipment.

A good theoretical knowledge and practical experience of audio recording and reproduction is essential. Candidates should also have experience of interlock system, multiple track recording, frequency modulation, audio dubbing facilities, compression, expansion and frequency equalisation equipment, measurement of distortion, wow and flutter and all other parameters in an audio system. An appropriate qualification would be an advantage.

Applicants for the above positions must be prepared to work on shifts in due course. Commencing salaries will be in the range £1800 to £2500, according to qualifications and experience. We operate a contributory pension scheme, free life assurance and sickness schemes. Assistance will be given with relocation expenses where appropriate.

Applications, quoting reference **YAZ. 50,** giving details of qualifications and career to date, should be addressed to : **The Personnel Manager, Ilford Limited, Christopher Martin Road, BASILDON, Essex.**

FOR SALE—TRADE

UNIMIXER 4S

Mixing unit for professionals in studio and on location. (1 stereo pair and 2 pan controlled mics.) Any input imp. 25-600 ohms. S/n ratio greater than 55 dB with an input signal of 180 μV at 200 ohms or 70 μV at 30 ohms. Individual test certificate. Price **£45.** Further details:

SOUNDEX LTD.
18 Blenheim Road, London, W.4. Tel. 01-995 1661

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

Building a mixer. Use our plug-in printed circuit modules. Want a mixer built—ask us for a quote. Latest module, 2W monitor amplifier £6. Write:—Rugby Automation Consultants, 220 Alwyn Road, Rugby.

Lancashire. Tandberg, Ferrograph Tape Recorders, etc. Plus over 10,000 high fidelity systems. After-sales service. Holdings Photo-Audio Centre, 39-41 Mincing Lane, Blackburn BBA 2AF. Tel. 59595/6.

Bulk Erasers. Will erase up to 8¼in. tapes including cassettes, 42/6 each, postage 2/6. Clement Wain Ltd., Newcastle, Staffordshire.

Copyright Free Sound Effects Discs. 7″ E.P's and 12″ L.P's. Catalogue from Rapid Recording Services, 21 Bishops Close, London, E.17.

Impex pre-amplifier model M.S.7. Stereo magnetic pickup pre-amplifier designed for use with the Ferrograph Series Seven recorder. This attractively cased unit is made in Britain giving the high standard of performance required for the Series Seven recorder.—Price £9. Details available from: Impex, P.O. Box 2BB, Newcastle upon Tyne, NE99 2BB.

Microphones, headphones accessories, discounts. Write for a quotation. Central Scotland Audio, 6a-12a, Canal Street, Falkirk, Stirlingshire.

FOR SALE—PRIVATE

E.M.I. Type RE301 Professional Rack mounted ¼-track stereo tape recorder. 2 speeds 3.75 and 7.5 i.p.s. on ¼″ tape. Machine has five amplifiers and four heads. Built in monitor speaker and switchable meter. A superb machine in perfect working order. Price £160 o.n.o. S.A.E. for further details to Cutler, 58 Trent Boulevard, W. Bridgeford, Nottingham.

One pair KEF Concord Loudspeakers £68. One Trio AM/FM Tuner (TK 350T) £56. Tel. High Wycombe 24316.

Vortexion WVB5 15/7½ full-track £75. AKG D19C with W24 windshield £12. Garrard 301 Turntable £10. Brenell deck £10. Sunbury-on-Thames 87108.

Excellent condition. Quad 22+2 Quad II £35, Goodman Magnum K (pair) £50, Revox 736, 4-track, chassis £85, Chapman AM/FM £20, SME 3009 £20, Thorens TD.150 £18, Ortofon SL15E+transformer £24. G. Samant, 10 Hope St., Filey, E. Yorks.

E.M.I. Professional Tape Recorder type BTR.4. Perfect condition. Phone 01-994-6275.

WANTED

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

Opera Lover ¼-tr. stereo 3¾ copy Boheme Broadcast Pavarotti Freni. Woods, 11 Mannicotts, Welwyn Garden City, Herts.

STUDIO FACILITIES

EDEN STUDIOS LTD.

Word's getting around that the Studio that's having great success with its own recorded productions, also has a particularly fine pressing and disc cutting service. Please write or phone for leaflet.

11 EDEN ST., KINGSTON, SURREY
01-546-5577

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

Fanfare Records. Tape-disc pressings, demo's, masters, any quantity. Studio/mobile. Neumann disc cutter. S.A.E. brochure. 1 Broomfield Close, Rydes Hill, Guildford. Telephone 0483-61684.

mjb recording and transcription service

Vinyl pressings and acetate demodiscs. Limiting, compression and equalisation facilities; high undistorted cutting levels with feedback cutter heads. Booklet available.

10 LOWER ROAD, COOKHAM RISE, MAIDENHEAD, BERKS.
Tel. Bourne End 22231 Member A.P.R.S.

Pressing Specialists, stereo or mono discs manufactured from your own tapes. Mobile recording service. North Surrey Recording Co., 59 Hillfield Avenue, Morden, Surrey.

County Recording Service. Send your tape for transfer to disc to the people who care about quality. Full time disc recording engineers, using modern cutting techniques. Telephone Bracknell 4935. London Road, Binfield, Bracknell, Berkshire.

Your tapes to disc. 7in. 45—£1.10.0, 10in. L.P. £3.10.0, 12in. L.P.—£4.0.0. 4-day postal service. Masters and Vinylite pressings. Top professional quality. S.A.E. photo leaflet: Deroy Studios, High Bank, Hawk Street, Carnforth, Lancs.

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

Graham Clark Records. Tape to disc pressings. P. F. A. House, 182A Station Road, Addlestone, Weybridge, Surrey. Tel. Weybridge 43367.

In the centre of Birmingham you'll find Zella. Recording Studios, Custom Record Pressing, Mobile Recording Unit. Zella Records (B'ham) Ltd., 32 Bristol St., Birmingham 5. Tel. 021-622-2684.

MISCELLANEOUS

Tape Recorder Repairs by Specialists. The Tape Recorder Centre, 82 High Holborn. London, W.C.1.

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

Repairs. Our modern service department equipped with the latest test equipment including a wow and flutter meter and multiplex stereo signal generator, is able to repair Hi-Fi and Tape Recording equipment to manufacturers' standards. Telesonic Ltd., 92 Tottenham Court Road, London, W.1. Tel. 01-387-7467.

Highest cash prices for tape recorders. 9.30-5. Immediate quotations. 01-472-2185.

TAPE RECORDER HIRE

Ferrograph, Uher, etc. tape recorders for hire. Full details from Magnatape Hire Services, 191-193, Plashet Road, London, E.13. 01-472-2185/2110.

TAPE EXCHANGES

Try a new hobby for the New Year and use your Recorder every day of it! Particulars 4d. Worldwide Tapetalk, 35 The Gardens, Harrow.

INDEX TO ADVERTISERS

COMET

Hi-Fi DISCOUNT WAREHOUSES

- All items offered are brand new, latest models in manufacturers' sealed cartons. Fully guaranteed with after-sales service.
- Over 1000 items in stock. Complete Free price list on request

Open Daily to the public from 9 a.m. Closed Tuesday 1 p.m.
Mon. & Sat. 5-30 p.m. Open until 8 p.m. Wednesday, Thursday & Friday.

STEREO AMPLIFIERS

	Rec. Retail Price	Comet Price
ARMSTRONG 521	£56 0 0	£46 0 0
DULCI 207	£25 0 0	£17 0 0
DULCI 207M	£30 0 0	£20 19 0
FERROGRAPH F307	£59 0 0	£47 19 6
GOODMANS Maxamp	£54 0 0	£37 19 6
HL 505	£23 2 0	£16 19 6
LEAK Stereo 30 Plus	£53 0 0	£41 19 6
LEAK Stereo 30 Plus, in teak case	£59 10 0	£46 19 6
LEAK Stereo 70	£65 0 0	£52 0 0
LEAK Stereo 70 in teak case	£71 10 0	£56 19 6
LINEAR LT.66	£21 0 0	£16 19 6
LL Stereo Amplifier	£23 10 0	£16 19 6
METROSOUND ST20	£36 0 0	£28 19 6
PHILIPS RH 591	£73 0 0	£55 19 6
PHILIPS RH 590	£49 0 0	£37 12 6
PHILIPS RH 580	£26 0 0	£19 19 6
PIONEER SA 500	£62 1 11	£42 19 6
PIONEER SA 700	£98 0 0	£69 19 6
PIONEER SA 900	£134 2 0	£96 19 6
PIONEER Reverberation	£45 9 11	£32 19 6
QUAD 33 Pre-amplifier	£43 0 0	£38 19 6
QUAD 303 Main Amplifier	£55 0 0	£48 19 6
ROGERS Ravensbourne	£59 10 0	£46 19 6
ROGERS Ravensbourne (cased)	£64 0 0	£49 19 6
ROGERS Ravensbrook	£44 0 0	£34 19 6
ROGERS Ravensbrook (cased)	£49 0 0	£38 19 6
SINCLAIR 2000	£30 9 0	£22 19 0
SINCLAIR PROJECT 60/2 x 230/PZ5	£23 18 0	£16 19 0
SINCLAIR PROJECT 60/2 x 250/PZ8/trans.	£32 17 6	£23 8 6
SINCLAIR NEOTERIC	£61 19 0	£45 19 6
TELETON 150	£29 0 0	£19 19 6
TELETON 203E	£28 15 0	£19 19 6
TELETON GA 101 30w. RMS	£33 15 0	£22 19 6
VOLTEX 100w. Stereo Discotheque, eight electronically mixed inputs	£185 0 0	£139 0 0

TUNERS

*ARMSTRONG 523 AM/FM	£53 15 3	£44 19 6
*ARMSTRONG 524 FM	£41 17 8	£34 19 6
ARMSTRONG M8 decoder	£9 10 0	£7 19 6
*DULCI FMT.7 FM	£22 1 0	£17 19 6
DULCI FMT.7S Stereo	£31 0 0	£25 5 0
GOODMANS Stereomax	£82 10 5	£63 19 6
LEAK Stereofetic Chassis	£59 18 0	£51 19 6
LEAK Stereofetic in teak case	£67 3 6	£58 19 6
PHILIPS RH 690	£39 0 0	£31 19 6
PHILIPS RH 691	£83 0 0	£70 10 6
PIONEER TX500 AM/FM	£77 18 9	£63 19 6
PIONEER TX900 AM/FM	£153 13 10	£125 0 0
QUAD Stereo FM	£51 0 0	£39 19 6
ROGERS Ravensbourne	£61 17 9	£49 19 6
ROGERS Ravensbrook	£45 0 2	£39 19 6
ROGERS Ravensbrook (cased)	£51 5 3	£42 19 6
*SINCLAIR 2000	£26 14 6	£19 4 6
SINCLAIR PROJECT 60	£25 0 0	£20 19 6
TELETON 201X FM	£36 0 0	£29 19 6
TELETON GT 101	£47 10 0	£33 19 6
TRUVOX FM 200/IC	£60 11 10	£39 19 6

All above tuners are complete with MPX stereo decoder, except where starred.

TUNER/AMPLIFIERS

AKAI 6600	£142 10 7	£112 0 0
ARENA R500	£82 0 0	£66 19 6
ARENA 2400	£90 6 0	£71 19 6
ARENA 2600 Stereo AM/FM	£111 6 0	£94 0 0
ARENA 2700 Stereo	£105 0 0	£85 0 0
ARENA T1500F	£72 9 0	£59 19 6
ARENA T9000	£303 9 0	£258 0 0
ARMSTRONG M8 decoder	£9 10 0	£7 19 6
*ARMSTRONG 525	£91 17 9	£76 19 6
*ARMSTRONG 526	£104 14 3	£86 19 6
GOODMANS 3000	£77 14 7	£52 19 6
PHILIPS RH 781	£74 19 6	£54 19 6
PHILIPS RH 790	£125 0 0	£101 19 6
PIONEER KX330 AM/FM/SW	£78 12 4	£62 19 6

COMET for after-sales service

Throughout the U.K.

Service Depots at Leeds, Goole, Wakefield, Doncaster, Hull and Bridlington

	Rec. Retail Price	Comet Price
PIONEER SX770 AM/FM	£160 8 6	£125 19 6
PIONEER SX990 AM/FM	£194 14 8	£149 19 6
TELETON F2000	£51 10 0	£31 19 6
TELETON 7AT 20	£105 0 0	£79 19 6
TELETON 10AT1 150w. RMS	£160 0 0	£109 0 0
TELETON R4200	£51 15 0	£35 19 6
TELETON TFS50	£75 10 0	£55 19 6
TELETON MX990 with Speakers	£67 5 0	£48 19 6
TELETON R.8000 with Speakers	£63 5 0	£49 19 6
TELETON CR55	£120 0 0	£95 0 0
WHARFEDALE 100.1	£131 5 0	£105 0 0

All above Tuner-Amplifiers are complete with MPX stereo decoder, except where starred.

PICKUP ARMS

GOLDRING Lenco L75	£12 6 6	£10 10 0
GOLDRING Lenco L69	£9 5 9	£7 0 0
SME 3009 with S2 shell	£31 6 3	£25 19 6
SME 3012 with S2 shell	£33 7 3	£28 19 6

CARTRIDGES ALL MAKES STOCKED AT DISCOUNT PRICES

DELIVERY BY SECURICOR
WITHIN 72 HOURS

ALL IN-STOCK items delivered by SECURICOR within 72 hrs. (Add 20/- only for Securicor delivery). All goods fully insured against loss or damage whilst in transit.

TURNTABLES

GARRARD SP25, fully wired with Goldring G800 Magnetic cartridge, Complete with base, plinth and Cover. Special price £20 19 6

ARENA SP25, with base and cover	£22 1 0	£17 19 6
DUAL 1219 transcription	£60 8 0	£49 19 6
DUAL 1209 transcription	£42 12 4	£34 19 6
GARRARD SP25 Mk. II	£15 11 4	£10 10 0
GARRARD AP75	£23 16 0	£17 10 0
GARRARD SL55	£13 17 9	£11 12 6
GARRARD SL65 B	£19 6 5	£14 19 6
GARRARD SL75 B	£35 12 4	£27 10 0
GARRARD SL95 B	£45 9 1	£36 10 0
GARRARD 401	£31 14 2	£25 19 6
GARRARD SL72 B	£30 2 0	£24 19 6
GARRARD 3500, with GKS cartridge	£15 15 0	£11 19 6
Base and Cover to fit GARRARD SP25, SL55, SL65B, and 3500	Special Price	£3 19 6
GOLDRING GL69 Mk. II	£26 12 6	£21 10 0
GOLDRING GL69 P Mk. II	£35 2 10	£27 19 6
GOLDRING 70Sp.	£26 0 0	£21 19 6
GOLDRING GL75	£36 8 2	£29 19 6
GOLDRING GL75 P	£46 18 8	£39 19 6
GOLDRING Covers for 69P and 75P	£4 4 3	£3 8 0
GOLDRING GL 75 complete with plinth, cover and G800 E Cartridge	£67 19 0	£53 19 6
GOODMANS 3025	£37 14 9	£25 19 6
McDONALD MP 60	£15 0 0	£10 19 6
McDONALD 610	£18 19 6	£13 19 6
Base to fit McDONALD turntable	£3 13 0	£3 2 6
Cover to fit McDONALD turntable	£2 12 0	£2 2 6
PHILIPS 228	£19 19 6	£16 19 6
PHILIPS GA146	£29 19 6	£24 19 6
PHILIPS 217	£32 0 9	£27 4 0
PHILIPS 202 Electronic	£64 0 0	£54 0 0
PIONEER PL11	£50 17 11	£39 0 0
THORENS TD125	£75 17 8	£61 19 0
THORENS 125AB	£120 3 11	£99 19 6
THORENS 150A Mk. II	£43 12 7	£32 19 6
THORNES 150AB Mk. II	£47 8 7	£40 19 6
THORENS TX11 Cover	£4 2 3	£3 13 6

BASES, PLINTHS AND COVERS STOCKED

SPEAKERS

ARENA HT 27	£18 18 0	£13 19 6
ARENA HT 28	£17 17 0	£12 19 6
ARENA HT 21	£10 10 0	£9 5 0
ARENA HT 7	£19 19 0	£17 0 0
ARENA HT 10	£22 1 0	£18 19 6
ARENA HT 20	£32 11 0	£26 19 6
ARENA HT 26	£78 15 0	£65 19 6
B & W DM3	£63 0 0	£52 19 6
B & W P2H	£94 10 0	£79 0 0
B & W DM1	£32 0 0	£25 10 0
CELESTION Ditton 120	£24 0 0	£18 0 0
CELESTION Ditton 15	£32 0 0	£24 0 0
CELESTION Ditton 25	£65 0 0	£49 0 0
DULCI AS 3	£8 8 0	£6 19 6
GOODMANS MINISTER	£22 9 0	£18 19 6
GOODMANS Majesta	£57 0 0	£44 19 6
GOODMANS Maxim	£20 7 9	£16 15 0
GOODMANS Mezzo II	£30 18 0	£22 19 6
GOODMANS Magnum-K	£40 2 0	£28 19 6
GOODMANS Mirimba	£24 0 1	£18 19 6
GOODMANS Mambo	£22 5 6	£17 19 6
GOODMANS 3005 (pair)	£25 0 0	£18 19 6
KEF Celeste	£29 0 0	£21 10 0
KEF Concord	£43 10 0	£32 19 6
KEF Concerto	£53 10 0	£41 19 6
KEF Cresta	£22 3 4	£17 19 6
LEAK Sandwich	£45 10 0	£32 19 6
LEAK Mini-Sandwich	£29 15 0	£21 19 6
LEAK 300	£29 10 0	£20 19 6
LEAK 200	£23 0 0	£17 19 6
LEAK 600	£45 0 0	£32 19 6
LOWTHER Acousta (with PM6)	£45 10 0	£38 7 6
LOWTHER Acousta (with PM7)	£53 0 0	£45 19 6
LOWTHER Ideal Baffle	£35 10 0	£29 17 6
PHILIPS RH481	£11 0 0	£9 2 6
PHILIPS RH482	£18 0 0	£14 19 6
QUAD Electrostatic	£66 0 0	£52 19 6
SINCLAIR Q16	£8 19 6	£7 19 6
WHARFEDALE Speakers		
Airedale	£69 10 0	£55 19 6
Denton	£19 0 0	£14 19 6
Super Linton	£22 10 0	£18 10 0
Melton	£29 10 0	£22 19 6
Dovedale 3	£39 10 0	£29 19 6
Rosedale	£59 10 0	£46 19 6
Triton (pair)	£55 0 0	£42 19 6
Unit 3 Speaker Kit	£11 19 6	£9 10 0
Unit 4 Speaker Kit	£16 0 0	£12 10 0
Unit 5 Speaker Kit	£23 10 0	£17 19 6

LARGE RANGE OF CHASSIS SPEAKERS AVAILABLE. PLEASE SEND FOR DETAILS.

HI-FI STEREO TAPE DECKS & TAPE RECORDERS

AKAI X200D	£190 0 0	£159 19 6
AKAI 1800SD	£199 8 4	£167 0 0
AKAI 4000 4-track Stereo	£124 18 0	£99 19 6
AKAI 4000 D 4-track Stereo deck	£89 19 1	£69 19 6
AKAI 1710L 4-track Stereo	£89 17 0	£69 19 6
FERGUSON 3246	£43 0 0	£33 19 6
FERROGRAPH 722	£242 10 9	£202 0 0
FERROGRAPH 724	£242 10 9	£202 0 0
GRUNDIG TK 121 (Twin-track)	£54 15 7	£43 19 6
GRUNDIG TK 149 4-track	£57 12 8	£47 19 6
PHILIPS 4500 4-track Stereo Tape Deck	£126 0 0	£98 19 6
PHILIPS 4408 4-track Stereo	£139 0 0	£109 0 0
TOSHIBA GT 840 S	£110 0 0	£79 19 6
TOSHIBA GT 601v Twin Track	£45 3 0	£29 19 0
TOSHIBA 850 SA	£94 0 0	£59 19 6

COMET Hi-Fi DISCOUNT WAREHOUSES

Dept.SS Reservoir Road, Clough Road, Hull HU6 7QD. Tel. 407906 and 407877

Customers are welcome to call personally.

or Dept.SS 68A Armley Rd. (Artist St.) Leeds LS12 2EF. Tel. 32055 (5 lines)

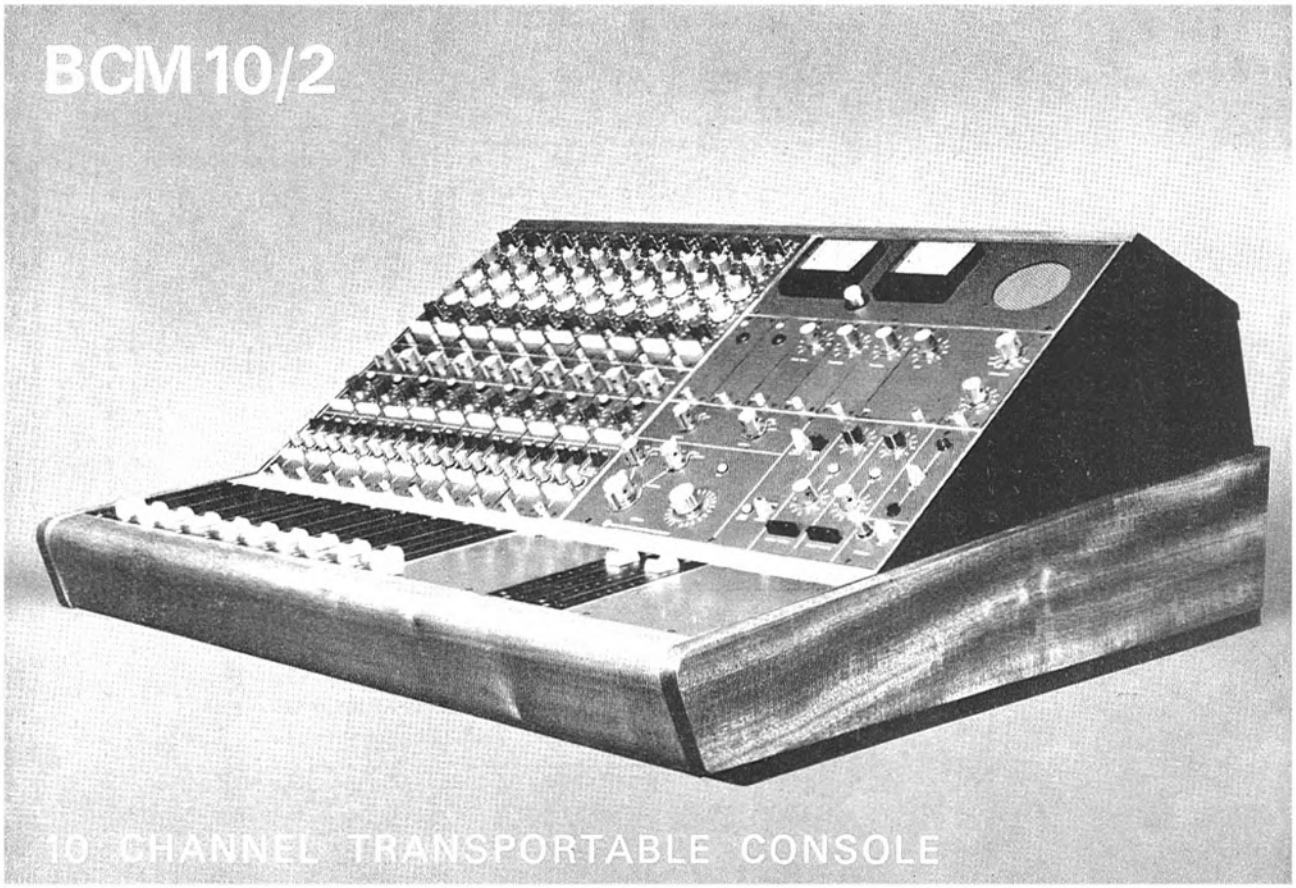
(Service Dept., New Road Side, Horsforth, Leeds)

Ample Car Parking facilities

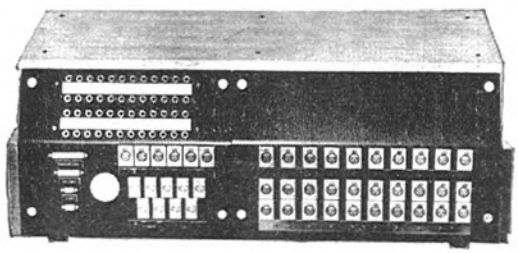
Comet guarantees that all prices quoted are genuine. All items offered available at these prices at the time this issue closed for press. Add 9/- for post, packing and insurance on all orders (Cartridges 4/-) **or, if Securicor delivery required, add 20/- only.** Make cheques, Money Orders payable to "COMET".

Neve

SOUND
CONTROL
EQUIPMENT



New compact versatile design by Neve styled to the needs of modern studios



The Neve BCM 10/2 marks a new departure into the field of sophisticated audio control. It embodies ten full mixing input channels and two output groups and is conveniently transportable.

Facilities are included for echo, studio foldback and talkback communication, stereo monitoring, cueing and D.J. "combo" working.

All signal inputs and outputs are on XLR connectors at the rear.

Thus the BCM 10/2 provides for every possible requirement within its class. It is competitively priced and available for quick delivery. Full specifications will be sent gladly on request.

Telephone 076 386 776 (Ten lines) Telex 81381

Rupert Neve & Co. Ltd. Cambridge House, Melbourn, Royston, Herts, England.