

DECEMBER 1968 2/6d

# tape recorder

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SURVEY OF TAPE  
TO DISC STUDIOS

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TANDBERG 7 SERVICING

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A VISIT TO  
LEEVERS-RICH

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RECORDING OUTDOORS

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GRUNDIG TK2200  
AND C200 REVIEWS

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ANNUAL INDEX

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REPORT ON THE  
NORTHERN AUDIO FAIR

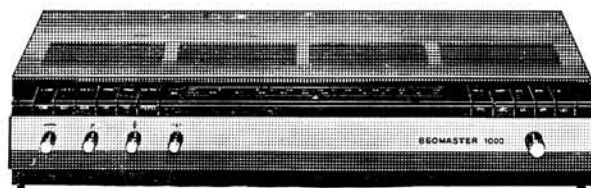
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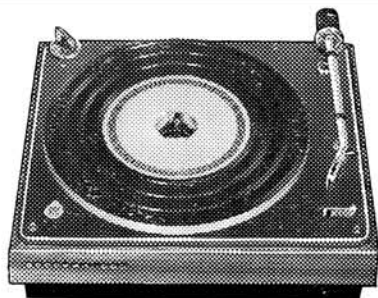


# Bang & Olufsen— for those who consider design and quality before price

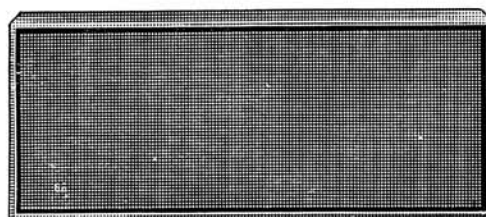
Bang & Olufsen audio equipment is made for those who consider design and quality first. There is a wide range of radios, record players, amplifiers, loudspeakers and radiograms, all designed to give unprecedented pleasure to ear and eye. Your B & O dealer will advise you how to start a system that will give you enjoyment for the years ahead. Here is just one selection.



BEOMASTER 1000



BEOGRAM 1000



BEOVOX 2400

**BEOMASTER 1000** The complete audio spectrum is reproduced naturally and faithfully by the Beomaster 1000. Truly magnificent to look at, this stereo FM radio/amplifier is available in teak or rosewood finish. The front panel is worked in stainless steel with piano-key selector switches. The long, low-line cabinet lies elegantly along your bookshelf—the centre-piece of an advanced high-fidelity music system. Technically superb, giving 15 watts

audio output per stereo channel, the Beomaster 1000 allows instant choice between radio, tape recorder, gramophone and two separate sets of stereophonic loudspeaker systems. There are individual bass, treble, and stereo balance controls, plus 'scratch' and 'rumble' filters. A B&O stereo decoder is fitted for reception of stereo broadcasts, and the illuminated radio dial has flywheel tuning. Price £99. 5. Od.\*

**BEOGRAM 1000** A stereo turntable unit mounted on a suspended shock-proof plinth and featuring the world famous ST/L 15° tone arm, hydraulic lowering device and SP7 diamond stylus. Specially engineered speed selector with vernier adjustment. Available in teak or rosewood finish. Price £40. 15. Od.\*

**BEOVOX 2400** The Beovox 2400 is a high fidelity wall mounting or bookshelf speaker, to DIN standard, with one bass, one mid range and one tweeter unit (9½" x 23½" x 10⅞"). The neat simple lines contain the acknowledged skill and craftsmanship of this world famous Danish range, that will add exceptional tonal quality to your audio system. Available in teak or rosewood finish. Price £33. 0. Od.\*

\*Recommended retail price

Fully descriptive literature is available from your B & O dealer or direct from  
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Every make and model of Tape Recorder and Hi-Fi Unit is available for immediate demonstration by our specialist staff who will be delighted to assist you in selecting equipment to suit your individual requirements. Only from NuSound can you benefit from all these invaluable features—the most comprehensive range of equipment on display in the country, expert staff, free technical advice, immediate demonstration of any model and the finest after-sales servicing available.

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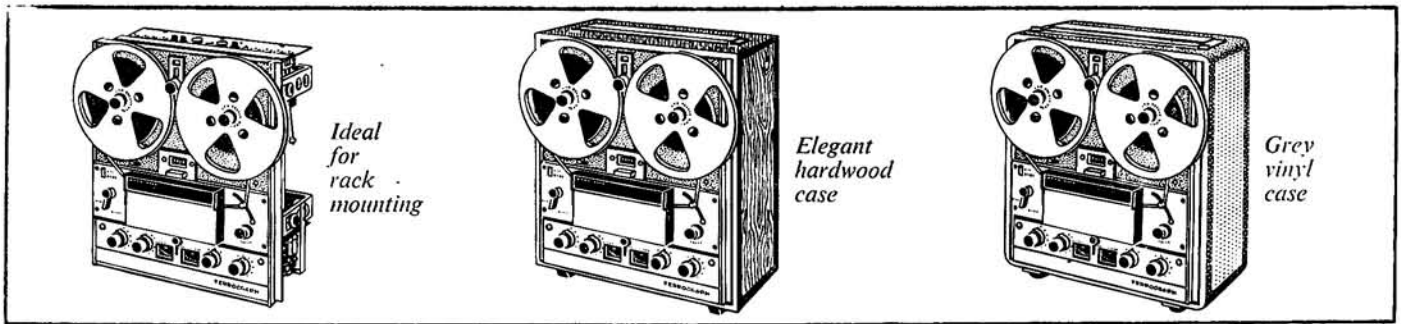
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& HI-FI  
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# Ferroglyph New Generation Series 7-







# not a year old and already a classic

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

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

Available in Mono, and in Stereo with and without end amplifiers; embodying a unique range of 30 features including:

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

U.K. Retail prices from £135 incl. P.T. Please see next page for list of Ferrograph Stockists



# FERROGRAPH

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

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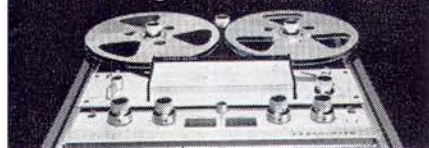
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# FERROGRAPH

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Ferrograph New Generation Series 7

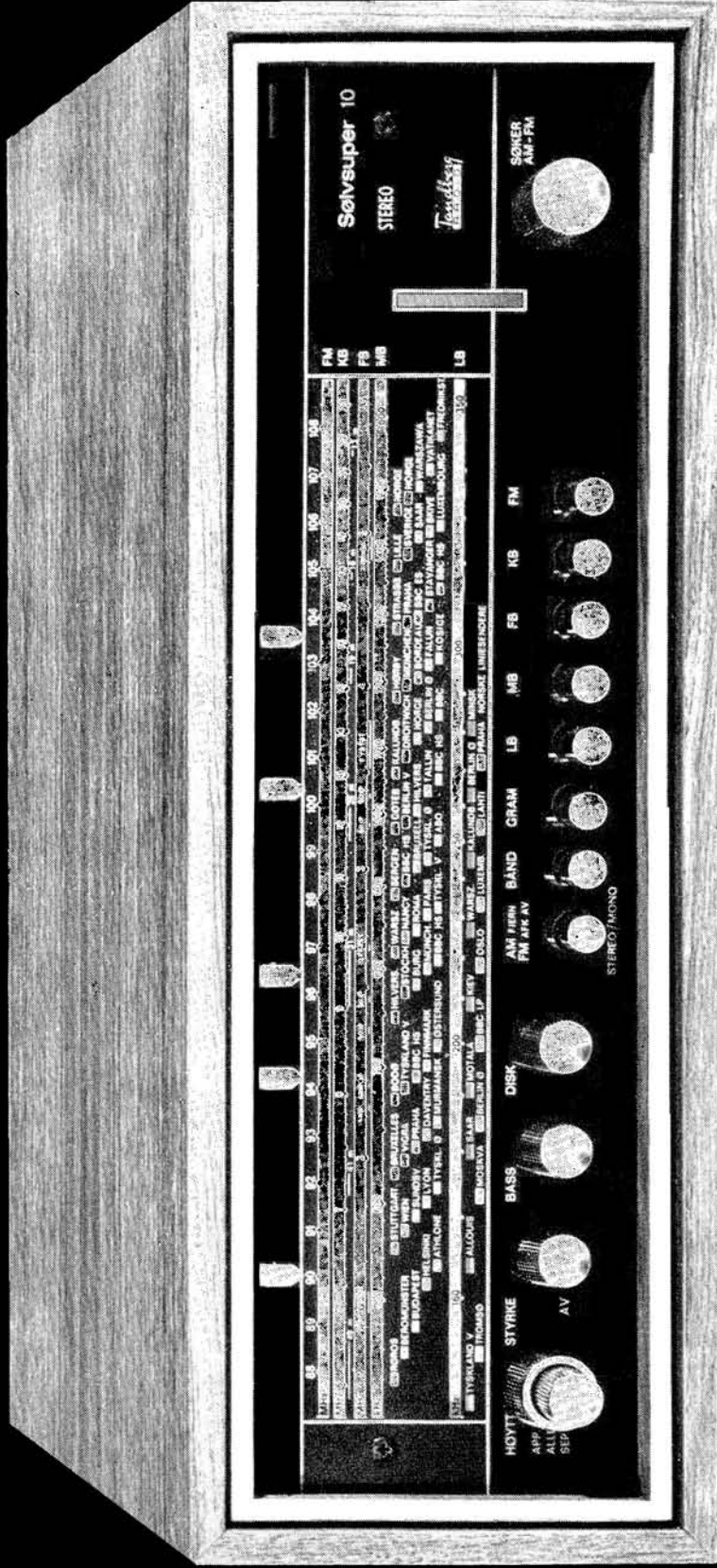
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the tape recorder with  
the hearing-is-believing sound





# New from Tandberg



## Solvsuper 10.71 combined FM/AM Tuner and Stereo Amplifier

It's all there. Everything the heart of your Hi-Fi system should have. A 12 watt stereo amplifier. An exceptional FM/AM tuner with provision for a stereo reception decoder. Combined in an elegant low line teak case.

The Solvsuper 10.71 incorporates these features:—

- ★ 5 wavebands; long, medium, short, coastal and FM.
- ★ Automatic frequency control on FM.

- ★ Push button selection of wavebands, or external gramophone tape recorder etc.
- ★ Separate bass and treble controls.
- ★ Adjustable FM station indicators.
- ★ Separate gain controls on each channel.
- ★ Electronic beam tuning indicator.
- ★ 2 x 6 watts output.
- ★ 15" long x 9" wide x 5 1/4" high.
- ★ £65.0.0.

The Solvsuper is also available in two other versions:—  
10.70 with a single built in speaker (mono)  
10.72 with two built in speakers (stereo)

Elstone Electronics Limited,  
Hereford House,  
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*move up to*  
**Tandberg**



# HI-FI in the Home

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

This fully illustrated book has been written for the music lover who wants to understand how to achieve the best possible domestic sound quality.

Technicalities are clearly explained and terms defined throughout the text. It deals very satisfyingly with its subject, through musical sounds, components, choosing equipment, installation, care of records, to future developments. There is a comprehensive glossary, bibliography and index.

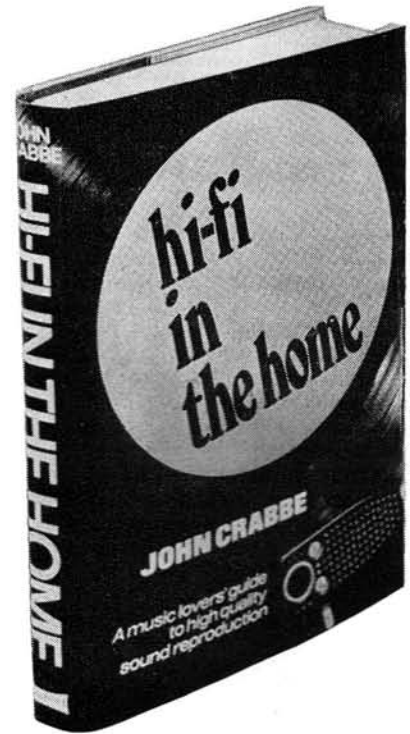
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brings you the  
**Swinging Sound  
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### MP613 MALAR

Stereo Tape Recorder—4-track, 3-speed. Frequency response: 7½ i.p.s. 50—19,000 c/s. 3½ i.p.s. 50—12,000 c/s. 1½ i.p.s. 80—6,000 c/s. Output 4 watts mono, 2 x 2 watts stereo. Automatic stop, three position speaker switch. Dual volume control. Four push buttons: recording (special lock prevents erasing) radio, gramophone and microphone. Three position channel selector. High speed rewind. Instant stop. Pause control. Built-in four-channel mixer, multi playback, synchro playback. Combination head, fine laminated Fe-Ni-core, range 50 dB. Max. 7" reel. Available in teak or rosewood with transparent dust cover. Size 15½" x 12½" x 7".



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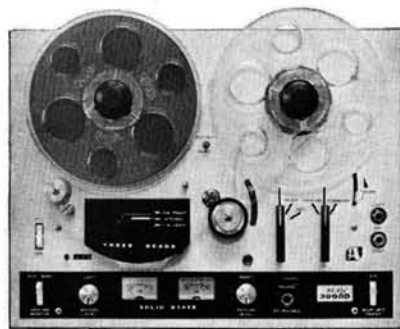
I710W

**AKAI M9 High Fidelity Stereo Tape Recorder (right) Cross-field Head. All Silicon Transistor Amplifier. 4-track stereo/monaural recording and playback. 3 speeds (1½, 3½ and 7½ ips) plus 15 ips with 15 ips adaptor kit. Hysteresis synchronous 2-speed motor. Wide Cross-field frequency response. All silicon transistor amplifier. Sound on sound. Automatic shut off, Automatic stop. Automatic pinch wheel release. Automatic lever release. Recording mode switch. Bass switch. Tape shifter in fast forward rewind operation. DIN jack, stereo headphone jacks. Four digit index counter with reset button, VU meters. Finely oil-finished wooden cabinet or vinyl leather wooden cabinet. £195—PLUS—SENSATIONAL OFFER to every purchaser of the M9, a FREE pair of Wharfedale Super Lynton Speakers currently valued at no less than £41 4s. 0d.!**



M9

**AKAI I710W Stereo Tape Recorder (left) The Shield Type Head for High S/N Ratio. 4-track stereo/monaural recording and playback. 3 speeds (1½, 3½ and 7½ ips (15ips optional)). Automatic shut off. Pause lever. Tape cleaner. Tape shifter in fast forward/rewind operation. 4 hours maximum stereo recording capacity with a 1,200ft. tape. DIN jack, Stereo headphone jack. 3-digit index counter with reset button. VU meters. Finely oil-finished wooden cabinet. £109—PLUS—SPECIAL OFFER with each machine—FREE ACCESSORY KIT (value £12 18s.) PLUS FREE pair of Stereo Headphones value £6 10s.**



3000D

**AKAI 3000D 4-track Stereo Tape Deck (left) High Quality Three Heads System. 4-track stereo/monaural recording and playback. For playback, the 3000D requires external power amplifier and speakers. 2 speeds (3½ and 7½ ips). Three heads (erase, recording and playback heads). All silicon transistor pre-amplifier. Automatic shut off, pause lever. Tape cleaner. DIN jack. Stereo headphones jack. 3-digit index counter with reset button. VU meters. Beautifully grained wooden cabinet. £99 10s. PLUS—SPECIAL OFFER with every deck FREE pair of Stereo Headphones listed at £6 10s. PLUS FREE COVER—PLUS TWO FREE MICROPHONES listed at 6 gns.**



X300

**AKAI X-300. 10½ in. Reel Studio Type Stereo Tape Recorder (right) (No Belts... Direct Driven Capstan). Crossfield Head. Solid State Amplifier. 4-track stereo/monaural recording and playback. 2 speeds (3½, 7½ and 15 ips optional). 4-heads (erase, recording, playback/monitor plus bias heads), 3 outer-rotor motors (Hysteresis synchronous 2-speed motor for direct driven capstan, two torque motors for fast forward and rewind). 50 watts solid state amplifier. Unitized amplifier circuit cards. Sound over sound. Automatic stop, Automatic shut off. Specially 90kc biased for recording of FM multiplex. Reel accommodation up to 10½ in. Piano key controls. Tape cleaner. 4-digit index counter with reset button. List price £263.18.3. OUR PRICE only 179 gns.!**

All these superb machines available on INTEREST FREE TERMS, one quarter of cash price deposit, balance over 12 months.



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## Look what HEATHKIT offer in High-Fidelity sound

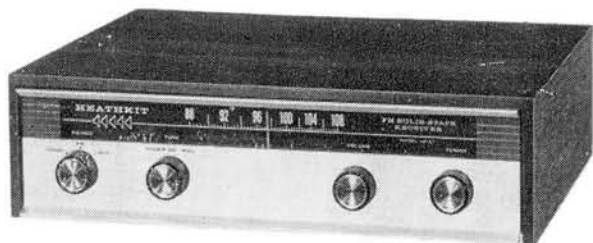
Top Value in a 30 watt FM Stereo Receiver, AR-14



A 31 transistor, 10 diode circuit for cool instant operation. Wide frequency coverage at 10 watts output per channel, continuous 15 watts per channel IHF music power. Wide band FM/FM stereo tuner plus the pre amplifiers and two power amplifiers. All at a low budget-saving price.

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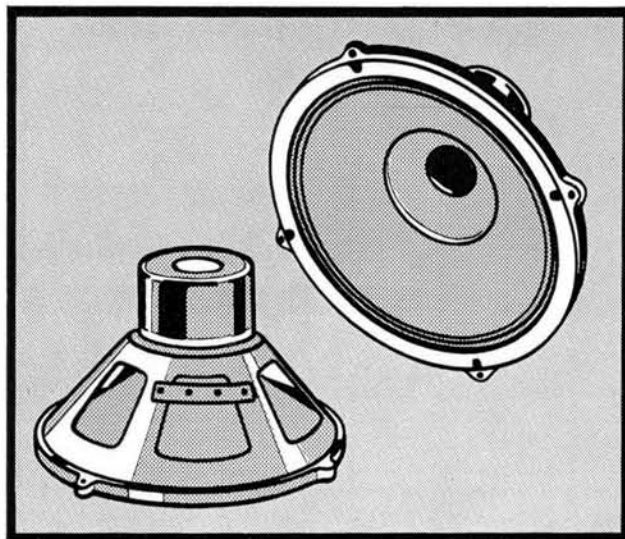
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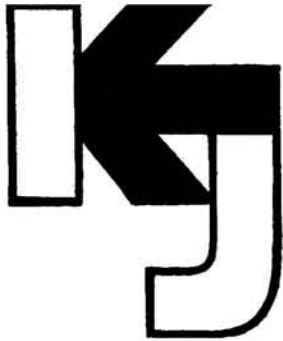
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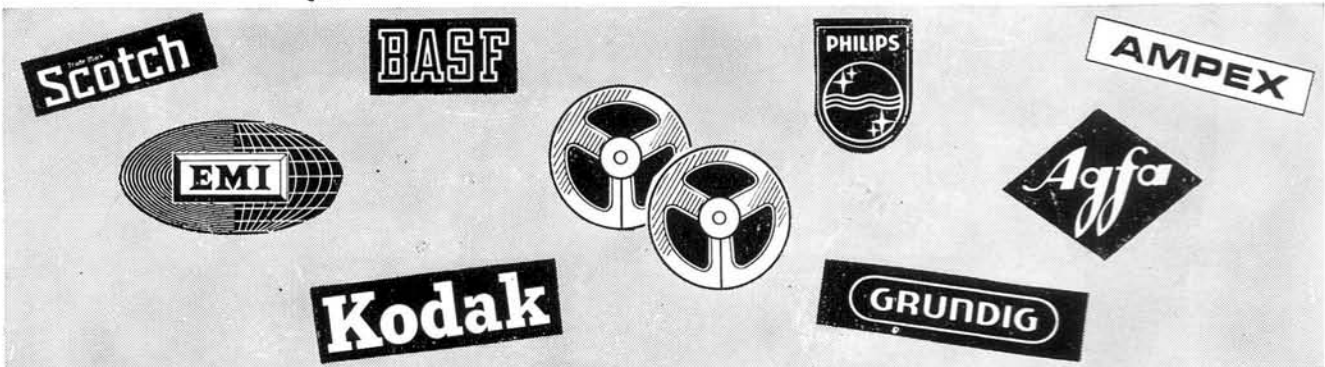
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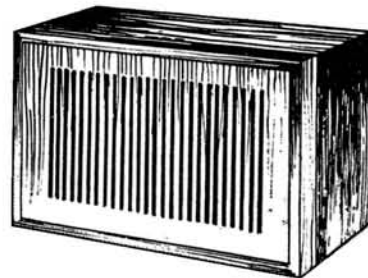
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# CHILTON

## DESIGN NOTES (Number 1)

By Tom Reps (Magnetic Tapes Ltd.)

### Why a single motor?

There is no reason why the performance of a single motor recorder cannot equal, if not exceed, that of a three motor design—provided the spool capacity is kept within eighteen centimetres. The rewind although slower can be made neater, and the tension matched to that of the record/play mode, ensuring more accurate operation of the tape position indicator. Generally the rewind speed is effectively reduced by half, by gearing down the motor drive to the relevant spool. This, however, doubles the effective motor power, enabling back tension to be applied to the feed spool, resulting in a matched spooling tension.

Heat dissipation, which is an important factor in the design of any tape recorder, is obviously improved by the use of one motor. Further, the motor supply is reduced in the record/play mode to limit motor temperature rise and, incidentally, reduce flutter.

On fast wind the motor is switched to full power, giving high acceleration, even in maximum drag conditions. One of the major drawbacks of a single motor tape mechanism has been the more complicated linkage and drive systems required to effect the necessary modes of operation—fast wind, record/play, etc.

The Chilton 100S has overcome this problem by using four solenoids, operating directly on the relevant mechanism, avoiding superfluous linkages and enabling the push button mechanism to be feather light. As the solenoids are operated at a low voltage DC, and are diode suppressed, they have proved to be trouble free. Normally with three motor mechanisms employing reverse torque on the feed spool, the back tension increases towards the end of the reel, even with constant torque motors. The Chilton 100S employs a constant back tensioning system which, together with tensioned rollers, not only maintains the low flutter towards the end of the spool, but enables smooth rewind to be achieved at all times. This feature was remarked upon many times by visitors at this year's Northern Audio Fair.

In conclusion, using one motor (Papst) reduces the weight, the cost and the heat dissipation. To ensure the utmost reliability, Polyurethane is used in preference to rubber where necessary.

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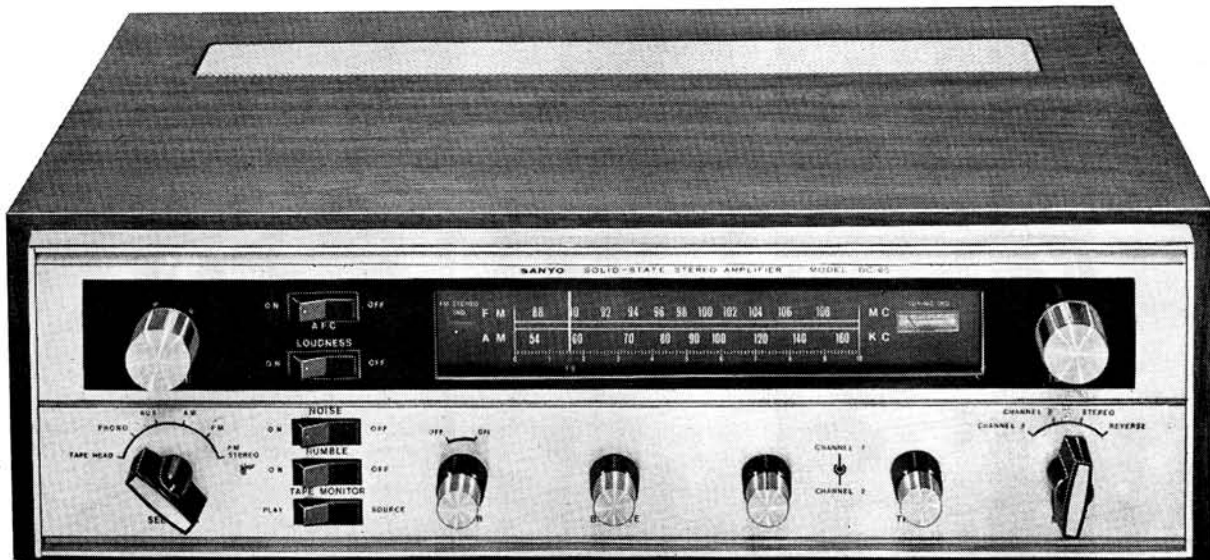
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Model 3232

## **LOOK! a Ferguson stereo recorder with track transfer and 2nd channel monitoring.**

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- Twin all transistor amplifiers • 3 speeds, 7" spools play up to 17 hours on double play tape (mono) • Automatic end of tape stops • Clutched dual concentric controls • Input mixing facilities • Latching pause control • Calibrated meter record indicators • Monitoring while recording on built-in speakers • Track transfer on mono • Second channel monitoring • Comprehensive input and output sockets • Suitable extension loudspeaker available • Supplied complete with two dynamic microphones, reel of tape (1200'), take-up spool and connecting leads.

Model 3232-**£91.13s.**

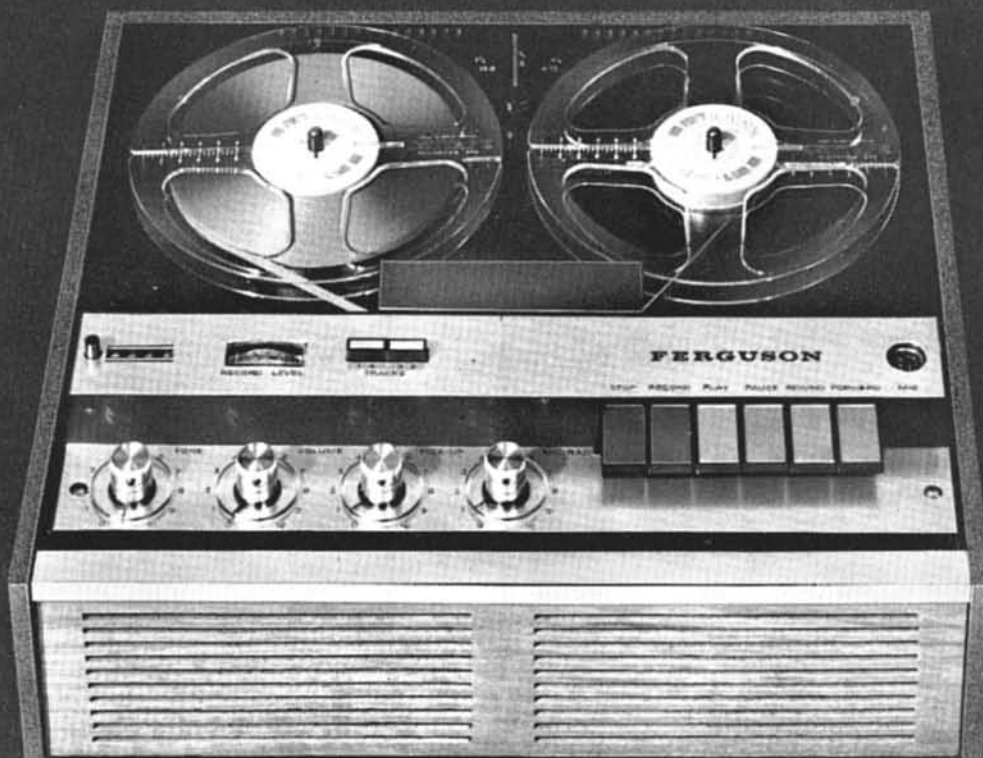
## **LOOK! a Ferguson mono tape recorder with 3 speeds and input mixing.**

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Model 3238

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Model 3238—£58.11s.

A wide range of accessories are available for all Ferguson Tape Recorders.

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Model 3236 **£26.14s.**

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- Dynamic microphone with remote stop/start control.
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## COVER PICTURE

A new generation of studio recorders, the *R Series*, is now being developed by Leever-Rich. The eight-channel *R165* is claimed to be the most advanced multi-track audio recorder ever conceived and will be followed ultimately by a 16-channel version.

## SUBSCRIPTION RATES

Annual subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 36s. and 47s. respectively. Overseas subscriptions are 38s. 6d. (U.S.A. \$4.60) for *Tape Recorder* and 48s. 6d. (U.S.A. \$5.80) for *Hi-Fi News*, from Link House Publications Ltd., Dingwall Avenue, Croydon, CR9 2TA.

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

WHO WANTS to make a disc, and why? Two questions raised in the course of preparing our survey of private tape-to-disc studios (page 584). The answer, perhaps, is reflected in the occasional reader's letter querying the lifetime of tape recorded programmes. Few tape recordists can be persuaded to commit themselves to a definite 'they should last forever' and we ourselves would only quote a vague 'indefinitely'. Perhaps the tape manufacturers have calculated the theoretical life of a magnetic recording, but they appear never to have published the results. We must turn to the BBC archives, therefore, where we learn that steel tape Blattner Stille recordings made in the nineteen thirties are still up to their original standard. Common-sense suggests that print-through will accumulate in any spooled magnetic recording stored over a period of centuries, and this has yet to be disproved in fact or published in theory. Gradual erasure, or spreading, and the mechanical deterioration of base and coating materials during storage and in use all imply that tape recordings have a limited lifetime, but the yardstick is one of centuries.

It is interesting to note the quality of one's own early recordings against the quality obtainable on today's equipment. The further back one goes in time, the poorer is the sound quality. This phenomenon is obviously due to the gradual accumulation of experience in recording, and to the improved performance of modern tape and recorders. It is easily misinterpreted, however, as proof of magnetic decay! The attraction of gramophone records is the apparent permanence of a plastic moulding compared with a tenuous magnetic pattern. In terms of long-term storage, this may be a reasonable opinion. But being a purely mechanical recording medium, disc quality is directly related to physical wear and such wear is inevitable even with the lightest and finest of pickups. A really good pickup on a well-designed arm may cause negligible wear to a decent pressing, yet only the keenest audio enthusiast will meet the cost of such equipment.

Precisely how a direct-cut lacquer disc behaves when tracked by a very good pickup is debatable and must depend greatly on the disc material and the competence of the cutting engineer. It seems reasonable to assume that wear will be greater than in the case of a good vinyl pressing. Under less well controlled circumstances, reproducing a one-off disc with a poorly made gramophone, the record groove can literally be chewed of its lacquered plate. We must not overlook, of course, the application of private discs in communication between families overseas; gramophones still outnumber tape recorders by a substantial ratio. Far from gaining a secure long-term storage medium, private disc owners are really obliged to keep their master tapes in case the 'permanent' copy should wear or be damaged.

This issue of *Tape Recorder*, the largest we have ever published, celebrates the end of our tenth year. An eventful year, during which editorial pens have stretched to Japan (*Akai* and *Sony* visits in February and March), Czechoslovakia (*Tesla* in April), Norway (*Tandberg* in May) and finally home to *Leever-Rich* (page 592). We have published fourteen commercial tape recorder circuits, 13 constructional articles and reviewed 13 tape recorders. Including field trials and tests of minor items, we have produced a total of 43 reviews this year, most of them detailed and all of them honest.

Even the April budget did not prevent a boom in demand for recording equipment, so far as we can gauge from increased advertising support and a steadily rising circulation. Perhaps we should take this opportunity to thank the 46 contributors to Volume Ten for their efforts, and also our readers for their enthusiasm. Perhaps we should also wish everyone an enjoyable Christmas holiday but, December issue or not, there is still another month to go.

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#### AAU TELEVISION ADAPTOR

**C**HOOSING and wiring an isolating transformer to domestic television receivers, for the purpose of recording the sound programme, has long presented problems to tape recordists. The need for a fool-proof matching unit has been met by the *MAC Electronic Company, Villacousta, Portsmouth Road, Ripley, Surrey*, with the £7 7s. *AAU-TV*. Fitted with a satin chrome fascia, the 8.3 x 8.3 x 9 cm unit may be mounted in the receiver cabinet if so desired. A three-position switch provides the following distribution of loudspeaker signals: *internal on with external off, internal off with external on, and internal plus external on*. A pre-set attenuator is incorporated in the external socket, facilities for loudspeaker impedance matching being provided by a three-way plug at the rear. A plug-in steep cut filter is available as an optional extra to overcome any difficulties experienced with the 10 kHz line whistle. The unit is supplied complete with standard jack plug, miniature plug and socket, and wiring data.

#### NEW HEATHKIT CATALOGUE

**M**ORE than 250 audio, radio and educational products are listed in the 1968/69 Heathkit Catalogue, now available on request from *Daystrom Ltd., Gloucester*. A stereo tape recorder based on the 19/9.5/4.75 cm/s BSR *TD10* deck is included, costing £72 assembled or £58 in kit form (with purchase tax).



#### BRITIMPEX MOVE

**B**BRITIMPEX Ltd., importers of semi-conductors, valves, lamps and other electric components, are now occupying larger premises near the Earls Court exhibition hall. The new address is *8-12 Rickett Street, London S.W.6*. (Telephone 01-385 0883 and 1007.)

#### IEE EVENING LECTURES

**C**OLOUR Television, Educational Aids, and Radio and Sound Reproduction—three lectures in the IEE calendar for November. P. I. Nicholson will discourse upon colour television at the Engineering Lecture Theatre, University of Sheffield, on Thursday November 14. Educational Aids will be covered by R. C. Winton of Mullard Ltd. at the Large Engineering Lecture Theatre, Queens Building, University of Bristol, on Tuesday November 19. On Wednesday November 27, R. L. West will

cover Radio and Sound Reproduction in Lecture Room CG91, University of Durham. Further details are available from *E. A. Bromfield, Secretary, The Institution of Electrical and Electronics Technician Engineers, 2 Savoy Hill, London, W.C.2*. (Telephone: 01-836 3357.)

#### AUDIO EQUIPMENT AT DESIGN CENTRE

**T**TRUVOX, Reslo and the British Radio Corporation are among contributors to a display of sound reproducing equipment now being held by the Council of Industrial Design. Acoustical, Richard Allan, Armstrong, BSR, Garrard, Goodmans, Jordan Watts, Wharfedale, Rogers, Rola, SME and Tripletone complete the list, their products being on show at *The Design Centre, 28 Haymarket, London S.W.1*, until November 16.

#### AN AUDIO REPORT FROM OCCUPIED PRAGUE

**O**N August 21, when the foreign military units came to Prague, they first occupied the most important buildings in the city, driving out the staff. In spite of losing all broadcasting media, the personnel of Radio Prague were ready to operate substitute equipment almost immediately. Several underground studios were prepared, interconnected with an old emergency transmitter by way of telephone lines. Then the first announcements were made from various spots directly into telephones after dialling the appropriate number.

Only later were magnetic tapes applied but even this was not without problems. It appeared that the only available tape recorder had been shot through, though fortunately its mechanical system was undamaged. The amplifier inside was completely destroyed but was replaced with a new one in minutes by amateur assistants.

A number of Prague enthusiasts, who in the past had designed and built their own gramophones, mixers, etc., having no other sources, found their equipment being used for the purposes of official state broadcasting. The microphones that sometimes made the voices of popular radio announcers unrecognisable also belonged to amateurs. At such a time, of course, high fidelity was by no means essential. Similarly some old and very worn gramophone records which had rested for years on home shelves were unexpectedly put on turntables and played to the nation, making the pauses between news items more bearable.

This activity, though carried out with courage and devotion, did not satisfy the amateur participants very much; they knew their audio ambitions would be stifled, to say nothing of other troubles. It is the heart-felt desire of all Czechoslovak audio enthusiasts that the strained conditions in their homeland will soon be relieved.

#### FIRST INTERNATIONAL ELECTRONIC MUSIC COMPETITION

**O**. W. Wilson (USA) has been judged winner of the world's first international electronic music competition. The contest was organised by the Department of Music at Dartmouth College, New Hampshire, and the



winning recordings by Mr. Wilson and five finalists are being released by *Vox* this autumn. The finalists were Pril Smiley (USA), Josef Malovec (Czechoslovakia), Eugeniusz Rudnik (Poland), William Hellermann (USA), and Bohdan Mazurek (Poland).

A second competition for an outstanding composition of electronic music will be held in the spring of 1969. Copies of the rules may be obtained from *Jon H. Appleton, Director, Electronic Music Studio, Dartmouth College, Hanover, New Hampshire 03755, USA*.

#### FERROGRAPH APPOINT TECHNICAL CONSULTANT

**M**R. H. Davies, former Head of Sound Group in the BBC Engineering Designs Department, has joined the Board of the Ferrograph Company. His position will be that of Technical Consultant.

#### ITN ORDER ELCOM

**A**N order for 24-channel mixing consoles, transmission desks and 12-channel film dubbing units has been placed by Independent Television News. The equipment employs plug-in modules from the new Elcom 50 V rail range and is styled by Ware-Macgregor.

#### AUDIO DIARY 1969

**S**IXTY-EIGHT pages of audio, electronics and sound recording data are offered in the 1969 Audio Diary, now available at 8s. 6d. including post and packing from *Link House Publications, Dingwall Avenue, Croydon CR9 2TA*. The data section is divided into four categories entitled "Hi-Fi Information", "Tape Recording", "Audio Reference Data" and "Music, Acoustics and Hearing". Tape playing times, track positions and equalisation are included under "Tape Recording". A two-pages-per week personal section, five address pages and a full colour Underground map complete the diary.

#### NEXT MONTH

**FRITJOF BRODTKORB** analyses the Tandberg cross-field bias system in the January issue, appearing on December 14, while **Alec Tutchings** reviews the (conventionally biased) Tandberg 11 professional portable. For constructors, **John Fisher** contributes a tone-source and line-up meter and **L. Hayward** describes a method of producing 'phasing' effects on popular music.

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# tape recordings on trial

THE story of a criminal trial is always fascinating; especially when the public as a whole are affected. *R v Ali and Hussain* (1965) is a case in point, not only for its unusual features but because it seemed to create a licence to invade privacy. It was an appeal against a conviction of murder and during the judgement the Court expressly stated that a tape recording could be admissible evidence. This gave rise to the general impression that a wave of prosecutions would follow based solely upon recorded conversations which had been secretly obtained. There was an even greater fear that such recordings would be edited to provide the most damning evidence against the accused.

Over three years have passed since this case was decided and hardly any use has been made of this particular piece of law, so it is worth examining why the threat was never realised.

## COMMON SENSE

In the first place the Court was only stating what was common sense. It would have been idle to pretend that tape recorders did not exist, or that the machine was not capable of reproducing an accurate rendering of what it had recorded. Counsel for the accused recognised this, and never attempted to argue that tape recordings were inadmissible evidence as such, but only that the particular recordings were inadmissible. In order to clarify the law the Court asked to hear arguments relating to tape recording generally; then, having heard the arguments, decided that "it would be wrong to deny to the law of evidence advantages to be gained by new techniques and new devices, provided the accuracy of the recording could be proved and provided the evidence is relevant and otherwise admissible." The Court added that this did not mean all such recordings are admissible whatever the circumstances of the case. In other words, you can use a tape recording as evidence provided it complies with the rules of evidence.

In fact the case added little to the law of evidence that was not there before. As far

back as 1927 the issue arose as to whether a recording, in that case a dictaphone, could be used as evidence; then again in 1954, 1956, 1960 and 1962, so it was hardly a new problem. In every instance the argument centred around the admissibility of a particular recording as it did in the *Ali and Hussain* case, and not recordings in general because no one denied that a recording had been made.

## WHY PRESENTED

Evidence is the means whereby facts are proved. It is not proof of a fact itself, it is the foundation of the proof. So, when evidence is presented to the court, not only will a lot depend upon why it is being presented but also upon how much weight or importance can be given to it. A tape recording is certainly evidence of a recording having been made but it is not necessarily evidence of the truth of what has been recorded. It might be completely irrelevant.

The rules of the law of evidence are formidably numerous and complex. They have grown up over the years to prevent the indiscriminate use of irrelevant evidence. It has also been said that they are based upon the fact that all witnesses are liars and all juries stupid which leads to the result that a great deal of evidence is excluded. Much argument would centre round whether the recording was relevant; relevant, that is, to the facts in issue, and not put in merely to support a proposition. And then there would be further argument as to whether the recording was hearsay. The hearsay rule says, broadly, that all evidence not directly perceived by a witness is barred unless it can be brought in as one of the exceptions to the rule. This would rather cut down the field in which the recorded evidence could be of vital importance to a case to that of "admissions against interest", in short confessions.

Confessions are subject to the most stringent examination before they can be used "in evidence". They must be proved to have been made freely and voluntarily. In the case of a

recording, as in the case of a written statement, it must also be proved to have been made by the accused. There was some speculation in 1927 as a consequence of this last requirement, that a host of voice experts would come into being to swear to the identification of a voice. So far the Courts have been spared this creature.

Having passed all the hurdles of the law of evidence, that is not the end of the matter; it is only the beginning. One of the over-riding principles of English law is that every man is presumed innocent until he has been proved guilty. And that proof must be beyond reasonable doubt. Further, the jury, a body of ordinary men and women are the final arbiters of whether the prosecution have proved the guilt of the accused. It is not the Judge, or the lawyers, or any paid official who decides if a man is guilty, but the jury; they and they alone make the decision.

All juries today are familiar with tape recorders. They will be aware either from their own knowledge, or made aware by the defence, of the possibility of a tape recording having been tampered with, or completely fabricated. No jury is going to listen to a recording of a voice on a machine without some reservations in their minds of a degree of distortion of the truth or some basic unfairness about the presentation of mechanical evidence, especially if that should be the only evidence. They will decide just how much weight such evidence will carry, and if they decide it cannot carry much weight having regard to all the circumstances of how the recording came into existence, then they will pay little attention.

## HOTLY CONTESTED

Regularly in the Courts the police give evidence that they were present when an accused voluntarily wrote out, and signed a confession. Yet these confessions, which the accused admits are in his own handwriting, are hotly contested by him, often very successfully. Little imagination is needed to appreciate the fate of a tape recording in similar circumstances.



## TANDBERG SERIES 7

BY H. W. HELLYER

OUR circuit this month is of the Tandberg 74B, and is the later version, with serial numbers above 715001. Comparing it with the Series 6 range, which occupied our attention last month, we note a number of significant differences, and a general similarity of circuit design that will enable us to dispense with a great deal of discussion of circuit detail and concentrate more upon the mechanism.

Fortunately for our claim upon editorial space, we can kill both birds with this single stone, for the rudimentary factors of mechanical construction are the same, and are, indeed, carried through later versions of Tandberg tape recorders—a sure sign of a good quality approach. Freed from the need to bedazzle a fickle consumers' market with a change of model several times a season, the best manufacturers concentrate on gilding an already pretty perfect lily. Witness our own Ferrograph and Willi Studer's veteran Revox, who have only this year departed from well-tryed basic designs. (Which is not to say that no evolution

has taken place within the familiar packages.)

Some of this evolution has centred around transistors. But while clinging to 'traditional' valved circuits and hesitating to take the plunge fully into solid-state circuitry until the Model 12, Tandberg, in common with many other leading makers, used the transistor for its special qualities rather than as a sop to modernity. The result was a single semiconductor stage in the Series 7, the first part of the two-stage playback preamplifier.

Because the signal being handled is extremely low at this point of a tape recorder circuit, the problem of noise eradication, particularly of eliminating hum, means that playback preamplifiers have to be very carefully designed. The use of DC heating for valves, low HT coupled with high stability components and careful layout, are all tricks that we have seen employed to get maximum signal gain without hum and noise, and the transistor, particularly the silicon transistor, provided the answer to the very delicate low-signal preamplifier stage. In fig. 1 quite conventional methods are employed, though they may seem unfamiliar at first inspection.

A *p-n-p* transistor is used, with the emitter connected to a potentiometer tap on the main 170 V HT line, to make it a few volts positive to the collector. The style of presentation shows this stage in a conventional 'signal' mode, i.e., apparently upside-down. This is a cross that we old-timers, suckled on valve circuitry, have to bear. The youngsters take valves and transistors in their stride, with an enviable equanimity. At a recent lecture, when I attempted to illustrate a 'signal chain' argument with the example of valve amplification, one bright star piped up with a question: "What is the parallel to hole travel in the way that valve is supposed to work?"

There are  $\frac{1}{2}$ - and  $\frac{3}{4}$ -track versions of the Series 7, numbered 72 and 74, and they are completely stereo record and replay deck-plus-preamp units, as was the Series 6, but with only two heads, and using common power amplifiers. Common, that is, to both record and playback preamplifiers, and selected by the switching. The two channels are quite separate, except for the oscillator. This push-pull stage is very similar to the one previously described, but operates at a higher frequency, 85.5 kHz, and has somewhat different switching arrangements. It is, of course, matched for bias to a record/play rather than a record-only head. Whether this head-matching, the higher frequency, or some other characteristic has escaped me, I do not know, but I have found that waveform eccentricity can have a more drastic effect on Series 7 recordings than on the Series 6, which is remarkably 'self-adjusting.' A tendency to slight harshness, with choral work particularly, where so many other factors may be blamed, could indicate a need to try a new ECC82 in the oscillator stage. And please, before denouncing the machine, check that supply voltages are correct, and that the HT rail really is up to its 270 V at the 'hot' side of the 1.2 K resistor.

The other variant is the 72B and 74B range, which incorporates an additional stage, a playback preamplifier output, giving 1 V output at 100 K. There must have been a temptation, during the design conferences, to add this stage (which was a bonus, due to the

use of a transistor first stage and double valves) to the playback chain, simply taking off a 'high-level' output. But Tandberg are well aware that this method is skimping and have done the honest thing. One would have liked to see an additional refinement of a cathode follower output after this stage, but you cannot have everything.

The Series 7 has done away with the separate high and low level input circuits we noted last month, and, instead, has an adjustable line input between the very wide sensitivity limit of 2.5 mV and no less than 7 V. Presets for this adjustment are on the rear panel, adjacent to the phono sockets. Varying the sensitivity also varies the impedance, between 100 K and 500 K, but as these controls will generally be used for a semi-permanent arrangement, this is no drawback. As before, insertion of the microphone plug breaks this line input circuit, so mixing has to be external. Obviously, there are ways of getting over this if you insist on complete versatility.

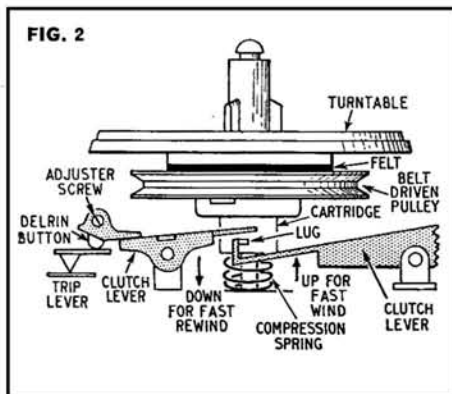
Output stages are built around the ever-popular ECL86 on the 74 model and the half ECC83/EL84 combination for the B versions. In addition, the B models have a centre channel output and a different speaker selector switch arrangement. The impedance of the centre channel output is to be a minimum of 400 ohms, and this is rather important if you need to take advantage of the public address potentialities of these machines. There is the inevitable temptation to "stick another speaker in", with lamentable results. Do not blame Tandberg. For monitoring during recording, the output is reduced by the insertion of an 82 ohm resistor, R118 in our circuit. Full 3 W audio is available on playback, and the only tone control is a bass switch employed to give an 8 dB boost at 100 Hz. When this is in the 'normal' position, the feedback circuit gives a 4 dB boost at 50 Hz. Some care is needed when servicing, as a report of "one channel down" could so easily turn out to be a slight lack of the required boost, caused by a switching interconnection, or feedback loop component fault. Having been caught myself, I pass on the warning.

It is a fact that better quality equipment has to be more critically judged. Ironically, better quality tape recorders may be affected more drastically by small faults than their less ambitious counterparts. Hence, one valve slightly below par will not pass unnoticed on machines such as the 7, whereas a cheaper recorder will tootle away quite happily for a year before the owner becomes aware that the distortion has gone up!

In other words, before getting involved in complicated tests and service procedures with circuits such as that accompanying this article, always check with a valve replacement for the stage you diagnose to be the probable root of the fault.

Mechanical details of the 6 and 7 ranges are the same, and the following notes may be taken to refer to both. Foremost is the balanced clutch system, which is so efficient on this range of machines that brakes can be dispensed with altogether. The only drawback, from the operator's point of view, is that tape loading needs a little more dexterity. It is disconcerting, the first few times one laces up a

(continued on page 579)







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Tandberg, to juggle the tape in the auto-stop spring space and around the take-up spool, then find it flying back to the feed spool as the power is applied. It becomes a little easier when we know how the clutch system works.

Some reference was made to the clutch system of Tandberg machines in an article devoted solely to this subject in September of this year, and we can refer to a drawing (repeated as our fig. 2) which shows the rudiments of the system. The spool carrier turntable rests on a belt-driven pulley. The single belt of quite respectable diameter, is crossed and runs in flanges of the motor pulley (crossed at the left, running in the upper flange to the front—this is important). Before making any adjustments at all, the setting of the height of the motor pulley should be checked. Many a "noisy mechanism" complaint turns out to be no more than a pulley set too high, or a belt running in the wrong groove. The pulley is secured by a single Allen screw. Its flange between the two belt grooves should be slightly below the line drawn from the bottom of the groove of the belt pulley of each side (as in fig. 2). Actual spacing is 0.5 mm, and this should bring the speed change idler into the middle of the appropriate diameter. What is most important, at the lowest speed of 4.75 cm/s, there should be a similar clearance between the top of the speed pulley and the next step up, i.e. the 9.5 cm/s diameter. It is rather difficult to judge this, and I have found it better to ensure that the lifting mechanism puts the drive pulley smack into the middle of the diameter for 19.5 cm/s, and work from this point.

It should not be necessary to alter the height of the lifting mechanism, and certainly not in an effort to cure a fault, but there is always the possibility that one may have to reset a machine that has been tampered with. Here, we must stress, first get the motor pulley at the right height, then select speeds and check the way the drive wheel lands, and only adjust by adding or subtracting washers between the crescent shaped arm and the holder, at the end remote from the pulley wheel. In the faster speed position, the pulley should be only 1 mm below the upper rim of the flywheel. The flywheel height can be altered by addition of little washers in the lower bearing. (It is wise to check these for wear when irregular running is the fault.)

There are two types of lifting mechanism, the later version being designed to release the pulley from motor and flywheel in the neutral position, which stops scuffing, but makes it more than ever necessary to use the start facility rather than the joystick alone when doing frequent 'stop-start' work, as when editing.

If any finer adjustment of the motor drive system is needed, the speed change idler may have to be adjusted for each individual speed. This is a bit of a chore, but when the mechanism tends to be slightly more noisy on one speed, usually the fastest, than another, this adjustment will often cure it. On the inner side of the curve of the crescent lever a small lifting arm can be seen, and this has bent forks. Check first that the lifting operation is correct in relation to the joystick movement, because this

is tied up with the power switching. The lift-off should be complete before the switch operates to cut off the current. Movement is very small, and this should be done with the power off and a meter connected to check switch closure, rather than as a hit or miss adjustment during running. Make sure there is adequate clearance between the drive pulley and the motor pulley when the lift-off is completed.

Next, loosen the screw on the transverse arm to which the forked bracket is attached, adjust the forks for individual lift, and retighten the screw. Finally, check the motor pulley and relative drive wheel heights as before, and you are ready to tackle the clutches.

Fig. 2 shows the take-up clutch. The supply turntable has something similar, except that the upward lifting lever is absent. This is the seesaw to the right of our diagram. Imagine the whole thing reversed, left to right, with this lever absent, and you have it. (That saves a drawing!)

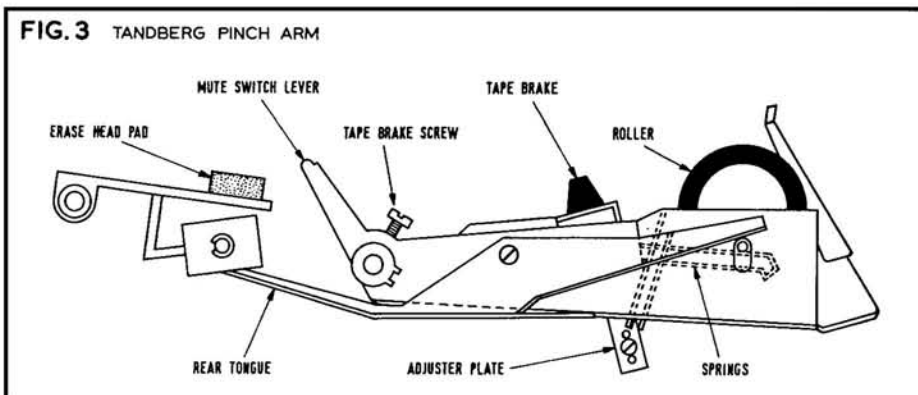
First, check the free function. Here, the motor is running and therefore the pulleys are driven, but there should be 0.5 mm clearance between pulley upper face and turntable lower face—in other words, not enough to compress the felt and inaugurate drive. Try this with no spools loaded, then with a full spool loaded, and the auto-stop spring held on with a piece of card to take the place of the tape.

When neutral is selected and the motor power

Here the cartridge is pushed up hard beneath the turntable to give full torque. The longer lever does this job for the right-hand spool and on the left side the tension of the spring alone is used, the lever merely allowing the cartridge to ride up. In all other functions, except neutral, this lever at the supply spool holds the cartridge down. If fast rewind is a bit sluggish, the trouble may not be the spring but simply an over-tight adjustment on the take-up side. The clearance between the pulley disc and the felt ring should be between 0.5 and 1 mm, selected by the relative positions of the trip lever and Delrin button, and thus set by the adjuster screw. Always go back over the functions to recheck after any adjustment, as each function is to some extent interdependent.

At this point I must take up the cudgels again on behalf of readers who have argued with Messrs. Elstone about vertical and horizontal operation. I know they will provide an end-play limiter for the flywheel spindle, but I have several times had to readjust clutches on Series 6 machines used alternately in either position. These machines will work happily in either position, but I venture to suggest they are happier left in one or the other. The clutch adjustment referred to, incidentally, has always been to reduce flutter.

Which brings us, at the end of this contribution, to the other prime instigator of this fault, the pressure arm and its adjustments. Fig. 3 shows the assembly and here we can see that there are two vital adjustments. First is the spring plate which allows the setting of the



is shut off, the left-hand clutch lever of fig. 2, and its counterpart for the supply turntable, both rise to the position shown, when the maximum friction between upper and lower halves is obtained.

Take-up is provided when the left section of the clutch lever in fig. 2 and the right section both sit in a position that allows the lug on the lower cartridge of the clutch to be free. Under this condition, the compression spring below the cartridge just gives enough upward pressure to work in conjunction with the weight of the spool and supply take-up torque. The screw on the outer end of the lever sets the position relative to the Delrin button and thus the amount of lift the clutch lever will be given by the trip lever. This should be set for correct clearance, testing with a full and an empty spool, with motor off, and again when running.

After this, fast winding can be checked.

springs for verticality of the roller, and this is best adjusted under running conditions, and with several different tapes. Next there is the tape brake, the small pad used for pause operation, which must be clear during normal run. The adjustment screw is near the hinge of the lever. Because there is always a slight clockwise pull with the left turntable, to prevent tape loops, and the selection of forward drive corrects for this, there may be a tendency for 'creep' unless this tape brake is exactly adjusted. Over-compensation can cause flutter due to inadequate clearance. It is not always obvious on first inspection, but both these points should be checked.

Do not overlook the tongue to the muting switch which may be 'on' too hard and again affect the pressure to some small extent. This is a minor fault, seldom encountered, but like other small things, vital to the good quality of which this machine is capable.

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# PHILIPS

Philips Electrical Limited, (Dept. TRC2), Century House, Shaftesbury Avenue, London W.C.2.



## recording outdoors by Peter Bastin

A DEPUTY-Editor—whose sanity I sometimes wonder about—once declared that his aim in life was to take a cheap battery portable recorder, suitably wrapped in a plastic bag, two feet down at Shoebury Ness. What he might do at that dizzy depth is his affair, but I have wondered how he would (a) manage to gurgle into a water-logged microphone and (b) ever get anywhere with bits of equipment floating all round him. Deputy editors have these cantankerous ideas; that's why they aren't editors.

Outdoor recording—including Shoebury Ness—is a matter of taste or preference. I don't care for it unless the material is to serve some worthwhile purpose. I see no value in taping tiny kids shrieking on the sands at Clacton or recording sweating fairground engines. It's all been done before. But, if the stuff is for a specific purpose, such as a documentary or a sound story, go ahead—but, at least get a *good* recording. Let people hear the sounds you have collected. Record them close up; nothing is worse than seeing poor Uncle Fred cupping his ear, trying to pick out Martha's kids from a background of traffic and wind. A good tip for starters is to take your machine into a bar and record, at full gain, the dreadful din of boozers and barmaids. It makes an excellent background atmosphere for all sorts of things and you can produce a tape-loop quite easily from it. I once heard that the BBC, for general crowd noises, used to use a recording taken at a Japanese football match, played backwards. Presumably they had run out of rhubarb.

### GREAT URGE

There used to be a great urge to build up libraries of sound effects—trains, cars, buses and so on, but the present record library lists make this an unnecessary chore. Not that all commercially-produced sound effects are good; far from it. I have some records, produced by professionals, which leave a very great deal to be desired so far as quality and suitability are concerned. And the practice of marketing American sound effects without telling people is nothing short of misrepresentation. An American telephone bell is quite different to its British counterpart and is therefore a useless sound-effect. What is rarely marketed is the background or atmosphere type of recording—the bar-room noises, a football crowd cheering, the chatter in a cafe or a theatre foyer, and it is these effects which should be collected and stored.

I once recorded a noisy crowd in a bar in

North Wales. I chopped a length of the tape in two and joined it up, producing a perfect loop. Any consistent and jumbled-up sound can be joined together without the join being at all noticeable. I did this with a stream and with breakers on the shore. All these tapes, recorded on location, will be used at some time or another and may well save me a trip to the seaside.

Location recording has its hazards, of course. What is worse than standing in the centre of Birmingham, recording church bells, when a ripe Brummie accent asks you where the nearest Ansell's pub is? Wind (elemental, that is) has its hazards, too. This is why you should never attempt outside recording on any but a very still day without a wind shield. One can be made from a bit of thin plastic foam and some good glue and, in passing, a wind shield has other good uses: it can reduce excess top frequencies and can be useful in conditions where there are too many overtones or harmonics. Not to mention protection from spit when recording pop singers.

I once did a documentary about a small country town. This involved a considerable amount of location recording, ranging from a choir in the Abbey to kids playing in a park. The script called for a run-down on the historic Abbey and I decided that the best person to give such a run-down was the incumbent. So we walked up and down the Abbey while he talked but the finished recording sounded dead, no life. The reverberation of the great Abbey just didn't come through for the simple reason that we were in the middle of the Abbey and our voices did not reach the walls to start off the reverberation. So I added a recording of the Abbey choir, taken some months previously, with very satisfactory results. I also wanted the bells of a certain church, which I knew rang most convincingly at eight at night. I saddled up my (then) Fi-Cord and went forth. The rain was coming down in lumps and I cursed all that recording stood for. I took up position, got the setting right and switched on 30 seconds before eight. The bells were magnificent and didn't appear to be at all upset by the torrential downpour. I scuttled home and played back. Nothing. Nothing at all. I hadn't even switched the blasted thing on. Perhaps that's why I got rid of the Fi-Cord.

On the subject of recorders for location work—and by that one must, of course, mean battery portables—I have used seven different makes. The first was called a Clarion, back in 1959, and was a complete contradiction in

name. The second was a Grundig *Cub*, the most awkward thing in the world to handle, with a performance to match. Then an Elpico, followed by a Fi-Cord. The Fi-Cord was excellent at 19 cm/s, hopeless at 4.75 and the very devil to thread up. In fact, a BBC chap told me that they would like to use them but found that commentators fumbled them up so much that they had to go in for repair every few weeks. Then a vertical Philips job, very good but with no means of suitably slinging it over the shoulder unless you bought a carrying case. Which I did and I used this machine for quite a long time. A miniature Japanese toy costing 12 gns. was bought in the Edgware Road more or less as a joke. And joke it was. I tried everywhere to get a microphone to improve the scratchy and constipated speech quality, but failed. I used a Grundig *TK6* for about two years. Very good but with a maximum recording speed of only 9.5 cm/s. In the end, I bought a Philips *EL3301* cassette recorder, which I still use and swear by. I use a Grampian *DP4M* or 200 ohm Beyer microphone, boosted, with it and get recordings well up to professional location recording standards. I have had a good deal of material broadcast which has been recorded on this machine. It is, of course, the microphone which is the all-important link in location recording and if you use a good microphone, properly matched, you will be surprised at the results you can obtain, even on a £15 recorder. I once did a location interview for County Archives, where the microphone cost more than the recorder. This is not unusual and emphasises the point.

### AUSTRIAN BAND

Sometimes balance can be your enemy. Not so long ago, I was in Austria recording the proceedings on a Saturday night, when the town band, resplendent in brown uniforms and little green hats with fezzers, marched into the town square to sit down and oop-pa-pa for an hour or so. I milled about, picking up the wild, wild foreign accents of the German/Austrian/Danish/French/Italian/English crowd (to make into loops) and stood by. The band could be heard in the distance; slowly it approached. Wonderful stuff. Everyone clapped. The resulting recording was splendid right up to the point where the bass-drummer walked within five feet of me (or should I say two metres?). The healthy thump scattered the rest of the band and that particular bit of the recording sounded like the berserk innards

(continued overleaf)

of a faulty radiogram. Which is a distinct object lesson. Keep your eye on your modulation meter. The bright instruments of a band, the swirl of kilts or the whatever-happens-to-mini-skirts is your deadly enemy.

I recorded a little old man playing a harp in his stocking feet, 5,300 feet up in the Alps—or rather, my son did. This turned out very well, despite the fact that this cheery old peasant, in his eyrie nearly two miles in the sky, was using plastic strings on the harp. As a matter of interest, the only way up to this section of heaven was by chairlift—a wood and plastic baby-seat on a metal pole suspended from a wire, used by he-man skiers in the winter. My son wanted to know why I had not recorded the unique experience of soaring over tree-tops and ravines. I replied with all candour that I was too petrified to think of tape-speeds, modulation meters and loops and that my only thought on the terrifying 3000 feet climb was whether or not there would be a bar at the top selling brandy.

**SEEK PERMISSION**

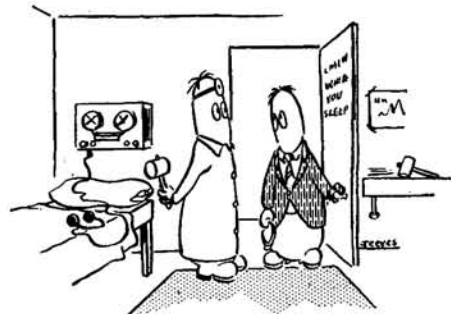
Recording speech from a public address system is usually a miserable failure. If you get too near, you pick up the normal deafening mains-hum from these things and if you get too far away, the result is a sort of booming, burbling grunting, nearly overpowered by general crowd noise. The best answer to this sort of problem is to seek permission to

mount your microphone next to the public address microphone. This is all right so long as the speaker doesn't use the technique employed by Belgian sailors on the cross-channel steamers: grab the microphone, stuff it in your mouth and shout like hell. If there is some alternative to recording the mess from PA systems—and there usually is—use it.

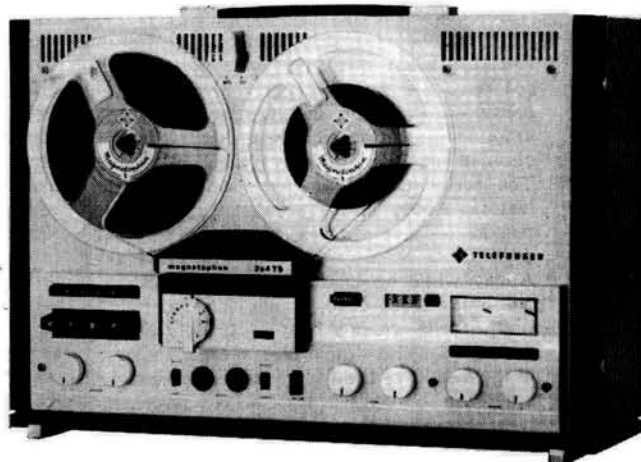
Outdoor recording requires a very special technique and it is not quite so easy as the average amateur thinks. Interviews must be carefully considered, with the interviewer in the background as much as possible—or, even better, out of it altogether. I have heard so many amateur interviews which have been too long or too boring or too badly recorded. There is a tendency amongst amateurs and many professionals to enjoy the sound of their own voices. After all, it's the person being interviewed whom the listener wants to hear. Recording open-air bands is a dicey one and should be approached, if possible, on studio lines. A small battery recorder, even with a good microphone, cannot do justice to a 60-piece band—not unless you are lucky and strike a point of natural balance and that is very debatable. Recording crowds, especially if they are getting steamed up about something, is the most rewarding work and requires little ability on the part of the recordist.

Never try a close-up recording of a horse neighing. Microphones are expensive and can give horses indigestion. Don't try recording trains (if you *must* record trains) very close. All you'll get is a classy sort of swishing-clonk which is very little use for any purpose. A motor-mower or moped engine is a useful

bit of equipment: played back at various speeds, all sorts of effects can be obtained. I suppose I could write a hundred do's and don'ts and I don't expect anyone would take any notice. Therefore, all I can say is what I said at the beginning: record outdoors only if you must and if you must, make sure you do it properly. Most people are now rather blasé about tape-recorders and playing a squeaky bit of tape which is supposed to be the family setting off for a week at Bognor, no longer fascinates them. People now (thank heaven) are beginning to expect recordings to sound like the real thing. And I wish some of them did.



*"We have the Sleep-Inducing Tape at three guineas or, for a mere ten bob . . ."*



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*The Telefunken 204 TS all-stereo recorder. Offers you an interesting combination of features. But one thing above all, it has its mind set on the most important single requirement, totally faithful reproduction.*

*What you get out of the 204 TS is exactly what you put in. It adds nothing of its own. Takes away nothing from the original sound. That's the Telefunken philosophy:*

*dedication to faithful reproduction.*

*Technical brief  
Vertical or horizontal operation. Front controls. Multiple 6 function switch. Sound on sound recordings. Separate controls for recording and playback, 2 level (each with calibrated meter), 2 volume and 2 tone. 2 built in speakers. Mains 'pre-select' switch.*

*Response characteristics (Din 45,511).  
40-15,000 cps at 3 3/4 ips*

*40-18,000 cps at 7 1/2 ips  
40-8,000 cps at 1 7/8 ips  
Signal to noise ratio  
50 db at 7 1/2 ips, 48 db at 3 3/4 ips  
Wow and flutter, ≤ ±0.25% at 3 3/4 ips  
≤ ±0.15% at 7 1/2 ips, ≤ ±0.4% at 1 7/8 ips  
£136.12.5*

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# PPM

## Postscript

### MODIFYING THE BUDGET PPM TO ACCEPT A TURNER METER

AS promised in the October *Budget PPM* article, a little more information on suitable transformers and meters. My original source of transformers has dried up but the components may still be obtainable at one or two surplus stores. They are about 2.5 cm cubic, painted grey and with six tags. Markings are CAH 43142.5 or 10K/18886. Both are similar to the meters used in the prototype and I would be interested to hear of new sources.

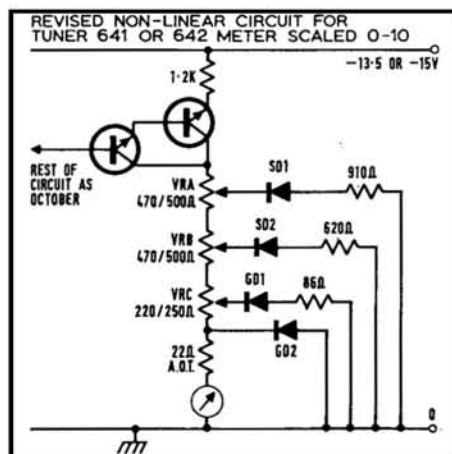
However, I have meanwhile contacted *Transformer Equipment Ltd, Railway Place, Wimbledon, London S.W.18*, who will produce the transformers to specification in small quantities (one up) for 31s. 6d. (specify "higher grade core for maintained inductance") in an unscreened version with solder tags; or 44s. (specify "higher grade core, etc.") in a Mumetal screening can which makes the transformer more suitable for use in compact or miniaturised amplifiers. I have not had an opportunity to examine one of the transformers as yet, but Transformer Equipment's price for small quantities is by far the most realistic that I have so far been given.

On the subject of meters, *Ernest Turner Electrical Instruments, Chiltern Works, High Wycombe*, have been most helpful and I am indebted to them for much information and willing assistance, for which I would like to express my thanks here. The original Turner meter units were type W909 with standard spade pointers, not W309 as I unfortunately wrote in the October article: apologies to all concerned.

Suitable 1 mA surplus units can from time to time be found at many London component and surplus stores—Smiths and others of Lisle Street, and the Edgware and Tottenham Court Roads are good hunting grounds. For those who do not relish carving up meters, Turners can supply a very elegant 1 mA 56 mm sq. clear front meter Type 641—highly recommended. This is available with a standard PPM scale (calibrated 1-7, white on black) for just under £7. Alternatively they can supply an equally elegant version of the 641, scaled

0-10 black on white for £3 17s. 9d., of which more below. These are the most suitable for mounting in pairs; anyone using the single meter arrangement might like to consider the 72 x 45 mm version, Type 642, which costs 87s. 9d. scaled 0-10.

Although one could ease off the Perspex front of the 641 meter and recalibrate by hand, this seems rather a pity, and a circuit using the meter as it stands seemed worthwhile. I have been playing with one of these movements with a view to using it in a PPM circuit, and the non-linear network—arrived at empirically from the original circuit—is illustrated here. The meter circuit is adjusted to read in 3 dB steps between 1 and 7, and 2 dB steps between 7 and 10. The result is a meter covering the same range as a standard PPM ( $6 \times 3 \text{ dB} + 3 \times 2 \text{ dB} = 6 \times 4 \text{ dB}$ ). With peak level at 8 (PPM 6), mid-scale 5 (PPM 4) is 8 dB below peak, and the meter reads 4 dB overload as on the PPM. Anyone used to a PPM therefore adjusts rapidly to it; the divisions are more useful than those of a linear voltage scale, and the circuit retains all the advantages of a PPM while being considerably cheaper. The circuit is adjusted in much the same way as the original circuit. With the three presets at mid travel, sensitivity is adjusted for a reading of 1; increase signal 6 dB and adjust VRC for a reading of 3; increase the signal 6 dB and adjust VRA for a reading of 5; increase signal 6 dB and adjust VRB for a reading of 7; increase signal 6 dB and adjust VRC again for a reading of 10. VRB should now need little adjustment, and the process can be repeated three times so that the scale reads in 6 dB steps 1-3, 3-5, 5-7, and 7-10, with the intermediate steps of 3 dB and 2 dB per division as described above. If necessary the 22-ohm resistor may be adjusted if the top end of the scale needs further correction. The circuit will just work with a 13.5 V supply, allowing for battery aging; a 15 V supply would give more latitude. Note that the meter zero should be set about 1 mm left of scale zero so that the standing current brings the circuit to read zero in the absence of a signal.



**Meter:** 1 mA f.s.d. moving-coil Ernest Turner 641 or 642, scaled 1-10. No title.

SD1, SD2: SX11, OA202 or equivalent silicon diodes.

GD1, GD2: OA5 or equivalent germanium junction diodes.

**Calibration Data**

0-1 = ∞ dB	5-6 = 3 dB
1-2 = 3 dB	6-7 = 3 dB
2-3 = 3 dB	7-8 = 2 dB
3-4 = 3 dB	8-9 = 2 dB
4-5 = 3 dB	9-10 = 2 dB

1 = -12 dB = PPM 1

5 = zero level = PPM 4

8 = peak level = PPM 6

10 = +4 dB overload = PPM 7

The performance of the 641 in the modified circuit and one of my doctored Model 909 units in the original circuit have been compared on programme and with pulsed inputs, and there seems little or no difference; if anything the 641 appeared fractionally better and certainly very suitable.



# TAPE TO DISC

## A SURVEY OF PRIVATE DISC RECORDING STUDIOS



Trusound disc-cutting installation

\* APRS, 47 Wallendon Road,  
Kenley, Surrey

COMPANY ADDRESS TELEPHONE NUMBER	AUDIO DESIGN (RECORDINGS) LTD. 45 HIGH STREET, BURNHAM, BUCKINGHAMSHIRE BURNHAM 1303	CALDER RECORDINGS LTD. REGENT STREET, HEBDEN BRIDGE, YORKSHIRE HEBDEN BRIDGE 2159	COUNTY RECORDINGS SERVICE LONDON RD., BINFIELD, BRACKNELL, BERKSHIRE BRACKNELL 4935	CRAIGHALL RECORDING STUDIOS (George Jeffrey Ltd.) 68 CRAIGHALL ROAD, EDINBURGH 6 031-552-3685
STUDIO FACILITIES	—	YES	YES	YES
STANDARD DIRECT-CUTTING	YES	YES	YES	YES
VARIORGROOVE DIRECT-CUTTING	YES	—	YES	YES
MASTER DISCS FOR VINYL PRESSINGS	YES	YES	YES	YES
DISCOUNT FOR CASH WITH ORDER	YES	—	YES	—
MOBILE RECORDING FACILITIES	YES	YES	YES	YES
POSTAGE & PACKING: 18 CM DISC AND RETURNED TAPE 25.5 CM DISC AND RETURNED TAPE 30.5 CM DISC AND RETURNED TAPE	3/- 4/6 5/-	2/6 3/- 3/-	4/6 4/6 4/6	
STEREO MASTER DISC CUTTING	—	—	YES	—
SPECIAL FACILITIES	Baby doll records cut on vertical cutter head. Tape transfer from Teac to Revox editing, etc.	Reverberation plate, dynamic limiter, twelve channel mixer fed from capacitor microphones.	Manufacturers of cutting styli.	Tape duplication.

# TAPE TO DISC

## A SURVEY OF PRIVATE DISC RECORDING STUDIOS

THE published list of Members and Associates of the *Association of Professional Recording Studios\** indicates that there are, in the British Isles, about eighty organisations with disc cutting facilities. It is doubtful if even this list is complete. For the purpose of our survey, only those organisations which announce their services in the nationally distributed journals have been included. This survey, in no way purports to be comprehensive for such a task would be impossible. Further, a number of organisations do not undertake to cut records for private purposes. Questionnaires were sent out to nineteen organisations and replies were received from thirteen. Those from *Warren Recordings* (N.W.4) and *Studio Sound* (Hitchin) arrived too late for inclusion.

Direct recording, a technique first pioneered by the BBC, uses a lacquer-coated aluminium disc as the recording medium, the lacquer usually being a softish material con-

taining nitro-acetate or simply acetate. These direct cut discs are used where only a few copies of a recording are required. A fact not often pointed out by organisations specialising in direct cut discs is that the surface of the disc is much softer than a commercial pressing and hence greater care is required in handling. A lightweight pickup is strongly recommended. Furthermore, older autochangers can damage the disc. The modern lightweight-pickup autochanger of the Garrard 3000 type can be used without appreciable disc damage. Due to the frightening speed with which some auto-changers hit the surface of the disc at the beginning of the record, it is recommended that manual control is used and the pickup lowered gently on to the record. With reasonable care, one can expect about 250 playings from a direct cut disc.

If more than a dozen copies of a recording

(continued overleaf)

DEROY SOUND SERVICE (1948)	EDEN STUDIOS LTD.	EXCEL SERVICES	JOHN HASSELL RECORDINGS	J & B RECORDINGS (MORDEN)	THREE COUNTIES RECORDINGS	TRUSOUND RECORDING SERVICES
HIGH BANK STUDIOS, HAWK STREET, CARNFORTH, LANCS. CARNFORTH 2273 (DAY OR NIGHT)	11B EDEN STREET, KINGSTON-UPON-THAMES, SURREY 01-546-5577	49 BRADFORD ROAD, SHIPLEY, YORKSHIRE SHIPLEY 55779	21 NASSAU ROAD, BARNES, LONDON S.W.13 01-748-7150	14 WILLOWS AVENUE, MORDEN, SURREY 648-9952 (DAY OR NIGHT)	1 BROOMFIELD CLOSE, RYDES HILL, GUILDFORD, SURREY GUILDFORD 61684	4 HITCHIN ROAD, SHEFFORD, BEDFORDSHIRE SHEFFORD 355
YES	YES	YES	YES	YES	YES	YES
YES	YES	YES	YES	YES	YES	YES
YES	—	YES	—	—	YES	YES
YES	YES	YES	YES	YES	YES	YES
YES*	—	—	—	—	—	YES (2.5%)
YES	YES	YES	YES	YES	YES	YES
5/- 5/- 5/-	3/- — 5/6		2/- 2/6 3/-	2/- 2/- 2/-	2/- 3/- 3/-	APPROXIMATELY 5/- PER ORDER
YES	*YES	—	—	—	—	—
New £6,000 Neumann cutter Backing groups and vocalists supplied. Songs orchestrated.  *Discount to trade only.	Fifteen channel mixer. Response control, echo, compression, as requested.  *For pressing orders only.	Equaliser, limiter double tracking.		Compressor/limiting and filtering during tape to disc copying. Professional EMI tape machines, Neumann, AKG and STC microphones. Our recordists are all professionals with musical background and can play at least 2 instruments each. They are capable of giving advice to musicians and talk their language. Special effects can be prepared for groups.		

## VINYL PRESSINGS (DOUBLE SIDE)

### 18 CM 45 SP VARIGROOVE

(SAME PRICES FOR STANDARD UNLESS ASTERISKED)

	12 DISCS	25 DISCS	50 DISCS	99 DISCS
AUDIO & DESIGN ... ..	—	20/-	15/6	11/3
CALDER RECORDINGS ... ..	—	—	15/-	12/6
COUNTY RECORDINGS * * ...	6/-	5/6	5/3	4/9
CRAIGHALL RECORDING ...	12/-	9/6	7/6	5/11
DEROY SOUND SERVICE ...	21/-	14/-	12/-	10/-
EDEN STUDIOS ... ..	22/-	17/6	10/3	6/9
EXCEL SERVICES ... ..	20/10	12/9	8/8	6/7
JOHN HASSELL ... ..	30/-	21/6	14/-	9/4
J & B RECORDINGS ... ..	26/-	18/-	13/6	8/7
THREE COUNTIES ... ..	20/-*	15/-	—	—
TRUSOUND RECORDING ...	—	21/-	15/-	9/6

\*\*Prices exclude cost of Master

### 30.5 CM 33 RPM LP

	12 DISCS	25 DISCS	50 DISCS	99 DISCS
AUDIO & DESIGN ... ..	60/-*	48/-*	48/-*	36/6*
CALDER RECORDINGS ... ..	—	—	34/-	30/-
COUNTY RECORDINGS** ...	13/9	12/3	12/-	11/3
CRAIGHALL RECORDING ...	37/6	32/-	25/-	17/-
DEROY SOUND SERVICE ...	55/-	35/-	30/-	25/-
EDEN STUDIOS ... ..	68/-	45/-	28/-	19/6
EXCEL SERVICES ... ..	45/10	28/10	20/6	16/-
JOHN HASSELL ... ..	55/-	44/-	26/-	20/-
J & B RECORDINGS ... ..	54/-	38/-	26/-	20/-
THREE COUNTIES ... ..	45/-	38/-*	33/-*	28/-
TRUSOUND RECORDING ...	—	44/-	26/-	20/-

are required, then it is cheaper to have a master made from the direct cut disc. Depending on the number of pressings required, either half-processing or full-processing may be used (up to about 100 pressings, half-processing is normally used), but in both cases pressings are made from the master or 'stamper'. The pressings are made from vinylite, a plastic which is soft at high temperatures, but becomes hard at normal temperatures. This form of disc is far more durable than the direct cut disc, but due to the cost of producing a master disc (about £6 per side for a 30.5 cm disc), it is only economic to produce pressings in quantity and becomes very reasonable (about £1 per double sided disc) for quantities of 100 or so. It should be mentioned here that for quantities of 100 or more pressings, every disc then becomes subject to purchase tax.

Direct cut discs were unobtainable until recently, DeroY now offering both these and stereo pressings. Few of the organisations had stereo cutting facilities, the work normally being done by one of the larger record companies (as is the processing).

Only one organisation in its supporting literature stated to which equalisation standard their records were cut. The BS (British Standard) equalisation curve for discs is often used, as is the RIAA (Record Industry Association of America) curve, both equalisation curves being within ±1dB of each other; however RIAA equalisation is more frequently encountered in commercial amplifiers. Another facility offered by a number of organisations is called 'Varigroove'. Whilst disc cutting machines will always cut grooves at constant pitch (normally around 80 grooves per cm for fine grooves), some machine can vary the pitch if the dynamics of the recording will permit this (Varigroove).

Thus the playback time can be extended by about 25% per side, but a 15% extension on the standard playing time is preferred by most organisations. Due to the more sophisticated machinery involved, varigroove prices tend to be correspondingly higher. Similarly disc cutting equipment varies greatly in price and this is reflected in the charges for undertaking the work. The extended playing time offered by the Varigroove facility is clearly dependent upon the type of recording made. For, if the recording contains many long loud passages of music or speech, the spacing may finish up with only a few more grooves per cm than Standard cut records. The basic principle underlying the cutting of Varigroove records is the use of a pre-hearing head on the tape playback machine, which senses the volume of the signal before the tape reaches the playback head. Thus as the tape passes the sensing head, the recorded signal generates a voltage which is passed to a servo mechanism controlling within certain limits the pitch of the recording. Due to the softer surfaces of direct cut records, it is preferable to use a coarser pitch than is normally used in commercial vinylite pressings.

A point frequently overlooked when pressings are being made from a master disc is *copyright*. Material is sometimes recorded which is protected by copyright and consequently a fee is charged by the Mechanical Copyright Protection Society Ltd. (MCPS) for the use of such material. The whole question



## DIRECT CUT DISCS (PLAYING TIMES AND PRICES)

### STANDARD GROOVE 18 CM 45 RPM SP

	PLAYING TIME PER SIDE [Minutes]	PRICE	
		Single Side	Double Side
AUDIO & DESIGN ... ..	3.5	24/-	30/-
CALDER RECORDINGS ... ..	3.5	19/-	21/-
COUNTY RECORDING ... ..	3.5	26/3	26/3
CRAIGHALL RECORDING ... ..	2.5	26/-	32/6
DEROY SOUND SERVICE ... ..	—	—	—
EDEN STUDIOS ... ..	3	19/6	22/6
EXCEL SERVICES ... ..	3	24/-	27/6
JOHN HASSELL ... ..	6	30/-	35/-
J & B RECORDINGS ... ..	5	21/6	26/-
THREE COUNTIES ... ..	4	22/6	25/-
TRUSOUND RECORDING ... ..	3.5	18/-	21/-

### VARIGROOVE 18 CM 45 RPM SP

	PLAYING TIME PER SIDE [Minutes]	PRICE	
		Single Side	Double Side
AUDIO & DESIGN ... ..	7	28/-	36/-
CALDER RECORDINGS ... ..	—	—	—
COUNTY RECORDING ... ..	6	29/-	29/-
CRAIGHALL RECORDING ... ..	4	26/-	32/6
DEROY SOUND SERVICE ... ..	4	18/-	21/-
EDEN STUDIOS ... ..	—	—	—
EXCEL SERVICES ... ..	not quoted	24/-	27/6
JOHN HASSELL ... ..	—	—	—
J & B RECORDINGS ... ..	—	—	—
THREE COUNTIES ... ..	—	—	—
TRUSOUND RECORDING ... ..	5	18/-	25/-

of copyright has been considerably simplified in recent years and a fixed scale of charges to recording organisations is now in force for small numbers of pressings; which replaced a system of charges that bordered on the ludicrous.

A number of organisations provide permanent studios for a wide variety of recording purposes. Many of these studios provide excellent facilities and the results compare favourably with much larger commercial studios. The majority of organisations undertake mobile recordings—the recording of a wedding service surely ranking as the most popular. Due to the high competition between companies making outside recordings, prices tend to be very reasonable, considering the time, travelling and work involved.

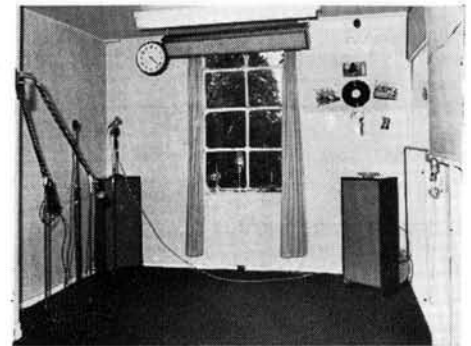
Finally, if you wish to submit your own tape from which you want a disc cut, these are the golden rules to remember :

1. Record at as high a speed as possible, preferably 38 cm/s or 19 cm/s.
2. If at all possible, leave the rest of the tape free from recorded material.
3. Time accurately the length of the tape, and do not over-run on maximum recording times.
4. Indicate the beginning and end of each side of the record, by a marker or leader in the tape.
5. Try not to over-record. Due to the treble boost applied on record, distortion becomes much more apparent on disc than on the original tape.

When you submit a tape, it is useful to inform the organisation of the following facts:

1. The speed at which the recording was made.
2. Whether a full, half or quarter-track machine was employed.
3. The tape recorder used to make the recording.
4. The running time of each section of the tape to be transferred to disc.
5. Any details to be printed on the labels.

(continued on page 609)



Trusound recording studio.

# Our sound studio has a carrying handle!

The new trans-portable PRO12 from Philips:  
the stereo studio recorder that's at home at home.

- Twin-track mono, dual-track mono, and twin-track stereo recording and playback.
- Tape speeds  $7\frac{1}{2}$  and  $3\frac{3}{4}$  i.p.s.
- Electro-magnetic speed control.
- Three inputs for each channel.
- Built-in facilities for mixing 2 inputs.
- dB Switch for lining up purposes.
- Multi-play and sound on sound.
- Permits check of recorded signal during recording (before and after tape).
- Built-in monitor amplifier with loudspeaker.
- Socket for headphone monitoring.
- Cue and dubbing facilities, with tape lifting devices.
- End-of-tape switch.
- Pause button.
- Very low cross talk between the two channels.
- 3 separate motors for individual drive of the capstan and tape reels.
- Correction filters for both speeds, automatically selected and independently adjustable.
- Independent bias adjustment
- Correction filters to CCIR standard.
- Diode input-output and extra monitor output.
- VU meter for each channel.
- Operation by means of relays.

Negligible start and stop times due to electro/mechanical control of pressure roller and braking system.

- Performance meets studio standards (DIN 45511).

**PHILIPS ELECTRICAL LIMITED,**  
Electro Acoustics Division, Century House,  
Shaftesbury Avenue, London WC2, England



# PHILIPS



# Beginner's Luck

**I**F John Shuttleworth's very interesting article in the August issue had been published last year, I would never have felt competent enough to have entered for the FBTRC competition.

All this ancillary equipment, wobble meters, signal generators, the pre-planning, know-how and care taken to produce a tape thought fit to enter. When I compare it with my effort, then I know that luck was with me to a great extent, as the recording was very much of an afterthought.

## BELL RINGING

I was invited to tape some bell ringing to be replayed at a talk to be given at the Beaford Art Centre by the Rev. John Scott and illustrated by colour slides of various churches and bells in that area.

"Come along to Down St. Mary about 6.30 next Monday evening. A pretty set of six there." It was certainly a pretty little church and I had plenty of time to find the best spot for the mic, sheltered from a light wind, connect up to the mains supply and await the arrival of the bell ringers.

That recording seemed to be quite reasonable and I thought how pleasant everything had been. "Now we are going off to several other churches for more recordings, so just follow us". Then began a kind of Monte Carlo practice dash through the countryside led by the intrepid reverend gentleman, with the bell ringers in close pursuit, and followed by an ever wondering recordist as hamlets and villages were passed at what seemed an alarming rate, but then high hedged lanes make 20 m.p.h. seem fast. On arrival at the next church, which was oil lit, the bell ringers

were ready before I had found the nearest electric supply, in a cow shed!

There was a loud mains hum when everything was connected up, but nothing could be done in tracing this as the farmer was busy milking his cows and the power could not be cut off.

So it went on with a race at each church trying to have the set all ready for the three chimes warning that the ringers gave me before starting a full peal. Fortunately I had one of those universal plugs as the source varied from church to church. Lugging a Revox at half gallop round a churchyard was a little akin to "mad dogs and Englishmen", but one had to be ready for those three fateful chimes.

Four different churches, 85 miles, and all done in three hours. A far cry from the quiet peaceful evening I had envisaged at the start. I later learnt that bell ringing in the villages had to be finished by 9 p.m., hence all the hurry.

I went out again with another champion team from West Down, but unfortunately there was a half gale blowing. Despite the use of wind shields, and in one instance having the mic 'up my jumper', most of this was a write off. Various other churches were visited at odd times and at the end of many recordings I was able to appreciate when a champion team was ringing, which in the words of the Devon folk song should be "steady and true like the men of Northlew".

The talk with slides and tape was well received by the audience, though I missed the speaker's cue twice and put out the wrong bell sequence. But folk are always kind and bear with one at these moments of distress.

So I finished with numerous mono and

stereo tapes, and there seemed to be little further use for them, except for the suggestion my wife made after some hours of enforced listening! Then I read in the *Tape Recorder* the full details of the FBTRC competition and suddenly thought the bells were just the thing for the documentary class.

An unusual subject with good quality ringing from fine old bells and with a new script written and beautifully spoken by the Rev. John Scott, himself a bell ringer and an authority on the subject, I had been given every opportunity to produce what could be a very interesting tape, at least that is what I felt.

The final assembly of the tape was an anticlimax as we had moved home and were now in an old farm house with the bare essentials being carried out by the builder and seven years of overgrowth in the garden. Somewhere in 36 tea chests were the recorders and the tapes.

## IRREGULAR SUPPLY

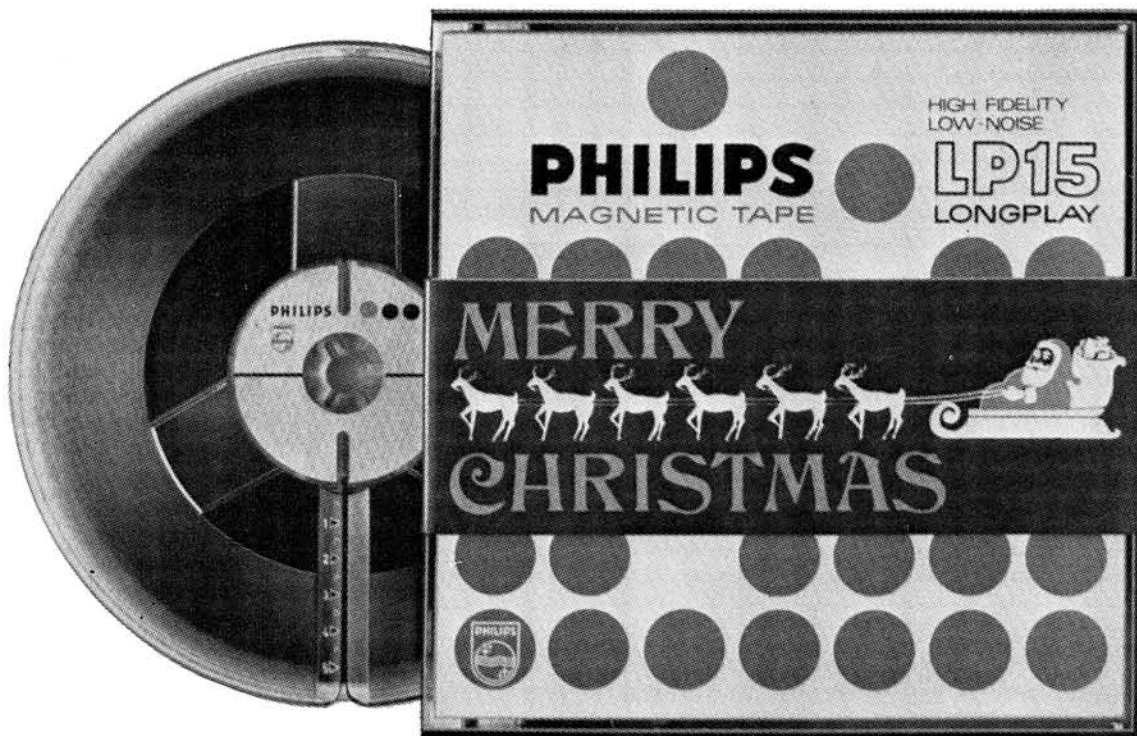
D-Day approached and, with an irregular electric supply subject to voltage drops and so many other pressing matters to attend to, it seemed that the gremlins would win and the tape would be a non-starter.

However the tape was put into the post, just in time, and eventually it met with approval by the judges.

A good maxim for a beginner seems to be: never fail to take any recording opportunity, as one can never tell where the final trail will lead. Sometimes an interesting subject can be more important than technical quality, though a combination of the two is the ultimate goal of every keen recordist.



# Give 'em a bit of hush for Christmas!



Give them our new High-Fidelity Low-Noise tape. It has a new magnetic oxide which virtually eliminates background noise from your recordings. Giving clearer, more brilliant sound than ever before.

We've come up with a new-style calibrated reel in an ever-lasting pack. They stand in clip-together racks to form a sound library.

Best of all, our quiet new tape costs no more than the noisy old-fashioned sort. So it costs no more to give 'em a bit of hush for Christmas!



**PHILIPS**  **HIGH FIDELITY**  
**LOW-NOISE**

Philips Electrical Ltd., Century House, Shaftesbury Ave., London, W.C.2.

a report on tape recorders seen, and tape recordings heard, at the Northern Audio Fair

THE last Audio Fair at Harrogate took place in 1958, a year before the first issue of *Tape Recorder* appeared on the bookstalls. It was the year Ferrograph introduced the *Series 3S* and the year of the first stereo discs. Reference to the catalogue for that event reveals a healthy complement of tape recorder manufacturers, though out of the eleven who were at the Grand Hotel then only three have survived, two of them returning to the Hotel Majestic in 1968. There were plenty of newer names as well, though how many of them will survive a further decade is a moot point, especially as the next ten years will see severe foreign (Japanese—the words are almost synonymous) competition as well as economic pressure at home.

Tape at the Audio Fair now assumes two rather paradoxical extremes, in that expensive high-quality instruments are exhibited along with tape cartridges and cassettes. The middle of the road 'good quality domestics' are usually frowned upon as this is a hi-fi exhibition, and although it might be legitimate to exclude the cassette and cartridge machines at present available on quality grounds, no one has made any such moves.

Anyone who did, would be confronted with the problematic Akai *X-1800* and *1800* which are intended to operate as conventional reel-to-reel machines but with the facility for playing and recording eight-track cartridges as well. The machines are a conventional three-speed Akai, with and without cross-field bias, and the cartridge slips into the side of the recorder. Although the facility of recording on eight-track cartridges is entirely confined to these machines, one cannot help thinking that 40 minutes of playing time—interrupted every 10 minutes—and with no fast wind or rewind is a trifle inflexible. A Philips cassette might be slightly more useful as it would enable owners of Philips machines to edit their tapes—dubbing on to reels, cutting and splicing, and then dubbing back again. The quality of the cartridge was poor—especially when compared with 19 cm/s tapes from the same recorders.

Another new machine, successor to the *X-355*, is the *X-360*, available with or without power amplifiers, and using a switched three-speed synchronous capstan motor. The machine has four speeds (a capstan sleeve, still!) all-solenoid operation, and a *Computomatic* AVC unit. This uses a servo-motor to operate a potentiometer—one can actually see the device rotating when recording—but the machine was so new that Akai engineers were quite unable to explain its advantages.



Akai X-360

*Reverso-matic* (automatic reversing) is carried over from the *355*, but a new idea is the *Automatic Dust Minder* which tells the owner when the replay head needs cleaning. The device consists of a pilot light actuated by a frequency-selective circuit which samples the replay signal; the system operates on the doubtful assumption that nothing detected over 7.5 kHz after ten seconds means the heads are dirty. The Akai demonstration tapes certainly were not lacking in the upper octaves, but 7.5 kHz is nearly one octave above the highest note on the piano, and most AM sets would not produce anything at this frequency whatever the programme.

#### SOLENOID MECHANISM

Taking advantage of the solenoid system, Akai have duplicated the *X-360* control panel on their *A-8000* tuner-amplifier, and all functions including *record* can be selected remotely by uses of these units.

Not new, but only recently introduced, the Akai *X-V* was played through its own amplifiers into Wharfedale speakers. Even 2 W per channel is sufficient to produce a decent volume level and there was no trace of motor noise—presumably the brushless servo-system is doing its job.

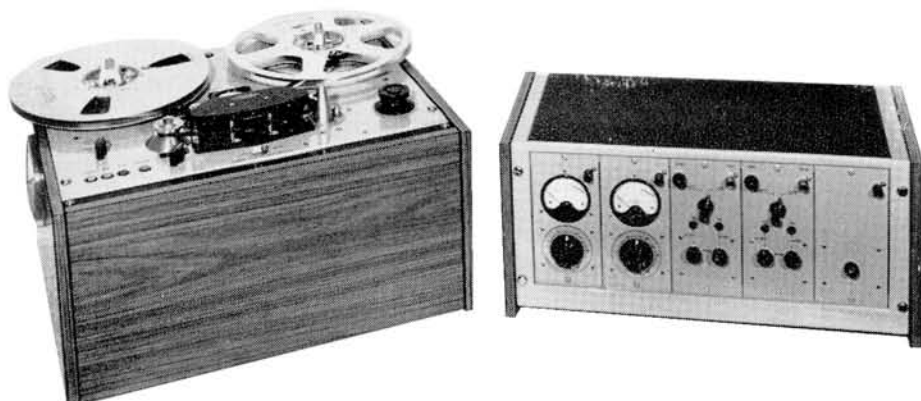
From an established Japanese manufacturer to a new British manufacturer *Magnetic Tapes Ltd.* For some time we have been subjected to tempting rumours about

their *Chilton* recorder but early production problems delayed the appearance of the machine until Harrogate. The *Chilton 100S* is a three speed stereo machine, available with or without built-in power amplifiers in  $\frac{1}{2}$ - or  $\frac{1}{4}$ -track versions. Motive power is provided by a Papst hysteresis synchronous motor, which is under-run in the record/replay modes and also fan cools the electronics when the amplifier is used separately. Spring-loaded rollers are used to stabilize tape motion and one of these incorporates a microswitch which neutralises the solenoid controlled deck in the event of tape breakage. Of particular interest is the provision of high quality 10 W RMS per channel amplifiers with a fully stabilized supply (no music power nonsense) which also incorporates a current-operated non-latching overload protection device. Tom Reys, the designer, demonstrated his faith in the performance of this section with a pair of wire cutters, changing speakers while the recorder continued playing—none the worse for the experience. With PPMS, Bogen heads, switched bias, and prices starting at £127 3s. 4d. (less power amplifiers but including tax), this machine appears to offer impressive value for money.

From the sublime to ingenious, Slot Stereo were showing an AM radio tuner shaped like an eight-track cartridge and designed to fit into their car/home players to give radio reception. This cost just over £4 and a version to fit into Philips' new *N2200 Cassetophone* might prove a money spinner. The *Cassettophone* is a cassette player with rewind only (to go forward turn the cassette over). Cheap and cheerful, it could well prove popular, especially if the pre-recorded *Musiccassettes* could be reduced in price. Besides their *PRO12*, seen at the Hotel Russell, Philips had four new domestic machines, two stereo and two mono, offering quite a lot for their price in terms of facilities. Ferrograph and Revox were both at Harrogate, the latter showing their *Disappearing 736* film—now rather the worse for wear. Confidentially, the *736* depicted at the centre of a small explosion was just a case with no mechanism—well that's their story anyway. The *A77* is now definitely subject to purchase tax, except for professional customers, and will be available at new prices starting at £140 14s. for the chassis-only version less power amplifiers.

Elstone Electronics were showing the new Tandberg *12X*. This has cross-field bias—the system used in the *6X* machines—built

(continued on page 607)



A visit to Britain's largest manufacturer of studio tape recorders

# Leever-Rich

BY RICHARD GOLDING

IN my wanderings around the studios, I have come to take Leever-Rich tape recorders very much for granted as basic pieces of professional equipment which go on working without fuss or drama for years at a stretch. One comes across them most frequently in the sound, radio and television departments of the BBC, Central Office of Information, and ITA, all committed to providing a public service or its equivalent and all demanding absolute reliability.

When I heard the other day that the BBC were going to send about 150 Leever-Rich machines back to the makers for alteration to slow speed operation, I felt sure there must be a story behind this, particularly as a proportion of these machines had been in service for over ten years and according to normal practice would have been written off the books years ago. At first sight it looked as though Auntie had gone to extremes and developed a veteran car complex about her tape recorders.

What I found of course was something quite different. Since the early 50's an increasing proportion of studio recorders have been bought from Leever-Rich until today the complement in service totals many hundreds, and it seems that neither price (the machines are in the higher price category) nor sentiment (except for the usual "Back Britain" policy) were major factors. On the other hand, the BBC have over the years developed a most efficient maintenance system covering all types of technical equipment, including programme recorders, and keeping detailed records of any breakdowns and their cause. In recent years this information has been accessible (internally) for computer analysis, to be taken into account when evaluating equipment for similar conditions of use—one cannot get much less sentimental than that when deciding on a 'best buy'.

The BBC has been long in deciding to change from its present practice of 38 and 19 cm/s working, but it must be remembered that programme quality standards are very high in all respects and must be maintained throughout complex sequences of editing and dubbing and must also be practical in terms of International programme exchange on tape. It has in fact taken over two years of careful tests to establish the lower tape speeds as a reliable operation. The changeover of the BBC overseas service to the new standards will involve the

conversion of about 150 Leever-Rich machines but costly as this will be, the annual consumption of tape is now so large that the total conversion and refurbishing cost will be saved in the first full year's operation.

Having gathered these facts, I made my way to Wandsworth to talk to the men who make these recorders and to see where and how they do it. Frankly, my first impressions were mixed, and the "hiding one's light under a bushel" phrase sprang to mind. A stone's throw from the forbidding gates of Wandsworth Prison, *Leever-Rich Equipment Limited* faces the world with the facade of a sober Victorian dwelling house. This contains the offices and commercial departments. Looking out to the rear I saw a sizeable vegetable garden (with some of the largest cabbages I have ever come across) beyond which was a much more recent single storey factory building.

Within this building are the production departments, fabricating almost every part of a Leever-Rich recorder. Largest of these, and easily the noisiest, is the Sheet Metal Department with its power guillotines, presses, gas, arc and spot welding machines used in making metal consoles, cases, trays, chassis, etc.

In a second bay is the production machine shop carrying out turning, drilling, milling, grinding and other machining processes on the component parts of the recorder mechanisms, which are assembled in an adjacent workshop. In this assembly shop I became aware that studio tape recorders are not the only products being manufactured and that a range of magnetic film recorders is in production for use in film and television studios. There are very practical reasons for manufacturing both products in the same factory: common amplifier designs, similar control circuits, spooling arrangements and in general similar manufacturing skills, yet Leever-Rich is the only firm in this country manufacturing for both professional film and tape recording markets.

This use of common manufacturing facilities and skills is also to be seen in the magnetic head department, where heads for both purposes are in course of manufacture. Indeed certain types such as 4-channel on 25.4 mm tape and 35 mm film are identical for the two applications.

The sections dealing with the assembly and wiring of amplifiers, and wiring of control

circuits, also produce accessory products such as *Leeraser* tape demagnetisers and audio equalisers.

The final adjustment and testing of finished machines is carried out in a separate suite of rooms. Here each completed machine faces a rigid programme of tests covering every aspect of its performance specification. This may take several hours for one of the standard recorders. For the more elaborate installations the whole process may take days, but the test department is the most vital operation in maintaining a company's reputation, and everyone here seems to realise that.

The variety of machines on test gives some idea of the range of the firm's products. The greater part of production is concerned with the standard *Series E* audio recorder and its derivatives. This machine is now in its *Mk 5* version and although little changed in appearance and mechanical design from its earlier generations, it has been progressively improved in performance and refined in detail to keep abreast of the continual progress in magnetic recording techniques and materials. This steady improvement has been possible without fundamental redesign because the original mechanical design employed a form of unit construction in which such items as capstan drive unit, head unit, spool motors, and control pack, were both accessible and easily removed as complete assemblies for service or, as sometimes occurs, for modification to suit new requirements. Thus, special models for purposes such as high speed copying, long duration monitoring, or speed lock to a reference time base, can be produced without undue difficulty.

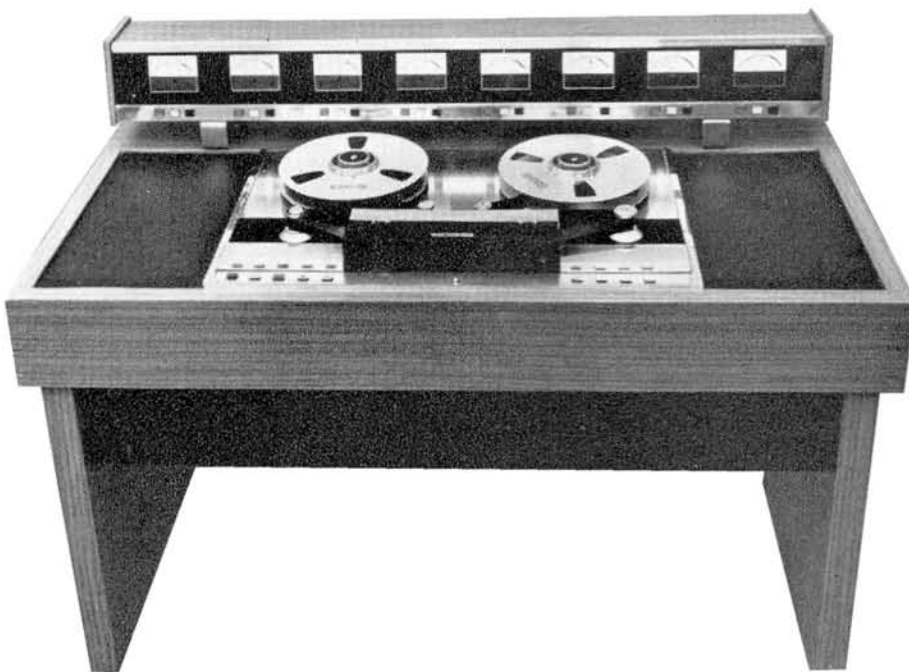
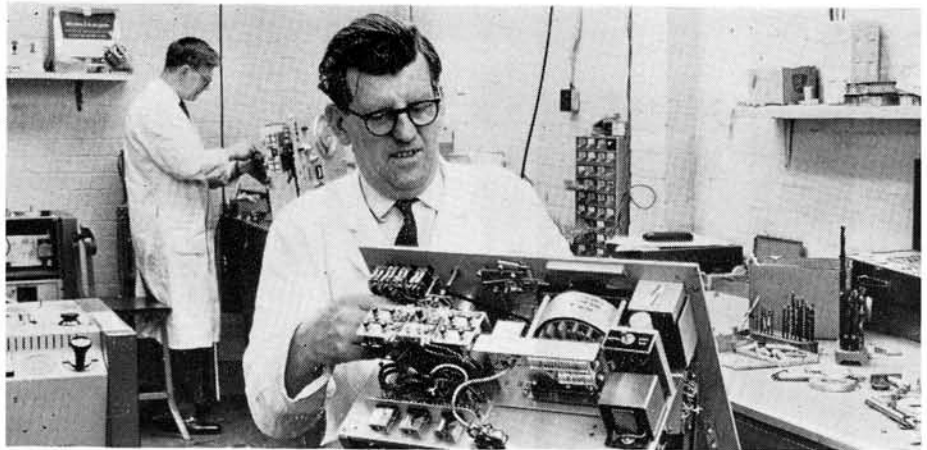
The removable plug-in head unit containing the erase, record and replay heads held in accurate alignment has been a notable feature of all Leever-Rich models since the firm began operations in 1951. It enables the machine to be converted from one track format to another in a matter of minutes, and in the case of the 6.25 cm model *E242* covers 1/1, 1/2, 2/2 and 2/4 arrangements (i.e. full track, 1-track, twin 1-track and twin 1-track).

The unit itself consists of a ground steel base carrying the connecting plug and the three head cages—separate Mu-metal screening boxes in which each head is mounted with a three-dimensional screw adjustment. The erase head is a ferrite cored two-gap type,



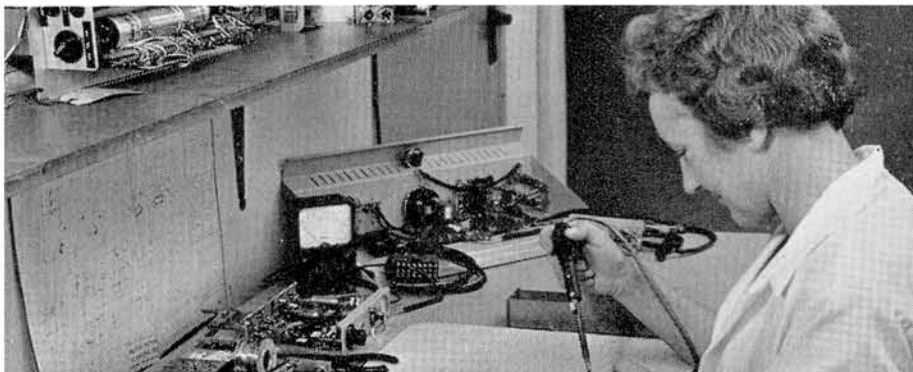
Left: Model E transportable recorder.

Right: Work progressing on slow-speed BBC recorders in the Engineering Assembly Department.



Above: The new Model R multi-track studio console.

Below: Production of printed circuit boards used in Series E recorders.

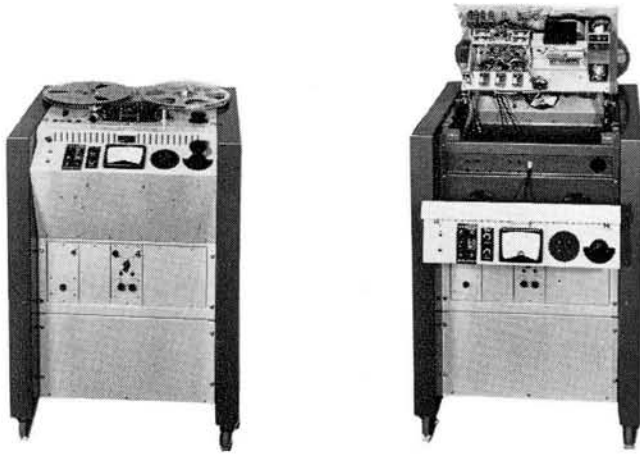


while the record and replay heads incorporate laminated Mu-metal cores with gap and pole face surfaces hand lapped to a micro-finish to achieve the high resolution required. Since separate record and replay heads are always used, there is no compromise on gap length, that of the record head being set at 25 microns ( $\mu$ ) to secure low noise-level with the 100 kHz oscillator used, while that of the replay head is 2.5  $\mu$  for maximum resolution of the very short wave lengths at the top of the frequency spectrum. The pole face is contoured to avoid the irregularities in LF response often met with due to head wavelength effects.

So fine is the finish obtained on the pole face that a microscope is necessary to see the replay gap. I asked a test engineer "how do you know the gap is 2.5 $\mu$  if you can barely see it—let alone measure it?" To which he replied, "We don't measure the gap itself, we measure the gap spacer, then after assembly we use electrical tests to ensure the correct mating pressure against this spacer." Cross checking by measuring the frequency at which head output dips to a nul (i.e. at which wavelength on tape equals the effective gap length), has proved the method to be very reliable. A further question as to how long a head lasts before it is worn out proved slightly tactless, the reply being "No professional would use a head to the point where it is worn out. We recommend that heads be changed as soon as the measured inductance has dropped to half its rated value."

With the exception of the motors, which are made by Croydon or Papst, every mechanical component is made within the factory under strict quality control and inspection. The wide use of ball races, light alloys, appropriate protective finishes, all speak of instrument engineering practice applied to a mechanism which has been designed to operate for many years without deterioration. I noticed, for example, that substantial machined bars and sections are used for the various operational linkages where one so often sees pressings and stampings of sheet metal used in other makes.

The deck itself is of pre-stressed Dural plate, machined to close tolerances, which is hinged at the rear so that it may be easily raised and locked open for access to the underside. It is so easy to get at any part of the recorder that there is really no excuse for neglecting the routine inspection checks  
*(continued overleaf)*



**Left:** BBC version of the Series E console. Mechanism and amplifiers are readily accessible for maintenance.

**Below left:** Manufacture of head shells.

**Below right:** Assembly of data recorder for flight simulator programming.

**Bottom left:** Assembly of a magnetic head.

**Bottom right:** 16 mm magnetic film transfer system.

employed by the larger commercial users, and this no doubt contributes to the reputation for reliability in use.

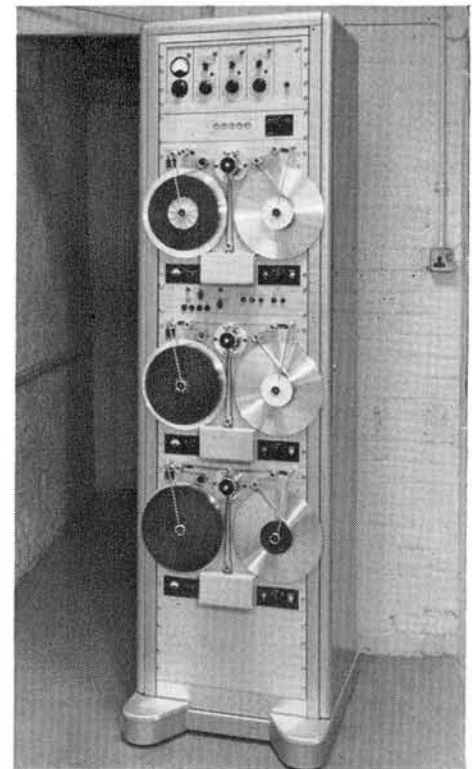
The tape transport employs three motors, the spool motors being of the torque type fitted with large brake drums and fail safe solenoid brakes. When in the fast wind mode, the tape motion can be continuously controlled from *fast rewind* to *fast forward* by means of a large potentiometer, a very useful facility for editing purposes. The capstan unit comprises a two-speed switched-pole hysteresis-synchronous motor mounted in line with the capstan shaft, to which it is coupled by a low-pass mechanical filter, the capstan shaft carrying a balanced flywheel. Thus motor hunting or flutter is filtered out and does not appear at the capstan shaft itself. Watching flutter tests being carried out, I became aware that in this firm a specified 0.1% RMS flutter figure does not mean you *can* achieve this figure on a good machine if you are lucky, it means that on no machine do you exceed this limit at any part of any sized spool in practice and the test engineers are concerned if they exceed half this figure on test.

The tape path, after leaving the left hand spool, passes round a sensing jockey roller to the spinwheel on the left, which is free running and carries a stroboscopic speed indicator for tape speeds of 38, 19 and 9.5 cm/s. The jockey/flywheel combination isolates the tape motion at the heads from the effects of bent spools or sticky splices, etc., occurring as it leaves the feed spool.

Passing on through the head group and capstan pinch, the tape finally drives a digital timing indicator which guides it on to the take up spool. As is customary on professional machines, no pressure pads are used in order to avoid flutter due to head friction, and wear of polefaces during fast spooling is overcome by two ceramic lift pins which normally hold the tape clear when spooling.

For editing purposes, it is necessary to listen off tape when spooling and a control button is incorporated to lower the tape on the replay head only, when required.

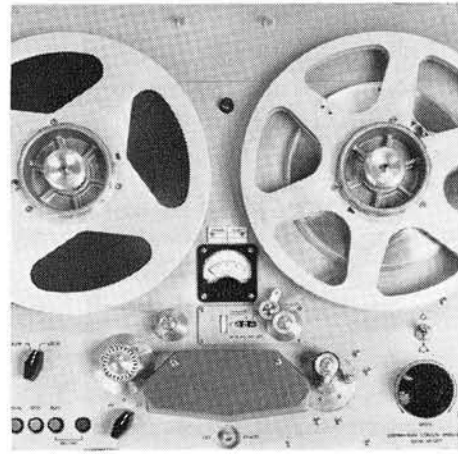
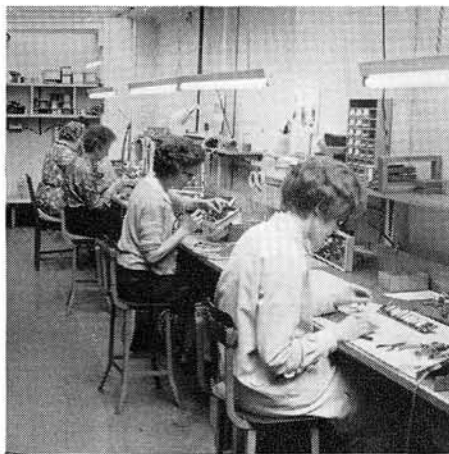
The functioning of the machine is controlled by a set of four illuminated push buttons, *spool*, *stop*, *play* and *record*. These actuate the main control relays in the correct sequence in each function, so avoiding risk of tape damage. For example if the machine is recording, pressure on the *spool* button will cancel the record circuits, open the pinch, lift the tape and



Right: General view of Wiring Department.

Far right: Plan view of the Series E deck.

Bottom right: An eight-channel R.165 undergoing development.



wind at the speed and direction set by the spool potentiometer. On the other hand if tape is being fast wound it would be dangerous to close the pinch, therefore *play* and *record* buttons are inactive until you press the *stop* button and bring the tape to rest.

A selector switch adjacent to the push buttons enables the deck to be switched to remote control, when all functions can be initiated by a similar push button group at a remote point such as a mixing console. In this condition the operation of the machine cannot be interfered with at the machine by accidental pressure on the deck push buttons, but the illuminating bulbs still indicate the function is in use at both machine and remote control point.

As with the deck mechanism, the associated amplifiers also conform to a unit assembly system, in this case of modular form based on five units side by side in the standard 48 cm rack width. Thus a complete recording amplifier forms a 17.8 high by 8.9 cm wide module; the replay amplifier is of identical size, all plugging into a 48 cm frame or nest taking their power supplies from a common supply unit. This system is adhered to, not only in the normal range of multitrack versions of the 6.25 mm *Series E* but also in the larger 12.5 mm and 25 mm machines coded *Series H* and *Series G*.

These larger machines follow the mechanical layout of the *Series E* but are built on an even more substantial deck plate with larger motors and of course the appropriate changes in pulley, capstan and head dimensions. Originally designed for data recording and instrumentation use, they are increasingly being purchased for four and eight channel mastering purposes in the larger disc recording studios.

I was interested to observe the differing emphasis placed on performance as between a standard audio recorder and the same machine in data recording form. A 38 cm/s audio recorder is designed to satisfy BS 1568 and uses CCIR/ISO equalisation, i.e. it is equalised to be within a total error of 2 dB for a bandwidth from 50 Hz to 15 kHz (in practice they are tested to give this accuracy up to 18 kHz). Unweighted signal-to-noise ratio will be 60 dB with 1/1 track. A data machine will be equalised on a constant recording current basis—no recording pre-emphasis—and, with the same tape speed and heads as the audio machine, will be within  $\pm 2$  dB from

50 Hz to 25 kHz. However, the effective unweighted signal to noise ratio will be some 10-12 dB less. *Which all goes to prove that when reading maker's frequency response figures on audio machines, wide frequency response is not in itself a desirable aim and will often involve serious penalties in regard to noise and distortion which make the actual recordings sound unpleasant to the ear, particularly when one or more generations of re-recording are carried out.* (Our italics—Ed.)

During my visit I saw a number of highly interesting tape recorders for special applications, including four-channel machines using the FM carrier system destined for programming aircraft flight simulator installations. Also a variant of the *Series E* carrying a replay head on a miniature lathe slide which permits the phase angle between tracks to be varied over a wide range.

This is a valuable research tool in autocorrelation work and the machine I saw was being supplied for a research project which involves investigation of the sonar system by which bats 'see' in the absence of light. Perhaps the Flanders and Swan *Song of Reproduction* was not so far-fetched after all.

One of the most impressive uses of the *Series E* machine is in tape copying plants, many of which have come into use in recent years, both in the pre-recorded tape industry and in educational establishments. The conditions of use are very severe, the machines working virtually all day long at speeds of 76 or 38 cm/s. Careful monitoring of every copy at normal running speed is completely impracticable in this sort of operation, and accordingly the penalties of any gradual deterioration of quality, let alone a complete breakdown, can be both embarrassing and expensive, particularly if a fault is not detected immediately.

A typical copying system I saw under construction comprised a master tape reproducer and five slave recorders, all mounted in a three-bay 48 cm rack. Its output capacity is more than 230.5 hour tape copies per eight hour day. At the maximum speed, the recorded frequency spectrum extends to over 100 kHz and calls for RF wiring and circuitry. The bias oscillator runs at 440 kHz and effective shielding has to be employed.

Another interesting machine based on the same tape transport is the *S.T.2* recorder-reproducer. This embodies the *Syncropulse*

interlock system pioneered by Norman Levers in the early 50's and records a synchronising control tone adjacent to the audio track. On reproduction this tone is used to control the capstan motor which is of the servo type. This feature is particularly valuable where recordings must be reproduced in accurate synchronism with film. In recording, the capstan motor speed is compared with the mains frequency (or other time base) and locks-in rather like a synchronous motor. On replay, the control tone on the tape is compared with the same time base and controls the capstan motor in a similar way to re-establish the exact tape speed. So far so good, but some half dozen different types of synchronised tape recorder are now in film and television use, each with a different track arrangement and time base pattern, and the transcription departments of studios are required to deal with all of these.

The *S.T.2* deals with these problems, having interchangeable head units to suit the various track formats, and a choice of time base and pulse shaping circuits for deriving the motor control information. The circuitry of such a device must necessarily be complex, yet all the units are arranged in an orderly pattern for easy maintenance, and the controls are so arranged that after a short driving lesson from the chief test engineer, Peter Harding, I felt I had acquired reasonable operating proficiency.

The *S.T.2* is normally used for tape-to-film transcription work in conjunction with the *Series F* magnetic film recorder, of which three main types are in production. These are called *F8*, *F16* and *F35*, taking 8 mm, 16 mm and 35 mm film respectively. Here, as with the *Series E*, a standard basic mechanism is

(continued on page 599)





# SONY

All the way and back again...TC-560D, SONY'S ingenious auto-reverse tape deck. The secret is E.S.P. (Electronic Sensory Perceptor), which automatically changes tracks and reverses the tape at the end of the recorded signal. This means uninterrupted stereo reproduction over the full length of the tape. *Recommended Retail Price £174.*

## Specifications

**Recording system:** 4-track stereo/mono recording and playback

**Power requirement:** AC 100, 110, 117, 125, 220 or 240V, 50/60 Hz  
16 watts, DC 12V

**Tape Speed:** 7½ ips, 3¾ ips, 1⅞ ips

**Reel capacity:** 7" or smaller

**Frequency response:** 20 - 21,000 Hz at 7½ ips  
50 - 17,000 Hz ±3dB at 7½ ips  
20 - 15,000 Hz at 3¾ ips  
20 - 8,000 Hz at 1⅞ ips

**Signal-to-noise ratio:** Better than 52dB

**Wow and Flutter:** Less than 0.15% at 7½ ips  
Less than 0.2% at 3¾ ips  
Less than 0.35% at 1⅞ ips

**Harmonic distortion:** Less than 2.5% at normal recording level

**Level indication:** Dual VU meter

**Fast forward and rewind time:** Within 2 min. 20 sec (1,200' tape)

**Inputs:** Microphone input jack: Sensitivity: -72dB (0.19mV)  
Impedance: 600 ohms  
Auxiliary input jack: Sensitivity: -22dB (61mV)  
Impedance: Approx. 100K ohms

**Outputs:** Line output jack: Output level: 0dB (0.775V)  
Impedance: 100K ohms  
Headphone jack:

**Output level:** -29/-38dB (28/10mV)  
**Impedance:** 8 ohms

**Dimensions:** 16¾" (W) x 6¼" (H) x 15¼" (D)

**Weight:** 28 lbs, 11 oz

**Accessories:** Empty reel R-7 A ..... 1  
Connecting cord RK-56 ..... 2  
Head cleaning ribbon ..... 1  
Reel cap ..... 2  
Dust protector DP-560D ..... 1  
Power cord ..... 1

**SONY**  
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Ascot Road, Bedford, Middlesex.



The National NV-1020E  
By Richard Golding

## CLOSED CIRCUIT



THE National NV-1020E is the latest low-priced helical-scan VTR from the Matsushita Electric Company of Japan to make its appearance in this country. It has undergone continual development while being used extensively in education and industry in Japan and now embodies several unique features of special interest to potential users over here. Among these is a still-picture control, an automatic head-cleaning button, an idler arm which stops the drive motor immediately if the tape happens to break, piano-key control for mechanical operation, and complete compatibility with all other 1020E models.

There are many variations of the helical-scan principle; some recorders employ a single head with a 360° tape wrap, with either an omega or an alpha tape path; other recorders use two heads with a 180° tape wrap; and one recorder, still in prototype form, uses four heads with a 180° tape wrap and a very complicated system of guides. All these systems are designed to achieve the very high writing speed necessary to record the detail in the TV picture. Writing speed refers to the effective head-to-tape speed, not the speed at which the tape passes through the transport, although this is important in audio-track terms and one would not expect to find a tape speed used that was lower than 15 cm/s. The writing speed in quadruplex studio VTRs is very high, and to achieve the resolution required in broadcast application it is in the order of 3800 cm/s. In the type of work required in education and industry, at least 760 cm/s is necessary.

The writing speed of the National NV-1020E is 1232 cm/s. This is achieved by using 12.5mm tape with a rotating two-head system, the tape being wound around half the drum in a 180° helical loop. The two video heads are mounted 180° apart on the head-disc assembly which rotates at 1500 r.p.m. thus recording the required 50 interlaced fields per second on slanting tracks across the tape. The slant is effected by placing the feed spool on a higher plane than the take-up spool and by giving a pre-determined inclination to the video head tracking on the tape. As the tape speed used is 24.9 cm/s the resultant writing speed is well above the minimum required.

There are three other heads in use. A combined audio control head records audio signals with AC bias on the top edge of the tape, and the control signal on the bottom edge. The control signal synchronises the rotating speed of the head against the vertical sync signal present in the video signal. The second head is a full-width erase used except when the machine is set in audio mode only. The third is the audio track erase for audio dubbing purposes.

The automatic head-cleaning button is set just above the head-disc assembly housing. This may be depressed when the recording appears to suffer through undue head clogging. It is an important factor with video that the tape should be in intimate contact with the head at all times, and that the head-gap should be very narrow. Generally the gap of an audio tape recorder is approximately 5 microns which enables it to record frequencies of up to 20 kHz; in video, however, the HF region is at least 150 times that of an audio recorder and so requires a head-gap as

narrow as 1 micron. The video head is subject to the accumulation of oxide and dust during use which, of course, degrades the recording and reproduction quality. The automatic head cleaning button requires only an occasional operation, for one or two seconds, and entirely removes the risk of physical damage to the heads.

The other controls on the deck are situated front right. Five press tabs govern stop, fast rewind, fast forward, play and record. The tape transport principle is conventional. When AC power is applied, the capstan and head motors begin to rotate. The capstan motor is attached to the motor pulley. Capstan fly-wheel, take-up reel, hub, and rewind idler are connected to each other by means of a belt. Therefore, when the capstan motor begins rotation, these satellite mechanical parts rotate simultaneously. When the play button is depressed, the pinch roller engages the capstan and tape transport starts simultaneously. The take-up reel pulley pushes the reel hub slightly upward by means of a clutch. The reel hub is driven by friction between felt placed on the surface of the reel pulley and the reel hub.

To the right of these controls are the video gain controls, the tape counter with re-set button, and the audio VU-meter. All the controls are together within more-or-less the span of the hand.

When the *record* button is depressed, the tape does not start, but the picture to be recorded appears on the screen of the monitor. By observing the picture, the modulation may be increased by turning the *Video control knob* to the right. Excessive modulation will produce a striping effect on the screen; the most desirable recording level is the point just before the stripes appear on the screen. When the adjustment is made, both *record* and *play* must be depressed simultaneously for the recording to begin.

The *audio control knob* contains both power source switching and sound recording adjustment, but it also needs to be used in conjunction with the *record* button. When this is depressed, the pointer of the level meter will swing, and the level should be set so that the needle deflects within the black zone during peak volume of the source material.

A still picture may be obtained and held quite easily on playback, by selecting a suitable moment on the monitor and then depressing the *Stop* button. The video heads still rotate but scan only one frame on the stationary tape. To obtain a clear picture and cut out any bending of vertical lines, the reels may be very slightly inched by hand. There is, however, a *reel handle* available for slow motion and framing.

In a recessed panel in the right-hand side of the VTR are the input and output sockets together with recording and playback phase controls. These should not be adjusted except for the following occasions: recording phase only when the VTR is serviced; playback phase when (1) playing a tape recorded by another VTR, (2) playing old tape, (3) the power source voltage is suddenly altered, (4) the signal-to-noise ratio of the recorded picture is excessively poor. The panel also contains video and audio output sockets, together with

(continued on page 599)

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It has a built-in mixer control, illuminated VU input meters and auto tape-stop.

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Grundig (Great Britain) Ltd. London, SE26



## CLOSED CIRCUIT CONTINUED

power supply, for a plug-in RZ converter unit thus allowing a domestic receiver to be used as monitor if required. A plug-in video adaptor is available to provide signals for use with any type of video monitor.

The NV-1020E uses a synchronous motor which syncs its rotation to the driving signal. The direct driving system is much simpler than a servo system. The head-disc motor is rotated at 1500 rpm and syncs with the vertical sync in the TV signal and the contacting period of the head against the tape becomes 1/50 sec. Noise is unavoidably created at the moment of head switching. If noise appears in the image it distorts the picture, so to eliminate this problem it is necessary to adjust the timing of the switching period a few lines of horizontal scanning above the vertical blanking portion of the TV signal.

In reproduction this operation is identical to recording. The locus recorded by head-A must be traced by head-A in reproduction. This operation is called head-sensing. To match both locus and head perfectly during reproduction, phase adjustment of the reproducing signal becomes necessary, for if the heads are tracing outside of the recording locus the signal to noise ratio and picture quality will be degraded.

As both phase controls are pre-set, there should be no need to adjust them except for the four conditions noted above.

The 40 dB signal-to-noise ratio is acceptable for industrial work. For any serious work performance needs to lie between 36 and 42 dB, while anything above 42 dB is likely to be wasted by shortcomings in other items of a CCTV system. The signal-to-noise ratio of a VTR generally improves with initial use as the head surface beds in, thus promoting more intimate contact with the tape. The bedding-in time varies, but optimum performance is

usually reached after about 40 hours of recording. The life of a head varies too, and can last 2000 hours. The National heads carry a guarantee of 500 hours or 3 months whichever is reached first, with replacement sets available at £25 per pair.

The price of the VTR is £398 and this includes take-up spool, a 2.5 metre AC cable 1.5 metre video cable and splicing tape. Beulah Electronics also distribute a great variety of ancillary TV equipment, including TV cameras and tripods, remote control camera panning units, monitors, and a very interesting Special Effects unit.

The National *Special Effects Generator* is an extremely versatile unit that, in view of its low price (£150), may be of special interest to CCTV operators already established. It allows a variety of special effects such as superimposition, fade-in and fade-out, and horizontal, vertical and corner-inset wipes. It accepts three signal inputs of TV cameras (composite 1.4 V p-p) and provides composite output. Two optional TV cameras out of three can be selected by operating the Camera Selector Switch. An external sync input connector is provided so that all TV cameras connected to the device can be converted to perfect 2:1 interlace by the addition of the National Sync Generator. The price of the latter is £165.

Beulah Electronics operate a Video Industrial Training Plan to enable companies to hire a complete CCTV system including VTR and Special Effects unit, if needed, for a few pounds weekly leasing charge. Specimen charges are: National TV Camera with 13 cm viewfinder, NV-1020E VTR, 63 cm Tutor Monitor and UHF/VHF Receiver:

Leasing charge	£4 11 10 per week
Less 42½% Corporation Tax	£1 19 0
Weekly Outlay	£2 12 10

Purchase Tax is not chargeable on National VTRs and consequently they will not be available for domestic purposes.

## SPECIFICATION OF THE NV-1020E

### Video

Recording system	Two-head helical-scan
TV signal	625 line
Recording time	45 minutes
Tape width	12.5 mm
Spool capacity	18 cm
Tape speed	24.9 cms
Video input	0.5-1.5 Vp-p75 ohms
Video output	1 Vp-p (0 dB)
Frequency response	2.2 MHz
Signal to noise ratio	40 dB
Still picture playback	

### Audio

Microphone input	-60 dB 20K unbalanced
Auxiliary input	-20 dB 1M unbalanced
Output	-20 dB 600 ohms unbalanced
Frequency range	80 Hz-10 kHz
Signal-to-noise ratio	40 dB

### General

Power supplies	117, 127, 200, 220, 230 or 245 V AC 50 Hz
Dimensions	26.6, 43.8, 42.5 cm (h w d)
Weight	23 Kg (51 lb)

### Distributor

**Beulah Electronics Ltd., 126 Hamilton Road, West Norwood, London S.E.27.**

## LEEVERS-RICH CONTINUED

common to all three types, the main differences being in gear ratios, sprocket and roller sizes and, of course, the plug-in head unit.

The film transport mechanism is a very substantially built unit with large torque motors for the spools and a symmetrical tape path of the closed-loop type. Only one film drive sprocket is used and changing speed between 24 and 25 f/s for film or TV standards is accomplished by changing this sprocket, which takes about a minute at the most.

The design is unusual in that no pad arms are used to hold the film on the teeth of the sprocket, nor are they necessary. This means that there are no friction surfaces in contact with the film anywhere and the machine can be used not only for SEP-MAG film (separate sound track) but also for COMMAG (married prints) without risk of damage.

Another unusual feature is the magnetic clutch in the drive to the sprocket which not only facilitates adjusting the start position of the film but also permits fast rewind without unthreading.

The chief engineer, Arthur Barr, pointed out

to me the special changeover facilities on the F8 model which accommodate either 8 mm or Super 8 mm and I felt prompted to ask who on earth would buy a machine like this to record 8 mm movies. "Probably no one" he said, "but we are selling quite a number in fast copying plants for producing 8 mm copies from 16 mm and 35 mm masters—it's about the only machine which will stand up to this sort of service."

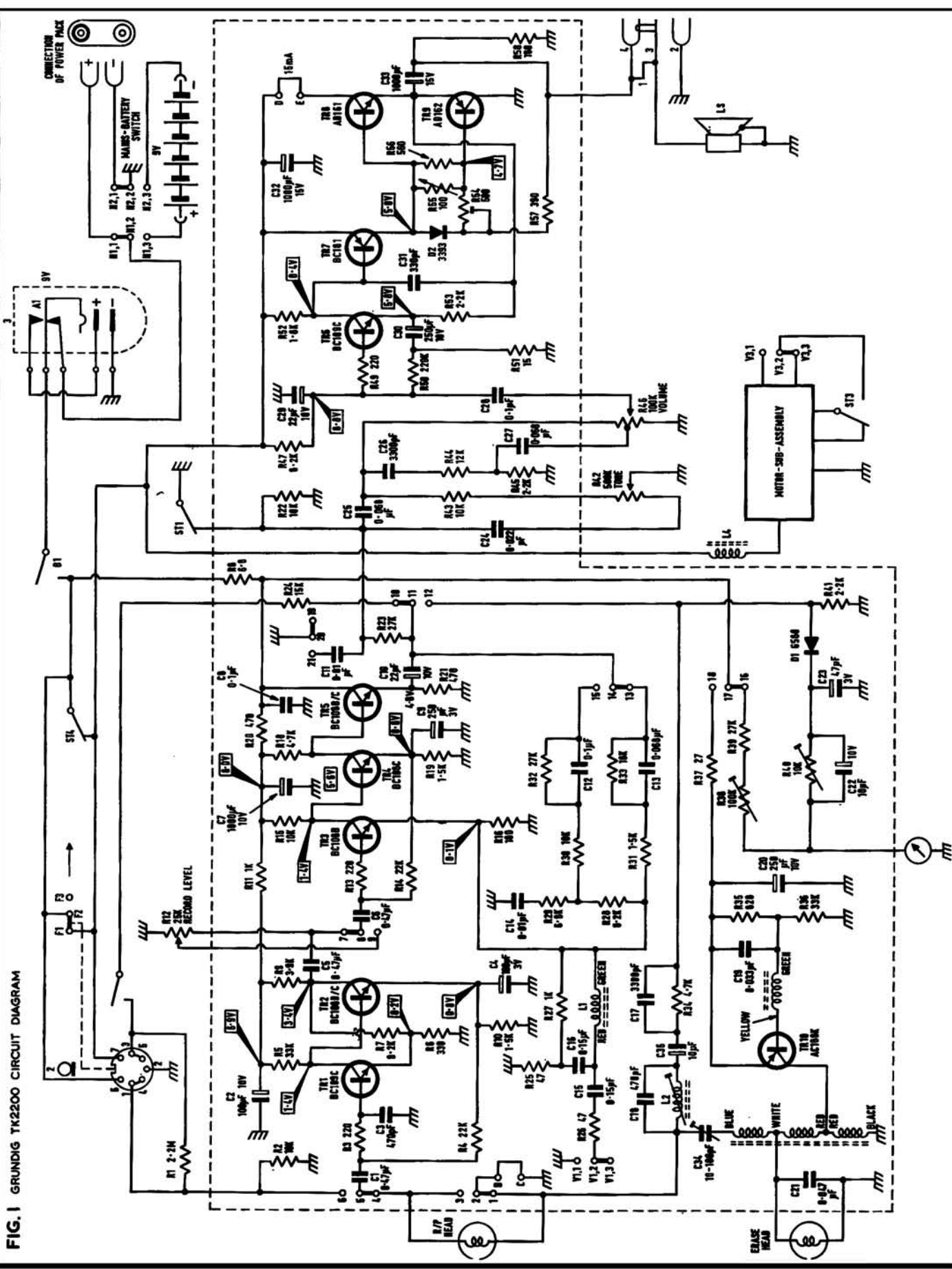
Most manufacturers are understandably shy about letting visitors prowl about their development departments, but I did manage to have a talk with Robin Bransbury who has been working on the new series of recording and replay amplifiers, and who showed me prototypes of the models which go into production in December. These have been designed particularly to suit the increasing requirements of multi-track selective recording machines, especially where facilities for simultaneous replay from the record head stack is required. They are very compact and a full complement of four record and replay amplifiers occupies only 17.8 cm of rack space, including oscillator and power unit. The record amplifier module contains its own record,

equaliser and monitor relays, and a plug-in equaliser network permits rapid change of speed range, or NAB/CCIR standard. The latest transistor and integrated circuit types have been used, and a power amplifier for bias and erase is included, working from a master oscillator in the power supply unit.

The associated replay amplifier has a similar plug-in equaliser arrangement. As with all professional equipment the output level is nominally 0 dBm into 600 line and in this case the clip level is +20 dBm.

During a final chat with Norman Leever and John Alcock, his sales executive, I made suitable complimentary remarks about the pioneering work done by this, one of our longest established firms in the recording field, and was agreeably surprised to find both these men much more interested in discussing forward plans for their products and how they will satisfy the studio requirements of the future. A new range of multi-track tape consoles, new styling, an original approach to constant speed drives—all these are in the pipe line and served to whet my appetite for a second visit which I look forward to in due course.

FIG. 1 GRUNDIG TK2200 CIRCUIT DIAGRAM



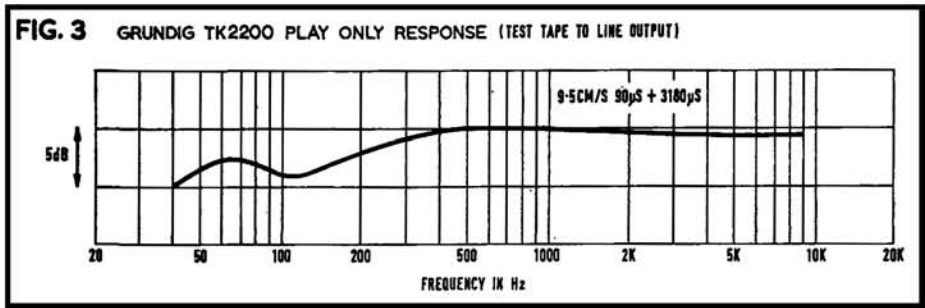
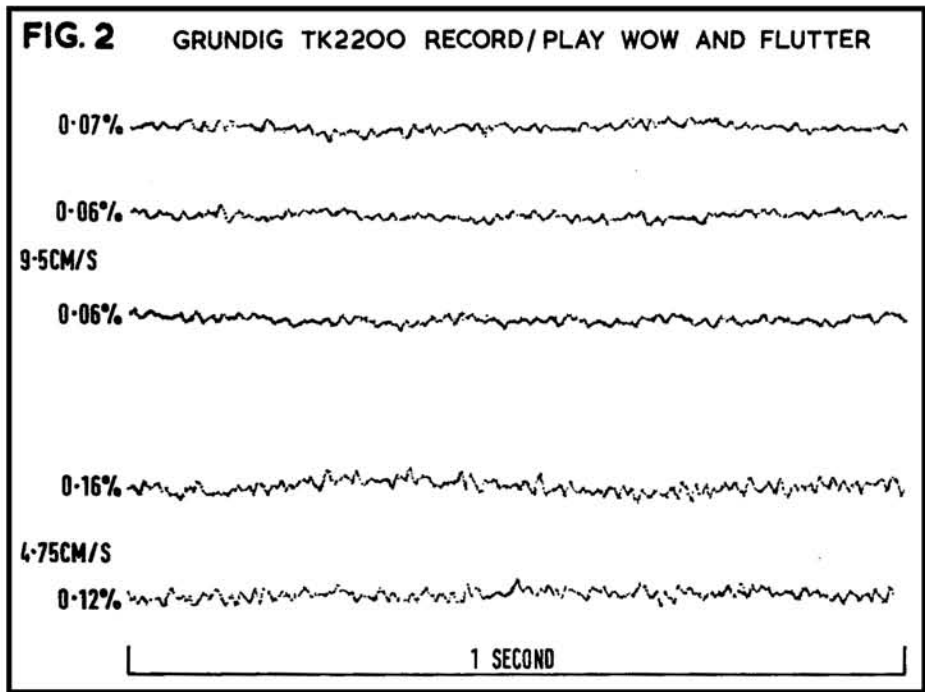
# equipment reviews



GRUNDIG TK2200

**MANUFACTURER'S SPECIFICATION** (9.5 cm/s). Battery powered  $\frac{1}{4}$ -track tape recorder. **Frequency range:** 40 Hz-15 kHz. **Signal-to-noise ratio:** 47 dB. **Wow and flutter:**  $\pm 0.25\%$ . **Power supply:** Six U2 cells or equivalent, or TN12 mains power pack. **Tape speeds:** 9.5 and 4.75 cm/s. **Spool capacity:** 13 cm. **Weight:** 12.5 lb. **Dimensions:** 35 x 21 x 10.5 cm (l x w x h). **Price:** £96 12s. including purchase tax. **Manufacturer:** Grundig Werke GmbH, 851 Furth, Kurgartenstrasse 37, West Germany. **Distributor:** Grundig (Great Britain) Ltd., London S.E.26.

THE upright styling of this machine has allowed the loudspeaker to be placed on one side of the case and the spools and drive mechanism on the other. The controls are on the top of the recorder and the batteries, or power pack, are inserted by removing a slide plate at the bottom of the case. The tape motion controls are rectangular press buttons labelled *stop*, *start*, *pause*, *wind* and *rewind*, with a round press button for *record* which is locked down by simultaneous operation of the *start* key. A three-digit tape position indicator, with press button reset, is conveniently placed at the right hand end of the control area and this is driven from the take-up reel with 10 turns of the reel clocking up 7 digits. At the left hand of the panel is the playback volume control which looks like a double edge operated control, but the two drums are locked together. The other control, on the other side of the record level meter, is a true double control with the front drum operating as record level control and the rear one acting as playback tone control—bass cut on clockwise rotation and



treble cut on anticlockwise rotation from a central level-response position.

Full wind or rewind of a 13 cm reel of LP tape (900 ft) took a fraction over two minutes in either direction, but wind or rewind on to a nearly full reel was rather sluggish and sometimes needed a helping hand to get things moving.

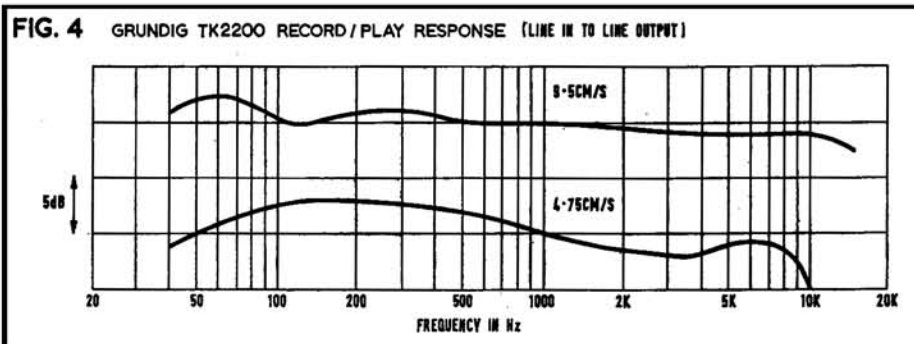
Long term tape speed was constant from beginning to end of reel but the mean speed at 9.5 cm/s was nearly 2% fast and is therefore

near the top limit at this speed. At 4.75 cm/s the speed was 1.4% fast. This is one of the few recorders where the speeds *can* be adjusted by pre-sets in the motor control electronics, but I will leave Mr. Hellyer to sort out the exact procedure in his excellent service notes.

Short term speed fluctuations were extremely small as will be seen by the fluttergrams of fig. 2. The meter readings were very steady and it was not possible to phase the record and play cyclical speed variations to build up a steady high value. This shows that the speed fluctuations are fairly random in nature so that cumulative record-play adding is unlikely. A low wow and flutter test tape also read 0.06% RMS at 9.5 cm/s. At the lower speed, a 1.5 Hz wow can just be seen on the top trace, giving a cumulative reading of 1.6% RMS. This is much lower than the capstan rotation frequency and is probably due to a slightly eccentric pressure roller.

The contra-rotating flywheels seem to be effective in maintaining a constant tape speed despite severe agitation of the recorder. Shaking the recorder with a twisting motion in the plane of the flywheels, so that the take-up

(continued on page 603)





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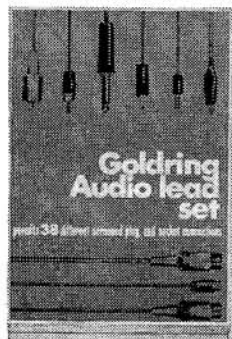
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Standard Play	Length	English price	German price
3"	150'	2/6	2/-
4"	300'	4/-	3/6
5"	600'	9/-	6/6
5½"	900'	11/6	8/-
7"	1200'	16/-	10/-
Long Play			
3"	220'	3/-	2/6
4"	450'	6/-	5/-
5"	900'	11/6	9/-
5½"	1200'	16/-	10/6
7"	1800'	23/-	14/-
Double Play			
3"	400'	6/-	4/-
4"	600'	8/6	7/-
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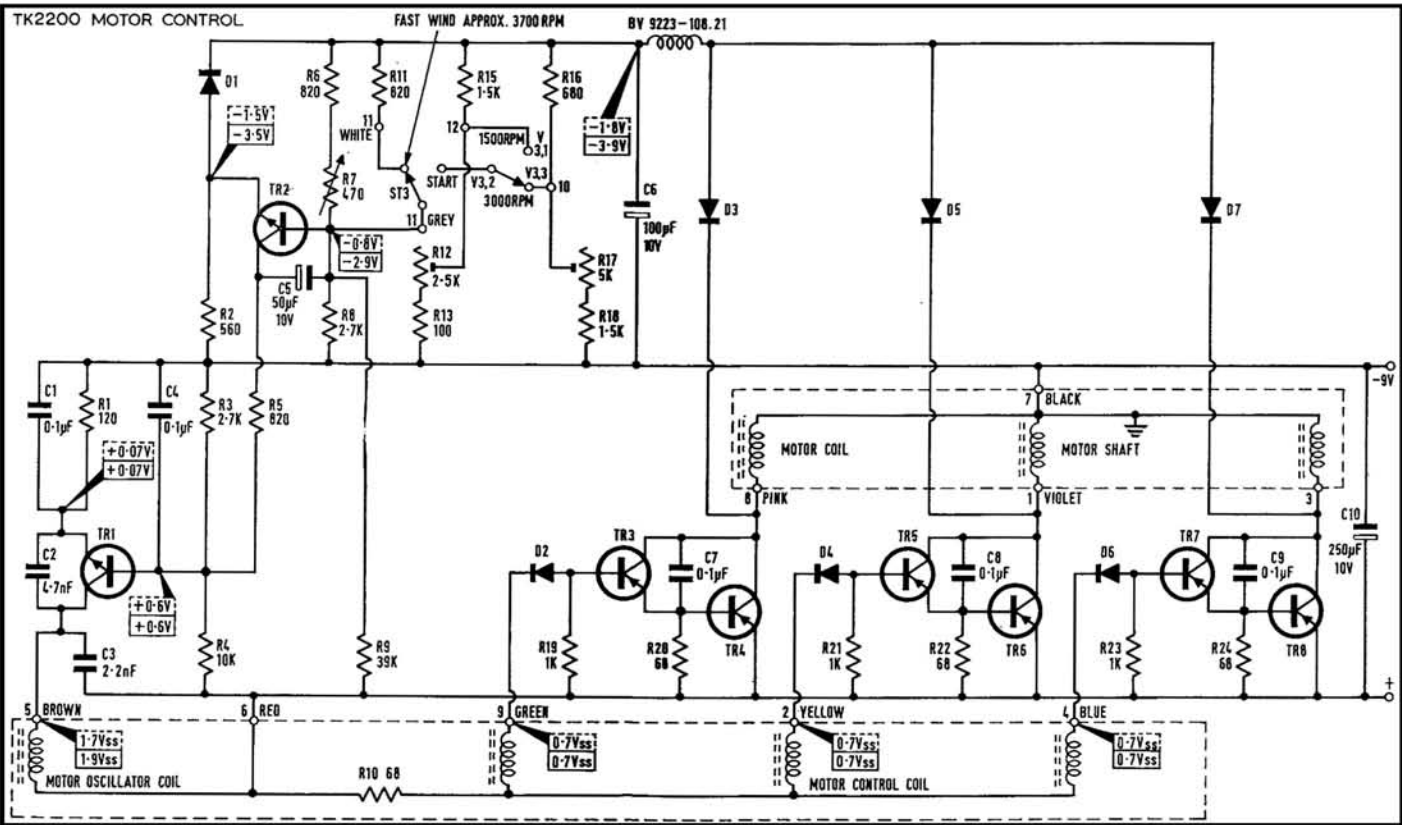
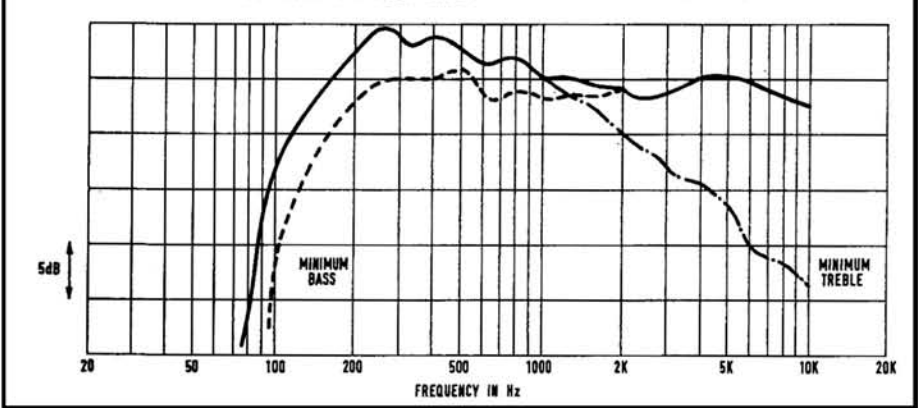
Phone: 53020

reel was momentarily stopped with a slight spillage of tape, produced no wow, in fact the only audible effect was a slight chirp as the take up reel took up the slack and jerked the tape slightly.

Fig. 3 shows the playback response to line output while playing a 9.5 cm/s test tape recorded to the new 90  $\mu$ S characteristic with bass pre-emphasis of 3180  $\mu$ S. It will be seen that, despite the bass rise on the tape, the playback response falls slightly at low frequencies.

Fig. 4 shows that extra bass pre-emphasis is used in the recording process to give a more even response and that the high frequency

FIG. 5 GRUNDIG TK2200 ACOUSTIC RESPONSE (WHITE NOISE TO SPEAKER SOUND OUTPUT)



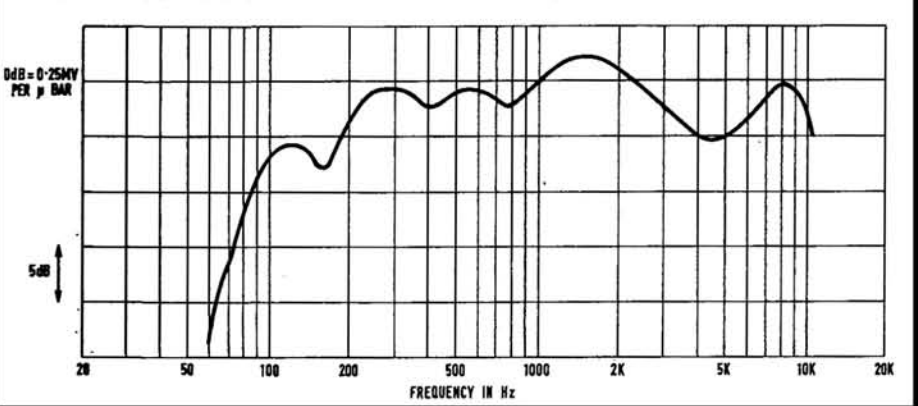
recording characteristic is close to the desired 90  $\mu$ S response. At 4.75 cm/s, the response is not quite so level, but is within  $\pm 3$  dB limits over the range 40 Hz to 9 kHz range.

System noise, with no tape passing the heads, was at the extremely low level of 47 dB below test tape level or 59 dB below peak recording level.

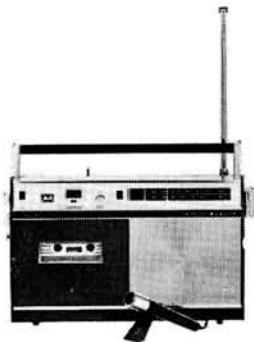
Recording distortion measurements at 1 kHz using BASF LGS35 tape showed 3.5% third harmonic distortion with the record level meter pointer just entering the red sector of the scale. Unweighted noise after erasing peak recording was 55 dB below peak recording level.

The acoustic response of fig. 5 was obtained by recording 25 one-third octave bands of  
(continued on page 605)

FIG. 6 GRUNDIG GDM 305 MOVING COIL MICROPHONE (1K)



# NATIONAL TAPE RECORDERS



**RQ.231/S.** Combined tape recorder and radio. This takes the Philips-type cassettes, incorporates VHF and MW wavebands, and will record from microphone (included), or from radio receiver. Dual mains/battery, sound monitor (public address system). One-touch lever operation, VU meter and battery check, tone control, A.F.C. switch, accessories supplied, remote control microphone with stand, C.60 cassette, and earphone. Complete at 67 gns.



**RQ.194/S.** The latest from National is the new four-track mono tape recorder, which offers more use and more fun in recording, and has features, usually only found on very expensive and larger machines. It lets you make multiple recordings, with sound-on-sound, and sound-with sound, e.g. tape some music, and then sing along, as you tape again. Presto! You are singing with an orchestra! It has automatic record levels, and it also changes automatically, from mains to battery, as required. Other attractions, are its monitoring system, two-speeds and attache-case styling, 5in. spools, P.A. system, and easy push-button operation. Complete with accessories, only £70.70.



**RQ.401/S** New system, records and plays, backwards and forwards. Features: mechanical reverse, automatic recording, Dual mains/battery, sound monitor, P.A. system, 2-speeds (3½ and 1½ i.p.s.), fast forward-rewind, record level and battery check, 4in. spools, 2-track, and complete with accessories. Priced at £39.17.2.



**RS.766/US.** Stereo tape-deck. Solid state.  
 ★ Stereo tape-deck with quality internal mechanism, inclusive of high performance, record amplifier, and playback pre-amplifier.  
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 ★ 3 tape speeds (7½, 3½, 1½ i.p.s.).  
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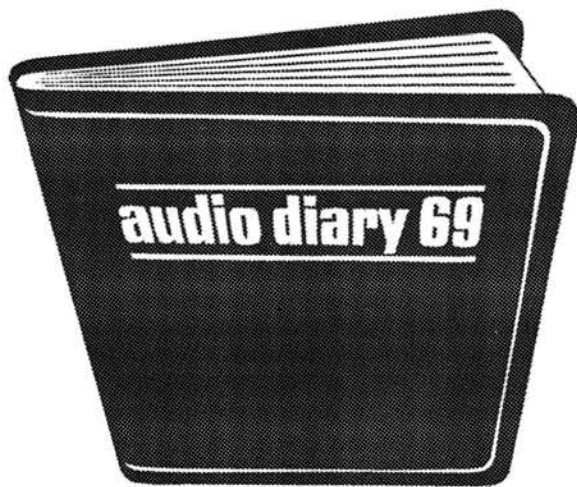
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filtered white noise and then measuring the sound output on the speaker axis during replay. The 'level' response position of the tone control gives a slightly bass heavy sound quality and the clockwise bass cut setting gave a response level within 3 dB limits from 200 Hz to 10 kHz.

The microphone response of fig. 6 was also measured using the white noise technique. The dip in the mid HF range from 3 to 6 kHz makes some voices sound slightly dull on this recorder.

The circuit diagram reproduced with this review shows that direct coupling of groups of transistors with DC feedback over as many as three stages is used for high thermal stability. The 'brushless' motor control is worth

attention as the current to each coil of the motor is switched in sequence through pairs of transistors which are biased 'on' by rectified high frequency signals derived from a rotating coil high frequency commutator. The back-EMF from the unswitched coils, which is directly proportional to the motor speed, feed a control transistor which alters the HF current to the 'commutator' so that the mean speed is governed to a high degree of accuracy.

A big feature of this recorder is the excellent signal-to-noise ratio. The system noise, at -60 dB level is a quiet, smooth, white noise, hiss with no vestige of governed motor noise or annoying high frequency spikes.

Wow and flutter remain low under the most extreme handling conditions, in fact I think the term "Easy G" should be borrowed from the advertising of other Grundig recorders and

used for this one in a different way!

The only mild criticisms I can make on this machine are the slightly 'lazy' wind and rewind, which may be a fault in this particular review model, and the location of the tone control. I feel that the proper place for this is for it to be paired with the playback volume control and not with the recording gain control. I also found during my tests that the azimuth of the head was wildly out and nearly two turns of the sealed adjusting screw were needed to bring it into correct azimuth as indicated by the official DIN 45513 test tape.

Nearly £100 is a lot to pay for a portable recorder, but for the true enthusiast, who wants something better than the £25-£35 fixed speed machines and can not afford to rise to the Uher or Nagra, this machine is well worth considering. **A. Tutchings.**

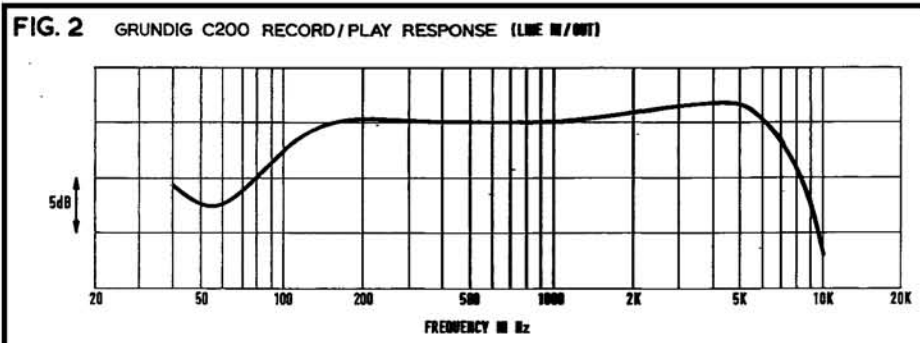
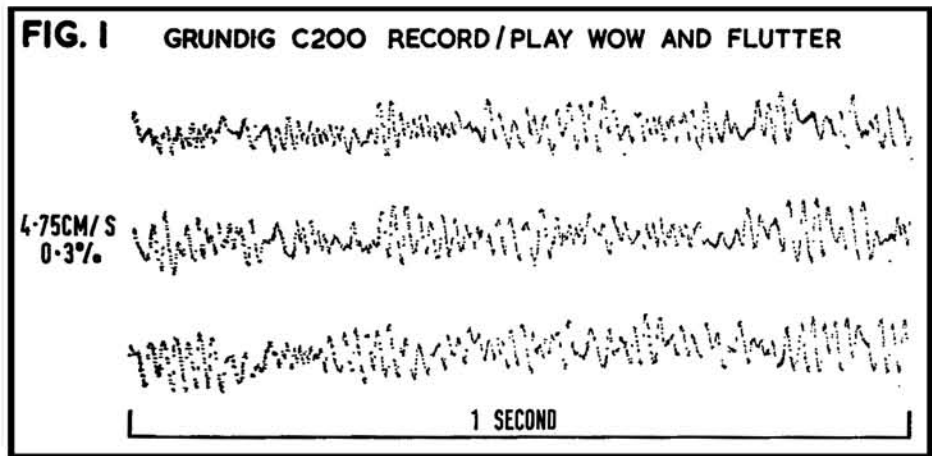
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THIS is the baby daughter of the Grundig TK2200 recorder reviewed on the previous pages. It is obviously female because of its kangaroo pouch cassette loading. Being conditioned by the use of a long line of cassette loaded machines, I dutifully laid this one flat on the table and loaded the cassette in the usual way, only to find that all controls were labelled upside down. Turning it over I found that the speaker was playing into the table top, and it was only on my third attempt that I tried it in the upright position and found, on turning the *Easy G* knob to the cassette eject position, that it was simply asking to be lifted out from its near vertical position.

Mr. Hellyer's comments about the *Easy G* control of the TK145 in the October issue make me hesitate to describe the version in this little recorder. It is certainly easy to use: one turn anti-clockwise to eject the cassette; one



turn clockwise to the *pause* position; and one further step to *record* or *play*, depending on whether the record button has been pressed. Right and left movements of the control give rewind and wind respectively.

The record controls, meter, record key and record gain control are grouped together directly below the centre of the carrying handle so that the fluted edge of the record gain control can be operated by one finger of the hand carrying the recorder. Playback volume and tone controls are much larger edge-operated controls on the right of the simple control panel.

The short term speed variations were mea-  
(continued on page 607)



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Sony TC350...	27	5	0	6	16	3	109	0	0
Beocord 1500...	31	10	0	7	11	8	122	10	0
Tandberg 62/64X	36	18	0	9	0	0	144	18	0
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Philips EL4305...	11	17	9	2	16	8	45	17	9

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Philips EL4306...	14	1	8	3	10	0	56	1	8
Ferguson 3230...	14	13	0	3	13	2	58	11	0
Ferguson 3216...	16	19	0	4	0	0	64	19	0
REPS M10	18	18	0	4	14	6	75	12	0
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Vanguard	18	18	0	4	14	6	75	12	0
Truvox R54	18	18	3	4	14	11	75	17	3
Tandberg 1526...	20	19	0	5	3	4	82	19	0
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Philips EL3310...	10	5	10	2	11	5	41	2	10
Tandberg 1521...	18	19	6	4	10	0	72	19	6
Truvox R52	18	18	3	4	11	7	75	17	3
Beocord 1100	24	10	0	6	2	6	98	0	0
Brenell MkV/3									
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Brenell MkV/3Mtr	28	0	2	7	0	0	112	0	2
Truvox R202	31	14	2	7	15	0	124	14	2
Brenell V/3/M...	32	16	8	8	5	0	131	16	8
Ferroglyph 713	33	18	4	8	9	7	135	13	4
Ferroglyph 713/H	35	16	8	8	16	8	141	16	8

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sured by recording a 3 kHz tone and playing it back into the WHM wow and flutter meter. The meter reading remained fairly steady at 0.3% wide band wow and flutter and 0.1% on wow, where the meter bandwidth was reduced to 10 Hz. The high speed pen recording of the flutter waveform shows that it is mainly 50 Hz flutter from the 3,000 RPM drive motor.

Fortunately the ear is not worried by HF flutter and, although the steady tone sounded slightly 'rough' and uneven, the pitch of the tone remained steady and pre-recorded music on the demonstration cassette sounded very smooth.

The record-play response of fig. 2 shows that the response is level within limits of  $\pm 3$  dB over the 100 Hz to 7.5 kHz range on line output and is worth feeding over the extension lead provided to a better amplifier and speaker. It does not really disgrace itself when fed to a high-quality sound system, and several visitors were very pleasantly surprised at the quality available from a Philips cassette.

The acoustic response was measured by recording bands of filtered white noise and measuring the sound output from the speaker during replay. The bass response is curtailed by the very small cabinet, but is reasonably level from 400 Hz to 8 kHz.

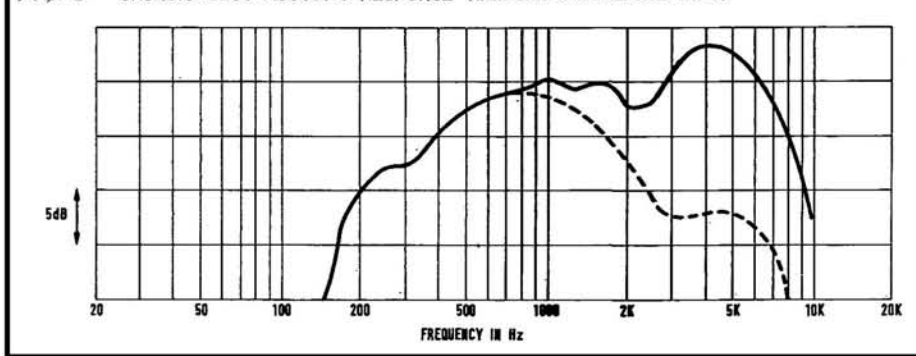
Speech quality from the microphone supplied with the recorder was exceptionally good and a glance at the measured response of the microphone (see fig. 6 of the Grundig TK2200 review) shows that the mid HF dip in response mentioned in the above review is compensated by the broad 4 kHz peak in the speaker response of the C200.

The C200 is practically as insensitive to handling as the larger TK2200 but for a different reason. In this case the mass of the flywheel and the cassette reels are low. Movement is little affected by swinging or spinning the light weight recorder.

At £50 this will hardly take the place of the ubiquitous transistor radio for teenagers, though its appearance is very similar, and one could 'twist', or whatever the modern equivalent is, without upsetting the beat of the music.

A. Tutchings.

FIG. 3 GRUNDIG C200 ACOUSTIC RESPONSE (WHITE NOISE TO SPEAKER SOUND OUTPUT)



THE HARROGATE FAIR CONTINUED

in power amplifiers and multiplex filters, a three speed deck,  $\frac{1}{4}$  or  $\frac{1}{2}$ -track heads to choice, and all-transistor circuitry. With the advent of the low voltage power supply for transistors, Tandberg have abandoned their magic eyes, which are dynamically similar to PPMS, opting for VU-meters instead. Although the change to meters makes sense it is a pity that only the Chilton is left offering the PPMS to those who appreciate this form of level indicator—presumably the majority of domestic manufacturers do not consider the extra cost justified. Of the Tandbergs, only the 6X machines now have magic-eyes. Other new machines included those in the Telefunken room, described in last month's *New Products*—similar in many respects to their earlier models, and identified by a TS reference number.

Dual had a revised version of their tape unit, to be called the CT9 28, probably slightly more expensive than the present unit and, they claim, rather better mechanically. The ganged independent volume controls are retained and the tension sensing mechanism has also been carried over to the new model which can be

used vertically or horizontally.

Outside the exhibition hall, tape and allied subjects were covered by Fred Judd in a well attended lecture on electronic music. Using a Tandberg recorder, Fred played a wide range of examples of electronic composition ranging from odd noises to a computer's very musical if rather monotonous rendering of *Daisy Daisy*. Although the results obtained vary from weird and fascinating to an unpleasant cacophony it was made abundantly clear that much effort and skill is needed to produce convincing tapes.

Tape also gave a convincing account of itself in a lecture by Gilbert Briggs of Wharfedale. Assisted by John Collinson, Bill Jamieson and Frank Thistlethwaite, Mr. Briggs had assembled a string quartet for the purposes of live/recorded demonstration. The recording was made on an Akai 3000 with AKG microphones, and reproduced through Wharfedale speakers the results were extremely lifelike. Although not easily confused with the original, the sounds were very acceptable on their own account, and if the room used was by no means of recording studio quality, the results obtained showed that careful microphone positioning can overcome many other shortcomings, even using what is basically a domestic machine.

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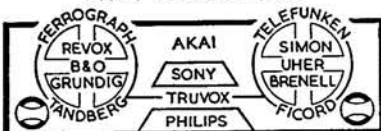
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### MAGNEGRAPH

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

## SITUATIONS VACANT

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

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

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