MAY 1967 TWO SHILLINGS

tape recorder

TAPE DRIVE SYSTEMS — AN AMATEUR SPECTACULAR
REVOX 736/HS REVIEW AND FIELD-TEST — A LOOK AT NUSOUND

SONY research makes the difference

Model TC530 – Features: 4-track stereophonic and monophonic recording and playback ☐ Quadradial (4-way) speaker system ☐ High precision all silicon solid state circuit ☐ Vertical or horizontal operation ☐ "Retractamatic" pinch roller for easiest tape threading ☐ 3-speed, full 7" reel capacity ☐ Tape position indicator ☐ Instantaneous pause control ☐ Two illuminated, calibrated VU meters ☐ Automatic "Sentinel" tape stop ☐ Stereo headset jack.

Specifications:

Power requirements: 65W, 100-125V and 220-240V AC. 50/60 c/s.

Tape speed: 7½ ips., 3¾ ips. and 1⅞ ips. instantaneous switching with automatic equalization change.

Reels: 7" diameter or smaller.

Recording system: 4-track stereophonic or monophonic.

Frequency response: 30-20,000 cps. at 7½ ips. (± 3dB 50-15,000 cps. at 7½ ips.) 30-13,000 cps. at 3¾ ips.
30-10,000 cps. at 1⅞ ips.

Wow and flutter: Less than 0.17% at 7½ ips. Less than 0.3% at 3¾ ips. Less than 0.4% at 1⅞ ips.

Power output: 5W R.M.S. per channel.

Signal-to-noise ratio: Better than 48 dB (at peak record level).

Harmonic distortion: Less than 3% at 0 dB line output.

Level indication: Calibrated VU meter x 2.

Tone controls: Separate controls for bass and treble.

Inputs: Low impedance microphone inputs: transistorised (will accommodate any microphone from 250 ohms to 1 K ohm impedance). Sensitivity –72 dB (0.19mV) High impedance (100K ohms) Auxiliary: Sensitivity –22dB (0.06V).

Outputs: Line outputs: 0 dB (0.775V), load impedance 100K ohms.
Speaker outputs: load impedance 2 x 8 ohms.
Binaural monitor output: will accommodate stereo headset Model DR-3C (10K ohms impedance).
Integrated record/playback connector.

Input: Sensitivity –62 dB (0.6mV) Impedance 10K ohms.

Output: Sensitivity 0dB (0.775V) Impedance 10K ohms.

Dimensions: 19 11/16" wide x 9 5/16" high x 15 7/16" deep.

Weight: 41 lbs. 10 ozs.

Accessories: Stereo recorded 5" tape, 7" reel. Two SONY dynamic microphone (F-96), Integrated record replay connector type RK-46 60c/s Motor pulley, Reel cap, Head cleaning ribbon, Splicing Tape.

Recommended retail price **120 gns.**

Sony offer the finest range of tape recorders from the battery portable TC 900 to the studio quality TC777.

For further details see your Sony dealer or write to:

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Tel: Gloucester 21591.

London Showrooms:
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4" 300'	10/6	8/6
5" 600'	21/-	16/10
5¾" 900'	28/-	22/6
7" 1200'	35/-	28/-
LONG PLAY		
3" 210'	9/-	7/3
4" 450'	14/6	11/8
4½" 600'	21/-	16/10
5" 900'	28/-	22/6
5¾" 1200'	35/-	28/-
7" 1800'	50/-	40/-
8½" 2400' BASF ONLY	72/6	58/-
10" 3600' BASF ONLY	95/-	76/-

DOUBLE PLAY	List	Our price
3" 300'	14/-	11/3
4" 600'	25/-	20/-
4½" 900' (BASF)	30/-	24/-
5" 1200'	42/-	33/8
5¾" 1800'	55/6	44/6
7" 2400'	77/6	63/-
TRIPLE PLAY		
3" 450'	22/-	17/8
4" 900'	39/-	31/3
4½ 1200' (BASF)	49/-	39/3
5" 1800'	66/-	52/10
5¾" 2400' (BASF)	90/-	72/-
7" 3600' (BASF)	115/-	92/-

SCOTCH

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5" 600'	20/6	16/4
5¾" 900'	27/6	22/-
7" 1200'	35/-	28/-
LONG-PLAY		
3" 300'	9/6	7/6
4" 450'	14/6	11/8
5" 900'	27/6	22/-
5¾" 1200'	34/6	27/6
7" 1800'	49/-	39/-
8½" 2400'	72/6	57/6
STANDARD (ACETATE)		
5¾" 850'	24/6	19/6
7" 1200'	30/-	24/-

DOUBLE PLAY	List	Our price
3" 400'	16/6	13/2
4" 600'	24/6	19/6
5" 1200'	41/9	33/6
5¾" 1800'	55/-	44/-
7" 2400'	76/6	61/-
TRIPLE-PLAY		
3" 600'	24/9	19/6
4" 900'	38/6	30/6
DYNARANGE (L/P)		
5" 900'	32/3	25/9
5¾" 1200'	40/6	32/6
7" 1800'	57/6	46/-
8½" 2400'	83/6	66/6

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A special offer of the famous Premium Grade Polyester BASF Tape. Brand new, boxed, with full leader, stop foil, and polythene sealed. Multiples of three 4" and 4½" sizes can be supplied in the BASF 3-Compartment Plastic Library Cassettes at no extra cost.

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GRUNDIG TAPE 40% Off

Brand new, fully guaranteed, Premium Grade Magnetic Tape. Complete with the specially designed Grundig Tape Storage Container. Full leader and stop foil at both ends and suitable for use with all makes of tape-recorder.

DON'T MISS THIS RARE OPPORTUNITY, SEND NOW!

TYPE	DESCRIPTION	LIST PRICE	ONE	THREE	SIX
GL 18	1800' L/P 7" reel	50/-	29/6	86/-	165/-
GL 15	1200' L/P 5¾" reel	35/-	24/6	71/-	137/-
GS 15	900' S/P 5¾" reel	28/-	15/6	45/-	84/-

Post and Packing 2/- for single reels. OTHERWISE POST FREE!

TRIPLE PLAY TAPE — HALF PRICE!

A large purchase from a "SHY" world renowned manufacturer enables us to make this unique half-price offer. Brand new, fully guaranteed, premium grade Polyester Base Tape with FULL LEADER and stop foil. In original maker's boxes and polythene wrapped at these EXCEPTIONALLY LOW PRICES!

	List Price	One	Three	Six
450' on 3" reel	22/-	12/-	35/-	66/-
600' on 3½" reel	27/6	14/6	42/6	82/6
900' on 4" reel	39/-	20/6	60/-	117/-
1800' on 5" reel	66/-	34/-	101/-	198/-
2400' on 5¾" reel	90/-	46/-	137/-	270/-

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

Don't forget our other ACCESSORY BARGAINS!

Tape Head Demagnetiser, essential for any enthusiast! Ready for immediate use. Fully guaranteed. Worth 50/- ... ... **Only 27/6** P. & P. 2/-
Tape Splicer, fully auto., no razor blades. Worth 32/6 **Only 16/6** P. & P. 2/-
International Polyester Tape 2400' 7" reel (boxed) **Only 25/-** P. & P. 2/-

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Brand new, Premium Grade, Polyester Base Tape from this famous manufacturer. Boxed, with full leader, stop foil and polythene sealed at this exceptionally attractive price.
1200' on 7" reel. Normally 35/-. OUR PRICE **19/6.** P. & P. 2/- single reels.
Three reels for **55/6**, six reels for **105/-**, post free.

ILFORD TAPE NEAR HALF PRICE

A bulk purchase of premium grade, top quality POLYESTER MAGNETIC TAPE from one of the world's foremost experts in film coating technology. With FULL LEADER stop foil, Polythene wrapping and in original manufacturer's boxes. Available in long-play base only at these BARGAIN PRICES!

	ONE	THREE	SIX
900' on 5" reel. List price 28/- ...	16/6	48/-	90/-
1200' on 5¾" reel. List price 35/- ...	22/6	65/-	125/-
1800' on 7" reel. List price 50/- ...	28/6	84/-	160/-

Please add 2/- P. & P. for single reels. Otherwise POST FREE!

SCOTCH 3M TAPE — HALF PRICE!

Brand new, fully guaranteed, premium grade, polyester base magnetic tape, double coated for the electronic industry.

SCOTCH (150 D/C) Polyester L/P, 900' on 7" reel. **ONLY 15/6,** P. & P. 2/-.
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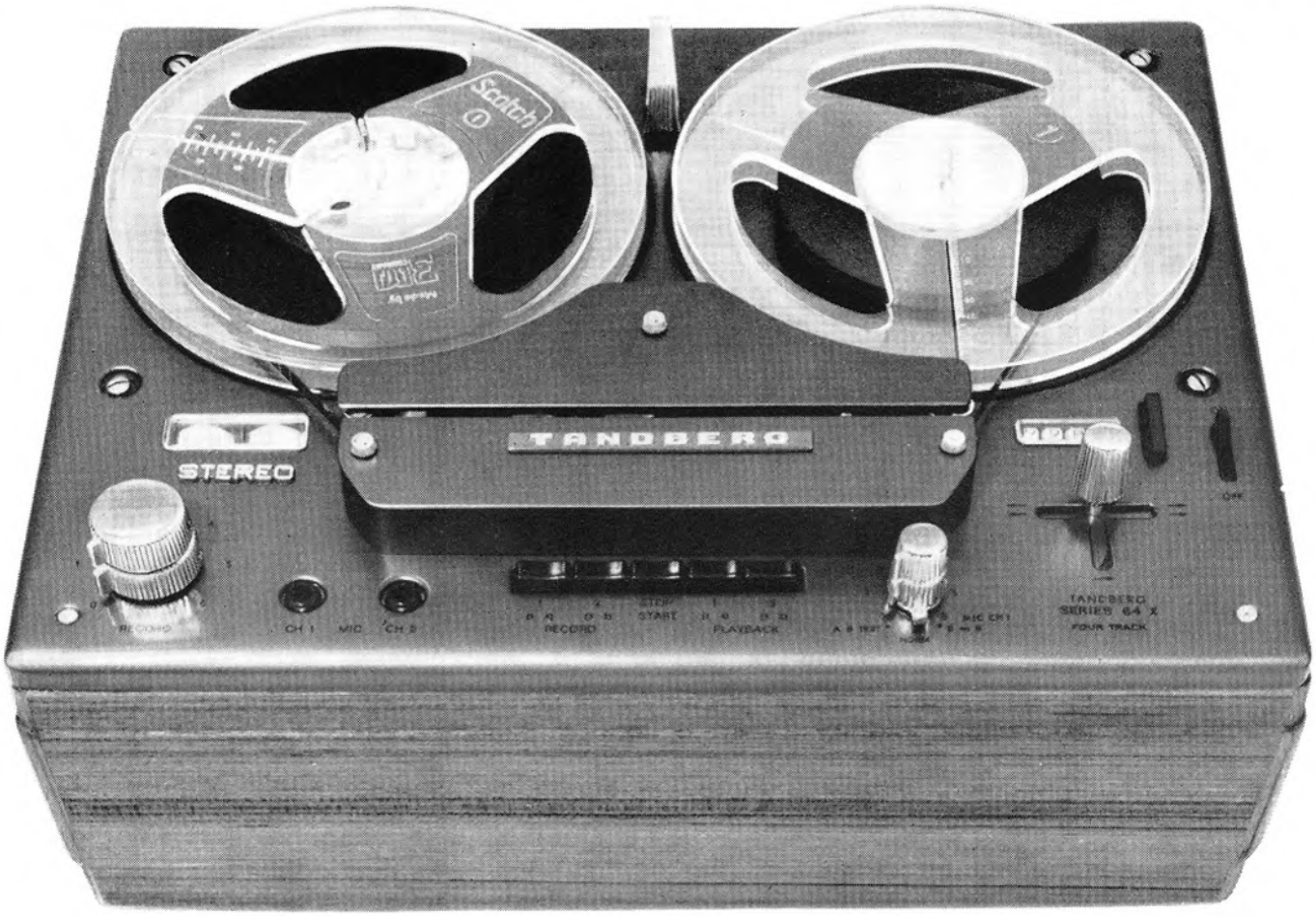
May 1967

The outstanding new Tandberg 6x



• The world's best stereo tape deck plus new bias head for guaranteed frequency response and unbeatable signal to noise ratio

Tandberg have taken their finest tape deck, added a Bias head and refined the circuitry. The result is the Tandberg Model 64X.

Frequency Response:
7½" per sec: 20-25,000 c/s
(± 2 dB 30-20,000 c/s).
3¾" per sec: 20-18,000 c/s
(± 2 dB 30-15,000 c/s).
1⅞" per sec: 30-12,000 c/s
(± 2 dB 40-8,000 c/s).

Signal to noise ratio:
7½" per sec: 62 dB. 3¾" per sec: 59 dB.
1⅞" per sec: 56 dB.

* Also incorporates Multiplex Filters (for stereo radio recording).
* A centre channel amplifier for simultaneous playback of two tracks into mono headphones.
* A fully transistorised oscillator circuit.
* Cathode follower outputs.
* 'On and off the tape' monitoring.
* 'Sound on sound' facilities.
* Superb teak and stove enamel finish.

The Tandberg 2 or 4 track, 3 speed Series 6X. 115 Gns.

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SERIES 6X
Also full details on the Series
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tape recorder

MAY 1967 VOLUME 9 NUMBER 5

INCORPORATING
SOUND AND CINE

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COVER PICTURE

A cartoon in *Punch*, not so long ago, depicted a scene similar to that provided by *Rank Audio-Visual* for this month's cover. In the cartoonist's version, however, a placard-waving elderly lady was visible at the window, evidently campaigning for the abolition of battery teaching. Those of us subjected to conventional language instruction might prefer the simple abolition of foreign languages.

SUBSCRIPTION RATES

Annual subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 30s. and 38s. respectively. Overseas subscriptions are 32s. 6d. U.S.A. $4.50) for *Tape Recorder* and 38s. (U.S.A. $5.40) for *Hi-Fi News*, from Link House Publications Ltd., Dingwall Avenue, Croydon, 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.

THE INNOVATION OF more detailed fluttergrams and modified response-curve scales turn our review columns upside-down in this issue. Responses will from now on be printed at the 25dB per frequency decade ratio used by *Bruel & Kjaer*. This scale has been widely adopted on the Continent and will simplify comparison of measurements between one magazine or manufacturer and another.

As tape mechanisms have improved over the last few years, the need for more sensitive pen-recordings has become apparent. The *WHM Fluttermeter* now feeding our reviewer's pen-recorder permits a closer analysis of fast flutter and makes it possible to isolate the wow component for the first time and thus print wow and wow-and-flutter recordings separately, hardly necessary with this month's subject, but to be included in future reviews. The clumsiness of the foregoing sentence also illustrates, we trust, the need for a single noun to supersede 'wow-and-flutter'. We have chosen to adopt the term 'wobble', coined within the walls of the *Revox-Studer* factory. This should also overcome the temptation to employ the term 'wow' as an abbreviation of 'wow-and-flutter' in contexts where the latter term has already been mouthed or written frequently.

Some days ago we witnessed the demonstration of a recorder so intriguing that it almost placed the *Sony* VTR in the shade. The device was basically a run-of-the-mill low-price Japanese battery recorder, distinguished by the inclusion of an FM radio receiver in its front control panel. A microphone was supplied with what seemed to be a 3ft. connecting lead but which in fact turned out to be a short *aerial* powered by a small transistor FM transmitter in the body of the microphone. Microphone and recorder were switched on, the monitor and tuning controls being adjusted until a squealing feedback howl emerged from the loudspeaker. A fellow journalist, presented with the microphone, then left the room to burble from an improvised bar. Despite some fading, dependent on the position of the microphone aerial, the system worked after a fashion and a good time was had by all. The combination costs some £70 and, thanks to the bulky and insensitive nature of the microphone, does not lend itself to the immoral application of 'bugging'.

Potential purchasers of this type of equipment should note that, while the microphones certainly operate on FM principles, they do not meet the GPO specification for radio-microphones. A radio microphone licence will be granted only to crystal-controlled systems conforming to *W 6489* (for narrow band) and *W 6490* (wide band) specifications, operating within the 174.562 to 175.058 MHz frequency range. Such equipment is manufactured by *Lustraphone*, *Audio* and *Wolfendale Electronics Ltd.* Even these will be licensed only when there is a clear intention to use a radio microphone with a public address system, as in the case of a person on a stage, film studio or lecture room where a trailing lead may prove an embarrassment, or with a recording system where possibly a person is observing and reporting on moving machinery. The GPO will only issue a licence where they are certain that the equipment will be used *with the consent of the speaker* and certainly would not authorise the use of radio-microphones for the purpose of 'eavesdropping'.

It is also worth pointing out that holders of an amateur radio licence do not have access to the 88 to 108 MHz frequency band common to certain Japanese equipment. The terms of this licence restrict the use of a station to the sending and receiving of messages to and from other amateur stations.

One of the clauses in the *Wireless Telegraphy Bill*, presented to Parliament recently to meet certain functions not covered by the 1949 Act, will make it an offence to manufacture (whether or not for sale), and also to import wireless apparatus which is likely to cause interference with other services. Variable-frequency Japanese radio microphones fall within this category.

We look forward to the Bill's acceptance in Parliament, but would warn readers against purchasing the Japanese equipment likely to be in the retail mill if and when it is made law. The Editorial Nose scents a number of less reputable dealers offering the devices at even lower prices than they have now.

On a more pleasant topic, we would like to thank the many hundreds of readers who completed and returned the Questionnaire published last month. We have been truly buried in replies and now face the horrifying task of analysing the general trend of likes and dislikes in order to create a picture of The Average Reader. A detailed report of our findings will be published in the very near future.

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Donald Aldous

Technical Editor of
'Audio|Record Review'

came to see how we make the incomparable Ferrograph

These are some of the things he wrote:*

Acknowledged quality and reliability. Quality and reliability are terms that can—as time has shown—be not unreasonably applied to Ferrograph machines . . .
. . . At last, I thought, I shall find the secret of the perennial success of these recorders leading to this rare reputation . . .

Enthusiasm and high standards. . . . one soon appreciated that tradition and pride of workmanship motivated this organisation. Coupled with the enthusiasm of the various heads of departments I spoke to, and the keen efforts of the workers to maintain high standards, it was readily apparent why Ferrograph has achieved its notable success over the years.

Service and stamina. Purchasers of Ferrograph recorders certainly buy them for keeps, as a glance in the Service Department showed a batch of early machines (2A models for example) returned for checking and to have their performance restored—where necessary—to its original level. Some of the cases had obviously received a fair bashing but the units all worked and would soon be restored to their pristine glory.

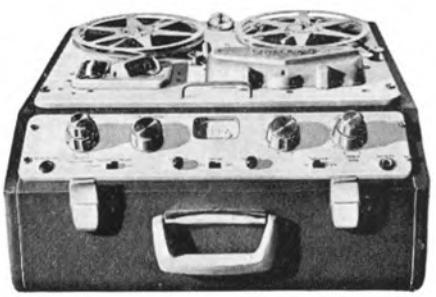
No useless gimmicks. The special models built for the Services have undoubtedly influenced the design of the domestic recorder from this organisation. Dependability and no useless gimmicks in the designs are characteristics that have emerged from this Forces' association.

Made on the spot. Self-sufficiency—in the sense that they manufacture the bulk of their own components—is another important feature . . . for me one of the highlights was the production of Ferrograph tape heads—a task not often undertaken by recorder manufacturers . . .

Quality control. Another contributory factor in the Ferrograph success story is the great attention paid to quality control or test procedures—from individual checks to further tests on the assembled equipment. Mechanical and electrical test methods are most extensive, with a case history sheet attached to each unit, providing information on frequency response, distortion, hum level and wow/flutter figures. This information is filed for reference . . . A speed micrograph . . . of the instantaneous velocity variation of the tape transport system, is also prepared. Incidentally it is the RMS value of this variation, as checked on a wow/flutter meter, which is the figure usually given for spec. purposes. In the Ferrograph Series 6 sample we saw, this figure came out at 0.14% at 7½ ins. p.s.

Certificate of Test. Certain Ferrograph recorders (and probably all models shortly) are despatched with a Certificate of Test, signed by the Chief Inspector, which summarises the performance data and includes the B & K pen-recorded frequency response curve and the speed micrograph chart. A reassuring document for any customer to receive with his machine. . . .

**** Donald Aldous also had many other interesting observations about the Ferrograph, published in the September 1966 issue of 'Audio|Record Review'. If you would like to receive a complete reprint, with Ferrograph leaflets, please send us your name and address.***



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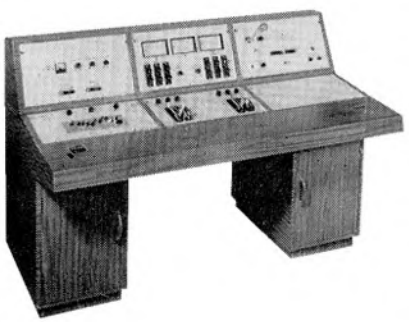
THE INCOMPARABLE TAPE RECORDER

WORLD OF TAPE

BACKGROUND MUSIC AT HARROW

TAPE as a source of background music and as a general aid to the public address contractor was the feature of this year's *APAE Exhibition*, held at the King's Head Hotel, Harrow-on-the-Hill, from 14th to 16th March. An odd setting, perhaps, for *Studer* machines, though these were displayed by *F.W.O. Bauch*. Also on this stand were various *Neumann* microphones, including capacitor units with FET preamplifiers built in.

Ampex, *Musicord*, *Reditune*, *Sound Coverage*, *3M* and *Planned Music* systems were demonstrated side-by-side. Video equipment made its appearance as usual, the helical-scan *Ikegami TVR 301E* being claimed the first fully compatible video recorder ever to sell at under £750. It is being imported by *Holiday Brothers Ltd., 61B Shaw Heath, Cheshire*. A continuous-loop announcing machine was shown by the GPO. Tape is stored in a small compartment behind the capstan and snakes through this reservoir, amazingly, without tangling. Displays by *Shure*, *STC*, *Lustraphone*, *AKG*, *Reslo*, *Beyer* and *Sennheiser* combined to make this year's APAE well worthy of the attention of the tape enthusiast.



ELCOM INSTALL SIX-CHANNEL CONSOLE

THE trouble with D. P. Robinson's *Studio Quality Mixer*, described between June and December 1964, was that users addicted to smoking had no means of stubbing out their cigarettes (apart from the peak-programme meters, perhaps). A six-channel mixing console recently installed by *Elcom (Northampton) Ltd.* in the Film Department of *Scottish Television* incorporates a script shelf complete with ashtrays. Other facilities include a compressor and an audio-response unit, wide-range tone controls on all channels, three VU-meters and talk-back microphone.

SALESMEN TRAINED WITH VTR

ONE commercial application for a *Sony* video tape recorder has been devised by *Sprite Ltd.*, manufacturers of caravans, who employed a unit in the training of salesmen at a recent conference in Newmarket. Groups of salesmen reproduced a possible sales situation in front of the camera, the recording being played later to each trainee for analysis. The great advantage of the scheme was the facility for self-criticism which could not otherwise have been presented to the salesmen.

The recorder was provided by *Sales Education and Leadership Ltd.*, along with two cameras and a small lighting system. It retails at £368 11s.

ST. IVES RUMPUS

A TAPE recorder caused what one reporter gleefully described as "The biggest rumpus in St. Ives (Cornwall) town council chamber for years", when one of the councillors brought his machine into the chamber without prior consent.

The councillor, who had previously complained of excessive secrecy and innaccurate minutes at council meetings, refused to comply with the Mayor's request that the recorder not be used. He declared that nothing in standing orders forbade tape recordings of open meetings and added that he would use it unless given an assurance that the minutes would be accurately reported. After a stormy debate, the issue was put to the vote and the recorder allowed to stay.

GRUNDIG ANNOUNCE CONTEST WINNERS

WINNERS of the *Grundig Schools' Tape Recording Contest* were announced recently, after being judged at the company's London showroom by Walter James (Editor of the *Times Educational Supplement*), Douglas Brown (Editor of the magazine *Tape Recording*) and a Northampton schoolteacher, Harry Walding. The contest was divided into three sections, representing *Senior*, *Junior* and *Infant* schools, and these were won by Brecon Secondary Modern Technical School, Boutcher C of E School and BFES School, Antwerp, respectively. All three are to receive *TK120* recorders as prizes.

CBS MUSICASSETTES

ARRANGEMENT between *Philips* and *CBS* has resulted in the CBS music repertoire being marketed on cassettes. The first release is to be made in May and will comprise twenty titles in the Andy Williams, Doris Day and Ray Conniff category. The *Musicassette* range now covers a total of fourteen labels, including *Pye* and *Polydor*, plus *HMV*, *Columbia* and *Parlophone*. Plans are in hand to produce language-courses and spoken-word recordings in the selection which is expected to reach 250 titles by autumn.

LEEVERS ON SOUND COPYING

LIVING up to its promising title, the recent *BKSTS* lecture on Copying ranged across a wide field of tape and cine topics. Norman Leevers (*Leevers-Rich*) commenced his talk by describing the pro's and cons of optical and magnetic-stripe film sound tracks. Film distributors faced a rather violent compromise between sound quality and copying convenience, since magnetic stripe offered a very much wider usable frequency response than the optical sound track. The maximum bandwidth obtainable from an optical track on 8mm film was a mere 3kHz. Mr. Leevers' contention was that magnetic-stripe copying is less of a problem now than in recent years, simply because cinema chains have come down in size, thus reducing the number of copies that would need to be made of any given film.

"What now?"

Turning to the subject of tape copying, attention was brought to the problems of speed-to-speed dubbing. A customer requiring mass copying of recordings to sell at 3¾ i/s might casually demand a 10kHz bandwidth without realising that this involved working to 40kHz at 15 i/s ! Having proved that there was more to high-speed copying than met the eye, however, Mr. Leevers went on to describe methods of tailoring individual dubbing systems to approach the ideal bandwidth.

Among the fascinating irrelevancies that interspersed the lively lecture were the statements that commercial tapes are generally dubbed backwards to eliminate the need for rewinding of each copy (and also to improve transient response), and an emphatic denial that tape decks can be made to operate ideally in any position other than the horizontal.

HASTINGS DRAMA

IN the hope of encouraging a nationwide rush to the shelves, public libraries all over the country recently held various exhibitions in support of National Library Week (March 11th-18th).

Regular readers of the *Tape Recorder* may be interested to hear that a series of miniature plays, written by David Haines for the magazine, were among the local literary exhibits displayed by the Public Library at Hastings. Included as the first of their kind to be published, the scripts aroused many enquiries.

Various exhibitors were asked by the Borough Librarian to contribute to a pamphlet of the book or books that had most influenced their own work. David Haines revealed his interest in dialogue to be the result of studying *An Actor Prepares* by Constantin Stanislavski.

NEXT MONTH

THE JUNE ISSUE of *Tape Recorder* will be published on Saturday, 13th May. G. T. Rogers will embark on the first of a series entitled *Elements of Tape Recorder Circuits*, a detailed examination of tape amplifier design. Derek Lyons contributes an intriguing piece—*Getting Spliced, South African Style*—while G. A. Cloud describes a new approach to tape erasing. The *WHM Fluttermeter* and *Sony TC350* will be reviewed.

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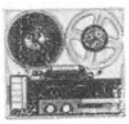
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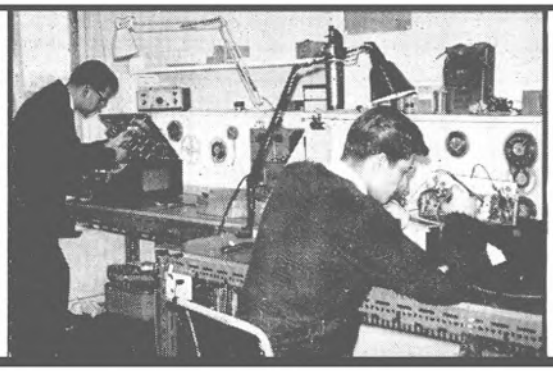
BY FRANK JONES



a look at NuSound

IT is the business of the retailer to establish a balance between the attention devoted to sales (with all the attendant hullabaloo) and that devoted to the provision of service for his customers. The extremes are epitomised by the perfectionists who reject every item obtained from manufacturers, and are consequently out of business within a week, and the High Street hack whose ideal specification would include the number of square inches of chromium plating on the lid, with which to assure the prospective buyer that the machine was truly hi-fi, and who wouldn't reject anything.

Mr. Allerhand of *NuSound* is not an extremist—he is merely a business man trying to establish his balance, and this he appears to be doing pretty successfully.

There are six NuSound showrooms in London, although this situation does not preclude provincial readers from taking an interest, for reasons mentioned later. Five of these shops specialise in tape recorders, the exception being the Lewisham branch which deals basically in hi-fi equipment. However, all branches will supply any item, even if it is not normally stocked, so the customer is not obliged to go touting his requirements all over the place—indeed most of the more popular items are available from stock at any of the shops.

Each shop, including the specialist Centre branches, stocks a full range of equipment, and both new and guaranteed second-hand machine are available. It is general policy not to stock machines under £30, as these are seldom any good and consequently more trouble than they are worth. The only exceptions to this rule are the few good battery portables under that price. Even above this one has to be wary—as *Tape Recorder* readers well know—and the dealer who offers free servicing on new machines (as NuSound do) cannot afford to sell unreliable or unsatisfactory recorders any more than we, the customers, can afford to buy them. Thus the shops are selective in what they stock, and their experience works in the customer's interest as much as in their own—a state of affairs that is unfortunately too rare. This weeding out process is an interesting one, and one or two manufacturers are conspicuous by their absence from the NuSound shelves.

Battery portables constitute a major part of the market at the moment and it is sad to reflect that there is only one British made portable currently in production, although it is hoped to see another available soon. Equally popular—and often a good deal more expensive—is the self-contained stereo mains machine, and once again hardly any British manufacturers produce one of these. Whatever the reason for this apparent apathy, it means that most of NuSound's business is concerned with the products of foreign manufacturers, mainly European and Japanese.

Because of this, servicing presents even greater problems than usual. A separate service department handles maintenance and repairs from all branches, and turn-round time ("I sent it last August and it's now December . . .") is generally limited by the availability of spares; some manufacturers are notably poor in this respect. The service department generally manages a 48-hour service and most makes of machine are accepted for repair, although priority is given to NuSound's own customers. However, there are several names, now defunct, which cannot be taken in because parts are unobtainable. The only solution here, it seems, is to get hold of some knowledgeable and capable enthusiast who is prepared to exert a little effort and ingenuity on the job. This sort of thing is commercially unviable, as such an approach would run up a huge bill in no time at all.

Tape recorders, in common with most complex mechanical devices, contain a large number of specialised parts that must be provided as part of the manufacturing/distributive process. Motor manufacturers have established an agency system whereby a dealer carries a complete stock of carefully listed parts—and serial numbers—in conjunction with the manufacturers' handbooks. This procedure, which is probably the envy of any conscientious retailer who has had to cope with requests for a "bent metal bracket that holds the left brake band on a *Grozsound Majesty*", seems to be the obvious answer to the problem of service, and the specialist NuSound 'one make' Centres now being introduced are an attempt to adapt the idea to tape recorder maintenance. Thus the Pentonville branch, the first shop to undergo conversion, is now the *Akai* Centre. This does not mean merely that the place is stocked up with Akai equipment; it involves the acquisition of every available relevant spare part and piece of information—no small undertaking with such large and comprehensive machines.

It is, in fact, an objective that is impossible to achieve, but for all practical purposes it means that the customer will find Akai bent brackets for the asking (and for the paying, of course). It is also intended that the staff shall include factory or distributor trained engineers—although this plan is obviously dependent upon the co-operation of the suppliers. Already one prominent British manufacturer has opted out of the scheme, which seems a pity.

Other branches in the NuSound chain are becoming one-make specialists, thus Bishopsgate becomes the *Sony* Centre and Holborn the *Bang and Olufsen* Centre. It is hoped that the idea will be further extended, and Mr. Allerhand would like to see other dealers follow suit—for the plan, if it succeeds, will not only stimulate sales of the machines involved, but will enable their owners to be sure of getting specialised service and advice, and off-the-shelf spares, whatever the record of the manufacturer or importer in these respects.

Another of NuSound's schemes—every bit as worthwhile as the Centre idea—is the free travel plan. The originator of this was a gentleman from Edinburgh who, after purchasing a very expensive recorder, remarked that the company could at least afford his fare home. This proposition did not seem that unreasonable and the economics were manageable. Thus anyone who purchases a new machine costing more than £30 is entitled to reclaim up to £5 travel expenses, at a rate of threepence a mile. The purchaser of a £30 machine who claims the maximum allowance is often costing the company more than it makes on the deal, but Mr. Allerhand considers that the custom is worth the price—and surprisingly the cheaper machines do not sell in very great numbers. It is obviously worth attracting a sale of £100 or so for a £5 discount, while the customer who has no local dealer can take advantage of the large selection offered by NuSound, at little or no extra cost.

Looking to the future, NuSound are already preparing for the day when the video-recorder is a common piece of domestic equipment. At the moment the Philips and Sony VTRs are the only competitors in a market which Mr. Allerhand believes is wide open. (There is perhaps no need to mention the position of British manufacturers here, as readers well know we are right out of the running in this field.) To prove Mr. Allerhand's faith in this opinion, NuSound are taking on a distribution agency for the Sony machines, and are able to supply and demonstrate the Philips, so if you have a few hundred pounds to spend . . .

The servicing problem that these extremely complex devices raise will necessitate a more rationalised approach than has hithero been adopted by tape recorder manufacturers. Only large and well equipped retailers will have the facilities to handle VTR's and the NuSound approach will probably be the only way to ensure that the customer can have his equipment checked and maintained without the risk of an expensive investment languishing on some railway station, while the owner writes frantic letters to the importer, or to the Editor of *Tape Recorder*. It is to be hoped that Mr. Allerhand's idea is successful, and that other dealers will see fit to follow his lead. The million or so machines that are said to be staring at the bed springs around the homes of Britain might well be in use if their owners had bought them from a shop that was prepared to discuss their needs intelligently instead of persuading them that this was worth having because there was £5 off the already inflated price—and with the abolition of RPM now with us, dealer service from 'small-men' is likely to become rare or even non-existent.

FIG. 1 GREATER AREA OF GRIP WITH BELT DRIVE THAN IDLER DRIVE

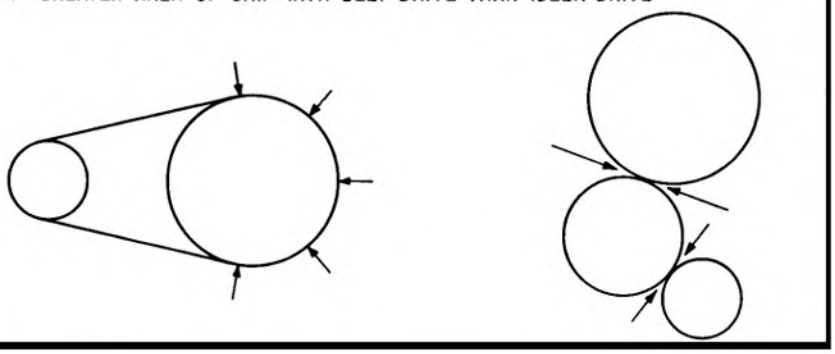
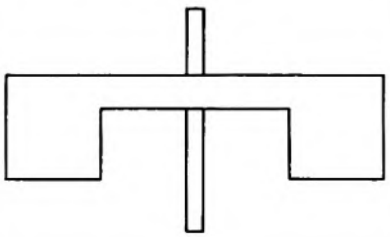


FIG. 2 CROSS SECTION OF FLYWHEEL SHOWING GREATEST MASS AT PERIPHERY



TAPE DRIVE SYSTEMS

V. D. CAPEL DESCRIBES TECHNIQUES OF DECK DESIGN

ONE of the basic requirements of all tape recorders is that the tape should move across the recording and playback heads at a constant speed. Any departure or irregularity in the nominal speed will cause a similar departure in the frequency of the reproduced sound. Thus a momentary decrease in speed during recording or increase during replaying will cause an increase in the frequency of the reproduced sound, whereas any increase in speed during recording or decrease during replay will cause a decrease of frequency. Speed variations can be regular or irregular, depending upon the cause. If they are of low frequency, that is below around 10Hz, they are termed 'wow'; variations at rates above this frequency are generally termed 'flutter'. Continuous wow or flutter often have a periodic or regular pattern, though other types of speed inconstancy sometimes occur, with speed perhaps shifting suddenly from one level to another. Clearly these are undesirable characteristics which the designers go to great lengths to try to eradicate. We will trace the tape drive system through its various stages to see just how these variations of speed are minimised.

The start of the chain is, of course, the *motor*. Mains recorders use motors whose speed is linked to the mains frequency. This frequency remains constant in this country at 50Hz to within a very small tolerance, and so the speed of the motors can be said for all practical purposes to be constant. In practice minor variations could still occur due to unequal friction in the bearings. The smaller low powered motors will generally be more prone to this sort of trouble, as they will be running near their maximum loading.

In the normal type of motor construction, the moving part, termed the *rotor*, rotates within the fixed part called the *stator*. One model favoured by manufacturers of better class equipment is the *Papst* motor. This uses an outer rotor, that is the rotor revolves around the outside of the stator. One of the advantages of this type of construction is that the rotor has considerably more flywheel action than that used in the conventional type. But more of this later.

The motors in battery tape recorders have no convenient speed reference, such as the mains frequency, to rely upon. The motors used in these instruments are of variable speed but they employ an electrical governor to keep it to the required limits. A pair of contacts mounted on the rotor itself are centrifugally operated. These open and close many times per second and cause the motor to proceed in a series of short impulses. The inevitable speed variations are subsequently smoothed to some extent by the flywheel, but of course the speed can never be as constant as it is with a good mains recorder. A few rare professional battery machines incorporate a frequency reference in the form of a tuned filter circuit, the motor itself generating a tone which is used —in conjunction with the filter—to maintain constant speed.

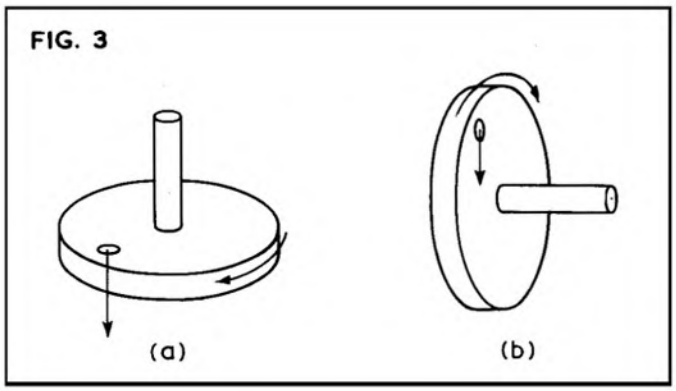
From the motor the power is applied to the flywheel by one of three methods: a belt, idler-wheel, or direct drive. Each has its respective advantages and disadvantages and the first two are to be found in roughly equal proportions in recorders by different manufacturers. Direct drive requires high motor power and is generally found only in professional or semi-professional models, using *Papst* motors.

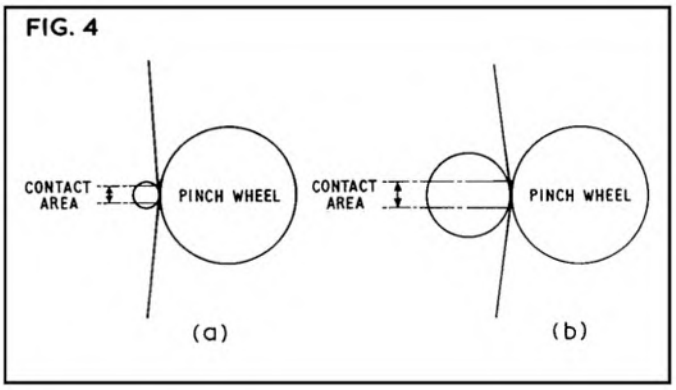
The belt has one great advantage in that the area of contact with its driving surfaces is greater than is obtained with the idler wheel. This can be seen by referring to **fig. 1.** It is clear that the belt is in contact with some of the circumference of the driving pulley and the flywheel (**a**), whereas the idler wheel has an area of contact that is confined to one small point on the circumference of both the driving shaft and the flywheel (**b**). The possibility of loss of contact—and hence grip—between the surfaces is greater with the idler wheel than with the drive belt.

There will be less mechanical noise introduced by a belt drive than by an idler wheel system. Irregularities and depressions on the edge of the idler wheel can cause a bump at each rotation, which is transmitted to the idler wheel support platform and can produce a sympathetic resonance there. Indentation of the wheel surface is especially likely where the idler remains pressed against its drive surfaces when the machine is switched off. A further advantage of the belt is its simplicity, as it needs no carrier platform and pressure spring, as does the idler wheel. This, however, is offset in some models by the provision of a jockey wheel to keep the belt taut.

The principal disadvantage of the drive belt is that it tends to stretch with age. This can lead to slipping and a slowing down of the recorder drive, and also an increasing tendency for the belt to jump off its drive pulleys. Because of this, belts need replacing far more frequently than idler wheels. In the service department of a well-known tape recorder manufacturer, whose machines have used both belts and idler wheels, it was found that a belt replacement was a commonplace job: almost every other machine had its belt stretched beyond the maker's tolerance. On the other hand, idler wheels only rarely needed to be replaced. The provision of sprung jockey wheels to compensate for stretching has to some extent helped in this matter, but eventually the belt stretches beyond compensation and so a replacement becomes necessary. This is not so bad where belts are readily obtainable and are easy to fit, but unfortunately this is not always the case.

Even when new, some belts will slip off if





they are suddenly loaded heavily, such as when the recorder is switched to rewind. A further snag is that a belt, being flexible, is subject to momentary stretching and contraction with load variations. This could happen if, for example, a tape spool was distorted so that at each revolution the tape rubbed against one of the inner surfaces. With a good belt system, using a belt with a generous cross-section or area, this effect may be minimal. But with many of the thin belts in current use some stretching and speed variation are inevitable.

Coming now to the flywheel itself, there are various considerations influencing its design. To appreciate these we must understand the basic principles involved. It is an elementary law of physics that all objects possess *inertia*. This means that they offer resistance to any force that attempts to move them or to change existing motion. Once moving at constant velocity, however, this opposition ceases and the only resistance to continued movement then arises from friction. Less effort, then, is needed to keep an object moving than is required to start it or change its motion in the first place. This will be verified by anyone who has attempted to start a car by pushing it! Once an object is moving it will now in fact resist any attempt to stop it, and so it is said to possess *momentum*. It can be seen, therefore, that any spinning object where frictional losses are low will resist any tendency either to speed it up or slow it down. Such an object is, of course, the flywheel, the purpose of which is to resist any tendency for speed variation. This 'flywheel effect', as it could be called, is dependent mainly on two factors, its speed and its mass. The faster it is rotating and the greater the mass, the more effective will its action be.

There is, of course, a practical limit to the weight of a flywheel in an ordinary domestic recorder. Such weight will be added to the weight of the instrument which, if a portable model (as most are), must be kept within certain limits. A certain amount of power will be dissipated in keeping the wheel revolving, so its size must bear some relation also to the size of the motor. Bearings and tape deck sub-assemblies must also be adequate to support the weight. All these things, together with the metal used in the flywheel itself, are of course related to the cost, and so this too must be a limiting factor.

There is one method which can be, and is, used to effect economies without substantially reducing the performance of the flywheel. The velocity of a rotating body is greatest at its periphery : as we go inwards the speed diminishes until it is zero at the precise centre. It follows, therefore, that the part of the flywheel mass near the edge contributes far more to the effectiveness of the wheel than an equivalent mass near the centre. If, then, a flywheel can be designed that has most of its mass near the edge and very little near the centre, the most efficient use is made of its weight. This is now common practice and an example of such a flywheel is shown at **fig. 2.** This is a cross-section, and it will be noticed that the inner portion is just a thin disc of metal whereas the outer sections carry most of the weight. Incidentally, this same principle is embodied in most gramophone turntables and accounts for the popularity, with many makers, of the deep turned-down edge.

It is also important that the flywheel should be balanced ; that is, any segment formed by an arc on the circumference and its two radii will be of exactly the same mass as any similar segment on the wheel. If this is not so, uneven running may result. Again, readers who are motorists will appreciate the difference that front-wheel balancing can make to the steering.

In the case of flywheels used on cheaper machines, these are manufactured to fairly close tolerances and matters are left at that. With the better models, however, each flywheel is individually balanced. Unlike the car wheel where small weights are *added* to make up for any inequalities, material is *removed* from the flywheel. Most commonly this is done by drilling holes at varying depths in the appropriate places near the rim of the wheel. The number and depth of the holes are governed by the amount of material that must be removed in order to achieve a perfect balance.

While this is desirable in the case of horizontally mounted tape recorders, it becomes *essential* with those instruments that are operated vertically. Such mode of operation means that the flywheel too must run in the vertical direction. Gravity will now have an effect on any inequalities in mass distribution. To understand this, let us consider the case of a flywheel where a small weight has been deliberately added at one point near the outer edge. As long as the wheel is kept horizontal, the effect of gravity on this weight will be the same irrespective of its position when it is rotating. The pull of gravity will always be downward in the same direction and at the same angle (**fig. 3(a)**). If we now mount this same flywheel so that it revolves vertically, as shown in **fig. 3(b)**, we have a totally different condition. As the weight ascends toward the highest point of the revolution, it is resisted by gravity which, of course, is trying to pull it back. Thus the force will be opposing the direction of rotation. When it passes this high point it will start to descend, but now its weight will be assisting the turning power applied to the flywheel. Therefore the effect will be to accelerate it. Thus each turn of the wheel would result in alternate slowing and speeding. The same effect, of course, applies if there is uneven mass distribution within the material of the flywheel itself.

One important lesson emerges here for the owner of the conventional horizontal recorder, and that is always to operate the instrument on as level a surface as possible. If the flywheel is balanced there will be little to worry about, but if it is not, then a recording will be made

(continued on page 207)

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AKAI X4	4 track stereo battery/mains portable. List £143. Two only. Brand new.	**79 GNS.**
PHILIPS TYPE	Cassette battery/mains portable. Brand new. List 27gns. Few only.	**21 GNS.**
AKAI 355	Professional 4 track stereo model. Brand New. List £247. 1 only.	**179 GNS.**
PHILIPS EL3536	4 track mono/stereo. Perfect condition. Original list £97.	**49 GNS.**
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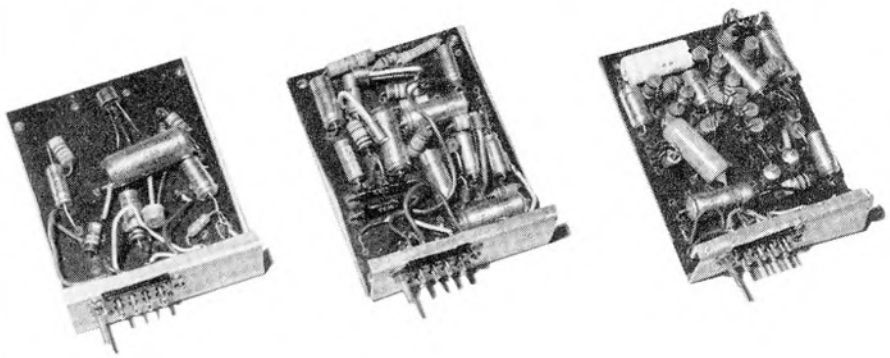

BY JOHN FISHER

VOLTAGE TABLE

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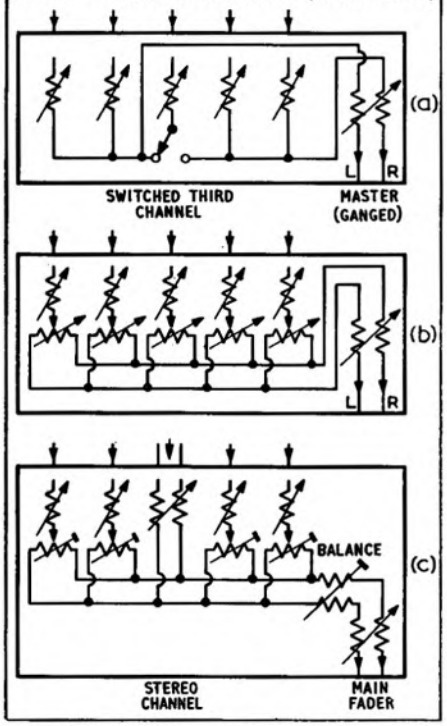
Unbalanced-input Amplifier	1.5V	4.6V	8V	10V	14.5V
Simple Balanced-input Amplifier	0V	3.2V	10V	10.1V	15V
Group Amplifier	0V	2.4V	15V	—	—

(Supply Voltage 24V ±1)

FIG. 1 STEREO CONVERSION (DIAGRAMMATIC)



(a) Simplest conversion, with one amplifier switched to right or left channel, and ganged mixing stages.

(b) Method of converting to stereo, feeding outputs from each fader to a pan pot and thence to ganged mixing stages.

(c) Full conversion, with extra amplifier to provide microphone amplifier with ganged fader, four pan pots on mono spot microphone balance control and ganged fader.

Photo (left to right): Output amplifier, high-input impedance amplifier and B.B.C. microphone preamplifier module.

IF one is to get the maximum performance from the amplifiers, with the minimum of bother and need for trouble-shooting, it is worthwhile making the results as predictable as possible—and as reliable as possible—by sticking to a few general principles. It is worth remembering that a mixer will not be particularly cheap if it is to be really good ; but on the other hand, it can turn out even more expensive if one is continually having to alter or replace components which are faulty or dubious. It is therefore worth calculating whether one can afford to build it first, on the basis of first-rate components, and to make only what one can afford to construct properly. It *is* possible to cut corners with fortunate cheap buys on the surplus market, but unless one is really sure of what to go for, and what to avoid, one is best advised to leave 'bargains' alone. Nothing is more frustrating to someone whose primary interest is in *using* his equipment to be continually repairing or redesigning instead of getting on with some recording.

One way of making the circuits behave as predictably as possible is to use fairly close tolerance components, particularly resistors. In circuits using considerable AC and DC feedback it is possible to make the performance a function of the 'passive' components rather than of transistor characteristics, and therefore it is worth using 5% resistors as far as possible. In general, the amplifiers in this mixer used 5% resistors throughout, except for the −Ve supply droppers which were 10% types. In order to reduce the chances of noise getting in through a particularly bad resistor—they are not common these days, but still not unknown —all undecoupled resistors are 5% high stability cracked carbon types ; it may be worth using the very low-noise metal-oxide film resistors in these positions in first stages, although these tend to be rather more expensive. The resistors should not be over-heated when soldering, and if leads are cut short a heat shunt should be used when possible. A hi-stab may not be so 'high' if it is really stewed.

Capacitors are equally important, and should be reliable types having low leakage currents. It is worth checking what the maximum voltage across them *could* be to ensure that their voltage rating is adequate. Unless one is sure of them, unbranded, surplus or used capacitors are best avoided as many of them have high leakage and noise which can cause trouble. Capacitors which have become overheated or otherwise damaged should also be avoided as far as possible, and it is probably safest to stick to new capacitors of one of the major reputable brands. All this may seem rather elementary, but it is amazing the trouble which the odd dud component can cause, and I for one prefer to avoid it as much as possible!

It is most important to check wiring before switching on or plugging in a module for the first time. I usually find it is most convenient to check each amplifier separately before plugging in, as this makes fault finding much easier; and to be on the safe side I prefer to check with a battery first, starting with a low voltage, to see that the voltage ratios around the circuit are about right, and gradually increase the volts up to the working figure, checking as one goes to see that all is well. A meter with a high sensitivity is desirable, so that voltages around the circuit are not significantly affected by meter loading. Careful use of a meter is also ideal for showing up low frequency instability or 'motorboating' when the oscillations are of sub-audio frequency.

Wiring can either be done with 'poor man's

(*continued on page 205*)

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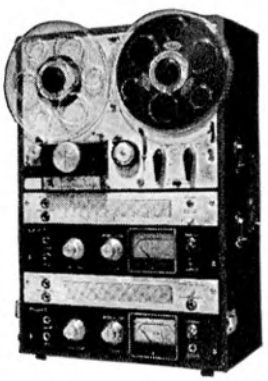

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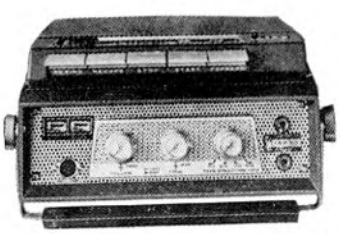

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printed circuit', bending wires of components on the reverse side of the panel (which can be specially drilled Paxolin sheet or the very useful pre-drilled Paxolin sheet), or an etched circuit makes a very neat job if one has the time and patience and the circuit is a final form which will not call for further modifications; these are always more difficult on etched or printed circuits. A well made etched circuit with low voltages and currents can be very reliable.

For the faders and presets, carbon-track potentiometers were used. The essential requirement is that there should be no crackles when the controls are operated. Some professional equipment makes use of stud contact potentiometers, in which a wiper traverses a series of small resistance steps. The advantage of this method is that settings are more precisely repeatable and the potentiometer law more accurate, and provided the studs are kept clean the noise introduced by the fader can be negligible. The chief disadvantages are the need to keep the studs clean and the high cost of such faders. Wire-wound potentiometers could be used, but they are not generally available with a log law. Carbon track pots seem to be perfectly satisfactory, provided the DC leakage current via the coupling capacitors is low, the tracks in good condition, and that no dust can enter the case of the potentiometer. It is therefore essential that the capacitors around the pots have low leakage currents, and that the potentiometer case is scaled or well closed.

The phase switches inevitably introduce clicks as they are operated, but to avoid intermittent noise and crackles due to poor contact, the contacts must be good and kept clean.

The contacts on the input sockets are wired so that unless there is a plug in one or other socket of a pair, the input is shorted, so that if an amplifier with no input is faded up the added noise is minimal. It is worth checking that the switching contacts on these sockets are making good contact *before* the sockets are bolted and wired in, as it is rather awkward to remove the sockets or adjust contact at a later stage. There must also be no possibility of the output sockets shorting.

DC CONDITIONS

The table gives approximate voltages in the circuits which may be useful when checking the DC conditions of the modules before testing with signal or mounting the amplifiers in the mixer. The voltages will vary to some extent owing to component tolerances, but those given are a guide and if the voltages are very different it is worth checking that the correct value resistors are in the right places, as it is quite easy sometimes to put adjacent resistors the wrong way round. If this does not reveal the fault it may be worth removing the transistors and examining any resistors in suspect positions to check that they have not 'gone high' during soldering—I try to remember to check resistor values before soldering in to eliminate any risk of putting in a dud, but it is easy to become lazy about this!

Most of the connections between the modules, potentiometers, sockets, switches, etc., are at a reasonably low impedance, so interconnections can be done with ordinary insulated unscreened wire without trouble, provided one takes a few precautions such as keeping output conductors away from their corresponding inputs, and high level signals away from wires carrying low level signals. This becomes a bit of a trouble around the switch bank, where wiring is rather crowded, but the transformer wires can be twisted together to cancel induced signals, which helps one over some of the difficulty.

Using unscreened wires allows one to employ colour-coded wiring, with a variety of colours or multi-coloured wires; this makes interconnection, signal tracing and fault finding much easier than it would be if all wiring were carried out using single-coloured co-axial cable. The lead from the high impedance input sockets to the unbalanced input amplifier is best kept screened, however, to avoid pick-up from high level signal conductors. Lightweight miniature coax was used for this, as the length involved is too low for any problems of capacitive losses.

Where the conductors are fixed, as between sockets and phase switches, single core wiring was used so that it would be rigid and could be bent to shape. Flexible wiring was used between the sockets and the bridge for the modules, and between the bridge and the switches, so that the bridge can be moved easily for alterations to wiring, etc.

The mixer as originally built is in monophonic form, but provision was made to convert to stereo when and if a stereo recorder is acquired. It is worth considering here some of the problems and possibilities in converting the mixer. The simplest, and possibly least satisfactory way of converting to two channel working would be simply to divide the mixer in half—one balanced and one unbalanced amplifier to each channel with the spare balanced channel switched to either left or right, and with a spare group amplifier and ganged main fader. Recordings made in this way are not often felt to be really satisfactory, and certainly the set-up lacks flexibility. It would be possible, using four microphones, to cover the 'sound stage' or area to be recorded with coverage of the centre as well as the sides, so reducing 'hole-in-the-middle' effects and the disconcerting shifts of image as a central performer turns to left or right. An improvement would be to connect the output of the central microphone amplifier to *both* channels so that the centre of the 'stage' can be covered with a single microphone, and one might in fact record using only three microphones, one for the left, one for the centre and one for the right.

Yet a further improvement, which is particularly attractive if one has a full complement of mono microphones and does not wish to buy a stereo one, would be to feed the output from each amplifier to both channels, each via its own pan pot (a pan pot, for those not familiar with the term, is a control which allows one to feed a controlled amount of the signal to each channel, the relative proportions of the signal fixing the apparent position of signals on replay). This would allow one to make the output from each amplifier appear to come from the relative positions of the microphones across the sound stage, giving a more complete and detailed sound picture, with the sound image created by one pair of microphones corresponding in position with that of the same source created by any other pair, provided the pan pots are correctly adjusted and balance correct.

The ideal solution is probably to combine the two systems (*fig. 1*), so that the mixer will accept a stereo signal from one main stereo microphone and signals from mono microphones to mix in via pan pots to get the precision and detail on large scale recordings that the use of multimicrophone techniques allow, both in mono and stereo. The need is possibly greater in mono, where the acoustic and echo cannot be 'separated' from the signal as they can in stereo, so that closer microphones and a drier acoustic background may be needed; at least, this is how I like my mono recordings, and dry recordings seem less affected by room acoustics on replay.

SPACE PROVIDED

To allow for any of these conversions to stereo, space and sockets are provided in the prototype both for an extra group amplifier and for an extra microphone amplifier—probably one of the BBC types—so that the centre microphone channel control can be ganged to cater for a coincident type stereo microphone (or two ribbon microphones a few inches apart with their axes at right angles, as a crossed-axis microphone, with similar effect). There is room behind the preset gain controls for pan pots for the remaining four amplifiers, and for a balance control if required (e.g., if the input to the recorder is ganged with no provision for balancing, or if the outputs from the stereo microphone or pair are unequal). I have not seriously considered the fitting of sum-and-difference controls to widen or narrow the apparent sound stage; this would be a nice refinement, but rather expensive and one would probably rarely use it enough in the 'widen' condition to justify the cost. If one carried refinements of this sort to the limit the mixer would soon become a rather large and unwieldy piece of equipment, and the essence of the original plan was to keep the mixer as portable (and therefore as much in use) as possible. It is very easy, as many readers may have found, to make equipment so complex or extensive that it becomes a discouragement to its use or to recording at all! A simple narrowing control can be fitted in the form of a variable resistor which progressively introduces crosstalk until in the extreme position the two signal outputs become identical mono ones.

The mixer has proved a very useful piece of equipment since construction was started (its first use was at the stage where only a couple of amplifiers were built and the mixed output was taken out across a 1K resistor with no group amplifier and fed straight into the microphone input of my *Brenell* recorder), and has contributed to several interesting recordings, one of which has since been made into a record for private release. This was of some light music sung by rather a good choir, and on this occasion the intention was to produce

(*continued on page 207*)

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a sound where one really *wallowed* in the echo and reverberation; 'flutter-echo' was not really what was required and the final solution was to record in a very large, high and extremely reverberant hall, making use of the natural reverberation. A good ribbon microphone was used as close as possible to the choir (who were bunched together more at the recording session than they could have been at a performance in public) and a high output moving-coil microphone was placed about 30-40ft. behind the choir-microphone to pick up the considerable reverberation and delayed sound, which was then mixed in as required. Using this arrangement, we were able to record and then play back the result to the choir until a satisfactory balance was achieved between reverberation and signal (or vice versa, depending on which way one looked at it!), and after that the balance was kept and the output levels controlled independently. The result was much nicer in our opinion than synthetic echo or reverberation; and certainly if one is having a mono recording with a fair amount of reverberation and 'atmosphere' on it, this seems to be a very satisfactory way, keeping the precision of close-in recording, with the consonants clear and crisp, but with a pleasant amount of atmosphere as well to put the recording into its correct 'perspective'. Other uses have been the normal ones of balancing several main microphones, etc.

Incidentally, it can be very useful to rig a distant microphone on a multi-mic recording, both as a reserve in case anything goes wrong with the other microphones and for adding a touch of echo; but also in case anything goes wrong with the performers. If the instrumentalists or choir are a little unsure of their notes or a little ragged on entries, it can be a kind thought to mix in a lot more reverberation to blur the sound; the result will be a more 'distant' recording, but the echo will help gloss over the mistakes and the recording will be much more popular—not unnaturally, people prefer an imprecise but relatively flattering recording to a crisp but unflattering one which shows up the mistakes! A mixer makes such changes of balance easier and more practical than when one is tied to dashing out in intervals, causing chaos moving a single microphone around.

In the circuit for the BBC microphone amplifier described in the March issue, the 200-400μF capacitor (incorrectly) drawn between the module pin 3 and the 4.7K resistor from the emitter circuit of the second transistor should be replaced by a wire link. In **fig 3** of the April issue, a 400μF capacitor should be connected between the junction of the input transformer and the 33K bias resistor, and earth. A rather obvious error also appeared in **fig. 1** (March). The output from the five faders should, of course, be fed together into the mixing amplifier. As shown, Fader Three is the only channel supplying the mixer amplifier.

Measured frequency response of the BBC microphone preamplifier is within ±1dB from 30 Hz to 12 kHz (±2dB from 25 Hz to 20 kHz). High input-impedance amplifier is ±3dB from 25 Hz to 20 kHz.

As a unit, the mixer performs well. The frequency response given above is perfectly adequate and although accurate noise measurements have not been made, hum and hiss are subjectively at a very low level.

TAPE DRIVE SYSTEMS

that *may* contain speed irregularities giving rise to wow. For those who use their recorder in varied locations and may not want to be bothered with levelling it exactly if such is not necessary, it may be worth a little time and effort in investigating to see whether or not the flywheel has been individually balanced. As has been mentioned, the presence of any drill holes will indicate whether this is so, though one cannot assume that the job has necessarily been done accurately.

With all domestic recorders the flywheel spindle is extended at its upper end to form the tape drive *capstan*. Thus the flywheel exercises a direct control upon the speed of the tape. If the flywheel were mounted separately, with some intermediate coupling between it and the drive capstan, any speed variation resulting from such a coupling would be passed on to the tape without the benefit of the controlling influence of the flywheel. This direct coupling, then, is really an essential. However, in turn this poses problems of its own, relating to the diameter of the drive capstan.

It is desirable, in general, that this diameter be as large as possible. If this is so there will be a greater area of the tape in direct contact with it and also a greater area of its surface will be in contact with the pinch wheel. (Matters can in fact be a little more complicated than this, as to some extent the tape is driven by the pinch wheel, which receives its drive from the capstan beyond the tape edges.) Hence the larger the capstan (and/or the pinch wheel) the better the grip on the tape and the less likely any slipping between the two (see **fig. 4**). This will ensure a steady constant speed. As the standard tape speed is fixed it follows that the larger the diameter of the drive capstan the slower it must revolve to drive the tape. Furthermore, as the flywheel is, as we have seen, directly coupled to the capstan, this means that the flywheel also must revolve at a slower speed.

We have seen earlier that the effectiveness of the flywheel depends in part upon its speed, so the larger the tape drive capstan the less effective will be the flywheel. The only thing that can now be done to restore its effectiveness is to increase its mass, and as we have already seen, there are definite limitations to what can be done in this direction.

To increase the speed of the flywheel *and* to maintain the tape speed at its standard level, then, we would have to reduce the diameter of the capstan and thereby introduce a smaller contact area with the tape and pinch wheel. Matters can, of course, be improved by using a higher tape speed, which will give a faster flywheel without any reduction in the diameter of the tape drive capstan. This is one reason why superior results can be obtained with the higher tape speeds. However, it is generally considered that the better frequency response is the principal advantage. With the development of modern heads, which allow the recording of increasingly improved frequency ranges at the lower speeds, the extended range of the higher speeds is becoming less and less of an advantage. The improved speed regulation, on the other hand, is undoubtedly a worthwhile asset.

However, the basic problem of capstan diameter versus flywheel speed remains. Most manufacturers effect a compromise by avoiding the two extremes and produce a tape drive capstan of moderate dimensions. There are, however, some manufacturers who consider that the advantages of either one or other extreme are preferable, and so we find models with either very large or very small capstans. Both extremes may be found at both ends of the price spectrum!

Recently an 18 gn. Japanese dictaphone has been introduced, containing a new approach to this problem. Normally the tape drive capstan is highly polished to prevent or discourage the formation of oxide deposits. In this unit it is engraved with a large quantity of hair-like lines. This gives a better grip than the polished capstan and so reduces any tendency for slipping to take place. This being so, a smaller diameter can be used than would otherwise be necessary, thus enabling a higher flywheel speed to be achieved.

A further advantage of this arrangement would be found when using one of the tapes that employ a very shiny and highly polished oxide surface. This is done by the tape manufacturer to reduce wear on the record head. Unfortunately, it can also introduce slippage due to a lack of adhesion between the tape and the drive system. It has been found that these tapes cannot be used with some types of recorder. An engraved capstan may improve matters here and allow the advantages of these tapes to be enjoyed more widely than they are at present.

AN AMATEUR STEREO SPECTACULAR

three BATRC prize-winners describe the production of a

WE three, Peter Cox a schoolmaster, John Penty a power station engineer, and myself a company secretary, have made numerous individual entries in the British Amateur Tape Recording Contest over a number of years with some degree of success, but our choices of subject matter, balance, treatment, etc., have been as highly individualistic as our personalities. Peter Cox likes a relaxed balance, taking as his model the sort of sound the BBC produces in a concert broadcast; I, who am accused of having 'tin ears', like the tightest of tight balances with an emphasis on the spectacular, while John Penty —the engineer amongst us—takes a very proper and happy position between these two extremes.

While we limited ourselves to making individual entries for the British and International competitions, our differences amounted to no more than good humoured criticism of each other's efforts. But when we decided to get together to record a stereo spectacular as a 1966 entry for the South Devon Tape Recording Club, of which we are all members, we had, of course, to reconcile our differences—the first of many human problems we found as difficult to solve as the technical problems.

About the choice of a subject—a grandiose musical version of the nursery rhyme *Baa Baa Black Sheep*—there was no difficulty, and a distinguished local composer, Ivy Mason Whipp, made a sophisticated arrangement of the rhyme to feature church organ, male and female choirs, three trumpeters, soloists and a real live lamb! A total force of well over a hundred—a sort of poor man's *Götterdämmerung*. For a title we chose *Tutti*—'the lot'.

While the composing was going on the three of us concerned in the actual recording carried out various tests in the church that was to do duty as our recording studio. We were strongly tempted to find a way to have the traffic diverted on the main road directly outside the church because a passing motor-cyclist in stereo is more intrusive and more difficult to mask than in a mono recording, but, although we eyed some suitable road signs, we eventually decided not to run the risk of being charged by the police for a stereo misdemeanour.

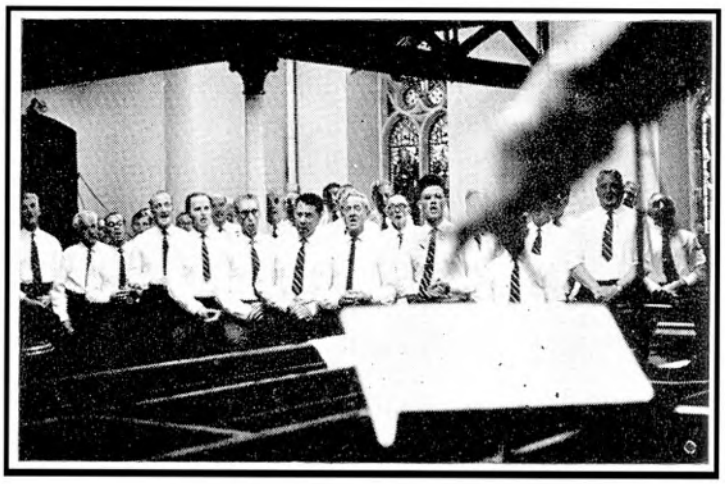
In the recorder we were using—a *Vortexion* ½-track *CBL* stereo machine—we had the greatest confidence, and also in the coincident stereo capacitor mike that John Penty had built—but there were other difficulties as John and Peter now explained.

Technically, this was the most ambitious and, in view of the size of the forces involved, difficult task that we had faced to date. Considerable experience of recording monophonically had shown us the necessity of monitoring the balance of sound in a separate room, for only in this way is it possible to evaluate the effects of microphone positioning. A preliminary reconnaissance of the building confirmed that there was available, well separated from the sounds of the performer, a suitable room complete with the necessary power-points—so technical problem number one was solved.

Our knowledge of stereo techniques was sketchy, to say the least, and we were not impressed with attempts to record stereo by the 'spaced' technique usually adopted by amateurs. The stereophonic effects obtainable with spaced omni-directional microphones are comparatively poor, by present day standards, so our next problem was to study as much of the available literature on the subject as we could find. Particularly valuable were H. Burrell Hadden's *Practical Stereophony* and the *BBC Engineering Division Monograph No. 38—Operational Research on Microphone and Studio Techniques in Stereophony.*

Luck came our way when one of us was able to be present in the control room during a stereo session carried out by a professional organisation. So outstandingly realistic were the results heard, that there and then it was decided that the most likely method to achieve the true stereo effect we were seeking was to employ what is known as the coincident microphone technique. An instrument suitable for such a purpose, as used by broadcast engineers, can cost over £200, so John Penty set to and constructed a stereo version of our mono capacitor microphone. This followed very closely the design published in *Hi-Fi News* of September and October of 1963. The circuit was, however, modified to employ Nuvistor 6C6 valves in place of the original 12AY7's. This resulted in a much quieter background noise. Suitable switching on the associated control unit enabled the polar response of each capsule to be varied from omni-directional, through figure-of-eight, to cardioid. For the conditions encountered in the hall, we found that the cardioid positions gave the most acceptable results.

Conversations with engineers confirmed what the literature said, that an exact balance



Photographs (left to right):
John Penty's version of the *Hi-Fi News* capacitor microphone.
Donald Aldous (Technical Editor, *Audio and Record Review*) and Albert Pengelly examine the *Vortexion* while John Penty peruses the mixer.
The *Plymouth Clarion Male Voice Choir* under the baton of Edgar Littlejohns.
Photographs by Colin Rowe, Plymouth.

must be achieved between the two channels of a stereo system—all the way from microphones to loudspeakers—if the images in the sound picture are to remain stable and not wander. Once again we set to work to construct the necessary equipment, so that the recording gain of each channel could be controlled while still preserving balance.

When microphone and control unit had been completed and problems of phasing solved, a rehearsal session was arranged with the majority of the performers being present. Although all equipment had been tested at home, when we set up in the hall we encountered the most appalling hum problem. Hasty unplugging of various leads showed that it was being picked up on the microphone cables. These being some fifty yards in length, there was ample opportunity for a few milli-volts of AC mains to creep in. It took us much valuable time to locate the source of the trouble. We finally discovered that the mains cable supplying the organ motor lay exactly underneath, and parallel with, our microphone leads! Repositioning cured that problem.

While John and Peter were grappling with the technical problems, I had been rounding up the necessary artists. Bartram Squance, the organist of Mutley Methodist church, was a sheet anchor in the whole enterprise, providing not only the instrument but also arranging for the use of his church. Two noted Plymouth choirs, *The Plymouth Ladies'* directed by Miss Dorothy Blagdon—winners at the Llangollen and Salzburg Musical Festivals—and the *Plymouth Clarion Male Voice Choir* under their conductor Edgar Littlejohns, of similar successes and excellence, readily agreed to co-operate. Since both these choirs broadcast, they already knew about studio discipline, balancing-up, retakes, etc., so that their experience, enthusiasm and co-operation made things much easier. Some of the soloists—for reasons best not gone into—disappeared from the scene, as did the real live lamb, who, in spite of every prompting from me as studio manager, could not be induced to baa on cue.

We were able to arrange a rehearsal to get a balance and some idea of dynamic range from everyone except the three professional trumpeters. Naturally, these had to be paid for at the appropriate Musicians' Union rate and, since this ran into double figures, we couldn't afford a rehearsal fee as well. This was a false economy and where we came unstuck. We had thought that as professional musicians and from what we had read about 'session' men, our three trumpeters could give us an 'instant' performance; but when we started to record, excellent as the trumpeters were as performers, we learned to our disonant horror that British military musicians apparently employ a different standard of pitch from the rest of the civilised world, so that our grand opening fanfare, carefully calculated to arrest the ears of the judges, was very much at variance with the organ, choirs and soloists. At this point John, Peter and myself seriously considered fleeing from the building and perhaps the country as well!

By the time a re-write of the trumpeters' parts had been made, over an hour of our precious two and a half hour session had gone, but by 8.30 p.m. we had two reasonable takes on tape only to find we were some twenty seconds or so outside the four-minute time limit if the recording was also to be eligible for inclusion in the International Recording Contest. To have to tell such willing performers at this juncture that their already short parts had to be further cut was not easy, and I envied John and Peter in the seclusion and sanctuary of their monitor room. A break of fifteen minutes, however, soon put everyone back in good humour, and three more takes were achieved before time ran out.

As always with amateur recordings, there is the curate's egg infection, but a listening panel drawn from the principals concerned—both performers and technicians — subsequently agreed on the take that came nearest to satisfying our musical and technical standards.

Lastly, what lessons did we learn from all this? First and foremost, the techniques employed in monophonic recording only remotely applied when we tried to capture the spread of sound stereophonically. We would dearly like, for example, to have used a spot microphone on the soloists, but this is only feasible if one's equipment includes such facilities as panpots. Incidentally, some professional engineers recommend that such exotic sounding controls as 'shufflers' be included as well!

And the final lesson after lugging all the equipment up and down three flights of stairs? Don't! Stay at home and watch the telly!

(*If you don't possess a telly, Mr. Pengelly's advice does not stand. Page 211 is waiting!* —**Ed.**).

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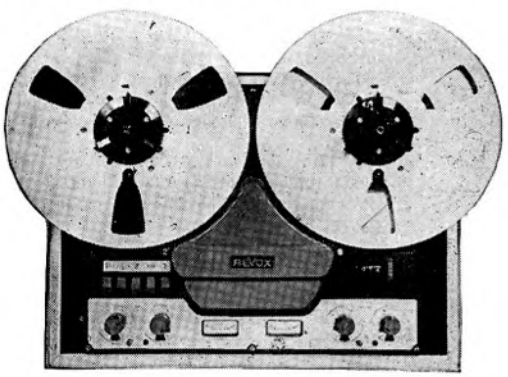

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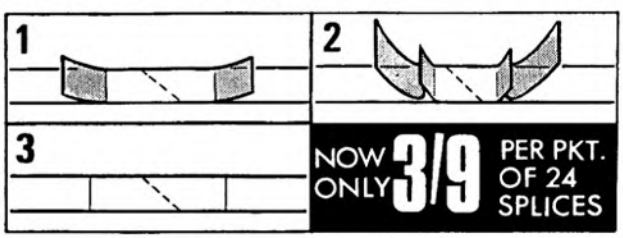

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DRY SPLICE

British amateur tape recording contest 1967

As sponsors of the 1967 Contest we have pleasure in printing here an official entry form, together with (overleaf) the BATRC rules. We announced last month that the Contest has been reconstituted with the full support of leading audio and tape recording publications. The organising committee, under the Chairmanship of Mr. C. Rex-Hassan, comprises Donald Aldous (Audio and Record Review), John Borwick (The Gramophone), Douglas Brown (Tape Recording Magazine), John Crabbe (Tape Recorder and Hi-Fi News), and F. C. Judd (Amateur Tape Recording). Miss Brenda Marriott (Grundig) is Vice-Chairman and Hon. Treasurer, and John Bradley, representing the Federation of British Tape Recording Clubs, is Hon. Secretary. Mr. Timothy Eckersley attends committee meetings as a BBC observer.

In addition to separate prizes and trophies for winners in each class (see Rule No. 1), the most outstanding tape in the Contest will be designated *Tape of the Year* and its producer will receive a silver challenge cup plus cash and equipment valued at £100 or more. There is the added incentive that winning tapes may be broadcast on the radio, and entries for the 1968 International Contest will be selected by the Federation of British Tape Recording Clubs (see Rule No. 8) from tapes submitted in the British event. Entrants may introduce a humorous element into their tapes if this seems appropriate, and a tape in any class may be recorded in mono or stereo. Separate awards will be given for the most humorous tape and the best stereo recording, though it must be understood that any tape submitted has to conform with the entry classes listed overleaf, and will be judged accordingly in the first instance. Winners will have their fares paid to London for a special celebration party and prize presentation at the 1968 International Audio Festival and Fair. All cups and trophies will be held by the winners for one year.

The Judges will take into full consideration the capabilities of the recorders and equipment used in the preparation of tapes, so that entrants need not feel handicapped by modest resources. Tapes will be judged on subject matter, quality of recording and originality, and the decision of the judges—who will have special knowledge of amateur recording—will be final. It is important to remember that recordings need not be stretched to fill the whole of the permitted playing time. Shorter tapes are often better tapes, so think carefully about editing before submitting a recording.

Readers of *Tape Recorder* will not need reminding that ours is an interesting and, at times, exciting hobby. Here is an opportunity to do something especially interesting so that you may look forward (with luck and skill) to the especial excitement of winning a prize. Don't be shy—have a go. And we look forward to meeting you at that presentation party

(Contest Rules overleaf)

CUT HERE

Entry form for British amateur tape recording contest 1967

PLEASE COMPLETE CLEARLY IN BLOCK CAPITALS

Name .....

Address .....

.....

Age..... *Occupation*.....

How long have you been recording?.....

DETAILS OF THE ENCLOSED RECORDING

Title (if there is one).....

.....

Exact Duration.....mins .....secs. *Stereo/Mono* delete as necessary)

Recorded at a speed of..... inches per second

Class in which you wish your tape to be entered: Speech and Drama. Documentary. Music. Reportage. Technical Experiment. Schools. Set Subject (delete as necessary).

Make and type No. of recorder(s) used.....

Make of magnetic tape used.....

Any other equipment used (i.e., microphone, mixer, tape splicer, etc.)

Give details and manufacturers.....

.....

When and where was the recording made?.....

Titles of works used (with names of authors, composers, duration, etc. See also Rule No. 5.)

.....

Name of any assistants and how they helped in making the recording

.....

.....

I declare that the enclosed tape feature is entirely my/our own work, and that I have not included on the tape any copyright material from radio, television, commercial recordings, or any other source, for which authorisation has not been granted.

Signed.....

Rules of the contest

1. Tape recordings may be entered in any of the following classes.

		Maximum Duration
(a) **Speech and Drama**	(Sketches, playlets, prose and poetry readings, fantasy, monologues)	10 minutes
(b) **Documentary**	(Sound story based on fact, informative, imaginative and/or entertaining, travelogue)	10 minutes
(c) **Music**	(Live vocal or instrumental performance)	10 minutes
(d) **Reportage**	(Sound snapshots, interviews, interesting or historic sounds, on-the-spot reports)	4 minutes
(e) **Technical Experiment**	(Sound composition, electronic music, musique concrète, multi-track music, trick recording)	4 minutes
(f) **Schools**	(Recordings of any aspect of school life or activities, made mainly by the pupils)	10 minutes

Tapes in this class may be entered under three age groups:—Infants (up to 7 years old), Juniors (7-12), Seniors (12 and over)

(g) **Set Subject**	For the 1967 Contest this is: *A tape letter to someone abroad*	4 minutes

2. Prizes will be awarded for the best tape in each class. There will also be special prizes for the best stereo tape and the most humorous tape. The tape judged to be the best in the Contest as a whole will be selected as the *Tape of the Year* and will win a major award.
3. Tapes must not exceed in playing time the maximum durations given in Rule 1, but may, of course, be shorter.
4. The Contest is restricted to amateurs. Those with technical experience in professional recording studios are ineligible. The production of tapes as regards the recording and editing processes must be entirely the work of the entrants.
5. No tapes submitted may contain anything taken from radio or TV transmissions or commercial recordings. Any competitor who has fully, or in part, used any literary or musical production of which he is not the author or composer, and which is still in copyright, must obtain authorisation from the author, composer or organisation owning or controlling the copyright and must produce proof of such authorisation. This proof must be submitted with the entry form and must state expressly that the author, composer or the organisation owning or controlling the copyright forgoes any payment by broadcasting organisations which may transmit the recording. (This does not imply that, in the countries where they apply, the normal rights of payment arranged by the organisations owning or controlling the copyright are relinquished.)
6. Recordings must be made on ¼-inch tape at 1⅞, 3¾, 7½ or 15 inches per second. Stereo recordings may be entered. The programme must commence at the beginning of the tape and only one track may be used in mono, or two tracks in the case of stereo or duo-play. (When judging there will be no reversal of spools to hear second tracks.) Tapes should be prepared between white or coloured leader tapes.
7. Each tape must be entered in one class only, but competitors may submit entries in any or all classes. The judges are at liberty to re-allocate entries to classes other than those named by the entrants where this is considered appropriate.
8. British entries in the International Recording Contest (CIMES) 1968 will be selected by the Federation of British Tape Recording Clubs from among the entries submitted to the 1967 British Contest, but prizewinning tapes in the British Contest will not necessarily go forward to the International Contest.
9. All tapes will be returned to the competitors provided adequate return postage is sent with the entries. The Contest Organisers will retain copies of the winning tapes and those of the runners-up. Copyright of these will be the property of their owners but the Contest Organisers reserve the right to arrange for the publication of the whole, or parts, of any or all of them, by radio, disc or tape, or by any other means.
10. The Contest is open only to those normally resident in the U.K. The decision of the judges is final and no appeal may be made, nor any correspondence entered into.
11. The closing date for receipt of tapes will be Saturday, December 30th, 1967. No entries received after that date can be considered in any circumstances. All winners will be notified immediately judging is completed and a complete list of awards will be sent to all entrants.
12. Every tape entered must be adequately packed, properly stamped, and addressed to: **The Secretary, British Amateur Tape Recording Contest, 33 Fairlawnes, Maldon Road, Wallington, Surrey.** A completed entry form and return postage must be included with each tape. Name and address should also be written on small labels firmly affixed to tape spools and to the containers.

SPECIAL NOTE:
Care should be taken in reading the section of the rules covering copyright. If in doubt, consult the *Mechanical Copyright Protection Society Ltd., 380 Streatham High Road, London, S.W.16.*

In the field / part 2 / Recording alarm calls

BY PHILIP RADFORD

PROBABLY most of those who take up bird recording do so with the aim of recording bird *song*. Many continue to use their portable tape-recorders for this purpose only, trying to collect as varied a selection of songs as possible. Yet territorial song is only part of a bird's sound life. Call-notes, by which birds keep together, and alarm calls are examples of other bird sounds.

A bird responds to danger by an alarm call ; this is a signal which prompts other birds to take immediate cover or to gather to face the enemy, depending on the circumstances. Thus, a hawk appearing overhead produces a high-frequency alarm call from a small bird. Other birds then dive to the shelter of the nearest bush or tree. Such a call is very hard to localise and is difficult to record as it is uttered so suddenly. Where a predator is perched, however, easily localised calls are made and birds assemble to mob the danger object. An obvious example is the loud clucking rattle of Blackbirds as a cat strolls down the garden. These alarm notes are characteristic for a bird species ; they are easy to record as often the bird has alighted and is intent on its mobbing behaviour.

The collection of alarm calls on tape can be a most interesting study. Quality depends on recording technique and apparatus, but whatever the result one's understanding of bird behaviour is increased.

A valuable aid to the study of alarm calls is the use of a stuffed owl or hawk. Sometimes one can be obtained cheaply at a country house sale. If the stuffed predator is placed conspicuously in the territory of a bird during the breeding season, there is usually a quick response by calls of alarm and aggression. Tits are readily recorded by this method. They are alert and pugnacious and will react in this way from January to the time when their young leave the nesting-hole, normally in May or June. In fact, it is difficult to set a stuffed owl in mature woodland in spring without hearing the angry churr of a Blue Tit.

Similarly, Great Tits are easy to record. Their calls are of much variety; a common one resembles the 'chink, chink' notes of Chaffinch. Various churring calls are also made. The Marsh Tit, black-capped, is found in deciduous woods. Its alarm is an urgent 'pitchoo' followed by a harsher 'cha, cha, cha'. Conifer woods are usually the breeding sites of the white-naped Coal Tit. A form of its alarm, not often heard, is a delicate reeling sequence. It is worth waiting patiently for such a recording. The alarm of the Long-tailed Tit is not easy to tape : the amplitude of sound is low. It is a thin 'zee, zee' interspersed with a sharp 'chup'.

Having obtained an alarm call on tape, play-back will often produce a mobbing response by resident birds, especially during the breeding season. But after a while interest wanes as no object is found for their annoyance. Playback of alarm has value in the observation of bird reactions, and can be a quick way of finding the breeding birds of a given area. It must be admitted, however, that there are times when playback or even the presence of a dead predator seems to have no effect whatsoever.

For some birds the approach of man is quite enough to trigger their alarm. This is particularly so if the nest is neared or if newly-flown young are hidden in undergrowth. It should be emphasised that there is no need to search for nests or young in order to record alarm calls ; interference with birds' breeding activities should be kept to a minimum.

Nightingales usually alarm in this way from undergrowth. The surprisingly different calls make it difficult for the beginner to realise that they can be made by one bird. A harsh frog-like croak is given, also a penetrating 'tac, tac, tac,' and a high-pitched 'hueet'.

Another bird which will alarm if one walks through its territory is the Stonechat. The handsome male with black head and white collar shows itself readily, perching on a spray of gorse making a sharp 'tack, tack, tack' interrupted by a thin 'wheet'. This alarm call is rather like that of Whinchat which also alarms readily, especially when nestlings have just flown. Whinchat has a conspicuous white eye-stripe, unlike Stonechat, and is usually found in more cultivated country. It can be difficult to distinguish recordings of the two birds.

Also on open country is the attractive Wheatear. Both sexes have white rumps and frequent moors and waste places ; the alarm is a hard 'chack, chack', different in quality from the notes of Stonechat and Whinchat. But the notes of all three can be likened to the sound of knocking two stones together. The study of recordings is a helpful aid to identification.

One of the most fascinating groups of small birds is that of the warblers. Their alarm notes are distinctive and make excellent recordings. Sometimes their habitats overlap and several species of warbler can be taped on the same occasion. There are two common warblers which breed near water. Sedge Warbler, with its rufous rump, moves rapidly to tangled vegetation when disturbed to give short bursts of a low, rasping churr. Reed Warblers nest in reed-beds and make scolding and churring notes if alarmed. When young have left the nest and cling to the reed-stems, adult Reed Warblers make soft, hooting notes of a nasal quality if danger threatens. Many of these sounds are difficult to describe; the use of a recording which can be replayed and discussed is of great help in their understanding.

The leaf-warblers, Chiffchaff and Willow Warbler have similar alarm notes, a thin high-frequency 'hueet'. Wood Warbler, a larger bird, makes a piping 'piu'. The warbler of open, bushy places is the Whitethroat. Usually it responds quickly to a stuffed owl placed in its nesting area. The alarm is a grating 'churr'. Lesser Whitethroat likes taller bushes and trees; its alarm is a persistent 'tac, tac'.

Blackcap, like Garden Warbler, breeds in the thick undergrowth of woodland and thickets. Again, a rapidly repeated 'tac, tac' is the usual call when threatened. Garden Warbler makes a noisy 'chuck, chuck, chuck' which can dominate all other small birds' notes on playback of a recording.

Birds of prey can be very demonstrative if their nesting area is approached. Occasionally, however, they slip away without call. The repeated and high 'klee, klee' of Kestrel is worth recording if a vocal bird can be located. Peregrine, unfortunately now so scarce, is very noisy if one strays near its nesting cliff. A shrill 'hek, hek, hek' is the usual cry.

The recordist must be prepared to be dive-bombed if he ventures near a breeding colony

(*continued on page 218*)

tape recorder service 64

MORE THORN DESIGNS ■ H. W. Hellyer

THERE are some loose ends to clear up, we said at the conclusion of last month's article. So let us get these out of the way first.

Perhaps most important is the microphone. The circuit has already been given, and the switching arrangements described. But it is the physical make-up of this crystal type microphone that defeats many owners, fearful of ruining what appears to be a sealed-unit in attempting to open it. **Fig. 2** therefore shows the interior of the microphone, with the wiring and the switch layout in sufficient detail for us to describe simple repairs.

The back of the microphone is pressed on the main body with four close-fitting pegs seating in the circular pillars at the corners. To remove the back, a thin blade should be inserted gently in the crack of the back edge and worked around to apply as nearly as possible an even upward pressure. Ideally, four blades could be used, when the back can lift straight off. Because the pegs are fairly long, almost the thickness of the microphone body, and a tight fit, uneven leverage only results in the back binding and perhaps cracking. Patience, and care, is the prime need in opening this little joker—but, once open, service is easy.

A crystal capsule is used and the *Acos 43-3* is a good, cheap replacement. But other types can be used, and the space available allows some scope for ingenuity. The switch is simply a shaped plastic slide with a spring-loaded peg that presses the blade to which the red lead connects away from that which carries the yellow (or black) lead. These two blades insert in slots in the plastic and the whole assembly comes to pieces quite simply—*too* simply if you turn the microphone over while working on it! The cable is held in place by its twist between the raised flanges of plastic at the bottom, and it is at this point, similar to the twist point of other kinds of microphone, including the *Acos 40* and the various *Philips* types, that a cable fracture may occur. The remedy is simple: shorten the cable by only a couple of inches and you can save yourself a couple of guineas for a new mike.

There are two other points: the microphone is padded with a wedge of foam rubber and the shielding of the connections is simply by a slip of foil with one side plain, insulated. Make sure this has not become buckled to cause a short-circuit. The other point is the connection itself. One terminal connects to the capsule casing, the other is insulated by a thin washer beneath the rivet. Clumsy soldering or careless handling causes shorts and intermittent connections here. Use no more heat than is strictly necessary and, with long-nosed pliers, employ a heat-shunt when soldering.

Next 'loose end' is the remote control facility, described in last month's article, but since then the subject of some correspondence and telephone conversation. The reason? That thorny subject—conversion for sleep-learning.

Despite John Mollon's comments in the February issue of *Tape Recorder*, many people find the device of a pillow-phone of some educational benefit. Who are we, who sell and service the various accoutrements, to gainsay the hypnopaedic enthusiasts? But with Messrs. *Thorn* we struck a rock. Briefly, we were asked by a customer to provide a ½-track *Ferguson* tape recorder with remote control facilities. Innocently, we supplied the machine and wrote off our order to the makers for the bits and pieces to convert the deck. Our study of the FTD2 and FTD4 decks had convinced us that such a modification could be made. But British Radio Corporation refused to co-operate, and their reply could be aptly paraphrased from the *British Radio Corporation Bulletin* for February, which, by sheer coincidence, arrived in the same post.

Reference was to the Ferguson 3218, but the same argument applies bearing out what David Kirk has preached so many times. To quote:

"Stopping the machine by switching the mains power off may cause tape spillage.

"When set to start by switching the mains power on, the rubber pinch-wheel is in contact with the tape and capstan while the machine is stationary. This may cause flats to develop on the pinch-wheel and thus impair reproduction.

"Appreciable time is required for the valves to warm up, which may cause a lack of reproduction of the first part of the recorded material."

A modified version of this particular machine has been made by Ferguson for the *Sleep Learning Association*, and is referred to as the *3218/SLA*, available to the general public as *3218/Z14*. This has a relay which can be operated from an external time switch. The lads at BRC know what they are talking about, and for anyone who contemplates modifications to his machine, the foregoing remarks may prove salutary, and we hope the succeeding notes may give a few alternative ideas.

Fig. 3 shows the modified circuit which incorporates the time switch and relay, and is simple to adapt to other machines.

In this set-up, the machine is switched on, the volume control adjusted and the play key depressed. With time switch off, the valve heaters are alight but the relay is not energised and thus there is no HT on the valves nor any AC powering the motor. The pause solenoid is operated, holding the pinch-wheel off and applying the auxiliary brake to the left-hand spool.

When the time switch operates, the relay energises, applying HT and AC power. The pause solenoid is released and playback takes place immediately. When the time switch reverts to off, the conditions go back to the previous stand-by position, with the brake application preventing spillage. No automatic rewind facilities are included and with a standard spool system only one sleep-learning operation per night is available. But if you want more than one, then an endless loop cassette is the answer and the length of tape is adjusted to the 'on' duration of the time switch.

We have been talking of sleep learning, and I am indebted to British Radio Corporation for the above hints; but readers of this magazine will realise that there are many more potentialities, including time-switched recordings. Some of us, to whom the supermarket burblings are anathema, may abhor the idea, but if you must be woken by the *March of the Gladiators*, here is the answer.

The group of machines that concerns us in this section, and which is typified by the circuit of **fig. 1,** uses the *DB42* deck. This can be recognised by the keys being central and the use of clear plastic knobs and a microphone socket at top right of the front panel. There are other distinguishing features, such as the shape of the spool carriers, with their flatter central portions, and the distinctive head cover; these machines are easily recognised.

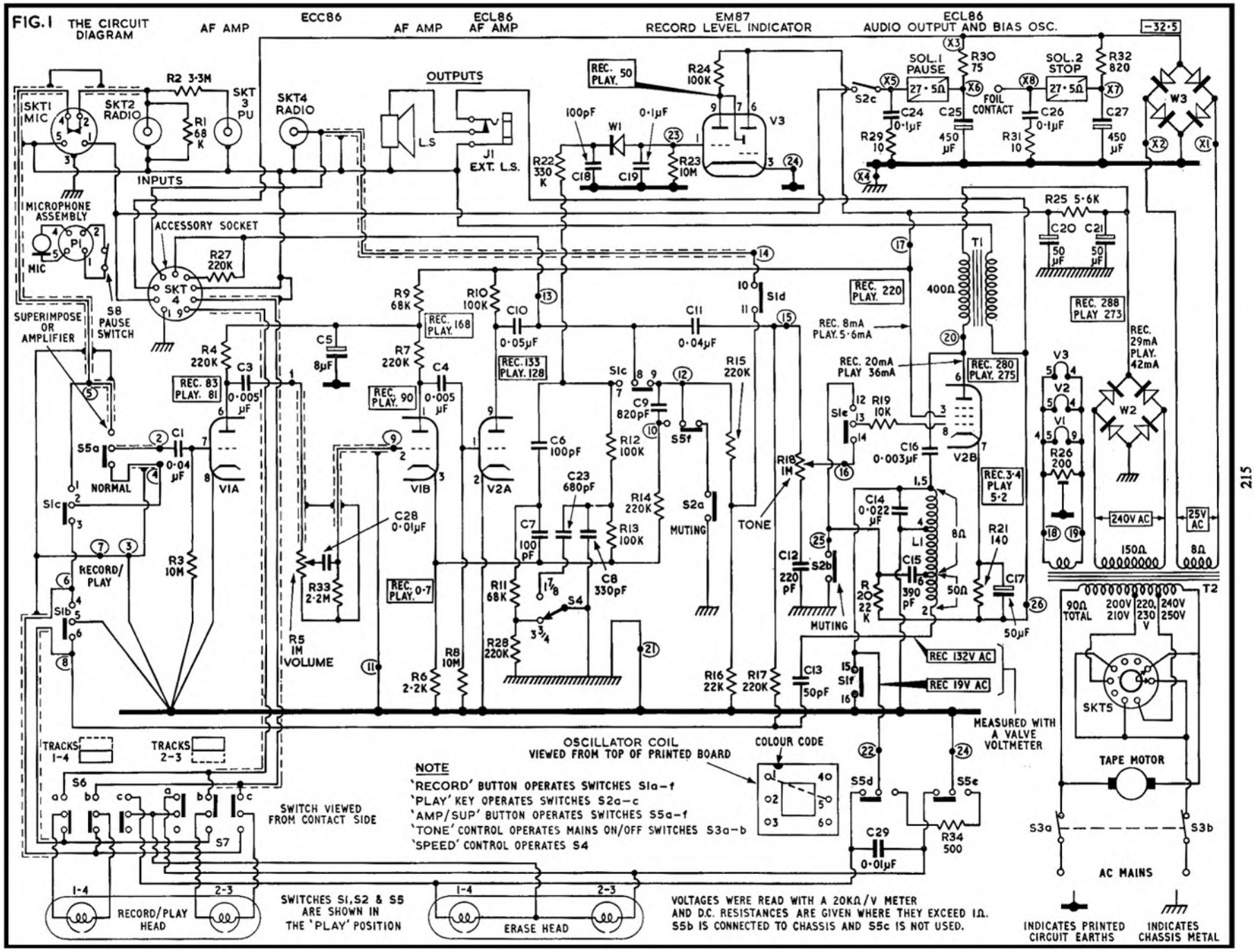
There are several things to watch for when servicing these machines. First, the spool carriers, which have a tendency to easy damage of the fluted spindles, are supplied with the felt pads loose; these have to be glued in place. It is no use hurrying this job. Good clutch action depends on a firm, even, felt (smaller type to the left) and it is better to wait for a day while everything sets firm than to have subsequent trouble.

Next, when taking off the top plate (seven screws), watch for the base and connections of the EM87. This is sprung into place and tends to lift, being normally held down by the plate. When tape is loaded for testing, the cable form can foul the tape as it comes from the left spool. Having damaged one precious test tape in this way, I feel it incumbent upon me to pass on the warning. A temporary strip of adhesive tape to hold it down is the answer.

When removing the chassis, watch out for the fan blades at the bottom of the motor. These are of plastic, but can give a nasty burr if the motor is switched on, and will catch and jam if the chassis is rested on bench or table unsupported.

The track switch is a common cause of instability, and is easily damaged by mishandling. Watch out for insufficient clearance or dirty contacts.

(*continued on page 217*)



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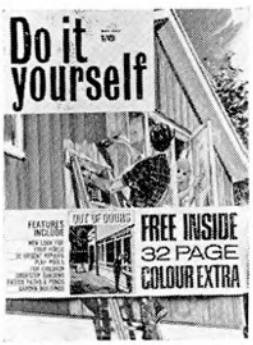

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FIG. 2

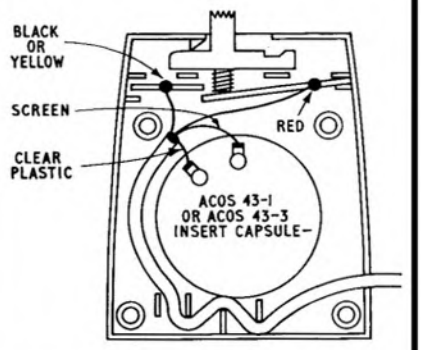
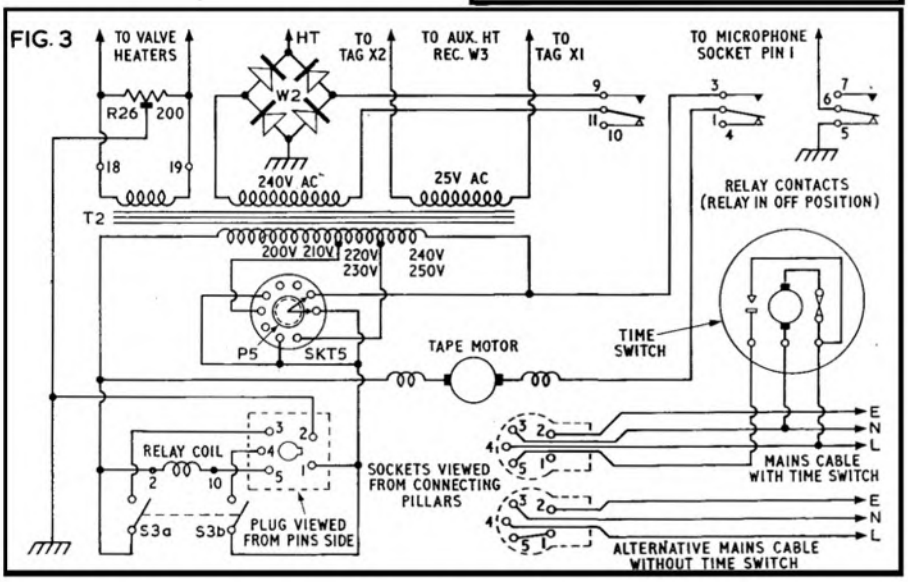


FIG. 3



Where poor take-up or noisy rewind is noted, look out for dried-out washers at the pivot of the spool carrier brackets, and at spindle bushes.

To cut down those annoying crackles, BRC take great care with their earthing, and you will find not only the speaker but also the metal grille earthed with a flylead. Make sure these joints are in order. Another typical BRC trick that could well be emulated by some other makers I could name, is a clip on the volume control spindle with a flylead to chassis. Many a volume control has been replaced in radio, television and audio gear because of 'noisy operation' when the only real fault was poor contact between the various moving parts. Tightening the grip at the entry point of the spindle and boss can help in many cases, or providing an additional screened connection between the outer shell of a control and the front mounting portion. Contact here often relies on the bent-over tags, and oxidisation is a long-term fault that causes high resistance, noises and sometimes hum. This effect is most noticeable when the control is moved and troublesome at low signal points of the circuit—such as a signal level control in a tape recorder or a gain control in a pre-amplifier.

But we digress. To return to our muttons, and the circuit of **fig. 1.** We note, as before, that a separate HT rectifier supplies power from a 25V AC winding to the 32.3V DC solenoid line for stop and pause solenoids, and also to a pin on the auxiliary or remote control socket. This gives us a handy, smoothed source for external amplifier or mixer powering, experimenters will not be slow to note. The solenoids receive a high initial 'helping' current by the charging action of the large electrolytic capacitors, and the holding current for the Pause solenoid is through R.30, the 75 ohm resistor, via S2C, closed by the switch on the microphone and by an external foot switch or other attachment between Pin 2 of the auxiliary socket and chassis.

One more small point that bears repeating: a hum-bucking resistor R.26, 200 ohms, is fitted across the 6.3V winding of the mains transformer. Do not overlook its effect, especially if a fault develops. Having only a day or two ago spent fruitless time chasing hum around one of the later Grundigs (which rely on sprayed paint on the casing for screening and therefore give a higher than normal hum level when opened up for service) only to find the cause was the obvious open-circuit at one end of the hum-bucking variable resistor, I feel a grudging respect for these little jokers.

This one normally needs no alteration, but a valve-change may alter the balance of things and then it is necessary to go to a bit of trouble.

The input stage should be screened electrostatically and the machine switched to record, with the oscillator 'killed' by a short across R.20. Tone control is set to minimum and volume control to maximum. Fix up a dummy microphone input with a 1kpF capacitor strapped across Pins 4 and 5 and when the machine has warmed up (at least ten minutes running time) measure from the junction of C10/C11 to chassis with a valve-voltmeter and adjust R.26 for minimum reading.

This may sound like a lot of rigmarole; but only last week I had a good machine in with a high overall noise level, hum, hiss, crackles, the lot! Altogether, there were ten separate things that had to be done, including degaussing, of course, to reduce the problem to within the specification figures. Any one of the 'cures' alone would hardly have been noticeable to the ear, but cumulatively the effect was remarkable. So do not disregard the trivial things in audio servicing; as one of my snooty colleagues too often observes: "That may be good enough for the TV rental boys—but not for us!".

Still on the subject of hum and noise, you will notice that the circuit shows two curious departures from the obvious. The first is the familiar common return of the signal leads for the input to V11. This means what it says, and any work on these components or leads must be completed by a return to the *status quo*, so to speak. Again, the earthing for S4 common and R.28 is shown going through a dot, marked 21, to common ground line. Now this heavy black line is the printed circuit common line whereas the shaded earth is a symbol denoting the metal chassis return. A similar arrangement is seen at the muting switch and at the microphone casing return, where the connections go directly to the metalwork.

Note that the speed switch is in conjunction with the playback equalisation and record pre-emphasis that is applied from V2A anode to V1B cathode. This apparently simple little circuit is worthy of study by the correspondents who ask what changes they have to make when they graduate up from a single-speed deck. For further reading on the subject, refer to the *Mullard* book of tape recorder circuits, or our dear friend and oracle, Mr. Spratt (*Magnetic Tape Recording—Heywood*).

The muting switch is a slide type mounted on the top deck, just to the right of and behind the head plate. It has three distinct functions. When the machine is switched off or to fast wind (provided the amplifier/superimpose switch is in the normal position), the output of V2A is shorted to chassis by one pole of S2. When the machine is switched from record to any other function, another pole, S2B, allows the oscillator to decay gradually, helping to cut down magnetisation. And S2C is used to break the pause solenoid circuit to prevent accidental operation of the pause switch during the intermediate state, between functions.

Finally, the amplifier switch S5 connects the input circuit for straight-through amplifier, but also reduces the bass boost by S5F shunting C9 and puts C29 across the feed line to the record/play head. In conjunction with the isolation of the erase head, this prevents partial erasure (reduces bias action) when superimposing.

of some sea-birds. Arctic and Common Terns are examples. Terns are always on watch and the nesting birds do not have to be approached closely in order to get good recordings. Vigilant terns swoop over the intruder, uttering a high-pitched and long 'kree-ah'. In the same way, a visit to a group of breeding Black-headed Gulls produces a vigorous clamour from the screaming birds: 'krik, krik, krik'. A harsh menacing cry is given if one nears the nest of a Great Black-backed Gull; it is a guttural 'ug-ug'. A similar alarm but of lesser amplitude, is given by Lesser Black-backed Gull while that of Herring Gull is a 'kah, kah, kah'. Common Gulls usually breed inland, especially in Scotland. Shrill 'kwak, kwak' notes are uttered if the breeding area is invaded.

Of wading birds and plovers, the one most likely to be encountered breeding in Britain is the Lapwing. This lovely green-crested bird nests on ploughed land in March and April. If its territory is threatened the pair will wail overhead, then dive with an angry 'pueet' at the invader. But the speed of flight of the bird makes it difficult to get a satisfactory recording. The common breeding wader of the seashore is Ringed Plover; it nests on sand-dunes or shingle beaches. Often it is a beautiful setting on which to erect the microphone to await the liquid 'tuu-ii' of alarm.

Probably most bird-recordists are interested in the common birds of their garden. The insistent clear 'nueet' of Chaffinch as a Magpie settles on a garden tree is a common alarm reaction. Less well-known is the slow nasal 'hueet' of Greenfinch; a prowling cat or human nearing the nest or newly-flown young will evoke this call. And so does a stuffed owl, placed in a conspicuous position, or the play-back of previously made alarm call recordings. An interesting alarm sound is that of Gold-finch, alerting its hiding young to danger. It is a plaintive, nasally intoned call, unlike that of any other finch.

ALARMING 'CHEEP'

In a garden, probably the first bird to react to an alarm situation is the House Sparrow. It is more wary than is generally realised: its alarming 'cheep' joins rapidly with that of other frightened birds. A harsh ratchet-like churring of surprising amplitude is given when the Wren is threatened; it may be difficult to convince some people that so loud a churr is made by so small a bird in their own garden. The Robin is more familiar. Its rapid 'tick, tick' of alarm has great carrying power. Play-back of this call in most gardens will bring a Robin to investigate.

Hence, the collecting of birds' alarm calls on tape can be commended as a worthwhile hobby. It can be carried out without harming the birds or decreasing their chances of successful breeding in any way. Replay of the tapes and discussion of the significance of the varied calls can be of much value to the naturalist. A series of unusual sounds is produced for possible analysis. Clearly, the method has importance in the teaching of natural history. Above all, it is of value to the one who carries out the recording in the field.

CROWN 800 SERIES

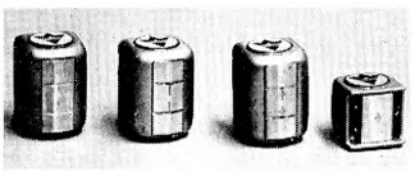
RECORDERS in the *800 Series*, manufactured in the USA by *Crown International*, are now available in Britain. A wide variety of models are being produced around a basic solenoid-controlled deck with 10½in. NAB maximum spool capacity. Standard speeds are 15, 7½ and 3¾ i/s, a frequency response of 50Hz—30kHz being claimed at the faster speed, within limits of ±2dB. Wow and flutter is better than 0.06% with 60dB signal-to-noise ratio on the twin-channel ½-track models. AB monitoring, four-input mixing, variable bias, and a photocell automatic stop are standard features. Remote control and automatic repeat/rewind accessories are available.

Distributor: Carston Electronics Ltd., 71 Oakley Road, Chinnor, Oxfordshire.

SANYO VOICE SWITCH

SUITABLE for use with any *Sanyo* tape recorder and, with limited modification, certain other models, the *VOI-1* permits voice-activation of power supplies. A miniature jack socket is incorporated to accept a microphone, on/off sensitivity being variable. The unit costs £5 15s. 6d.

Distributor: Sanyo Service and Sales, Marubeni-Iida House, 164 Clapham Park Road, London, S.W.4.



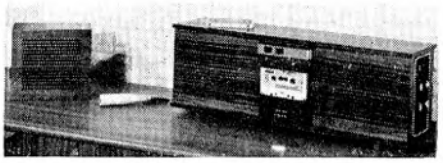
MINIFLUX TAPE HEADS

SUITABLE as replacements for *T* and *N* head types, the newly introduced *S* series are claimed to give ±1dB output linearity down to 20Hz. Hyperbolic contoured faces on the twin-channel versions permit improved head-to-tape contact without pressure pads and a reduction in dropout effects.

Distributor: Miniflux Electronics Ltd., 8 Hale Lane, London, N.W.7.

VAN DER MOLEN CASSETTE RECORDERS

TWO new recorders and a tape player have been introduced by *Van Der Molen*, all employing *Philips* cassettes. The *Sonic Eight* provides stereo recording and replay facilities at £51 9s., replay being through speakers mounted to the left and right of the tape mechanism. The left-hand speaker may be detached from the recorder cabinet without affecting the latter's appearance. The unit is



incorporated in a smaller matching cabinet. The *Sonic Seven* is of similar appearance but lacks recording facilities and costs £40 19s, which is also the price of the *Sonic Six* mon. recorder.

Manufacturer: Van Der Molen Ltd., 42 Mawney Road, Romford, Essex.

HENRY'S REVISED CATALOGUE

AUDIO and electronic products stocked by *Henry's Radio* and ranging from wire recorders to electronic organs, tape heads to transistor ballasts, are detailed and illustrated in the 200-page 1967 catalogue. Fifty pages cover microphones, tape and general audio equipment while a number of experimental circuits are included in the components section. The catalogue costs 7s. 6d. plus 1s. postage, refundable at 2s.

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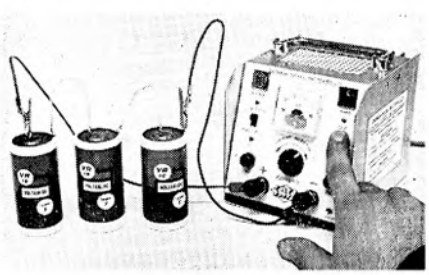

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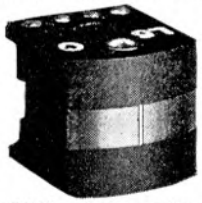
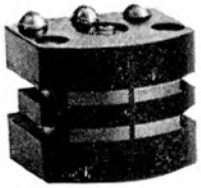
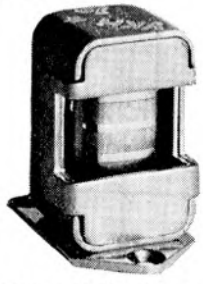


Type LF60. Low impedance half-track mono ferrite erase head with built-in oscillator coil. List £3, offered at 22/6 each.



Miniflux Type No. VLF4. Quarter-track stereo ferrite erase head as used on Reflectograph Model B, Simon SP5, Truvox, Brenell 3-star, Elizabethan FT1, etc. Listed at £3.10.0, offered at 32/6.



Miniflux Type VKH4. Quarter-track stereo rec./play head as used on Reflectograph, Brenell, SP5, Truvox, Elizabethan F.T.1, etc. Listed at **6 gns.**, offered at 55/- each.

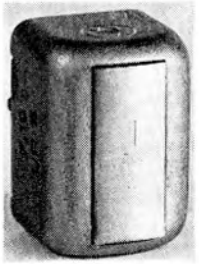


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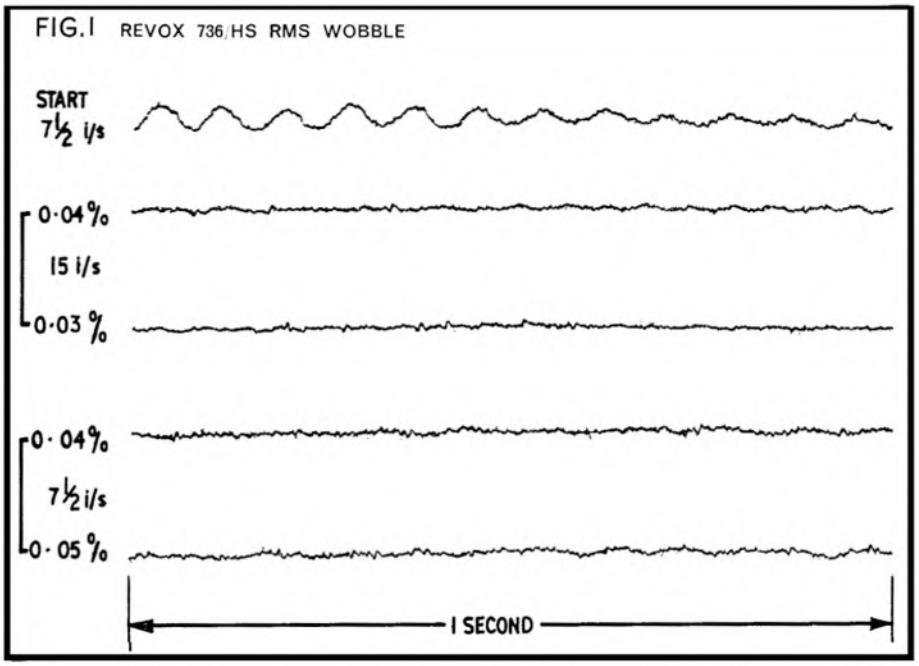
FIG.1 REVOX 736/HS RMS WOBBLE



THE letters HS in the type number indicate that this is a high speed version of the 736 fitted with a Swiss ground capstan of greater than normal diameter to give exact tape speeds of 7½ and 15 i/s, and with modified equalisation to suit these speeds. The larger diameter and precise grinding of the capstan should result in a just perceptibly lower wow and flutter than the standard 736. Comparison of the pen recordings of **fig. 1** with the ones published in the September 65 review of an earlier 736 show a very slight reduction from 0.05% RMS towards 0.04% RMS at 7½ i/s. The 15 i/s fluttergrams are even better at 0.03% and 0.04%. On both machines the exceedingly low tape flutter caused by friction on guides and heads should be noted. This is due to good guide design and positioning, and the absence of pressure devices against erase and record guide design and positioning, and the absence of pressure devices against erase and record heads. The starting transient is given for comparison with that of the earlier review; it will be seen that the amplitude is slightly reduced and the damping improved. I think this is due to the substitution of a photo-electric end-of-tape switch for the movable guide type in the early recorder. Whatever the reason, the subjective impression is that the starting wobble is over in a small fraction of a second—before one's finger leaves the start button—and it is difficult to excite it by touching the tape or by bad spooling. The tape transport is in fact as near perfect as no matter.

The playback equalisation was checked by playing 35μS and 70μS test-tapes at 15 and 7½ i/s to give the almost straight line responses of **fig. 2**. System noise with no tape passing the heads was 41dB below test-tape level at line outputs. The lower track responses were checked by running the test-tapes in reverse, with the expected result that the differences were so small as not to be worth plotting. The response to 20kHz was checked by running the 70μS tape at 15 i/s which gave exactly the same response shifted up one octave.

Recording tests at test-tape level gave the very similar responses of **fig. 3**, and further tests at peak recording level (12dB above test-tape level) showed only a slight fall at extreme high frequencies due to tape overload caused by the recording pre-emphasis.

Test-tape level was recorded at —7dB on the VU-meter, with peak recording level well off the meter scale. The actual distortion was measured with a newly acquired harmonic distortion meter and found to be exactly 3% at 12dB above test-tape level at 500Hz, and slightly less at 1kHz and 3kHz. This meter filters out the test-tone fundamental and measures all harmonics, together with mains hum, valve hiss and under-signal tape noise. A 250Hz high-pass filter was used between the recorder line output and the harmonic meter input to prevent errors due to hum and low frequency noise at lower recording levels. A total reading of just below 1% was obtained at test-tape level. Later tests disclosed the fact that my source tones had a residual distortion and noise of just below 0.5%, so that the above readings are if anything slightly pessimistic.

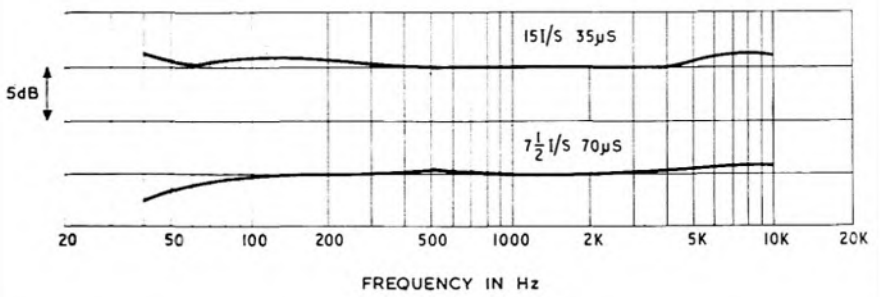
The normally accepted 5% distortion level for domestic recorders was some 14-15dB above test-tape level, depending on the tape used, and harmonic distortion tests at the recording head showed that record amplifier distortion was well below 1% at head currents 20dB above that needed to record test-tape level. This proves that tape is the controlling factor in peak level distortion, which of course is exactly as it should be, but often is not on many domestic recorders.

One of the most impressive features of this machine was that the responses of **fig. 3** could be obtained on almost any modern tape with no more than a plus or minus 2dB deviation at 10kHz. This is almost certainly due to the 'safe' over-biasing for minimum noise and distortion.

The overall electro-acoustic response was obtained by playing a 70μS white-noise test-tape containing 25 one-third-octave bands of filtered white-noise and measuring the speaker sound output with a calibrated microphone. The response of **fig. 4** is almost identical with that obtained in the early 736 review, and

(continued overleaf)

FIG. 2 REVOX 736/HS PLAYBACK RESPONSE (TEST-TAPE TO LINE OUT)



shows that the speaker at least has not been changed over the last year or two. The small peak at 250Hz was caused by a slight 'buzz' at high volume levels which seemed to be due to the plastic grill or cabinet, but it may have been some internal vibration which could only be heard through the speaker cone.

COMMENT

My comment on this 736/HS is to admit that I have squandered the housekeeping money for months to come by investing in it as a reference standard and yardstick against which all future recorders will be judged. I hope to spend the next month or two designing filters, etc., to ensure that my test equipment will be capable of accurately measuring the very low level of distortion in this recorder, so that future reviews can contain a meaningful distortion measurement to back up my subjective impressions of 'cleanness' or 'muddiness' which were the only standards we had to date.

This recorder was first tested some months ago and then sent back to David for a good work out on which his companion report was based. It was then returned for further tests to see if measurements disclosed any deterioration in performance. It is my pleasure to report that all the measurements I have since made agree exactly with my early figures!

I doubt if I shall be around in January 1997, but I will try to programme the computer, which by then will probably have taken my place, to give a further report on the 736/HS. It may confirm David's prediction (A Visit to Revox-Studer—January 1967) that the recorder will still be going strong thirty years from now.

A. Tutchings

FIG. 3 REVOX 736/HS RECORD/PLAY RESPONSE (LINE IN/OUT)

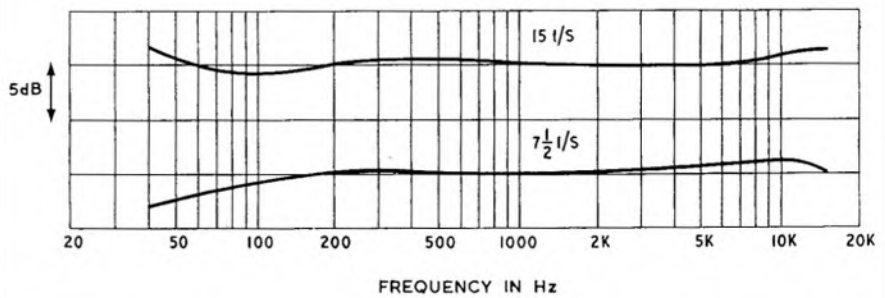
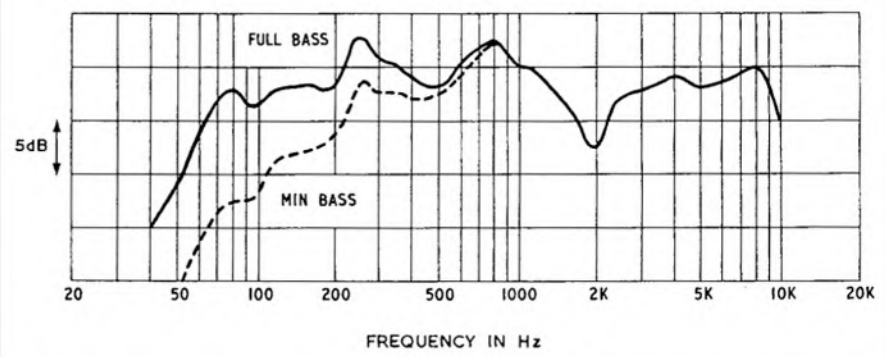


FIG. 4 REVOX 736/HS ACOUSTIC RESPONSE



FIELD TRIAL

THE 736/HS is the first *Revox* I have ever handled for any length of time and the third recorder I have used which embodied a 15 i/s tape speed. In appearance it is identical to the 736, which received a very favourable review at the hands of Alec Tutchings in the September 1965 *Tape Recorder*, subsequently reprinted in the 1966 *Audio Annual*.

A two-speed *Papst* motor is employed on the basic 736, applying direct drive to a very thin capstan spindle. Speeds are 7½ and 3¾ i/s, selected by two push-buttons on the left of the amplifier control panel. Price of that model is £133 7s. in ½-track or ¼-track form.

The 736/HS is available with ½-track heads only and has switched speeds of 15 and 7½ i/s. The model submitted for test was modified for the higher speed before leaving the *Revox-Studer* factory in Switzerland. The majority, however, are converted in this country.

Although superficially simple, the amplifier controls are arranged to provide all the facilities one expects from a stereo recorder. Record and play controls are grouped respectively to the right and left of the VU-meters. Two push buttons on the right permit record

track selection but have no effect on replay. Pressing one button illuminates the relevant meter and prepares the machine to record on one channel. Centring the buttons brings both meters to life and permits stereo recording. The speed-selector buttons may be similarly centred, cutting the capstan motor power, should the Revox be required to serve as an amplifier or mixer alone.

Adjacent to the track selector buttons are two gain controls with coaxial switch skirts. According to the position of these skirts, microphone, gram, or auxiliary inputs may be brought into circuit. Three phono sockets are provided on each channel to take the incoming signals. A preset attenuator is mounted near each auxiliary input. This arrangement of gain controls permits balancing of stereo material or, when recording mono, mixing of two microphones, microphone and gram, gram and radio, and so on. Another arrangement of the coaxial switches connects the circuits into a chain for cross-track recording, with or without mixing of an additional live signal. Yet another provides the clearest tape echo I have ever heard, this effect being close to artificial reverberation at 15 i/s. I must confess having experienced great difficulty in remembering how to distinguish between cross-track recording and echo control settings. There were so many permutations of switch and button positions that I would be inclined to paste the 'Special Effects' page of the instruction book on the lid.

The two rotary controls on the left of the panel govern bass and volume on the replay monitor channel. A coaxial switch on the bass knob acts as mains on/off, while the volume control skirt connects the monitor to left input, left tape, left-plus-right tape, right tape, and right input preamplifiers. The selector does not affect the signal feed to the low-level output sockets, which are duplicated, incidentally, and wired to two sets of twin photo sockets. An external speaker socket is also incorporated.

Five switches on the left of the head channel operate the solenoid deck. From left to right, these are rewind, fast-forward, play, stop and record. Record and play switches interlock in the time-honoured manner, but the record button may be pushed down during playback, causing obliteration of pre-recorded material. The proximity and similarity of stop and record buttons make this, for me, a valid criticism of the design.

Although many 736's will probably spend their lives with nothing bigger than 7in. spools, the deck is designed to accept 10½in. NAB or cine spools. The range of effective feed-reel diameters may thus vary almost ten-fold. Switched tape tension is incorporated, both photographs of the deck (with and without plastic covering) showing this in the nominal 'cine' position. The switch lever folds flush beneath the head cover when increased back tension is desired. This action simply increases the power to the left-hand motor, a sprung guide pillar filtering out any remnants of mains flutter likely to be transmitted through the tape. The 736 HS becomes wildly unhappy when the supply reel diameter falls below about 2½in. Three-inch spools are best prohibited from the machine since, to my amazement, the very small hubs pulled the speed down to some 6 i/s from a nominal 15 i/s! Wide-hub cine or NAB spools are probably worth buying in the long run—particularly if live recording at 15 i/s is anticipated. (Threading in front of the left guide tends to overcome this difficulty, state the distributors.)

A photo-transistor is built into the right-hand tape guide, in line with a beam of light from a lamp mounted behind the capstan. Only when the light-path is interrupted by the tape can play or fast-wind buttons be locked down. This autostop system, though technically sophisticated, has one or two practical drawbacks, all of which could be solved simply by fitting a switch in series with the lamp. In the course of its eight-week trial, the recorder was employed with others in the preparation of an amateur 16mm. film sound-track. Several tapes of individual effects were prepared, each effect being separated by a short length of timing tape. The timing tape proved sufficiently transparent to prevent the play switch engaging, the latter having to be held down throughout the effect duration. The moral is obviously to use opaque leader and timing tape.

The second disadvantage of the sensitive optical autostop was observed when, in the course of recording from a tuner, the tape stopped. Post mortem proved the cause to be an almost invisible reduction in tape width, possibly due to accidental stretching on another machine. (I understand that the bulb is mounted on a swivel base to permit adjustment of light intensity.)

No pressure pads or pins are employed to retain the tape against the erase and record heads, though a sponge-mounted curved Mu-metal plate is positioned against the playback head. Contact with the first two heads is maintained by a combination of radial head mounting and comparatively high back tension. Two pins are revealed when the head cover is removed but these serve only to draw the tape away from the heads during fast-wind, thereby prolonging head life. In some hands, however, I feel that the pins may be having entirely the opposite effect. During its cine sojourn, the 736/HS was left in the hands of an operator who had received only a brief instruction in the use of the five solenoid controls. The tape channel covers were left off to simplify the positioning of each new sequence. I was intrigued, some minutes later, to see the tape threaded *behind* the pins. Experiment showed the Revox to play quite happily in this manner and I began to wonder whether this was, after all, the correct way to thread the tape. When the covers were replaced, however, it seemed impossible to thread in any manner other than in front of the pins—namely between the pins and the pinch-wheel bracket. One or two readers have complained of severe head wear on the 736 and I am left wondering whether, for one reason or another, they are actually threading behind these pins.

No undue head or guide wear, and no oxide build-up, were noticed during the field test, and I would expect the Revox to fall into line with most other non-professional recorders and require replacement of one or more heads at intervals of between one and three years, depending on use. It seems logical that wear would be greater at 15 i/s than at 7½ or 3¾ i/s. Having a machine of this quality in the house, I naturally turned to it in preference to its chromium-plated bench-mates whenever any

(*continued on page 225*)

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recording task arose. There was thus ample opportunity for excessive headwear to appear.

Comparison of live (FM tuner) and taped material at 15 i/s was both easily achieved and a delight to hear. At that speed, the time lapse between input and reproduced signals, switching from 'Input' to 'Tape', was hardly noticeable and the only difference in quality was a very slight and very delicate tape hiss. Its effect was far less obtrusive than the mush—or low frequency hiss—that mars any recording below 7½ i/s.

Equally fascinating was the difference in quality between 15 and 7½ i/s. Further input/tape comparison at the two speeds showed no reduction in level of the treble material; merely a slightly dis-satisfying increase in treble distortion. Although minor, it made one aware that a tape recorder was being employed in the reproducing chain. For all that, I have never before heard any non-professional machine that produced so sweet a sound at 7½ i/s as did the Revox. Only when one compares this machine with the rest of the Tom, Dick and Harry 'domestic stereo' designs does one realise their inferiority to the Revox in terms of hum, tape mush and distortion. The comparison is hardly one of price, since one of the models employed alongside the 736/HS itself cost over £150.

At least one reviewer has criticised Revox for wrapping their solid design in plastic. True, there is a tendency towards cabinet vibration when the bass control is turned full up on some programme material but, at a sensible setting, the monitor quality is really incomparable. The cabinet is quite substantial and would resist more knocks than I would ever dare give a recorder, but tends to scratch rather easily. Four rubber studs set in the base would prevent much of this scratching without hindering the Revox practice of storing assembled 736's in nine-high piles—a total weight of over 3 cwt. being imposed on the machine at the bottom of the tower. There is no lack of strength in the cabinet, nor in the lid.

The choice of sprung coaxial metal spool locks is a good one—nothing to lose and nothing to work loose.

The spool containers at each side of the deck are narrow and deep—perfectly suited to 10½in. spools but all too inviting to the miscellany of phono leads, DIN/phono adaptors, 7in. spools and so on, that one tends to carry around. The trouble is that, once in, these are the very devil to extract! Although I religiously refuse to use any recorder vertically, the Revox was often raised to this position to extricate lost accessories.

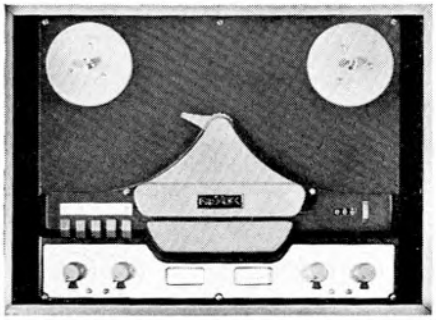
The mains cable cannot be stowed in the rear compartment if anything larger than a two-pin plug is attached—unless the lid is left flapping open. Since it would be impractical to increase the depth of the compartment, it might be worthwhile including a small notch in the rear lid.

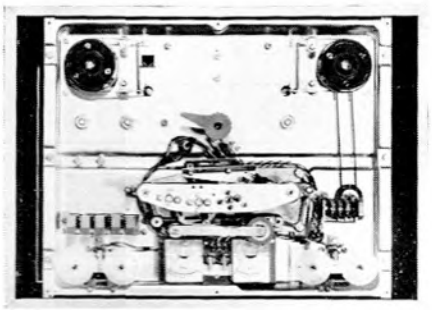
A photograph of the underside of the Revox is included (base removed), if only to show the immaculate layout and construction reflected throughout the recorder. Electronic servicing can be, in many instances, merely a matter of removing the base and prodding with appropriate test-gear. From a mechanical viewpoint, however, this is another of those machines that resents the intrusion of the home service-man. Solenoid mechanisms do not lend themselves to tinkering, and the tinker is given little opportunity. The heart of the Revox is inaccessible to ordinary mortals and best left that way.

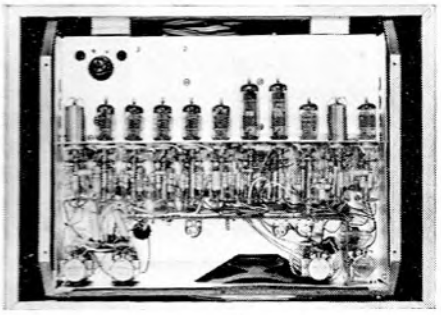
The advantages of 15 i/s operation may be outweighed by tape cost for the hi-fi enthusiast content merely to amount a more-or-less permanent collection of entertainment on tape. A library of full-track material at this speed would be expensive indeed, since a 7in. Standard Play reel assumes the capacity one might associate with a 3in. reel at 3¾ i/s. For the creative user, however, this is no problem. Once the film sound has been dubbed on to stripe, the production tapes can be erased and used elsewhere. Similarly, that four-minute competition tape is hardly likely to create financial difficulties when, again, all the 'practice takes' can be erased. Editing and trick effects (a one-second 'drumbeat' loop to create tension in a wartime execution scene) are achieved easily and quickly, with a bad-splice margin of several inches.

To conclude, the Revox 736/HS has many good and a few bad points in terms of external features and control facilities. In this respect it is no better and no worse than all the other 'semi-professional' designs. In terms of performance, however, it is superior to such an extent that it makes the rest seem toys.

D. K. Kirk







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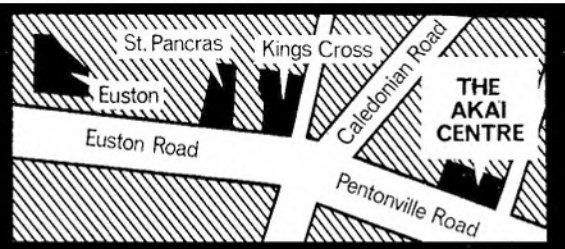

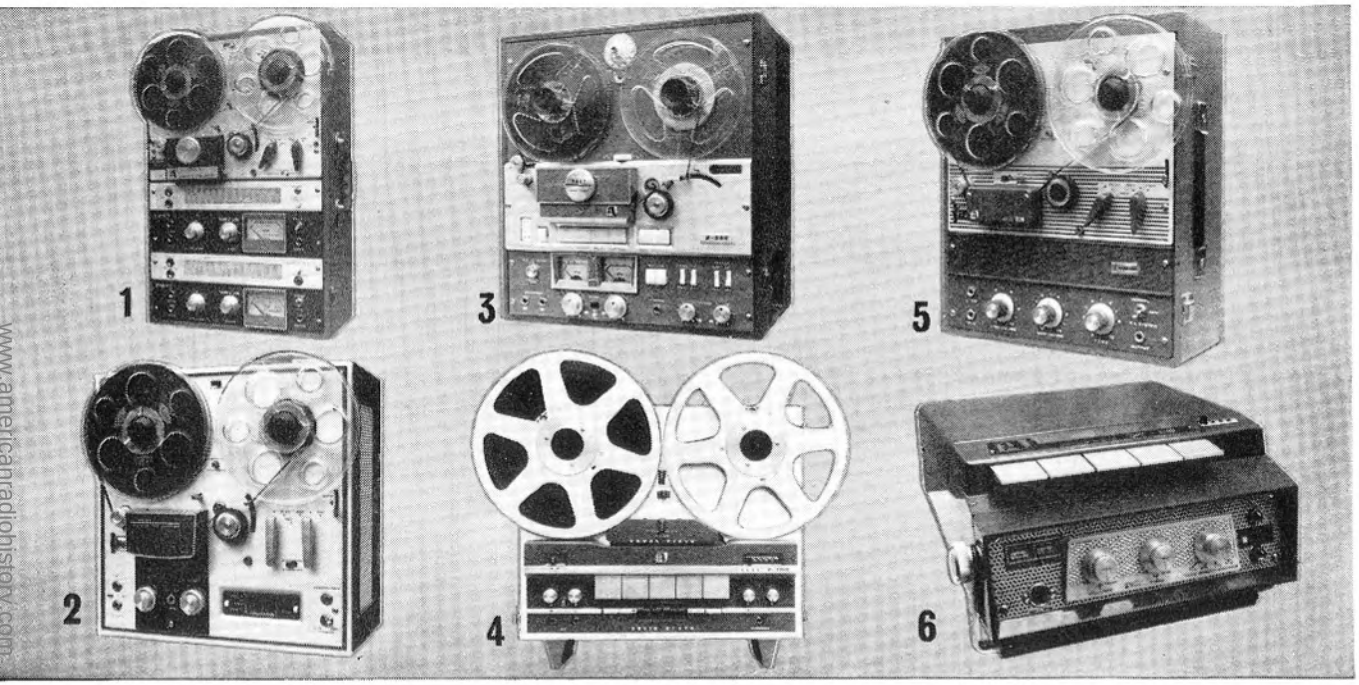

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