

JANUARY 1968 TWO SHILLINGS

tape recorder

東洋旅行の回想記
日本製

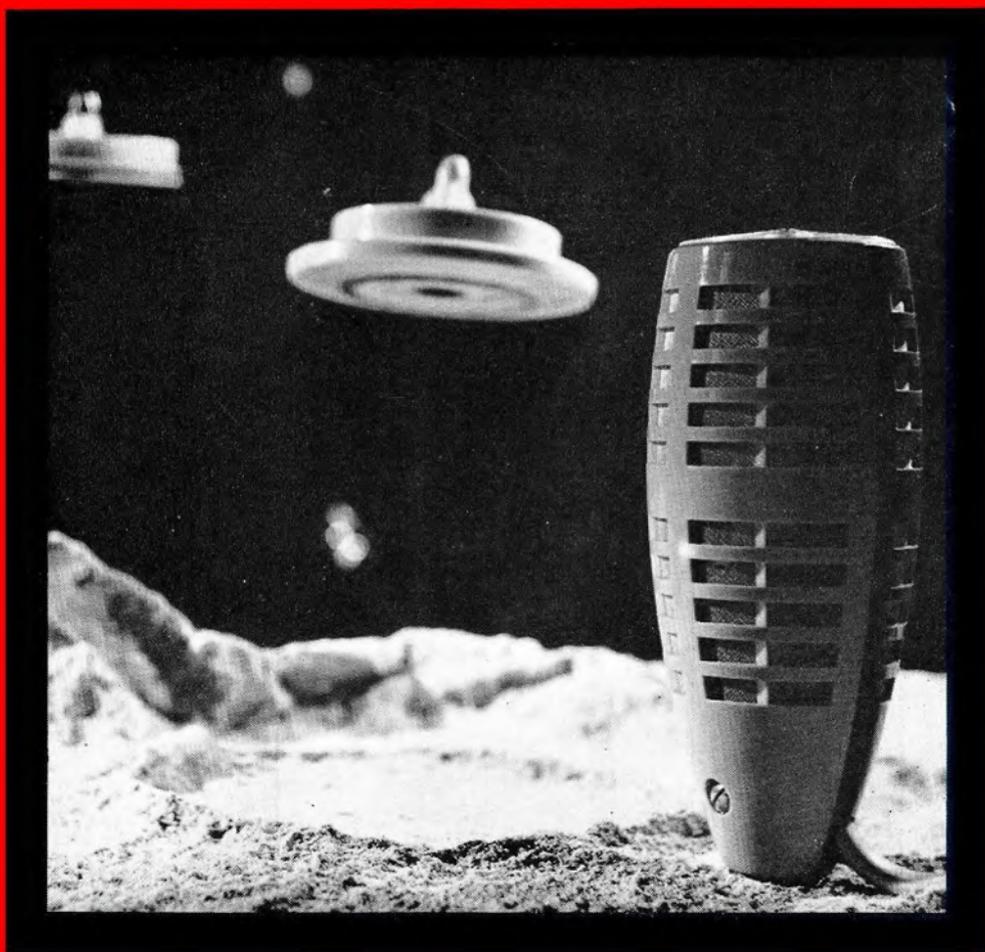
MADE IN JAPAN
MEMORIES OF A JOURNEY
TO THE FAR EAST

MEASURING WOW AND
FLUTTER

CYBERNETICS AND
PLASTIC GNOMES

PHILIPS EL3312 AND
EL7500 REVIEWS

JAPANESE ENGLISH



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- Digital counter with thumbwheel zero reset.
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- Operates on 230V AC supply.

STR-1 SPECIFICATION: Tape Speeds: 7½, 3¾, and 1½ ips. **Wow and Flutter:** Better than 0.15% rms on 7½ ips; 0.25% rms on 3¾ ips. 0.35% rms on 1½ ips. **Tape Size:** ½" wide, Long or Standard play. **Reel Size:** Standard, up to 7" / 5½" spools and tape supplied. **Digital Counter:** 3 digit counter with zero reset. **Heads:** ½ track erase record and playback. **Microphone:** Moving coil hand microphone (mono) bridge. **Semi-conductor complement:** 18 transistor, 1 silicon diode, 1 silicon rectifier. **Frequency Response:** 3dB, 40 c/s to 18 kc/s at 7½ ips. 3dB, 40 c/s to 12 kc/s at 3¾ ips. 3dB, 40 c/s to 7½ kc/s at 1½ ips. **Signal to noise ratio (unweighted):** Better than 40dB. **Inputs per channel:** Microphone 0.35mV. Auxiliary 50mV. **Outputs per channel:** 4 watts rms into 15 ohms. 1 volt rms (1,000 ohm source). **Speakers:** Two, high efficiency 8" x 5" pm 15 ohms. **Power requirements:** 200-250V AC, 50 c/s, 60 watts. **Cabinet:** Materials, 9mm. plywood covered with two tone Rexine with chrome fittings. **Dimensions:** 19½" wide x 7¾" high x 15½" deep.

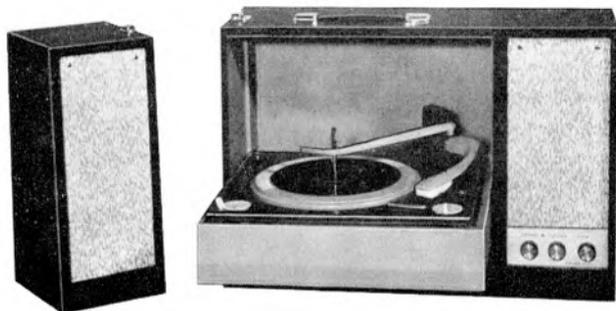


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LGS26	2,400' D/P 7" reel	77/6	49/6	145/6	285/-	365/-
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PES18	1,200' T/P 4 1/2" reel	49/-	34/6	101/-	196/-	273/-
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(Print Please)

January, 1968

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3"	150'- 4/9d.	225'- 6/3d.	300'- 8/9d.	450'- 13/9d.
4"		450'- 12/-	600'- 18/-	900'- 27/-
5"	600'- 15/-	900'- 18/6d.	1200'- 28/6d.	1800'- 45/-
6½"	900'- 18/6d.	1200'- 22/6d.	1800'- 36/-	2400'- 57/6d.
7"	1200'- 22/6d.	1800'- 28/6d.	2400'- 48/-	3600'- 75/-

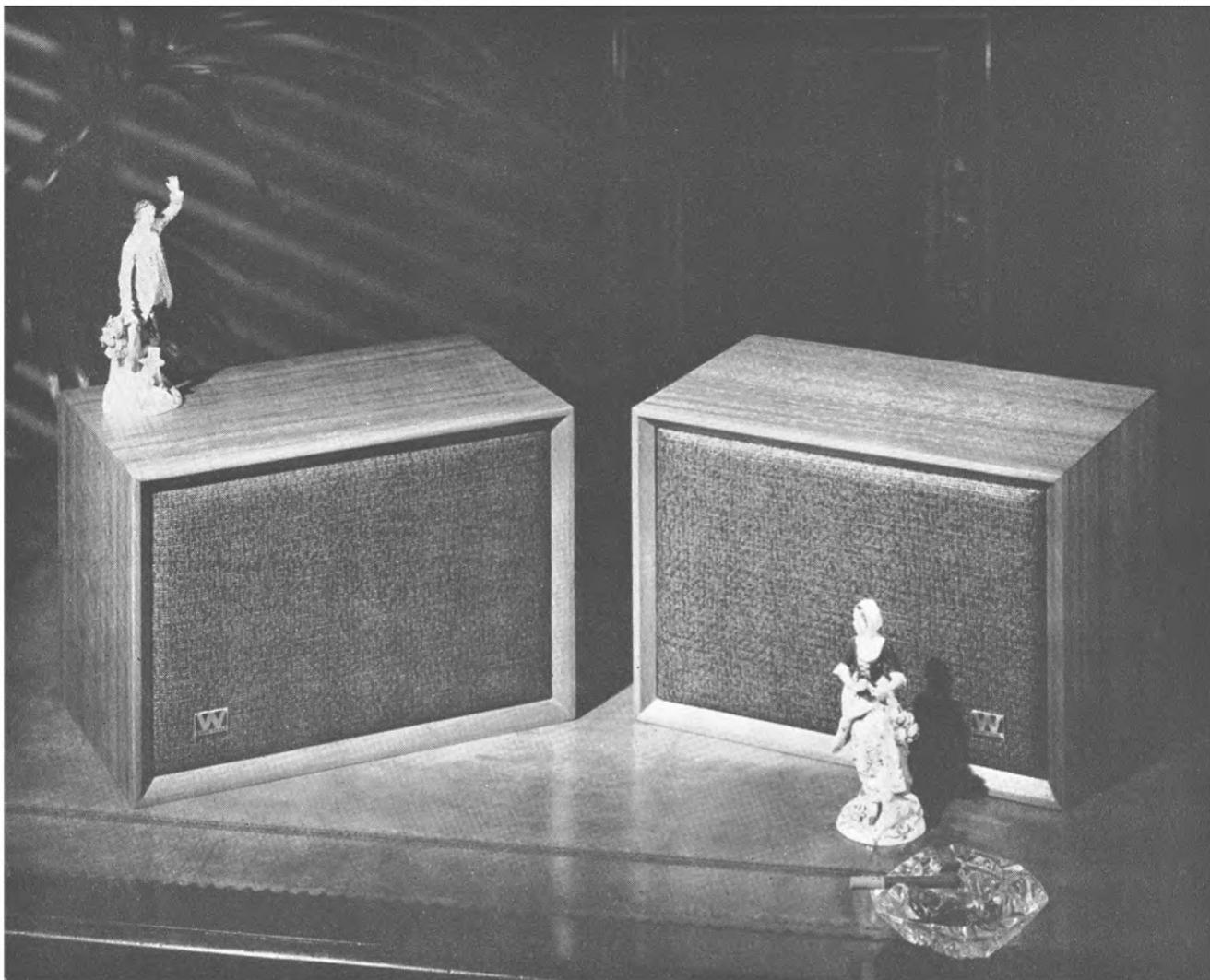
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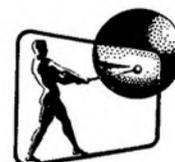
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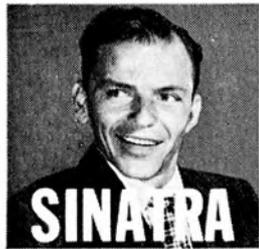
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9/11

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449 Unforgettable songs from the Continent! Romantica; Volare; La Mer; Never on Sunday; Al Di La; Quando, Quando; Mi'Lord; etc.



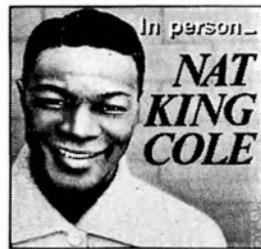
32 TV pianist Joseph Cooper plays this triumphant concerto with the Sinfonia under Dods. Also Saint-Saëns' poem Rouet d'Omphale.



443 Chart-topping folk group sing Morning Town Ride; Eriskay Love Lilt; Blowin' in the Wind; Kumbaya; Chilly Winds; plus 7.



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



202 One of Nat's greatest discs! You'll Never Grow Old; Because You're Mine; Walkin'; Because of Rain; plus 8 other tops.



89 Star cast singing all the greats: Climb Ev'ry Mountain; Do-Re-Mi; Lonely Goat-Hard; Favourite Things; Maria; Edelweiss; etc.



239 Virtuoso performance by Youri Bouk-off of Beethoven's finest concerto. L'Orchestre des Concerts Colannes with Pierre Dervaux.

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IMPORTANT! THIS IS YOUR ADDRESS LABEL — PLEASE PRINT CLEARLY	MY CHOICE IS NO.
MR _____	Enter choice number only in box.
MRS _____	
MISS _____	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Tick for mono 12" LP Tick for stereo 12" LP Tick for 3 ¹ / ₄ ips mono tape
STREET _____	
TOWN _____	This offer applies to G.B. and N. Ireland only.
4b4 For office use only	
3/ _____	COUNTY _____

tape recorder

JANUARY 1968 VOLUME 10 NUMBER 1

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COVER PICTURE

The Silly Season proved something of a late arrival in 1967 but, as winter approached, the British Public was treated to visitations from a ploy of Unbelievable Flying Objects. Not to be outdone, we offer our own forged Luna Landscape. The photograph—of a Philips microphone and two mysterious spool turntables—was taken by reader L. Newman.

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.

EVER IN SEARCH of an outlet for creative abilities, or a worthwhile application for elaborate equipment, some tape recording enthusiasts are endowed by nature with a strong sense of community spirit. To those for whom tape is a means to an artistic or social end, John Graham's *Sound of Weymouth* (page 13) is but one of the many welfare activities into which the tape hobbyist may channel his energies.

An important body known to welcome the support of tape recordists is the *Royal National Institute for the Blind*. Perhaps less well known, however, is the form of volunteer assistance that they find most useful for their Talking Book service. It takes the form, not of reading long texts into a microphone, but of demonstrating and maintaining subscribers' players. We mention this for the benefit of those readers interested primarily in the technical aspect of audio equipment, for whom tape recording is an end in itself.

Readers with a knowledge of recording machines and circuitry might seriously consider lending their energies to the small army of solderers and constructors currently devoting the occasional evening to RNIB work. It is the best of good causes, makes few demands in terms of time, and is well supported by the Institute's own service department. A letter to *The Manager, British Talking Book Service for the Blind, Mount Pleasant, Alperton, Wembley, Middlesex*, will receive a prompt and polite response.

Devaluation. There seems little doubt that the prices of imported audio equipment will rise in coming weeks. As readers will be aware, tape equipment has rather let down our audio industry in the matter of exports and imports. Perhaps the short-term effect of devaluation will be to line the streets of Tokyo with glittering, appealing, mass-produced British tape recorders.

The other day we heard a tale, said to be true, that epitomises the positive manifestations of the mass production system. It makes a pleasant change from the negatives—the fault-ridden car that was ceremoniously dumped by its frustrated owner at the maker's gates, the endless tape recorders that never satisfy their owners—and deserves a place among the legends of the audio industry.

It concerned an *Ampex* executive, one of the Financial Wizard breed, who expressed occasional friendly cynicism at the endeavours of his colleagues and subordinates. "We go to great lengths in effort and expense," he would taunt, "yet my own domestic recorder performs just as well as these professional giants"—a British deck, mass-produced electronics, the usual species of £30 machine.

At length, the *Ampex* staff enticed the recorder into their laboratory to measure its performance and prove the executive in the wrong.

The tale has a rather sad and unexpected twist, for the mass-produced machine was well up to professional standards of performance. A combination of electronic and mechanical variations from the mediocre norm had resulted in that subtle fault—perfection. Not that the executive accepted this. Both he and his faithful machine departed from the laboratory and, in blissful ignorance, lived happily ever after. When next you sight an *Ampex* man listening with strained expression to an Audio Fair domestic, show a little understanding.

There is a serious moral to this affair, well worth recognising if one is in the market for a low-price recorder. A constant tone test-tape can easily be made with a good domestic or semi-professional machine and a signal generator, plus recordings of a bell or piano, for subsequent reproduction on the tiny battery recorders that tend to litter the enthusiast's path with wow and flutter. Retailers earn their 33% by providing a service to the customer, a service which need not preclude the pre-purchase comparison of a dozen superficially similar machines.

Is there a £30 *Ampex* on *your* shelf?

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WORLD OF TAPE



INDUCTION AT FORDS

THE name of *Ford* is generally associated with high numbers—of manufactured cars, of employees and, not least—of visitors. Each month some 800 people are escorted round the Ford Tractor Centre at Basildon, Essex, where 55,000 tractors are produced annually for world markets. To overcome factory noise and to ensure a consistently accurate description of the manufacturing process, a tape recorded commentary is relayed from a *Uher 4000L* through a *Fi-Cord* induction loop installation. This loop induces signals in a small coil connected through a transistor amplifier to a lightweight headset worn by each visitor. Several parties may tour different parts of the factory at one time, since the premises is split into nine induction-loop areas.

The recorded commentary may be overridden by the guide, who can address the party through a microphone or connect another signal source.

'WHICH'? RETURN TO TAPE RECORDERS

SEVENTEEN mains and ten battery recorders, including cassette models, were reported upon in the November issue of *Which?* Following the style of *Consumers' Association* reviews, the report set out to compare products within a limited price range rather than concentrating on the detailed performance of one or more models. One of several interesting facts revealed by a survey of the Association's membership was that 93% of 730 owners were satisfied with the reliability of their machines. Commonest fault of which they complained concerned record/play heads. A slightly vague reference to "squint" heads stated that the recording head was out of alignment on 21 of the 27 machines tested. Purchasers of new machines were advised, if they had the slightest doubt about the performance of their machine, to

have their retailer check the head. The idea that specialist hi-fi dealers are always better at servicing than ordinary electrical retailers appeared, to the Association, to be a myth.

Both *Philips* and *Grundig* cassette recorders were tested but, though one was found better in some respects than the other and included in the four "Joint Best Buys", *Which?* did not choose to question the commercial foolishness that caused one cassette to be "slightly different, on the same principle but not interchangeable" with the other.

Several recorders were found to damage tapes, including a cassette model, but only one was considered electrically dangerous—the ventilation slot of a British machine giving access, with a test finger, to live components.

The actual comparison of recorders appeared to have been competently undertaken, and the finally selected "Best Buys" would certainly not be questioned by *Tape Recorder*.

A particularly interesting feature of the report was the reference to manufacturers' guarantees; despite similarities in the small print issued with each machine, most companies were found to interpret these restrictive guarantees liberally. One importer of Japanese equipment undertook to replace non-rotating parts free of charge for a five-year period. *Which?* found no difficulty in ordering parts through dealers.

INSECT LINGUISTICS

EXPERIMENTS in recording insect sounds at the University of Notre Dame have confirmed earlier views on the relevance of sound in communication between bees. The worker-honeybee's so-called 'waggle-dance' is accompanied by a 200-250Hz tone which appears related, in its detailed characteristics, to the distance the bee has lately travelled from a food source. Recent work by Dr. H. Esch shows that this phenomenon also applies to less sophisticated species of bees. One species—*Trigona*—could be enticed to the hive exit when played a tape of their own sounds but left the hive only if offered food. Another species, however, would return to a nearby food source if played a tape that had been recorded when they had returned from a previous recent visit.

BRENTFORD AUDIO COURSE

CONTINENTAL Cookery, Cake Decoration and Festive Fare are among the courses in Adult Education shortly starting their second session at Brentford Secondary School. Local readers might entice their wives to such studies by enrolling themselves in an equally attractive course—High Fidelity and Tape Recorders. This course covers the function, construction and maintenance of audio equipment, offering additional experience in cine-film/tape coupling and live recording. The Spring Session commences on January 8th.

SONY VTR AT BATH

THE ambitions of *Bath Hospitals Broadcasts Society* bore fruit recently when a *Sony* video recorder was temporarily procured to tape a local variety entertainment. A zoom lens was fitted to the camera, permitting long and close-up shots of the artists, who included local bell-ringers, musicians and a comedian. The programme was relayed live in sound to hospitals in the area. The taped programme was later televised to individual hospitals.

A Bath *Sony* dealer—*Ryland Huntley*—loaned the £350 recorder, £150 camera and £200 zoom lens.

NORTHERN HI-FI FAIR

AKAI, Telefunken, Tandberg, *Sony*, *Ferguson*, *Philips*, *Truvox* and *Grundig* were among audio manufacturers exhibiting at the *Northern Hi-Fi Fair* held at the *Merrion Hotel*, *Leeds*, on October 11th and 12th. The exhibition was organised by Mr. S. Tillman of *John Peters Ltd.*, a *Leeds* furnishing store. Eight thousand visitors are estimated to have toured the Fair which is expected to become a regular feature in the North.

BBC TO BROADCAST COMPETITION TAPES

WINNING tapes in the BBC amateur recording competition *On the Move* will be featured in a *Radio 4* (Home Service) programme on December 20th. The broadcast will commence at 9.30 p.m. and is produced by *Basil Boothroyd*.

REVOLUTIONARY TAPE TRANSPORT SYSTEM

ONE hundred tracks per inch of tape, freedom from the effects of tape elasticity, extremely high rates of stretch-free acceleration and accurate high-speed guiding are claimed by *Newell Associates Inc.* of *Sunnydale*, *California* for their drum-capstan drive system. The tape is wound on flange-free hubs to the left and right of the capstan and, in effect, employs the reels themselves as pinch wheels. The capstan is held under pressure between the supply and take-up reels, obviating the need for separate turntable drive motors. At no point is the tape under linear tension and there is thus no possibility of stretching. Very high speed reversal is said to be possible; less than one-tenth of a second from +120 to -120 i/s. Drive is applied almost direct to the head, the drum being practically the only factor affecting speed stability.

DEVALUATION

We regret that all prices in the editorial and advertising columns of this issue are subject to alteration, due to the devaluation of the Pound.

NEXT MONTH

SATURDAY 13TH JANUARY sees publication of our February issue which will include a description, by *Anthony Eden*, of a visit to the *Akai* factory. *Vivian Capel* will explain the art of recording sound effects while *Bernard Plumtree* asks *What's Wrong with Tape Records?* *G. T. Rogers* will describe the workings of the bias oscillator.

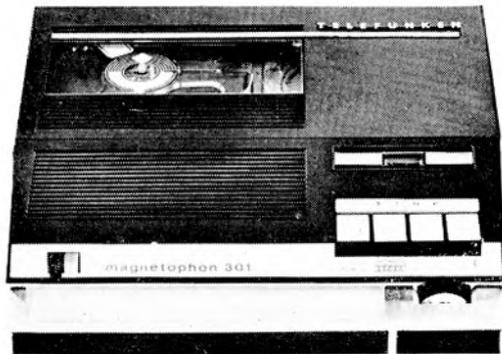
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99 LONG PLAY	300 TRIPLE PLAY



EMI TAPE LIMITED HAYES MIDDLESEX ENGLAND



THE SOUND OF WEYMOUTH

AN AMATEUR SERVICE FOR THE DORSET BLIND

BY JOHN GRAHAM

THE leisure activities of a blind person are very restricted—sightseeing, live shows, football matches, television, cinema films and so on are all visual activities. If in addition the blind person is old (65% of our blind are over 65) they find themselves confined to the house with radio and talking book. So an evening out is in itself a great event, and one in which they meet others and partake in a new experience is very much welcomed.

All this I discovered when I visited a large number of blind people in South Dorset to assess support for a possible tape-recorded programme. We very soon realised that it was of much greater value to offer an evening out to hear a programme than to take the programme to them in their own homes.

Thus we had to find a hall and transport before anything else. We were fortunate immediately, as it was possible to use a luxurious new lounge in the local Youth Activities Centre and found the youngsters were willing to help by doing most of the collection with their Dormobile. They were willing to steward and help the blind to their seats and some of the girls offered to prepare refreshments for the interval. What more could we ask! The local home teacher for the blind gave us names and addresses of blind people who might be interested, the local paper chipped in with publicity and with other voluntary workers pledging support. We were off!

We have never looked back since. Indeed, *Sound of Weymouth* has become something of a misnomer as we have listeners from five towns brought by volunteer drivers, the furthest town being 20 miles distant.

We decided on two 48-minute sound sessions separated by a 15-minute refreshment interval. Thus our programme fits conveniently on a 5in. reel of LP tape at $3\frac{1}{2}$ i/s with a swop of reels during the interval.

Three of us were actively engaged in programme preparation. Our signature tune: gulls and boats' sirens mixed into *Ebb Tide* was appropriate for Weymouth and an immediate success. One of us became responsible for outside documentaries (using our own *Telefunken 301* with *TD300* microphone), one worked on a 'Stop Press' item which reviews the week immediately prior to the monthly programme to give it all an up-to-date flavour, and finally the last member was in charge of music and he also put the final material together. The team has changed considerably over the past year and indeed it dropped to a

single person at one time. Currently, we are at full strength again. We worked on the premise that we would do nothing that the BBC could do better.

From the start we managed a good standard of reproduction quality. We entertained our listeners in a low ceilinged room by playing a small *Stella* through a separate amplifier and a speaker. Since then we have changed to a *Truvox R104* playing through its own speaker. Surprisingly enough this is better because it is *not* so easy to have the volume level *too* high! Blind people have acute hearing and they preferred the final system, although the lack of separate bass and treble controls on the *Truvox* is a little inconvenient for a final presentation. Later on finances might permit separate units once again.

In the early days we made hilarious blunders; I am sure it must have been the novelty of a night out that kept listeners hearing and deserting! In the first interview, with the local Mayor, I put the microphone on the same table as the recorder (an upright Philips portable in those days) without noticing that he was tapping the table with his match box. The resultant interview sounded as if it included a steam hammer with a diesel generator in the background. Nevertheless we were able to extract enough from it to be able to ask the Mayor to our first night and he listened to himself with evident pleasure.

On another occasion, when interviewing some cows, I discovered the VU-meter had gone dead. Looking down, I found that one cow had pulled the microphone plug from the recorder socket and was busy chewing it!

The Admiralty laid on a helicopter and pilots for interview and on this occasion nothing went wrong from the start at a Met. briefing to the final signing off of the pilot on his inter-com. The result, after 4 or 5 hours editing (always using two recorders and never scissors), was a 30 minute documentary on the Royal Naval Air Station at Portland.

Giant Pyrenean Mountain Dogs standing 7ft. tall and weighing 9 stone, Siamese cats, tropical fish, cows and calves, hens and sage warblers—all have their own peculiar recording problems. It is part of the fun to get over each hurdle and still come up with a programme at the end of the month.

Of course music plays a large part in any community, and recording problems in large barn-like halls are innumerable. Nevertheless,

enjoyable hours have been spent getting Mormon choirs and church pop groups on to tape as well as the easier tasks of recording local folk singers with the songs of the area. All have provided music for the programmes. Arthur Wofenden, one of the summer artists, performed magnificently and displayed the full talents of his organ from a full blooded air-raid in the *Dambusters March* to the *Whistler and his Dog*. He became a firm favourite with the listeners.

Channel swimmers, policemen, lifeboat workers, stage and radio personalities, Punch and Judy men, farmers and chess players . . . each have their own background and it is worth knowing something about this before starting each interview. Ralph Wightman, farming broadcaster, M. M. Botvinnik, ex world champion chess player, Hughie Green, compere, have all 'appeared' in *Sound of Weymouth*.

On occasions, during the interval we serve special tit-bits. After an interview with a Chinese restaurant owner he kindly presented enough Chinese food to provide some for everyone. After an interview in a Spa, we offered sulphur spa water, although on this occasion with very few takers! Christmas Cake and mince pies at Christmas; it all makes for variety.

Some of our material also comes from tape correspondents who now take a personal interest in helping with material for the programme. At Christmas the survey of the festive season around the world was mainly composed of interviews with visitors to Dorset from all quarters of the globe and it was completed with contributions of music and comment from overseas contributors. The result was probably the best thing we have done.

Sound of Weymouth is not unique. There are many similar organisations all over Britain, some even on a weekly basis. The Oxford organisation is one that inspired our own start and it is run in much the same way, but others are run by circulating tapes and magazines—they are all welcomed and all of value. Some last only a short time, while others are with us permanently. Many of the programme organisers help each other and exchange material. Naturally any of the material collected for our programme is freely available to other such organisations. Just write to me at 'Trees', 325 Chickerell Road, Weymouth, England.



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JAPANESE ENGLISH

SOME REFLECTIONS ON INTERPRETATION
BY DAVID KIRK

THERE are several aspects of Japanese thought enigmatic to the European mind. Failure to understand the customs and civilities of a host nation can lead to unintentional insult and embarrassment. This is all the more tragic in that it concerns the relations between actual civilised communities, over-riding the petty fluctuations of international politics.

Mr. Anthony Eden informs us, on page 26 of this issue, that the Japanese people have difficulty in understanding the exact nature of the "Englishman's sense of humour". Perhaps I may attempt partly to explain the latter by saying that, if I succeed in what I am doing, English readers of this article will find some of its contents amusing. Their amusement will not be cynical. They will not be laughing at the linguistic inexperience of the Japanese translator—who is to be envied for his knowledge of two totally different languages—only at the double meaning behind "ham and noise" and "dumping factor". Japanese readers, however, and I gather we are honoured to have several in high audio places, may be offended by the implied criticism of their linguistic abilities. The purpose of this preamble is to emphasise my particular desire not to cause offence.

MILDEST CRITICISM

Even the mildest criticism of a person or product in Japan is, to my knowledge, considered a grave insult. There is nothing incomprehensible in such an attitude, and our own country might be a more contented place if its people accepted individual human feelings as being the most fragile and important factor of everyday life. Two forms of criticism are considered acceptable in Britain. One is *constructive criticism*, suggesting improvements in a product or a technique, while the other, for want of a better label, is *lighthearted criticism*. The English are exceptionally free with rebukes and insults of the second sort—to their friends, colleagues and political administrators. This article is offered in that same light-hearted spirit but with the quite

serious suggestion that our Japanese friends closely examine their translation arrangements and, if necessary, employ Western assistance.

We commence with a little advice on loud-speaker placing from an instruction manual supplied with two bookshelf speakers: "Speaker system placement has the relative contacts with tonal quality of reproduction. Speaker system is recommendable to be placed in front of firm rigid wall, and without any sound-reflecting objections. Stereo speaker system offers its most efficiency under the same circumstances at both sets put on." A little further on, under the heading "Caution in Using": "This cabinet is fulfilled of fine materials under quality control system, and can be kept of itself being apart from the sudden changing situation in temperature, humidity". The loudspeakers in question incorporate small meters showing input power, for which the following claims are made: "The adjustment of speaker volume is previously arranged only with ears under various circumstances, which causes such unfavorable situation as of much distortion and shortening speaker utility in the long run. Aforesaid neck point is improved by observing accurately input power with VU Meter embodied. This device serves to reproduce the distortionless fine sound system as well as enlarge speaker utility as so ever." Almost impossible to understand; would the non-technical purchaser regard this as typical 'jargon'?

MECHANICAL CABINET

A battery recorder exists with "Light mechanical plastic cabinet". Another recorder incorporates "automatic shut-off" while yet another, "an ideal addition to your sound system" comes complete with "Empley Reel (R-?A)". Why the question mark? "If required, the fancy bag can be obtained" for a Japanese test-meter, according to the instruction leaflet.

In no less regal a position than the rear of an expensive stereo tuner-amplifier are the words "Multiplex Sepalation". The operating

instruction book for this unit has a section devoted to "Maitenance" which, in all fairness, is extremely well written if one allows for occasional printing errors. All the best recorders appear to have "Hartly" oscillators, at least one being "Engineered for professional use and the discriminating user continuous automatic reverse". Thanks to automatic reverse, there is "no need to chang reels".

IMPROVED STANDARD

There is no doubt that the standard of translation has improved during the last two years. *Aiwa, Akai, Ikegami, National, Pioneer, Sansui, Sharp, Sony, Teac and Trio* now produce English-language sales literature with remarkable competence. Much of this material is very attractively presented, in colour, and probably intended to sell its product on appearance alone. Nevertheless, the Japanese and English languages are so different that every single brochure and instruction booklet bears evidence of slightly uncomfortable 'Japanese English'. "Robust mechanism for excellent durability produced by our engineers with abundant experience" is a sentence that can be readily understood by the English reader. It is not so strange as to seem amusing, nor is it strictly incorrect or illiterate. One characteristic of Japanese English, even at its best, is the tendency for sentences to lack an obvious beginning or conclusion.

"Direct reproduction from the tape head by equaliser for head." "Independent filters for high and low and also tone controls for right and left respectively." "Low power consumption and instant functioning by 'All transistor system'." These 'sentences', or statements, convey the impression of having been translated literally word for word from their original language. My knowledge of Japanese is nil, but I can recall the clumsy convulsive English produced by a word-for-word schoolboy translation from German. The humorist Peter Cooke once suggested a pointed example of

(continued on page 35)

closed circuit No3

PRACTICALLY NO STANDARDS AT ALL
BY RICHARD GOLDING



Instruction in CCTV production being given to teachers at the Inner London Education Authority's Islington television centre.

VIDEO TAPE recorders fall into two categories according to their cost and applications. *Ampex* transverse-scan (or *RCA* quadruplex) with its four magnetic heads performing 960 transverse sweeps of a 2in. wide tape for each second, is very expensive and can only be afforded by television broadcasting companies and a very few fortunate educational authorities. It is completely compatible and a tape made on an *Ampex* machine can be played back on an *RCA*, and vice versa, anywhere in the world. It is capable of recording very high quality pictures in monochrome or colour for relay to large audiences over long distances.

Helical-scan, using a horizontally-mounted head-disc to scan a slanting tape path, with machines ranging from about £350 to £1500, is generally suitable for use in small closed-circuit installations and, at this moment, has not been developed to the extent of being able to relay high quality pictures over a broadcasting system. The bandwidth is narrower and its timing is not so accurate as transverse-scan. Our old enemies—wow and flutter—also prevents such machines being used for broadcasting for speed and instability causes jitter on domestic receivers.

GREAT DISADVANTAGE

A great disadvantage with helical-scan is the lack of compatibility between machines made by different manufacturers. Most manufacturers now claim compatibility for VTRs of similar design. Whether or not this claim is true, it is certainly impossible to record on one make of machine and play back on another, for the standards are so varied. The *Ampex 7003* uses 1in. tape at a speed of 9.4 i/s; the *Philips ET 2770* uses 1in. tape at 10 i/s; the *Loewe Opta* has 1in. tape at 7 i/s; the *Ikegami 301* has $\frac{3}{4}$ in. tape with a speed of 9 i/s while the *Ikegami 311E* uses 1in.

tape at 10 i/s; the *Sony* has $\frac{1}{2}$ in. tape travelling at 7 $\frac{1}{2}$ i/s; and the *Shibaden SV700E* uses $\frac{1}{2}$ in. tape at a speed of 6.7 i/s. The writing speeds of all these machines are different, and so are the length of tape-wrap and the degree of the helical trace for each make. Some machines have a 360° tape-wrap. Others, working with two heads, have a 180° wrap with the second head taking over where the first head leaves off.

This is a drawback where educational television is concerned, where tapes may be required for playback on other machines at other colleges or universities, or in CCTV chains where interchange of programmes is desired. In the early days of 8mm. sound we used to complain about the incompatibility of the various sound systems, though that was less serious. It is due, of course, to the pattern of development of helical-scan, which is still more-or-less in the experimental stage, although all machines available are designed and produced to most exacting requirements.

At the moment domestic demand for the VTR is virtually non-existent. Of course there are people who have bought machines for home use, but the total number of these both here and in America would hardly keep the manufacturer of the cheapest machine in business. Home consumption cannot be a serious consideration until the price comes down to at least the level of an ordinary domestic receiver.

REAL MARKET

The real market is in primary, secondary and further education, and in industrial education. The basic problem facing education and industry is that there is more information available than ever before, more students to inform, and relatively fewer instructors to handle the material. Television, and CCTV in particular, makes it possible to combine the talent and creativeness of the best teachers and

instructors with skilled production methods to provide the best presentation to the greatest number of students. Video tape permits the storing and rebroadcasting of programmes to other groups or at more convenient times, so reducing the amount of duplication of work on the part of certain specialist instructors so that these instructors may be employed in producing other work.

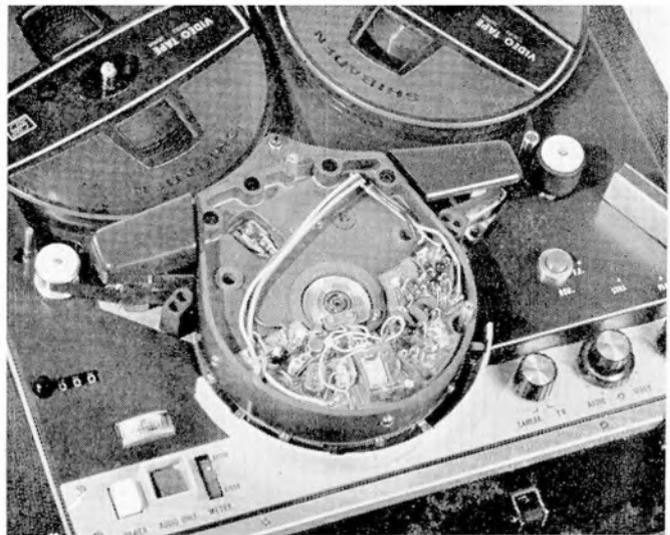
UNDER CONTROL

Some authorities have the situation well under control. The Inner London Education Authority, for instance, now has two television studios completed which are being used for the training of teachers in programme techniques at the new TV centre at Islington. This is expected to be the largest educational CCTV system in Britain and will provide programmes for over 1,300 London schools and colleges by 1970. The cameras and studio equipment in the first two studios have been supplied by *Marconi*. The first transmissions will be made in September 1968 to 300 schools in North London. By then the work of adapting the building as a TV centre will be completed with two additional studios. Most of the *Marconi* equipment in the control rooms, such as vision and audio mixing equipment, monitors and control room/studio intercom systems, has been specially designed for educational studio applications. In the ILEA scheme, facilities are available to mix vision signals from up to six cameras and sound signals from up to 12 sources such as microphones, telecine machines and disc reproducers. A *Marconi* telecine bench is installed in the larger control room, for televising films, slides and captions. Local and remote control facilities are provided in order that the equipment on the bench may be operated from either studio control desk.

This is all rather wonderful, but there are



Shibaden CV700E aerial howl experiment.



Shibaden SV700E head assembly, with head cover removed.

many small education groups outside the larger schemes (and this includes industrial education) who are suffering from lack of funds, lack of information, and lack of direction. The National Audio Visual Aids Centre is doing its best to clear up the confusion, but with such a diversity of equipment available to be tested and reported on, and with such a lack of technically minded people in the groups to appreciate and act upon their reports, they have a most difficult task to perform.

So far, authorities have been wary of anything other than Ampex or Philips, but they are now becoming aware that certain VTRs in the lower price range are quite adequate for some CCTV needs. With low budgets in mind, the National Audio Visual Aids Centre has recently tested the Shibaden SV700E, priced at £495, and a technical report of its performance is to be published shortly. Other recorders are due to be tested and reported upon in the next few months.

COMPLETE COMPATIBILITY

The Shibaden seems to have an impressive performance. Complete tape compatibility with other Shibaden SV models is claimed and it has audio-dub and still-picture facilities. Twin rotary heads operate against a tape-wrap of 180° recording and playing each field, unlike the Sony which uses the 'skip-scan' system. Other details are: positive head location and tracking control; frequency range of over 3MHz; more than 270 lines horizontal resolution; and 38dB signal-to-noise ratio. It weighs 52lb. and uses ½in. tape at a speed of 6.7 i/s for a total recording time of 70 minutes.

It is imported from Japan by *Thermionic Products Ltd.* who have carried out exhaustive tests and experiments with the machine. The Thermionic engineers had occasion to in-

vestigate complaints of aerial howl from ordinary aluminium tube dipoles. They mounted a pair horizontally on a vibration generator and vibrated them vertically at the point of juncture. At certain frequencies wave patterns formed on the dipoles, giving rise to the howl. It seems evident that similar vibration takes place in certain wind conditions due to the formation of regular eddies on the lee-side of the circular section tube. The trouble was eventually cured by using a suitable filter, thus damping out the vibrations. The experiment was videotaped and the effectiveness of various filters were measured by stopping the tape at the critical frame and applying calipers to the monitor screen. This is shown in our picture.

It is often claimed that the cost of video tape is high when compared to 16mm. cine film, especially when tape is used to store library material. This does not stand up to examination. 2,400ft. of ½in. tape gives 70 minutes recording time on the Shibaden and costs £14 10s. The cost for same time in 16mm. original filmstock, even the cheapest monochrome available, would be far more even without counting the film cutting ratio. Cost of copies of the original film would still be at least twice the cost of tape. You might just about break even when using film copies against one-inch tape, but the cost of the original film would still be higher.

UNWANTED MATERIAL

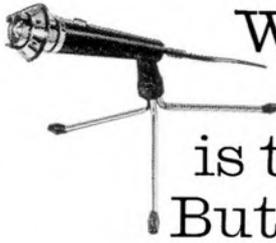
Film, however, has one firm advantage over tape in that there is ease in editing—both in cutting out unwanted material and in repairing mistakes in the performance. It has more mobility, for lightweight cameras can be taken out and used at a moment's notice, but transfer to video tape is a problem. Unless all systems are working to perfection, the process of transferring film pictures via a

monitor to the VTR can result in serious lack of quality.

A welcome arrival to low-cost video tape recording is the new Sony portable recorder and camera set which is exclusively designed for location picture and sound recording. It is battery-powered and weighs only 12lb. Playback can be made instantly with the Sony CV-2000 and complete interchangeability between the two machines is claimed. Built into the Sony camera is an electronic viewfinder for accurate focusing and framing, and the microphone clips on top of the camera. There is only one snag—it is not available here at the moment and has to be ordered direct from Japan.

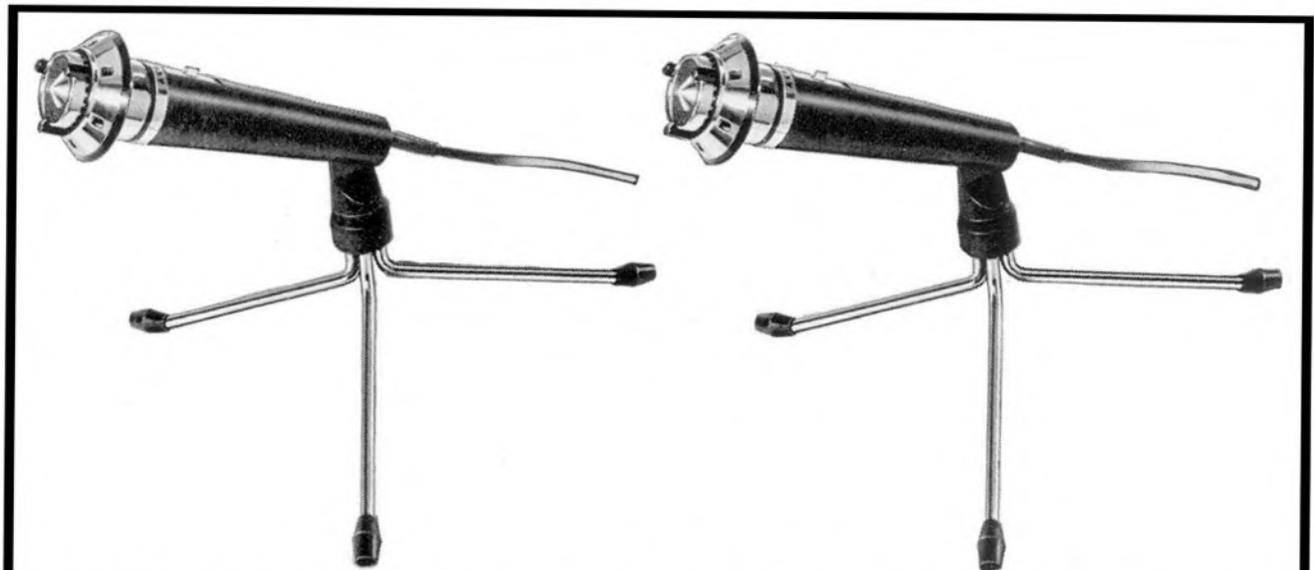
ONLY ONE

Of all the VTRs available only one comes complete with a monitor: the Sony CV-2000. VTRs have a video-frequency output via cable rather than using the broadcast method of superimposing the pulses on a VHF signal and radiating this signal from an aerial. Through this method, high definition is achieved, but to take full advantage of it reception must be made on monitors specially designed for the purpose. Domestic receivers can be modified to take the video signal, but the degree of realisation of the high definition depends on the efficiency of the modification and, of course, the quality of the receiver. There are many monitors available which are usually much more expensive than the equivalent size of domestic receiver, although Shibaden market a very interesting monitor at a very competitive price. This gives an 8 x 10in. picture receiving VHF and UHF channels plus the Shibaden VTR and TV camera. It also has a built-in timer to select and record required TV programmes automatically. It costs £64. A 19in. monitor is available with the same facilities at £89.



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YOUR OBEDIENT SERVANT

BY H. W. HELLYER

PART FIVE - CYBERNETICS AND PLASTIC GNOMES

FIG. 1 ESSENTIAL SECTIONS OF THE DATA-PROCESSING COMPUTER

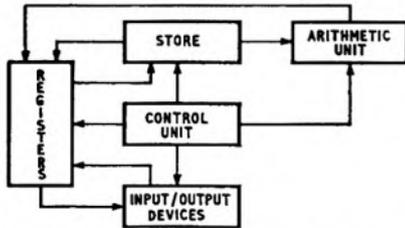


FIG. 2 FLOW DIAGRAM BASED ON ROUGH TESTS OF A TAPE AMPLIFIER. BASIC INSTRUCTIONS WITH ALTERNATIVES

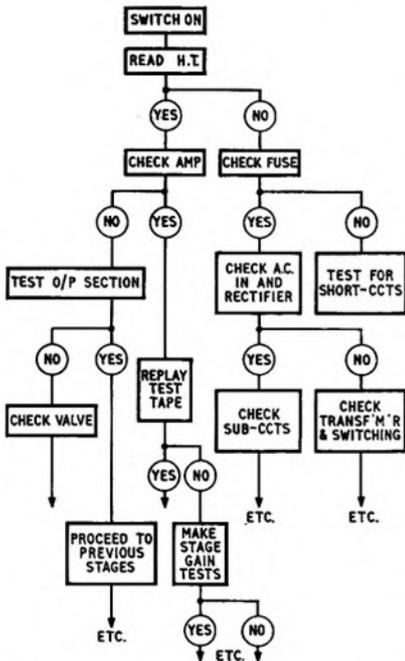
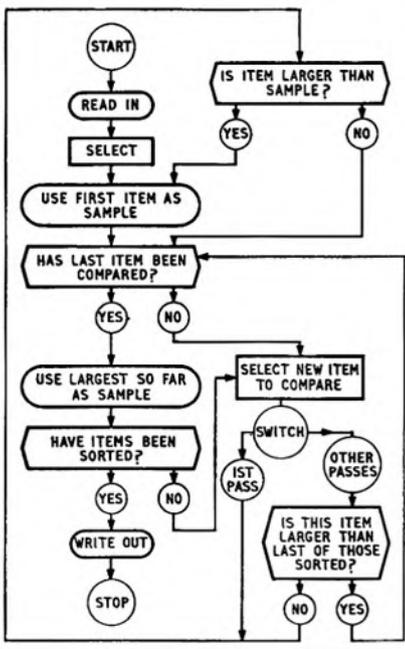


FIG. 3 SIZE SELECTION FLOW DIAGRAM NOTE DIFFERENT SHAPES OF BOXES FOR CONTROL INSTRUCTIONS, SAMPLING OPERATION, ETC.



IT came as something of a shock to this technician, hearing the casual remark of a don in a radio interview: the computer companies would rather have a man with a First in Greats than the specialised science degree—philosophy is the stuff from which our future logicians are bred. Yet there is a lot of truth in it. Just take a look at the advertisement pages of the national press; there is a shift of emphasis. Computing is centralising and evolving. What with National Computing Centres trying to standardise languages, and the National Data Processing Service struggling to influence the communications industry on programming, we may be in for a kind of electronic war. It is not without significance that the country's largest computer to date, the Burroughs B8500, is to be put to work for Barclays Bank. Off with the white coats and on with bowler and pinstripes!

The importance of data processing is becoming more and more evident. Not only in banking and commerce but in international telecommunications and the everyday graft of industry. We, who are on the fringe of the magnetic medium with our technically clumsy tape recorders, may find the growth pattern rather awesome. Science fiction writers must have a hard time these days, when all they can predict comes to pass before their thoughts leave the printers. The old joke about the computers that chat to each other while the house burns down has a hard core of truth. There is already a trend toward linking computer systems, with peripheral users having access to a continually growing data store. To quote the business manager of *ICT*: "In a further 10 years the orientation is likely to be between the user who keeps his computer in the filing cabinet and the user who keeps his filing cabinet in a computer".

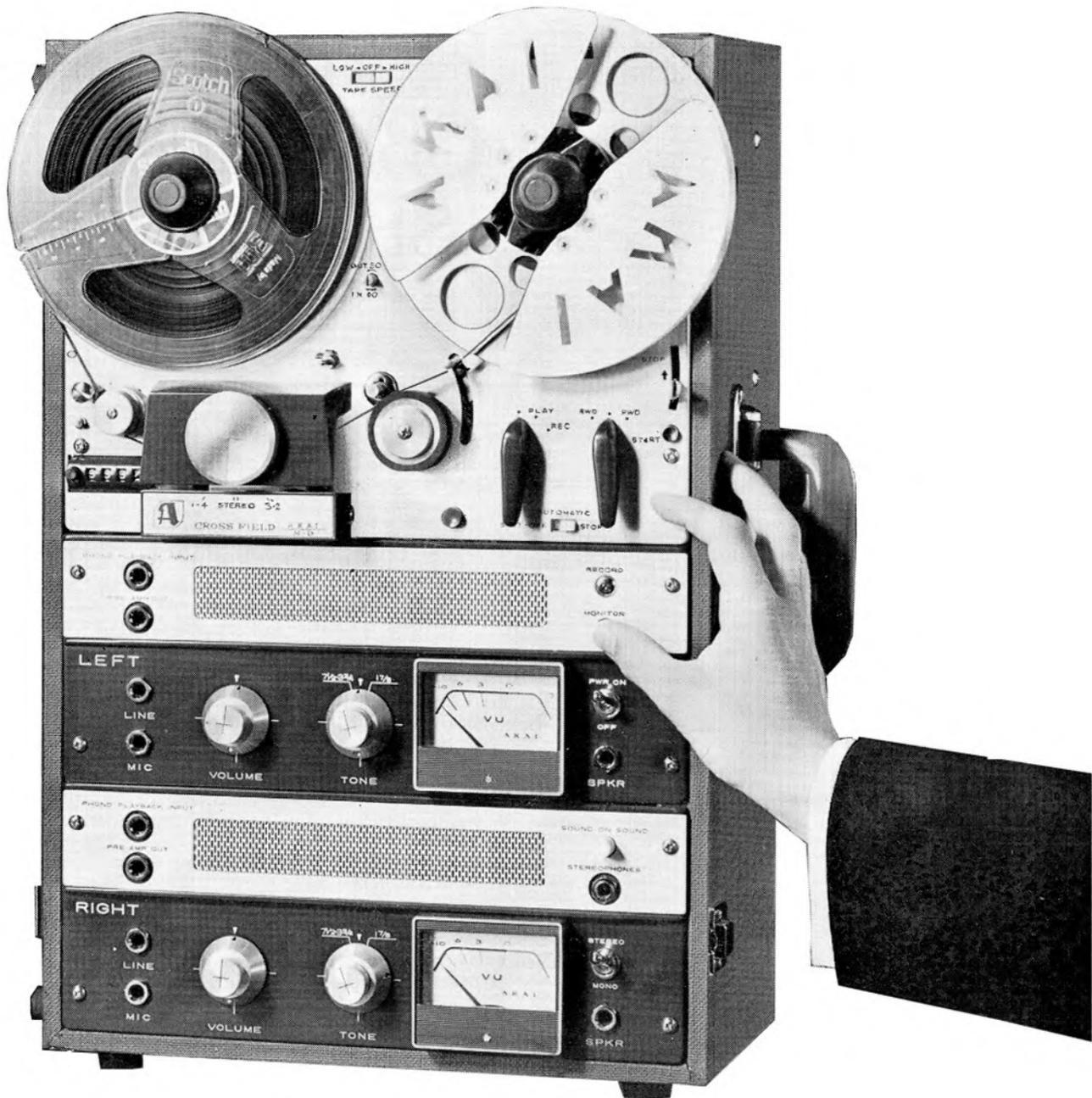
It is not easy to draw a dividing line between 'pure' mathematical computing and data processing, in its accepted sense. The solution of a mathematical problem usually means a long, involved computation from a comparatively small amount of data. Processing generally needs a small amount of actual maths, but reference to a vast store of data—and quickly. Thus, the data processing technique depends greatly on storage and selection. Speed is the essence, and, of course, the prime reason for employing a computer at all. When we are considering data processing, we must begin by thinking of the programming, i.e., the instruc-

tions that the human operator is going to give to the machine to enable it to carry out its wizardry. We can assume that the store has a certain amount of data already memorised, to be drawn upon as necessary, and to be added to as the computation goes along. This is normal computing practice: data flow is circular, the arithmetic and logic unit receives data from the storage unit when programmed what to select, processes it and adds the result of its processing to the storage unit ready for the next time of access. We have already seen some of the methods whereby this is accomplished, but to refresh our fallible human memory, a glance at fig. 1 may suffice. Here we have the input/output section—the peripherals—instructing the control unit which commands the 'hardware loop' of store, registers and arithmetic unit, collecting the processed information finally and feeding it to the output device. Various combinations of these units will be found, and specially constructed computers may have certain sections omitted or amplified for special applications.

We have already seen that the computer can only respond to on/off switching pulses—or signals that equate to these. Its advantage is the immense speed with which it can perform this series of operations. This requires that the instructions fed to it are themselves 'coded' to trigger off groups of functions. In data processing, special languages are used for compiling the programmes that instruct the computers. A typical process may require tabulation of many items of information, cross-reference against stored data, re-selection and filing, as well as read-out. The computer programmer must first learn his language, usually what is termed a 'higher-level language', before he can instruct his machine. The older types of language were simply machine codes, where the commands are a combination of numbers, letters and symbols.

In the early days there was little standardisation, each manufacturer favouring his pet approach. Later, symbolic languages evolved, using mnemonic combinations of numbers and letters, based very often on the original machine languages, and, as with most other competitive systems, some codes went to the wall, others survived. The automatic computer translates the symbolic language to suit its own operation, under the control of its programmer. Automatic coding languages help to cut down

(continued on page 21)



The Akai M.8 has a head start on all other tape recorders.

See how much better performance you get when you buy an Akai M.8—the tape recorder with the unique Crossfield Head.

Competitive Recorders

18,000 Hz at 7½ ips

12,000 Hz at 3¾ ips

6,000 Hz at 1½ ips

the Akai M.8

21,000 Hz at 7½ ips

18,000 Hz at 3¾ ips

10,000 Hz at 1½ ips

The Akai M.8 offers you a choice of four speeds—1½, 3¾, 7½ and 15 ips. The M.8 will give you 4 hours of true stereo high-fidelity music, up to 21,000 Hz at 7½ ips from standard 1200 ft. tape. Even at 1½ ips it provides a response up to 10,000 Hz.

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 Akai M.8 and Akai X-100D.

NAME

ADDRESS

clerical errors as well as speeding up the programming process which, being part of the human being's job, is still the weak link in the computing chain. The chief languages that have survived are ALGOL, FORTRAN and, latterly, COBOL, short for Common Business Oriented Language.

Programme languages can be divided into *commands* and the *operands*, each being interdependent. Commands fall into five main categories: arithmetic, logic, control, data transport and miscellaneous. Arithmetic commands are pretty obvious, including Add, Subtract, Multiply, and Divide. Also included may be such instructions as Extract or Compare. These overlap into the general area of logic commands. Control commands allow the instructions to be varied or reset, either by the programmer, or, because of previous instructions, by the computer itself. One vital operation is the Jump, whereby the sequence of operations is changed. This usually entails selection of data from a different part of the store, and could be a time-wasting and complicated operation if the prior instruction was not 'written-in' to the programme.

Data transport commands are what they imply: blocks of words are moved and selected, much in the way that the tape recorder is instructed by the push of a knob or lever to wind, rewind, record, play or stop. But the computer does a little more than this, pre-selecting the place at which the whizzing spools shall stop to pick up a particular block of data. This needs the double-braking devices mentioned previously, whereby a fierce brake is applied to a fast revolving spool and then, just before the crucial tension at which the tape itself would be under stress, the fierce brake releases and an auxiliary servo brake, geared to the back tension, takes over and gently decelerates the transport. In a much simpler form, Telefunken did this on a number of machines. Readers who have had the chore of resetting these after maladjustment will appreciate just how delicate the balance has to be. But, when running properly, the system is very effective.

MULTITUDE OF SYNTAX

After which digression, we come to the Miscellaneous section. This can cover a multitude of syntax in the machine language, but generally it is taken to mean the 'red tape' commands: Stop, 'Round off numbers,' 'No operation,' 'Shift,' etc., which are almost human switching operations. They are necessary, and cannot be entirely automatic, for the human being has to have some control over the computer if we are not to end up in an Isaac Azimov world. We must make sure our obedient servants stay that way.

Operands are a kind of machine shorthand for selecting addresses in storage. We have already seen that by 'address' we do not mean 45 Sycamore Street, W.11, but rather a coded computer word that may denote quite a lot of actual instructions. To take an example: suppose we have a computer with thousands of registers, each register containing a fixed word-length of (typically) 32 bits. Then the registers are referred to by their addresses, i.e., the gate

switching we considered in a previous article. So each register can be referred to by its own address.

Although we saw how this was done in binary code—so that by simple on-off switching it was possible to select any one of, for example 0 to 1,000,000 individual registers with a six-digit selector—in the coded languages the registers may be grouped off and named. The advantage of this is that with the loop system, where the contents of registers may be continuously varying as new information is fed back, the same register can always be selected by name word code, although the content of the register is actually a number. Thus, if the instruction is ADD-24267-46453 in a multi-address computer then the information in register 24267 is added to the accumulator, and the combined information is fed into storage address 46453. The combined information may then be selected when required from 46453.

The duties of a programmer are fairly well defined. He first weighs up his problem and makes a complete, detailed statement of what the computer is expected to do. This is the crucial part of the job: nothing must be left to chance, because, whatever the science-fiction boys say about sophisticated electronic brains, the computer cannot really 'think' for itself. It must be programmed to obey instructions.

CABALISTIC DOODLING

Next, our programmer prepares a flow diagram. There is nothing mysterious about this, although it looks sometimes like the cabalistic doodling round a black magic manifesto. Fig. 2 is a typical flow diagram, and, if inspected closely, turns out to be nothing more than an elementary routine (very crude) instruction of repair sequences for the electronics of a tape recorder. The author took some trouble working out a fairly complete one of these, and it hangs on his workshop wall—but whether anybody ever takes any notice of it is another matter. I like to think that the instructions are registered in the memory stores of our engineer's brains!

As an example of the business computer flow diagram, let us suppose the problem is to make up a wages sheet. The instructions to the machine, put into everyday language, may be: "If Joe Bloggs works on Sunday, pay him £3 extra—*unless* he knocked off half an hour early, in which case pay him £2 10s.". To take another example, the computer is being programmed to determine whether one item is smaller than another by making a comparison. This is quite a practical example: in mass production, thousands of plastic gnomes are coming off a line and being graded. A surveying device scans each passing item and feeds a signal to the input device of the computer. The information is fed in and the first example is used as the largest item.

The computer is now faced with an alternative. It is asked to switch Yes or No if last item has been compared. If the answer is No, it is instructed to select a new item. The conveyor belt moves on a notch. But a switch is incorporated, diverting gnomes smaller than a certain limit to another packing bin, while the borderline cases go back into the general mill and are assessed again, each time compared against the largest. If, on the other hand, the answer to the first question had been yes,

the passed gnome would be promoted itself to the largest and used as a comparison.

Some sort of protective limitation has to be written in, or some unfortunate is going to find his lawn and bungalow overshadowed by a swollen plastic gnome, rather as our illustrious Editor is eventually going to have to build his house within the horn of his loudspeaker (I suppose you *do* read *Hi-Fi News* also?). Putting aside all jokes, the flow diagram of fig. 3 is precisely what we have been talking about, a kind of short-hand book of instructions for selecting items in comparison with size. In practice there is a great deal of refinement. Computer manufacturers even issue templates with different shaped brackets and 'boxes', for different sorts of instruction to ease the programmer's task. Within these blocks, the actual written instructions may eventually be a form of mumbo-jumbo, with symbols denoting particular factors, such as work-costing, hours analysis, discount, etc. Boxes showing control operations, such as tests or tally changes, are generally marked with a heavy dot.

After preparing the flow diagram, the programmer writes the instructions in the language which his computer will understand. This means translating the flow into a sequence of written instructions, coding them and selecting the known groups of addresses, in the same way as we automatically set our test meter to the highest voltage range before reading off an unknown voltage—well, don't we?

A part of this operation is the selection of sub-routines. Previous experience, which made us switch our meter appropriately, has shown the programmer that he may expect such-and-such conditions if certain sequences occur. A lot of work is short-circuited by storing what are called sub-routines, which instruct the computer to perform some well-defined operation if certain answers turn up in the course of the programme.

CRITICAL MOMENT

His final task is to clear the programme by debugging it. Human error is still possible and, given a wrong instruction because at the critical moment when a programmer was transferring his flow diagram to the coding form a mini-skirt flashed by, the computer will logically go on multiplying when it should divide. Hence some of those household electricity bills for a million pounds that occasionally hit the headlines, we suppose. Debugging normally entails going over certain parts of the preceding stages of programming to make corrections, or to correct in the light of further information (or the absence of further distractions).

Teams of programmers get together to do desk debugging, each one playing the part of the unit in the computer to which the information is being fed, or from which information is being extracted. Test problems may be used to check the sequence, especially useful where a fairly routine sequence is set up. But the elegant method is to use the computer itself to do the debugging, and storage dump routines may be employed. Here, we have a kind of picture of the processing in a tabular form. The storage dump can be taken off at a known satisfactory point in the programme, listing in address order the contents of each word or field in storage. Then, after the sequence has

(continued on page 31)

FIG. 1

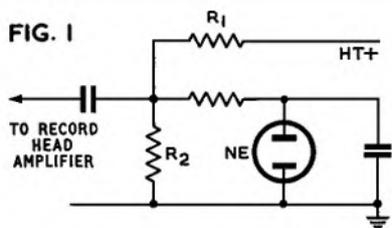


FIG. 2

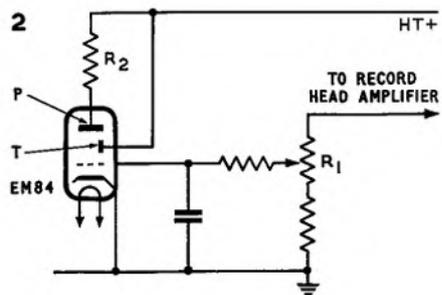


FIG. 3

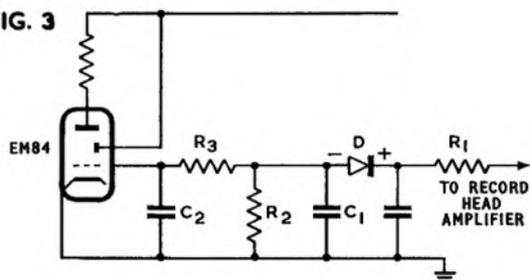


FIG. 4

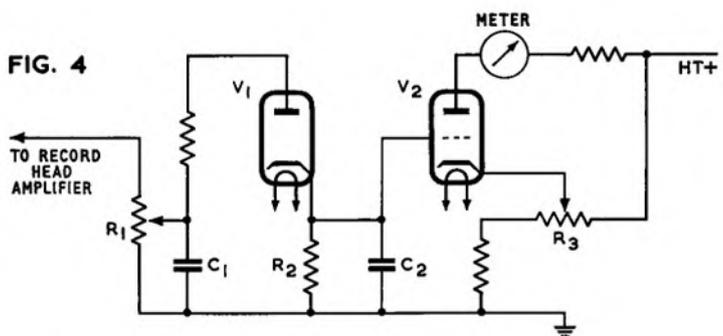


FIG. 5

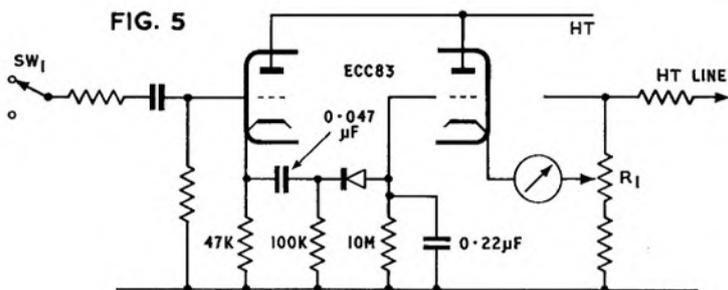
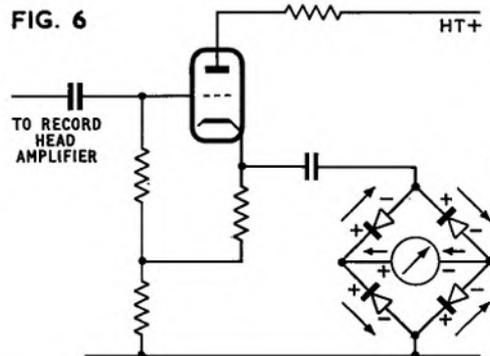
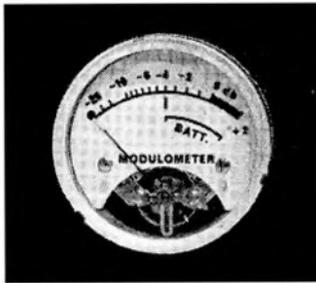


FIG. 6





elements of tape recorder circuits

PART 8—RECORDING LEVEL INDICATORS

BY G. T. RODGERS

THE next important item of equipment to consider—together with its associated circuitry—is the recording level indicator. This tells us the magnitude of signal being implanted on the tape, a knowledge of which is essential to ensure a good recording. Let us see why this should be so.

If the recording circuit gain is advanced too much the tape will be over-recorded (over-modulated), producing excessive distortion on playback. An upper limit is therefore set to the amplitude of signal recorded on the tape to avoid introducing intolerable distortion, and this maximum should be shown clearly by the indicator. At the other extreme, too low a signal voltage, results in incomplete modulation of the recording medium, necessitating increased gain on playback. This is also bad since the increased replay amplification required results in an increased level of the noise which is always present in electronic circuits. In other words, if the recording gain is set too low, a poor signal-to-noise ratio will be the result.

Obviously the optimum level is somewhere between these two extremes, and the main function of the recording indicator is to help us keep the level somewhere near to this ideal.

Just how well the indicator does its job depends on the type and quality, and on the manner in which it is connected to the recording amplifier. In addition, the maximum setting of the recording voltage allowed by the indicator must be the true maximum corresponding to a fully loaded tape, and this depends on how accurately the indicator is calibrated for use in the particular circuit.

ANOTHER FACTOR

Another important factor to bear in mind when setting the record level is the type of programme material being handled. Obviously if this is reasonably constant in loudness, like speech for example, a fairly high level (say three-quarters of maximum) can be used. In other cases, however, where loud and soft passages occur, a lower recording level is necessary so that the peak passages can be accommodated without bringing in too much distortion. In such cases advantage can be gained by altering the record setting *carefully* during the recording. This practice requires

a certain amount of skill, as abrupt alterations are easily noticed on playback. The idea is to ease back the level *gently* in anticipation of peak volume sounds, and bring the level up again as gently for soft passages. This, of course, requires a detailed knowledge of the programme.

Having said something about the *function* of indicators, let us now look at the main *types* in current use and assess their relative merits.

The simplest type of indicator, a neon lamp, lights when the record level is just high enough to cause distortion. During recording the level of the signal is adjusted so that the lamp flashes only on the peak audio voltages. With such an indicator there will be no warning when the record level is too low, and to remedy this some recorders employ two neon lights, one showing the maximum level permitted and the other set to light only when the record level is adequate for a satisfactory signal-to-noise ratio.

TYPICAL CIRCUIT

A typical circuit using a neon lamp is shown in fig. 1. R_1 and R_2 form a potential divider which applies the correct amount of HT (usually about 50V) to the neon, NE. This voltage itself would be insufficient to light the lamp, and the extra voltage (which might be in the order of 30V) comes from the amplified audio signal which could, for example, emanate from the stage that drives the record head.

Another type of indicator, used extensively in domestic equipment, is the luminous-anode valve or magic-eye. The principle on which this operates is quite simple and similar in many respects to the cathode ray tube in a television receiver. The anode of the valve is phosphor coated and when electrons move from the heated cathode and impinge on its surface, energy is given out as light. However, the grid of the magic-eye serves to deflect the electron beam and the position of the light source depends on the voltage applied to the grid.

A typical circuit using an EM 84 indicator valve is shown in fig. 2. The input to the grid is tapped off from the record head supply as shown, the pre-set potentiometer R_1

enabling the indicator to be correctly calibrated. R_1 can therefore be adjusted so that the maximum level shown by the magic-eye corresponds to the agreed maximum level of distortion to be tolerated.

When the record level is very low there will be a very small negative signal at the control grid of the valve. Under these conditions maximum current will flow through the valve via the main plate P and this will cause a large voltage drop across the anode resistor R_2 . This has the effect of reducing the voltage to the target anode T and there is no glow. In the presence of a negative signal at the control grid, current flow through the valve is reduced, the anode becomes more positive and there is a smaller voltage drop across R_2 . The target now becomes more positive and the valve lights up.

The magic-eye as we have so far described it would follow the audio signal and produce a rapidly flickering indication, which is somewhat difficult to interpret. To overcome this, a circuit along the lines of fig. 2 is often employed.

It will be recalled that simple resistance-capacitance circuits have a time-constant which is related to the time required to charge up the capacitor. In fig. 3 C_1 will charge up on negative signals through the germanium diode (D) at a rate depending on the values of C_1 and R_1 . But C_1 discharges through R_2 and not back through R_1 because of the very high back-resistance of the diode.

FOR THE HUMAN EYE

The circuits comprising C_1/R_2 and C_2/R_2 have time-constants, and these are typically in the order of $\frac{1}{20}$ th and $\frac{1}{10}$ th second respectively. The reading on the magic-eye is then maintained for a period of $\frac{1}{10}$ th second, which is long enough for the human eye to follow.

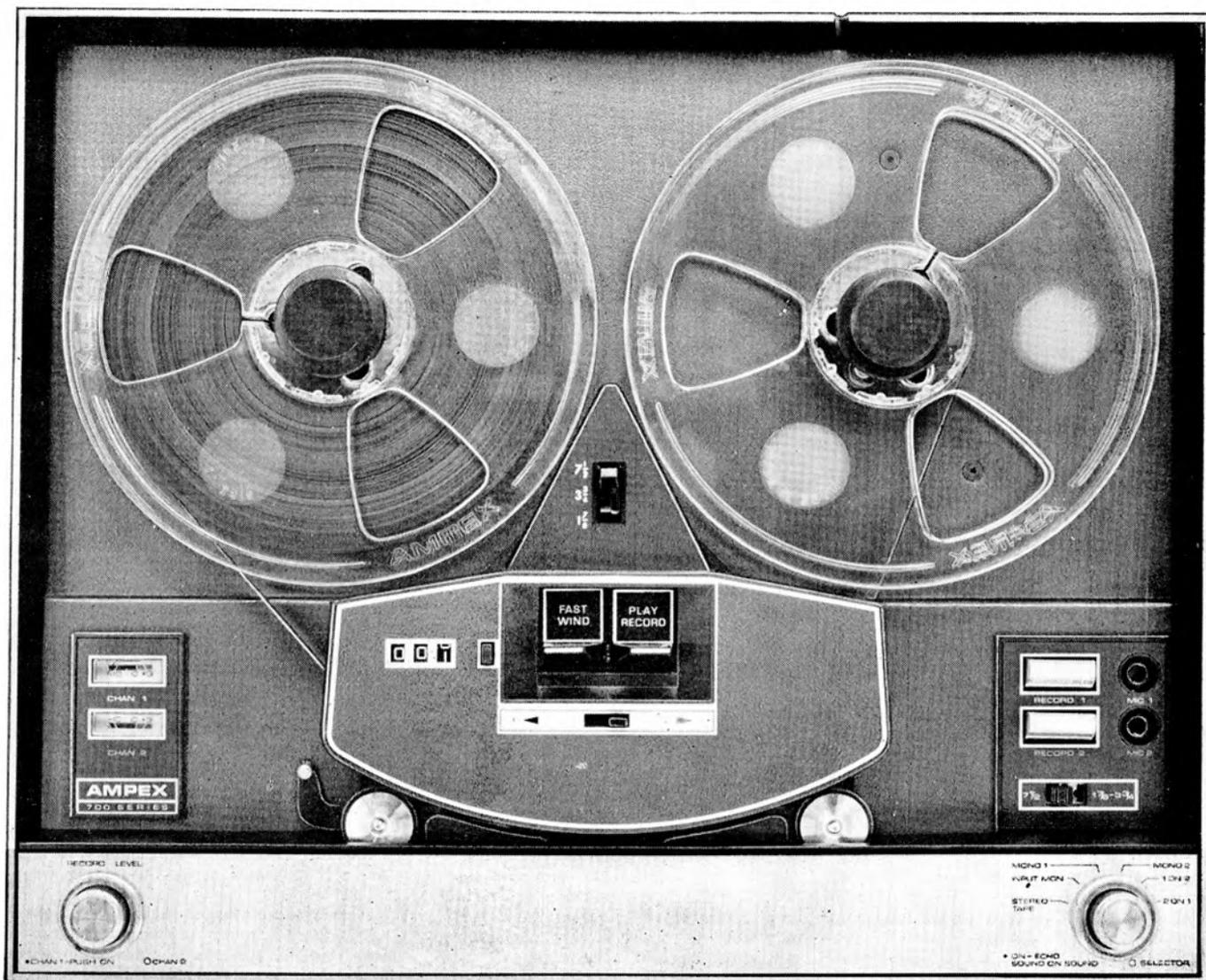
Although the magic-eye indicator serves adequately in many domestic machines it does not give the precise information about modulation depth which is required in some professional types of recorder. Use is therefore made of the peak programme meter (PPM) which is designed to indicate the *maximum* level of a sound signal. There is another type of meter called the volume unit meter (VU), but we shall come to this later.

The peak programme meter and its associated circuit, which incidentally is featured in such semi-professional machines as the Ferrograph and Vortexion, is in the form of a valve voltmeter arranged so that the meter needle rises quickly in response to sharp bursts of sound (peak levels) and then falls again *slowly*. A typical rise-time might be 4mS. and the decay time approximately three seconds, which enables the *peak* values of the record voltage to be indicated very clearly.

In contrast to the VU-meter, which can give misleading results, the PPM is the best means of indicating the record level, and if the scale is suitably calibrated the percentage modulation of the tape can be read off directly. Fig. 4 shows a simplified circuit using a diode and triode, though these valves would normally be enclosed in one double valve such as the ECC 83, with one half strapped as a diode.

The variable potentiometer R_1 enables the meter to be calibrated so that a reading of,

(continued on page 31)



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AMPEX

CA-9TR1

OUR READERS WRITE . . .

. . . about additional data

From : K. C. Hart, 178 Downs Road, Hastings, Sussex.

Dear Sir, Whenever you publish tape recorder review specifications, would it not be a good idea to include the following data :—

- (1) Tape position indicator (fitted or not fitted)
If fitted :—
- (2) State type (pushbutton or wheel reset).
- (3) State from which spindle the counter is driven (Supply spool or take-up spool).
- (4) State ratio of actual spool turns to index-counter reading (these vary widely amongst different makes).

With the above information the purchaser of a second recorder would be assisted in choosing a machine with the same index-counter characteristics as on his first machine, and may be saved the trouble of going through all his tapes to find and note a fresh set of tape position index numbers to suit his new machine.

Yours faithfully

(The four points suggested in Mr. Hart's letter will be embodied in future reviews whenever practical—Ed.)

. . . about the Design Study

From : J. G. D. Pratt, Hammonds Cottage, Ripley Lane, West Horsley, Leatherhead, Surrey.

Dear Sir, When replying to your Tape Recorder Design Study questionnaire I also sent a covering letter expressing some doubts about the ability of the study to get out some of the more interesting facts. I am glad to say that the summary which you have just published has largely demolished my fears. Those fears were largely based on the dangers of deriving statistics about several groups of people with incompatible requirements if the groups are all mixed together. The figures, however, suggest that the replies come from a fairly homogeneous group all wanting a 'movable' machine. Those who want a true portable must all be comprised within the 6% who set a 30lb. weight limit; those who want to build in are probably shown in the results as needing no loudspeaker (9%) or as being content with low-level output (5%). In other words, about 15% of your replies related to true portables, to "builders-in", or to some other minority group(s) whose nature is not revealed; the remaining 85% concern those who want movable machines. So although the study is unlikely to reveal anything about the very small minority groups, it is a good guide to the requirements of the very big majority group.

However, I must still task you to task, mildly, for some of your remarks; you imply several times that because a reply says "don't want so-and-so", that "so-and-so" is an unwanted facility. The other extreme is possible, what is actually wanted may well be a better "so-and-so" than it is practicable to incorporate in a machine. For instance, someone who wants to mix and is determined to do it probably

will not want a mixer incorporated in his machine; he will insist on having it as a separate unit. More obviously, someone who does not want a loudspeaker on his machine is not necessarily someone who does not want a loudspeaker at all! Someone who does not want adjustable bias may be acutely conscious of the importance of correct bias, and who therefore always buys the same make and grade of tape. There are quite a number of non-sequiturs of this general type in your text.

Lastly, the significance (in a statistician's sense) of your findings depends on the size of the sample—i.e., on the number of replies which you had to deal with. Assuming this number to be a few thousand, the figures which you publish are likely to be correct to within about 2; for example, your finding that 48% want a 1 minute rewind time ought really to be understood as 'about 46% to 50% want a 1 minute rewind time'. Of course, my figure of plus or minus 2 is only an indication of the order of this uncertainty, and is merely intended to warn anyone against rash deductions, such as imagining that there is an unquestionable preference for 1 minute (48%) rather than 2 minutes (46%). Even so, the question is probably intimately tied up with question 4 about a rewind control, and the published figures reveal nothing about such correlations between different questions.

For all that, I personally find the study very interesting, and manufacturers will doubtless find it instructive. So congratulations to all concerned both for the idea and for its execution.

Yours faithfully

. . . about Revox buttons

From : Colonel R. Bose (Retd.), Calcutta Race Course, P.O. Hastings, Calcutta 22, India.

Dear Sir, I feel the Revox has been unfairly criticised for "small sins" in H. W. Hellyer's interesting article *That Little Extra* (August 1967). The red and black buttons are no problem at all if you try the following method of locating them when the deck cover is being replaced.

Make four loops out of ordinary cotton thread, about 2ft. long, and tie them round the bottom of the four red and black buttons. Pass the loose ends of the thread up through the holes in the top plate and then replace the plate. A slight pull at the four loose ends of the thread will see all four buttons through the top-plate holes in less than a minute. Finally, cut the threads off with a razor blade. I feel sure that most Revox owners already practise this method.

Yours faithfully

(A pair of household sewing needles may also be used to position the buttons through the deck cover, yet another method being to hold the Revox upside down and let gravity do the job!—Ed.)

. . . about recording in Eastern Europe

From : S. G. Brown, 8 Chestnut Crescent, Maulden, Bedfordshire.

Dear Sir, I was very pleased to see Philip Towell's article *On Location in Czechoslovakia* but there are many points on which I would like to comment.

To begin with I should explain that my work takes me into Eastern Europe for an average of ten days each month and the main reason why I am writing is because I consider that tape recording, like music, can become an international 'language' and so contribute towards a better understanding between nations.

Eastern Europe and its people are looked upon as somewhat of an unknown quantity by the West due to the considerable adverse publicity given to these countries immediately after the Second World War. Unfortunately, publicity has not kept pace with the changes and progress of these countries and this to my mind, is a serious short-coming in the Western Press, although there has been a serious attempt to put this right during the past twelve months or so.

To make direct comment to some of the statements made by Philip Towell, I would at first ask for the erasure of the words "iron curtain", the "iron curtain" no longer exists. One can now travel into and move about freely in all Eastern Europe countries with the exception of the USSR. Most certainly a visa is necessary but in the case of Czechoslovakia, Hungary, Rumania and Bulgaria these are obtained without any difficulty and in fact in the majority of cases, one arrives at the airport of embarkation or entry point at the international boundary and a visa is granted immediately upon application. In other cases, one needs to obtain a visa before travel but providing one gives evidence of genuine business or tourist interests, no problem arises. In the case of the USSR, although there is a restriction of movement, this does not seriously affect one's sojourn in the Soviet Union. Many countries in the Middle East require a visa for entry and I believe I am right in saying that a visa or at least an entry permit is required for the USA.

Philip Towell has referred to "how perseverance can win through". I have taken my Ficord 202A on many occasions, in fact now it accompanies me regularly and I have never made any application to any authority. The only precaution I take is to make sure that my IFSR membership card is current and securely locked in my passport by an elastic band which also secures my vaccination and health certificate.

I can understand that the Czechoslovakian Embassy did no more than quote the relevant customs regulations for in all probability they would feel a little hurt if one did not trust them to this extent.

The customs and currency control are no more stringent in Eastern Europe than many countries in the West including our own and if the worst did come to the worst, Mr. Towell would have experienced no more than a request by the Customs Officer to deposit the

(continued on page 31)

made in japan

MEMORIES OF A JOURNEY TO THE FAR EAST

General Tokyo Street Scenes and Audio Dealers



BUY a 20 yen ticket at Tokyo Central Station, board a Yamate Line train heading towards Ueno, and two stations later you will arrive at a major rail intersection called Akihabara. This has more to recommend it than a maze of railway lines, for it is here, in the centre of Tokyo, that the major electrical wholesale shops are situated. Near the station, streets and alleyways are packed with every conceivable type of electrical shop, selling everything from transistors to washing machines. It is here that many Japanese come, to browse amongst the shops, to compare prices, and then return home with their latest acquisition on the ever-crowded trains.

Akihabara is a good place to start looking into Japanese electronics because, more than anything else, the products available here reflect the demands of the average Japanese person. Electrical goods are cheap, being usually a little over one half the equivalent British price. But to say this alone would give a very misleading impression. For the average Japanese wage is about half of ours, taxes are high, accommodation and land are very expensive, and food not very cheap. The survival of the Japanese nation and their rise to an affluent society is all the more remarkable considering that a married woman in a family does not, by tradition, go out to work.

Japan is a country of contradictions and contrasts, with old and new existing side by side. There are two entirely separate cultures, one belonging exclusively to Japan while the other is the very recently introduced European culture. The absorption of Western culture and science into the Japanese way of life has proceeded at such high speed that even the Japanese cannot comprehend how quickly their lives are changing. Not always have these changes been for the best: some of the age-old Japanese customs have crumbled under Western influence.

Much of this new culture and new technology came from America after World War II, and many Japanese products are today made with the American market in mind. This is particularly apparent in the electronics field. The Japanese have always been noted for their ability to copy Western countries, but the speed with which they have caught up, and their subsequent development in the elec-

tronics industry, is one of the most fascinating aspects of Japan. Whether or not their progress will be maintained—now that they have caught up with Western development—is a matter for speculation. Whilst their development in certain fields of technology is bound to continue, I do not think that their overall rate of progress will be maintained. One notable exception to this is the *Sony Corporation*, whose incredible progress will be described in a later article.

Whatever we in England may feel about copied designs, the Japanese greatly respect the countries from which their technology is taken. Japanese people, especially young students, are very interested not only in our technology but also our way of life. Wherever I travelled and stayed in Japan I found young people eager to make my acquaintance and to learn about our country. They are very keen to find out more about our music and literature, both of which are very popular in Japan.

Two things I was asked about concerned the place of women in our society (life is very different for a woman in Japan) and the Englishman's sense of humour, of which, for

some reason, they have all heard. "Please teach me the Englishman's sense of humour" was an often heard request. Not an easy task in ten minutes! As a people I always found them perfect hosts, and all the people with whom I came into contact helped to make my nine-week stay a very memorable experience.

After browsing around the tape recorder and hi-fi shops of Akihabara I came to the conclusion that, perhaps in common with the Americans, the Japanese do not employ tape equipment in an individually creative manner. This may help to explain three things. Firstly, there is no magazine comparable to *Tape Recorder* encouraging people to make the best use of their audio purchases. Secondly, there is very little in the way of good quality reasonably priced microphones or mixers for live recording. There are many cheap microphones, some of which are available over here at about the same price as in Japan, but little to compare in quality and price with, for example, the products of *Grampian* or *Reslo*. I can only presume that on the domestic market there is little opportunity for live



Newly-built Akai factory in Tokyo.



BY ANTHONY EDEN

recording. The people with whom I spoke indicated that little encouragement is given to making individually creative recordings. Whilst manufacturers are quite happy to make many thousands of machines each month for the domestic market, no-one appears to follow this up and encourage wider use of the equipment. Most of the machines available on the domestic market are made for simplicity of operation and designed for their good looks. Thirdly, the portable type of tape recorder is not used in the same way as ours, 'portable' merely meaning that it can be *played back* anywhere. The source of sound is very often pre-recorded tapes. The portable type of machine is therefore designed to give a reasonable quality at low cost.

The type of customers most manufacturers are aiming at are young people, who can have the type of music they want, where they want. For this reason DC erase is used very widely, and the additional noise so introduced when recording would not cause offence to that type of user. This type of machine is really designed for the domestic market, and it is very unfortunate that some manufacturers try to sell these machines in England, where they have to stand comparison, price for price, with the superior European models.

The average Japanese home, and the rooms therein, are very small. This fact, coupled with cost, may help to explain why very few stereo recorders are in use at home. There are many stereo record players in use, often of the portable variety with two detachable speakers, which form the lid of the unit. For most people who wish to listen to stereo music, the best places to visit are the coffee shops that abound throughout the country. The most famous coffee shops of Japan are situated in the Shinjuku district of Tokyo, and provide every form of music from traditional jazz to classical, with a startling impact and at ear-splitting level. The source of sound in these coffee shops is almost invariably gramophone records.

There is also a large domestic demand for portable mains machines. Few of these machines find their way to England. A number of manufacturers have combined two demands by having a fairly robust machine

(continued on page 29)



TELEFUNKEN

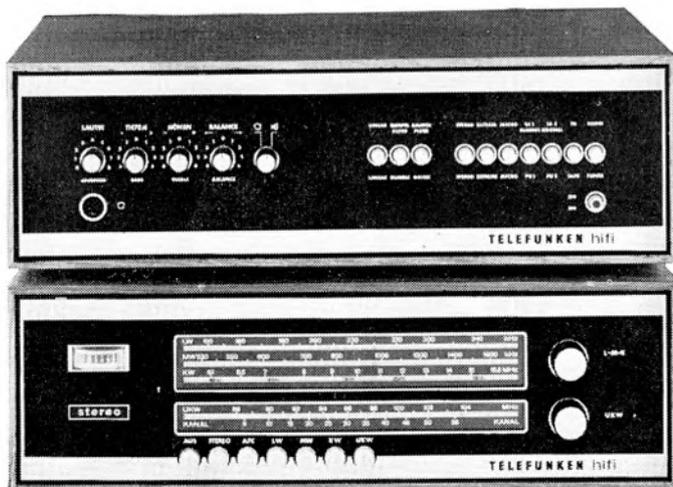
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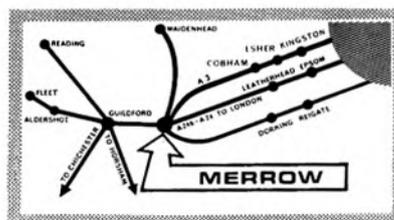


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that can be used either from batteries or from the mains via a built-in mains unit (for example the Sony TC800). This type of recorder will certainly have AC bias and erase and usually a reasonable tape transport system. There are no less than 14 manufacturers producing domestic tape recorder sales for the Japanese market, the main ones being *Fidelia, National, Sanyo, Sony, Standard* and *Toshiba*. If company reports are a good guide, it appears that most manufacturers' sales of tape recorders are booming.

The majority of Japanese stereo tape recorders are exported, and in fact some makers of stereo equipment do not sell on the domestic market at all. One concern stated that 90% of all its tape recorders were exported, 60% of the total going to America. Leading the field of stereo machines for export are *Akai, Sony* and *Teac*, along with some other manufacturers. Of all the companies I had a chance to study, only *Akai* produced high fidelity equipment exclusively. Most of the other companies also had production lines for colour television, washing machines and refrigerators. The specialist companies in the tape recording field do not appear to be as common as in England, but, as one company claimed, "We produce everything from tiny transistors to gigantic generators". This is remarkable considering that many companies have grown up as a single unit and are not the result of take-overs.

NO EUROPEAN RECORDERS

After wandering around the audio retailers of Tokyo, it soon became clear that there was not a single European tape recorder on display. With high import charges and Government restrictions the cost would be prohibitive to most people in Japan.

Without any doubt, the largest influence on the Japanese design of consumer goods is the American market. Since it consumes over half of Japan's exports, it dictates the new trends and designs. Some equipment is designed in America for production in Japan. In this case the American importer has his own name on the products going to America, and the Japanese name for exports elsewhere. Recently, British importers have been doing the same thing, and products bearing names like *Murphy* and *Ultra* can be seen coming off Japanese production lines.

During my visit to a number of factories, I was amazed to learn that the American market for tape recorders was so diverse and so insatiable. *Toshiba*, for example, were producing over 10,000 tape recorders per month for one chain of department stores in America. The machines here were mainly in the domestic mono and stereo category. *Akai*, similarly, were producing stereo tape recorders (under the brand name of *Roberts*) at a very high rate to send to America.

I was very interested to find that, although we in England consume less than 1% of Sony's tape recorders, they take more than a passing interest in our requirements. For the British market demands far more of the high quality type of machine than does America, and as such is a more rewarding customer. A line of communication is being set up, I understand, from the consumer to the retailer, back to the English Sony agents and thence to the main research and development teams

made in japan

give very reasonable results. Imported *Scotch* tape is widely available there. After venturing into some of the smaller shops, I found that there is much in the way of reject computer tape (often poorly spliced), and generally low quality tape by unnamed manufacturers. I suspect some of this tape finds its way to England.

One important point in connection with tape: The Japanese have a very wide 'spoke' type of tape spool which is much stronger and less prone to warping than most European-made spools. Sony supply such spools with some of their tape recorders. Is it possible to have these spools made more generally available in England?

GREAT STRIDES

The latest warfare to develop between manufacturers in Japan is the production of various forms of domestic video tape recorder. At present, interest is centred on helical scan machines first made practical by Sony. Sony are now making great strides forward and have succeeded in producing a battery video recorder. The major problem in producing this machine was to find a really reliable battery. I guess that by now this problem must be solved. Already work is going ahead to produce both mains and battery machines capable of recording colour. The Sony battery video tape recorder weighs only 12 lb. and one person can operate both sound and vision quite easily. The first demonstration of this machine was made at the 1967 New York Consumer Electronic Show.

PROTOTYPE MODEL

The Tokyo *Shibura Electric Company* (*Toshiba*) are now producing a video tape recorder which will be marketed in England. The production lines were being set up for the tape recorder at a factory near Osaka whilst I was in Japan. The basic design is similar to that of Sony. However, on the prototype model I saw at the *Giza* showrooms of *Toshiba* in Tokyo, the machine could record either colour or black and white. The colour definition was excellent when recording live, but did no credit to the video tape recorder when recording from colour television. The fault lies, not in the recorder but in the very mediocre definition and poor colour contrast of the Japanese colour system. We are fortunate indeed to be spared the agony of watching colour on the American NTSC system. The choice of NTSC for Japan is being regretted in some quarters already.

The *Akai Electric Company*, after a promising start in the video tape recording field, appear to have shelved developments—for the moment at least. *Akai* planned to use a fixed head system, with cross-field bias. They first demonstrated a VTR in 1965 at the Tokyo Audio Fair. Subsequent developments and modifications were made and the speed was reduced to 30 i/s, with a 1MHz bandwidth. The tape transport system was based on the *X-300* tape deck. However, development has been held up because, in order to obtain the necessary bandwidth, the tape-head gap has been reduced to one micron and the limiting factor is now the tape itself. Unless the tape is of the highest quality, drop-out and dirt collecting at the pole faces can seriously affect the quality of the picture.



The Tokyo headquarters of Sony.

in Tokyo. This is a big step forward in understanding and satisfying consumer demands.

In passing, it is interesting to note that the value of trade between England and Japan is about the same in each direction. Whereas Japan exports consumer goods, we export mainly goods of the non-consumer variety. The largest single import to England from Japan is not radios, cameras or tape recorders as might be expected—it is tinned fish!

After the many depressing reports about quality of Japanese recording tape, I took with me my own supply of tape for use on my *Q-Cord* portable recorder. After some trials with Japanese tape, I was agreeably surprised to find that at least some manufacturers make good quality tape. *Sony* and *Synchrotape* are amongst the most popular brand names and

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Akai 1710	20 14 9	5 3 9	79	
Tandberg 74	24 8 3	6 2 1	93	
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Tandberg Series 12	27 11 3	6 17 10	105	
Revox 736 2 or 4-T	31 4 9	7 16 3	119	
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Akai X355	62 14 9	15 3 9	239	

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Fidelity Playmatic 4	8 2 9	2 0 9	31	
Elizabethan LZ34	8 18 6	2 4 8	34	
Ferguson 3218	8 18 6	2 4 8	34	
Telefunken 201	8 18 6	2 4 8	34	
Ferguson 3222	9 3 9	2 6 0	35	
Philips EL4305	9 9 0	2 7 3	36	
Grundig TK140	10 2 2	2 10 7	38½	
Philips EL4306	11 0 6	2 15 2	42	
Ferguson 3214	11 11 0	2 17 9	44	
Truvox 44	12 6 9	3 1 9	47	
Ferguson 3216	12 17 3	3 4 4	49	
Tandberg 843	15 9 9	3 17 6	59	
Philips EL3556	16 5 6	4 1 5	62	
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Tandberg 6X	28 17 6	7 4 5	110	
Ferrograph 632	33 1 6	8 5 5	126	
Ferrograph 634	34 12 6	8 13 4	132	
Brenell STB2/5/2	37 10 0	9 7 6	150	

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Grundig TK120	7 14 11	1 18 9	29½	
Philips EL3310	9 3 9	2 6 0	35	
Grundig TK18L	9 3 9	2 6 0	35	
Grundig TK125	10 7 6	2 11 10	39½	
Truvox 42	12 6 9	3 1 9	47	
Tandberg 823	14 3 6	3 10 11	54	
Tandberg 92	18 2 3	4 10 7	69	
Brenell Mk. V3	19 8 6	4 17 2	74	
Brenell Mk. V3(Meter)	20 14 9	5 3 9	79	
Truvox R102	23 7 3	5 16 10	89	
Brenell V/3 'M'	24 8 3	6 2 1	93	
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Ferrograph 631/H	26 5 0	6 11 3	100	

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ELEMENTS OF TAPE RECORDER CIRCUITS CONTINUED

say, 8 on the scale corresponds to a full depth recording. Bias frequencies, which are apt to give a false reading, are by-passed through the capacitor C_1 . The diode V_1 only allows a uni-directional signal (the positive half of the audio signal) to pass on to the triode V_2 via the components R_2 and C_2 , and then on to the DC meter in the valve anode circuit. The rate at which C_2 is charged depends on the time-constant of C_2 , R_2 and the forward resistance of the diode, and these values are chosen so that the peak signal voltages have sufficient time to produce an essentially proportional swing on the meter. As mentioned earlier, a typical rise-time might be 4mS. The power required to drive the meter, which is usually a 1mA full scale deflection DC movement, is drawn from the triode valve, the potentiometer R_3 backing off current from the HT line so that it is zero when no signal is present.

Fig. 5 shows an alternative peak reading indicator employed in one commercial recorder. The audio signal is taken from a late amplifier stage just before the feed to the tape head. In this way a signal is taken from a point in the record amplifier after high frequency pre-emphasis thus giving a true indication of head current, and an HF filter prevents bias current from producing an unwanted reading on the meter. The first half of the double triode ECC 83 converts the high impedance output from the record amplifier to one of low impedance, the

arrangement being known as a cathode-follower. The low impedance output is then fed to the second half of the double triode through the diode, which has a low resistance in one direction but will not allow the signal to pass in the opposite direction. A low impedance unidirectional signal output suitable for driving the 1mA moving-coil meter is therefore obtained at the cathode of the second triode as shown, the potentiometer R_1 enabling the meter to be adjusted to zero when no signal is applied to the record amplifier.

In contrast to the PPM, the VU-meter is inexpensive to produce and has become popular with manufacturers of some domestic tape recorders. It consists of a rectified moving-coil meter having specially designed dynamics so as to measure the average volume level of a sound being recorded; some allowance must therefore be made for peaks. In practice its readings are purely arbitrary, since the movement of the pointer depends not only on the volume but also on the frequency and type of programme material. Another shortcoming of this type of meter is its fast 'fall time', resulting in to-and-fro movements of the pointer as it attempts to follow the average sound level.

LESS SENSITIVE

The movement of the VU-meter is less sensitive to sudden transients than the peak programme meter, and whereas the latter will rise more or less proportionally to peak signals and then fall off slowly, the VU-meter does not respond *proportionally* to sharp

peaks. This is an unforgivable fault in a component designed to measure distortion level.

One way of connecting a VU-meter, particularly in professional installations where average signal level may be of importance for other reasons, is to place it (in series with a 3.6K resistor) directly across a 600 ohm output. This could come from a 600 ohm transformer, the amplifier stage preceding it being part of the record amplifier of the tape recorder.

Another method is to connect the VU-meter across a low impedance cathode-follower output as shown in fig. 6. In this circuit a full-wave copper-oxide rectifier is used so that electrons flow through the meter as indicated by the arrows, in both the negative and positive halves of the input signal. Sometimes the cheaper half-wave rectifier is used, but in this case only half the audio waveform is used and the rectifier only delivers half as much current to the meter. This may mean a more sensitive and therefore more expensive meter, or alternatively more amplification prior to the rectifier.

In some recorders, particularly professional types which employ either VU or PPM meters, facilities are available for metering the amount of *bias* current going to the record head. This is important in professional equipment because bias affects distortion and frequency response and has a fairly critical optimum value. Next month we shall look into this more closely when we consider the working of the bias and erase oscillator unit.

READERS' LETTERS CONTINUED

article with them until such time as he left the country. He should not under-estimate the young lady in the customs, she is as astute as any Western counterpart.

He then mentions that he will never regret having taken the recorder with him and quite rightly so; I too, have never regretted it either. Recordings I have made in USSR, Czechoslovakia, Hungary and Poland are invaluable.

His experience at the wedding is one that is quite common in these countries. These peoples basically are no different to us and they thoroughly enjoy joining in and helping the amateur recordist and also the amateur photographer.

The currencies of Eastern Europe are non-convertible and so sterling, a convertible currency, is in short supply. As in all things of short supply a black market exists. If I may give a word of advice to anyone visiting these countries, avoid the black market like one would avoid a plague, for in any case, the higher exchange rate for tourists in most countries means that one can get by very comfortably.

In making a generalisation in that their shops were drab, I think Mr. Towell is being a little unfair unless one goes on to say that this is comparable with many shopping areas in the United Kingdom. I have spent many a pleasant evening window-gazing in Vaclavske Namesti, the main shopping centre of Prague, where the standard of window dressing is most

certainly comparable to any of the main shopping centres in the large cities of this country.

In all cases one is free to move about within the limits of one's visa and may it be clearly understood, that if one wants to go beyond the limit of one's visa, one only has to approach the appropriate authority and providing one's request is reasonable, there will be no hesitation in granting permission.

I understand Mr. Towell's surprise at one of his party taking a close-up photograph, for in the United Kingdom this is taboo. You may be interested to know that one is free to take as many photographs as one likes in the theatres of East Europe providing one does not use flash. One final small point, the beautiful castle in Prague is the Hradcany.

If any reader has the opportunity of visiting Eastern Europe my advice is do not hesitate for one moment. If you are not a member of the FBTRC, join immediately. Their membership card and that of the IFSR are your visa for recording. When in these countries behave as you would behave in any other country including your mother country and you will find that the authorities will be pleased to assist you, the peoples will be happy at the prospect of joining in with you and in all probability, you will make more friends than you would at home.

Admittedly the tape recorder is a little known quantity in Eastern Europe but needs are changing rapidly and we shall soon find a recording movement as active and interesting as that which we have in the West.

Yours faithfully

YOUR OBEDIENT SERVANT CONTINUED

run through, a selective dump is supplied and can be compared. The dumps are in machine language and look like interminable lists of figures to you and me, but cross-referencing enables the programmer to spot errors.

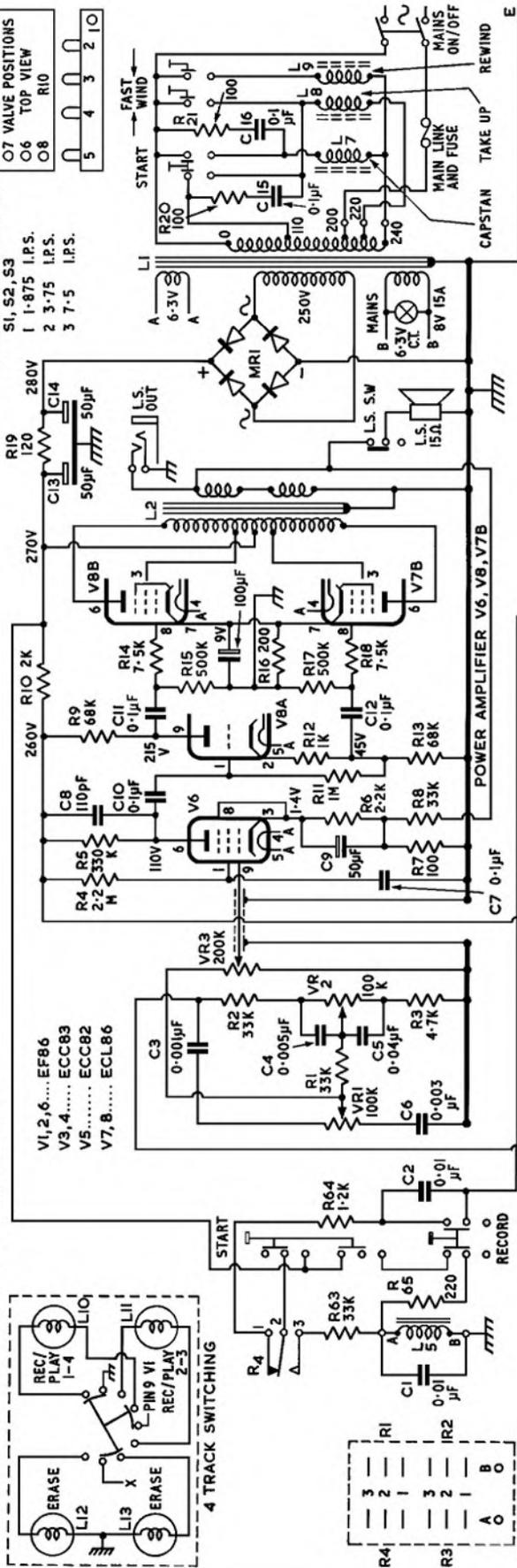
Because of the high cost of computer time, debugging is better done at the office desk than the computer console. Moreover, the operator can make mistakes and actually insert wrong information to the programme while attempting to debug it.

In this series of five articles we have taken a very superficial look at the way in which the very processes we employ for pleasure are used in business, science and industry. Tape, and the magnetic medium generally, is very much an obedient servant. It is not the only servant, and present straws in the wind indicate that we may one day be more concerned with optical methods. Space restrictions prevent our delving more deeply, but if these notes have given one or two of us cause to think, they will have justified the labour. One point that was thrown out idly was the refined mechanisms employed in these very expensive machines. We should have dearly loved to be able to illustrate and describe them, but have been unable, as yet, to chip away at the free-masonry of the computer makers' castle. This is a point of interest that will really have to wait until later.

To those that have borne with me thus long —best wishes for 1968. May your tapes never tangle!

FIG. 1

REPS R.10 CIRCUIT DIAGRAM



AND a happy New Year to you all. Even to those Editors who let the Christmas spirit affect their page make-up and cause poor, hard-working contributors to rewrite a newly-minted article to fit the juggled diagrams!

Let us hope it is not an omen for 1968 to start this article with an apology. Fig. 1, which should have appeared last month, is the circuit diagram of the *Reps R10 Mark 1*. The other circuit is the early version of the *Mark 2*, now labelled fig. 2. It will be noted that there are some significant changes, particularly in the pre-amplifier and driver stage sections.

We have already discussed the relay circuit, and readers who have the December issue at their elbow can now see what I was trying to talk about. Both the Mark 1 and early Mark 2 models employed the 'assisted pull-in' relay circuit, and this had the disadvantage that an interruption of supply voltage, even for quite a short period, resulted in the relay dropping out while on play, and reverting to record—with results that owners of spoiled pre-recorded tapes will recognise to their chagrin! Next month's relay circuit is quite different.

BACK TO THE FIGS

So now, back to the figs. 1 and 2 circuits and a component common to both, which experience has shown to be a weak link in all models. This is the $0.01\mu\text{F}$ coupling capacitor from the anode of the meter amplifier to the diode rectifier. This is C47 in fig. 1 and C3 in fig. 2. The tendency is for a slight leak to put intermittent DC on the grid of the meter amplifier, causing alarmingly erratic readings and recorded levels. It only needs a small leak to put positive voltage on the grid, and the answer is to replace with a high grade ceramic component, or, if only a paper capacitor is available, to use a high insulation type. The less obvious trick here is to eradicate the switching pulse that must occur, even with the best regulated HT circuit, and to take the 'hot' end of the anode resistor of the meter pre-amplifier stage (V4B in fig. 1) directly to the main HT line. This is done in our fig. 2 (R4), but note the meter line still goes to the switched HT. The meter circuit of later models is, as we shall see, quite different. In fact, a different meter is used, although the specification is very similar and the movement is 1mA for full scale deflection, as before.

Keeping to the record amplifier, we may take a look at the boost coil, L4, and the switched components for pre-emphasis associated with S2 and S3. Complaints of varying 'top response' are often attributable to incorrect bias. With the bias oscillator coil linked anode to anode, which cuts out the oscillator, an input of 2V at the gram socket should produce a valve-voltmeter reading of approximately 6V at the $0.1\mu\text{F}$ capacitor feeding the record head (C39 and C38 on figs. 1 and 2 respectively). As a monitor test, this signal should give 11 or 12V across a 15-ohm resistive load over the output. An oscilloscope is useful here, for a distortion test is needed to prove whether the reading is a 'true' figure or a mean 'lumping' of signal plus distortion.

If this is in order, we can check that the bias is correct. In fig. 2 some representative figures are given on the circuit. Remember that these are valve-voltmeter figures. It is no use measuring with even the best quality multimeter and expecting comparable results. The frequency of the oscillator is 65kHz. It should very seldom be necessary to attempt to tune the coil, and indeed it is very difficult to do so. The push-bell circuit is very efficient. Perhaps the weakest link is the ECC82 valve itself. If there is a notable lack of oscillator output, suspect the erase head, which can impose a drain on the available current while still working fairly well. A good 70V bias should be possible, and with this, using most high quality tapes, excellent recordings can be obtained.

EARLIER MENTION

Earlier mention was made of the boost coil. One fault that has been found here, and at some parts of the output section of the circuit, is a dormant dry joint. It does not affect replay very much, but recordings become quite erratic, with intermittent bass emphasis. As monitoring is via the R3 section of the relay switching, and prior to the V3-V4A stages, some confusing results can be obtained. Playing back a known good pre-recorded tape proves the playback circuits and switching. Attention can be concentrated on the equalisation (or, to be more accurate, pre-emphasis) switching associated with S2 and S3 if erratic recording is the fault.

Apart from these odd dry joints, contacts on the switch wafers (mounted on the speed-change switch) should be checked. In addition, the actual mounting of the switch wafers has been faulted on some occasions. It may seem silly to bring this up when the machine has been in production for several years, but so often the author has had machines brought to him following years of faithful use, and discovered faults that must have been dormant for all that time, finally provoked by the attendant angels of St. Cecilia (patron saint of radio service mechanics, believe it or not)!

For the benefit of those who are rooting around for an early Reps to bring it back into service, allow me to direct your attention to the actual mounting of the switch wafers. These can be too high, giving intermittent short-circuits and erratic results. Reps are not alone in this: Messrs. *Ferroglyph* and *Brenell* are equally liable to recording faults caused by bad contacts at switch wafers, and the constant bench companion of an aerosol switch-cleaner has been blessed more than once.

To digress for a moment. After the preparation of the Brenell articles last autumn, we had occasion to send a new *Brenell Mk. 5M* back to the factory, having tried in vain to eradicate a slight but annoying instability on low volume replay. Mr. Raine, of Brenell, reported to us that the trouble was eventually traced to a switch wafer, the point being proved by judicious use of an electric fire and compressed air line; "two additions to the workshop tool kit", as he wryly added. This sufferer has long been suspicious of the aerosol 'freezer' issued by service factors, except for some television repair work. But now . . .

(continued overleaf).

REPS
R.10
MARK 2

BY H. W. HELLYER

tape
recorder
service

One feature of this circuit that will have attracted the attention of some of my indefatigable critics is the quite careful shaping of the recording curve and the comparative simplicity of replay equalisation. Are Repts taking too much trouble?

Well, of course, results give the answer to this question, and certainly, recording with a good microphone on a Repts R10 will prove the good design mentality behind a decision to add a pound or two to production costs. From the point of view of servicing, however, such switched component changes add a possibility of trouble. Before cursing the probable need of laying out seven or eight pounds for a replacement record/play head, always check the switched pre-emphasis components and the bias. More often than not, the recording fault will be buried in this section.

Bogen heads of this quality, as used here, will defy quite a lot of wear. In fact, the 'bedding down' process of heads and, in particular, pressure pads, leads to a great lengthening of tape recorder life. The chap who replaces his pressure pads every time they show a bit of discolouration may be sacrificing a bit of 'edge' from his upper frequencies. Tom Repts is particularly careful about this point—hence his modification of the Collaro Studio head assembly.

On replay, we find there is only a switched change of resistors between the pre-amp and main amplifier stages. This is quite sufficient to give us the lift we need for equalisation. On the later circuit, which we shall give next month, a little more complication arrives, with varying feedback. For those who wish to experiment, the best of all worlds can be gained by taking the prime points of all the circuits. Mark 1 enthusiasts swear by the playback quality of the early circuit, and my own ears must allow them a valid point. But against this must be put the possibility of input stage noise as EF86 valves begin to age. It would be interesting to hear the views of some of our more erudite readers on the subject of pentode noise.

BITTER EXPERIENCES

For my own part I favour triodes, even if more of them per circuit are necessary, and costs must go up. As for transistor circuits—unless we are prepared to use silicon planar devices in the early stages, my bitter experiences prove that good valve design wins every time. My eyes ache with probing into congested printed circuits of—ahem—over-seas models (and one or two home products), with one channel 'hissy' or slightly 'down' in stereo circuits, where the discrepancies are, naturally, much more noticeable to the user.

All of which has led us again from the circuit under discussion. Returning to fig. 2, we next direct our attention to the pre-amplifier, driver and output section. This is built on to the separate rear chassis, and symmetrically arranged at the left of the cable compartment. The circuit is quite conventional, and any troubles are generally those met with valve failure or component breakdown as with any comparable amplifier. The output transformer is not a particularly generous one, and it is only by limiting the operating voltages and using the ultra-linear method of working that good results can be



obtained. But these results are genuine, as the connection of a really good loudspeaker will prove.

The principal faults are the usual ones: possible breakdown of coupling capacitors. C10 in fig. 2 can develop a leak, but always replace both C10 and C11 in this case. The damping factor can be improved by adding a 47K across the 4.7K feedback resistor R13, where this higher value is employed. In later models a much better stability factor, and less distortion at higher drive levels, is gained by biasing the output grids, but we shall discuss this later.

Another very important feature of later models is the use of a 100-ohm protection resistor across the extension loudspeaker output jack, which is then of the 'closed-jack' variety. This is a mod. well worth doing. For my own part, I favour using a lower value, some 68 ohms rather than 100, but remember that the lower your protection device, the higher its dissipation rating. A 68 ohm, 1W, does the job well enough. Under fault conditions I have seen the 100 ohm, even at 1W, begin to get uncomfortably hot. Also there is a tendency for arcing from the pins of V8 pentode section to the chassis, and any evidence of burning here should lead one to check first the drive section, then the cathode bias, then the transformer itself.

The text of this contribution is shorter, to allow space for the two diagrams. I hope this compression has not resulted in missed points and welcome any discussion on these models. Once more, allow me to apologise for delays in dealing with individual queries—my face is as colourful as the new covers of our companion journal, *Hi-Fi News*, but please do not go away in disgust. Any queries will be dealt with just as soon as my soldering iron cools off.



'German English': "I, out of the door, go, must".

Despite the slightly stumbling phraseology of English-language Japanese brochures, the main problem besetting practically all of them is the prevalence of printing errors. This is quite understandable; absolute accuracy is difficult to achieve in one's own language and must be very much harder in a totally alien script. "Erequence response," "Solid-stats circuitry," "Muxplex," "Eveready batteies," and a delightful reference to "Childlen" catch one's attention during a quick glance across an array of sales leaflets.

My purpose in raising these points is to comment that the present standard of translation can be immensely improved very easily indeed. Japanese manufacturers have shown great efficiency in developing and producing low-cost consumer products for home consumption and Western markets. This efficiency can be extended to British sales literature by submitting the proposed texts of new brochures to the importer for revision. Ten minutes work by a competent English press officer, or a technically informed marketing manager accustomed to the products being described, could save the Japanese translator hours of detailed checking and re-checking. Both the manufacturer and the importer stand to profit from such an arrangement, for it would bring Japanese sales and servicing literature into line with the consistently high standard of English achieved by Scandinavian, Dutch, German and Swiss manufacturers.

IMPRACTICAL IDEAL

In a few cases this ideal solution would be impractical, for some U.K. agents are notoriously apathetic about publicising and servicing the products they handle—as Japanese manufacturers are becoming increasingly aware. One importer, representing several European and Japanese companies, regularly submits press information to *Tape Recorder* which has been re-typed from the original 'Japanese-English', complete with the most obvious errors. This total and facile negligence left us with an extremely low opinion of the distributor, an opinion which reflects undeservedly upon the manufacturers. The solution to this problem is a change of agency.

This would be a dismal note on which to end, however, and I would rather leave the conclusion to 'Phon' who has expressed a fondness of "the comical expressions and unusual phrases that (he suspected) are deliberately manufactured by some branch of the Foreign Trade Agency and cunningly inserted to gain attention". Phon concluded his December 1965 column in *Hi-Fi News* by quoting his favourite piece of mistranslation—not Japanese but Austrian in origin. It concerned an electrostatic loudspeaker.

"... the static high tone speakers known so far features the flat diaphragm, therefore the reflection takes place in copious bundles... this new speaker has no baffle plates, by-pass lines, metal tubes or similar auxiliary means which would after all bring fading symptoms, knots, and irregular reflexions in their wake due to their different running times." British Rail, please note.



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PERSONAL BIAS

THE TRIALS AND TRIBULATIONS OF TAPE CORRESPONDENCE BY JOHN ASHCROFT

"QUICK," said my nephew, dragging the bedclothes from my bloodshot gape. "Somebody on the phone from London—it's urgent."

Strewth, I thought fuzzily, falling downstairs in Lancashire—I've done it at last. I could see hordes of manufacturers and lawyers looming in grim ranks around John Crabbe's desk, all eyes on a magazine open at my last article. I grabbed the phone and croaked: "Hello?" and a bright female replied: "It will be eight-ten precisely." Pip! Pip! Pip!

And the family chanted: "April Fool!" This year I played safe and spent All Fools' Day at the Audio Fair. But recalling that rotten trick reminds me of other rotten tricks to play on a friend. A tapespondent once carefully timed a juicy piece of news so that its punchline vanished on to the leadertape. He retaliated to my complaints by recording the first minute of his reply on almost minimum gain, then going up to normal.

I started his tape, scowled, cleaned my heads and tried again. "Tcha," said Ebenezer; "his machine's up the creek." We whacked up the amplifier until the room was full of roaring fizz, hum and tape-hiss, and the distant voice was just about audible with our ears against respective loudspeakers. Then the full gain bit came on, the speaker-cones whistled and shuddered in audible agony, and the dog tried to jump through the keyhole of the china cabinet.

When our brains stopped rattling, Ebenezer snarled: "I suppose he thought that was funny. I'll sort him out." While I chatted into the mike, Neb sat by the recorder and at unpredictable intervals snapped down the gain and raised it, making occasional words suffer a peculiar drop-out. Soon he was fading in and out more slowly, and finally he did a marvellous smooth fade occupying thirty seconds. The replay honestly frightened us; when my tapespondent heard it he'd go haring down the High Street and throw his machine at the dealer.

SAME WORDS

But, as Neb remarked, the chap was less green than cabbage-looking, and he soon twigged that the same words suffered on repeated replaying. So he afflicted my machine with horrendous flutter; every now and then, as I listened to his reply, his voice suffered a great twang-ang-ang-anggg that set my teeth on edge. Obviously the tape was catching the spool-rim, or sticking together on the left-hand spool and being tugged free.

At each twang I leapt to the machine and scowled ferociously at the tape; five seconds after I got fed up of waiting for another one,

and sat down, came another attack. Finally it dawned on me that he'd been plucking at the tape as he made the recording. It's nice to have friends, or so I was told once.

Copyright be blown I decided, when I retaliated by introducing a disc and using the infinitely variable speed of the *Goldring Lenco GL70* to vary the pitch up and down very slightly and smoothly. Playback made my ears sea-sick. It worried my tapespondent, too, by all accounts, until again he twigged that the same bits of the music suffered on each replay.

Still, it seemed to cure him once and for all. His eventual answering tape was a model of decorum and technical excellence. At the end of Track 1, he said "I see I'm running off the tape here, John, so if you'll turn the spools over . . ." The tape-hiss dropped away as the leader began passing the heads. I stood up and began strolling towards the machine, and from the loudspeakers behind me an angry voice bellowed: "Not just yet, you twit—let me finish!"

I boggled and froze. It frankly terrified me. The crafty devil had spliced a bit more tape into the middle of the leader, and recorded those kind words on it. Since then I've been itching to get my own back, but not even the gold-mine of malice that masquerades as Ebenezer's brains can dream up a suitable vengeance. So if anybody has any ideas on how to drive tapespondents round the bend . . .

IN THE STICKS

Mr. P. J. H. Pittam of Leeds loudly laments the state of affairs "out in the sticks." He complains that local dealers display little audio gear and less desire to demonstrate properly. "Just imagine," he writes wistfully, "a real hi-fi dealer, with soundproof demonstration rooms, competent staff with enthusiasm for the job, and equipment they really want to sell. I wonder if such a place exists? Perhaps John Ashcroft may know."

If Leeds readers can help Mr. Pittam, I'll gladly pass on any information. Meanwhile, odd things can happen at *this* end of the Liverpool-Leeds canal. My regular dealer keeps me pretty well satisfied, but some Merseyside shops have a lot to learn. For instance:

Into one garish palace went Derek, with bulging wallet and an urge to buy some gadget or other, *Mark IV*. Being bitterly experienced, he insisted on opening its box (which had obviously been done, already, by someone else). Lo and behold, the box contained *Mark III*, several quid cheaper.

"That's queer," said the salesman, and reached down the *Mark III* box; sure enough, it held *Mark IV*, several quid dearer. "We

must have demonstrated them, and got the boxes mixed up," he said, with a light and carefree laugh that didn't inspire much confidence.

"Oi!" said Derek, squinting at *Mark IV*. "What's happened *here*, then? Look at this lead, snapped off. The back's dented in. And what about this module, all bent out of alignment?"

"Oh yes, sir; these things can happen. Still, a new module, a little shove, a couple of minutes with the old soldering iron, it'll be right as rain."

"What?" growled Derek. "If I pay for something, it works! Do you expect customers to repair things before they can use them? And look at the dust on it. You can stick it back on your shelf and keep it for some other fool."

This uncouth outburst upset the salesman. To mollify him, Derek said: "All right then, I'll have the *So-and-So* tape-deck, $\frac{1}{2}$ -track, model *such-and-such*." An assistant went to the store-room; soon came a plaintive cry: " $\frac{1}{2}$ -track, you wanted?" Derek confirmed it. At last the assistant returned, dusty and disgruntled. "Not one in the place," he said, obviously blaming Derek for this.

"Course we have," said the salesman. "Let's have a look."

"You needn't bother! There isn't a $\frac{1}{2}$ -track model in the place—we've only got the two-track version." At this news, Derek felt an attack of the twitches coming on, so he went home and dug out the whisky bottle from the dummy speaker in his den. (*Owners of stereo equipment will have to puzzle this out for themselves—Ed.*)

Oh, and suddenly it's the shristles again. A "round robin" friend dared query the veracity of this column in general and the existence of the shristle in particular. So I borrowed Ebenezer's tape of the original shristle, and dubbed it on to my section of the round robin. But another member of the group, a Manchester journalist, was not convinced.

SIX INCHES

"Can't be right," he grumbled. "A shristle is about six inches long, with hairy legs and staring eyes. It has a very fierce bite, and comes from South America."

Well, the plot thickens. The *Grundig* engineers once discovered a whole clan of incinerated cockroaches in a recorder sent back for repair, and the damndest gremlins inhabit my own equipment; but I must admit I've never seen one that looked like *that*. And if I ever do, I'll utter one yelp and go steaming up the canal to join Mr. Pittam in the safety of the sticks . . .

MEASURING WOW AND FLUTTER

BY W. H. MYALL

THOSE readers who followed my previous contribution on this subject (August 1967 issue), will recall that the views put forward were dependent on the early acquisition of a hypothetical tape. This was assumed to have been perfectly recorded with a 3kHz sine-wave with no wobble whatever. Thus when it was played back on the machine under test, the frequency deviations painted an accurate picture of the speed variations.

DOWN TO EARTH

To come down to earth, it is clearly necessary to consider how we can achieve the same end with the more tangible tapes at our disposal. The first thing which comes to mind is the possibility of preparing a test-tape on which the recorded wobble is small enough to be ignored. While this might be practical up to a point, it has limitations when used to check the better quality machines where only small errors are anticipated. As recent reviews in this magazine have shown, there are at least one or two machines in the upper-price domestic range with wobble figures at 0.04% and perhaps less.

To highlight the problem of preparing a test-tape with a significantly lower figure, I can hardly do better than quote from the specification of a certain sophisticated recorder intended for computer applications and costing around £3,500. At its lowest tape speed of 30 i/s, a figure of 0.03% RMS is given, which is hardly small enough, by comparison, to be ignored. A solution on these lines, therefore, would seem unlikely to be forthcoming.

OWN TEST TAPE

As far as machines with their own recording facilities are concerned, that is, excluding disc and tape players, we can get round the problem by using the machine under test, firstly to produce its own test-tape, as it were, by recording from a suitable oscillator and then, after rewinding, by replaying the tape on the same machine and determining wobble by means of a suitable measuring device. The reading thus obtained will be the combined effect of the wobble introduced during recording and a similar, if not identical, wobble introduced during replay.

When we reflect on the need for a wobble measurement, a figure by which we can easily decide whether a particular machine reaches a required performance, or by which we can compare one machine with another, it is at once evident that the measurement we obtain

by this method serves the purpose almost as well as if we had used that elusive hypothetical tape in the first place. The only requirement is that it should be generally understood that the figure applies to the double operation of record/replay.

Taking, as we have done previously, the simple case of a single frequency (sine-wave) wobble, then the RMS sum of this 'double wobble' is given by:

$$(i) \sqrt{a^2 + b^2}$$

where *a* and *b* are the RMS values of the two wobbles. It is important to note that this only applies provided *a* and *b* are *not* of the same frequency. Clearly, if they are *exactly* the same frequency, then their sum can be anything between *a*+*b* and *a*-*b* according to their phase relationship. In our particular case, however, although they have the same *nominal* frequency, they are not likely to retain exact synchronism on account of mechanical considerations, the result being that a beat frequency will be produced which can be integrated to give their RMS sum.

SIMILAR ARRANGEMENTS

As the mechanical arrangements on tape recorders are usually similar on both record and replay we can consider *a* as being equal to *b*. Then (i) simplifies to:

$$(ii) \sqrt{2} \times a$$

In other words the meter reading for the combined operation will be 1.414 times the recorded wobble. If we accept that this figure serves our purpose as a figure of merit as it stands, it avoids the need to perform any operation on it to arrive at the figure for a single run.

Quantities whose sum is given by expressions of the form (i) possess an interesting characteristic from our point of view in that their sum is determined mainly by the larger of the two values, the smaller value having little effect until it approaches the larger. As an example, if *a*=1 and *b*=3, then their sum = $\sqrt{1^2 + 3^2} = \sqrt{10} = 3.16$, which is only just over 5% greater than 3. Nothing more than Pythagoras at work of course.

EASILY SEEN

The reasons for this can easily be seen from fig. 1. This represents a small amplitude flutter in the presence of a larger amplitude wow. (Drawn this way for convenience; their relative amplitudes and frequencies are irrelevant.) The higher frequency, falling, as it does, symmetrically about the lower, con-

tributes nothing to the RMS sum except where the lower frequency waveform approaches the axis.

This effect shows up in more ways than one. There is no doubt that it simplifies the preparation of a test-tape, because it means that we can ignore a recorded wobble of up to one third the minimum wobble we intend to measure and with no more than 5% error in the measurement. Nevertheless, the problem of the tape player is, for the moment, still with us, because to measure 0.03% we need to achieve 0.01%, which at the present state of the art is asking a lot.

DIRECT SUM

Under similar conditions the peak reading is going to be the direct sum of the recorded and replayed peak wobbles, but this will only be experienced by the meter when the signals fall into phase, so a lack of synchronism is still as essential as in the case of RMS. Note that the peak value will have doubled, whereas the RMS increased by only $\sqrt{2}$. The ratio $\frac{\text{peak}}{\text{RMS}}$ has therefore increased from $\sqrt{2}$ to 2 and this is the factor we now have to use to convert the RMS to peak.

So much for the simple case. Turning now to the practical aspect instead of a sine-wave wobble we shall almost certainly have a complex waveform and this is being added to itself on replay with an irregular change of relative phase giving rise to beat frequencies extending down to zero.

LOWER LIMIT

The lower limit of frequency which can be integrated is determined by the meter time-constant (standardised at 0.4 second). Below this figure the meter performs the familiar rise and fall depending on the waveform and the degree of creep. A similar effect caused by very low frequency wows can be avoided by limiting the response of the circuit. One commercial instrument indicates these as 'peak wow' on a separate meter.

It will be appreciated that after the first few seconds we are not likely to see any difference in the behaviour of an RMS meter, the reading being substantially the same so long as the machine under test turns out the same wobble waveform . . . which is as required.

The behaviour of a peak-reading meter under similar conditions warrants a closer look. To emphasise the point to be made, let us

take a waveform of the type shown in fig. 2. This, incidentally, I have borrowed from the April 1967 issue of *Tape Recorder*. By 'peak reading' we mean, of course, the maximum peak. From what has already been said, this will only be experienced by the meter when the recorded 'pip' on this waveform coincides with a similar pip on replay. The question which immediately comes to mind is "how long do we wait in order to be sure that the peak reading indicated is, in fact, the maximum peak?" bearing in mind that we do not necessarily know the waveform beforehand. The RMS value will be substantially the same with or without the pip, so there would seem to be no justification for leaning towards RMS readings on this score.

A further interesting situation on which this has a bearing is the case of re-recording. It is not unknown in commercial work for the finished recording to be the result of several re-recordings of the original. I believe the expression used is, for example, 'fifth generation', where the original has been transferred four times. A knowledge of the build-up of wobble in these circumstances would obviously be of interest to an engineer contemplating such a procedure.

GREATER RATE

As we saw earlier, the peak value builds up at a greater rate than the RMS, and it is not difficult to foresee that the calculated RMS wobble may promise a better sound quality than would be suggested by the peak value. Here, again, we may be prompted to ask "which figure relates more closely to the subjective effect"?

Having produced an original recording and transferred it once, we are in the now familiar situation in which the two peak errors have to coincide to become manifest. If we re-record a second time, then we have, in effect, three replicas of the wobble waveform distributed at random along the tape, and in order that the peak error should become evident, three 'pips' have to coincide. (One may be familiar with the chances of throwing three sixes simultaneously with repeated throws of three dice). The likelihood of this occurring is clearly going to diminish by a similar factor each time we re-record (or add another die). As we already know that the total RMS value builds up at a slower rate than the peak, the general picture is of a waveform getting progressively more 'peaky', but with the maximum peaks becoming more widely distributed. Armed with this know-

ledge, we can have a fair idea of the sort of result to expect from a given number of re-recordings.

Although the example given is an extreme case, the reasoning applies equally in respect of the peak of greatest amplitude whatever the waveform. The predicted RMS value, on the other hand, similarly falls short of the ideal in that it gives no warning of the possible peak error which, nevertheless, is always on the cards.

SPECIAL PROBLEM

As pointed out earlier, measuring the wobble of a tape or record player, or in fact any type of reproducer without recording facilities, poses a special problem as the recording has to be prepared on another machine. The views relevant to this have become somewhat scattered in the attempt to arrange things in what I hope is a logical order, so it may be as well to summarise these by drawing up a sort of ledger.

With RMS we can tolerate a certain error on the test-tape and obtain a pre-determined accuracy of measurement without making any allowance for this error. This strictly applies to a sine waveform, but we are obliged to

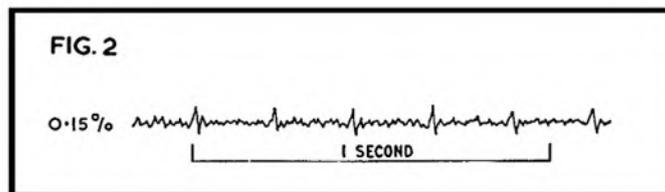
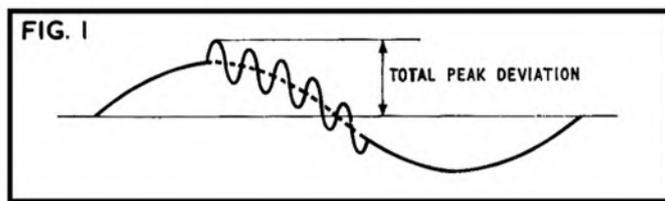
standardise on a waveform anyway. The calibration of an RMS meter itself is based on a sine-wave, but no-one is under the illusion that wobble is sinusoidal. The important thing is unanimity.

DIRECTLY ADDITIVE

With peak readings we cannot ignore the error on the tape because it is directly additive and to do so would demand a near-perfect test-tape. We can, on the other hand, make the necessary adjustment more easily with peak values. It is easier merely to subtract the peak tape error than to juggle with Pythagoras. As if to redress the balance once more, one can never be quite certain that the peak value has been observed. Hobson could hardly have been more confounded.

SMALL BAND

Whilst admitting my reluctance to offer solutions, I hope this in no way detracts from the interest, and if it is felt that this article contributes more towards confusion than a clearer understanding, it may at least provide incentive for that small band who enjoy banging their heads against the wall now and again.



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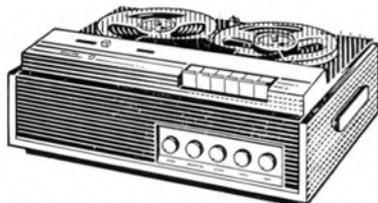
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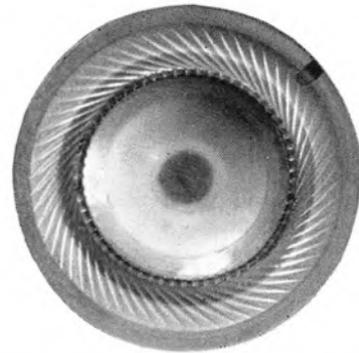
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Telex: 23894

TELEFUNKEN M.28 STUDIO RECORDER

SILICON-planar transistors and a three-motor solenoid-controlled deck are features of the *M.28* series developed by *Telefunken*. The series comprises three professional-quality recorders—Model *28A* operating at $7\frac{1}{2}$ and $3\frac{3}{4}$ i/s $\frac{1}{2}$ -track, *28B* and *C* both incorporating 15 and $7\frac{1}{2}$ i/s speeds and being respectively full-track and $\frac{1}{2}$ -track machines.

Illuminated mode-selectors, twin VU meters and four-channel mixing facilities are accompanied by self-compensating feed and take-up tension, ferrite heads and digital elapsed time indicator, the latter driven from a contact roller.

The capstan is driven by a flat belt from a hysteresis synchronous motor giving better than $\pm 0.8\%$ wow and flutter (DIN 45507) at 15 i/s. Overall frequency response at this speed is 40-100Hz ± 1.5 dB, 100Hz-16kHz ± 1 dB. Weighted signal-to-noise ratio is 58dB at 15 i/s and 54dB at $7\frac{1}{2}$ i/s (DIN 45405), erase damping being 70dB at 1kHz. Spool capacity is 10 $\frac{1}{2}$ in., prices being £566 (28A), £473 (28B) and £517 (28C).

Distributor: AEG (Great Britain) Ltd., Lonsdale Chambers, 27 Chancery Lane, London W.C.2.

**DE-LUXE CASSETTE RECORDER**

PHILIPS are now marketing a de-luxe version of the *EL3302* miniature recorder, somewhat less miniature and costing £30 9s. The *EL3303* features upward-facing record-gain, tone and volume controls and a larger speaker than its counterpart. It is battery powered and incorporates a swivel handle.

Distributor: Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

AMPEX STEREO TAPE UNIT

OFF-tape monitoring from a third tape head, inter-track transcription, echo effects and dual-capstan drive are features of the new *Ampex 753* stereo tape unit. The recorder incorporates switched equalisation for



$7\frac{1}{2}$ and $3\frac{3}{4}$ i/s, frequency response at these speeds being 40Hz-15kHz ± 3 dB and 50Hz-7.5kHz ± 4 dB respectively. Unweighted signal-to-noise ratio from peak recording level to broad-band noise is 46dB at $7\frac{1}{2}$ i/s and 43dB at $3\frac{3}{4}$ i/s. No equalisation is provided for $1\frac{1}{2}$ i/s. Playback is to preamplifier stages, the unit being intended for use with external power amplifiers.

The 753 is fully transistorised and guaranteed for one year. 'Deep gap' heads are claimed to provide exceptionally long head life. Dimensions of the machine are 15 $\frac{1}{2}$ wide x 13 deep x 6 $\frac{1}{2}$ in. high, weight being 23lb. Price is £82 19s. excluding £6 6s. teak case and Plexiglass cover. Distributor: Ampex (Great Britain) Ltd., 72 Berkeley Avenue, Reading, Berkshire.

VIKING STEREO TAPE UNIT

AMERICAN-made *Viking* recorders are now being imported by *Transatlantic Music Tapes*. The *423* has two heads and operates at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{1}{2}$ i/s. Claimed frequency range at these speeds is 50Hz-15kHz, 50Hz-10kHz and 60Hz-5kHz respectively. A three-motor deck with mechanical mode selectors is incorporated, other features being silicon transistor circuitry, illuminated VU meters and a mechanical pause control. Dimensions of the recorder, which will function horizontally or vertically, are 15 $\frac{1}{2}$ x 12 $\frac{1}{2}$ x 8 $\frac{1}{2}$ in. Price is £151 4s. Matching loudspeakers with built-in 2 x 15W amplifiers are also available, bringing the total price to £208 19s.

Distributor: Transatlantic Music Tapes (Distributors) Ltd., 36 High Street, Salisbury, Wiltshire.

**SOUND EFFECTS ON TAPE**

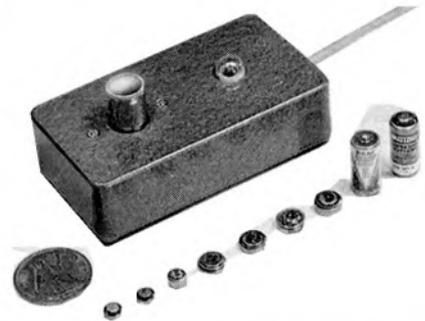
RECOTAPE Recordings have lately introduced a series of ten sound effects tapes selling at 21s. each ($7\frac{1}{2}$ i/s) and 15s. ($3\frac{3}{4}$ i/s). There are no restrictions on the private or public use of the effects, which include non-copyright musical segments. Copying for re-sale is the only prohibition. Each tape is recorded on one track and contains some five minutes of effects.

Distributor: Recotape Recordings Ltd., 36 High Street, Salisbury, Wiltshire.

SOUND EFFECTS ON DISC

FORTY minutes of mood music and sound effects are contained on the 12in. LP disc *Sound for a Picture Evening (Volume 2)*, now available from CDC. The disc complements *Volume 1* and two earlier records, all intended for the tape recording/cine enthusiast. Galloping horses, cathedral bells, oars in water and a cocktail party are among the contents of this particularly versatile LP, which is divided into "Special-Purpose Music", "Moods", "Off-Beat Moods", "National Portraits" and "Sound Effects". Price including copyright fees is £2 9s. 6d.

Distributor: Commercial Drug and Chemical Company Ltd., Photographic Division, 460 Holloway Road, London N.7.

**MINIATURE BATTERY CHARGER**

CROWBOROUGH Electronics are now producing what is believed to be the first charger ever marketed specifically for sub-miniature nickel-cadmium cells. The unit is intended for 10DK, 20DK and D151 cell types but will also rejuvenate any of the silver-oxide or miniature-mercury cells currently in use, including the relatively popular 212, 312, 13, 575, 675 and 407. A double-wound mains transformer is incorporated for absolute safety, plus a neon mains indicator. The transistor circuit gives a constant charging current independent of mains voltage fluctuations, battery voltage or polarity. Versions are available for 240V and 110V operation. Running costs are described as negligible.

Manufacturers: Crowborough Electronics, 3 Rotherhill Road, Crowborough, Sussex.

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5"	900'	10/-	14/6	5"	900'	9/9	14/6	5 1/2"	1200'	12/3	17/6
7"	1200'	12/3	17/6	7"	1800'	12/3	25/-				

Double Play (Polyester)		Leda Tape		TAPE 70		Triple Play (Polyester)		Leda Tape		TAPE 70	
3"	300'	4/3	6/6	3"	600'	8/9	13/-	4"	600'	8/3	12/6
4"	600'	8/3	12/6	4"	900'	12/6	17/6	5"	1200'	15/3	22/6
5"	1200'	15/3	22/6	5"	1800'	22/6	35/-	5 1/2"	1800'	19/3	29/6
7"	2400'	21/9	37/6	7"	3600'	38/6	62/6				

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equipment reviews

PHILIPS EL3312/GL559

MANUFACTURER'S SPECIFICATION. Compact mains stereo cassette recorder and pair of matching external speakers. **Power supply:** 220-245V or 110-127V, 50 or 60Hz. **Tape speed:** 1 1/2 i/s. **Frequency range:** 60Hz-8kHz. **Signal-to-noise ratio:** 40dB. **Wow and flutter:** 0.5% p-p. **Level indicator.** VU-meter. **Three digit instant reset tape position indicator.** **Weight:** 7 1/2 lb. (recorder only). **Dimensions:** 12 1/2 x 8 1/2 x 3 1/2 in. (recorder), 10 1/2 x 7 1/2 x 7 1/2 in. (GL559 speaker). **Price:** £71 14s. 2d. including two GL559 loudspeakers. **Recorder only:** £50 8s. **Distributor:** Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.



THIS is a well designed set of equipment for the completely non-technical user. The cassette can be changed or turned over with less effort than loading a gramophone record on a turntable. It is stereo all the way, no provision being made for using the four tracks individually. The tracks are recorded in pairs whenever the record key is pressed so that mono record or play is only available by selecting or paralleling the input connections.

It is essentially a small-scale stereo installation. The best stereo image is obtained with listener and speakers forming a 4 to 6ft. triangle. If the spacing or listening distance is increased, the relatively low power output and lack of bass response in the speakers becomes obvious.

The stereo microphone supplied feeds both tracks of the tape, and stereo recording of several voices is most impressive as the listener can pin-point each speaker, with room effects much less obtrusive than in similar mono recordings. Just the thing for party recording!

The output stages and speakers remain in circuit whilst recording so that monitoring is possible if the microphone is in another room or far enough away to prevent acoustic feedback. This same facility also allows stereo listening to disc via a DIN PU socket at the rear of the recorder, or to mono or stereo broadcasts via the DIN diode socket which also accepts the microphone input.

The demonstration stereo cassette provided

with the recorder contained mainly pop and light music which was reproduced pleasantly with what might be termed medium fidelity. The top octave above 5kHz and the bottom two octaves below 200Hz were rather attenuated. Some waver or wow was noticeable on sustained piano chords during these listening tests.

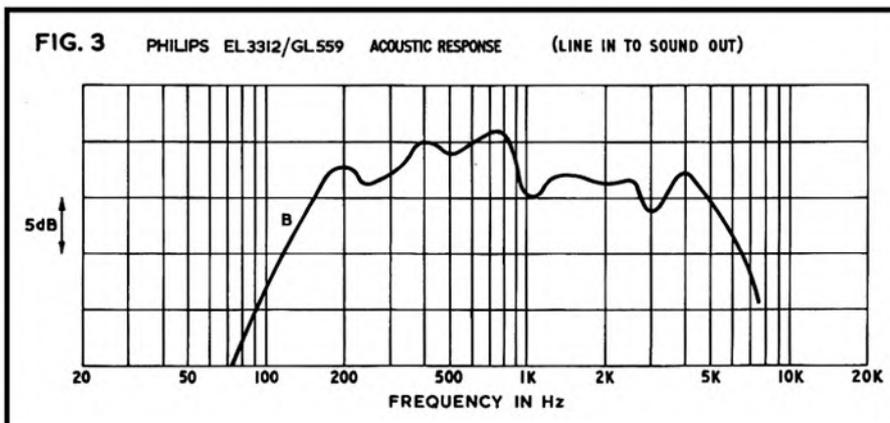
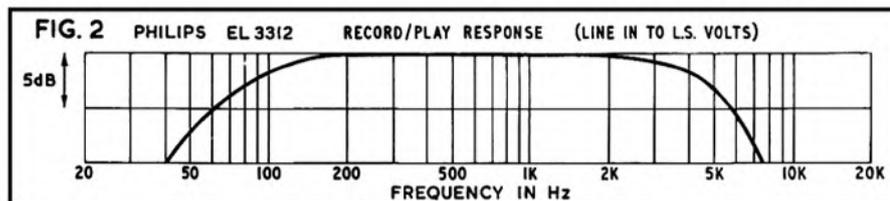
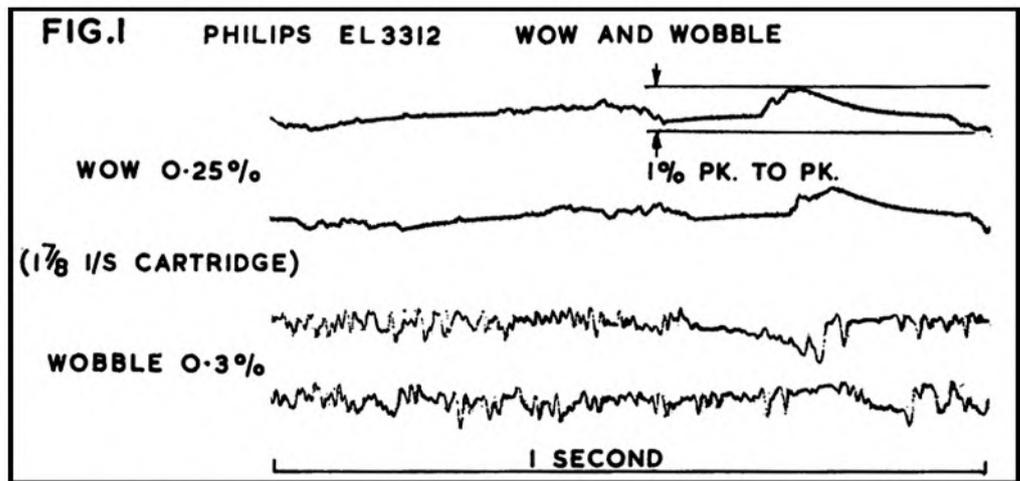
Steady tone recordings disclosed a once-per-second wow which was eventually traced to a loose tyre on the capstan pressure roller. The upper pen traces of fig. 1 shows that a sharp change of speed occurs at each revolution of the capstan roller with a deflection of nearly 1% p-p. This is obviously well outside the specification and is a fault in the review machine. The high frequency flutter shown on the broader band lower traces is almost entirely due to tape friction effects at guides and heads.

As the tape used in the cassette is of non-standard width, it was not possible to measure separately the play and record equalisations by the use of test-tapes recorded to known levels and frequency characteristics.

Overload recording tests at 500Hz showed that distortion reached 5% with the record level meter needle just entering the red sector of the scale. Reducing the recording level by 12dB dropped the distortion to 1.5% at 500Hz and 1.3% at 1kHz. A distortion reading of 1.3% was also obtained at 3kHz but it is doubtful if this means very much as the head gap cannot 'read' the high frequency harmonics at this low tape speed.

The 500Hz 5% peak level recording was erased on the machine and the unweighted signal-to-noise ratio measured at 43dB.

(continued on page 45)



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5½" 900' 7/-	5½" 1200' 9/9	7" 2400' 19/-	5½" 1/9	By Return
7" 1200' 9/-	7" 1830' 12/9		7" 2/-	Service

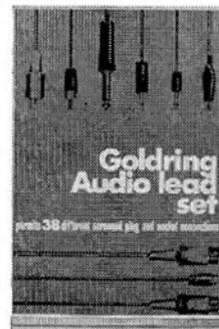
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System noise, with the pause control stopping the tape, was 48dB below peak recording level and consisted mainly of transistor hiss and very low level mains hum.

Fig. 2 shows the record/play characteristic measured from the line input to the voltage across the loudspeaker terminals of the right-hand channel. The response is level from 100Hz to 4kHz within 2dB and is down

10dB at 40Hz to 7.5kHz. The response of the left-hand channel was checked and found to be virtually identical.

The overall electro-acoustic response was measured by recording twenty one-third-octave bands of filtered white-noise and measuring the sound level on the speaker axis on replay with a calibrated microphone. The response of fig. 3 shows a reasonably level response from 150Hz to 5kHz, with a slight heaviness in the 400 to 900Hz region due to speaker cabinet resonances.



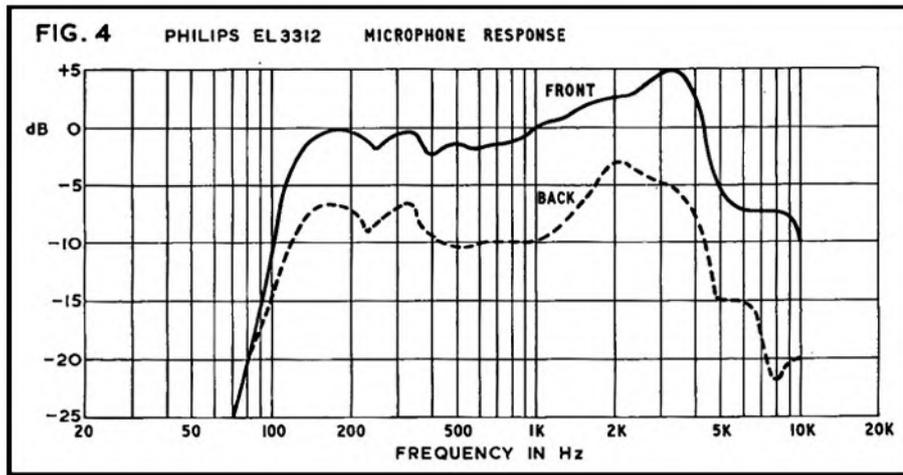
GL559 loudspeaker

Finally, the upper section of the stereo microphone was tested in a white-noise sound field to give the front and rear responses of fig. 4. It will be seen that the front-to-back discrimination is maintained at about 10dB over the useful recording range of the recorder. This was measured in a small room with some sound reflection from the walls, so that it is a practical measure of the directivity of the microphone in the kind of environment in which it will normally be used. The same measurement in the open air would probably exceed 20dB over most of the frequency range.

COMMENT

I would guess that this equipment is aimed squarely at the teenage market. Who else would be prepared to collect all recordings in stereo cassette form? He or she probably already possesses plenty of single-play disc recordings and may have few inhibitions about adding a new medium now or in the future.

A. Tutchings.



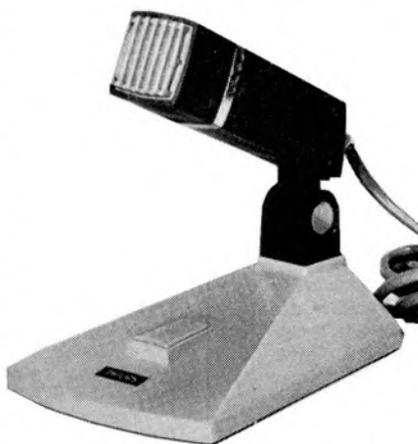
THE creative instinct is strong in all of us, and before the electronic art became so complicated (in the days of my youth it was the wireless) those who so desired could construct radio receivers, tuners and amplifiers, etc., in which a minimum performance could be guaranteed by the designers, and in many cases this minimal performance was of a very high standard. The advent of tape recorders with their very stringent requirements of hum, background noise, etc., together with complicated circuitry and mechanics effectively put paid to the efforts of all but the most ardent of home constructors.

However, even the most skilful amateur (and the majority of professionals, too) would shudder at the thought of tackling the assembly of a microphone, especially a moving coil type with a performance approaching that of professionally produced equipment!

For a number of years now Philips have been producing home construction electronic and scientific kits of varying complexity. These are now used by many educational establishments on the continent (and it may be noted in parenthesis that the most popular stand in the Firato 1967 Exhibition was the Philips section devoted to these constructional kits). Philips have now tackled the problem of producing a microphone kit, and the object of this review is to describe our (self and 12-year-old son) efforts in assembling and testing. Because of worldwide distribution of these products, the question of language becomes very important in assembly instructions, and in the 14-page booklet provided this language difficulty has been overcome in a very novel manner: apart from an introductory paragraph in eight languages, the assembly instructions are in the form of num-

PHILIPS EL7500
KIT MICROPHONE

MANUFACTURER'S SPECIFICATION. Moving coil microphone kit with table stand, on/off switch and lavalier cord. **Source impedance:** 200 ohms, 500 ohms or "high". **Price:** £7 7s. **Distributor:** Peto Scott Ltd., Addlestone Road, Weybridge, Surrey.



bered sketches only, each assembly sketch following on logically from the one before.

The major pieceparts of the assembly are impact polystyrene in medium and dark grey colours, and the overall decor is modern and pleasing. It can be used either as a stick or 'lavalier' (clip and cord being provided)— additionally, a desk stand is part of the complement. All the major components are nested in individual compartments of the carton whilst a plastic envelope contains the fixing screws, cement, cord, etc.; the only additional tools required are a lightweight soldering iron, screwdriver and penknife. Items such as glue and solder are provided.

The microphone capsule is a lightweight moving coil unit and is self-contained complete with its own acoustic filter. Its nominal impedance is 200 ohms and a matching transformer for 500 ohm and high impedance (25K) is provided. The microphone proper is carried in a small 'box' on top of the main body, which is divided into two sections. The major volume is connected to the microphone housing via a small hole resulting in two resonating cavities in order to extend the bass response. Fitting into the main body is a sub-assembly carrying the ON/OFF switch and the matching transformer. Provision is made for this sub assembly to be removed (it is held by two fixing screws) for changing impedances, fitting new leads, etc. Otherwise, the whole assembly is cemented, polystyrene adhesive being supplied for the purpose.

The assembly is quite straightforward, being accomplished by a twelve-year-old in less than two hours. After assembly the unit worked first time, but we were disappointed

(continued on page 47)

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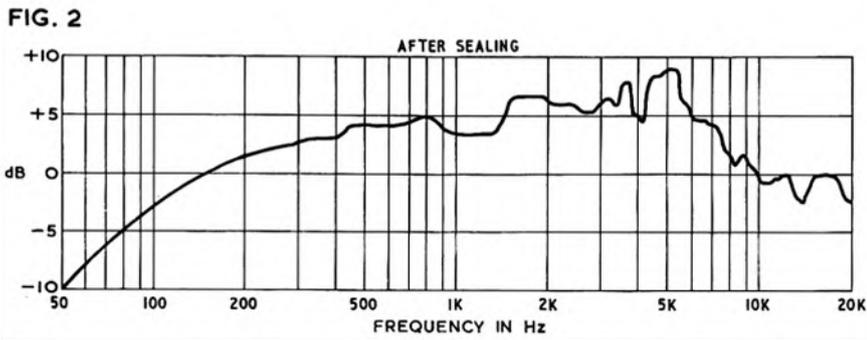
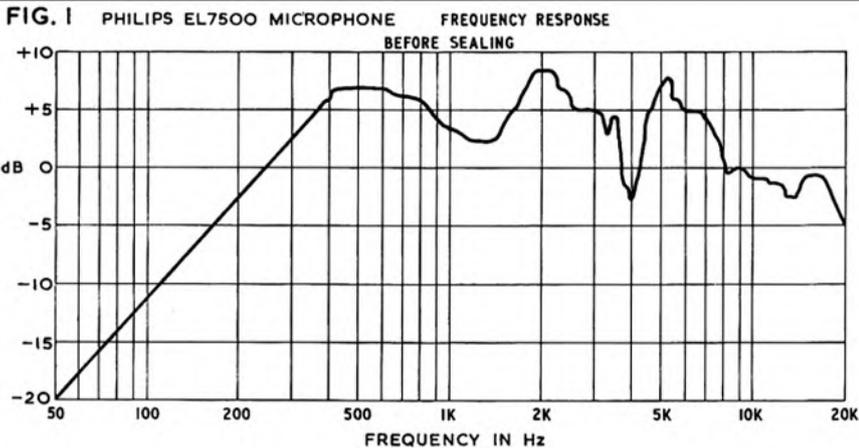
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by apparent lack of bass response. Fig. 1 shows the measured response of the microphone immediately after assembly. From the shape of the response curve it was apparent that there was some air leakage in the cavities. We found these leaks to be in three places: (1) The holes for the connecting wires to the microphone between the top cavity and the switch assembly. This was easily overcome by judicious application of cement. (2) At the junction between the main body and the top cavity, due to insufficient amount of cement between the two units. (3) The most serious leakage was around the gasket (number 36 in the assembly drawings) between the top grill and the microphone proper. A liberal application of *Plasticine* between the gasket, microphone and the main casing effectively solved this problem. The final performance curve is shown in fig. 2.

Sensitivity is 200 μ V per μ B at 200 ohms, and 2 mV per μ B or high impedance setting of the transformers, which is adequate for most domestic tape recorders. The response



is seen to be substantially flat from 100 Hz to 20 kHz apart from the slight roll off below 100 Hz the overall performance is better than that claimed by the manufacturers. When used in the hand, or as a neck microphone, it is insensitive to external noise, and speech is clear and crisp. For music recording some degree of bass lift may be necessary.

Summary: We are favourably impressed

with the performance and presentation of this kit. Assembly is straightforward and virtually foolproof. With the exception of our criticism regarding the sealing of the microphone insert, we have nothing but praise for this microphone, which represents excellent value for money and at £7 7s. would be an ideal Christmas present for any aspiring tape recordist.

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AN
 OCCASIONAL
 COMMENTARY

BY DROPOUT

**column
 speaker**

MOST people know that when two or more pieces of electronic equipment are connected together, the whole series should be earthed at one point only. That is fair enough, and simple enough when the same pieces of equipment are permanently connected together in the same place; but what happens, for example, when the tape recorder is used at home with an external amplifier, to which is also connected an FM tuner and a gramophone? At home it is simple: all the equipment is connected to a single earth point on the control-unit of the amplifier—no earth loops, no hum.

But what happens when the recorder is taken away from home, to be used on its own? One can open the mains plug and reconnect the green lead, and open it again when one gets back home and disconnect the green lead; and re-connect it the next time one goes out, and disconnect it again . . . but it is a shattering bore. Has any reader evolved a simple means of making and breaking an earth connection quickly, safely and efficiently? If so, I should like to hear it. But why does no manufacturer, so far as I know, make a plug with this highly desirable facility?

Merely to be able to unscrew the earth pin would hardly do the trick: the loose pin would get lost, inevitably, and it is needed to open the safety-shutter on the mains socket, anyway. No, I should think some form of positive switch, or a shorting-link which could be removed and inserted into different holes for safe-keeping, would be the answer. I know I should welcome such a plug. A switch or link on the recorder itself would do the job, of course; but it seems to me that the safest and most convenient place is at the plug.

The world of photography has much in common with that of recording. But one of the things that abound in the camera sphere is the gadget-bag, which nobody seems to have designed for use with a recorder. Yet the number of things one needs for a location recording session far exceeds that needed for most photographic outside sessions.

I have two former U.S. Army satchels which I take round with me. One has the reel of miniature mains-cable, assortment of plugs—all connected via a few inches of cable to rubber three-pin 5A sockets (I made that lot up before those handy universal plugs were brought out), and any other gear concerned with getting the watts into the recorders. The other holds the bits and pieces concerned with getting the signal: microphones, transformers, cables, adaptors and the like. But I cannot pretend that the result is orderly, or that I can instantly put my hand on the thing I need, without much groping in the bag.

Compare this with the interior of a good photographic gadget-bag, with its spare lenses safe in compartments, its pockets for new and exposed film and the rest. Recording gadgetry may not be so easy to accommodate; but I visualise padded pockets for delicate microphones, each with a compartment for relevant transformer, if used; pockets into which tapes may be thrust so that they stay there; straps to prevent reels of heavy cable from bashing about. All pockets would be easily labelled so that any friend who is helping could know at once where to look for the insulation-tape. Such a portmanteau would not be small or cheap; but it would save precious minutes getting set-up, and it would make vastly quicker and more effective that last-minute check on whether everything is aboard. I shall not soon forget arriving at an organ session and discovering that I had no microphone transformer with me!

To complete a series of grumbles: it occurred to me a short time ago to wonder when architects will get round to the existence of recording. I was setting-up with a friend to record a concert, at which the first performance was to be given of a work by a local composer who had specially asked us to record it for him. We were naturally delighted and honoured; and as there would be an audience present, we decided that the only way to approach the assignment was to sling the microphones above the auditorium. The job we had doing that simple thing would take me beyond the confines of this column to describe; and the truth is that the not-intolerable results we achieved were more by good luck than art.

One end of the supporting cable could be attached to a side-gallery; but there was apparently nowhere where the other end would go. In the end we did manage with a floodlight fitting and a cable crossing the auditorium at an acute angle. Ever tried getting mikes to face forward from an angled rope? One of these days, doubtless, a building as modern as the one we were in will have proper pulleys built-in; and it would not be difficult to have them fitted even in the more ancient places. I imagine that there are few amateur performances of anything, anywhere, which are not recorded. Give us the tools, and we will finish the job.

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TAPE EXCHANGES

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Sanyo puts you in the world class

From Sanyo, a new range of magnificent hi-fidelity equipment that puts your sound in the world class. As an example the MR 999, Sanyo's superb mains stereo/mono tape recorder incorporating two x 6 watt per channel output amplifier, about 105 gns. Speakers extra. Four tracks, three speeds. Sound on sound, sound with sound facilities, automatic shut off. Separate volume control for each channel on record/playback. Some choice features of its specification are given here—but get the full story from your hi-fi dealer. Sanyo also make tape decks, record players, solid state tuner/amplifiers.



Specification: Mains Stereo/Mono tape-recorder, using tape deck of above with two x 6 watts per channel output amplifier—extra for speakers. *Tape Speeds:* 7½ ips (19 cm/sec), 3½ ips (9.5 cm/sec), 1½ ips (4.75 cm/sec). *Wow Flutter:* 7½ ips : 0.15% R.M.S., 3½ ips : 0.20% R.M.S., 1½ ips : 0.30% R.M.S. *Frequency Response:* 7½ ips : 30—18,000 c/s 3½ ips : 30—10,000 c/s, 1½ ips : 30—8,000 d/s. ±3 DB. *Output Power:* Maximum: 6W x 2. *Erase Rate:* Less than 65 dB. *Dimensions:* 20" (W) x 10" (d) x 16" (h). *Accessories:* Microphone x 2, recording tape 7", empty reel 7", patch cord x 2, reel stopper x 2, splicing tape, speaker lead wire x 2, capstan sleeve, microphone stand x 2.

SANYO

RELIABILITY IS BUILT IN

2 Hours of music with the first quintuple-play cassette from BASF



Actual size of cassette C.120

With the BASF Compact Cassette C.120 you can record 2 hours of music—an hour on each track. Beat, Jazz, Pop—anything you like! You could, for example, make up a small tape library like this:—

5 BASF Compact Cassettes C.60=5

22½ hours of music—from the smallest library



BASF United Kingdom Limited,
5a Gillespie Road, London N.5. Tel: 01-226 2011.

hours playing time. 5 BASF Compact Cassettes C.90=7½ hours. 5 Compact Cassettes C.120=10 hours.

You can then have 22½ hours of music filed together—Music as you like it. A cheap and practical tape library in the minimum space.

Ask your dealer about the new BASF Compact Cassettes C.60, C.90 and C.120. And remember, every cassette comes with a handy reference index which enables you to make a note of each recording—and quickly find it when you want to play it.

