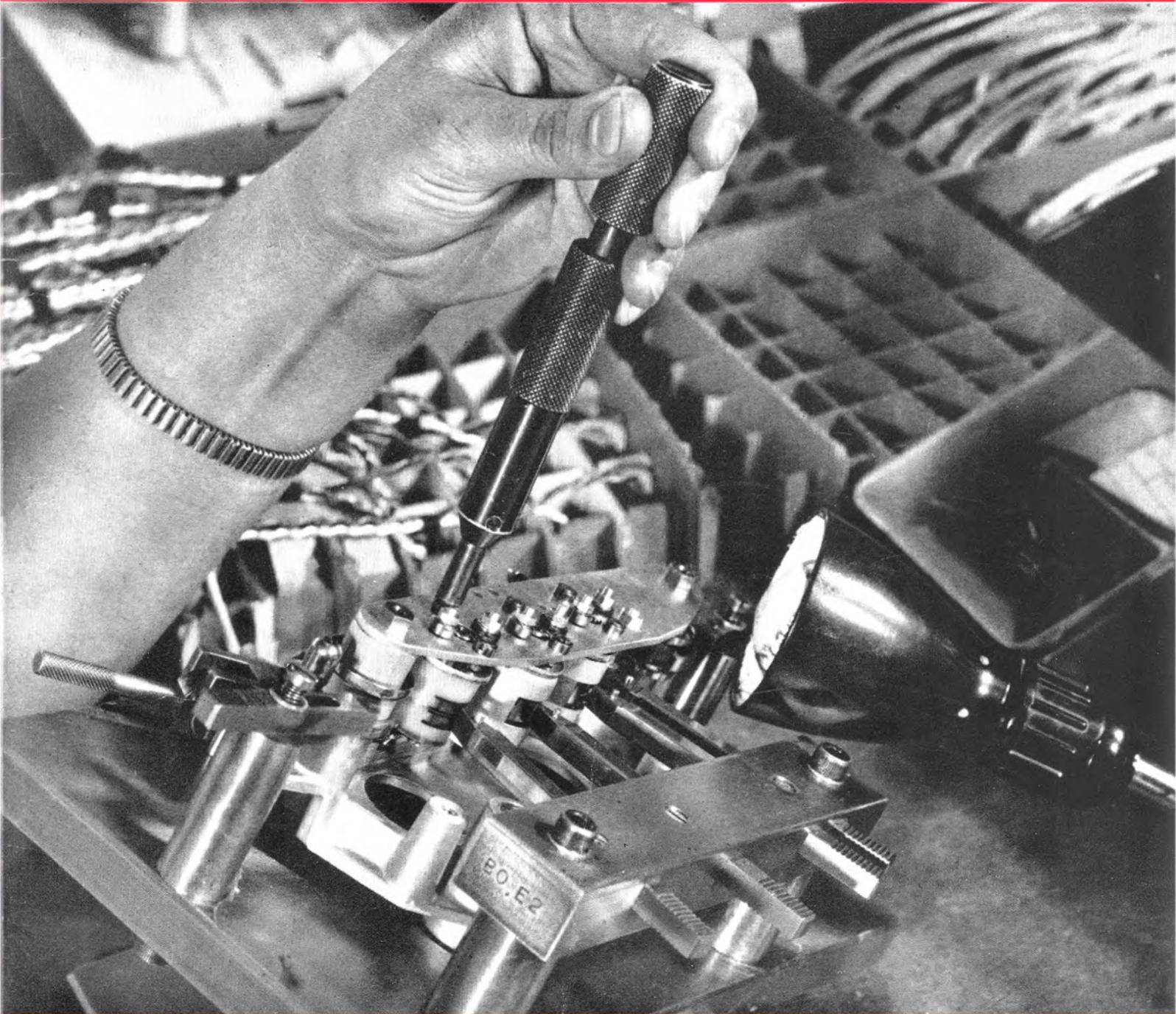


JANUARY 1967 TWO SHILLINGS

tape recorder



PHILIPS EL3556 REVIEW – CONSTRUCT A MICROPHONE WINDSHIELD
GILBERT AND SULLIVAN AT CAMBRIDGE – A VISIT TO REVOX / STUDER

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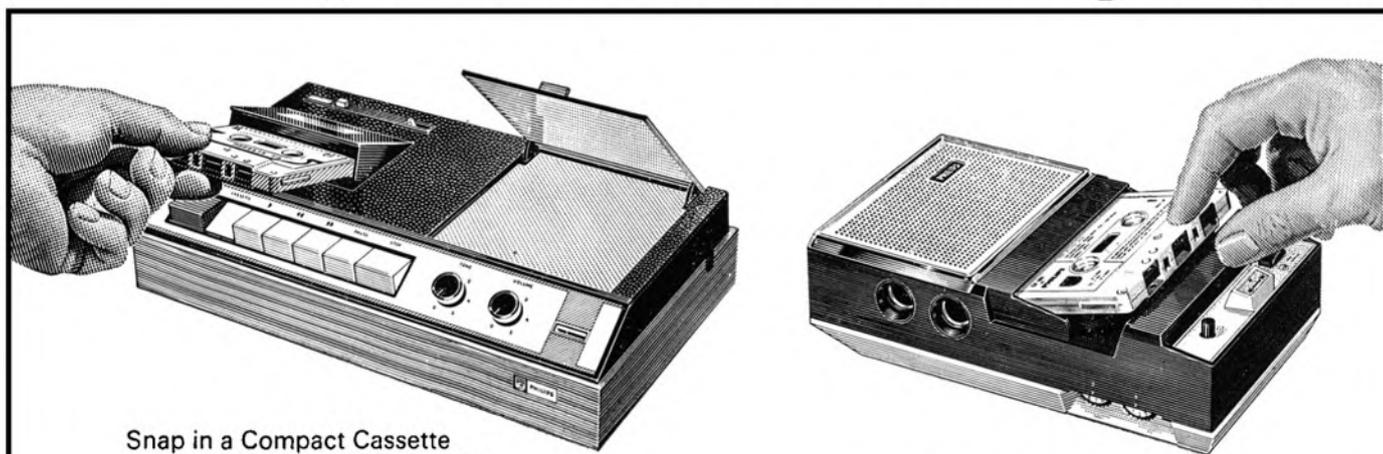
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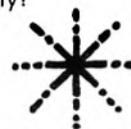
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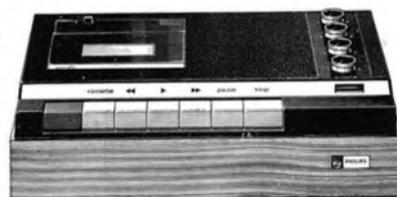
On the road! Philips Portable Cassette Recorder is also available in a car mounting, where it runs off 6-12V car battery and plays through car radio. Complete with car mounting unit and 3 extra Compact Cassettes, Model NP1630 41 gns. Car Mounting only: Model EL3794, £12.10.0.



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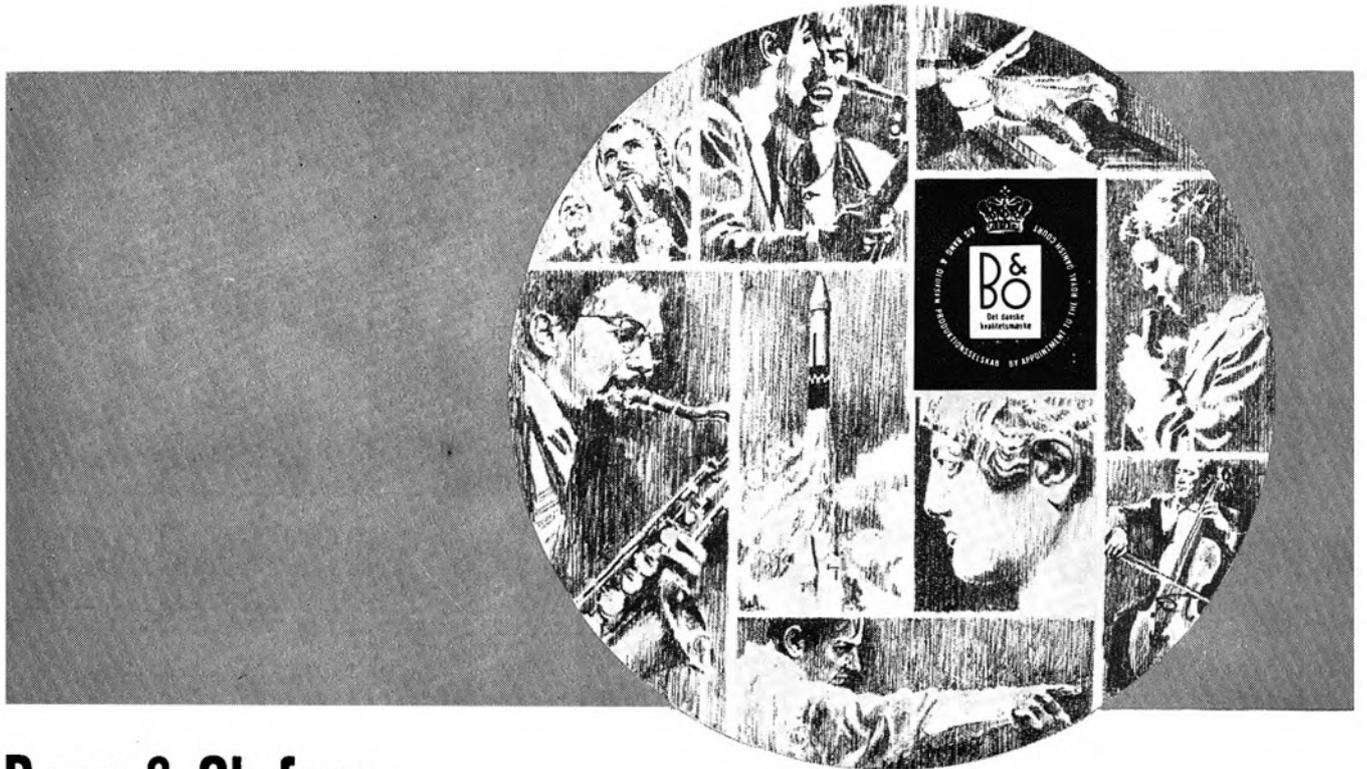


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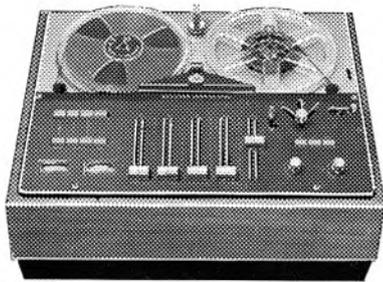
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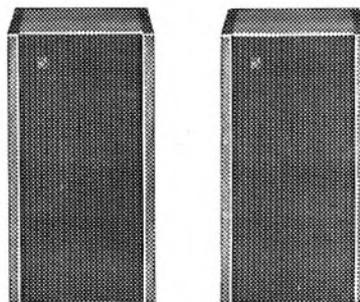




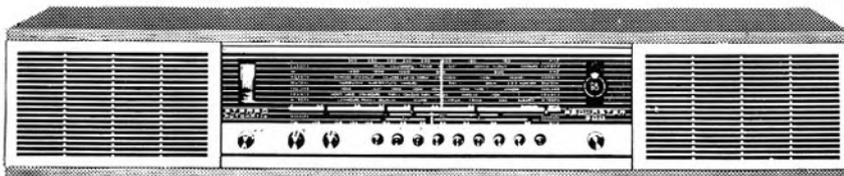
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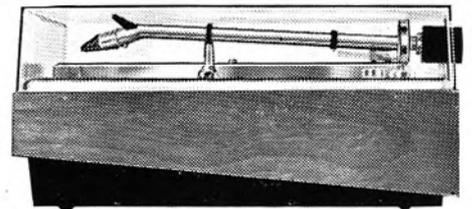
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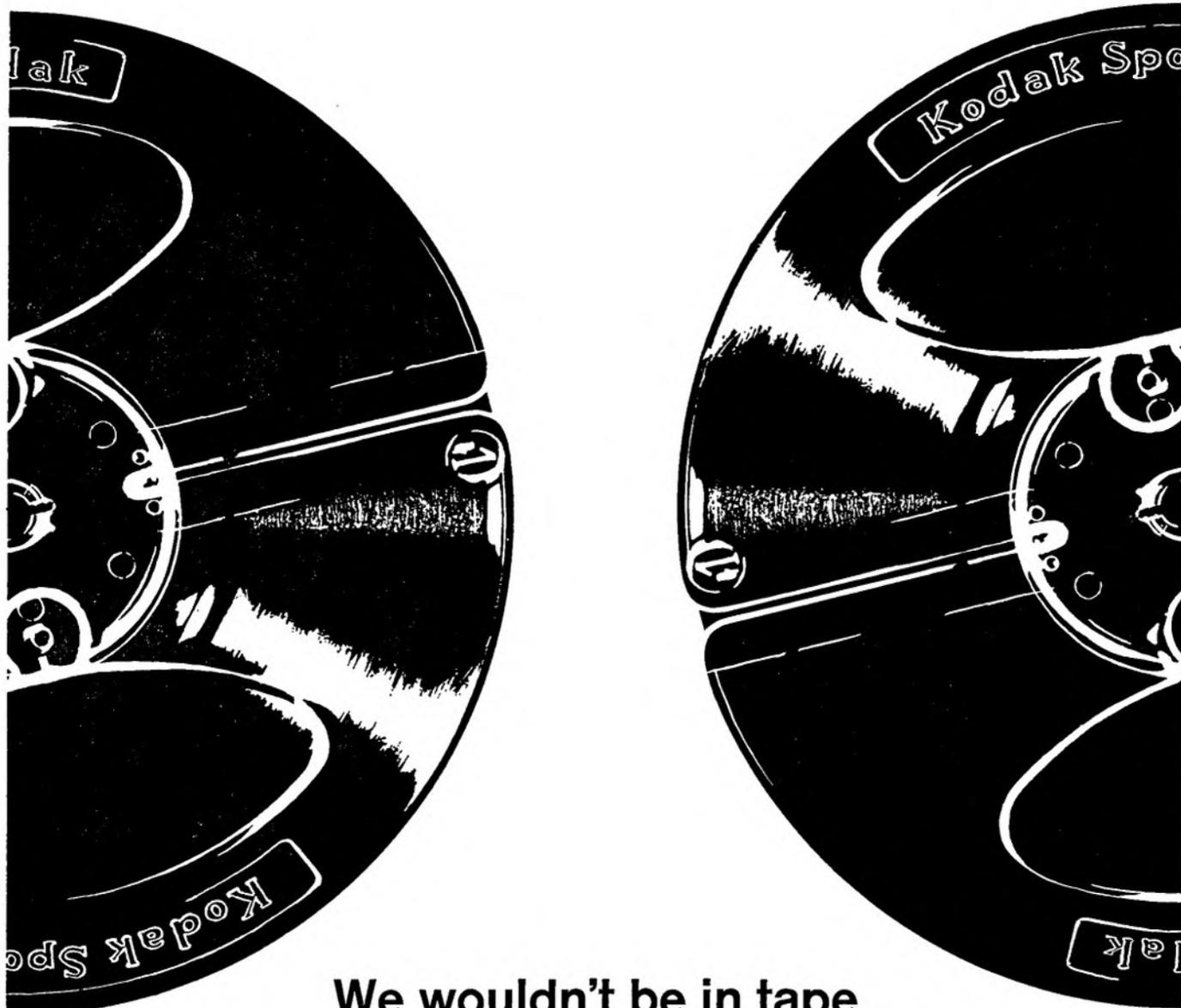
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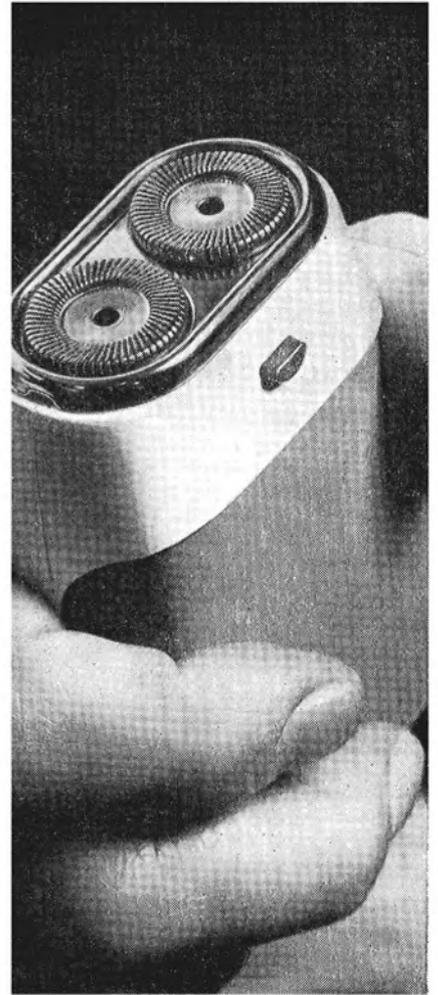
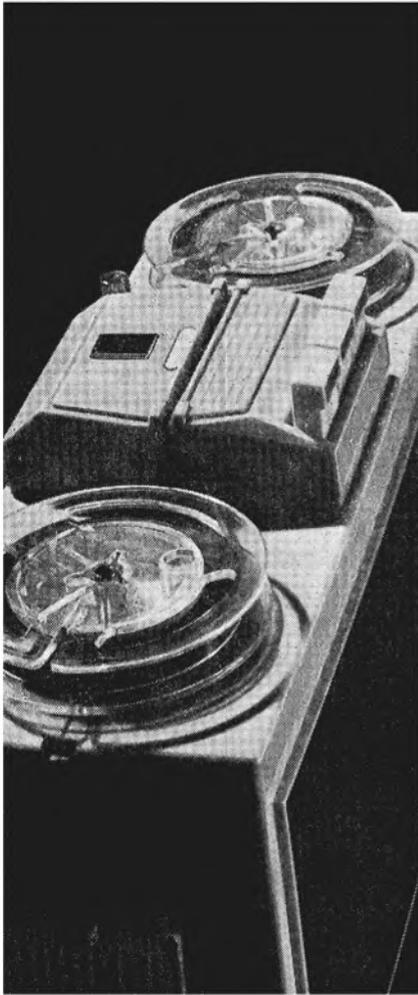
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tape recorder

JANUARY 1967 VOLUME 9 NUMBER 1

INCORPORATING
SOUND AND CINE

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COVER PICTURE

Our front cover this month shows one of the many steps that go into the production of a *Revox 736* tape recorder. Here the tape heads can be seen undergoing angular adjustment prior to being incorporated on the 736 chassis. Other aspects of *Revox* manufacture are described on page 22.

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.

WITH THIS ISSUE we enter our ninth year of publication. Eight active years of tape recording, millions of recorders sold, millions of yards of tape in computers, national and international tape competitions, language teaching schools, tape libraries of sound-effects, son et lumiere, tape as an aid to drama—it all looks very bright and promising on paper. But tape recording *as a hobby* has still to get off the ground when compared with photography or hi-fi. It is encouraged by, and manages to support, three magazines, yet by all accounts most of those two million or so recorders bought in Britain are under the stairs or in the loft.

Many will no doubt be dusted and plugged in for the entertainment of children and guests during this festive season, and it is up to those wishing to propagate the gospel of active taping to take every opportunity of encouraging friends and relatives to *keep* them dusted and plugged in. Enthusiasts acting the host could make a point of providing good entertainment via the tape medium—David Haines' plays, for instance, can be a great source of mirth—while those who are guests might discover with delight that their hosts own tape recorders, and proceed to demonstrate that ownership is worth coupling with use. A legacy of renewed interest, perhaps even genuine enthusiasm, could be dotted around the country. One never knows, our subscription department may even be inundated with fresh orders for *Tape Recorder*! Anyway, whether hosts or guests, we wish all our readers a joyful and magnetic Christmas, and a 1967 full of good sounds well taped.

At present, 'sounds,' but increasingly in the future pictures also. Following Gordon King's investigation of the Sony domestic video recorder, we report this month on a professional system. There is a certain sadness and irony here, for EMI, pioneers in high definition television and early advocates of tape recording in the UK, are marketing a Japanese instrument. What, in heaven's name, is happening to our electronics industry? We apparently cannot compete with the Americans in the computer field, it has been seriously suggested that we opt for colour television on 405 lines, thus making us uniquely old-fashioned in Europe, and now we have to *import* a professional video recorder. Baird and Blumlein may well turn in their graves.

This month we also carry an article on the *Revox/Studer* factories, noticing with further sadness that the BBC uses Studer recorders for want of a British machine of equivalent quality. Similarly, a type of capstan entirely new to domestic recorders is employed on a Dutch model reviewed in this issue. In this case the system seems imperfect, but at least someone has applied some fresh thinking, a commodity sadly lacking in much British tape recorder design.

Too many of our manufacturers suffer from a mixture of insularity and false pride, an

attitude also sometimes found in magazines. Following a worldwide trend, a year behind American magazines and several years behind European publications, we are this month going over to *Hertz* as the unit of frequency (see note on page 11). We notice, however, that one of our contemporaries in the practical radio magazine field has declared its opposition to such a change, claiming that the good old British *cycles per second* has the virtue of carrying its meaning within itself. This is all very well, of course, for people who read English, but 'cycles per second' uses different words in each language, while Hertz is universal. It could be argued that microfarad be written as $\mu \frac{Q}{V}$, Volts as EMF-units, Gauss as $\frac{\phi}{a}$, Henries as 1V ind/1A/sec, and so on. No doubt all very enlightening, but hardly practical.

For those who wish to glow with pride, we British do have the Farad, Maxwell, and Watt though whatever their nationality, we shall stick to Volts, Amps, Ohms, Farads, Henries, Watts, Gauss, Maxwells . . . and Hertz.

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WORLD OF TAPE

PAINLESS HERTZ

READERS will notice a small change in terminology in this issue. In line with our sister publication *Hi-Fi News*, and some other audio magazines, we enter 1967 with *Hertz* in place of *cycles per second*. This unit is now normal in audio circles throughout both North America and Continental Europe and, as increasing numbers of manufacturers—with an eye on exports—are finding it convenient to use Hz and kHz instead of c/s and Kc/s, we have decided to follow the international trend. Some further comment on this change will be found in the Editorial on page 9.

COMPONENTS BY POST

COMPONENTS, kits, audio equipment, valves, transistors and "special services" are among the contents of the *1967 Electronics Catalogue* prepared by *DCA Electronics Ltd.*, 28 Uxbridge Road, Ealing, London, W.5. The catalogue is described as a time-saving shopping medium and is available for 1s.

A NORWEGIAN SWEDE

THE Norwegian *Radionette* company have pointed out to us an error in a recent *New Products* reference to their *Multicorder*. This was incorrectly referred to as being of Swedish manufacture.

TAPE CONTEST PRIZE GIVING

PRIZES were presented to winners in the 1966 *British Amateur Tape Recording Contest* at the Criterion, Piccadilly, on November 4th. Winners and their tapes were detailed in the November issue (page 407), the top tapes in each of the three sections—together with the "Tape of the Year"—being replayed on this occasion for the benefit of assembled guests. Josephine Douglas presented the prizes to all

except Mr. A. F. Grant, who came all the way from Aberdeen on behalf of the St. Peter's R.C. Secondary School (who made *The Bus Run*) only to discover that the Mastertape Trophy had not yet been retrieved from last year's winner! However, all the other shields, cups, cheques and packages of tape were to hand, winner P. Griffin (*Breeze and I*, first prize in 'advanced amateurs' section) kindly donating part of his prize to charity.

During the evening Mr. Robert Corfield, a runner-up in the British Contest, received a prize of 250 Swiss Francs for his success in the International competition, as reported separately by John Bradley on page 21.

After the ceremony we learnt from Alan Brown, maker of *Excerpt from Macbeth*, 'Tape of the Year,' that possibly he had been the first ever to use the sound of boiling rhubarb for serious effects. The word 'rhubarb' is often used (so they say) by actors for crowd noises on the stage, but Mr. Brown's mother could hardly have expected the rhubarb simmering innocently on her cooker to provide—at half speed—the bubbling cauldron for Shakespeares' Witches, or to become famous in the process.

Entries were down on 1965, but the organisers have high hopes for the 1967 BATRC—details of which will be announced at some future date.

BIAS AND MONITORING

THE employment of a single valve as a monitor amplifier, on playback, and bias oscillator, during record, has often been adopted by tape recorder manufacturers as a means of keeping down the price of their products. A new circuit developed by *Thorn* allows the output valve to power a bias oscillator, but retains the monitoring facility during recording. A transistor power oscillator



"Berg's Chamber Concerto for violin, piano, and Thirteen Wind Instruments always stops him squawking."

is wired in the output valve cathode circuit operating current being supplied to the transistor collector and base by a potential divider. A tapped tank coil in the collector circuit is coupled inductively with a coil in the emitter circuit, the bias current feeding then through capacitors to the record and erase heads.

LACK OF VISION

THE combined effect of two small errors in the layout of *A Japanese Miracle*, published in December, may have caused some considerable confusion to readers. We apologise for this inconvenience and would point out that the article was continued from page 473 to 481 and thence to 488, not simply from 473 to 488 as published. Also, the first line of text on page 473 was wrongly transposed to the top line of page 481.

CROYDON POSTAL CODE

AS part of a new scheme to automate the GPO system, the area of Croydon occupied by Link House Publications has been uprooted from Surrey and replanted in CR9 2TA. Correspondence intended for *Tape Recorder* and other Link magazines should therefore be addressed to *Link House, Dingwall Avenue, Croydon, CR9 2TA*.

BBC BROADCAST THEIR CONTEST WINNERS

NOT to be confused with the *British Amateur Tape Recording Contest*, the BBC recently ran a national tape recording competition organised by their North Region studios. Successful tapes are to be broadcast at 9.30 p.m. on the Home Service on Wednesday, 14th December—the day this magazine is nominally published. Lasting 30 minutes, the programme is expected to be narrated by Colin Shaw. We understand that the BBC were delighted at the response to the competition, which was on a theme of *Summer*.

SCOTCH PRODUCE A VTR

THE New York Hilton Hotel was the site chosen for the press debut of the *3M Wollensak VTR-150* video tape recorder. *Scotch* ½ in. video tape provides the recording medium, transported at 7½ i/s past a helical-scan rotating head. Tape costs thus amount to some £13 per hour, price of the recorder being

(continued overleaf)



K. McKenzie (above) receives his prize for *Grandfather's Chronoclasm*. "Tape of the Year" trophy, won by Alan Brown (left). P. Griffin (lower left)—creator of *Breeze and I*. R. Partridge accepts the Oxford University Recording Society's prize for *Making of a Mass* (below).



WORLD OF TAPE CONTINUED

about £500 (\$1500). Camera, monitor/receiver, microphone, headset, tape and recording leads add another £500 to the price.

The Japanese manufacturer *Matsushita* (*National*), themselves marketing a £530 video recorder in the USA, have announced that they are currently developing a model to sell at less than £200. They hope to introduce this in 1967.

BBC DEVELOP SLOW-MOTION EQUIPMENT

A SLOW-motion television machine has been developed by the BBC Designs Department, comprising a modified video tape recorder and a magnetic disc unit. The equipment permits slow-speed reproduction or indefinite stop-motion within seconds of the scene being taped. Four images of each frame are recorded from tape by the magnetic disc to overcome flicker. Used for the first time during the recent *World Cup* football series, the system will be the subject of a lecture to the IEE/IERE/Television Society, by Mr. P. Rainger, on 24th October.

GREAT SEA BATTLE OFF BAKER STREET

MADAME Tussaud's Waxworks off Baker Street is the site of a spectacular reproduction of the Battle of Trafalgar, installed to celebrate the 161st anniversary of Nelson's finest hour. The unusual feature of this particular installation is that it is accompanied by tape-recorded sound-effects, ambi-

tiously produced by *Theatre Projects* (*Sound*) Ltd. Seventy-eight reels of tape, 160 hours of mixing and 1,300 splices went into the recording — one of the biggest undertaken by the company since its inception in 1960.

EMI IMPORT SONY PROFESSIONAL VTR

IN addition to the recently announced £365 domestic video tape recorder (imported by *Debenhams Electrical*), *Sony* are now marketing a high-quality television recording chain in Britain, under the auspices of *EMI Electronics*. The system centres on a helical-scan solenoid-controlled machine — the *PV120U* — which utilises 2in. tape, transported at 5 i/s. Frequency range of the recorder is up to 2.5 MHz, versions being available to suit 405- and 625-line standards. Two audio channels are provided, with respective signal-to-noise ratios of 40 and 30dB, for sound and general monitoring



purposes. Facilities are provided to allow sound to be added after the video information has been recorded.

The *PV120U* sells for £2,820, an 80-minute reel of *Sony* tape being £47 (empty tape spools are £8 10s.). Replacement video and sync heads are £51 each and have a useful life of some 500 hours. An accessory remote-control switch unit is available for £29.

A sync pulse stabilising unit is available at £990, and may be employed to give greater picture steadiness than is possible when the recorder is simply locked to the mains. In addition, a video waveform monitor may be purchased for £354.

NEXT MONTH

TO BE PUBLISHED on Saturday 14th January, the February issue will include a critical examination of 'sleep-learning' by John Mollen of the Oxford University Institute of Experimental Psychology. Battery portables — the *Telefunken M.401* will be reviewed, the *EMI L4* field-tested, and the *Oplacord 408* discussed in *Tape Recorder Service*.

B & O PRICE REDUCTIONS

REDUCTIONS in the prices of several *Bang and Olufsen* products have been announced by the importers. Among the models involved are the *de luxe 2000K* and *2000T* recorders, reduced by 10 gns. to respective prices of £131 5s. and £135 9s. The *1500* tape unit has fallen 8 gns. to £101 17s. The *Beolit 600* portable radio has been reduced by 3 gns. to £26 5s., the *611* by 2 gns. to £34 13s., and the *800* by 7 gns. to £40 19s.

SONY REVOX REPS
WYNDSOR PHILIPS FERROGRAPH GRUNDIG
UHER TELEFUNKEN AKAI
BANG & OLUFSEN
ELABETHAN
FERGUSON TANDBERG
whatever the name

★	MAINS 4-TRACK	Deposit		12 Monthly Cash Payments		Price		
		£	s. d.	£	s. d.		Gns.	
	Fidelity Playtime ...	9	9	0	1	11	6	27
	Ferguson 3222 ...	12	5	0	2	0	10	35
	Grundig TK140 ...	13	6	0	2	4	4	38
	Philips EL3558 ...	14	14	0	2	9	0	42
	Ferguson 3224 ...	15	8	0	2	11	4	44
	Wyndor Vanguard ...	20	13	0	3	8	10	59
	Philips EL3556 ...	21	14	0	3	12	4	62
	MAINS 2-TRACK							
	Ferguson 3220 ...	8	15	0	1	9	2	25
	Grundig TK120 ...	10	6	6	1	14	5	29½
	Tandberg 823 ...	18	18	0	3	3	0	54
	Brenell Mk. 5/3 ...	25	18	0	4	6	4	74
	Brenell Mk. 5/3 'M' ...	32	11	0	5	8	6	93
	Ferrograph 631 ...	33	5	0	5	10	10	95
	Ferrograph 633 Connoisseur	42	0	0	7	0	0	120

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STEREO/MONO							
Philips EL3312 ...	16	16	0	2	16	0	48
Sony TC250A ...	19	19	0	3	6	6	57
Philips EL3555 ...	26	5	0	4	7	6	75
Akai 1710 ...	27	13	0	4	12	2	79
Sony TC260 ...	33	19	0	5	13	2	97
Tandberg Series 12 ...	36	15	0	6	2	6	105
Truvox PD104 ...	36	15	0	6	2	6	105
Beocord 1500 ...	36	15	0	6	2	6	105
Revox 736 ...	44	9	0	7	8	2	127
Beocord 2000K De Luxe	43	15	0	7	5	10	125
Beocord 2000T De Luxe	45	3	0	7	10	6	129
Akai X-350 ...	66	10	0	11	1	8	190
Akai X355 ...	83	6	4	13	17	9	239
BATTERY							
Philips EL3301 ...	9	9	0	1	11	6	27
Telefunken 301 4-T ...	18	18	0	3	3	0	54
Akai X-4 Stereo ...	34	13	0	5	15	6	99
Uher 4000L ...	36	1	0	6	0	2	103

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GOING LIKE THE CLAPPERS

BY ANTHONY WIGENS

A CLAPPER board consists of two pieces of wood hinged together at one end. Each piece is marked with a clear pattern, so that examination of a strip of film will clearly reveal the frame in which they first make contact when they are banged together. The lower piece of wood will usually have a slate inset so that a description of a particular shot can be marked on it, and easily erased.

You may have seen studio shots of the clapper board being used in professional film productions. It is part of Hollywood film lore by now. From clapper boy to film producer, in the manner of newspaper boy to big time publisher. On a film set the procedure runs this way :

The director, satisfied that the scene is properly lit and adequately rehearsed, calls out "Roll 'em !" At this point the cameraman switches on the electric drive of his blimped camera, and the sound recordist starts the tape recorder, which is wired in sync to the camera. A moment later the sound man, wearing headphones, indicates to the director that his machine has hit sound speed. The director nods, turns to the clapper boy, and says "Mark it !"

The boy steps in front of the camera smartly, holding the board up in line with the lens, and says, "Scene sixteen, take one" or whatever is appropriate, then closes the top hinged section hard, to make a sharp 'clack' which can register on the sound track. He then hops out of the way and the director calls "Action !"

Ultimately the director views the mute rushes and decides which 'take' of each shot is the best. On a tricky scene, especially on a day when actors are a few degrees under, there may be any number of takes. The editor can identify each by reading the inscription on the clapper board.

When editing begins the editor has the chosen takes assembled on one roll of film (a cutting copy, not the original film) and a separate roll of magnetic coated film carrying the associated sound track. The start point of each take can be visually recognised by examination of the film : where the clapper board is closed the actual instant of contact

can be recognised. At the same time the start point of the sound track can be detected by the 'clack', precise location being established by running the magnetic film backwards and forwards over the track reader, as the editor's sound head is called.

With positioning established, both picture and sound are locked on synchronisers, so that if the picture is advanced fifty frames, the sound is advanced the same amount (frame counters show the editor the length of each shot—particularly important where timing is critical, as when cutting pictures to music).

I have gone into this matter of professional sync technique at some length to emphasise the importance of the clapper board. Even if you are not ultimately editing with magnetic film on synchronisers, you do need to know where to start the tape in the recorder for a dubbing session. It is possible to hold up the shot description on a sheet of paper, read out the legend, drop it, and then clap your hands before the camera. A perfectly functional method, but shoddy to behold. My theory is that any exercise designed to achieve professional results is best undertaken in as professional a way as possible.

For my first sound recording efforts I have been using an improvised clapper board. It works. I have not shown a photograph for this month's progress picture on production of *The Country Lovers* because I am ashamed of it. Being wood, it really needs strong lettering for legibility. It is also difficult to erase earlier inscriptions, because they have been written strongly ; I resolved to buy a professional clapper board for subsequent sound recording sessions.

Alas for the aspirations of the man using amateur gear who tries to buy professional trappings. I have searched catalogues galore, such as Edric's professional hire service and the *Film Year Book*, trying to find the right company to contact. So far I have drawn a blank. But my heart is as set on that simple item now as once it was on owning a canvas folding chair with the magical word 'director' stencilled on it . . .

Filming proceeds quietly but effectively on *The Country Lovers*. At this stage our problems

are prosaic, though bothersome. Little things like *someone* always being on holiday when location filming is planned. Next time I'll make a short version of *Dr. Zhivago* and work in the winter when people aren't constantly popping off !

Almost as big a problem is that of parking the car. Rarely, very rarely, does a country road provide a layby anywhere near the spot picked for filming. The time this involves in hunting for locations on my own is horrifying, because I have huge tracts of country to comb still. A helicopter seems the solution.

Time is always a major factor in film work, but last summer brought it home to me with a vengeance. Editing of *The Country Lovers* is clearly going to occupy months. But other lengthy operations can't always be anticipated. Shopping for batteries for the Philips portable is a constant chore. In our part of the world *Ray-O-Vac* batteries don't appear to be well distributed. On one occasion I called at five radio dealers before finding one which stocked the leak-proof version. I needed five of these cells. Four were all they had in stock . . .

Ever-ready have much better distribution. But, as I discovered when I wrote a test report on the EL 3300, the base of the Ever-ready U11 doesn't make perfect contact with the recorder's terminals, and there are intermittent breaks in the power circuit on occasion, especially after the recorder has been moved. The *Ray-O-Vac* cell has a different base design and has never failed me yet. I now buy up quantities when I see them on sale and keep them by me.

With long takes in the field, it is essential that batteries should be at full power, or the tape is pulled a little more slowly through the machine than it should be (it's slow enough already, being $1\frac{1}{4}$ i/s. Incredible the quality it provides). Naturally, on playback with a new set of batteries, the pitch alters. One ruse I've used in the past, when I've suspected that a tape has been recorded too slow, is to remove the complete set of dud batteries and keep them for the time when I need to re-record the slow tape. They are then put back in the machine and if I'm lucky I can get a transfer of the sound without too much distortion.

NO NEED TO THINK

BY WILLIAM HENRY



PART TWO SOME COMMERCIAL DESIGNS

SINCE the preparation of the first part of this discussion, my friends at Grundig have pointed out that (a) automatic recording level is not so new as I may have implied, and (b) the description of the principles, based on the Philips EL3552 circuit, does not tell the whole story.

Making allowance for some friendly rivalry,

we must acknowledge that AGC has been used in sound recorders for more than ten years—I am informed that over a million Grundig *Stenorettes* have been produced—but must restate our case. Using any automatic system for speech alone is very different from applying the technique to the recording of music. It is vital that the alteration of gain to

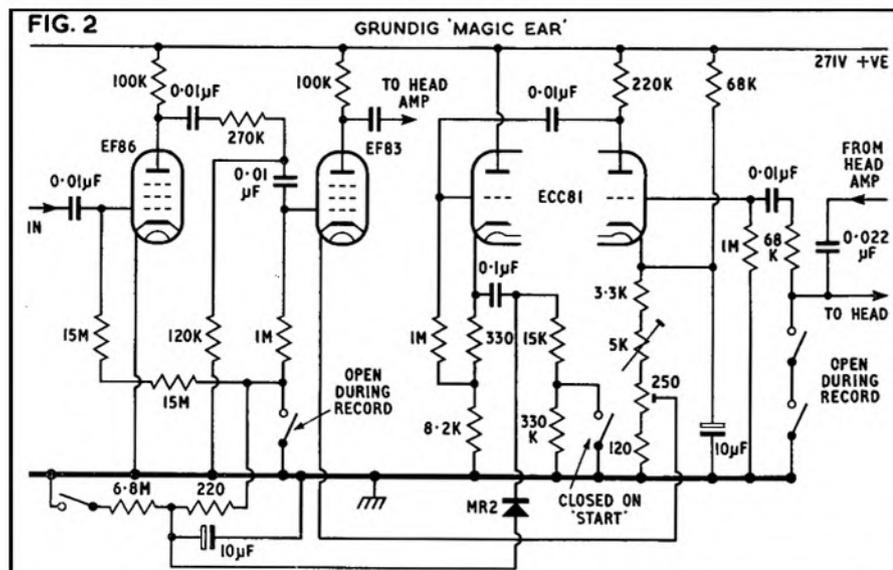
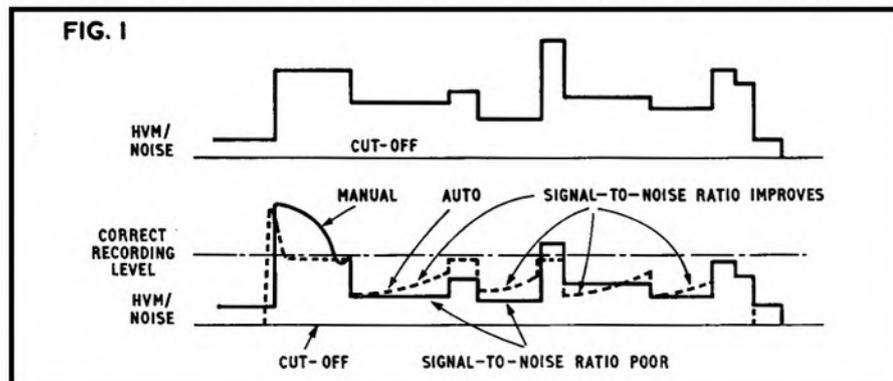
avoid overload shall not modify the original signal.

To do this, the tape recorder must maintain the full dynamic range of the signal, or crescendos and quiet passages will be smoothed out to a common loudness. It must keep the best possible signal-to-noise ratio, which usually means recording at as high a level as possible, short of overloading. To do this, the automatic circuits must be adjusted so that they give full gain to weak signals while not allowing the amplifier to exceed the full recording level.

Next, the control network must incorporate a delay arrangement, so that the correct recording level is maintained for a period of time—this period varying for music and speech, the latter being much shorter. Equally important is the muting facility which enables the amplifier to retain its noise and hum-free operation even where no input signal is present; i.e., full gain should not be automatically applied in the absence of a bias-operating signal.

Of similar importance, though seldom considered in the literature on the subject, is the fact that the recording and playback characteristic must not be altered. There is a rise in gain at high and low frequencies, to compensate for system losses and recording head characteristics, and feedback circuits are used to tailor the response curve so that we can play back a pre-recorded tape with confidence. The control system used in automatic devices must not interfere with this correction circuitry. This often means quite complicated switching and auxiliary circuits, some of whose components may appear irrelevant at first sight. In this section, we hope to show the various methods whereby leading makers have achieved their object, explaining the process as we go along.

To begin with, fig. 1 shows an idealised (and virtually impossible) input signal, followed by the comparison between the signal as recorded with manual control, dependent upon our personal responses, and automatic control, determined by the setting of the machine. Note that an initial adjustment is needed to get the signal peaks within the correct recording level



of the machine, as indicated by meter or magic eye. Then, when the signal drops, the dynamic range forces us to accept a poor signal-to-noise ratio unless we hover anxiously over our gain control, and subsequent peaks again run us into distortion. The automatic control makes a much more rapid initial adjustment than our reflexes will allow, tends to keep the signal in an 'improving' mode to beat the signal-to-noise deterioration, and again levels off the signal when subsequent peaks occur.

This is a Grundig diagram, modified to suit our purpose, and our first example must be the now famous 'Magic Ear'. Although the TK18 was the innovator, and a basic circuit of this model is given at fig. 2, there are now a number of machines modified to include the 'automatic' facility—TK18, TK23, TK400, etc.

The arrangement usually incorporates an EF86, low-noise pentode, a vari-mu valve, such as the EF83, and a double-triode control amplifier. The signal passes through the EF86 and is fed to the EF83. If it exceeds a pre-set level, the EF83 conducts and feeds the head amplifier: triode section of the ECL86. The frequency correction network is connected between anode and grid of this stage. Part of the signal is applied to the control amplifier. Second half of the ECC81 is adapted to cathode-follower circuitry, with a rectifying diode in the output circuit to produce a negative DC signal. This charges up a 10 μ F capacitor, which discharges through one or two resistors, depending on the time-constant required, and this biases back the EF86 and EF83.

When the signal is below the 'threshold level', the EF83 remains cut off. A greater signal than the pre-set threshold causes it to conduct and the control amplifier receives a signal. The bias across the cathode load of the cathode-follower is rectified and the negative DC thus obtained biases the EF86 and EF83 stages. The amount of bias depends on the signal level—the greater the signal, the greater the bias. But because of the time-constant of the circuit, the charge across this large capacitor is maintained even when the signal again falls below threshold level. As the charge falls away, the EF86 and EF83 gradually increase their amplification factor, but if a signal arrives causing a greater voltage at the electrolytic than its discharge level, the voltage across the electrolytic again increases, applying the appropriate bias. The time delays quoted, 15 minutes for music, 3 minutes for speech, are the time it takes for the charge to die away with no further triggering impulse rising above the threshold; but when the machine is switched off, or to playback, the electrolytic is short-circuited, discharges, and is ready to start again.

Points to be noted about this circuit are the arrangement of cathode circuitry of the control half of the ECC81, where the resistors form a potentiometer from HT to chassis, and the cathode voltage can be set very precisely, so that adjustment of threshold and pre-set sensitivity controls is exact. Also, the 10 μ F electrolytic across this cathode must be of a fairly high working voltage, in fact 70/80V; and the MKT type which acts as a charge capacitor for bias has a working voltage of 125V.

Setting-up of the threshold control can be a bit fiddly, and on no account should this be

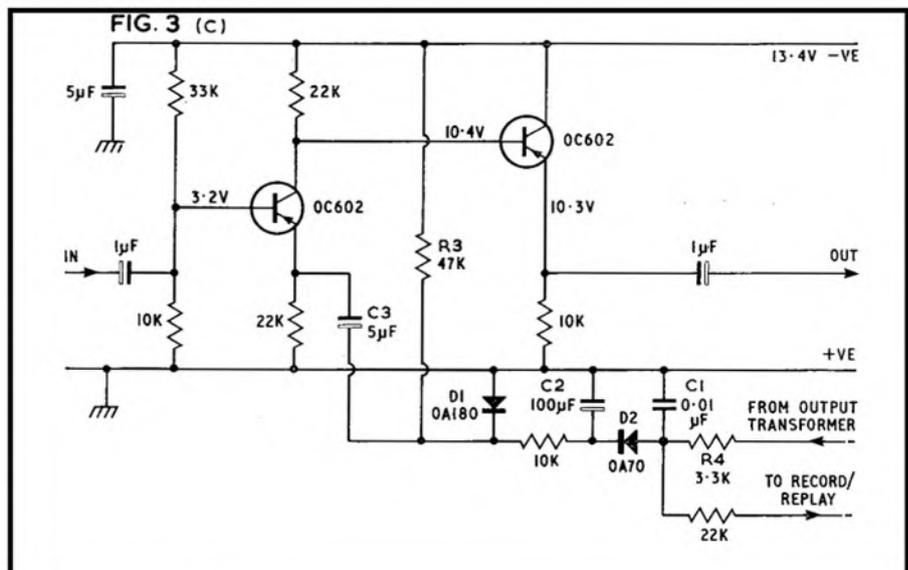
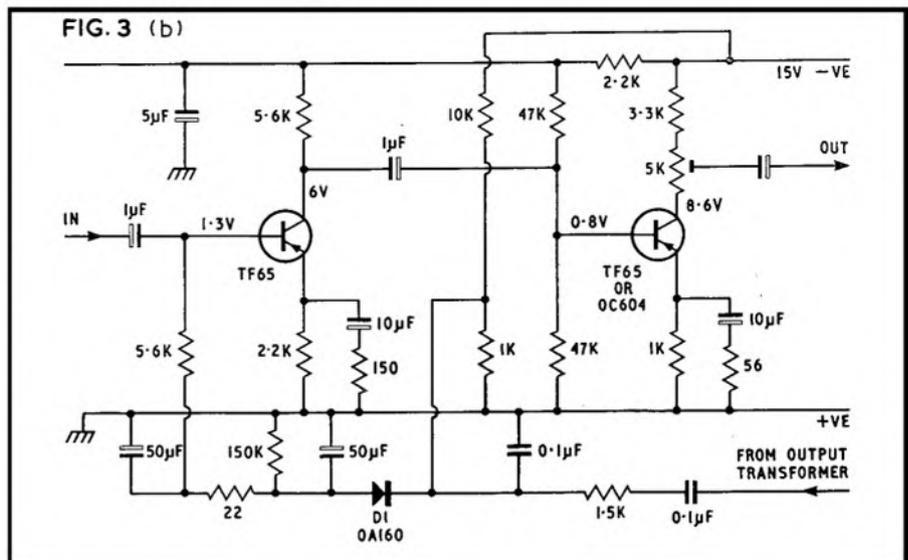
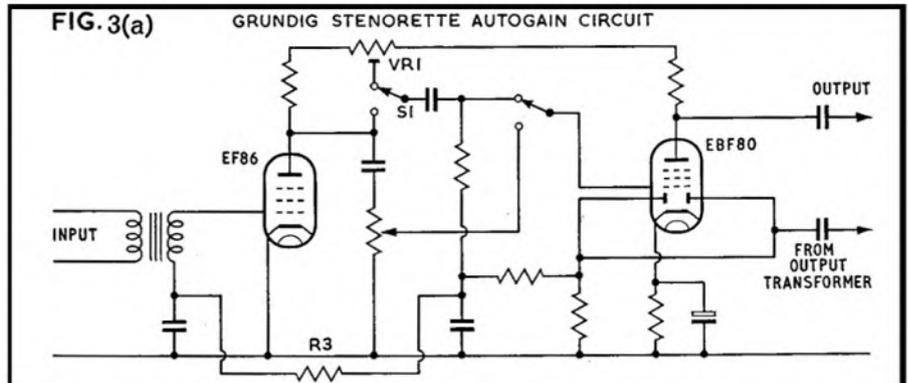
done by trial and error. A valve voltmeter, audio generator with regulated output and matching networks are needed to obtain the best results—and full details can be given to readers who may need this information and are prepared to take a little trouble.

Still on the subject of Grundig, but this time with an emphasis on the dictating machine, fig. 3 shows three variations on a common theme. 3a is the older, valved version of the

Stenorette, which reverts to the method of automatic control that we considered in the first section of this article.

A double-diode-pentode is the heart of the circuit. The diodes are strapped to form a single rectifier, receiving a signal from the output transformer which produces a proportionate DC bias across the 10 megohm rectifier load. R2, C2, R3, C3 filter audio

(continued overleaf)



frequency variations from this bias voltage to avoid feedback, and the bias is applied to the pentode section of the combined valve, with a reduced amount also tapped off and fed to the EF86 input stage (via R4/C4). There is a two-position sensitivity switch, which, in conjunction with the pre-set sensitivity control, allows immediate switched control of the signal level without affecting the automatic facility—a boon to the busy secretary.

The transistorised version, shown in fig. 3b, also takes the control signal from the output transformer, but uses it in a different way. As the control of the base bias of TR1 has to be effected without alteration of the load impedance of the transistor, the diode D1 is part of the stabilising circuit. As the audio signal causes D1 to conduct, the base potential of TR1 changes, without affecting the impedance that the base-emitter circuit 'looks into' and gain is regulated in proportion to the controlling audio voltage.

Again, this is a direct method, with no attempt to provide delays and so on, and, as the machine is intended only for speech, such refinements are not needed. However, fig. 3c shows a slightly different method, employed in the *Stenomatic* dictating machines, where the emitter voltage is varied and this is included to lead us on to more ambitious transistor control circuits. The *Stenomatic* is something of a throwback, using coated foil wrapped around a rotating drum, instead of conventional tape, but the circuit is still of some interest. The signal from the output transformer is applied, via a low-pass filter R4, C1, to the diode D2, rectified and passed as a positive voltage to counter the forward resistance of D1, which is biased by R3. C2 filters audio frequencies from the circuit and C3 acts as a charge capacitor. The voltage across C3 acts as a reference level to control the bias of TR1.

The foregoing shows that control of a transistorised circuit is not always quite so straightforward as control of a valved amplifier. It is not sufficient to shoot in a rectified and filtered portion of the amplified signal, as the impedance of the transistor is much more critical than the grid-cathode circuit of an amplifying valve. An example of yet another way of effecting control is seen in fig. 4, which is the section of the *Fi-Cord 202* used for automatic recording control. But it is worth noting that the 202a (now being sold at about half-price) had the automatic function deleted. *Fi-Cord* were never very happy with it, and the circuit given here is used as a guide to techniques rather than an aid to trouble-shooting!

A choice of manual and automatic recording levels is provided by turning the gain control fully anti-clockwise, when the switch S2A opens and TR2 is part of the collector load of TR1. A fixed collector load, R4 is provided to prevent damage during switching. TR2 is shorted out in the playback mode, but during Record, the emitter bias of TR2 is set by the resistance of VR1 in its minimum position. A rectified audio signal is received at the base of TR2, causing it to change impedance, thus acting as a varying AC load to TR1 collector. The impedance varies inversely with the

amplitude of the signal being fed back.

Coming back to the more comprehensive types of automatic recording level circuit used in machines intended to handle a wide range of signals—both dynamically and in frequency range—we next take a look at the *Elizabethan Automatic 2* and 4 (fig. 5). This is again a valved circuit, with a vari-mu amplifier, but a circuit at first sight much simpler than either the Grundig or Philips models previously considered.

The points to note about it are (a) the very high—80M—load resistor, which in combination with the 1μF charge capacitor provide the long time-constant, and (b) the use of two pre-set controls, needing some careful setting up of the circuit.

There is, in fact, a similar catch in setting up this circuit as we found with the Grundig Magic Ear. If an over-adjustment is inadvertently made, we have to go back to square one and start all over again; no use simply easing back the control setting—the bias, once triggered, stays in play for the time-constant delay period. (No arguments from purists about 63.2% please!)

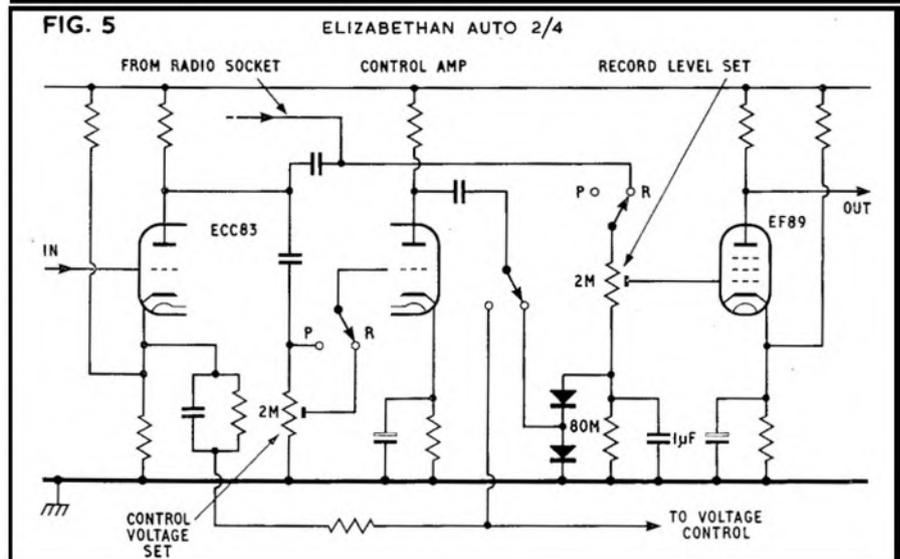
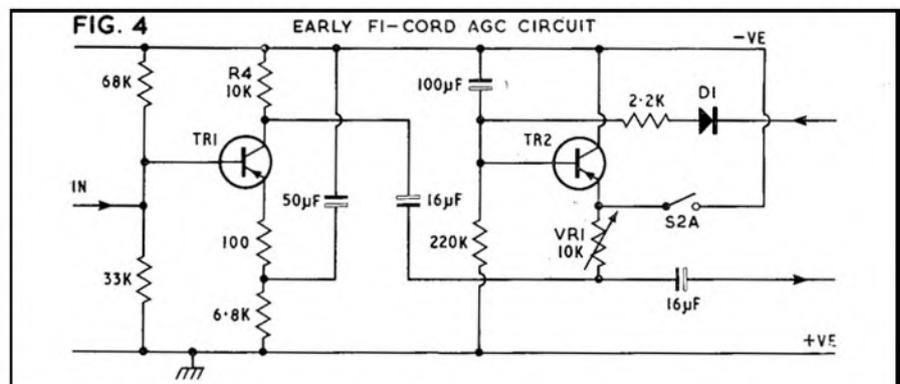
As fig. 5 shows, the circuit consists of a control amplifier which boosts the signal sufficiently to provide a rectified bias to the EF89, via a pre-set recording level control, whose purpose is to limit the voltage applied to the grid. The control voltage pre-set is then adjusted for the maximum triggering voltage after the record level has been determined. The

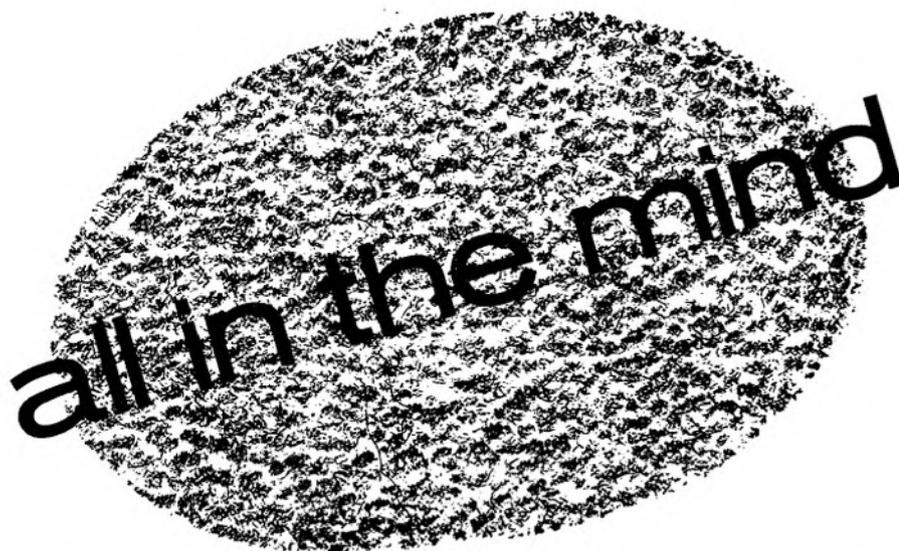
actual figures, using a valve voltmeter at the anode of the driver stage (triode section of an ECL86), which is the stage subsequent to the EF89, and an input of 2mV at 1kHz to the microphone socket, are 12V record level, and the triggering input is 20mV. This gives a 20dB control range, although in practice there is some spread, and an input of 100mV will give readings between 6 and 24V at the ECL86 triode anode—but if the input is then reduced to 2mV and the 1μF discharged, a reading of more than 8V should be obtained.

When adjusting, the control voltage pre-set begins fully clockwise, the 1μF charge capacitor is temporarily short-circuited to discharge it, and the record level pre-set is turned slowly until the 12V reading is obtained. Then the input is increased to 20mV—slowly again—and the control pre-set turned back until 12V is again read. If you over-run this figure, discharge the 1μF and start once more. Then carry out the wide-range check from 100mV, noting a reading of between 6 and 24V, reduce to 2mV in, discharge, and note that at least 8V output is obtained.

Sounds very complicated, but like all advantages, automatic recording level must be earned by taking that little extra care in initial setting—after which we can sail along happily, and ignore the quirks of interviewees who persist in bellowing into the mike!

Fidelity, Telefunken, Sony and the simple and effective circuit used in that prince of portables, the *Nagra*, will be discussed next month.





PERSONAL BIAS BY JOHN ASHCROFT

THE curse has struck again. The other month I said my proximity made the most reliable equipment suffer improbable malfunctions. (*A Nagra commencing a David Kirk trial in our office 'died' on us a few minutes before Mr. Ashcroft walked in on his first visit. We presume that he brought his curse down from the hills with him, and can only hope that he took it back up there when he left.*—Ed) The following week I bought a foreign stereo mike whose maker's name is a byword for quality and dependability. On one channel, a speaking voice modulated the tape happily at half gain. On the other, I had to swallow the mike and shriek my gizzard raw before anything condescended to register faintly. The mike went back to the importer, and was returned, fully operational, within a few days—which makes a gratifying contrast to my adventure with the highly renowned British mike-maker, described in the last column. All the same, it shows my gremlins are still around. "You think you have problems?" says an embittered colleague. "They should employ me as a tester . . . any random sample I select inevitably goes haywire."

His magnetic stereo-cartridge and his amplifier have been double-checked and pronounced perfect; so have his stylus and pickup arm. Together, on paper, they produce heavenly sounds. In practice he gets a thin dull racket with reduced treble yet miraculous magnification of any snap, crackle and pop on a mint disc.

He spent over a hundred pounds on an American recorder of worldwide renown: it recorded scarcely anything at full gain, although with the volume at nominal zero on replay the amplifier hiss and hum was clearly audible ten feet away.

His protests produced a replacement which fully modulated the tape whenever the gain rose above zero; its recordings were the loudest he'd ever heard, but were 90%-odd distortion. So he exchanged it for a British machine of solid build and impeccable reputation. On arrival, it refused to work. A taut mains-lead connection had snapped in transit. When this was fixed, one amplifier still remained on strike; he traced this to a soldering

fault. Now the machine works perfectly . . . but he can't use his favourite brand of tape on it.

Oh, the stuff records beautifully. But let me explain. Until recently it was my favourite tape, also. I dubbed some material on to a new reel of it, for replay at the club, on a similar machine. After five minutes a vicious crack from the loudspeaker frightened us. After four minutes, another; then after three minutes . . . two . . . finally the cracks were coming every few seconds. Airily, Ebenezer told us that it was due to static discharging from the tape.

But it happened only on that make of recorder at $7\frac{1}{2}$ i/s. At $3\frac{3}{4}$, no trouble; on other recorders, no trouble. On the afflicted machine, all was well as long as we persuaded a volunteer to divert the tape manually from one guide (that is, poke his finger among the works and see what happened). He got fed up of standing there while static discharged itself silently through his clammy trembling finger so we abandoned the programme. Since then I've heard of other owners of this excellent recorder having similar problems with this (equally excellent) tape . . . and some had used the two together for years without a single spot of bother.

Coincidence, perhaps, but lately this reputable tape no longer has its name printed on it, and seems to be responding less cleanly on my equipment . . . a modification in bias and general production? I don't know; but there's certainly a feeling of unrest among colleagues who formerly swore by the stuff.

Some spools of equally reputable manufacture were on sale at reduced price. I tried it: the stuff left a purple stain on the head-faces which meths would not remove, and it took three playings of an 1800 foot spool of another tape to wear off. And as for really cheap tape . . . we began assembling the club library on a brand which cost about a quarter the usual price and recorded very well indeed, but . . . ! Its edges became frayed, it stretched horribly at the least provocation, and squealed like a tortured banshee on several makes of machine. And the results of fast-winding and braking on certain machines were gruesome.

Incidentally, I had always thought that two well-known British recorders were filled with concrete in case their owners wanted to record *musique*, but now I am convinced it's to keep them from taking off during fast-wind. People criticise the comparatively leisurely winding on my machines, but at least I can watch the counter and halt within seconds of the word or sound I am seeking. The fast-wind on these other two machines frightens me. I keep thinking of those indicators on *The Time Machine* blurring into invisibility, and when the process is halted I'm always vaguely surprised to find that it's still Friday.

As for the stereo mike which is now behaving satisfactorily . . . I stood it in the front garden, closed the window, and monitored on two loudspeakers. From up there, a dog's bark—and the echo from another point. From over here, a treeful of birds; over the road, more birds on a hedge, so clearly defined that you could point to every one; in contrast, the distant purring drone of a *Fordson Major* tractor, and a peculiar clattering from a neighbour's garden (defensive screens being erected?).

A van purred sedately across the room; a *Mini* went speeding by; and, most shattering, a lorry laden with bales came groaning from a bookcase, changed gear ferociously in the middle of the fire (well, wouldn't you?) and thundered off through the living-room door. Stereo can definitely transform acceptable sound-effects into much livelier experiences.

Mind you, 'stereo' is a misnomer. Regardless of what advertising copywriters tell us, we don't get three-dimensional sound; the effects come from a flat *area* lying between and beyond the speakers, and the dimension of height is missing. Even so, weird illusions occur, and my experiments produced a real beauty.

Far and high, hence slow-moving, an aeroplane murmured across the sky. At first it comes from somewhere near the ceiling, on the right (nowhere near the speaker); after a while it rumbles way overhead, and eventually ends up crawling along the ceiling on the left (again, nowhere near the corresponding speaker). Heard in utter darkness it's almost scaring—the plane actually seems to hover slightly *behind* me at one point. All right, all right, it's psychological, it's a fluke of room acoustics, and Ashcroft's been at McFee's *Mountain Dew* again—but it fascinates me, and I'd like to hear of anyone else's similar experiences.

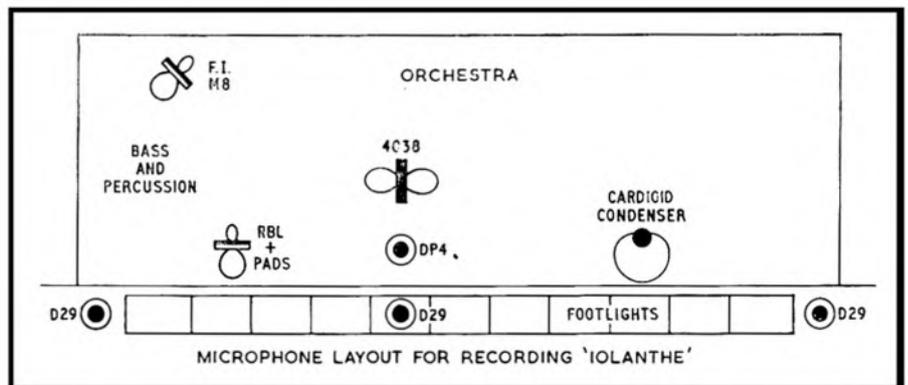
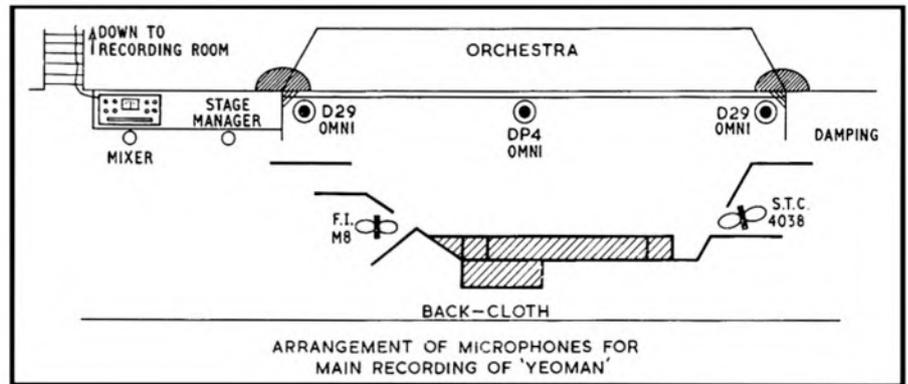
Now I want a battery stereo machine—just a robust, reliable, simple basic recorder operating at $7\frac{1}{2}$ i/s, no needless speeds and fancy frills. Oh, and it must use inexpensive batteries—unlike those recommended for the mono machine I'm currently using. Ha!—reminds me, I was going to buy a rechargeable battery kit for it. The recorder-makers advertised them, saying the batteries could be "run down and recharged almost indefinitely." Some detailed queries resulted in the following encouraging news from the same source: the batteries did not maintain full power for the stated period, and after four or five rechargings should be replaced entirely as they began to gas and swell more rapidly and trigger the charger cut-off switches before actually absorbing anything like a full charge.

I'll leave you to ponder on that.

Gilbert and Sullivan at Cambridge



JACK POINT* DESCRIBES AN EPIC AMATEUR RECORDING



EVERY year the Cambridge University Gilbert and Sullivan Society produces one of the G. and S. operas in a Cambridge theatre. For the last few years the performances have been recorded for playback at the Annual General Meeting—where the recording and memories are mellowed by flowing wine—and for transfer to disc when there was sufficient demand to make this economical.

In the spring of 1964 *Iolanthe* was produced at the *A.D.C. Theatre*. It was then that the first serious attempt was made at recording one of the society's productions; in previous years there had been attempts with a single microphone slung high in the auditorium, but these inevitably suffered from audience noise and lack of clarity.

Theatre people are sometimes a little wary of recordings, and the recording team were not on this occasion given quite as free a hand as they would have liked, thus causing quite a few problems when it came to rigging the microphones.

No microphones were allowed on stage other than three placed at intervals along the

footlights—the rest had to go in the orchestra pit on a level at which they would not be visible to the audience against the illuminated stage. This meant that, even using directional microphones (an *STC 4038* cardioid capacitor, *Reslo* and *Film Industries* ribbons) backed up by a *Gramplan DP4* and three other moving-coil omni-directional microphones, the orchestra came over rather too loudly and the chorus at the back of the stage were muffled or, at times, almost inaudible. In addition, there was an amount of stage noise picked up by the microphones in the footlights, although audience noise was virtually nil. Soloists at the front of the stage (generally more quietly accompanied—came over rather better, and this naturally affected the subsequent choice of items for the record. Although the orchestra was reasonably balanced internally, due to the liberal use of microphones, its intonation sometimes left a little to be desired (as so often happens in amateur performances), so that the heaviness of the orchestra relative to the singers was not a help. From the point of view of the audience in the theatre, however, the balance was much better, and any faults were overlooked in the tremendous spirit of the occasion.

The microphone cables were bunched together in the pit with insulating tape and led out through a skylight in the wings down the side of the theatre and in through the window of the props room below, where the workshop had been turned into a temporary studio. This was shut off by a fire-proof door before every performance, and a thoughtful fire officer provided extinguishers and buckets of sand just in case the equipment should overheat!

The recording was made on two *Brenell* decks using kit built versions of the *Mullard Type C* valve recording amplifier, with external peak-reading meter. The tapes were run at 15 i/s for best quality and ease of editing, with the tapes overlapped and with fresh tapes each night so that the best performances of the week, of each item, could be picked out and used when making the record.

The microphones were fed into two mixers; one was a small commercial type having four channels and the other, fed by the first, a home-made valve mixer belonging to a member of the *Cambridge University Tape Recording Society* who was organising the production of the recording and doing the mixing. Three other members of the team ran the decks

*"Jack Point" is the collective nom-de-plume of the Cambridge students and enthusiasts involved in the recording.



(monitoring either off tape or direct from the mixer), adjusted recording levels as necessary, gave cues and made notes in the script—as well as switching on a battery of kettles during the applause preceding *Act 1* finale to make coffee for friends in the cast.

For monitoring, a Mullard 5-10 amplifier fed a *Wharfedale* 8in. unit which was mounted on a well-damped concrete column. Although not exactly portable, this arrangement gave a respectable account of the quality and allowed quite a high listening level.

For the playback in St. John's College, it was suggested that each act should be played without breaks at the tape changes (remembering that even 8½in. reels of LP tape last only half an hour at 15 i/s) with a refreshments interval between the acts. This called for split-second timing of starts and changeovers on cue as each tape ran out; lengths of tape for a five second run-up were measured off on each reel and the tape was held on the cue mark with the pause control, until the overlap cue came up. It was then possible to switch or cross-fade between the tapes five seconds later when both tapes were running at the right speed, with no risk of 'snatch'. It was amusing to see the faces of people who watched the

tape on one machine running out, while the music went smoothly on! It takes practice but the changeover can be done with no break and no overlap at all, just like a well made splice.

The recording produced some discs and dubbings which were quite popular, but one of its greatest values was as experience for subsequent large scale recordings. Among the points to emerge were that next time there should be better coverage of the chorus at the back of the stage; that, provided they were correctly placed, fewer microphones could be used with better results (with far less needed for the orchestra); and there could be considerable economy on tape by recording the music at 15 i/s whilst making a separate complete recording of the whole production at 3½ i/s for the playback at Society meetings and for the archives.

In 1965 the G. & S. society were invited to perform in the Arts Theatre. The performance was to be of *The Yeomen of the Guard* and once again the recording was to be in mono (although it provided an excellent opportunity for doing experiments at rehearsals with multi-mic stereo).

A special recording session would have been

the ideal, with the cast and orchestra in an empty theatre, for this could lessen the amount of editing, allows retakes, and makes balancing and microphone placing so much easier. However the cast seemed to prefer a 'live' recording, and so the idea of a special recording session was scrapped. Fortunately, however, the stage manager did agree to having microphones on stage, provided they were out of sight.

The main recording was made on a Brenell machine, with the Cambridge University Tape Recording Society's mixer (built by David Robinson, and a forerunner of the one described in his series of articles in *Tape Recorder*). In brief, this mixer will accept inputs from six microphones in mono, or three spaced microphones on each channel for stereo; it has conventional rotary faders and ganged main fader, balance and level pre-sets, stereo PPM, headphone monitor output, talkback facilities, a built-in line-up tone source with warning flashers, and twin control keys for two recorders such as the Tape Society's *Revox*. (The *Revox* was not used for the master recording for this was to be at 15 i/s, so these control keys were not utilised, but full use was made of all the other facilities.) (continued on page 21)

99

Emitape 99—the long play tape formulated for 4-track recorders

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THE INTERNATIONAL SOUND RECORDING CONTEST

A REPORT BY JOHN BRADLEY

THE modern and airy Hilversum Studios of the Dutch VARA Broadcasting organisation were the setting, on October 23rd and 24th, of the 15th International Contest. Some 56 tapes were heard, from twelve countries as far apart as Mexico and Japan. Twenty-one jurors, from the eight national amateur recording organisations represented (including three from the *Federation of British Tape Recording Clubs*), had the difficult task of selecting the best entries in the six mono and six stereo classes and then selecting the best overall mono and the best overall stereo tape for the two *Grand Prix* awards.

The six British entries, five mono and one stereo, did well in the final judging. First prize in the Schools Mono class was awarded to Robert Corfield (see photo) for *Wendy and Elizabeth*, a joint effort of Urmston County Junior School for Boys and Flixton Secondary Girls' School. The prize for this was 250 Swiss Francs given by *Radio Sankt Gallen* of the Swiss Radio Organisation. Ken McKenzie of Sunderland gained a second place in the Technical Performance Mono class with his tape called *Grandfather's Chronoclasm* (First-prize winner in the Novices section of the British Contest). The prize for this was ten reels of *BASF* tape given by the German *Soundhunters' Club*. Third place in the

Actuality Mono section went to Peggy Buchanan of London S.W., for her tape *Summer Microcosm* and this was one of the six recordings nominated for the Grand Prix Mono, an honour eventually gained by Lucien Wasmer (Mexico) for his very lively *Mexican Popular Music* entered in the Documentary class. In the Stereo section of the Contest, John Shuttleworth's *Negro Spiritual*, which was one of the items from his second-prize winning entry in the Advanced Amateur section of the British Contest, faced great competition from the other 13 contenders in the Music or Speech class. The sixth place awarded showed that the tape had great merit and it was very well received by the judges. The Grand Prix Stereo was awarded to Svend Nielsen of Denmark for his *Magic Band* a technical performance entry using speed changes and multi tracking to produce first horn, second horn, trombone, trumpet and tuba playing *The Devil's Tongue* when in fact only a single trombone were used.

Czechoslovakia were present at the Contest for the first time and one of their entries *Music for Don Quixote*, by Milos Haase, took the first prize for Technical Performance (Mono) and this was one of the tapes which received an airing on Dutch television before the first day's judging was over. The Czechs have



In London for the British Contest presentation, Robert Corfield received a prize for his success in the International.

returned home to arrange for the 1968 International to be held in Pilsen where there are some very modern new radio studios. The German Soundhunters' Club have invited the International Federation (FICS) to hold next year's Contest in Berlin, and Denmark is hoping to arrange for the 1969 event to be in Copenhagen. Hosts to the judges and delegates were the *Dutch Sound and Picture Hunters*, who entertained their guests right royally from the evening of Friday the 21st October until well after midnight on the 24th, managing to fit in a visit to the Philips *Evoloun* exhibition at Eindhoven prior to the prize-giving dinner. At this, they presented everyone with a stereo LP of the famous *Perlie Dutch Street Organ*, a handsome and appropriate memory of the stay in Holland.

G. AND S. AT CAMBRIDGE CONTINUED

For the main recording, two ribbon microphones—an *STC 4038* and a *Film Industries M8*—and three omnidirectional moving-coil microphones were used, with an *Acos Mic 39* for talkback and *AKG* headphones for monitoring at the mixer. The sixth channel of the mixer was available for coverage of the orchestra in the Overture, at the complete recording.

The mixer itself was positioned under the lighting bay at stage left, in good view of the stage, from where one could communicate easily with the lighting engineer and the stage manager. The Brenell was operated in the ironing room in the basement of the theatre, below the Principals' dressing room; there it was possible to monitor off tape through a speaker as a check on the quality of the recording quality, whilst listening through a single earphone for cues from the continuity girl up at the mixer.

The feed was at low impedance via an unbalanced coax line, which surprisingly gave no trouble even with all the lighting circuits around. Monitoring through phones direct from the mixer allowed balance to be checked, and monitoring off tape at the recorder allowed a second check on quality; the feed level was controlled at the mixer with the master fader, using the PPM as indicator (after lining up the mixer and recorder meters on the mixer's tone source), and in addition the level could of course be controlled at the recorder if necessary.

A continuity girl is a great help, and only on the one night when the volunteer did not turn up was it realised just how valuable such a person is in minimising the distractions to the person doing the mixing, soothing furrowed brows and frayed nerves, turning score pages, writing into the script cues, remarks and levels for future reference when necessary, and actually giving cues down the talkback system.

That describes the basic set-up. The microphones and cables were arranged with the co-operation of the theatre management, the lighting engineer and the stage manager in time for a run through of levels at the dress rehearsal. It was agreed that microphones could be placed on stage, provided they were invisible to the audience.

Bearing in mind the balance problems of the previous year, the main microphone (*Grampian DP-4*) was suspended from and level with the proscenium arch, thus giving a reasonable balance between orchestra, soloists and chorus. It had been hoped to use a cardioid condenser microphone again, in this position, but at the last minute it became necessary to use the omni *Grampian* as the condenser microphone's power pack was out of action. In the unusually reverberant theatre, and over the stage, the *Grampian's* slight fall off in bass response was, if anything, an advantage.

To reinforce sound coming from the sides of the stage, two omnis were positioned behind the right and left pillars at the front: here, the mixer's phase switches were essential. These two microphones were backed by felt and small cushions to cut down reflections from the flat

backs of the pseudo pillars, and they were mounted in 'Cats cradles' in an effort to minimise stage rumble transmitted through the solid medium of the pillars.

The two ribbon microphones—the 4038 and the *Film Industries*—were mounted on stands at centre right and centre left facing centre back. (Fortunately the set was the same throughout, so these did not have to be moved for scene changes.) These mics were only faded up when needed for sounds close to them, in order to minimise pick-up of noise from the wings where people moved around or as actors came on stage. One ribbon had to be rapidly repositioned at the dress rehearsal when it was discovered that the 'bomb tank' (for the *Arquebus* in Act II) had been arranged to detonate immediately below the mic. In its new position, it was screened from the blast by part of the 'Tower'.

These backstage microphones were a great help in achieving the presence and clarity of consonants from the chorus which were rather lacking in the previous year's recording.

Since the *Grampian* on the proscenium arch provided most of the signal, fading the other microphones in and out caused no great changes in perspective but permitted a much more live, clear sound than would otherwise have been possible. However, the policy of having only the fill-in mics up at whichever part of the stage the action was taking place tended to break down when it came to "What a tale of cock and bull": Then, the jester and gaoler danced madly round the entire stage, and on occasion seized the spot light stands and the 4038 as they careered past!

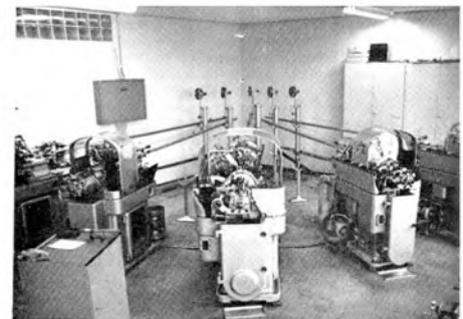


Above left: The Zurich headquarters of Revox/Studer.

Above right: A view of the Revox factory at Löffingen.



Left: The daily schedule is determined at morning meetings between Willi Studer (second left) and members of his staff.



Right: A bank of automatic lathes at Löffingen.

A STUDY IN PRECISION

DAVID KIRK VISITS THE REVOX AND STUDER FACTORIES

THE corridor is long, clean, silent and deserted. A succession of anodised handles protrude from the side walls, each revealing the location of a large flush-fitting door. Here and there, sun penetrates the half-light. Yet we are standing in the centre of a busy factory; the backbone, in fact, of a sizeable modern building in which the *Revox 736* stereo tape unit is manufactured.

In vain, we search for production lines, for the endless belts upon which so many mass-produced articles journey into existence. This clinical corridor, in fact, is itself the *Revox* production line. Into one end are fed the materials, the components, and from the other emerges the completed machine. In the course of this journey, the embryonic *Revox* passes through many of the doors, and it is there, in the self-contained adjacent rooms, that the processes of construction take place.

Opened at Löffingen in January 1966, the factory stands in the beautiful Black Forest area of Germany, close to the Swiss border. On the southern side of this border, in Regensdorf, near Zurich, is yet another centre of *Revox* production, 736's here being manufactured alongside *Studer* professional recording equipment. Why two factories? Demand

for the *Revox* has so increased in recent years that considerable expansion of production was warranted. Why two countries? It is financially very convenient to export from Switzerland to other EFTA countries, and direct from Germany to fellow-members of the Common Market. Tape recorders produced at Löffingen are, therefore, unlikely to appear on the British market, although a certain amount of sub-assembly work is exchanged between the two factories.

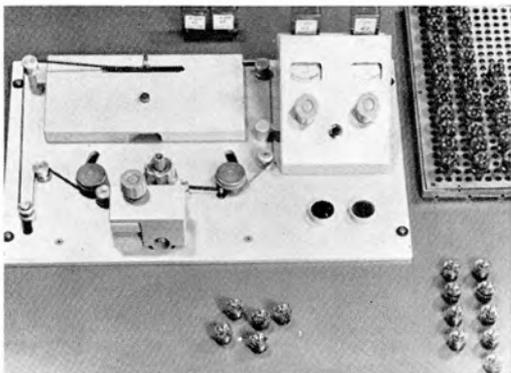
The German branch is in almost every sense, save architecturally, a duplicate of the *Revox* section of the Swiss *Revox/Studer* factory. All product development and design is handled in Regensdorf, along with most of the costing, invoicing and accounting. Accounting (though not design work . . . yet!) is achieved with the aid of an *IBM 360* computer, an impressive roomful of equipment with an equally impressive 18-volume service manual.

It should be emphasised that manufacturing tolerances, tools and quality control are identical in the two factories. Simply to avoid duplication of description, therefore, we shall examine in some detail *Revox* production at Löffingen, later concentrating on the manu-

facture of *Studer* equipment in the Swiss factory.

One of the first doors on the left of The Corridor opens into a spacious room containing coil-winding machinery. The room, indeed, seems *over-spacious*, and we are informed that the building was designed to accommodate future expansion. Heads, oscillator coils and transformers are wound at the factory, much of the plant being operated by girls. Automation is visible to various degrees throughout the building, an example being the automatic coil winder which produces four oscillator coils simultaneously, the precise number of turns being checked on a counter.

After coil-winding and assembly, the head cores are placed in a *Payne* rotating grinder—one of disappointingly few British-made tools used on the Continent. This machine ensures that the gap in each completed head will be parallel-sided along its full length. Now the core assembly is locked in tinted *Araldite*. The colouring conforms to a simple code, erase heads being white, record heads green, and replay heads red. To render the *Araldite* even harder than is normally needed when it is used as a domestic epoxy-resin adhesive, the heads are oven-hardened in moulds. Once

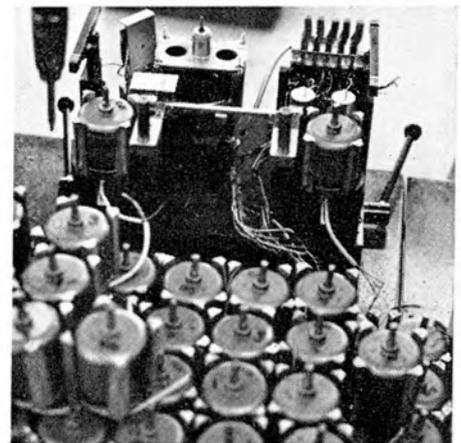


Above left: Six drilling operations, in Switzerland, means one operator and six drills. No time-consuming bit-changing.

Above right: Design and draughting room at the Zurich premises.

Left: A small loop transport employed in testing of newly-manufactured heads. Note plug-in test-circuits.

Right: The Revox deck is almost entirely assembled in a rack before the deck plate is added.



A STUDY IN PRECISION

DAVID KIRK VISITS THE REVOX AND STUDER FACTORIES

baked, the Araldite covering the head working surface is machined off. Finally, the playback heads are subjected to frequency response and output tests, before being fed into the assembly pipeline.

A distinctive feature of the Revox is the component-cage system of circuit construction, each valve in the tape amplifier having its relevant circle of resistors and capacitors built immediately below the valve-base. The only printed circuits in the 736 are the twin VU-meter drive and the oscillator. Besides being easy to service, the cages are simple to assemble and solder. This work is undertaken in small jigs, which clamp the valve base and lower tag-board in place while the components are added. Automation is visible at this stage also, the labour being taken out of wire cutting and stripping. Another machine cuts and bends component leads.

The 736 incorporates three *Papst* motors—two for spooling and the third, an outer-rotating cage hysteresis-synchronous model, driving the capstan. In fact, the capstan spindle is not an integral part of the motor, but is fitted concentrically to the motor spindle by a resilient coupling—to remove the last possible trace of mains flutter.

Although the motors are made by a German company, Revox produce their own capstan spindle and flywheel, and check the dynamic balancing of the resultant combination.

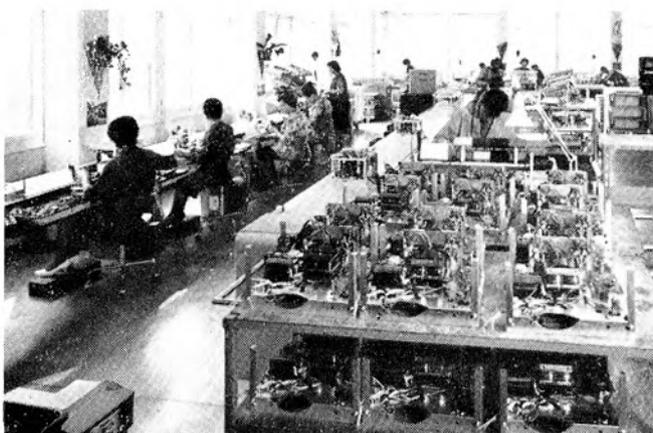
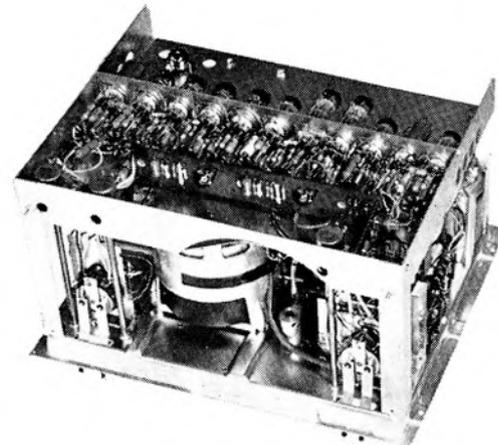
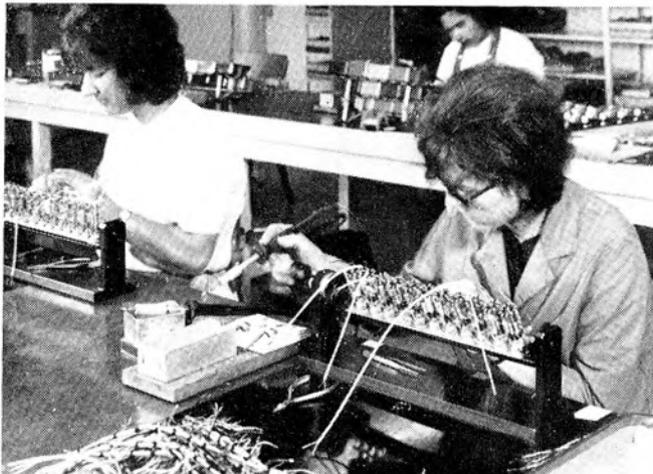
The capstan spindle, a complex piece of machining, is accurate to one thousandth part of one millimetre. To be of any long-term use, the component must be hardened. Since hardened steel is difficult to work in a lathe, and since the hardening process adds a non-uniform coating of grit to the spindle, capstan grinding becomes a more involved process than meets the eye. Each spindle is turned down, in the soft state, to a fraction above the required dimensions. At this point, the metal is hardened. Now a second stage of fine machining takes place, to remove deformations incurred during hardening. In this way, only a few thousandths of an inch are turned out of hard metal instead of the sixteenth-or-so that would need to be removed—at great cost to the cutting head—if the spindle were hardened initially.

In addition to three motors, the 736 contains three solenoids, governing tape transport and braking. All mechanical controls are operated electrically, and the recorder is ideally suited to remote or time-switch operation.

Willi Studer, who owns, and takes an active interest in running, the Swiss and German factories, dislikes contracting work outside his company or buying existing mechanical components. Thus, even the relays are manufactured on the premises. Two large presses, each giving a pressure of some 40 tons, stamp out the metal cups in which each solenoid is housed. In two stages, flat metal is forced into the shape of a small container and then increased in size. The operator is protected from the 40 ton punch by a thoughtful design feature: both hands are required to press separate buttons before the machine can burst into action.

Mechanically, the Revox is a comparatively simple design. The use of solenoids and one-motor-one-function drive contribute to this simplicity. For all this, we were surprised by the ease with which each deck is assembled. Most decks are constructed around the metal top-plate. With the 736, this plate is one of the last items to be added. Three motors, brake mechanism, solenoids and push-buttons are placed together on a cradle (see photograph). At this point the deck plate is slipped over the top of the cradle, each component fitting precisely through gaps in the deck. The many

(continued overleaf)



holes puncturing the deck, incidentally, are all drilled at one go. The head mounting, too, is manufactured in this way, a sizeable multi-bit drilling head boring a series of holes simultaneously.

The deck plate is manufactured from pressed steel, coated against corrosion, and shaped to give greater rigidity than would otherwise be obtained with comparatively thin and lightweight metal. Our comparison, by the way, is not with other semi-professional recorders, but with the deck plate employed on the Studer A62 and C37: a Duralumin construction 2ft. 2in. wide by 1ft. 7in. deep, the thickness of which varies from $\frac{3}{8}$ in. to 1in.

Once on the cradle, the 736 deck is screwed in place with an air-driven tool, after which the heads, revolution counter and auto-stop are added. The auto-stop deserves special mention. A small lamp supplies light through a guide post, along a transparent plastic conductor, to a photo-transistor. When magnetic tape is threaded through the recorder, the light-path between plastic conductor and photo-transistor is blocked. In the event of the tape breaking, running out, or being substituted by a short length of transparent leader, the photo-transistor activates a solenoid trip, bringing the mechanism to a halt.

When the upper deck is fully assembled, it is bolted to a lower chassis on which is housed the tape amplifier circuitry. The resultant steel case, supported in the vertical plane by

four metal arms, provides protection from accidents or mishandling.

In one of the most highly automated parts of the Löffingen factory, one or two machine-minders, in charge of five or six lathes, produce literally thousands of small components—guides, rods, tubes, brake-drums—for incorporation in the 736. From one corner of the room, five tall clamps feed several yards of rod to a bank of automatic lathes. A tension device ensures that, as each tiny component is shaped, cut, and dropped into a storage container, so more metal is supplied to the lathe's hungry jaws.

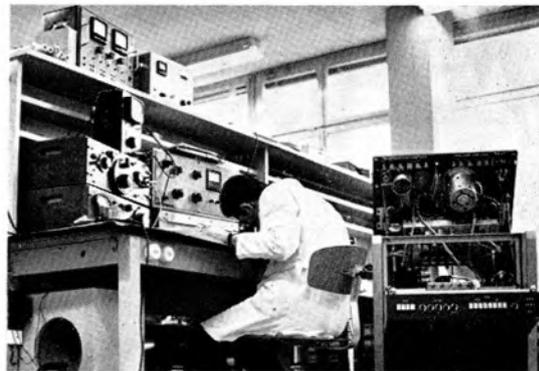
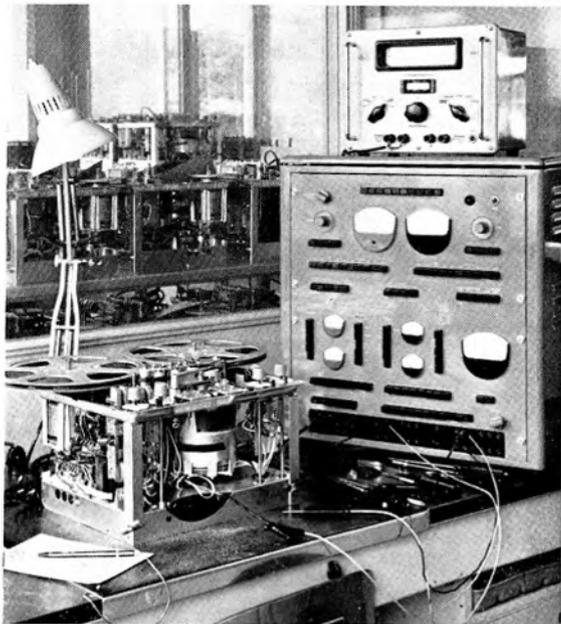
The automatic lathe is a fascinating machine to watch. It functions completely alone, tended only at regular intervals for accuracy of cutting and rod replacement. In principle, the lathe is not unlike the mechanism of a conventional gramophone record changer. A 'programmed' disc rotates at very slow speed beneath a series of hinged rods. At least once per revolution, each rod is forced to move about its hinge by a mole-hill protrusion from the turntable. This rod movement passes through one or more levers and culminates, for example, by swinging a cutting head against one portion of a newly-turned half-formed tape guide. Where a tool is required to cut into the metal for a long period (four or five seconds), the aforementioned 'mole-hill' will have a substantial plateau, at least in the eyes of the rod against which it acts. In a similar

manner, the turntable can be made to 'order' drills, saws, and other cutting heads into position, as well as pull fresh metal into the jaws at the end of each operation.

Throughout the factory, test gear of one sort or another is employed in the quality control of individual components. Representative sample testing is not practised here, every critical component being checked before assembly, so the chances of buying a 'bad 'un' are extremely small. Dynamic balancing of the flywheels is undertaken on a unit costing some £1,800, after which each motor is inserted in a skeleton recorder for wow and flutter measurement. Now a feeler gauge is applied to the capstan to check that the spindle is within the specified 1/1000mm. This is not the last wow and flutter check that the motor will be subjected to, since each completed Revox receives a comprehensive check immediately on completion. Here, for a second time, it passes under the gaze of an EMT optical-display wow and flutter meter.

Wow and flutter consume so much mental energy in the Löffingen and Regensdorf factories that, to make life easier on the larynx, Revox/Studer engineers have coined the term *wobble*. Every 736 that leaves the factory must conform to the specification of better than $\pm 0.1\%$ peak wobble at $7\frac{1}{2}$ i/s.

But 'wobble' has another meaning. I wobbled (mentally) when I was informed that the multi-storey Swiss factory at Regensdorf



Far left (above): Revox recording amplifier being assembled around the valve bases.

Far left (below): General view of the electronic assembly floor at Zurich.

Immediate left (above): A 736 from the under-side. Note valve-base construction and size of capstan motor.

Immediate left (below): A stack of completed recorders towers over the Löffingen mechanical assembly benches.

Above: A 736 chassis ready for final examination before leaving the factory. The large test-instrument is factory-designed and built. It supports an EMT fluttermeter.

Above right: A professional Studer machine is subjected to passing-out test.

Right: The completed Revox 736.

incorporates a nuclear-fallout shelter. Down in the bowels of the building, we saw this impressive and, I trust, singularly useless, construction. The shelter is equipped with a radio-active-air filter and can be sealed from (the ruins of?) the factory by massive doors. A large spider stands sentinel outside an emergency exit hatch, from which a half-finished tunnel leads to the car park. It is apparently mandatory, under Swiss law, for all factories to be within access of such a shelter.

Automation is less evident at Regensdorf than in the German factory, but machines are still used in such a way as to obtain maximum productivity from each member of the staff. Six drilling operations are performed by one man on one component, the need for time-consuming changing of drill-heads being overcome by the simple solution of providing six drills. Neither does one see burly workmen hammering metal or tin-plate chassis into shape. The Revox deck-plate is stamped out beneath a 100 ton press.

That a component may be large does not detract from the care that goes into its construction. The metal supports on which the Studer deck stands, when fitted to the professional recorder chassis, are accurately milled to ensure total freedom from vibration.

The Studer range of professional recorders are acknowledged to be among the finest studio machines in the world. Where a broadcaster does not use them, it is almost invariably

due to lack of finance rather than any disinclination towards the product. Superficial examination of a queue of recorders awaiting final test provided some insight into the qualities of the portable (172 lb.) and console (330 lb.) machines. They are all, of course, solenoid-operated and designed to function at 15 and $7\frac{1}{2}$ i/s. Single, double and four-channel models are manufactured, to take $\frac{1}{4}$ in., $\frac{1}{2}$ in. and 1 in. tape respectively.

A tape-timer is connected to a rotating guide, the working surface of the guide being perforated to prevent air-bubbles between metal and tape causing errors, and displays minutes and seconds to an accuracy of three seconds in half-an-hour. An instant-zero button is built into the machine, tactfully positioned out of sight at the side of the cabinet.

Ensuring constant reverse tape tension as the effective feed-spool diameter changes is a problem that many manufacturers refuse to face. The Revox 736 incorporates switched tension to suit 10 in. and 7 in. spools, while a flexible guide-spring irons out any mains flutter incurred by the feed motor, which endeavours to rotate in reverse during record or playback, thus providing the action of a conventional clutch without the accompanying wear. Even switched tension is something of a compromise, and the professional Studers feature a unique tension sensor. This device, a pair of guides mounted on a sprung movable

turntable, is connected to a potentiometer. Any variation in tension correspondingly alters the value of the potentiometer, which controls an eddy current brake on the DC feed motor, through a power-transistor and ancillary circuit. This same turntable will stop the machine at the end of the tape, or in the event of tape breakage. The tension turntable may be locked, if necessary, to simplify editing.

Not that editing needs any further simplification on the Studer. An inked rubber marker is positioned opposite the playback head, ready for instant use. About an inch to the right of the capstan, the tape passes across a slot in the deck and it is through this slot that, at the touch of a button, a motorised scissor pops out from the depths to slice the tape, thereafter returning whence it came. Graduations on a Plexiglass deck panel show the exact distances between scissors, erase, record and playback heads.

The fastidious construction of the professional machines serves its purpose in the long run. The Revox will give good service for 30 years-or-so, but the Studer is built to last!

At which point we extend our thanks to Mr. Studer and his staff for their hospitality, and for a mammoth (though nevertheless enjoyable!) dinner. Our appreciation is due, too, to the U.K. agent for Revox, Colin Hammond, in whose Jaguar the journey was made.



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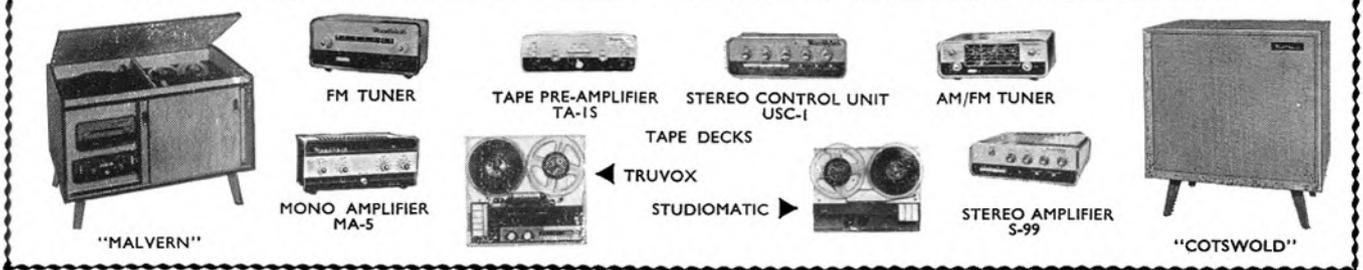
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PART 14 SOME BASIC CIRCUITS

BY MICHAEL GORDON

WE now have knowledge of the transistor effect and of the basic transistor building blocks, and while there are many more things that could be told about transistors and their circuits, to delve exclusively into these would be deviating too far from the general course of this series. However, transistor aspects pertinent to the actual circuits employed in battery-powered recorders will be discussed along with the circuits themselves.

The stages in battery or mains/battery models follow along the same lines as those of mains-powered valve models. We have the simpler type of recorder where most of the stages work in similar or different modes for recording and playback. With this type of machine, for instance, the early stages will serve as microphone or recording programme signal amplifiers when recording and as playback signal or head amplifiers when playing back the recording. Similarly, the playback output stages may operate as the HF signal generator (for bias and erase) when recording.

Changeover from one mode of working to the other is handled by the record/playback switching system, and this may be a simple type of multi-contact rotary switch or a more sophisticated, mechanically-ganged slider type of switch, with the various switch sections located close to the circuits concerned.

The more expensive models often feature separate recording and playback channels, which is by far the best arrangement, since it allows tight tailoring of the recording and replay characteristics, and makes it possible to monitor the recording being made direct from the tape, via the playback circuits and separate head.

Few models are fully stereo on recording and playback, but some of them are designed to record two-channel stereo (quarter or half track) and deliver on playback low-level signals in both channels, suitable for headphone monitoring or for feeding to a separate stereo reproducing system. Sometimes there is a single reproducing channel with built-in speaker, allowing the two channels to be played back separately or in parallel, and sometimes facilities for connecting a mains-powered output stage for the second channel should it be required to use the machine for playing stereo through speakers.

The reason for these limitations is that speaker playback output stages call for fairly

high battery power to give a reasonable power audio output, especially on two channels, so very large batteries would be demanded for useful stereo playback through speakers.

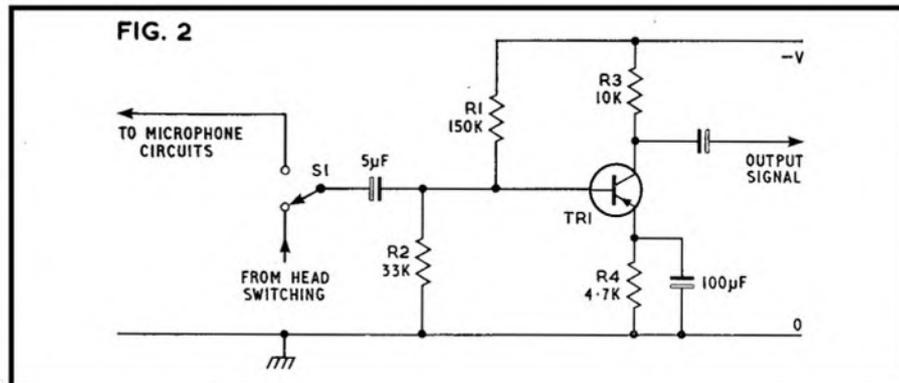
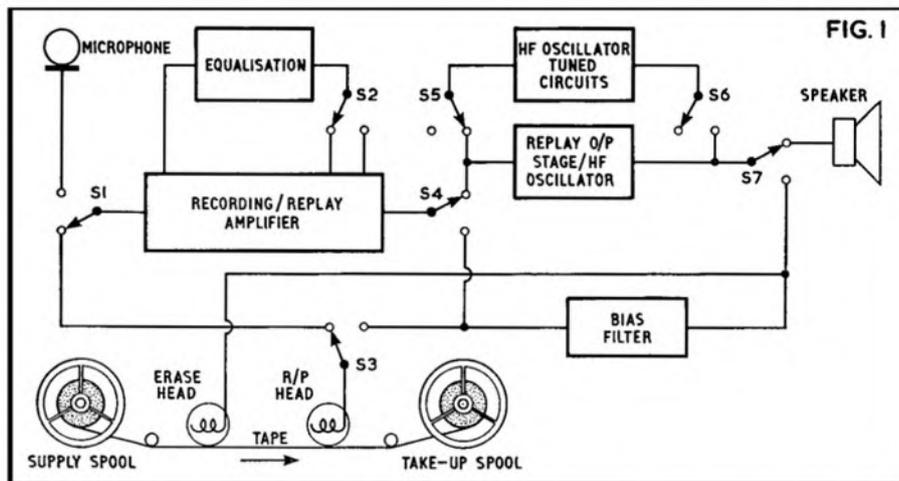
In any case, the need for battery-powered speaker-stereo rarely arises in 'the field'. The general requirement is for a way to monitor the field-recorded signals, mono or stereo, and 'phones are ideal for this purpose.

Mains/battery models have a greater scope in providing the necessary large transistor power for good speaker audio but, again, this type of machine would be used on mains (not batteries) in the home for playback.

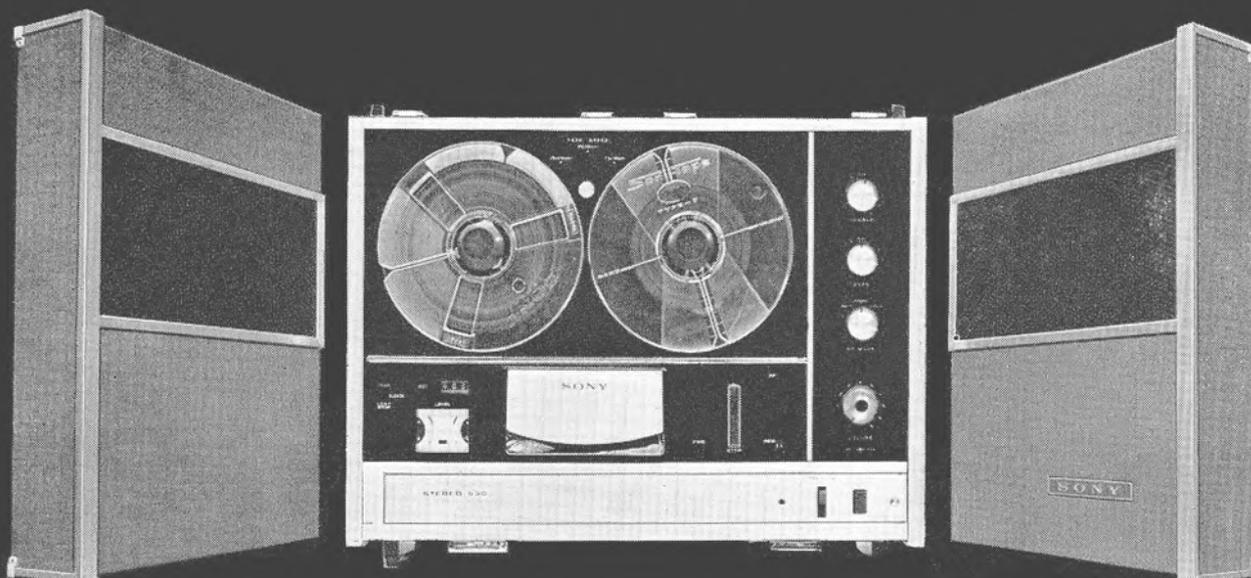
Battery-powered recorders are not really designed for high quality playback in any case,

but they should record with low distortion and noise, especially the more expensive models. The recording so produced should be replayable either over the hi-fi system, from the battery recorder which made it, or on the mains-powered domestic tape recorder. In the former case, the actual recording characteristics are not all that important provided the low-level replay circuits of the recorder are tailored to accept them, but in the latter case the battery recorder must be capable of recording a tape that is acceptable by the playback channel of the domestic machine. This is mentioned because recordings made by some battery models sound pretty grim when

(continued on page 29)



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Signal-to-noise ratio:	Better than 48 dB (at peak record level).	Weight:	41 lbs. 10 ozs.
Harmonic distortion:	Less than 3% at 0 dB line output.	Accessories:	Stereo recorded 5" tape, 7" reel. Two SONY dynamic microphones (F-96). Integrated record replay connector type RK-46 60c/s Motor pulley. Reel cap. Head cleaning ribbon, Splicing Tape.
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Tone controls:	Separate controls for bass and treble.		
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played back on the main machine. High noise and treble and bass loss are common symptoms which show up in the wider playback spectrum of the better quality machine, and as a consequence the battery model may not be used as often as it could for field activities.

Some of these problems will be considered as we explore the circuits of the battery models, and we will start off with the simpler type of machine which employs a common channel, switched over record and playback.

This is shown in the form of a basic block diagram in **fig. 1**, in which switches S1 to S7 are mechanically ganged to the record/playback control on the deck. They are all shown in the *playback* position on the diagram.

Following the playback signal from the head, we see that it passes through S3 and S1 to the input of the amplifier, and that this is equalised for playback by S2 connecting the appropriate equalising networks and filters.

The equalised playback signal at the output of the amplifier is taken by S4 to the input of the playback output stage, which seconds as HF oscillator in the *record* position, but when switched to playback the oscillator fails to work since its tuned circuits are disconnected by S5 and S6. The playback audio is finally fed to the speaker through S7, which also disconnects the erase head circuit.

In practice, the above description may not match all models, and some models may have more or less switch sections, depending upon specific design. Indeed, some of the better class machines will be found to incorporate a separate singled-ended or push-pull HF oscillator which then allows the playback output section to monitor the recording signals while a recording is being made.

One, two or sometimes three transistor stages are used in the front-end of the recording/playback amplifier, and sometimes an extra stage comes into operation in the record position to give extra boost to the microphone signal or to act as a matching artifice between the microphone and the main amplifier.

With the machine switched to *record*, S1 substitutes the microphone signal for the head signal and S2 adjusts the equalisation. S3 and S4 connect the output of the amplifier, this time, to the head and the playback output stage turns into an oscillator by S5 and S6 applying the appropriate feedback tuned circuits. The speaker is disconnected from this modified stage by S7, which also directs the HF signal to the erase head. HF signal is also

applied to the head which is now carrying the recording signal, via the bias filter network.

It will be instructive to look at the various stages of **fig. 1** block diagram in circuit form and then compare them as we go along in playback and recording modes.

In the first instance, both the microphone and playback head signals are extremely weak, so the amplifier must make a particularly good job of lifting these signals with the minimum amount of distortion and noise, so that they will be of sufficient level to operate the subsequent stages with little or no impairment of quality.

A typical first stage is shown in **fig. 2**. Now, from last month's article we will recognise this as a common-emitter amplifier, but with one or two additional components. The transistor is a *p-n-p* type, therefore requiring a negative potential on collector and base, relative to emitter, to bias the emitter junction for forward conduction and the collector junction for reverse conduction.

The small negative bias required for the base is tapped off at the junction of R1/R2, which forms a potential-divider across the supply line. The ratio of R1/R2, therefore, gives the bias required to set the collector current to the class-A working point which, for low-level amplifiers, is used for transistors as well as valves.

As an example, a small signal transistor may require a base current as low as 10µA to give a collector current of about 1mA which, incidentally, signifies the transistor *current gain*. That is, the collector current divided by the base current, giving a gain of 100 in the example. Now, to obtain this base current of 10µA, a potential of about 250mV may have to be applied across the emitter/base junction, and this potential is tapped from R1/R2. In practice, a small counter-potential is developed across the emitter resistor R4, since through this flows both the collector current and base current.

Two important factors of all transistor circuits concern the stabilising of the DC working point and the prevention of an effect called *thermal runaway*. The working point is stabilised by R1/R2 and thermal runaway is prevented by the emitter resistor R4. It works like this: Any increase in collector current due to temperature rise of the junction produces a corresponding increase in voltage across R4, which makes the emitter go more negative with respect to the base. This, of course, is the same as the base going more positive with respect to the emitter. This reduces the forward current in the emitter

junction and pulls back the collector current towards its correct value.

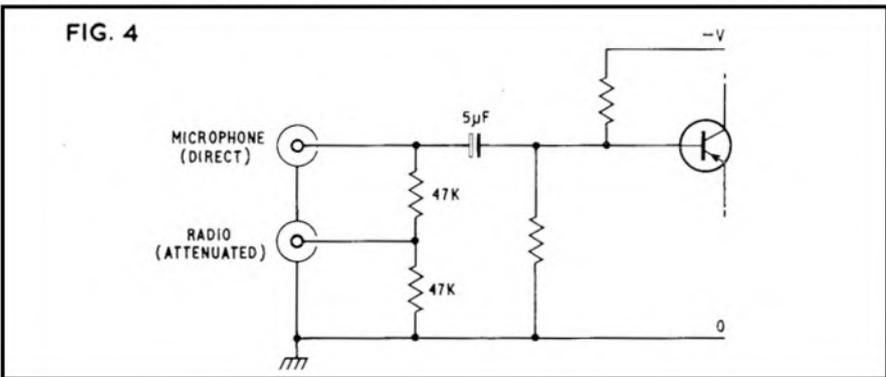
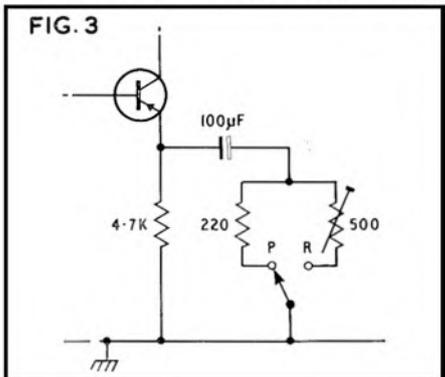
Earlier articles showed that reverse conduction tends to increase across a semi-conductor junction as the junction temperature rises. This results from a multiplication of minority carriers, and because it increases the power dissipation of the junction it causes a rise in temperature. The effect is thus aggravated, causing more current to flow, then a higher temperature and so on in a chain reaction until the transistor 'fuses' if the external circuits can supply sufficient current. The emitter resistor prevents this from happening.

From the signal aspect, however, this resistor by itself can cause negative feedback, the same as an unbypassed resistor in the cathode circuit of a valve, but in **fig. 2** it will be seen that R4 is, in fact, bypassed by a 100µF electrolytic capacitor. The impedance of this is sufficiently low to bypass even the lowest of signal frequencies. Thus, from the signal's point of view there is very little impedance (i.e., AC resistance) in the emitter circuit and no signal is developed here to cause degenerative or negative feedback; but so far as DC is concerned there is resistance and hence DC feedback.

The first stage is rarely equalised to any extent, and it often serves as a frequency-flat amplifier on both record and playback. However, a simple frequency-correcting arrangement is sometimes switched into the emitter circuit, and this takes advantage of the negative feedback effect mentioned above. Such an arrangement is shown in **fig. 3**, where it will be seen that the emitter resistor is not shunted directly by the 100µF electrolytic. Instead, it is shunted by the capacitor *in series* with a resistor, and the value of this resistor changes from playback to record, and vice versa.

Now, the maximum shunting of the emitter resistor occurs when the impedance of the capacitor to the signal is many orders below the resistance of the emitter resistor. It will be recalled that the impedance of a capacitor becomes higher as the frequency falls, and at DC, of course, there is no reactance at all (i.e., effective open-circuit). Assuming that the capacitor is valued to have a very low impedance at the lowest signal frequencies handled, then there is no degenerative feedback, even at low signal frequencies. The presence of a series resistor, however, alters matters, mainly in terms of stage gain when the capacitor is of a very low value. The ordinary emitter resistor satisfies the DC requirements, while the capacitor-coupled shunt resistor applies always

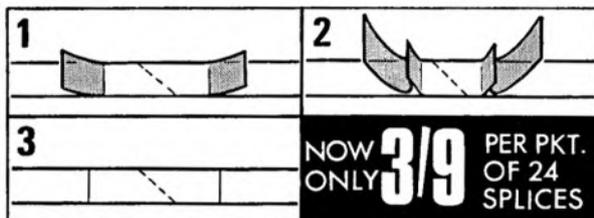
(continued on page 39)



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SOME GENERAL GRUNDIG PROBLEMS

BY H W HELLYER

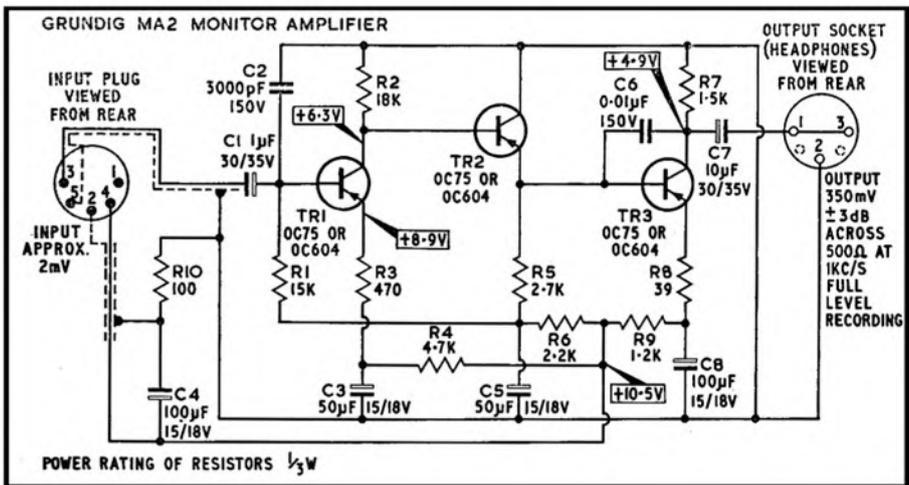
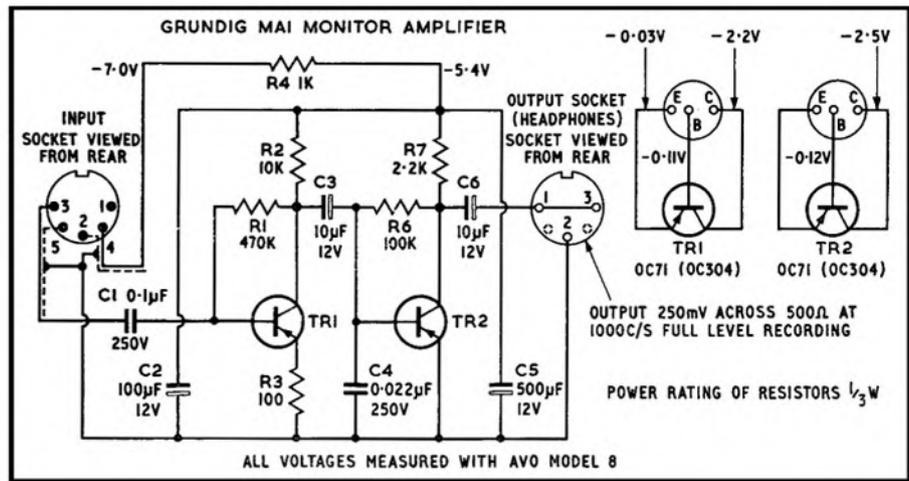
The above recorder is shown as it was actually delivered to Grundig. It is a gentle reminder that over-enthusiastic amateur servicing can do more harm than good! Meanwhile...

THE longer this series of articles goes on, the more I feel like Scheherazade, spinning out a never-ending series of tales as if my life depended on it.

Never-ending, for the number of machines, and variations of design, proliferate with each season. Some of this type-juggling, no doubt, has sound technical reasons for its un-nerving persistence. Some would appear to be governed by a compelling need to greet each trading period with a face-lift, and scant regard for any improvement to the gubbins within the box. Others greet each technical innovation with a wild hail and build fancy gewgaws that soon out-date—if they have not disintegrated meanwhile!

SOLID WORTH

Not so Grundig. There is no question about the solid worth of their early machines, which still soldier on faithfully. In my own workshop, a regular influx of *TK5*, *TK9*, *TK820* and *TK830* veterans adds to the weekly intake. Servicing these models can be a bit taxing, especially where some well-meaning predecessor has tinkered with leaf-springs or relays; but we have grown used to the regular faults and can generally cope, only being beaten on the odd occasion when special spares are not obtainable. Belt-changing has become second



nature, and the dexterous twist of the guide cylinder to present an unworn face, the cleaning and softening of clutch felts, adjustment of brakes, etc., are almost instinctive. We begin to wonder how the makers can expect to sell new models to the proud owners of these 'battleship' machines.

FINING DOWN

Yet the new types continue to appear, and with each batch we note a fining down process. The latest models, with their cord-grip brakes, much lighter motors and mechanical drive sections, seem strange at first—as if some other company had taken over the production. Until we study the circuits and see the characteristic switching, the little touches of equalisation and other correction, the decoupling and bias, and know that we are again handling a machine that is capable of being brought up to a true maker's specification when bench test is needed.

Praise? Well, why not? Any workshop that handles a wide variety of machines will afford an opportunity of making comparisons, and this struggling technician says it is more than mere mass-production technique that enables this firm to market models of good quality at competitive prices.

Nevertheless, there are snags; there are

draw-backs, and little peculiarities that catch people out. Our workshop handles the work for two branches situated in major ports and we have a fair proportion of 'imported' machines arriving for service. We also get the occasional request to modify hi-fi gear for shipboard use, or installation in another country.

Here we need to point out one snag. Voltages (AC, of course!) can be transformed—that is little trouble, and most machines are capable of having their power supply circuits altered to take any local supply. Those that are not can soon be adapted.

Frequency is quite another problem. In this country, we employ a 50Hz mains, as most people know. Other countries may use 60Hz. Whereas a transformer designed for one will work at the other—if a little less efficiently—a motor will not do its job correctly, being 'tied' to the mains frequency by its design.

EXTERNAL CONVERSION

Some manufacturers, such as the AEG company who market *Telefunken*, will supply an alternative 50 or 60Hz capstan for the motor to get over the problem of varying speed with frequency. But Grundig advise that the conversion is best carried out externally, by

(continued on page 33)

hear ye!

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a microphone windshield

M. G. SKEET DESCRIBES A USEFUL ACCESSORY

AN article by Ralph West in the April 1963 *Tape Recorder* has prompted this variation of his design. Undoubtedly his device, to allow a ribbon microphone to be used outside, performed well, but as he states, it "... was only wanted for dawn chorus recording, looks were not important". Here, then, is a design which can be used in broad windy daylight and which is more suited to the hand-held stick microphone. Cost is around 10s. the main items being four sieves obtainable from *Woolworths* with $3\frac{1}{4}$ in. diameter and $\frac{3}{64}$ in. mesh.

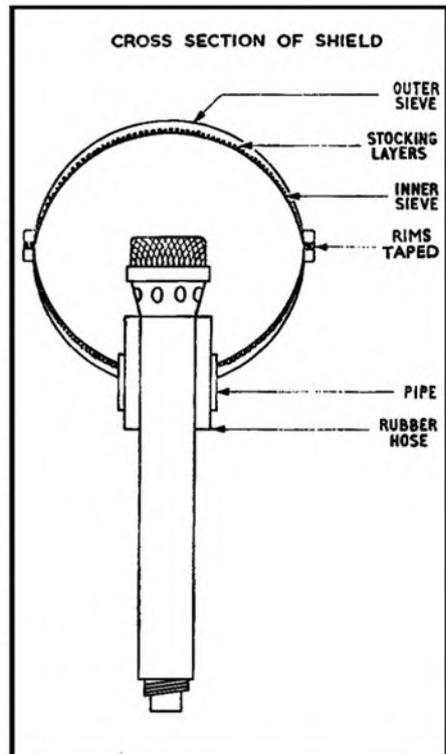
The basic principle is that a pair of sieves are put one inside the other and several layers of ladies' nylon stocking (acknowledgements here to Mr. West) are imprisoned in the gap between each pair of sieves. The diagram shows the basic arrangement. Both inner sieves have the rims removed; this is easily accomplished with sharp pointed scissors. The mesh does not fray. An easily-stretched thin plastic tape holds the completed halves together. The fixing of the shield to the microphone body caused the most heart-searching. Eventually a rubber hose was found that slid over the body of the microphone from the connector end. The search continued for a brass or copper-something easily soldered—pipe with internal diameter that passed over the head of the microphone and fitted snugly over the rubber hose.

Two points to note here. Not all stick microphones are enlarged at the head end. If a cardioid microphone is used no obstruction

must occur to any slots or holes at the rear of the head or along the body. Also if any of these slots or holes are outside the windshield, it is unlikely that the windshield will be fully effective.

The best assembly order is as follows:—
Remove handles and hooks from all sieves. Cut central holes in both lower sieves to allow the pipe to pass through. Solder pipe to inner lower sieve and remove rim from both inner sieves. Put five or more layers of ladies' nylon stocking between each pair of sieves. The number of layers depends on the degree of protection required and how wind-sensitive the microphone happens to be. Stockings of 15 denier material are satisfactory. In the case of the lower pair of sieves, cut a hole in the stocking material to allow the pipe to pass. Trim excess material from between the pair of sieves. Tape together each completed half of the shield. Finish off by fixing the lower outer sieve to the pipe. This can be done by binding with a few turns of tinned copper wire and soldering. Too much heat may damage the nylon stocking.

From the performance point of view no audible effect on frequency range was detectable. The excellent cardioid characteristics of the particular microphone shielded, the *Fi-Cord FC901*, appeared to be unaffected. Diaphragm disturbance, usually severe, does not occur in winds of many times the strength of the breezes that previously made outside recordings useless.



TAPE RECORDER SERVICE CONTINUED

feeding the machine with its required voltage at the right frequency from a properly designed converter. These items can be a bit expensive, but are certainly the best solution if the machine is likely to be brought back to home waters at some future time. Convertors for the purpose, and for operation from car battery, etc., can be obtained from *Valradio Ltd.*, 57 Fortress Road, London N.W.5.

Although Messrs. Grundig favour this approach, they will supply 60Hz motor pulleys for some machines, and the conversion entails this change plus removal of a compensating bracket, easily tackled by depressing the fast-wind key and pushing the right-hand clutch from the idler. On some models, it is also necessary to resolder the voltage selector leads to alternative tags—which are marked.

Another point often raised is that of connection of a normal, i.e., AC mains-operated, tape recorder to external equipment, also mains powered, but possibly AC/DC. The classic example is the television receiver, which

has its valve heater chain in series, with a ballast resistor dropping the voltage from full mains supply, and a half-wave valve or metal rectifier for high tension voltage supply. This type of circuitry, whose only real virtue is manufacturing economy—whatever the advertisements may say—by the omission of an expensive mains transformer, means that the chassis of the apparatus has to be directly connected to one pole of the supply. This should be the neutral pole, giving the maximum protection against inadvertent bridging of live and earth poles, which is dangerous and could be lethal.

NEON LAMP

In my opinion, all such apparatus should be obliged to have a neon lamp fitted, as a 'Danger' warning if the mains connections are reversed. This is not simply chagrin at having received a number of shocks in my daily work—more than once the mains supply has been wrongly wired at the power point. It is a common-sense protection of those who have to handle the equipment and who may have no knowledge at all of electricity.

Correspondence with readers has revealed one disturbing fact: many people are under the impression that all that is needed to afford protection is a pair of capacitors between the two pieces of equipment, or better still, a transformer. This is at best a half-truth, at worst an invitation to disaster.

A little thought will show that the capacitor theory breaks down on two fronts. First, the capacitor simply offers a path of alternative impedance to AC—you might just as well stick your fingers in the power socket as use a capacitor to connect it. Secondly, the use of a capacitor in the earthy line of a signal connection is an open invitation to hum.

The transformer approach is a different matter. While it is true that a transformer affords the necessary isolation, it must be remembered that to give protection against mains voltages, it must have sufficiently good insulation between primary and secondary and between secondary and core to withstand the mains-plus-signal voltages. Thus, an audio transformer is no solution. There are specially developed transformers, such as the *Wharfedale*

(continued on page 41)

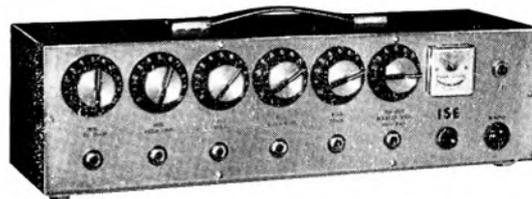
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5½"	1200'	16/-	10/6
7"	1800'	23/-	14/-
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STEREO ON A SHOESTRING

THE cheapest stereo tape recorder—and the first stereo mains/battery portable—is now being manufactured by Aiwa. Retailing at £46 4s., the TP.1002 offers ¼-track stereo, recording from high level source or dynamic microphones (supplied), and replay through separable loudspeakers. Speeds are 3½ and 1½ i/s and the spool capacity is 5in. A single meter, switchable from one channel to the other, indicates recording level and, on replay, battery voltage. Separate gain controls are provided for each channel, while a three-position switched tone control caters for both left and right. A 4 x 2½in. speaker is located in the recorder, a second unit being supplied in a detachable plastic cabinet. Output power is 500mW per channel. AC record and DC erase bias are featured by the 3½ x 11 x 15in. machine, which weighs 10 lb. including internal mains unit.

Of similar appearance and specification is the TP.712, a monophonic mains/battery portable with automatic gain. This machine sells at £27 16s. 6d.

Distributor: B. Adler and Sons (Radio) Ltd., Coptic Street, London W.C.1.

FIDELITY PLAYTIME

ONE of the first recorders to be designed around the new BSR three-speed tape deck is the Fidelity Playtime. Claimed frequency range at 7½, 3½ and 1½ i/s is 70 Hz-15 kHz, 70 Hz-9.5 kHz and 70 Hz-7 kHz respectively. Wow and flutter at the fastest speed is quoted as 0.15% RMS. The Playtime takes spools of 5½in. diameter and features a three-digit instant-reset position indicator. Output power is 3W, noise level being quoted as -50dB. Half and ¼-track versions are available, at respective prices of £26 5s. and £28 7s.

Manufacturer: Fidelity Radio Ltd., Olaf Street, London W.11.

SENNHEISER CARDIOID MICROPHONE

LOW-price newcomer to the Sennheiser microphone range is the MD 411 moving-coil cardioid. It is described as a "younger brother" to the MD 421 and has less features and a slightly wider performance tolerance in return for a substantial price reduction. The £13 9s. MD 411 is superficially similar to the £31 12s. 6d. MD 421, but lacks the latter's variable bass attenuator and hum-cancellation coil. A triple-impedance transformer is incorporated, giving a choice of 25K, 800 ohms and 200 ohms. The cardioid characteristic is claimed to extend well into the bass region, making the microphone suitable for feedback-free PA use.

Distributor: Audio Engineering Ltd., 33 Endell Street, London, W.C.2.

ANTEX SOLDERING KIT

ALTHOUGH several kits incorporating soldering 'guns' are now available, kits with conventional irons seem a comparative rarity. Antex recently commenced catering for this market by introducing their Precision soldering kit, to sell for £2 9s. 6d. This comprises a CN 240 15W miniature iron, interchangeable ⅜in., ⅜in. and ⅜in. bits, reel of resin-cored solder, heat-sink, and cleaning pad in a durable plastic case. A 36-page illustrated book on soldering is also supplied.

Manufacturer: Antex Ltd., Grosvenor House, Croydon, Surrey.

DYNATRON STEREO RECORDER

DYNATRON are now marketing a three-head stereo tape recorder based on a Garrard deck. The STR.1 operates at 7½, 3½ and 1½ i/s, with respective quoted wow and flutter figures of 0.15%, 0.16% and 0.2%. Two VU-meters and a four-digit instant-reset rotation counter are featured, along with separate bass and treble tone controls. The deck employs a Papst motor and has a solenoid-controlled auto-stop. Output power is 3W per channel. The STR.1 measures 15 x 13 x 6½ and costs £82 19s.

Distributor: Dynatron Radio Ltd., St. Peter's Road, Furze Platt, Maidenhead, Berkshire.

TRUVOX BELGRAVIA

TRUVOX are now marketing a silicon-transistor recorder based on their Series 100 deck. The RB.102 (¼-track) and RB.104 (½-track) Belgravia models are of similar appearance to the current R102/4 recorders but have the additional feature of a wooden cabinet, with teak finish and slotted loudspeaker grille. Both the new designs have been priced at £96 13s., including 7in. tape, dynamic microphone, and accessories.

Manufacturer: Truvox Ltd., Neasden Lane, London, N.W.10.

BSR PRODUCE A NEW DECK

LIGHT mechanical push buttons, speeds of 7½, 3½ and 1½ i/s and a pause control are features of a completely new deck now being manufactured by BSR. The TD20 is attractively styled and has a spool capacity of 5½in.



Knurled-wheel or push-button re-set counters may be fitted to order. Dimensions of the deck are 12½ x 10 x 4 ⅞in. and the price is £14 (¼-track), £15 (½-track). The TD2 and TD10 decks will continue to be produced.

Manufacturer: BSR Ltd., Monarch Works, Old Hill, Staffordshire.

ALBA MARKET MAINS/BATTERY PORTABLE

MANUFACTURED by Sanyo, the Alba R19 mains/battery tape recorder features interchangeable capstans giving speeds of 3½ and 1½ i/s. Spool capacity is 3in. and overall dimensions are 10½ x 8½ x 3in. The recorder is supplied complete with microphone, mains lead and miniature jack patchcord. Price is £24 3s.

Retailing at £29 18s. 6d., the ¼-track Alba R18 employs a BSR TD2 3½ i/s deck and incorporates a four-valve amplifier with an output power of 4W. Separate bass and treble controls are fitted, with Phono sockets permitting connection of microphone, gram, monitor and external speaker.

Manufacturer: Alba (Radio and Television) Ltd., Tabernacle Street, London E.C.2.



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Telefunken M.24 Professional Tape Recorder	£90
Uher 4,000L Portable Tape Recorder with Mike	£70
Loewe-Opta 416 Battery/Mains Portable Tape Recorder	£30
EMI-L.4. Portable Tape Recorder with Mains Charger, Grampian DP4	£90
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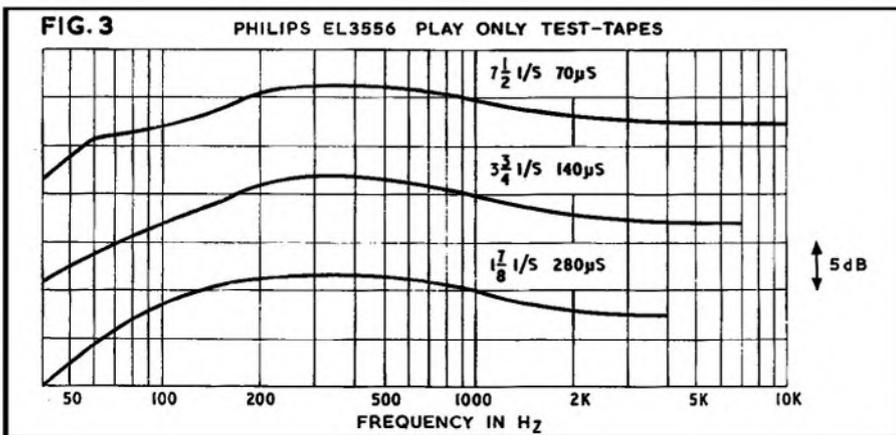
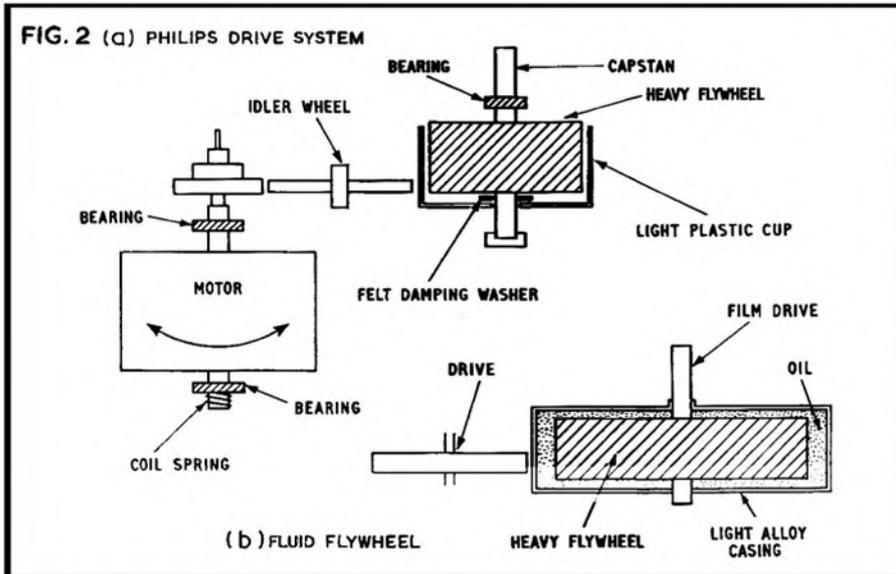
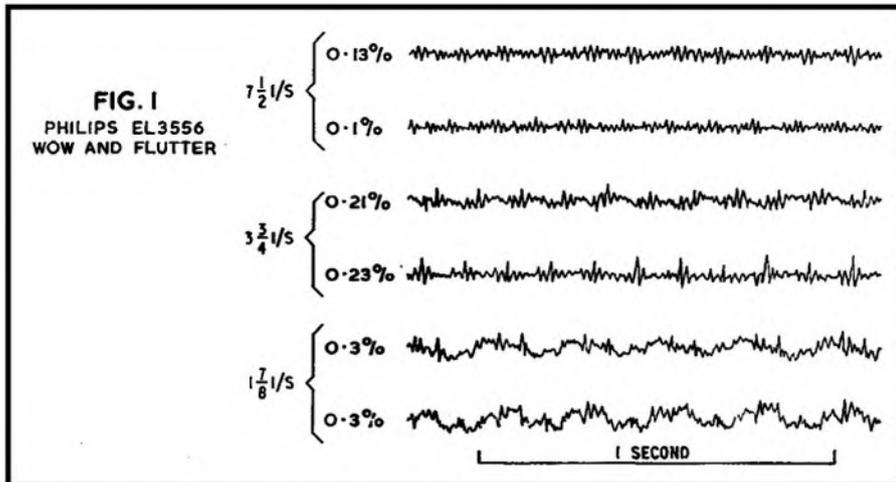
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equipment reviews

PHILIPS EL3556



THE Philips EL3556 is in the higher price bracket for a mono 1-track recorder, but it offers a very wide range of tape speeds, a higher than usual power output and wide range bass and treble tone controls to make the best possible use of the well equalised responses on internal or external loudspeakers.

At the lowest speed of 1 7/8 i/s a 7in. reel of double play tape will play for 8 hours per track—32 hours per reel. The four digit counter gives you a fair chance of finding a given item within about five minutes maximum spooling time to an accuracy of about plus or minus five minutes, always providing that you have remembered to set the counter at the start of the tape—the instantaneous re-set button helps here—and providing you know which of the four tracks contains the item you want! Personally I never remember to re-set the counter no matter how simple it is made for me. What is needed for my kind of memory is an automatic re-set when the tape reaches the end of rewind—with foil operated auto stop it is only a further small step to add a lever to re-set the tape position counter.

The wow and flutter performance of this machine is not at all outstanding—a 50Hz flutter is evident at all speeds, with a 4 and 2Hz wow at 1 7/8 and 7/8 i/s respectively, fig. 1. This is all the more remarkable when the drive system is examined and the design principles understood. Although not fully effective in this machine, the basic ideas are good and have in fact been used in professional recorders and film drive systems for many years.

Fig. 2a shows the Philips drive system. The motor complete with its own bearings, drive spindle and stepped pulley is mounted coaxially on further bearings so that the body of the motor is free to rotate over a small arc. A light centring spring is used to hold it in its mean position. As used in a large Ampex instrumentation recorder with the lowest wow and flutter ever measured, any imperfection in

(continued overleaf)



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PHILIPS EL3556 REVIEW CONTINUED

the drive to the flywheel, which in the Ampex weighed about 30 lb. and was, as I remember it, of about 30 in. diameter, reacted on the motor so that it rotated to take up the fluctuation while the cartwheel, sorry *flywheel*, continued its even rotation undisturbed.

In the Philips drive, the idler wheel drives a light plastic cup which is coupled to the flywheel proper by a felt damping washer, the idea again is that the plastic cup absorbs any drive imperfections while the flywheel continues on its merry way undisturbed.

Fig. 2b shows the film drive version of this filter which was known as a 'fluid flywheel'. Again the outer drum is driven from an imperfect drive system—usually gears to provide absolute synchronisation in the film system—and the flywheel which drives the sound scanning drum is coupled only through a thin film of viscous oil. This was so effective that the drive could be stopped and started again with the flywheel motion almost undisturbed.

I am afraid that the two low frequency filter systems are not compatible, the suspended motor should drive a *very* heavy flywheel, many times its own weight, while the decoupled flywheel should cope with minor speed changes if properly designed. Probably one or the other would be more effective in the recorder under discussion.

The playback equalisation was checked to line output by playing test tapes recorded to standard CCIR DIN recording characteristics of 70, 140 and 280µs. The resultant responses of fig. 3 indicate that the Philips playback equalisation is nearer the NAB time constants of 50, 100 and 200µs.

System noise with no tape passing the heads was 35dB below test tape level at 7½ i/s, -33dB at 3½ i/s, -32dB at 1½ i/s and -29dB at ½ i/s.

Record-play responses to line output are shown in fig. 4 and these meet the specification at the two higher speeds, but fall a little at the high frequencies at the lowest speeds.

Overload tests at 500Hz showed that visible waveform distortion coincided with closing of the beams in the magic eye record level indicator at about 10dB above test tape level. Thus unweighted signal-to-noise ratios ranged from 45dB at the highest speed to 39dB at the very low speed of ½ i/s although it was found advisable to record at about 6dB lower mean level (magic eye beams only closing to ¼ in. gap) at the two lower speeds to avoid sibilant splash caused by extreme high frequency pre-emphasis in recording.

The tone controls only operated on the output stages, so that their effect on the sound output of the internal speaker was measured by recording 25 one third octave bands of filtered white noise at 7½ i/s and measuring the sound output on the speaker axis at central and extreme settings of the bass and treble tone controls. The solid curve of fig. 5 shows the response in the mid position of the controls, and the dotted upper and lower curves show the sound output at full clockwise and anti-clockwise settings.

The response of the microphone supplied with the recorder was also measured in a white noise sound field to give the response of fig. 6.

FIG. 4 PHILIPS EL3556 RECORD-PLAY RESPONSE (LINE IN/OUT)

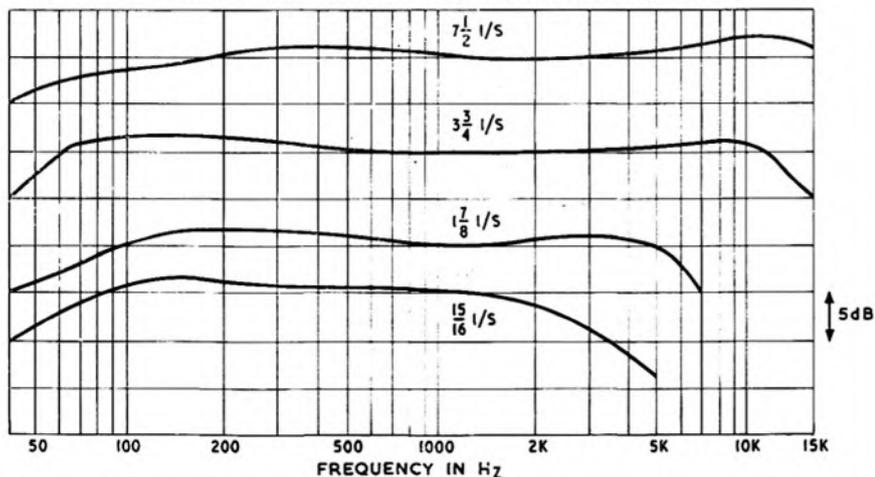


FIG. 5 PHILIPS EL3556 ACOUSTIC RESPONSE

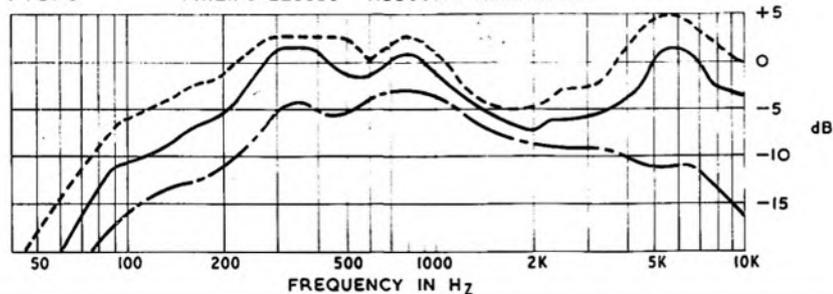
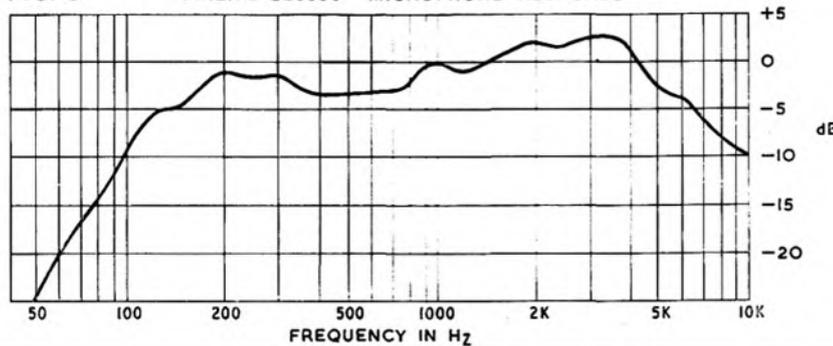


FIG. 6 PHILIPS EL3556 MICROPHONE RESPONSE



This is a good quality domestic recorder well suited to family use on its own internal speaker system. The independent bass and treble tone controls allow the sound quality to be set to suit all tastes and listening levels. The line output is adequate to feed external amplifier and speaker equipment although the high frequency flutter may become noticeable on certain kinds of programme material on true hi-fi equipment. **A. Tutchings.**

BATTERY TAPE RECORDERS CONTINUED

a little negative feedback, depending upon the resistor's value. The higher the value, the greater the feedback and the less the stage gain. It is thus possible to obtain two gain conditions, one for record and the other for playback, by switching two resistors, as in the circuit. The resistor which is switched in on record is variable, meaning that the record gain can be

adjusted to suit the microphone (or programme signal) level.

Moreover, if the reactance of the capacitor allows some feedback to occur from the main emitter resistor, the resistor in series with it can be adjusted to tailor the low-frequency end of the response a little. In this way, bass attenuation would result, and the roll-off could be adjusted by the value of the series resistor. Tricks such as this will be found in various models, and they are just as well to remember.

When there is just one first stage, as in fig. 3, signals of higher level than those delivered by an ordinary microphone are accommodated by feeding them through an attenuator network. This, in fact, is common practice in battery models. Sometimes there is a small slider-type switch, microphone input in one position and radio or pickup in the other, but mostly an arrangement similar to that shown in fig. 4 is used.

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TAPE RECORDER SERVICE CONTINUED

WMTI, to couple a loudspeaker output to a low impedance input, and this is one way of connecting AC/DC equipment to the tape recorder. But it prevents take-off at a high impedance signal point, and at a pre-output stage point, necessary to reduce distortion.

The correct way of doing things is to use an isolating transformer, suitable for mains voltages, having a 1:1 ratio and capable of handling the mains power of the apparatus, to feed the AC/DC equipment, which can then be treated as a 'normal' AC item, and connected in whatever way we desire for best signal conditions—which is really the object of the exercise. Unfortunately, this transformer is rather an expensive piece of equipment.

A WORD OR TWO

Still on the subject of inter-connection, a word or two about the preamplifier circuits here. These are the two Grundig Monitor Amplifiers, used to extend the facility of the standard tape recorder. As can be seen, the MA1 is a simple job, using a pair of OC71 transistors and giving a quarter-volt from full recording at an output suitable to drive a low impedance headphone. (Low, in this case is a relative term—some 'phones are of less impedance.) This small amplifier, very neatly built, with a single flylead terminated by a 5-pin DIN plug, is now available on the surplus market and has been dropped by Grundig in favour of the more ambitious MA2.

The latter gives a better output, greater, with improved response, less noise, more stability, and is again designed to take the output from a head winding to power either an external amplifier or a monitoring headphone. By reconnecting to the tape recorder, sound-on-sound is possible, transferring the playback signal from one track to mix with the signal being recorded on the other. This is the same principle as we have seen Philips use with their EL3774 and 3787 amplifiers, but with less complicated circuitry.

STRAIGHTFORWARD AND EFFECTIVE

The two small amplifiers shown are quite simple, straightforward and effective. Now that the MA1 is cheaply available, it could be used to form the basis of a number of small projects. The circuit is built up on tag strips in a well-spaced screened box, lending itself to easy modification. No prizes are offered for clever ideas—we have seen enough of match-box TV and the like to be wary of set-shrinking designs!

As a final word, the matter of relative sensitivities for supplying a tape recorder with microphone and radio or gramophone pickup input has been broached. There is some misunderstanding about the machines which apparently offer similar inputs. These are generally the automatic recording jobs, and this subject is being dealt with elsewhere, so all I need to say is that the tape recorder takes care of the apparent discrepancy in level but—and it can be a big but—the impedance has to be watched. Input matching for the microphone is generally higher than for radio, to preserve the frequency range.

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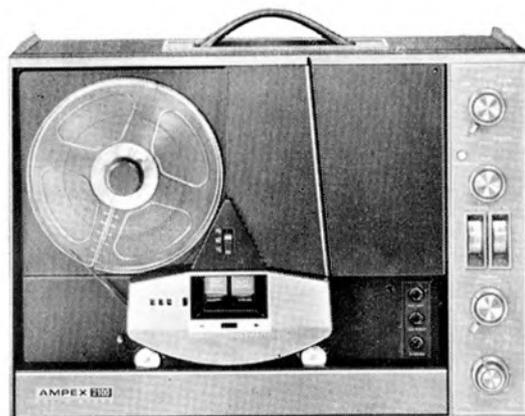
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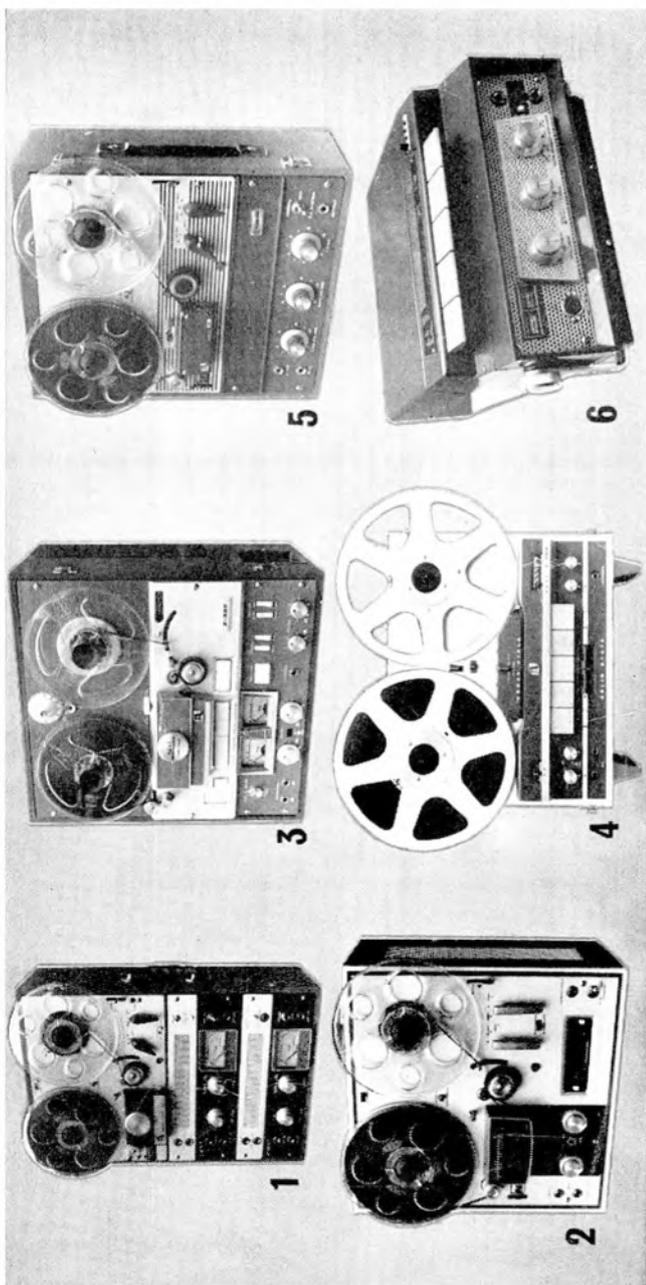
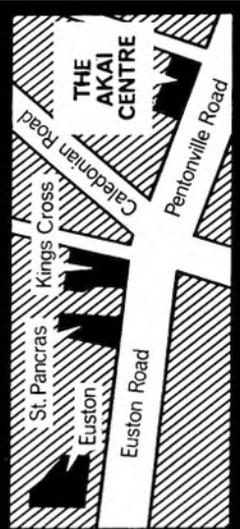
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