

JULY 1968 2s 6d

tape recorder

CHOOSING AND USING
A MICROPHONE

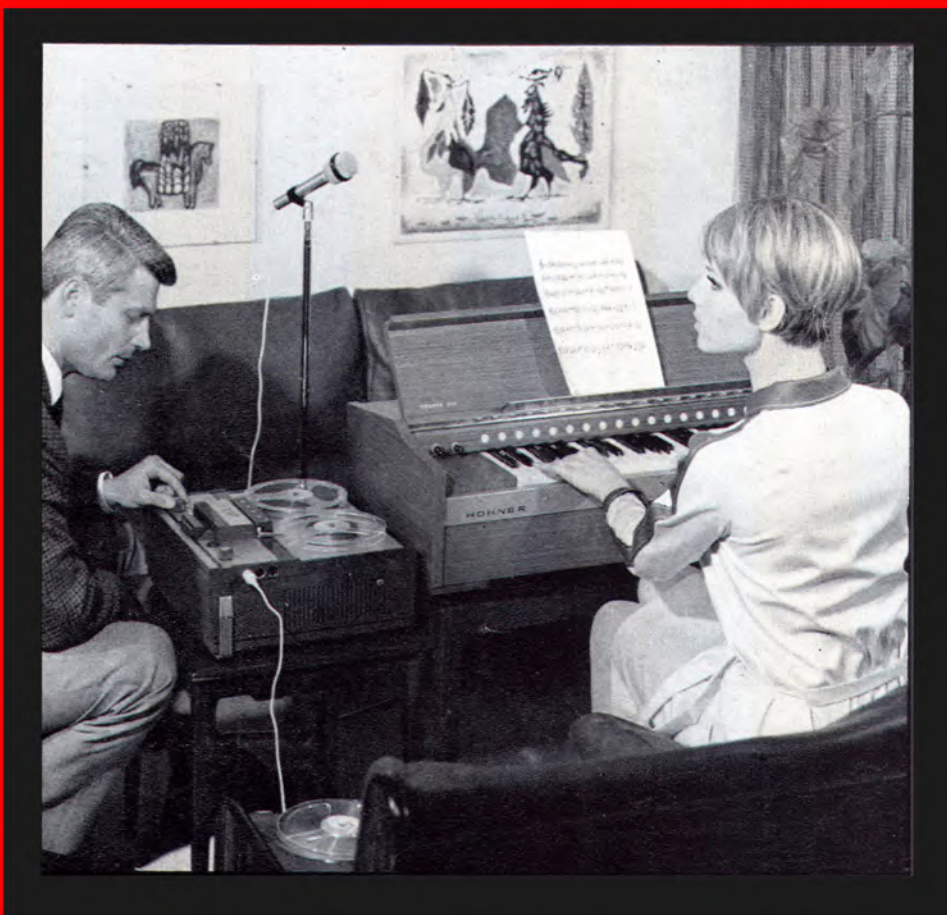
PRACTICAL TEST OF
FIVE MICROPHONES

TWO MICROPHONE
MOUNTING ACCESSORIES

SURVEY OF DYNAMIC,
RIBBON AND CAPACITOR
MICROPHONES

AKAI 3000D REVIEW

AUDIO FAIR REPORT



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4"	450'	14/9	12/-	*7"	2400'	79/-	63/6
4½"	600' BASF, Agfa only	22/-	18/-	10"	4600' Agfa only	140/9	112/9
*5"	900'	29/2	23/9	TRIPLE PLAY			
*5½"	1200'	36/5	29/6	3"	450' Not Scotch	22/3	18/-
*7"	1800'	51/7	41/9	3"	600' Scotch only	24/10	19/9
8½"	2400' BASF, Scotch only	74/-	59/6	4"	900'	40/-	32/3
10"	3280' Agfa only	85/9	68/9	*4½"	1200' Agfa, BASF only	50/-	40/3
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10½"	4200' Agfa, BASF only	113/6	91/6	5½"	2400' } Agfa, BASF only	91/4	73/6
SCOTCH DYNARANGE (L/P)				7"	3600' } only	116/6	93/6
5"	900'	32/8	26/3	QUADRUPLE PLAY			
5½"	1200'	41/-	33/-	3"	600'	37/-	29/6
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BASF PES.35 L/P Low Noise				COMPACT CASSETTES			
5"	900'	36/10	29/9	C.60	17/6	14/3	
5½"	1200'	45/6	35/6	C.90	25/-	20/3	
7"	1800'	63/-	50/9	C.120	33/6	27/-	
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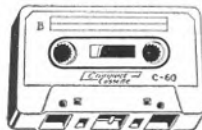
	LIST PRICE	ONE	THREE	SIX
BN7 1200' on 7" reel (Dynarange)	50/-	40/-	117/6	230/-
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1800' on 5" reel Gevasonor	66/-	41/6	122/-	238/-
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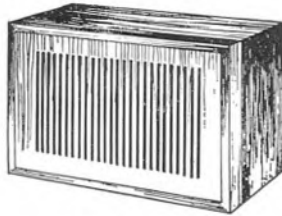
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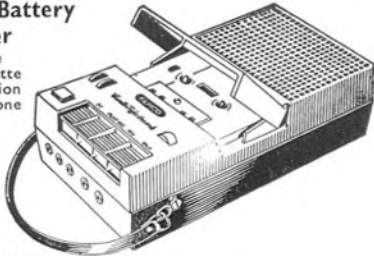
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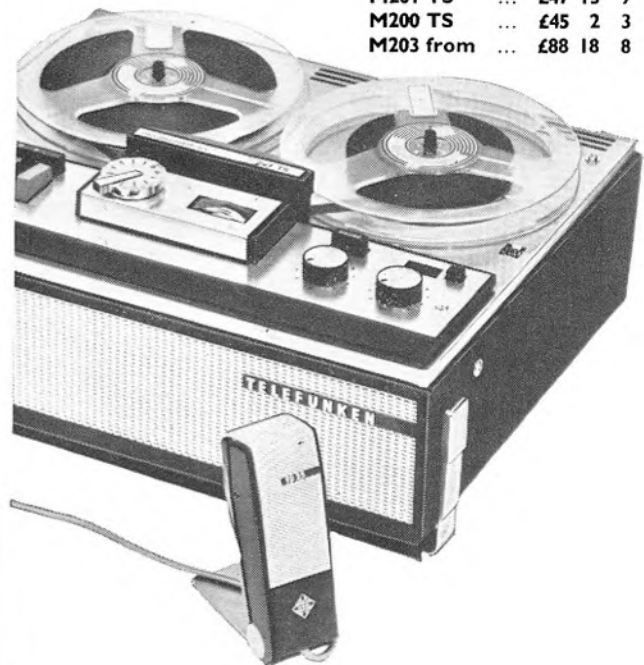
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JULY 1968 VOLUME 10 NUMBER 7

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COVER PICTURE

The question of recording electronic keyboard and electromagnetic string instruments is touched upon elsewhere in this issue. Switching noises can disrupt electronic organ recordings made from a direct line source, though the alternative microphone/loudspeaker combination creates coloration and distortion. An electric wind organ is a possible answer to the problem! The *Hohner* on our cover is indirectly connected to a *Uher 724L* recorder.

SUBSCRIPTION RATES

Annual subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 36s. and 41s. respectively. Overseas subscriptions are 38s. 6d. (U.S.A. \$4.60) for *Tape Recorder* and 42s. 6d. (U.S.A. \$5.10) 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.

IT IS THE AIM of enthusiast journals such as ours to maintain factual accuracy in published articles, while at the same time provoking readers into active pursuit of their hobby. Occasionally, a lapse in the first endeavour can create a sharp rise in the second—nothing is so controversial as an error. In truth, however, the error in our May Editorial was not deliberately contrived to provoke letters from multi-track musicians or *Ferrograph* designers, even though, once received, these communications are thrust eagerly into the correspondence column.

As Malcolm Hill explains in his letter on page 320, one of the seven complaints in our "carping Editorial" was invalid. This one misplaced moan was not due to any lack of theoretical knowledge, however; merely to increasing impatience with 'push it and see' control formations that were meaningless without an operator's booklet. The recorder in question was not a *Bang & Olufsen 2000*—as many owners hastened to point out—but a *Tandberg 64X*. The programme source was a *Hofner* cello acoustic-electric guitar.

The source of our error lay in the assumption that a stereo recorder was potentially capable of recording an A track and later reproducing this while simultaneously accepting a parallel signal for the B track. Our motive was partly to retain the left/right separation of melody and accompaniment.

The Japanese stereo recorder on which the experiment had commenced possessed little more in the way of electronic controls than a track selector and two potentiometers governing record/replay gain. But even with this minimum of features it could easily have been converted to give the modest facilities we required. The moral of our Editorial was that the recorder should not have needed such modification. To achieve true multiplay (live source plus Track-A on to Track-B) an additional potentiometer was required, which would increase costs; however, simple 'sound with sound' facilities entailed nothing more than re-wiring of the track selector and input/output connectors.

Since preparing the May Editorial we have successfully produced multi-track recordings on a *Tandberg 62*, the *64X*, a *Revox A77* and an *Ampex 753*. But success is a relative term, since mechanical and tape deficiencies limit the resultant quality. None of the recordings compared favourably with 38 cm/s tapes made more conventionally with *Revox 736HS*, *Ferrograph 2A/H* and *Brenell Mk. 5* recorders. We had to buy the *Ferrograph* and borrow the *Brenell* to prove the point, due to a reticence among certain manufacturers in submitting equipment for review.

In mentioning the virtues of certain 'mature' designs, we find ourselves returning to the subject of the June Editorial, which gave the recently applied 33% purchase tax as a further reason for not buying new low-price domestic

recorders. By way of a postscript, we would quote the recent experience of John Shuttleworth with an eight-year-old *Ferrograph* Series 4. This machine was brought to him with a badly split cabinet after being dropped on to a stone floor. Wow and flutter was measured as 0.14% RMS to the end of the reel, frequency response being 50 Hz—12 kHz ± 0.5 dB with 2% distortion and 52 dB signal-to-noise ratio—all well within 19 cm/s specification. The cost of repairs amounted to the price of one tube of wood glue.

Finally, a complete change of subject. This issue is devoted largely to microphones and sees the first of several integrated subjective and objective microphone tests. Several contributors engaged in live recording will be assisting in the preparation of microphone trials to accompany formal reviews, and we hope to make this a regular feature in the course of the next few months.

FEATURE ARTICLES

- 301 TAPE TRANSPORT MECHANISMS
—Part 4
By G. T. Rogers
- 308 A PRACTICAL TEST OF FIVE
MICROPHONES
By D. P. Robinson and A. Tutchings
- 314 MICROPHONE SURVEY
- 319 ONE MAN'S MIXER—Part 2
By M. G. Skeet
- 321 CHOOSING AND USING A
MICROPHONE
By C. N. G. Matthews
- 323 TWO MICROPHONE MOUNTING
ACCESSORIES
By John Fisher
- 324 RECORDERS AND RECORDINGS AT
THE RUSSELL

REGULAR ITEMS

- 299 WORLD OF TAPE
- 305 TAPE RECORDER SERVICE
By H. W. Hellyer
- 320 READERS' LETTERS
- 334 CLASSIFIED ADVERTISEMENTS

EQUIPMENT REVIEWS

- 329 AKAI 3000D STEREO TAPE UNIT
By A. Tutchings

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STR-1 SPECIFICATION: Tape Speeds: 7 1/2, 3 3/4 and 1 7/8 ips. Wow and Flutter: Better than 0.15% rms on 7 1/2 ips; 0.25% rms on 3 3/4 ips; 0.35% rms on 1 7/8 ips. Tape size: 1/2" wide, Long or Standard play. Reel Size: Standard, up to 7". 5 1/2" spools and tape supplied. Digital Counter: 3 digit counter with zero reset. Heads: 1/2-track erase record and playback. Microphone: Moving coil hand microphone (mono) supplied. Semi-conductor Complement: 18 transistor, 1 silicon bridge rectifier. Frequency Response: 3dB, 40 c/s to 18 kc/s at 7 1/2 ips, 3dB, 40 c/s to 12 kc/s at 3 3/4 ips, 3dB, 40 c/s to 7 1/2 kc/s at 1 7/8 ips. Signal-to-noise ratio (unweighted): Better than 40dB. Inputs per channel: Microphone 0.35mV. Auxiliary 50mV. Outputs per channel: 4 watts rms into 15 ohms, 1 volt rms (1,000 ohms source). Speakers: Two, high efficiency 8" x 5" pm, 15 ohms. Power requirements: 200-250V AC, 50 c/s, 60 watts. Cabinet: Materials, 9mm. plywood covered with two-tone Rexine with chrome fittings. Dimensions: 19 1/2" wide x 7 1/2" high x 15 1/2" deep.

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ELECTRONIC MUSIC SURVEY

A SURVEY of studios engaged in the production of electronic music is being conducted by the Arts Council of Great Britain. Readers who themselves have experience of such composition, or who know of privately or jointly owned studios so engaged, are invited to contact Keith Winter, Music Assistant, Arts Council of Great Britain, 105 Piccadilly, London, W.1.



BLUMLEIN HONOURED

THE British Kinematograph, Sound and Television Society (BKSTS) met jointly with the Royal Television Society in London on 1st May to commemorate and honour A. D. Blumlein (1904-1942), whose many contributions to audio, television and radar have had lasting effects. Various people who had worked with Blumlein, or have used his ideas, contributed short talks on his life and activities, and it was of particular interest to note that, in addition to the work on stereo perception and recording for which he is famed, he conceived and developed one of the world's first completely electrical disc recording systems. He made a moving-coil microphone at a time when the idea was rare, and was responsible for the first use of techniques in microphone feeds and amplifier circuitry which we all take for granted today.

During the evening, Joan Coulson of EMI Records demonstrated some 78 r.p.m. discs made by Blumlein's team in the 1930's to illustrate stereo separation and other effects. But audio was only a part of his many and varied electronic activities. The gathering was attended by Blumlein's widow and two sons, the elder of whom contributed a few words.

IC TELEVISION RECEIVER

NEWS has arrived from Japan of a miniature television receiver based almost entirely on integrated circuits. Developed by Matsushita, the unit incorporates a 3.8 cm. screen and measures 13.7 x 8.2 x 4.4 cm. Power is from four U-3 nickel cadmium batteries,

NEXT MONTH

RECORDING FOR TELEVISION by Peter Bastin. *Understanding Bias* by Gerald Ghevin, and a description of the *Arriflex Electronic Cam System* by Richard Golding, will be among the features in our August issue, to be published on Saturday, 13th July. Alec Tuchings will review the *Ampex 753* while David Kirk field tests the *Revox A77*.

giving two hours continuous operation. The price in Japan will be in the region of 40,000 Yen (approximately £46.6.0.)

Smaller receivers have been produced by *Sony*, *Sinclair* and *Standard*, but this is the first to make extensive use of IC's. Some 230 components are required in a comparable conventional receiver.

NEW WORK ON KERR EFFECT

RESEARCH into optical replay of magnetic tapes by Professor Treves of the Weizmann Institute of Science and Philip Smaller of *Memorex* has solved the noise problem associated with Kerr effect techniques. Polarised light reflected from a magnetised surface changes plane angle by degrees dependent on the field orientation. The resultant beam may be converted into light of varying intensity which, in turn, is converted photo-electrically into a replay signal. Imperfections in the tape, however, have hitherto rendered the noise level too high for practical application. Messrs. Treves and Smaller, working at *Ampex Laboratories* in California, have evolved a two-layer tape comprising a high coercivity coating which stores the recorded signal and a low-coercivity read-out layer. The latter is subjected to an alternating field during replay which repeatedly reverses the polarity of 1 bit digits without affecting the O bit. Variations near the frequency of the applied field are detected by the replay circuit which consequently ignores noise created by tape imperfections. The system is expected to have applications in television recording and data systems.

BFOC COUNT THEIR SUCCESSES

THE past twelve months have been particularly successful for members of the *British Ferrograph Owners Club*, reports its secretary George West. Peter Bastin's winning contribution to the BBC *On the Move* contest, Roy Bannister's notable *British Amateur Tape Recording Contest* entries, and the success of Harold Wilde and Mr. West himself in winning the *Merseyside Tape Contest* are among examples quoted by the secretary. Confirming views expressed in our June Editorial, he adds that a substantial proportion of the membership use vintage *Series 2* and *3* models. **British Ferrograph Owners Club, 9 Red Hall Gardens, Leeds 17, Yorkshire.**

IMITATION ROBOTS AT THE IEA

THE Amazing Miss Honeywell' that attracted visitors to the *Honeywell Controls* stand at the 1968 *Instruments, Electronics and Automation* Exhibition was not in fact a simulated woman; from our observations we concluded that her metallic exterior and sunglasses concealed a well-rehearsed actress. Why else should she have climbed into a cabinet before her head was removed and why, otherwise, should the cabinet have backed on to a wooden partition via a double-mirror frame? According to rumour, the actress was herself manufactured by a product of *Elliott-Automation*!

The IEA exhibition occupied a wide area of Olympia and was supported by a remarkable number of tape transport manufacturers specialising in data and video recording. Two



familiar mechanisms, the *Tandberg 6* and *Truvox 200*, were seen on *Elliott* and *Thermionic Products* equipment respectively, both modified for data analysis. Probably the most original tape mechanism at the exhibition was the Elliott *AIR3* portable recorder, which twisted 25.4 mm. tape from a vertical feed spool through one 45° and two 90° angles to a horizontal dual-pinch-wheel drive, past an 18- or 33-track in-line head, and finally back to a vertical take-up spool.

Another portable data recorder, the American *Pemco 110*, bore remarkable resemblance to the *EMI LA*. Any speed from 2.375 to 152 cm/s and a choice of three tape widths are available, frequency range at maximum speed being DC to 300 kHz on up to 14 channels. Power consumption is claimed to be one fifth that of conventional portable recorders. The 110 weighs 24 lb.

AKAI REVIVE THEIR VTR

DIFFICULTIES encountered on the 76 cm/s (30 i/s) *VX-1100* cross-field bias video recorder are believed to have been overcome and a substantially modified version has been announced, still using fixed heads but operating at 114 cm/s (45 i/s). A 1 MHz video bandwidth is quoted, the anticipated price on the us market being little more than £200 including 48 cm. monitor. The mechanism is solenoid-controlled and weighs 50 lb.



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Sony TC260	29	5 0	7	5 0	116	5 0
Tandberg 12/21/41	31	10 0	7	17 6	126	0 0
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Philips EL4408...	33	16 8	8	6 8	133	16 8
Sony TC530	41	10 0	10	6 3	165	5 0
Beocord 2000K	44	10 0	11	8 1	177	10 0
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Telefunken 201	11	18 9	2	19 7	47	13 9
Ferguson 3228	11	19 0	3	0 0	47	19 0
Philips EL4306	14	1 8	3	10 0	56	1 8
Ferguson 3230	14	13 0	3	13 2	58	11 0
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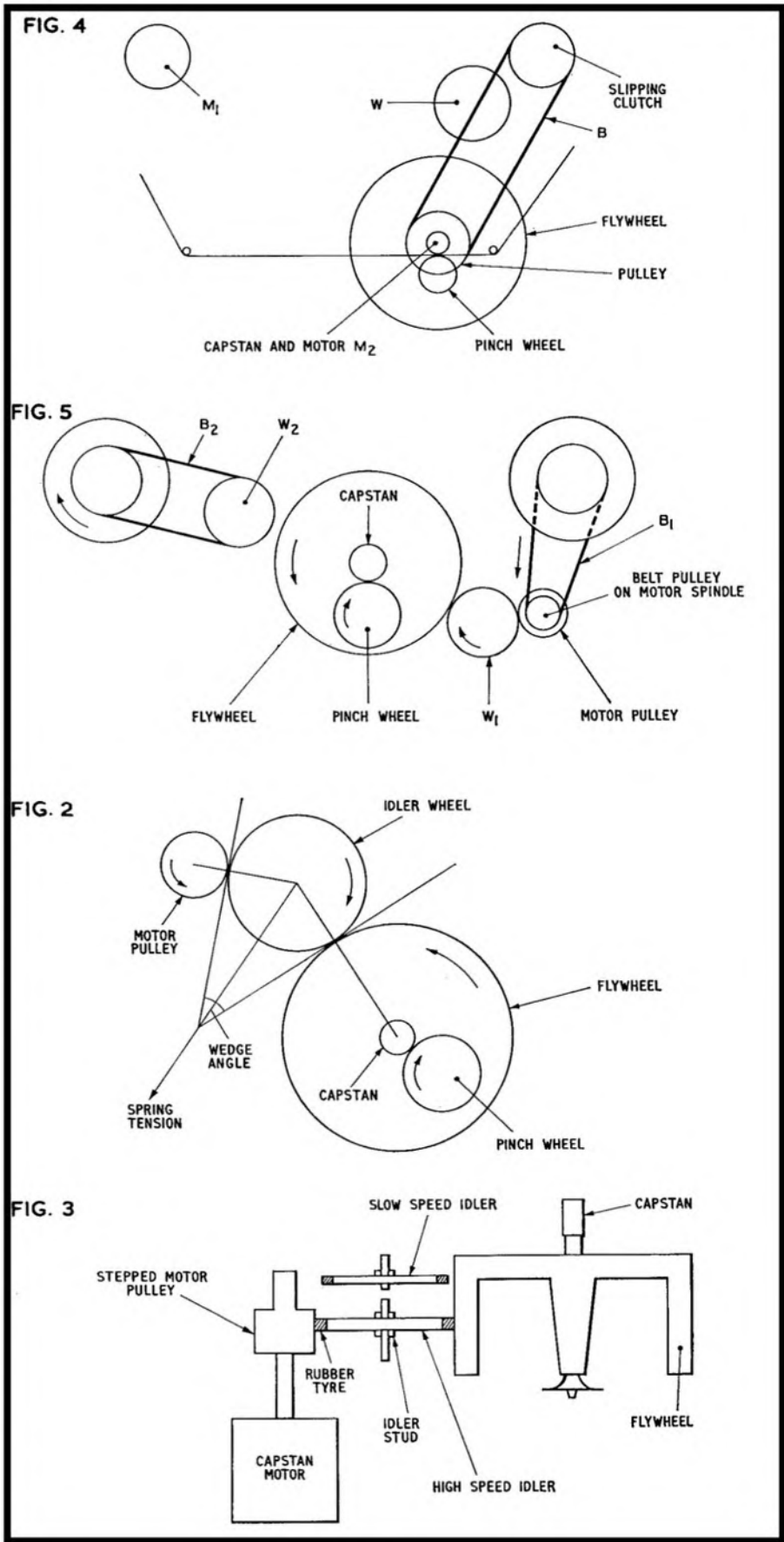
controls the motor supply voltage to keep the tone at 1.6 kHz under varying conditions of strain. Changing the tape speed from 19 to 9.5 cm/s simply involves switching the discriminator to seek 800 Hz. The system is such that the recorder is essentially independent of both mains voltage and mains frequency variations.

In any tape recorder, the power of the capstan motor has to be sufficient to overcome any friction in the drive system and if this motor is also used to drive the tape reels a reserve of power must be available to prevent speed inconsistencies. In mains driven machines there is little difficulty in building a motor which can develop sufficient torque, but in DC portables the motor must be capable of running for a reasonable length of time on one battery charge and this usually dictates a motor of modest power. Another problem is weight and physical size, which tend to increase as the power of the motor increases. In view of this it is essential that the drive system is designed not only for freedom from speed irregularities but also for maximum transfer of torque to the capstan and flywheel and, in single motor machines, to the pulleys driving the tape reels as well. The problem is of course eased where more than one motor is used, although drain on the battery can be considerable, especially during fast wind or rewind of the tape. In modern DC motors, using lightweight ceramic magnets to produce the static field, a remarkable power-to-weight ratio can be achieved together with an improved speed regulation; their use in portable machines is rewarded by the prospect of longer battery life and a more reliable wow and flutter performance.

The simplest method of transmitting motor power to the capstan is by a *direct drive* where the lower end of the capstan spindle is directly coupled to the motor. We have already seen that a large, heavy, slow-running motor is essential here, and if more than one tape speed is required a means of pole switching will have to be provided. The advantage of this system, which is widely used professionally, is that there is no transmission of power from one shaft to another and therefore no need for intermediate wheels, belts and rubber tyres, all of which can introduce severe wobble into the drive if they are not correctly maintained. The single rotating shaft also eliminates the possibility of slippage in the capstan rotation and since it is always driven by a synchronous motor, it is capable of precise long-term speed stability. Direct drive is also capable of excellent flutter characteristics, although irregularities in the motor core structure and variations in damping as the motor rotates have to be minimised by careful design of the motor. As we have seen, one way of doing this is to use an outer rotating cage motor where the extra flywheel effect will help to iron out these irregularities. Another way is to use a resilient coupling between the motor and capstan as in the *Revox 736*.

Another method of drive which is capable of low wow and flutter is the intermediate or idler wheel drive. With this system a high speed motor can be successfully coupled to a

(continued overleaf)



large diameter capstan—in other words a speed reduction can be incorporated into the drive. Fig. 2 shows the basic layout. The idler wheel has an outer tyre of natural or synthetic rubber and after being cemented to the wheel it is ground so that it is absolutely concentric with the axis of the idler stud. The idler is mounted so that it makes contact with the flywheel rim and the motor pulley is also the metal rim of the flywheel. As the motor rotates, torque is transmitted by friction to the flywheel. Since the area of contact between the intermediate wheel and the metal shafts is so small it is important that the idler mounting is arranged so that the wedge angle between the flywheel rim and the motor pulley is correct. The idea is to get enough traction to deliver the torque and yet not stall the motor. The mounting should also allow a horizontal movement of the wheel so that spring tension may be set up in the direction of the wedge angle, providing a constant pressure which is applied equally to the flywheel and drive pulley. It is also essential that the idler wheel bearing is accurately made and maintains the correct alignment of the wheel in a vertical plane with the flywheel and motor pulley.

The diameter of the motor pulley is determined by the diameter of the flywheel, the speed of the motor shaft, the capstan diameter, the mechanical loss in working the rubber tyre, and of course the tape speed. In this type of drive, change of tape speed can therefore be accomplished by using a stepped pulley with separate idlers for each speed (fig. 3a). Since the flywheel and capstan diameters are constant and the intermediate wheel does not affect the speed ratio between the flywheel and the motor pulley, the circumference of the latter would have to be doubled if the tape speed is increased from 9.5 to 19 cm/s. This system works very well as a speed changing device although, to avoid possible damage to the rubber tyre, it is necessary to ensure that power to the motor shaft is switched off when the idler wheels are changed.

If it is properly maintained and well designed, the intermediate wheel drive can function for a long period without slippage; however, the condition of the surface of the idler is of the utmost importance. For instance, minute traces of oil on the tyre causes slippage and severe wow and it is also possible for the rubber to deteriorate rapidly in this condition. Extreme caution should therefore be exercised if it becomes necessary to apply oil to the drive bearings. Even with normal use the rubber wheel wears to a smooth glaze-like finish which causes slippage and the only real remedy here is to replace the wheel. Fortunately this can be done easily if an exact duplicate spare is obtainable.

Another problem with rubber idler wheels is that there is danger of flat spots, causing wow and even mechanical noise. This condition can develop from leaving the tyre in contact with one of the metal shafts when the mechanism is halted. The solution here is to have provision in the drive for automatically disengaging the idler when the stop switch is operated. Intermediate wheel drives are complex and it is essential that all the rotating

parts and the bearings are carefully made if the system is to be reliable and essentially free from instantaneous speed variation.

An alternative method of drive has a rubber belt which links the motor pulley to the flywheel. The spring loaded rubber idler is not used here since the belt has enough elasticity to remain taut for a useful length of time, although it does become slack with use and needs replacement. The main advantage of the belt drive is that its area of contact with the flywheel and motor pulley is greater than that of the idler wheel, so there is less chance of slippage. The belt drive is also simple in basic construction and since there are no movable mountings and springs the system produces very little mechanical noise.

For a good belt drive it is essential that the pulleys are properly made so that they closely fit the cross-sectional shape of the belt, thus reducing the tendency for it to jump off. A belt of generous size is also desirable as this reduces stretching with age and also resists momentary stretching and contracting which tends to occur with sudden load variations—it therefore reduces wow and flutter. A thick belt also helps to absorb the shock caused by sudden load changes such as when the drive is switched to rewind.

From the designer's point of view, one of the principal problems with a belt drive is the difficulty of arranging a change of speed. Apart from the possibility of using a two-speed motor, it is necessary to provide a means of transferring the belt from one pulley to another, which is no easy matter, or have provision for changing the diameter of the capstan. On some machines this can be done by physically removing the capstan sleeve and replacing by another of appropriate size so as to get the necessary speed change. However, this method makes for undue wear on the capstan shaft and this, together with the possibility of the spindle becoming soiled, can make the capstan eccentric with resulting wow and flutter. Furthermore, if the capstan sleeve is an accurate fit on to the shaft it will be difficult to remove and therefore bothersome and time consuming to change.

MANY VERSIONS

In practice one finds many versions of the above drive methods, although the complexity of the system is to a large extent governed by the number of motors employed. Three-motor machines often have fewer levers and rotating parts than single or two-motor machines where, as we shall see, the power distribution is more complex. But this does not necessarily mean that three-motor units are more reliable—in general a high standard of design and construction is the criterion of quality and not the number of motors employed.

In single-motor machines there has to be a reserve of power from the motor to drive the reels. Inevitably some power is consumed by the transmission as well and the motor has to be capable of supplying this and yet remain constant in speed. In three-motor machines the power is shared by smaller sized motors with special attention being paid to the capstan motor where precise speed control is essential.

In three-motor drives (e.g. fig. 1, Part 1) power is supplied to each motor when the start

switch is operated. When the recorder is set to play or record this switch will supply the capstan motor with its full operating voltage and also power to the reel motors which, as we have seen, are controlled by fixed resistors in the motor wiring so that the correct tape tension can be maintained. During fast winding the resistor is by-passed and a greater voltage applied to one or other of the reel motors so that maximum shuttling speed can be achieved. Operating the start button will also have the effect of moving the pinch roller so that it makes contact with the capstan. Usually this is effected by a lever which is spring loaded so that the correct pressure is established. Pressure pads, if fitted, are also mechanically linked to the start switch so that they move into place during record and playback but not during fast winding. These functions on modern tape decks are often selected by means of push buttons which are interlocked so that the mechanism cannot be damaged by indiscriminate use.

In the more expensive machines the mechanical functions of the deck are often controlled by solenoids. These are really electromagnets which are linked to an operating lever and perform the necessary mechanical changes when they are energised by an electric current; they therefore enable remote control of the tape deck.

In some professional decks a variable speed spooling facility is offered. This control is made possible in three-motor machines by varying the relative voltage between the two reel motors by means of a rheostat. This of course varies the relative pull between the two motors and since these are arranged to pull in opposite directions with respect to the tape, fine control of the spooling speed is possible.

Fig. 4 shows the basic layout of a two-motor tape drive. Motor M_1 is used for rewinding the tape and also, when driven at a reduced voltage, for supplying the necessary back tension. The other motor M_2 drives the capstan directly and the take-up reel indirectly by means of the belt drive B. One end of the belt runs on a pulley attached to the flywheel, and since this must be constant in speed, the other end of this pulley drives a slipping clutch (see Part 1). This reduces the pull of the take-up reel and also enables it to reduce speed in relation to the amount of tape on the reel. During fast forward wind the idler wheel W makes contact with the flywheel and the take-up reel spindle and turns this at high speed, overriding the belt driven clutch disc. A basic arrangement similar to fig. 4 can be used for an indirectly driven capstan. Either a belt drive or an intermediate wheel can be used where in the latter case an additional puck wheel would be used to drive the take-up reel during fast forward wind.

A more complex power distribution is used in a single motor drive, fig. 5. This example uses an intermediate wheel W_1 to drive the capstan during recording and playback. The belt B_1 , drives the take-up reel through a slipping clutch and during fast forward wind this clutch is designed so that it is mechanically locked and so the reel is driven at fast speed by the motor through B_2 . For fast rewinding the rigid coupling is disengaged and the supply reel driven at high speed through the belt B_2 attached to the rubber idler W_2 which is powered by the flywheel.

BANG AND OLUFSEN

1100

BY H. W. HELLYER



THERE are four machines with which we shall be concerned in this section of articles, the *Beocord 1100, 1500, 2000 and 2000 de Luxe*. As there are many points of similarity, it would be a waste of space to deal with each separately, and to give complete circuits of each would tax our Editor's patience to the limit, so we begin with the circuit of the 1100, which is a self-contained machine (i.e., with its own internal loudspeaker), and provides a good, basic example.

One point should be made clear right away. In talking of the 1100, we really mean the modified 1000. This earlier machine suffered from motor troubles and was withdrawn, to be modified and renamed, but only slightly changed, so that we can refer to the diagram of **fig. 1** when discussing its main features.

This is a mono tape recorder, $\frac{1}{2}$ -track, three-speed, with the range of input selection you would expect on a semi-professional model, but without input mixing. Straight-through amplification is possible and the 10 W output drives an external 3.2-ohm loudspeaker. Up to 12 W can be obtained,

and with a good external loudspeaker extremely satisfactory results are possible in the amplifier mode. On replay, I have found this less happy at full output, the rated 55 dB figure for signal-to-noise ratio being hard to attain after the machine has been in service for some time. There are reasons for this, which can be overcome, as we shall note later.

The internal loudspeaker on this model is really only intended for monitoring. It is mounted in a position below the wood cabinet, i.e., 'in the black', slightly to right of centre, and has a close mesh grille so that it needs a close inspection to realise that a loudspeaker is there at all! It is not designed to handle more than 3.5 W. During recording, monitoring is possible and the 30-ohm preset potentiometer, which is the rearmost of the selection of sockets and controls on the left side panel, permits control of monitor level, without the usual device of a separate record and replay amplifier, using the replay gain as monitor control. This part of the circuit is worth studying by someone wishing to modify a machine with no monitor facilities.

From the output to the inputs: there are three—microphone, gram pickup and radio, and they are not quite so straightforward as they may appear. This business of inputs is one of the pitfalls for the operator who wants to connect B & O equipment to other items. As may be expected, some matching fiddles are required—although we can hardly blame a manufacturer for matching the various bits and pieces of his own range. Some day there will be a *real* agreement on standards; we are part the way there already, with the latest DIN suggestions. The adaptation of B & O with odd items of external gear would indicate that we have not quite reached our goal.

If you take a close look at the sockets you will note that the 'common' pins (No. 2 of a 180° five-pin DIN) are linked and taken to a direct chassis return. But the zero line, i.e., the positive common of the whole amplifier circuit, is *not* returned in this way. It need not be, of course, when the construction is a series of plugged and wired printed circuit boards. In fact, to prevent hum problems it is imperative that we suppress the temptation, during servicing, to make convenient earth return connections.

Microphone input is one example of the need to observe the manufacturer's ruling. A low impedance (50-200-ohms) microphone is used, and the unbalanced input which is normal for general purpose microphones—that is, with the screening of a single-core cable returned to the low potential point (usually the chassis)—gives a sensitivity of 35 μ V. But (here is the snag) the actual connection is to pins 1 and 3, that is as for a balanced input but minus the earth. The screened portion of the plug then acts as a hum screen. So take care with the wiring: no stray whiskers please.

Similarly, the input to the gram socket uses pin 3 and (common return) pin 2 rather than the conventional 1 and 2. Moreover, the wiring is arranged in such a way that pin 4 is a link line for low impedance cartridge input. This needs a circuit alteration to the feedback loop as well, as is quite plainly illustrated. The high impedance sensitivity is 75 mV, suitable for crystal or ceramic

cartridges, but perhaps a bit too sensitive for the cheaper types of the former.

Again, the sensitivity of the radio input is very high, and some attenuation will undoubtedly be needed if a conventional tuner is employed. 1.6 millivolts at 47 K is all very fine for the outputs from the *Beomaster* range of equipment, or even the *Beolab*, but the tape recorder circuits will try to turn themselves inside out if we connect a *Leak*, an *Armstrong*, a *Rogers* or what-have-you to this radio input. So once more, beware! There is a certain amount of input protection, but it is never good practice to overload, whatever protection is provided.

This is a general matter with the other parts of the B & O range. Tape recorder 'in-and-out' sockets on the amplifiers and tuner-amplifiers give an output to suit B & O machines, so connection of a 'normal' machine may prove rather unsatisfactory. The recordings will be insensitive in the general run of 'high impedance' inputs, or so-called 'radio' inputs, and playback through the B & O amplifiers, etc. will need the gain turned full up and some treble cut to improve the output and reduce the hiss.

UNDESIRABLE PRACTICE

Only today I had the problem of matching a *Van der Molen Sonic Eight* (see last month's contribution) to a B & O 900 tuner-amplifier. Apart from the undesirability of such a practice, I had to modify the link leads which the customer had bought 'across the counter' and pretend I enjoyed doing so. It took quite a bit of juggling with attenuator resistors to get acceptable results, especially when a magnetic cartridge of good quality was fed into the amplifier and replayed through a pair of good speakers, simultaneously recorded at, heaven help us, 4.75 cm/s ($1\frac{3}{8}$ i/s), then replayed and compared with the previously heard sound. The only way of doing things was to use a 'looped' plug at the Van der Molen end, with inputs to the *microphone* socket, attenuated with 100 K in series (in the DIN plug itself on each channel) and taking off the output from the tape recorder from pins 3 and 5 of the 'In-and-out' socket, which still did not load the B & O amplifier as well as could be desired for good noise figures.

The foregoing is not a plea for ultimate standardisation. It is merely an example of the sort of problems we are bound to get when odd items of gear have to be linked. In an ideal world there would be no need to juggle; in reality we have to buy what we can afford, then try to fit it to what we already possess. But there are inevitable limitations, and always the odd cases when the only solution is an external 'buffer' or matching amplifier. With transistors getting cheaper all the time, and the major manufacturers issuing suggested circuits along these lines, such devices are worth consideration—and probably a lot less trouble than hours of plug-happy fiddling.

Before moving on to bigger and better things we should take note of the automatic gain control facility on the machine we are supposed to be discussing. This is one of the 'brute force' types. No *Magic Ear* refinements here, simply a feedback circuit that suppresses loud sounds and gives a certain

(continued overleaf)



amount of dying-off time. The switch is a 'pull-on' device linked to the gain control.

The actual setting appears to be rather on the high side—that is, equivalent to a level of about number 7 on the control when used manually, which means that if one sets up manually at the conventional 'just below half' position for a recording from a controllable source, then switches to 'Auto', the meter bashes over to the right and there is an immediate plunge toward controls to avoid overloading. Another argument perhaps for the externally controlled signal to match the required sensitivity of any recording equipment?

If we look carefully at this AGC circuit we note that the lower left-hand transistor is employed as a regulator, with selection of record mode grounding the 330-ohm resistor tapped on the gain control and open-circuiting the slider contact to give a fixed tapping across the signal potentiometer which is applied to the next UWO029 stage. But when manual control is selected, by pushing down the knob, not only is the gain control

brought back into circuit, but the positive electrode of the 10 μ F electrolytic in the base circuit of the regulator stage is taken to the return line. When erratic automatic recording is the fault, check these return paths, and, in particular, suspect the OA70 diodes, which object strongly to any excess of current and can easily go 'high'. When replacing, always use a heat shunt—even a crocodile clip on the lead-out wire will suffice—and leave enough length on the wire end to twist it and provide the diode with a certain amount of 'spring'. The construction of these components is not really intended for miniature mounting techniques and internal fractures are prevalent from bad mounting in all sorts of equipment (especially, I grieve to report, mass produced television receivers).

One feature of transistorised equipment is the prevalence of regulation circuits. I understand this subject is soon to be dealt with separately, so shall not waste too much space on it, but would ask you to note first the fairly simple regulation of fig. 1 and then the more complex circuit which is shown in fig. 2 and is the power supply section of the 1500 and 2000 range of machines.

In the simple type we have a transistor inserted in the positive return line and acting as an electronic switch, controlled by its base bias. This, in turn, depends on the 'sampler' transistor which is virtually across the load, in turn controlled as to its conducting point by a zener diode. When current drawn by the load increases beyond a certain amount, protection is afforded by the AD149 ceasing to conduct, i.e., the 'switch' opens. But note, in this circuit, the way the zero return line is taken to one side of the mains transformer secondary by a small network that also includes a zener diode. We can now see one reason for the separate chassis return lines mentioned when we were looking at the inputs. Earthing directly at the common

line would unbalance the regulator circuit and, in fact, one reason for hum or instability on loud signals when this circuit is in use may be failure of this zener diode.

In the more complex circuit of fig. 2, which includes the oscillator circuit of the later models, and will save us a little space in the next couple of articles, we note that four transistors are employed, again with an AD149 in the return line, but not quite so obviously. One of the OC75 transistors is the overload device. It is biased so that current consumption through the load greater than about 2 A will make collector current flow, reducing the voltage to the base of the AC128 and cutting off the AD149. This is the left-hand of the two OC75 transistors on our diagram. The upper one is part of the load-sensing circuit, with its base biased by a preset potentiometer to give the appropriate regulation. The idea of these composite circuits is not only to protect directly against overload, but also to act as a kind of servo device, in the same way that a zener diode, or even a simple diode, may be employed as a 'clamp' in a bias circuit, to maintain as near static conditions as possible. This means that the circuit must be proof against rapid variations yet not upset by ripple voltages. In practice, the smoothing becomes very effective, but is vitally necessary to replace any faulty components with exact values. No use slapping any old electrolytic across the line and hoping for the best in these circuits.

On the other hand, the nightmare of blown output stages by short-circuits can be reduced if not eliminated by the use of such overload protection, and constructors may care to study these circuits for possible adaptation. Note that failure of the zener diode will usually result in 'low HT' rather than hum, which is more likely if one of the transistors goes haywire.

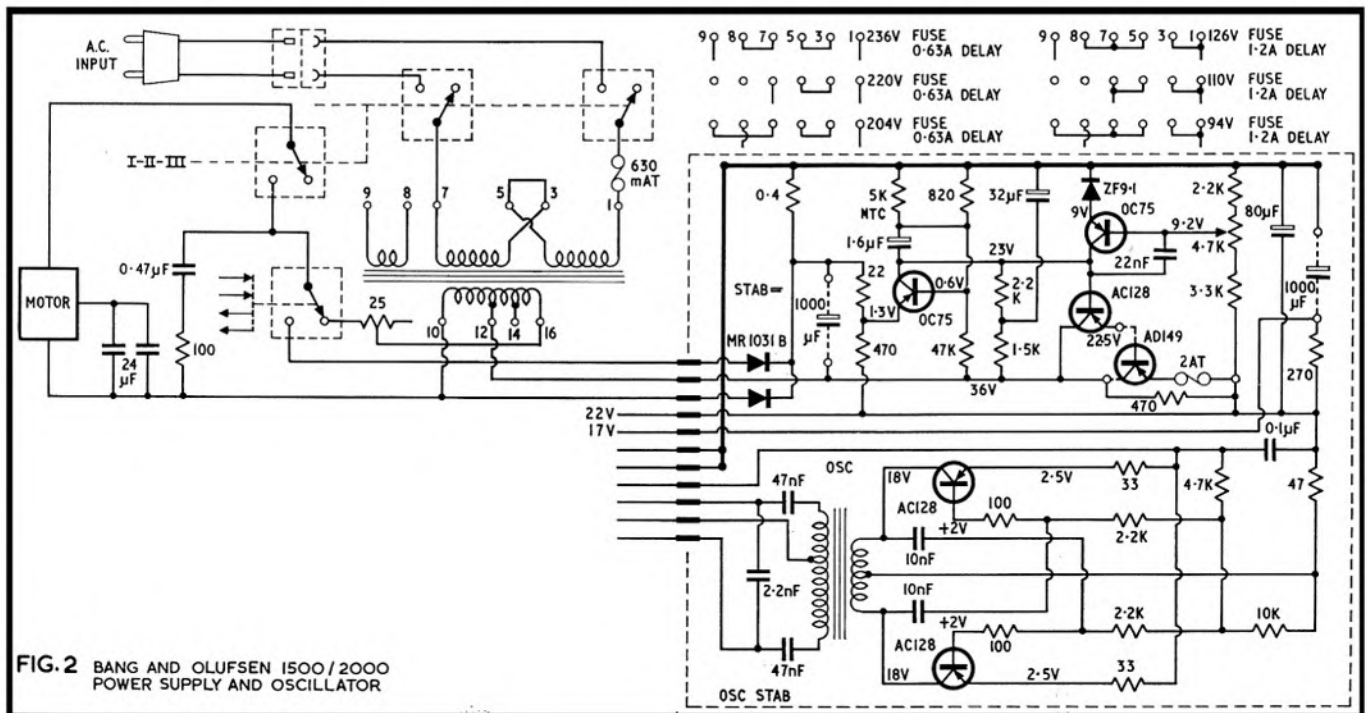
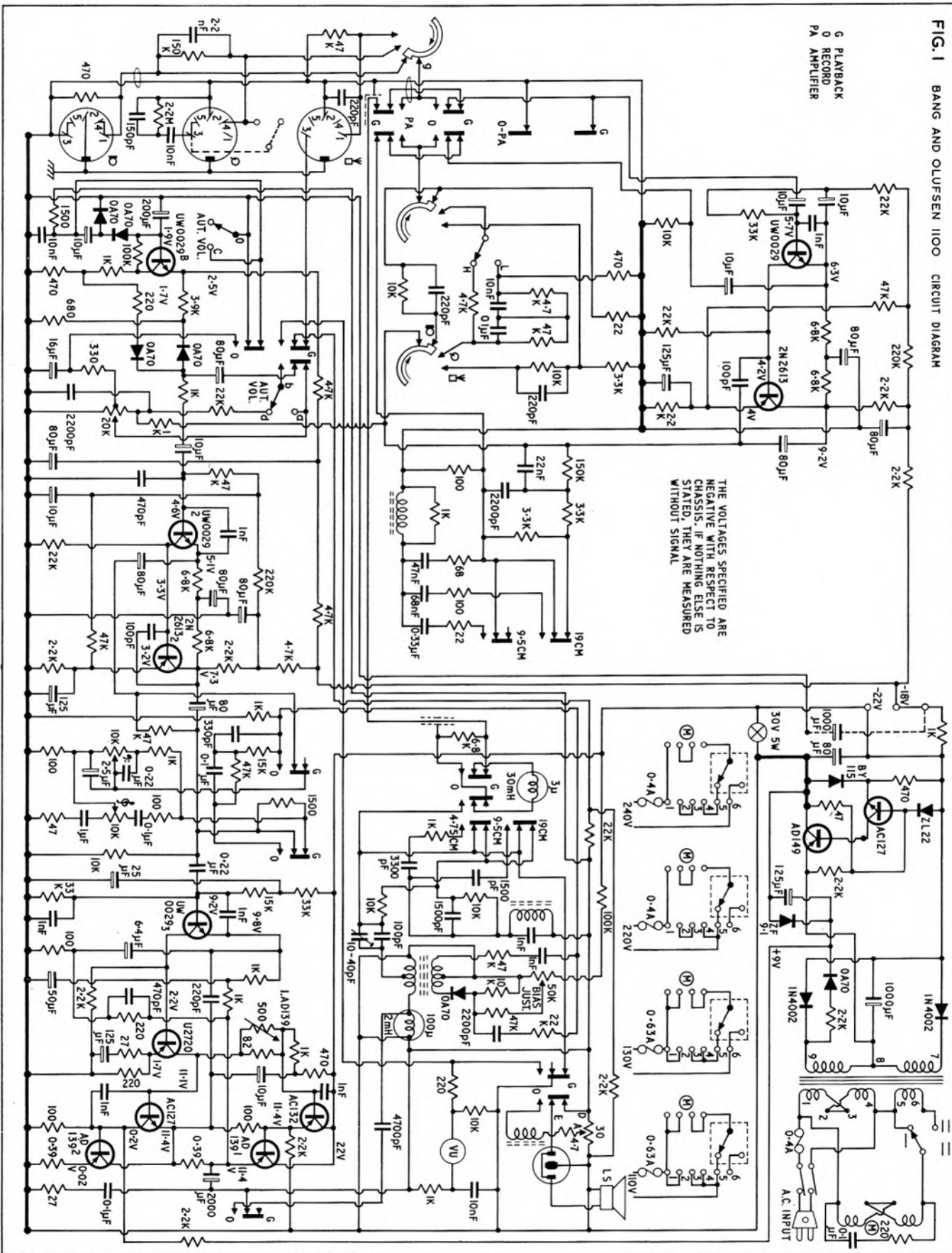


FIG. 1 BANG AND OLUFSEN 1100 CIRCUIT DIAGRAM

G PLAYBACK
 0 RECORD
 PA AMPLIFIER



5

Fig. 1. *STC 4113* cardioid ribbon on supplied stand.

Fig. 2. *Grampian GR2L* figure of eight ribbon.

Fig. 3. *Walchris 63M* figure of eight ribbon.

Fig. 4. *Sennheiser MD421HN* cardioid dynamic on supplied stand.

Fig. 5. *Sennheiser MD211* omni-directional dynamic on supplied stand.

A practical test of five microphones

BY D. P. ROBINSON AND A. TUTCHINGS

FIG. 1



FIG. 2



FIG. 3



FIG. 4

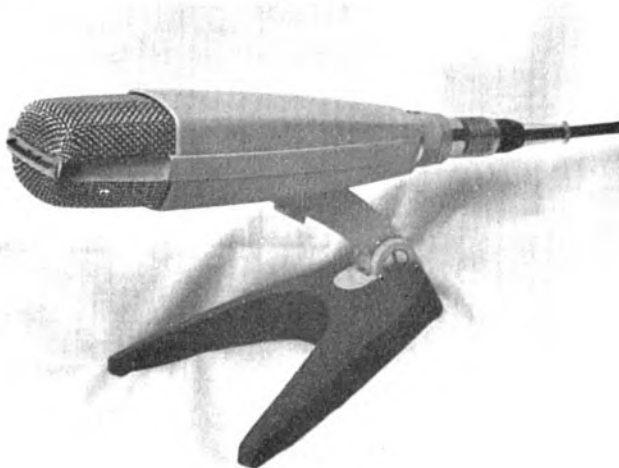
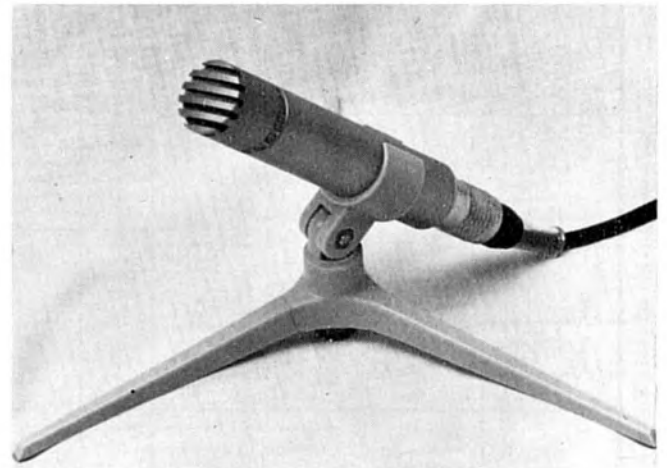


FIG. 5



SOME time ago I was asked if I could arrange some practical tests on a few microphones to accompany a technical appraisal made by Mr. Tutchings. Five microphones had been sent for review, and it was felt that it would be more interesting to review them altogether and compare the results.

The choice of microphones is bewildering, as a quick glance through the survey (page 314) shows, ranging in price from £2 to £200. This sample covers the intermediate range of about £10 to £40 and so is representative of the microphones which serious amateurs would consider for music recordings. There are obviously very many cheaper types, most of them ceramic or crystal, and equally there are many more expensive studio and broadcast types which are regrettably out of most people's range.

The practical tests consisted of simple trials with speech which gives a very good indication of the quality, followed by music recordings made on location. The first step was to photograph each one and these are shown in order of price. Fig. 1 shows the *STC 4113* moving-coil, a neat cube, together with its stand—and the first criticism! The stand is made from a tube of 2mm. aluminium, and the microphone is held in place by a screw passing through a tapped hole in this tube, thus bearing into the microphone connector to hold the whole assembly in place. Now this thickness of aluminium is not suitable for tapping, particularly in applications where the screw is run in and out as here, so it was not very surprising that, by the time the review model arrived in my hands, this thread was stripped. Otherwise, however, this is a nicely designed microphone and desk stand, with grey crackle paint finish relieved with satin finished aluminium.

Fig. 2 shows the *Grampian GR1* ribbon microphone, well constructed from two aluminium castings, again satin finished with matching perforated screens front and back. There is a simple clamp to adapt the microphone for stand mounting which incorporates an adaptor for the most commonly used threads.

Next in the price range is the Danish *Walchris* (fig. 3), another ribbon looking very similar to the old *Film Industries*—which brought back memories of my first recordings

where I used this as the main microphone. The *Walchris* is finished in shining chrome and light grey crackle paint; it does not appear to have any simple method for stand mounting.

There is then a large price jump to the two *Sennheiser* microphones; the first is the *MD421*, which is nicely engineered (if a bit large) in light grey plastic and polished chrome. I must report here that a friend irreverently compared it to an electric razor of the old type, and you can see what he means! The accessories are very well thought out; the desk stand is shown in fig. 4 and the thread which fixes the microphone to the stand is the same as for the floor stand, making it easy to transfer from floor to desk stands. Finally, the bracket between the microphone and stands unclips to leave the body of the mic free for slinging.

The second *Sennheiser* is the *MD211* (fig. 5), a very small lightweight omnidirectional unit, finished in satin chrome. As with the *MD421*, accessories are well designed; the photograph shows the elegant stand which separates, leaving visible an adaptor for either slinging or fixing on to a desk stand. Both the *Sennheisers* come with a variety of wind shields.

With the exception of the *Walchris* and the *STC*, all the other units came in adequate boxes, made either of rexine covered wood or plastic. The two exceptions might normally be supplied in a box if they were not for review; a good box is really essential for storing microphones, which are delicate instruments.

Why, oh why, cannot manufacturers get together and decide on a standard connector and standard wiring for microphones? This is of course no new complaint, but, when faced with four different connectors, the problem came into focus again for me. After all, some companies make a living supplying adaptor cables from one 'standard' to another. The *Walchris* was the most unusual—I had never seen the type of coaxial plug supplied here. At first glance I thought it was the video RF (F & E) screw connector, but when I started to wire up one as an adaptor I discovered that while the outer thread was the same the inner pin was about half the size of the F & E. The two *Sennheiser* microphones used the DIN plug in the screw locking form, and this seems to be standard in much European equipment; at higher prices the *Tuchel* connector is preferred, even though it is large and will not stand being walked on—surely a requirement for a microphone or signal connector. In the USA, and increasingly so here and on the Continent the Cannon XL connector is standard and has a convention in wiring which is almost universally adopted—although one major recording company for reasons known only to itself does not use this standard. This type is very good but it is expensive at around 16s. a half compared with 4s. for the DIN. The *Grampian* has its own connector.

The *STC* uses the new bayonet locking DIN plug, which is compatible with the screw and normal DIN connector in mating but not, of course, in the locking arrangement. But the *STC* has a female connector on the mic, and the *Sennheiser* a male. During this wiring session, I found that all the microphones with the exception of the *Walchris* were two-wire plus screen; that is, they could be operated

either balanced or more commonly fully floating. This is usually essential in high quality recordings as it avoids earth loops and helps to remove hum pick-up and RF interference. For these reasons the ability to operate in this way is an important consideration when buying a microphone.

Eventually all the microphones were fitted with plugs, and fed into separate channels on a six-way mixer. Each channel on this mixer has a gain control and also a pre-set gain. Using these the gain from each microphone to mixer output was adjusted to be the same with the channel faders fully open; the microphones were placed in front of a loud speaker producing 700 Hz signals to produce the test signals. (A detailed description of this mixer was published in this magazine, June-December 1964.) My first listening tests were just speech—a fairly stringent test, especially when the voice is well-known, which means not your own! The microphones were faded up sequentially, the outputs recorded on a *Revox 736*, and then the tape played back in another room through a *Quad* loudspeaker for comparison.

The *src* on the voice sounded a little limited at the extremes of the frequency range, but gave good clarity. It was quite adequate for this speech recording—the high frequency losses were balanced by the low, so that the result sounded natural.

The *Grampian* sounded life-like, with a wide range and, more important, a smooth response in this range. Like all ribbon microphones, it showed the rising bass characteristics as the source approached the microphone.

The *Walchris* on the other hand sounded boomy, mainly because of the lack of top response. The voice was very woolly in comparison with the other microphones.

Contrast this with the *MD421*, which is a very good microphone for speech. The curve of its response shows a slow rise to +5 dB at high frequencies compared with the medium range. There is a small rise in the bass, probably in an attempt to flatten the overall response for music, but more of that later. The voice came through very well, with just a slight emphasis on the sibilants which aids intelligibility. There is a speech/music switch on the casing of the microphone, which introduces what sounds like a drastic cut in the bass response, and this can be very useful in certain applications.

The last microphone was the *MD211*, which I judged to reproduce the original sound most faithfully. It has a wide, very flat range, with only a few minor humps and bumps which would not be revealed in a voice test.

Whilst the arrangement for voice testing was set up, I checked the directional characteristics, which were as expected. The *STC* was a cardioid, but not very pronounced; I would estimate only about 10-15 dB in the medium frequencies. The *Walchris* was a true figure-of-eight, but with a frequency difference between the front and the back; there is a better high frequency response at the front, which is the side with the maker's label on it.

The *MD421* is a good cardioid, and seemingly well maintained over the greater part of the audio frequencies. The *MD211* is omnidirectional, with only a very slight loss in extreme upper frequencies at the rear of the

(continued on page 311)

Fig. 1. *STC 4113* cardioid ribbon on supplied stand.

Fig. 2. *Grampian GR2L* figure of eight ribbon.

Fig. 3. *Walchris 63M* figure of eight ribbon.

Fig. 4. *Sennheiser MD421HN* cardioid dynamic on supplied stand.

Fig. 5. *Sennheiser MD211* omnidirectional dynamic on supplied stand.

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We don't mention
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at all.

In order to make this ad, pleasant reading, we have deliberately avoided using glossy superlatives—we leave these for the ad. men. All you need to know about the MD421 cardioid microphone and the MD211 omni directional microphone has been said in the microphone review in this issue of *Tape Recorder*.

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microphone. This is normal and occurs because of the finite size of the unit.

The next series of tests were music recordings, and a typical arrangement is shown in fig. 6. The instrument is a square Mozart piano, ideally suited for this comparison because of its fairly wide dynamic range and pronounced transients. The microphone boom is quite intimidating for the performer—rather like the Presidential election address!

The same technique of matching the gains of the microphones was used, but this time there were seven microphones in use—the *Reslo* as a standard ribbon whose characteristics I am familiar with, and a monophonic capacitor microphone as another reference, particularly for the high frequency end. The recorder in this case was the new *TRD* machine (fig. 7).

The performance of the *STC* was very similar to that on the speech tests—not a very wide range microphone. The output was also rather low in comparison with other microphones and this means that the input microphone amplifier in the tape recorder or mixer has to be that much better for a given signal-to-noise ratio. The highest output signal possible (consistent with flat response) will give the best signal-to-noise ratio.

The Grampian had plenty of output and produced a very acceptable sound; it is very similar to the *Reslo* but with a top response which extends further. The whole register was smooth, and there were no nasty dips or peaks that could be detected.

The Walchris was also insensitive—about 6-8 dB below the Grampian, for example. It had a tendency to be boomy on the piano, and the high frequency response was definitely poor. This microphone was undoubtedly the worst of the sample.

The MD421 was not as satisfactory on music as on speech; the high frequency rise predominated so that the piano chords lacked depth in the bass. I was surprised at this in view of the market this microphone is aimed at, but it would appear from the manufacturer's literature that it has great application in the television studio and for outside reporting, to which its characteristics are more suited. I would strongly question the statement in the supporting literature that "recording experience has shown the desirability of a response curve which rises with increasing frequency" as applied to music; this rise is a consequence of the construction of moving-coil cardioids, and is very expensive to smooth out. I was not very impressed by the performance of this microphone with music.

The last microphone was the MD211 and with this the piano sounded very natural, with a smooth silky response. It was only after comparison with the capacitor microphone that some of the failings were revealed. It was not as crisp under transient conditions (for which a capacitor mic is renowned) and this showed up with sharp staccato chorus; but the difference is very slight, and this microphone produces a good sound. Since it is omni-directional it can have only limited use in stereo as a main microphone, but it is ideal for an injection or spot microphone—not least by virtue of its small size which makes it easy to hide before soloists.

The final test was with the windshields; these fit very simply over the ends of the two Sennheiser microphones. This makes the MD421 rather bulky as the windshield is about 9 cm. in diameter, but the MD211 is still compact with its smaller 5 cm. shield. Both of these performed well, reducing all breath and wind noise. On speech there was no noticeable change in the frequency response of either microphone; a third denser windshield for the MD211 did affect the response, but had a remarkable effect in stopping gale force winds! Both the two normal types would be quite adequate for reducing wind noise on outside recordings and for close speaking or singing soloists.

In conclusion, the best general purpose microphone of those tested is the Grampian GR2 ribbon. It has an extended frequency response, providing a useful output level, and with a directional characteristic making it suitable for use in pairs for stereo recording. It is well built and fairly robust, although ribbons are more delicate by their nature than moving-coils. For more specialised work, the MD211 is a good omni-directional unit which would be extremely useful in stereo recordings as an injection or soloist microphone, and can be recommended as such with confidence.

Finally, I should like to thank T. J. Wade for assisting in the recording session, and G. D. Roe for taking and processing all the photographs in this article.

D.P.R.

SENNHEISER MD211

MANUFACTURER'S SPECIFICATION.

Moving-coil pressure-sensitive transducer. **Frequency response:** 40 Hz-20 kHz ± 2.5 dB. **Sensitivity** (at 1 kHz): 0.13mV per μ B. **Impedance:** 200 ohms. **Connector:** Tuchel T3260. **Directional characteristic:** Omni. **Pin connections:** 1 and 3 signal (balanced), 2 case and screen. **Dimensions:** 2.2 cm. diameter x 12 cm. **Weight:** 5 oz. **Manufacturer:** Sennheiser Electronic, 3002 Bissendorf, Hanover, West Germany. **Distributor:** Audio Engineering Ltd., 33-35 Endell Street, Shaftesbury Avenue, London, W.C.2. **Price:** £35 15s. (MZW211 windshield: £4 15s.) (MZY102 desk tripod: £4 18s.)

THIS MICROPHONE is claimed to be the finest moving-coil model in the world, with a response so flat and so wide in range that it matches the performance of a studio capacitor type.

It is often seen in use as a hand microphone on television in this country and abroad. It is especially favoured by singers because of its wide and level frequency response, small size and lack of handling and breath noise.

The frequency response was measured in a white noise sound field up to 10 kHz and on pure tones over the top octave to 20 kHz. It will be seen that the measured response is indeed within ± 2.5 dB limits over the range 40 Hz-20 kHz.

The sensitivity also checked well against the specification at 0.14 mV per μ B sound pressure.

Speech quality was smooth and completely uncoloured when reproduced at normal listening level on both wide-range headphones and loudspeakers.

If speech is reproduced above normal level, the well known BBC giant voice, with heavy chest tones and dull sounding upper register is in evidence, though this is not the fault of the microphone but of the ear's changed response at different listening levels. The expert sound engineer knows that 'effort

(continued overleaf)

Fig. 6
The five microphones under examination, a *Reslo*, and the author's capacitor design, suspended above a Mozart piano.



Fig. 7
Tape Recorder Developments recorder and the author's stereo mixer used in the music tests.



5

equalisation' consisting of a bass cut of about 10 dB at 100 Hz and a broad 3 kHz peak of 3-4 dB to give 'presence' has to be applied to make the voice sound natural at these higher listening levels.

I had no opportunity of trying this microphone on live music, but the response curve and uniform polar response suggests that the limiting factors are likely to be the acoustic environment and the quality of the intermediate equipment which passes the sound on to the listener's ear.

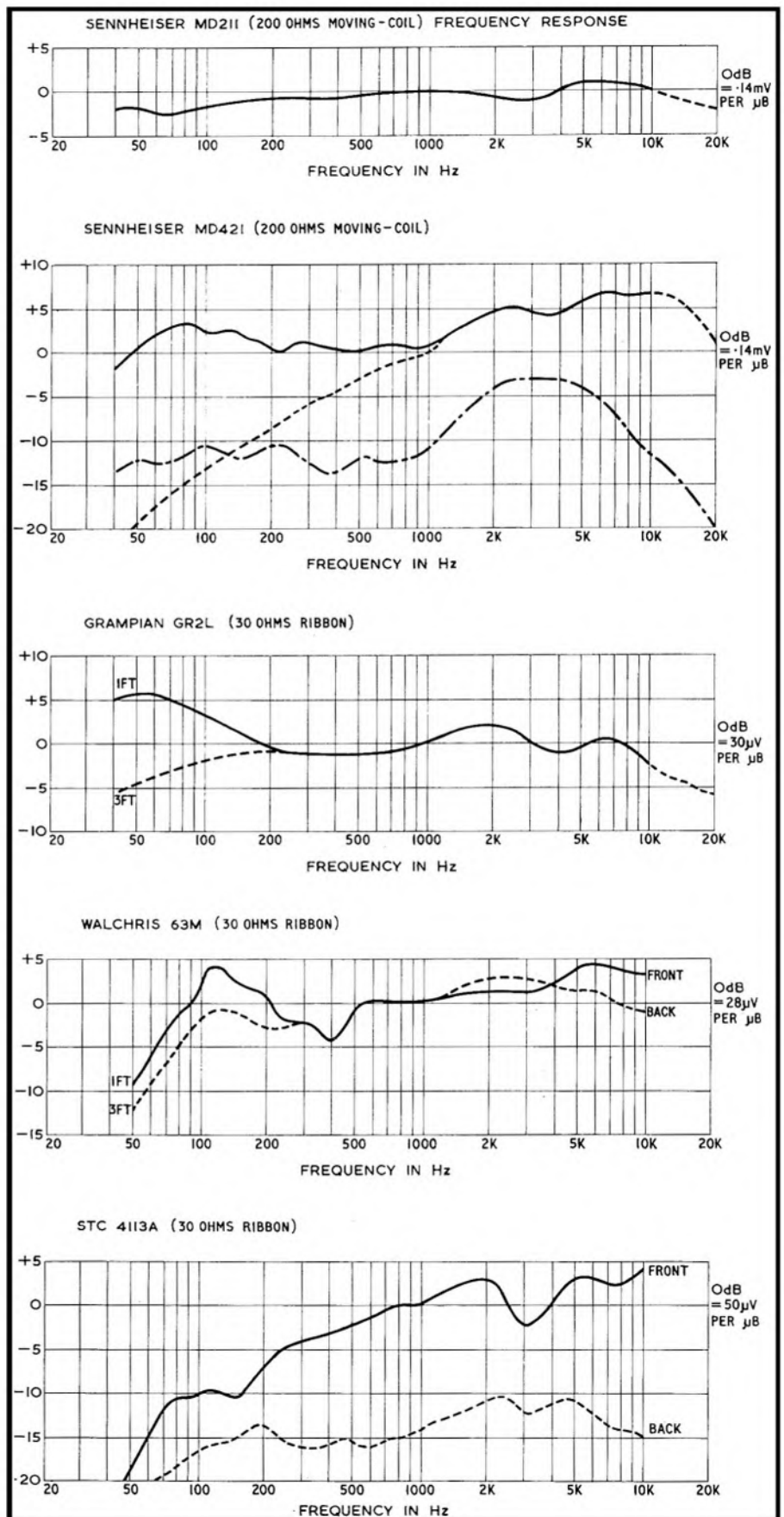
SENNHEISER MD421HN

MANUFACTURER'S SPECIFICATION.

Moving-coil single-element cardioid microphone. **Frequency range:** 40 Hz-20 kHz, variable bass attenuator. **Sensitivity** (at 1 kHz): 0.15 mV per μ B. **Impedance:** 200 ohms. **Directional characteristic:** Cardioid. **Connector:** Tuchel T3260. **Pin connections:** 1 and 3 signal (balanced), 2 case and screen. **Dimensions:** 4.6 cm. diameter x 19.5 cm. **Weight:** 14 oz. **Manufacturer:** Sennheiser Electronic, 3002 Bissendorf, Hanover, West Germany. **Distributor:** Audio Engineering Ltd., 33-35 Endell Street, Shaftesbury Avenue, London, W.C.2. **Price:** £32 10s. (MZW22 windshield: £3 18s.) (MZT421 desk stand: £2 19s.)

IN CONTRAST to the *Sennheiser MD211N* moving-coil microphone, the *MD421* cardioid has been designed to deliver the best possible speech quality under a wide variety of acoustic conditions. A continuously variable bass cut equaliser is built into the microphone case, covering a range from +3 dB at 100 Hz, for music reproduction, to -12.5 dB at 100 Hz for close speech under conditions of high ambient noise level. The treble response rises 5 dB at 3 kHz and the response is maintained at this level to 15 kHz to give 'wetness' and silky sibilant reponse well off the axis of the microphone. The cardioid polar response also aids in the reduction of unwanted noises with a front-to-back ratio of better than 12 dB from 1 kHz down to the lowest frequencies. The measured front-to-back ratio is reduced to barely 10 dB from 1.5 kHz to 5 kHz, but this is probably one of the compromises found to be necessary to maintain optimum intelligibility in interview work where the subject must be kept in the sensitive pick-up area while the interviewer has to address his questions from the side or rear of the microphone.

This microphone also contains a hum-bucking coil which is wound round the



internal microphone capsule as near as possible to the actual speech coil so that the microphone may be used in a heavy hum field near lighting cables, electric motors or transformers which may be encountered, for example, in a television studio.

In short, this is a 'workhorse' broadcast quality microphone which provides some of the selective qualities of stereophonic human hearing on what must often be a monophonic listening channel.

GRAMPIAN GR2L

MANUFACTURER'S SPECIFICATION.

Ribbon pressure-gradient microphone. **Frequency range:** 40 Hz-15 kHz. **Sensitivity** (at 1 kHz): 30 μ V per μ B. **Impedance:** 30 ohms. **Directional characteristic:** Figure of 8. **Dimensions:** 14 x 4.5 x 3.2 cm. **Weight:** 9 oz. **Finish:** Satin chrome. **Manufacturer:** Grampian Reproducers Ltd., Hanworth Trading Estate, Feltham, Middlesex. **Price:** £11 5s. (GR2 with 25, 200, 600 ohms and 50 K transformer: £11 15s.)

THE GR2L MICROPHONE is unusual in being perfectly symmetrical about the vertical axis. This means that the front and rear polar

diagrams are identical so that exactly the same frequency responses are obtained on either side of the microphone. This symmetry is achieved by placing the energising magnets above and below the pole pieces and by shaping the magnet structure so that the shallow cavities on either side of the ribbon are equal.

Fine texture foam pads are placed in close proximity to the ribbon to apply resistive damping at the natural ribbon resonance and to reduce breath noise. Handling noise is also reduced by mounting the whole magnet assembly on soft rubber within the microphone case.

A small internal transformer steps up the ribbon impedance from approximately 0.1 ohm to 30 ohms in the GR2L under review so that a long line may be used between the microphone and a further matching transformer in or near the microphone preamplifier.

The measured frequency response at one foot distance from a small sound source shows some bass rise due to 'proximity effect' where the spherical sound field increases the pressure difference between the two sides of the ribbon at frequencies below 200 Hz. In a plane wave-front at a distance of 3 ft. or more from the sound source, the response falls slightly as shown by the dotted curve. The slight bumps in the mid-high frequency

response are caused by a broad cavity resonance within the magnet and pole piece structure, partly cancelled by a dip in response which occurs on all ribbon microphones when the mean distance from front to back of the ribbon is equal to one wavelength of the incident sound. The shortest distance from front to back is horizontally around the poles and is approximately 4.5 cm. The longest distance is vertically around the energising magnets, a distance of approximately 5 in. The mean distance is thus about 3½ in. and a glance at the sound wavelength frequency chart on page 23 of the 1968 *Audio Diary* shows that this corresponds to 4 kHz, where we find a slight dip in response. It is only a slight dip as it is the result of the averaging of many possible path lengths from front to back of the ribbon. If all path lengths were equal, cancellation would be exact and the response would fall to zero at this frequency.

Sensitivity at 1 kHz is 30 mV per microbar sound pressure, so that a 50:1 transformer will deliver 1.5 mV into a high impedance amplifier.

Sound quality is smooth and clean with no ribbon resonance coloration—a common complaint of poorly designed ribbon microphones—and pure tone tests over the 10-20 kHz range show that the response at 16 kHz is down 5 dB from the 1 kHz level.

WALCHRIS 63M

MANUFACTURER'S SPECIFICATION.

Ribbon pressure-gradient microphone. **Frequency range:** 80 Hz-18 kHz. **Sensitivity** (at 1 kHz): 30 μ V per μ B. **Impedance:** 30 ohms. **Directional characteristic:** Figure of 8. **Dimensions:** 4.2 cm. diameter x 10.2 cm. **Weight:** 6.5 oz. **Distributor:** Britimpex Ltd., 16/22 Great Russell Street, London, W.C.1. **Price:** £16 16s. (Semi-flexible stand and 10 ft. lead: £4 4s.)

THIS MICROPHONE seems to break all the rules in ribbon microphone design and yet it still comes up with a perfectly adequate performance.

The back of the ribbon is almost completely enclosed by a series of horseshoe magnets with only tiny slits between the magnets to allow sound access to the rear of the ribbon. One would therefore expect a marked difference in the front and rear responses, but in fact the difference is barely audible and measurements show only ± 1 dB differences up to 4 kHz and no more than ± 2.5 dB at 10 kHz.

The main ribbon resonance is relatively high at 120 Hz, but a dip in response between 200 and 400 Hz effectively removes the characteristic ribbon resonance harmonics which colour the response of so many ribbon microphones. I spent some little time in trying to track down the reason for this fortuitous dip in mid-low frequency response,

but I arrived at no satisfactory explanation and was left with the problem of whether it was a lucky accident or a piece of cunning design. The same lingering doubt persisted over the smooth high frequency response; but, whatever the reason, the fact remains that the microphone sounds good and handles well.

Sensitivity is slightly low at 28 μ V per μ B, but a 50:1 transformer will deliver 1.4 mV into a high impedance amplifier.

The case is a cast aluminium cylinder with adequately wide slots, lined with two layers of metal gauze and thin fabric to act as a wind shield and to provide some resistive damping to the ribbon. The bottom cup contains the ribbon-to-line transformer and a three pin socket for the connecting cable.

STC 4113A

MANUFACTURER'S SPECIFICATION.

Ribbon cardioid microphone. **Frequency range:** 80 Hz-15 kHz. **Sensitivity:** -87 dB/V/dyne/cm², 45 μ V per μ B. **Impedance:** 30 ohms. **Outlet connector:** 3-pin PREH. **Front-back ratio:** 15-20 dB. **Dimensions:** 7 x 5.1 x 3.8 cm. **Weight:** 10.5 oz. **Price:** £11 11s. **Manufacturer:** Standard Telephones & Cables Ltd., West Road, Temple Fields, Harlow, Essex.

THE CLASSIC METHOD of producing a cardioid ribbon microphone is to divide the ribbon into two halves, terminating the lower half with a pure acoustic resistance so that it acts as a pressure microphone, and leaving the back of the top half open so that the normal figure-of-8 response is obtained. As the two lobes of the figure-of-8 have opposite polarity and the non-directional circular response of the

pressure element has only one polarity, the resultant response adds at the front of the microphone and cancels at the rear to give the well-known cardioid polar diagram. Unfortunately a pure acoustic resistance down to, say, 50 Hz is very bulky and usually consists of a folded wool filled tube of about 20 ft. effective length packed into a 'bomb' under the ribbon elements of the microphone.

The alternative, adopted for the compact 4113 microphone, is to terminate the whole back of the ribbon with an acoustic resistance element which combines the functions of resistive damping and the production of phase shift for sound waves reaching the rear of the ribbon. In the space available, the acoustic resistance must necessarily become reactive at low frequencies so that the cardioid response is only maintained down to 250 Hz. It will be seen from my measured response that the front-to-back ratio remains at 10-15

dB over most of the mid frequency range, rising to 20 dB at 10 kHz and falling to 5-6 dB at very low frequencies.

The response falls by 10 dB at 100 Hz, making the microphone very suitable for natural speech reproduction, but it will sound rather thin on music or distant sound effects. The dip at 3 kHz is probably due to the reduction of differential sound pressure on the ribbon which occurs when the effective path length from front to back of the ribbon is equal to one wavelength of the incident sound.

Speech quality is clean and crisp and the cardioid response is very useful for the suppression of unwanted background noises or room effects or the reduction of acoustic feedback in sound reinforcement systems.

Sensitivity is slightly higher than that specified at 50 μ V per μ B and is high for a low impedance microphone of this size.

MICROPHONES

This survey is split into three categories covering ribbon, capacitor and dynamic microphones respectively. There is no purchase tax on microphones unless they are produced by tape recorder manufacturers specifically for their own products. The latter are excluded to eliminate price anomalies between 'dressed' microphones and the manufacturers' own equivalents.

** Sensitivity is quoted in dB relative to 10V/N/m² at 1 kHz or alternatively in mV/N/m².

* Price dependent on accessories.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m ²)**	PRICE
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RIBBON MICROPHONES

M130	Hand	Figure of 8 (double ribbon)	Equal	200	0.9	£61 16s.
M160	Hand	Super cardioid (double ribbon)	12-25	37.5/200	1	£62 18s.
M260	Hand	Super cardioid	12-20	37.5/200	0.9	£24 11s.
M320	Stand	Super cardioid	20	200	1.4	£37 10s.
M360	Stand	—	—	200	—	£87 10s.

Beyer (Fi-Cord International, Charlwoods Road, East Grinstead, Sussex)

M8	Stand	Figure of 8	Equal	low, medium or high	—85	£9
M8A	Stand	Figure of 8	Equal	low, medium or high	—85	£9
M8S	Stand	Figure of 8	Equal	low, medium or high	—85	£8 15s.

Film Industries Ltd., Station Avenue, Kew Gardens, Surrey.

GR1/L	Stand	Cardioid	10	25	—90	£11 10s.*
GR1/X	Stand	Cardioid	10	200	—82	£11 10s.*
GR1/M	Stand	Cardioid	10	600	—77	£11 10s.*
GR1/H	Stand	Cardioid	10	50 K	—58	£11 10s.*
GR2/L	Stand	Figure of 8	Equal	25	—90	£11 10s.*
GR2/X	Stand	Figure of 8	Equal	200	—82	£11 10s.*
GR2/M	Stand	Figure of 8	Equal	600	—77	£11 10s.*
GR2/H	Stand	Figure of 8	Equal	50 K	—58	£11 10s.*

Grampian Reproducers Ltd., Hanworth Trading Estate, Feltham, Middx

VR64	Stand	Figure of 8	Equal	low, line or high (high Z)	—56	£8 18s. 6d.*
VR65/NS	Stereo Stand (double ribbon)	Figure of 8	Equal	20,200 or 600 (0.6 K)	—74	£17 17s. 6d.*
4-70	Noise cancelling (double ribbon)	—	Equal	20,200, 600 & 50 K (50 K)	—	£26 5s.*
4-50	Pencil Studio	Figure of 8	Equal	20,200, 600 & 50 K (50 K)	—65	£18 18s.*

Lustraphone Ltd., St. George's Works, Regents Park Road, London, N.W.1.

MB301	Stick	Cardioid	20	200	1.2	£22 1s.
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Mikrofonbau (Denham & Morley Ltd., 173/5 Cleveland Street, London, W.1.)

CR2	Stand	Cardioid	15-20	40,250 or 600	—58	£13 18s. 6d.*
RBT	Stand	Figure of 8	Equal	40,250 or 600	—58	£13 2s. 6d.*
RBT/S	Stand	Figure of 8	Equal	40,250 or 600	—58	£16 0s. 6d.*
VRT	Stand	Figure of 8	Equal	40 or 300	—81	£18 18s. 0d.
SR1	Stand	Figure of 9	Equal	40 or 300	—73	£30 19s. 6d.

Reslosound Ltd., Spring Gardens, London Road, Romford, Essex.

SM33	Studio	Cardioid	15-20	30, 50, 150, 250	—87 (50 ohms) —81 (50 ohms)	£80
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RESLO



BEYER
SOUNDSTAR



NEUMANN
KM76



NEUMANN
KM74



AKG
D14S

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m ²)**	PRICE
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300	Studio	Figure of 8	Equal	30, 50, 150, 250 or high	—87 —79.5 —57.5	£56
315S	Hand	Figure of 8	Equal	30, 50, 150, 250, or high	—89 —82 —59	£34
330	Hand	Super cardioid	15-20	30, 50, 150, 250, or high	—86 —80 —78	£45

Shure Electronics Ltd., 84 Blackfriars Road, London, S.E.1.

4038	Studio	Figure of 8	Equal	30, 300	—84 —76	£60
4104	Noise cancelling	Noise cancelling or Figure of 8	—	30, 300	—72 —62	£75
4115	Public address, Noise cancelling	Noise cancelling or Figure of 8	—	30, 300	—72 —62	£30
4113	Hand, stand	Cardioid	15	30, 50 K	—60	£11 11s.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m ²)**	PRICE
4119	Hand, stand	Hyper cardioid	17	30, 300, 50 K	-90, -78, -54	£29
Standard Telephones & Cables Ltd., West Road, Temple Fields, Harlow, Essex.						
53M	Stand	Figure of 8	Equal 30	28±V	£16	16s.
Walchris (Britimpex Ltd., 16/22 Great Russell Street, London, W.C.1.)						
CAPACITOR MICROPHONES						
C61	Studio	Cardioid	20	50, 200	-64	£85
C12A	Stand	Variable	20	50, 200 (maximum)	-68	£130
C24	Stand, studio	Variable	20	50, 200 (maximum)	-68	£250
DX11	Stand, internal reverb. spring	Cardioid	14	200 and high	-74, -52	£30 10s.
AKG (Politechna Ltd., 182/4 Campden Hill Road, London, W.8.)						
4131	Measurement	Omni	—	57 pF	-46	£47
4133	Measurement	Omni	—	20 pF	-60	£47
4135	Measurement	Omni	—	6.4 pF	-74	£47
4138	Measurement	Omni	—	3.5 pF	-86	£54
B & K Laboratories Ltd., Cross Lances Road, Hounslow, Middlesex.						
FC1200	Hand	Cardioid or Omni	20	30, 300	10	£40 15s.
SC600	Hand	Omni	—	200	1.5 mV	£20 3s. per µB
SC650	Hand	Cardioid	15	200	1.5 mV	£26 16s. per µB
SC700	Hand	Omni	—	200	1.5 mV	£30 per µB
SC750	Hand	Cardioid	15	200	1.5 mV	£32 3s. per µB
SC800	Hand	Omni	—	50 bal	0.25 mV	per µB £38 12s.
SC850	Hand	Cardioid	20	50 bal	0.25 mV	per µB £42 18s.
SC900	Hand	Omni	—	50 bal	0.8 mV	£51 10s. per µB
SC950	Hand	Cardioid	20	50 bal	0.8 mV	£55 15s. per µB
FC1200A	Hand	Cardioid	15-20	30, 300	15	£36 10s.
Fi-Cord International, Charlwoods Road, East Grinstead, Sussex.						
KM73	Studio	Omni	—	200	30	£87 6s.*
KM74/75	Studio	Cardioid	25	200	30	£92 9s.*
KM76	Studio	Omni, cardioid, Figure of 8	—	200	26	£110 6s.*
U77	Studio	Omni, cardioid, Figure of 8	—	200	50	£118 4s.*
KM83	Studio	Omni	—	50, 200	5	£82 14s.*
KM84/85	Studio	Cardioid	25	50, 200	5	£86 14s.*
KM86	Studio	Omni, cardioid, Figure of 8	—	50, 200	7	£101 13s.*
U87	Studio	Omni, cardioid, Figure of 8	—	50, 200	8	£106 14s.*
KML	Lavalier	Cardioid	25	50	10	£71 16s.
U67	Studio	Omni	—	50, 200	11	£138
		Cardioid	25		20	£138
		Figure of 8	Equal		14	£138
M269C	Studio	Omni	—	50, 200	9	£158 18s.
		Cardioid	25		15	£158 18s.
		Figure of 8	Equal		11	£158 18s.
M49C	Studio	Omni	—	50, 200	4.5	£158 7s.
		Cardioid	25		6	£158 7s.
		Figure of 8	Equal		8	£158 7s.
M50C	Studio	Omni	—	50, 200	15	£156 13s.
KM53C	Studio	Omni	—	50, 200	15	£128 18s.*
KM253C	Studio	Omni	—	50, 200	15	£148 18s.*

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m ²)**	PRICE
KM54C	Studio	Cardioid	25	50, 200	12	£131 14s.*
KM254C	Studio	Cardioid	25	50, 200	12	£151 13s.*
KM56C	Studio	Omni, cardioid, Figure of 8	—	50, 200	9	£146 2s.*
KM63	Studio	Omni	—	50, 200	9	£127 5s.*
KM64/65	Studio	Cardioid	25	50, 200	9	£130 12s.*
KM66	Studio	Omni, cardioid, Figure of 8	—	50, 200	10	£143 18s.*
U64/65	Studio	Cardioid	25	50, 200	11	£107 2s.
SM2C	Studio	Omni, cardioid, stereo	—	50, 200	10	£258 5s.
SM23C	Studio	Omni, cardioid, stereo	—	50, 200	10	£267 1s.
SM69	Studio	Omni, cardioid, stereo	—	50, 200	15	£272 11s.
MM5	Measurement	Omni	—	50, 200	5.5	£267 4s.
Neumann (F. W. O. Bauch Ltd., Holbrook House, Cockfosters, Barnet, Hertfordshire)						
MKH105	Studio hand	Omni	—	200 bal.	-37	£68 15s. 6d.
MKH405	Studio boom	Cardioid	18	200 bal.	-37	£79 18s.
MKH805	Studio	Uni	25	200 bal.	-31	£104 16s.
Sennheiser (Audio Engineering Ltd., 33 Endell Street, London, W.C.2.)						
4136	Studio stand	Cardioid	32	30, 300	-60	£110
4126	Studio stand	Cardioid	32	30, 300	-84	£96
Standard Telephones & Cables Ltd., West Road, Temple Fields, Harlow, Essex.						
DYNAMIC MICROPHONES (MOVING-COIL)						
D11D	Pencil	Vari-cardioid	15	500 & 50 K	-72.5, -54	£7 15s.
D12	Stand	Cardioid	18	60, 200	-81	£30
D14S	Stand	Vari-cardioid	14	60 & 50 K	-80, -52	£10 15s.
D19C	Pencil	Vari-cardioid	16	60, 200	-80, -72	£18
D19E	Pencil	Vari-cardioid	16	60, 200 & 50 K	-80, -75, -54	£22 10s.
D24B	Pencil	Vari-cardioid	18	60, 200	-80, -75	£48 10s.
D25B	Boom, stand	Vari-cardioid	18	60	-81	£55
D58	Noise cancelling	Figure of 8	—	60, 200	-88, -82	£11 15s.
D66	Stereo, stand	Cardioid	14	200	-73	£12 15s.
D109/60	Lavalier, hand	Omni	—	60, 200	-84, -78	£12
D119CS	Pencil	Cardioid	16	200	-75	£22
D119ES	Pencil	Cardioid	16	60, 200, 50 K	-80, -75, -54	£26
D200C	Pencil	Cardioid	18	200	-77	£23
D202E	Pencil	Cardioid	20	200	-76	£32
D501	Reporting, P.A.	Cardioid, omni	15	60, 200	-73	£13 10s.
D503	Flexible shaft	Cardioid	15	60, 200	-73	£16
D505	Hand, stand	Cardioid	15	200	-74	£13 10s.
D507	Flexible shaft	Cardioid	15	200	-74	£16
D1000C	Pencil	Cardioid	20	60, 200	-78, -72	£29
AKG (Politechna Ltd., 182/4 Campden Hill Road, London, W.8.)						
95/1.5	Hand, table	Omni	—	500, 20 K	-74	£2 12s. 6d.
95/50	Hand, table	Omni	—	50 K, 2 M	-54	£3 3s.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m ²)*	PRICE
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70/1	Stick, lavalier	Omni	—	200, 10 K	—80	£7 10s.
70/4	Stick, lavalier	Omni	—	50 K, 2 M	—57	£8 8s.

Acos (Cosmocord Ltd., Eleanor Cross Road, Waltham Cross, Hertfordshire)

TX/M	Radio mic	Omni	—	600	—55	£35
TX/MN	Radio mic	Omni	—	600	—55	£35
TX/D	Radio mic	Omni	—	600	—55	£35
TX/1N	Radio mic	Omni	—	200	—70	£60
TX/1	Radio mic	Omni	—	200	—70	£60
TX/C	Radio mic	Omni	—	200	—70	£60
TX/CN	Radio mic	Omni	—	200	—70	£60
TX/45	Radio mic	Cardioid	18	30	—78	£70
TX/65	Radio mic	Cardioid	18	30	—77	£80
560F	Lavalier	Omni m/c?	—	200	—70	£12
570F	Lavalier	Omni m/c?	—	200	—80	£37

Audac Marketing Co. Ltd., Forest Works, Carey Road, Wareham, Dorset

M23	Lavalier	Cardioid	—	200	1.2	£9 7s.
M64	Lavalier	Cardioid	—	37.5, 200	2	£19 2s.
M64SH	Stand	Cardioid	—	37.5, 200	2	£26
M67	Hand	Cardioid	16	37.5, 200	2.2	£39 9s.
M69	Hand	Cardioid	16	37.5, 200	2.4	£29 4s.
M88	Hand	Cardioid	20	37.5, 200	2.8	£61 4s.
M100	Hand	Omni	—	37.5, 200	1	£61 4s.
M110	Lavalier	Omni	—	200	1	£28 11s.
M119	Hand	Omni	—	200	2.2	£15 14s.
M601	Hand	Cardioid	15	37.5, 200	2	£24 13s.
Soundstar XI/N	Stand	Cardioid	—	200	2	£19 15s. 6d.
Soundstar HLM	Stand	Cardioid	—	200, 500,	2	£21 8s.
M55	Stand	Omni	—	200, 80 K	1.2	£8 5s.
M80	Stand	Cardioid	15	200, 80 K	1.8	£12 18s.
M808	Stand, stereo	—	—	200, 80 K	—	£25
M57	Hand	Omni	—	200	2	£13 16s.
M410	Hand	Cardioid	20	200	—	£16 15s.
M410S	Hand	Cardioid	—	200	—	£17 10s.

Beyer (Fi-Cord International, Charlwoods Road, East Grinstead, Sussex)

709	Hand, stand	Cardioid	20	20	0.7	£12 10s.
710	Hand, stand	Super-cardioid	20	200	1.5	£25 10s.

Bouyer (Douglas A. Lyons & Associates Ltd., 32 Grenville Court, London, S.E.19.)

643	Stand/gun	Super-cardioid	25	50, 150,	—48	£507 10s.
642	Gun	Super-cardioid	23	50, 150,	—48	£119
644	Gun	Super-cardioid	20	150	—53	£31 17s.
668	Boom	Cardioid	20	50, 150,	—51	£194 16s. 8d.
RE15	Boom, hand	Super-cardioid	24	150	—56	£90
676	Hand, stand	Cardioid	18	150,	—57	£28 16s. 4d.
627	Hand, stand	Cardioid	18	150,	—58	On App.
655c	Hand	Omni	—	50, 150,	—55	£77 17s. 6d.
654A	Hand, stand	Omni	—	150	—55	£30 6s. 8d.
635A	Hand, stand	Omni	—	150	—55	£32 1s. 8d.
623	Stand	Omni	—	150,	—56	£16 11s.
636	Stand	Omni	—	150,	—55	£20 17s. 8d.
649B	Lavalier	Omni	—	150	—61	£31 15s. 10d.

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms)	SENSITIVITY (mV/N/m ²)*	PRICE
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647A	Lavalier	Omni	—	150,	—60	On App.
602TR	Hand	Communications, Noise cancelling	—	High 100, 500	2 V	£26 16s. 8d. maximum

Electro-Voice (KEF Electronics, Tovil, Maidstone, Kent)

DP4/L	Hand	Omni	—	25	—85	£9
DP4/X	Hand	Omni	—	200	—77	£10 5s.
DP4/M	Hand	Omni	—	600	—72	£10 5s.
DP4/H	Hand	Omni	—	50 K	—53	£10 5s.
DP6/L	Lavalier	Omni	—	25	—77	£9
DP6/X	Lavalier	Omni	—	200	—77	£10 5s.
DP6/M	Lavalier	Omni	—	600	—82	£10 5s.
DP6/H	Lavalier	Omni	—	50 K	—77	£10 5s.

Grampian Reproducers Ltd., Hanworth Trading Estate, Feltham, Middx.

TS212A	Hand	Omni	—	200	—77	£8 10s.
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Hartley Electromotives Ltd., Monkmoor, Shrewsbury, Salop.

DO-20	Hand, stand	Omni	—	50,	0.6	£12 10s.
DO-21B	Hand, stand	Omni	—	200	1.2	£18 15s.
DO-35	Lavalier	Omni	—	200	0.7	£18 10s.
DD-1	Hand	Omni	—	50	20	???

LEM (Douglas A. Lyons & Associates Ltd., 32 Grenville Court, London, S.E.19)

LM100	Stand	Omni	—	50	—80	£3 3s.
				200	—74	£3 3s.
				500	—66	£3 3s.
				200/50K	—50	£3 18s. 6d.
LM200	Stand	Cardioid	15	50	—80	£4 19s. 6d.
				200	—74	£4 19s. 6d.
				500	—66	£4 19s. 6d.
				200/50 K	—50	£5 15s.

London Microphone Co. Ltd., 182/4 Campden Hill Road, London, W.8.

LFV59	Hand, stand	Omni	—	Low, line or High	—54	£9 9s.
VC52/	Noise cancelling	—	—	Low, line or High	—	£9 19s. 6d.
THSB 4-20	Hand, stand	Omni	—	20, 200,	—54	£15 15s.
4-30	Hand, stand	Hyper-cardioid	20	600 & 50 K (High)	—54	£18 18s.

Lustraphone Ltd., St. George's Works, Regents Park Road, London, N.W.1.

MB150TR	Stick/Std.	Omni	—	200,	1.2	£3 3s.
				50 K	18	
MB250TR	Stick/Std.	Cardioid	12-15	200,	1.1	£4 14s. 6d.
				50 K	22.5	
MB160F	—	Omni	—	—	—	£4 4s.
MB160	—	Omni	—	—	—	£3 13s. 6d.
MB170S	Stick/Std.	Omni	—	700	2.4	£5 5s.
MB170	Stick/Std.	Omni	—	700	2.4	£4 14s. 6d.
MB170TR	Stick/Std.	Omni	—	700, 50 K	2.4	£6 6s.
MB270S	Stick/Std.	Cardioid	15	200	1.5	£15 15s.
MB270	Stick/Std.	Cardioid	15	200	1.5	£14 14s.
MB270TR	Stick/Std.	Cardioid	15	200, 50 K	1.5	£16 16s.
MB220	Twin, stereo	Cardioid	15	200	1.5	£12 12s.
MB220TR	Twin, stereo	Cardioid	15	200, 50 K	1.5	£14 14s.
MB101	Studio	Omni	—	200	2	£14 14s.
MB201	Studio	Cardioid	15-18	200	1.5	£15 15s.
MB215	Studio	Cardioid	15-18	200	1.5	£16 16s.

Mikrofonbau (Denham & Morley Ltd., 173/5 Cleveland Street, London, W.1.)

LBB9001/05	Lavalier	Omni	—	200	—79	£12
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MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms.)	SENSITIVITY (mV/N/m ² **)	PRICE
EL6015/10	Hand, stand	Cardioid	17	500	-71	£15 10s.
EL6016	Hand, stand	Omni	—	500	-71	£12
EL6025	Stand	Cardioid	17	500, 25 K	17	£20
EL6026	Panel, stand	Cardioid	17	500	17	£16 10s.
EL6033/10	Hand, stand	Cardioid	17	50	17	£26
EL6033/10	Hand, stand	Cardioid, Omni	17	500	17	£26
EL6035/10	Hand, stand	Cardioid	18	500	18	£26
EL6036	Hand, stand	Omni	—	500	-71	£20
EL6037	Hand, stand	Cardioid	18	500, 25 K	-71.5	£28
EL6042	Hand, stand	Omni	—	200	-79	£32
EL6061/02	Hand	Cardioid, noise cancelling	—	500	—	£10

Philips (Peto Scott Ltd., Addlestone Road, Weybridge, Surrey)

CPD	Hand	Cardioid	10-20	40, 250, 600 and high	-88	£16 11s.* £17 13s.*
EC1	Hand	Omni	—	40, 250, 600 and high	-88	£19 10s.*
PD	Pencil, stand	Omni	—	40, 250, 600 and high	-88	£8 15s. £9 15s.
MPD	Lavalier	Omni	—	40	-88	£9 17s. 6d.
MMD1	Lavalier	Omni	—	40	-89	£11 0s. 6d.
MPD2	Hand	Omni	—	40	-88	£6 10s.
VMC2	Stand, PA	Omni	—	15	-89	£10 4s.
THM/L	Hand	Omni	—	40	-89	£6 17s. 6d.

Reslosound Ltd., Spring Gardens, London Road, Romford, Essex.

SM5A	Studio	Cardioid	18-20	50	-84	£140
SM5B	Boom	Cardioid	18-20	150	-79.5	£140
SM50	Studio	Omni	—	30-50, 150-250	-85, -79	£45
SM51	Studio	Omni	—	50-250	-81.5	£38
55SW	Stand, Boom	Cardioid	15-20	30-50, 150-250, 35 K	-84, -78, -57	£32
SM56	Studio	Cardioid	15-20	30-50, 150-250	-83.5, -76.5	£50
SM57	Studio	Cardioid	15-20	30-50, 150-250	-83.5, -76.5	£38
SM58	Studio	Cardioid	15-20	30-50, 150-250	-83.5, -76.5	£50
SM60	Studio	Omni	—	50-250	-81.5	£30
SM76	Studio, pencil	Omni	—	50, 250	-80.5	£65
533SA	Hand, stand	Omni	—	High	-54.5	£18 10s.
533SF	Hand/Std.	Omni	—	25	-85	£16 10s.
540S	Stand	Omni	—	50-250 or high	-77 (low)	£19
544	Pencil	Cardioid	15-20	50-250 or high	-77 (low)	£30
544F	Pencil	Cardioid	15-20	25	-89	£28
545	Pencil	Cardioid	15-20	50-250 and high	-78 (low)	£32
545F	Pencil	Cardioid	15-20	25	-89	£30
545S	Stand	Cardioid	15-20	50-250 and high	-78 (low)	£34
545SF	Stand	Cardioid	15-20	25	-89	£32
550S	Stand	Omni	—	50-250 and high	-79 (low)	£26
					-57.5 (high)	

MODEL	TYPE	PICK-UP PATTERN	FRONT/BACK RATIO (dB)	IMPEDANCE (ohms.)	SENSITIVITY (mV/N/m ² **)	PRICE
556S	Stand	Cardioid	15	30-50, 50-250, 40 K	-84, -78, -57	£50
560	Lavalier	Omni	—	150-250 or high	-80 (low)	£15
560F	Stand	Omni	—	25	-85	£13
561F	Goose-neck	Omni	—	25	-85	£12
565	Hand/Std.	Cardioid	18-20	50-250 and high	-78 (low)	£36
565S	Stand	Cardioid	18-20	50-250 and high	-78 (low)	£38
566	Stand	Cardioid	18-20	30-50, 150-250	-75, -55 (high)	£50
PE566	Stand	Cardioid	15-20	30-50 and high	-75 (low)	£52
570	Lavalier	Omni	—	50-250	-80	£35
570F	Lavalier	Omni	—	25	-85	£35
570S			—		-80	£38
571	Hand/Std.	Omni	—	50-250	-81	£35
572G	Goose-neck	Omni	—	50-250	-81	£40
574SA	Hand/Std.	Omni	—	100 K	-56	£12
574SF	Hand/Std.	Omni	—	25	-85	£11
578	Switched pencil	Omni	—	50-250 or high	-80 (low)	£30
578F	Switched pencil	Omni	—	25	-92	£30
78S	Switched pencil	Omni	—	50-250 or high	-80 (low)	£32
581SA	Hand/Std.	Cardioid	15-20	High	-56.5	£23 10s.
581SF	Hand/Std.	Cardioid	15-20	25	-87.5	£21
585SA	Hand/Std.	Cardioid	15-20	High	-56.5	£25
585SAV	Hand/Std.	Cardioid	15-20	High	-56.5	£27
585SB	Hand/Std.	Cardioid	15-20	50-250	-79.5	£22
MD421	Studio, hand	Cardioid	18	200 bal	2	£36 17s. 6d.
MD411	Hand	Super cardioid	20	200, 1000, 25 K	.12, .25, .25	£15 14s.
MD408	Stand	Super cardioid	20	200	.13	£22 5s. 6d.
MD21	Hand	Omni	—	200	.2	£25 10s.
MD211	Hand	Omni	—	200	.13	£41 12s. 6d.
MD214	Lavalier	Omni	—	200	.1	£34 17s. 6d.
MD420	Hand, noise cancelling	Super cardioid	20	200	.16	£18 18s. 6d.
MDSIN	Stereo	Super cardioid	20	200	.13	£30 11s. 9d.
MD722	Hand	Super cardioid	18	500	.12	£6 16s.

Sennheiser (Audio Engineering Ltd., 33 Endell Street, London, W.C.2.)

4037A/C	Hand	Omni	—	30	-76	£26
4021	Stand	Omni	—	300	-81	£20
4105	Stand	Cardioid	15	30	-83	£25
4112	Lavalier	Omni	—	30	-84	£24

STC Ltd., West Road, Temple Fields, Harlow, Essex.

VL1	Pencil	Omni	—	30-50, 50 K	-76	£14 14s.
VL2	Pencil	Omni	—	30-50, 50 K	-76	£16 16s.
VL3	Stick	Uni-directional	18	30-50, (4 kHz) 50 K	-91, -58	£18 18s.

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4"	450'	6/-	5/-
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7"	1800'	23/-	14/-
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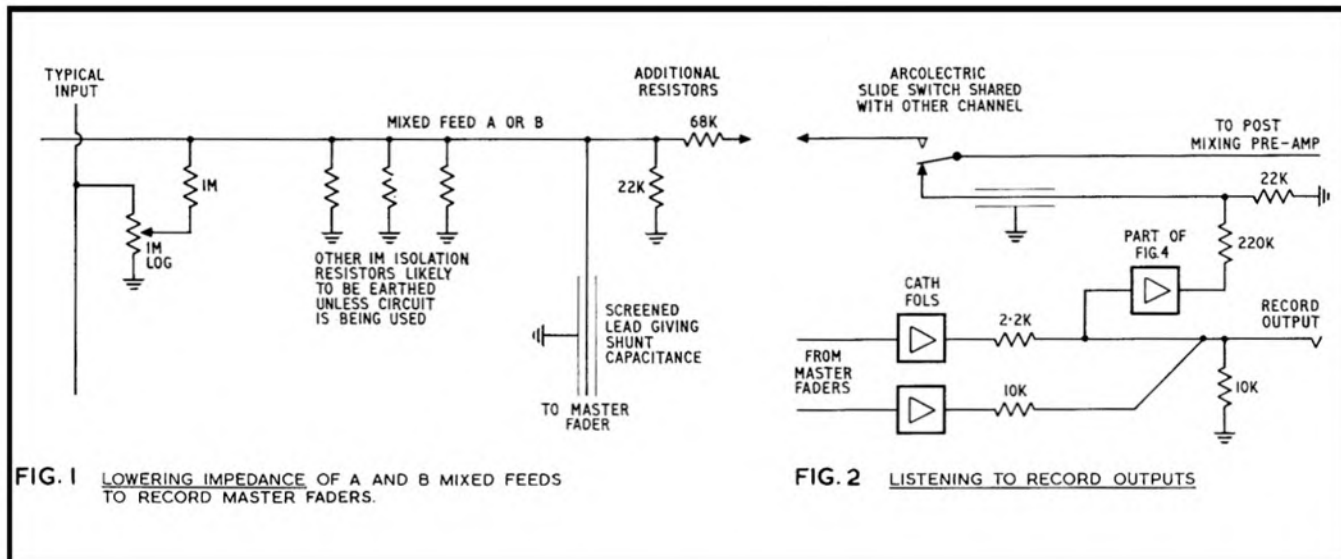


FIG. 1 LOWERING IMPEDANCE OF A AND B MIXED FEEDS TO RECORD MASTER FADERS.

FIG. 2 LISTENING TO RECORD OUTPUTS

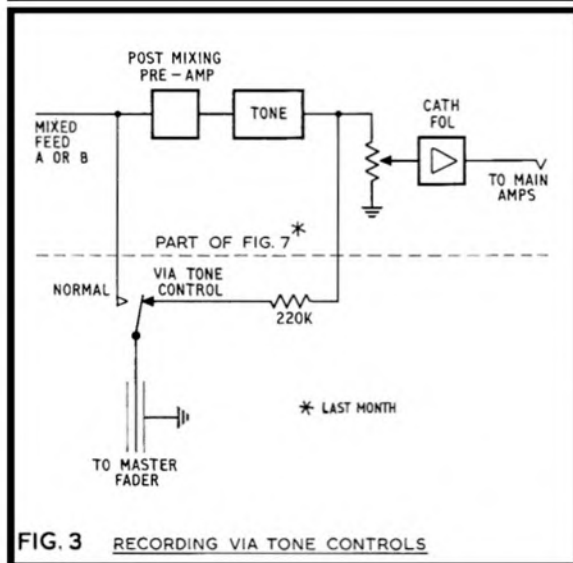


FIG. 3 RECORDING VIA TONE CONTROLS

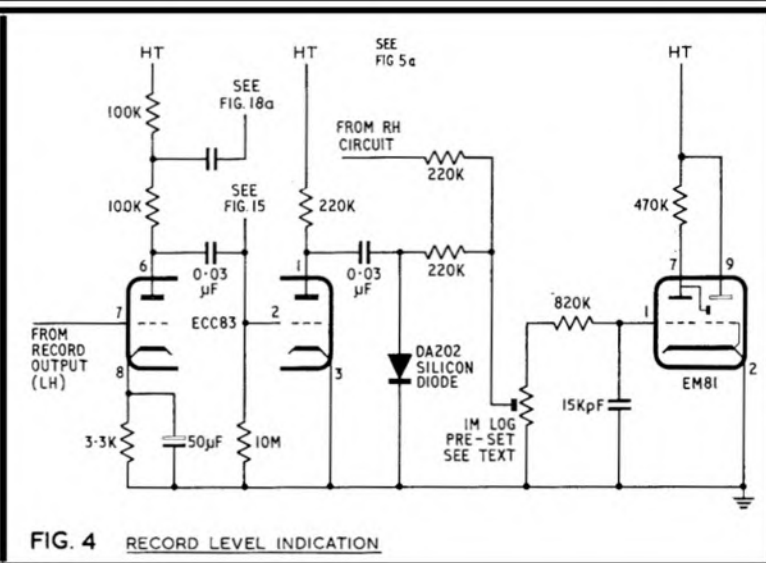


FIG. 4 RECORD LEVEL INDICATION

ONE MAN'S MIXER part two—some concluding circuits

BY M. G. SKEET

IT was thought wise to have the output sections at each end of the mixer. This was to keep as much separation as possible between what is being listened to and what is being recorded—they can in fact, as previously mentioned, be entirely different programmes. The 1 M isolation resistors (fig. 1) are situated as near as possible to the grid of the post-mixing preamplifier to avoid pick-up of unwanted signals. Both master faders on the record outputs are fitted near each other at the appropriate end of the mixer and hence the connection from mixed feeds A and B to their master fader must be screened. This produced a shunt capacitance of some 200 pF due to the type of lead chosen.

What effect this has on the higher frequencies depends on how high an impedance it shunts. At 10 kHz, a loss of 6 dB with respect to 1 kHz came about as a result of this seemingly small capacitance. The cure was to lower the impedance of the circuit at the point of connection by providing the two additional resistors shown. A disadvantage is a loss of signal to the post-mixing preamplifier, but this was not found to be serious. Layouts of mixers produced to incorporate the ideas being discussed will vary. Consider carefully the impedance, at the point of connection, of any screened leads, because the simple remedy described above may not always be applicable.

Sometimes one requires to place the main

amplifier outputs across the record outputs. Having provided this facility, the author uses it to conduct endless (to others) A and B checks on, say, disc quality versus a tape recording just made of the same signal.

The signal to be recorded is sent to the tape recorder over mixed feeds C and D. This can be monitored by use of a slide switch as shown in fig. 2. Assuming the tape recorder has separate record and playback heads and amplifiers, then the outputs from the tape machine can be connected into the mixer and monitored by restoring the slide switch. This is assuming that the appropriate potentiometers (fig. 6 last month) send the signal

(continued on page 322)

OUR READERS

write

... about synchroplay

From: John Stevenson, 15 Vernon Avenue, Marton, Blackpool.

DEAR SIR, I refer to your Editorial in the May 1968 issue. If I interpret your desires correctly, I think I am right in saying that the *Bang & Olufsen 2000 de luxe* will replay from the upper half of the recording head whilst recording on the lower track. This function is obtained by pressing the SYNCHRO button. I myself have used the machine since its introduction for making up tape slide shows to ensure exact synchronisation of, say, a music change and a pulse for a slide change.

I must say that I have yet to find a machine which will offer an eight-way mixer, 6-8 W power amplifiers that will on their own work two *Radford Auditorium* speakers and will also

provide noiseless on and off tape monitoring.

I have no connection with B & O or their importers but of all my hi-fi equipment, which comprises a *Shure V-15*, *Radford*, *Brenell* and *Revox A77*, I would least like to be without the *Beocord*.
Yours faithfully

... about multiplay

From: Malcolm Hill, 93 Severus Road, Newcastle-on-Tyne, NE4 9NP.

DEAR SIR, I write in answer to your May Editorial, agreeing that many stereo recorders have confusing and illogical switching arrangements. I have taken great care that this criticism cannot be levelled against the new *Ferroglyph*. As far as I know, it is unusual in having separate tape/source switches for each

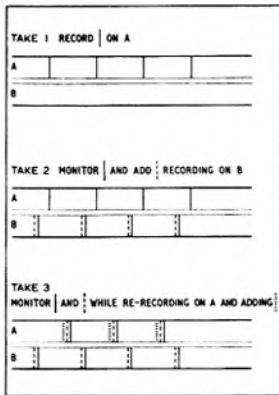
channel, giving great flexibility since each track is completely independent of the other. They can, however, be coupled by a TRANSFER switch having three positions: off, lower-to-upper, and upper-to-lower. The transferred signal may be from either tape or inputs as selected by the tape/source switch. If source is selected, inputs from both channels may be recorded on to one channel—i.e. four-way mixing. The switch also gives the facility of playing either track, or any input, through both power amplifiers. It will even produce the old favourite, echo!

If a link is made between two pins on the auxiliary socket of the recorder, both tracks of the tape or both sets of inputs mix together and may be heard in either or both loudspeakers.

This is, I believe, just about every combination of interconnections possible and so I feel that I do not really come into your category of out-of-touch designers!

Your Editorial went sadly astray in its complaints about multitracking facilities on current recorders. I really cannot believe that you have done any multitrack recording since you seem thoroughly confused about the whole system. (See page 297 regarding out-of-touch journalists—Ed.) It is easy to make synchronised recordings with such machines as the *Ferroglyph*, *Revox*, *Beocord*, *Tandberg* and *Brenell*, in spite of their spaced heads. Your confusion is between *duoplay*, which is simply the mixing upon subsequent replay of two identically and independently made tracks, and *multiplay*, which is the re-recording whilst adding something new from track to track.

(continued on page 323)



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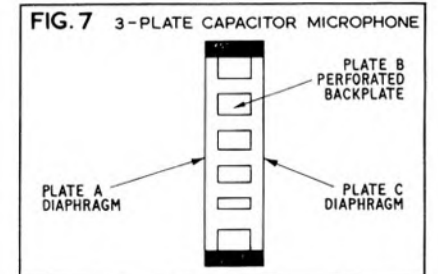
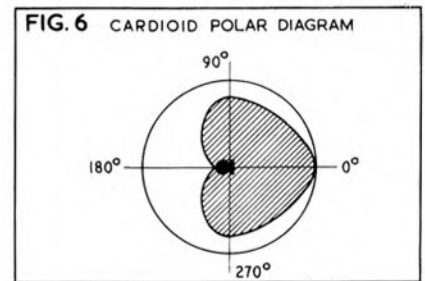
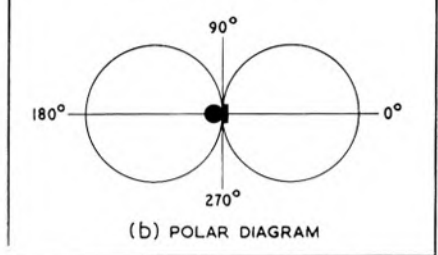
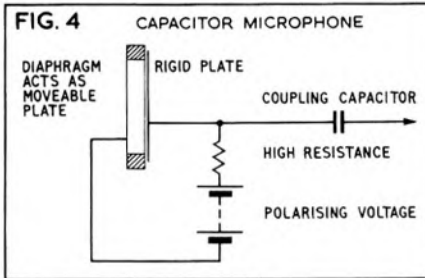
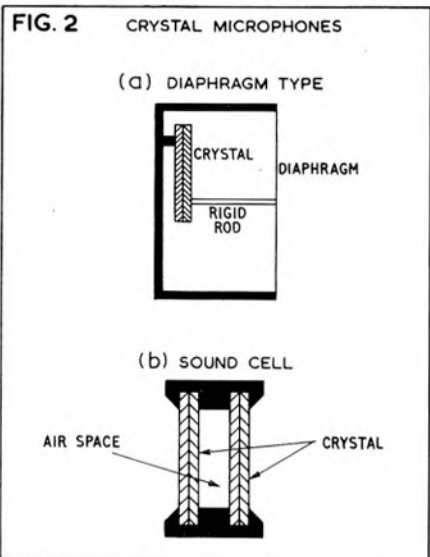
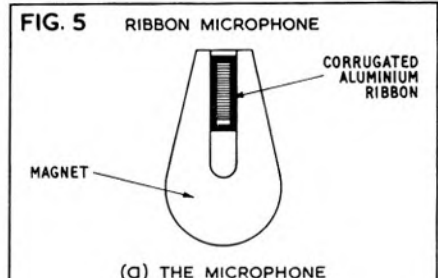
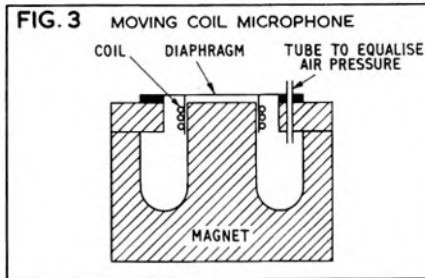
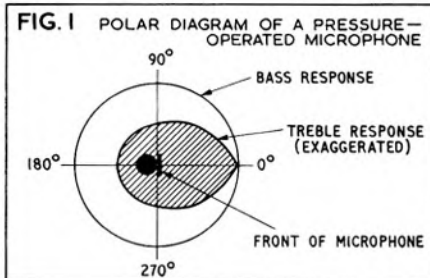
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CAVES

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choosing and using a microphone

BY C. N. G. MATTHEWS



A MICROPHONE can cost less than a pound, or it could come to more than a hundred pounds. The variation in types and quality is as wide as this. If you are buying a microphone it pays to get the best you can afford—provided that it is the type you require. But there is no need to be wildly extravagant, because microphones good enough to produce really first-class results can be purchased for a few pounds. Within reason, as much depends upon the microphone type and how it is used as upon what you pay.

This deserves a little attention because the best equipment in the world will not give good results unless it has the right material to work on. If the microphone distorts a sound before it gets as far as the recording amplifier we cannot hope for good quality reproduction.

All microphones can be classified under three main headings: *pressure operated*, *pressure gradient operated* and *cardioid*. Ideally, the pressure operated microphone responds equally to sounds coming from all directions, while the pressure gradient operated microphone is most sensitive to sounds coming directly from back and front. The cardioid microphone, which is a combination of the

other two types, is most sensitive to sounds coming from one direction only. The best choice depends upon conditions and upon the type of recording being made, but the microphones supplied with tape recorders are usually pressure operated. They are the most useful for general purposes and, with a little ingenuity, can to some extent be used for directional work.

As the name implies, the pressure operated microphone is operated by air pressure variations due to the sound wave. Ideally, it is equally sensitive to sound waves at all frequencies coming from all directions. We can show the frequency and directional sensitivity of a microphone by drawing a *polar diagram*, of which an example is given in **fig. 1**. The microphone is at the centre of a circle marked off in degrees—we should remember that the microphone is sensitive upwards and downwards as well as purely horizontally, and look upon this circle as the projection of a sphere. The circle is marked off in degrees and zero angle is directly in front of the microphone. The microphone sensitivity is measured at as many angles as is convenient and marked off along appropriate radii of the circle. By

joining the points we get a plan of the microphone's horizontal sensitivity. If the plan is a perfect circle, then the microphone is equally sensitive in all directions. And since this plan is the projection of a sphere, we can deduce that the surface of equal sensitivity is a sphere all round the microphone.

At low frequencies, the polar diagram of a good pressure operated microphone is more or less circular, as indicated by the outer line in **fig. 1**. But as we raise the frequency, the directional response shows an increasing tendency to become elliptical. So the microphone is *omni-directional* at low frequencies but tends to become *unidirectional* over the upper frequency range.

The microphone has this response because the sound falls only on one side of the *diaphragm*. This is a thin sheet of material which either communicates pressure variations to an active element or itself generates the audio frequency EMF. Air is so elastic that at low frequencies the pressure changes strike the diaphragm at more or less equal strengths whether they come from the front of the microphone or the back. At high frequencies, though,

(continued overleaf)

CONTINUED

there is simply not time for a pressure change at the back to get round to the front before the pressure changes again.

The original pressure operated microphone was the *carbon*. Carbon microphones are cheap and sensitive, but they have many disadvantages. These days we are unlikely to find them used anywhere but in telephone systems.

The crystal microphone is the type most likely to be supplied with your tape recorder. It is cheap, light, efficient and gives a relatively high voltage output, though it is rather sensitive to hum and can cause difficulties when used on the end of a long cable.

The crystal microphone relies for its action upon what is called the *piezo-electric effect*. Certain crystals, of which Rochelle salt and quartz are notable examples, generate an EMF when they are subjected to mechanical stress. We can show this effect in an arrangement of the kind shown in fig. 2(a). Here, a thin, rigid rod joins the diaphragm to one end of a slice of crystal. Air pressure variations striking the diaphragm are transmitted to the crystal and so cause an alternating EMF to be generated. The crystal shown is a *dimorph*, or double slice. It gives extra voltage output because the EMF's generated by the two halves are doubled.

A diaphragm type crystal microphone has a level frequency response up to about 6 kHz. While this is satisfactory for speech, it is nowhere near adequate for music. Your crystal microphone will probably be of the *sound cell* type shown in fig. 2(b). Two dimorphs of crystal are sealed into either side of a cavity, leaving an air space between them. By eliminating the mechanical connection, this brings the frequency range up to at least 10 kHz, which is quite good enough for most domestic recording purposes. Crystal microphones with even better frequency responses are available, but they tend to be expensive.

The moving-coil is the other major type of pressure operated microphone. It is a rugged piece of machinery, popular with both amateurs and professionals. A good moving-coil microphone may have a worthwhile frequency range from below 40Hz to above 15 kHz—a great improvement on the average sound cell crystal variety.

The construction of a moving-coil microphone is shown diagrammatically in fig. 3. In some ways it resembles a modern tweeter loudspeaker. The coil, which moves in the narrow, annular gap of a powerful permanent magnet, is wound on a light former attached to the diaphragm. When the latter is moved by a sound wave, an audio frequency EMF is generated in the coil. To prevent back pressure from upsetting the performance, an equalizing tube leads into the cavity.

A well-designed moving-coil microphone is omni-directional at all frequencies. It will stand up to no end of hard wear and tear and can be found in most professional recording studios. Here it is very often used with the diaphragm facing upwards, so that performers speak or sing *across*, rather than *into* it.

Another important pressure operated microphone, the capacitor type, is shown in fig. 4. The diaphragm forms one plate of a capacitor, the other being a rigid piece of metal. A sound wave striking the diaphragm varies the distance between plates, thus causing variations in capacity. Now the relationship between voltage, capacitance and quantity of electricity in a capacitor can be expressed as $V=Q/C$. If we apply a polarizing voltage through a high resistance, Q cannot change rapidly, so any change in capacitance must produce a corresponding change in voltage. So the voltage across this type of microphone varies in time with the sound wave.

A good quality capacitor microphone has a more or less flat response from about 20 Hz to 18 kHz. So here we have a device with a far better range than the human ear. If we can produce electronic equipment as good as this microphone, we can make perfect recordings.

In fig. 5(a) we see the only type of modern microphone that does not employ a circular diaphragm, the pressure gradient operated microphone. It consists of an extremely thin corrugated aluminium ribbon, suspended between the poles of a magnet. Whenever this ribbon is moved by a sound wave, an EMF is induced. Now, the ribbon microphone is open back and front so it is operated by the *difference* in pressure between back and front. This means that a sound wave coming from the side will produce no movement of the diaphragm because it applies the same pressure to both back and front. So we get the bi-directional, figure-of-eight polar diagram shown in fig. 5(b).

Ribbon microphones are particularly good

on transient sounds because the ribbon is so light, and their frequency response approaches that of the capacitor microphone. But they are fragile and do not give a high output.

Both moving-coil and capacitor microphones can be modified to give the bi-directional properties of the ribbon. With the capacitor microphone, we simply drill holes in the back plate. Then the diaphragm becomes pressure gradient operated because the sound wave can reach both sides of it. And we can design moving-coil microphones so that the diaphragm is open back and front.

Under many recording conditions there are unwanted background noises. We can avoid most of them by making the microphone truly directional. One way in which this can be done is by including a ribbon and a moving-coil unit in the same case. A half-cycle of sound wave striking the front of the ribbon produces a voltage whose polarity is opposite to that which would be produced by the same half-cycle striking the back. But the half-cycle of voltage produced by the moving-coil unit is the same polarity whatever the sound direction.

So when we combine the two units, signals coming from the front are additive while those produced by sounds coming from the rear tend to cancel out. This gives us the heart-shaped polar diagram shown in fig. 6. It is from this diagram that we derive the name, *cardioid*.

We can make a ribbon microphone or a bi-directional moving-coil microphone into a uni-directional microphone by fitting it with an *acoustic labyrinth*. This is merely a cavity designed to prevent sounds from reaching the back of the diaphragm. In this way, we get half of the figure of eight polar diagram.

It is possible to make a capacitor microphone which will give any of the three responses according to how it is connected. We use a three plate capacitor as shown in fig. 7, with a diaphragm on either side of the perforated backplate. The diaphragms are mechanically coupled by the airspace between them and so will move simultaneously. When just one of them is connected to the polarizing voltage, the microphone is operated by pressure and pressure gradient at once. Hence it has a cardioid polar diagram. The second diaphragm can be polarized so that it either aids or opposes the first. When the two are aiding, the microphone is omni-directional; when they are in opposition, it is bi-directional.

ONE MAN'S MIXER CONTINUED

along mixed feeds A and B. The record master fader on feeds A and B must not be operated. Incidentally if it is, then you have one way of providing an artificial echo—but that is another story.

It is essential in all A-B checking that the same signal levels are used. Due to the losses involved in the record outputs, straight switching between these and mixed feeds A and B would mean a lower level from the former. Fig. 4 shows use being made of an ECC83 preamplifier feeding the magic-eye circuitry. To match levels accurately and also keep the impedance down, as a screened

lead is used, the control of levels is done by potential division.

Reference to fig. 3 will show that, with the slide switch as illustrated, a recording could be made of a signal after it has passed via the post-mixing preamplifier and tone controls. Hence for special effects or for 'correction' of poor signals, the A and B mixed feeds may be recorded after passing through the tone control circuit. Having provided this facility and having put a slide switch in each of the mixed feeds, another use was found.

A colleague had some discs of American origin called *Music Minus One*. These provide the rhythm backing to allow the listener to add the missing solo instrument. The discs were mono, but what happens if we

record them with a phase reversal and with one channel via a tone control giving a bass cut? A mono microphone provided for the aspiring soloist and fed to both channels in phase and without tone controls enables the recording to provide on playback a 'spread' of sound on the backing, but with a solid central soloist!

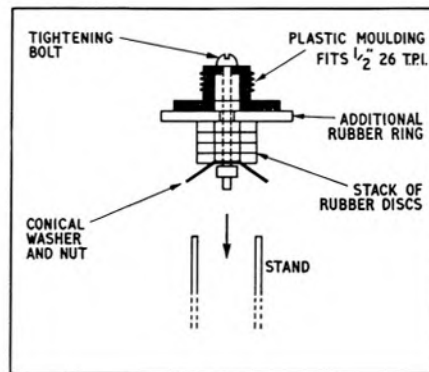
This question of keeping levels roughly similar brings to mind the need to mention that the 2.2 K and 10 K resistors after the record output cathode-followers allow just this in one particular respect. Without the difference in value, it was disconcerting to have a greater level from mixed feeds C and D than was obtained from A and B. Having
(continued on page 331)

two microphone mounting accessories

A SIMPLE STAND ADAPTER

A SIMPLE microphone adapter, adjustable to fit a range of stand diameters, can be made from one of the bottle lamp adapters available at 1s. from *Woolworths*. It consists of a plastic moulding which screws into the standard $\frac{1}{2}$ in. 26 tpi microphone thread used, for example, on *Reslo*, *Film Industries* and *Lustraphone* microphones, and a stack of rubber discs which expand when compressed by a conical metal washer which, in turn, is screwed towards the plastic moulding.

These adapters are available in two sizes of rubber ring and can be used with stands which do not have a permanently attached threaded adapter, or with stands improvised from aluminium tubing or from one of the large old-fashioned bird-cage stands. If preferred, the plastic moulding may be replaced



with a threaded brass fixing as used on wooded lamps, with a brass washer soldered or Araldited to the top of the threaded portion.

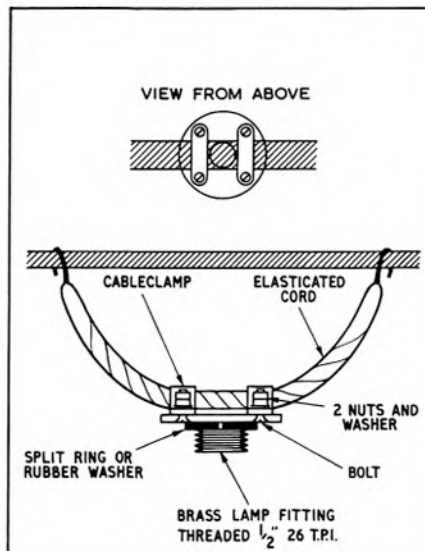
The adapter can be tightened up sufficiently firmly to be used safely with many miniature or domestic microphones, but one needs to use a little care with the heavier types—it would be safer at least to use the rings from two such lamp-adapters on a single microphone adapter in one stack. If an extra rubber washer, wider than the top of the microphone stand, is inserted between the top of the stack of rubber discs and the plastic moulding, this gives the microphone some slight isolation from direct contact with the stand and may help to reduce noises transmitted through the stand provided the microphone cable is not clamped firmly to it.

Terry clips are a convenient way of securing a microphone cable tidily down the side of a stand. If an oversize clip is lined with plastic foam strip this avoids scratching the stand or chipping a paint finish, and helps damp vibrations transmitted through the cable.

A SOFT SUSPENSION

SUSPENDING a microphone from a rope or wire across a large building is often the most convenient way of getting the microphone in the right position for balance and out of the way of performers and audience. It is therefore worth making up a suspension for the microphone which avoids most of the problems of twisting as the rope stretches under tension or as the temperature and humidity change. It also allows the microphone to be angled correctly before the assembly is hoisted into position, making use of the positioning devices fitted to *VR 53* and *64*, *Reslo* and *Film Industries* microphones, while providing a soft suspension that one piously hopes will reduce rumble and vibration transmitted through the suspending rope.

The components are simple: one of the elasticated cords, fitted with two heavy wire hooks, intended for strapping luggage to the back of the motor-cycle or to a car roof-rack, and obtainable from *Woolworths* or *Halfords*; a brass lamp-socket fixing, as used for making table-lamps, also obtainable from *Woolworths*; countersunk bolts, nuts and anti-rattle washers to fit; one rubber washer or split-ring washer. The brass lamp fixing screws into the $\frac{1}{2}$ in. 26 tpi (a plague on tpcm!) thread of the microphone. The centre of the elasticated cord is clamped to this by the cable clamps, using anti-rattle washers and lock nuts to avoid accidents. The assembly can now be hooked over the suspending rope and taped in position to prevent sideways movement as the microphone is hoisted. The microphone can be angled before hoisting, using its own tilting arrangements. The rubber or split ring washer allows some adjustment of the direction in which the microphone faces (once the appropriate holes



for the clamping screws have been found) but it may be necessary to drill and countersink an extra set of holes in some cases.

It is important to leave a loop of cable above the microphone before tying off the microphone cable to the suspending rope, to prevent twisting the microphone as the rope comes under strain, and also to leave sufficient slack in the microphone cable as it is tied off along the suspension rope to allow for stretch in the rope as it comes under strain.

A small word of warning may be appropriate here. The strain in the rope or wire from which the microphone is suspended can be considerable, particularly if it is tightened so that the rope nears the horizontal: it is

essential that a sufficiently strong rope be used. If the rope breaks and the microphone falls, the damage to the microphone is the least consideration: it may well injure someone severely or cause expensive damage to instruments or fittings. Nylon rope, although expensive, is very strong for a given diameter, but allowance must be made for stretch—which can be considerable—and it may need adjustment after a short period. A wire suspension can be very strong and thin, but if it does snap it can whip dangerously, causing an additional hazard. Natural fibre ropes must be stored carefully to prevent rotting or over-drying, and should always be checked for strength before use.

READERS' LETTERS CONTINUED

Duoplay is limited to mono $\frac{1}{4}$ -track recorders using compromise record/replay heads and cannot exceed two parts since no re-recording takes place. Multiplay can have any number of recordings in it (the Brenell Audio Fair demonstration had twenty) and the time lag between record and replay heads is irrelevant.

The method is as follows: first 'take' on Track-A. Replay, re-recording it on to Track-B and adding new material (yes, I know it shifts back along the tape but you are going to wipe out Track-A in a minute so what matters?). If a mistake is made whilst adding the second take, it can be done again since the first is still intact on Track-A, but when the mixture is safely on to Track-B the process can be repeated as often as required. The next step would be the copying of the first and second takes from Track-B back to Track-A whilst adding the third take.

Simple? Of course it is, and hardly worthy of a carping Editorial! *Yours faithfully*

recorders and recordings at the Russell

A REPORT ON THE 1968 AUDIO FAIR



IF the success of an Audio Fair can be judged by the number of new recorders on display, then the April exhibition was probably the most successful in 13 years. Even the pessimists were catered for—bemoaning the obsolescence of *Revox 736*, *Ferrograph 6*, *Vortexion CBL* and *Truvox 100*. These old standards had their faults, however, and there is every reason to hope that the new generation will be as good mechanically as were their forebears electronically.

A great profusion of scantily dressed young ladies decorated many stands and stairways during the exhibition (see *Hi-Fi News* for further details), among whom were representatives of the *Agfa-Gevaert* company. Their purpose was to attract visitors into Room 353 for a taped copy of classical, jazz or popular music. The copies were made on *Uher Universal* recorders. There is evidently nothing like a gift (or a girl) to keep a room full.

Akai ran a well-organised demonstration of their mains and mains/battery stereo recorders—the *X300*, *X355*, *I710W* and *X4*. Two of the *Akai* staff travelled from Japan to discuss sales and technical questions, Mr. Miyoshi Kuroki having a particularly impressive command of the English language.

AKG introduced a *D.1000* “musician’s microphone” finished in 24 carat gold. Another (?) useful feature is a three-position switch tilting the frequency response about a 4 kHz point. The new *K.20* and *K.60* headphones were demonstrated, each being available with 70 or 600 ohms impedance.

A novel idea in tape recorder mounting was conceived by *Ampex*, the deck of their *753* fitting flush in an improvised wall.

BASF are one of the most publicity-conscious

companies in Europe and have a substantial staff engaged in the preparation of technical literature supporting their chemical products. Several films have been made showing the virtues of *BASF* tape, the latest being *The Timeless Track* which was screened at frequent periods throughout the Audio Fair.

Microphones of all shapes, prices and specifications were shown by *Beyer* under the aegis of *Fi-Cord International*. *Fi-Cord* are themselves now manufacturing a range of relatively low price capacitor microphones. The *FC600*, *650*, *700*, *750*, *800*, *850*, *900*, *950*, *1200* and *1200A* between them offer a substantial variety of polar patterns and specifications. Details appear on page 315.

A new *Brenell* is an earth-shaking event and this year we were treated to two surprise models. The *SSM* has a similar mechanism to the *Mk. 5 Series 3* with slightly restyled controls. Its prime feature is plug-in transistor circuitry with a most impressive specification. At 38 cm/s (with the larger of the two standard capstan sleeves), frequency response is 40Hz - 20 kHz \pm 2dB with a 66 dB signal-to-noise ratio (CCIF weighted) from erased tape. Signal-to-noise ratio from virgin tape is 69 dB and the replay amplifier itself is 75 dB, weighted. Output power is 8W RMS from a transformerless low-distortion stage (0.06% second harmonic and 0.04% third), the internal monitor level being deliberately attenuated. Source and off-tape monitoring facilities are provided, while a 100 kHz oscillator frequency is said to avoid pilot-tone beating on stereo FM broadcasts.

The second *Brenell*, shown in prototype form on the ground floor stand (see photo), has a potentially very successful future. It is

completely solenoid controlled, all mode selectors being mounted in a separate unit at the end of a multi-core cable link. Speeds are 19 and 9.5 cm/s, electrically selected by a switch on the deck. Alternative versions will be available with selector buttons incorporated on the deck and for combined remote/normal control. *Brenell* are among the fringe companies catering equally for domestic and industrial markets and have been hindered by the indecision of the Customs and Excise authorities in defining which types of equipment will be exempt from the 33% tax. The *SSM* is expected to cost some £140 (mono), possibly plus tax. The solenoid design may be confined to industrial consumers if the tax would otherwise come into force. No nominal price has yet been decided.

Another manufacturer involved in The Great British Revival, if such it can be called, is Tom Reps’ new company *Magnetic Tapes Ltd.* Exhibiting under the *Chilton* trade mark, they displayed on Booth 59 a dummy (‘prototype’ in more polite terminology) of the stereo *100S*. The permanently closed door of Room 354 was one of the mysteries of the exhibition, many readers calling upon us to enquire when the recorder was to be demonstrated. *Chilton* were in fact one of the last companies to apply for the 1968 Fair and, having succeeded in their application, were finally let down by a component manufacturer. Despite well-meant pleas from our staff to improvise the missing switches for a weekend demonstration, Mr. Reps’ damned perfectionism dissuaded him from the idea! For all their misfortune, the company have managed to keep their post-budget price down. From its former £120 15s., the *100S* has risen to £145—still barely within



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reach of the average enthusiast.

One of the most pleasant noises at this year's exhibition came from Room 302, where EMI were feeding a *BTR4* studio recorder into *Bowers and Wilkins* loudspeakers.

Many a pilgrim to the Hotel Russell must have journeyed specifically to see the new *Ferrograph*. Its claim to herald "a new era in tape recording" are in many respects true, for it displays in abundance that rare commodity—original thinking. The *Series 7* possesses no adjustable guides but the problem of flange-scraping is not forgotten. Both turntables may be varied in height to suit the physical characteristics of the spools. In addition to being tidier and more convenient, this eliminates the speed fluctuation which can occur when a tape deviates from a true lateral path.

The redesigned head channel is particularly easy to thread once the cover has been hinged back. Pressure pads are still used against all three heads but can be retracted during playback for accurate editing. Export orientation explains the *VU*-meters: a separate *PPM* unit is available for the purists, with or without a remote start/stop switching device. The latter exploits the solenoids which lock the mechanism in place once the mode has been selected. Another concession to export markets—the solitary *DIN* socket, looking very foreign indeed among a neat array of standard jacks. Continuously variable spooling speed, a four-digit spool rotation counter, 21 cm. spool capacity and a gaunt extruded-aluminium finish are among other features, the finish being matched on the *F307*, a separate transistor stereo amplifier retailing at £56. Silicon and *FET* components are incorporated, facilities being included for connection of magnetic

pickups. A headphone output is provided on the front panel.

Grampian were limited to a booth this year but managed to squeeze the bulk of their microphones, mixers and recording accessories into a relatively small space. Among the exhibits was the *GR2L* microphone, reviewed on page 313.

A pleasantly informal continuous demonstration of tape and general audio equipment was organised by *Grundig*, the products of this prolific company covering two spacious racks and a wall mounting. Three *TK340* $\frac{1}{4}$ -track stereo recorders also performed bravely at a formal *British Amateur Tape Recording Contest* prize-giving on the Saturday, playing the successful entries into stereo headphones.

Lowther, formerly specialists in the manufacture of high-quality loudspeakers and drive units, have expanded into the production of electronic musical instruments. The *Organino Electronic Keyboard* was designed by Heinrich Van der Horst, son of *Radio Electronica* editor W. Van der Horst. Designer and instrument are visible—the former barely so—in the photograph. The original Dutch model, manufactured by *Neonvox*, spanned four octaves with twenty basic voices. A five octave keyboard is incorporated on the *Lowther* version, manufactured in Britain under licence. Among the many voices, or simulations, obtainable on the instruments are Harmonium, Oboe, Accordion, Viola, Cornet, Clavichord, Trumpet, Krummhorn, Clarinet, Spinet and Harp. Combining the twenty voice keys and sustain pedal produces a wide range of new electronic effects. A second pedal controls swell, or loudness, additional facilities being included for vibrato of variable rate.

1. David Kirk (left) discusses *Tandberg* with Arthur Dakin of *Elstone*.
2. The *Truvox* demonstration, photographed at an Easter pre-hearing.
3. Cyril Rex-Hassan, Audio Fair organiser, presents a *BATRC* trophy to Philip Towell.
4. The two-speed stereo *Philips PRO12*.
5. A prototype *Brenell* solenoid deck (left) and the transistor *SSM* (centre).
6. T. H. Reps, designer of the *Chilton 100S*, poses by his recorder.
7. Heinrich Van der Horst seated at the keyboard of his *Organino*.

Despite the versatility of the *Organino*, the retail price is relatively modest at approximately £185. This figure has been achieved by devoting all energy to active circuitry and omitting the power amplifier and loudspeakers normally found in commercial organs. Two line outputs are provided, suitable for the inputs of a domestic high quality music reproduction system. Connected to separate channels of a stereo amplifier, the instrument will create a spaced pseudo-stereo effect, each half of the keyboard being fed to a separate loudspeaker. The instrument really raises only one question: should a microphone be employed when recording it?

Lustraphone proffered a new range of microphones—the *Series 4*—supported by a four-page leaflet which, when examined in detail, had some very worthwhile advice to offer the recording enthusiast. The *4-40* studio and *4-50* professional ribbon microphones were of particular interest, offering good quality at modest cost. *4-20* and *4-30* moving-coil units, respectively omni-directional and hyper cardioid, are more suitable for recording in difficult conditions where wind or violent vibration are likely to be experienced, and are said to give good speech and music results.

The *Multicore Model 21 Video Tape Splicer* attracted some interest—mainly academic—to Booth 62. If the *Sony* helical-scan system is ever generally adopted as a standard, we may see a lengthened splicer capable of cutting between frame tracks.

Philips' PRO12, originally £189, may have a very *PRO* price indeed if made liable to Mr. Jenkins' third. The recorder is said to breach the gap between domestic and industrial/

(continued on page 327)

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3-ips (9.5 cm/sec)		
1-ips (4.8 cm/sec)	Input impedance	Weight
	Microphone 50K ohm	18 lbs. (8.6 kg)
Wow and flutter	Line in 200K ohm	Accessories
7- $\frac{1}{2}$ ips: 0.15% R.M.S.	Output impedance	Empty reel 7"
3-ips: 0.20% R.M.S.	Line out 2K ohm	Patch cord x 2
1-ips: 0.30% R.M.S.	Headphone 8 ohm or 10K ohm	Reel stopper x 2
	Frequency response	Splicing tape
Recording time	7- $\frac{1}{2}$ ips 20-20,000 c/s	Dust cover
96 min at 7- $\frac{1}{2}$ ips	(\pm 3db 30-15,000 c/s)	Recommended
(stereo 7" 35 μ tape)		retail price £78

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8



9

studio markets and has a fine speed control with stroboscopic indicator. A solenoid mechanism, vU-meters with 10 dB switched sensitivity, three $\frac{1}{2}$ -track stereo heads, variable tape tension and a radial-wrap head mounting suggest a well-conceived recorder. The PRO12 is said to meet DIN 45511 studio standards, tape speeds being 19 and 9.5 cm/s. Spool capacity is 18 cm. maximum.

"All tapes are now coated in Polyester backing . . ." said the Audio Fair catalogue, mysteriously, when describing a new low-noise Philips tape. The ingenious library container developed for cassettes has been scaled up to suit standard spools in which Philips tape may now be purchased.

Reslo microphones decorated the walls of Room 348, though demonstrations seemed confined to Chapman tuners whenever we were within the region. Newest exhibit was the UD.1 omni-directional microphone, a smaller version being the 'pop proof' OD.1.

Colin Hammond invested £1000 in an ambitious little film celebrating the birth of the Revox-Studer A77. Before it introduced the latter, however, we were treated to a long-distance shot of the earlier 736 sitting in isolation in a gravel quarry. Then came an appalling pun—"The Revox 736 stands alone"—followed by an explosion. It was not a dummy, Mr. Hammond assured us; they really did detonate two 736's before completing the film—the bits were available for inspection. The film had a particularly sad postscript, however, for the projector took umbrage on the last day of the exhibition and blew up in sympathy.

When the A77 itself was allowed to perform,

it produced an exceedingly sweet noise through two Quad electrostatic loudspeakers. Both mechanically and electronically, it is undoubtedly representative of the audio recorders we shall be seeing in the mid-1970's.

Engineers are well-meaning fellows, motivated in the main by a fondness for experiment rather than a desire to sell. The Scotch demonstration, nevertheless, was in our opinion one of the most tasteless cacophonies ever purveyed at the Hotel Russell. Their idea of ambiophony was a four-channel aural blitzkrieg relayed from a multi-channel Ampex 300 to Wharfedale Teesdale loudspeakers via two WHF 20 stereo amplifiers. Gilbert Vintner's *The Trumpets* was very impressively recorded and, reduced to a merely loud level, might well have been enjoyable. The organisers however, chose to reproduce the tape at something approaching flat out; the result was physically painful. When one additionally considered the intrusive tape noise (despite the Dolby), the degree of print-through (*Dynarange 202*) and the frequent passages of distortion, the overall effect became insulting.

Sennheiser took considerable care in preparing their demonstration, which comprised tape recordings made on good domestic recorders (*Bang & Olufsen 2000* and *Vortexion CBL*) by L. K. Desmond, N.C.H. Druce and Denys Killick. The relative merits of four microphones were illustrated by a programme of nineteen tapes. Also in Room 355 was a versatile four-channel professional portable mixer with sliding gain controls, PPM level indicator, 1 kHz line-up oscillator, pre-fade listen facilities and a capacitor microphone power supply. The units may be connected



10

8. *Hi-Fi News* contributor Hector Houghton ('What's Wrong with Hi-Fi?') eyeing the Reslo booth.

9. *Tape Recorder* contributor Peter Bastin (left) and BATRC organiser John Bradley.

10. Malcolm Hill (background), designer of the *Ferrograph Series 7* electronics.

together to form an eight or twelve-channel system.

Nothing live at STC this year, but Mr. Fisher is already thinking ahead to the 1969 Audio Fair. The 4113 ribbon is reviewed on page 313.

Stereosound have entered the tape recorder market with an inexpensive $\frac{1}{2}$ -track stereo design based on the *BSR TD10*. Pre-budget price was £45 3s.

The *Tandberg* range increases year by year, currently comprising *Series 8, 9*, and *15* mono recorders and stereo *6X* and *12*. Model *11*, additionally, represents their entry into the purely professional market. The demonstration centred on a *64X*, showing what can be achieved at slow speeds when opposing-field bias is correctly applied. Newest of the range was the *15*, a prototype of which was shown to us at the company's Oslo factory in January. The vU-meter is an unfortunate compromise which accompanies complete transistorisation: it is not economic to incorporate an HT power supply purely for a magic-eye.

An interesting accessory on display in Room 160 was the *Tape Recorder Spares* skirting-board loudspeaker socket. In addition to servicing the most obscure recorders ever left by collapsing manufacturers, *Tape Recorder Spares* produce a comprehensive range of plugs and sockets to aid the connection of audio equipment.

Telefunken manufacture some superb professional tape recorders, though the quality for price of their loudspeakers leaves something to be desired. Room 247 was devoted to domestic tape equipment and audio

(continued overleaf)

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AUDIO FAIR REPORT CONTINUED

systems playing in a continuous open demon-
stration.

Tape Recorder Developments were not
worried by the budget since the bulk of their
production was being consumed by industrial
studio and educational establishments. The
DPA1 performed practically non-stop through-
out the four-day exhibition and has earned a
good reputation since first being marketed in
1967.

Guitars, clarinets, saxophones and bagpipes
littered the Truvox room and were played into
a Series 200 recorder. After each recording,
the musicians accompanied their tape to
produce two-man quartets, one man duos, or
what have you. The 200 is essentially similar
to the silicon-transistor 100 but features a
number of electronic and mechanical improve-
ments.

The Royal de Luxe shown by Uher was
a rather expensive recorder at £198 9s.
before tax. Whether such a machine will sell
at £242 11s. remains open to conjecture. Half
or ¼-track stereo heads, source/tape monitoring,
compensated 'loudness' control and a pilot
device for automatic slide projection are among
its facilities. Four speeds, 10 W per channel
(sinewave) amplifiers and twin VU level
meters are also included.

A new Vortexion seemed inevitable when, in
September 1966, we heard of the coming
Ferrograph. The latest three-speed Wearite
deck forms the backbone of a Series 7 stereo
recorder with FET and silicon transistors,
two PPM's and a 10 to 15 W per channel
monitor having a claimed 0.1% distortion
level at 10 W. Like the CBL, the Series 7 has
input facilities for low-impedance microphones.
Vortexion anticipate exemption from the 33%
purchase tax on non-industrial recorders;
we wish them success.

Outside the Hotel Russell, the Technomark
company put on an excellent Mini-Fair in the
bowels of the Tavistock. Bang & Olufsen,
Radford and Sony equipment competed to
enchant visiting ears. Shortly after the exhibi-
tion came the news that Sony were parting
from Technomark to form their own British
branch. There is a moral here for those
companies—importers and others—handling
a family of products that compete with each
other. The products themselves: a neatly
styled stereo recorder based on the TC530
mechanism and designated the TC230W.
Complete up to 4 W per channel power
outputs, the recorder is available with or
without SS-23 loudspeakers. Meters and
amplifier controls are mounted on the vertical
front panel, an arrangement that will appeal to
many users as it overcomes the need to hover
above a horizontal deck panel. Retracting
pressure pads and pinch-wheel make this, and
the TC530, particularly easy to thread.

Conclusions? There was a definite trend
toward satisfying the 'semi-professional'
market, though high price and elaborate
gimmicks were not necessarily accompanied
by quality. The world's tape recorder manu-
facturers have been particularly active in the
past year, British companies moving well to
the fore. It remains to be seen whether the
Chancellor of the Exchequer has quashed
anyone's ardour.

equipment reviews

AKAI 3000D STEREO

MANUFACTURER'S SPECIFICATION.

Quarter-track stereo tape recorder with silicon transistor preamplifiers. **Tape speeds:** 19 and 9.5 cm/s (7½ and 3½ i/s). **Wow and flutter** (play only): less than 0.15% RMS at 19 cm/s; 0.25% RMS at 9.5 cm/s. **Frequency response:** 30 Hz-22 kHz at 19 cm/s; 30 Hz-14 kHz at 9.5 cm/s ±3 dB. **Distortion:** 2% at 1 kHz, 0 VU. **Signal-to-noise ratio:** 50 dB. **Equalisation:** NAB. **Inputs:** 0.5 mV (microphone), 50 mV (line). **Power supply:** 100-240 V AC, 50/60 Hz. **Power consumption:** 30 VA. **Dimensions:** 40 x 30 x 14 cm. **Manufacturer:** Akai Electric Co. Ltd., 12, 2-chome, Higashi-Koiya, Ohta-ku, Tokyo, Japan. **Distributor:** Pullin Photographic Ltd., 11 Aintree Road, Perivale, Greenford, Middlesex. **Price:** £105 11s. 4d. including £16 6s. 4d. purchase tax.

THE basic mechanism of the 3000D is similar to that used in the Akai ST-1 (reviewed in April 1966), the M6, 7 and 8 series and indeed the new 1710W which was first shown at the Audio Fair and which will be the subject of a future review.

A single heavy-duty induction motor drives the flywheel and capstan via a rubberised flat belt and the wind and rewind spool turntables through intermediate idler wheels. The wind and rewind time for a 1,800ft. 18 cm. reel of LP tape is 4.5 minutes in either direction.

The push button reset tape position counter is driven from the supply reel and clocks up exactly one digit per revolution, i.e. ten reel revolutions give a reading of 10.

The fixed speed capstan drives the tape at 9.5 cm/s and a capstan sleeve is provided to increase the diameter for 19 cm/s. This particular sleeve was a reasonably tight push fit, and a screw-on cap was incorporated to hold it firmly in position. An adjacent pin is fitted to park it when the lower speed is being used.

The erase, record and playback heads are laid out on a 15 cm. radius semi circle and no pressure pads are used, the tape being held against the heads by the reverse tension only.

Tape speed was constant within 2% limits on an 18 cm. reel, but speed dropped by

(continued on page 331)



FIG. 1 AKAI 3000D RECORD/PLAY WOBBLE

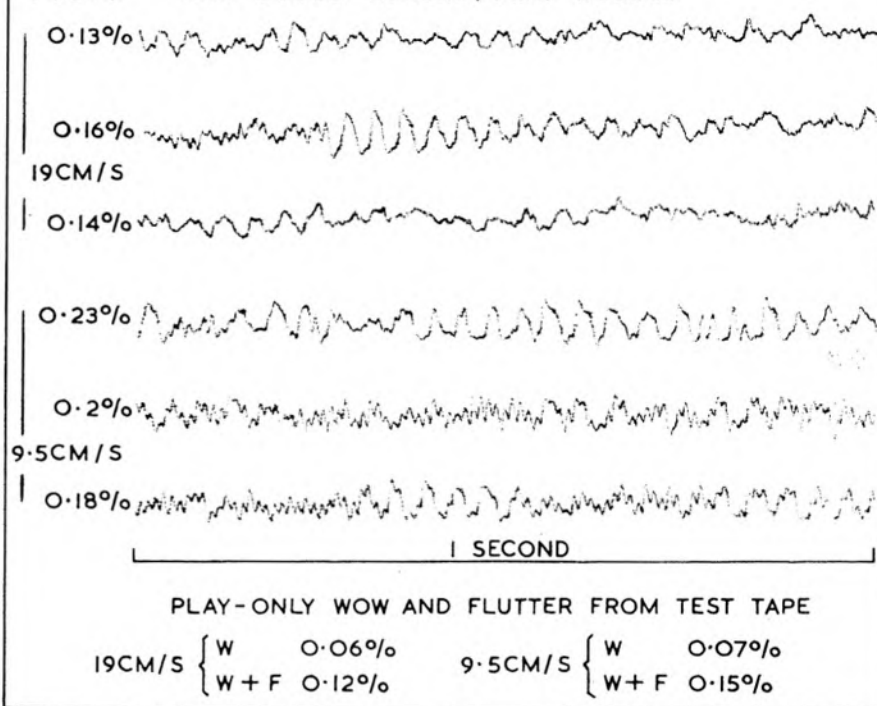


FIG. 2 AKAI 3000D PLAY ONLY RESPONSE (TEST TAPE TO LINE OUTPUT)

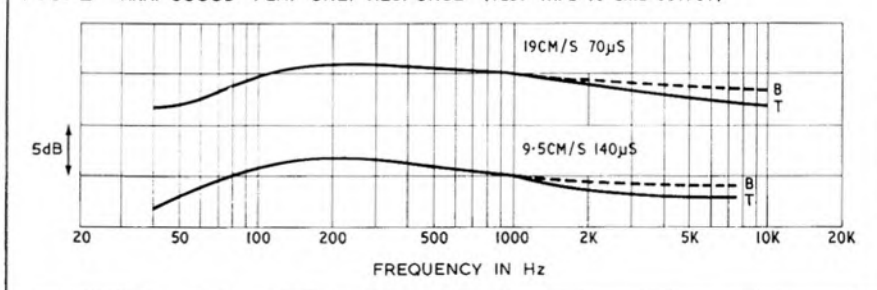
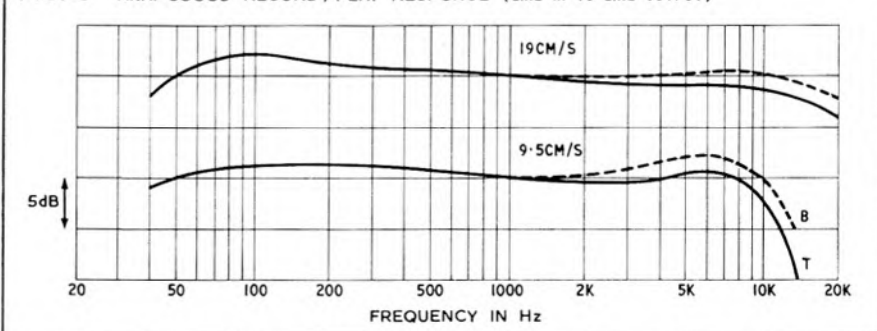


FIG. 3 AKAI 3000D RECORD/PLAY RESPONSE (LINE IN TO LINE OUTPUT)



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nearly 5% on the inside of a 4.5 cm. hub 7.5 cm. spool and became completely unstable on a 3 cm. hub message spool.

The panel in **fig. 1** shows the play-only wow and flutter readings from a low wobble test-tape. These readings are well within the specification which, it should be noted, are for playback only.

The pen recordings of **fig. 1** show a predominant 25 Hz flutter from the 1,500 r.p.m. drive motor. There is a trace of 2 Hz wow on the lower 19 cm/s trace which can only be due to the pressure roller. The 25 Hz flutter could be clearly heard on a sustained tone, and there was also a random unsteadiness as the various low frequency components due to belt, capstan and pressure roller came in and out of step on the combined record/replay tests.

The play-only tests using 70 and 140 μ S standard test-tapes revealed a 1.5 dB difference

in the high frequency equalisation of top and bottom tracks, but the general trend of both responses showed the 3 dB step in response which is characteristic of a CCIR tape played on NAB equalisation. It can thus be deduced that the playback equalisation is close to the NAB 50 and 90 μ S time-constant response.

System noise with no tape passing the heads was 45 dB below test-tape level unweighted.

Recording tests on reference tape showed that test-tape level (10 milli-Maxwells per mm. tape width at 500 Hz, 19 cm/s) was recorded at -5 dB on the VU meter. Peak recording level, at 12 dB above reference tape level, was well off the meter scale on continuous tone; 500 Hz distortion was 2% at 19 cm/s and 2.7% at 9.5 cm/s.

The overall record replay responses at test-tape level are shown in **fig. 3**. The extra NAB high frequency pre-emphasis together with the standard NAB 3180 μ S bass rise gives a level response within 3 dB limits from 40 Hz to 20 kHz at 19 cm/s and 30 Hz to 12 kHz at 9.5 cm/s.

Unweighted signal-to-noise ratio, from 500 Hz peak recording level to erased tape noise, was 54 dB. Tape hiss (via 250 Hz high-pass filter) was 58 dB below peak recording level.

The dynamics of the VU-meters were satisfactory: the full dynamic range of the tape was utilised with the mean deflection of the meters reaching half scale with occasional excursions into the red on sustained peaks.

COMMENT

The frequency response and signal-to-noise ratio of this recorder are excellent as are the layout and operation of the controls.

This review machine suffers badly from 25 Hz flutter due to an eccentric motor pulley or shaft but it is difficult to say whether this is a general or typical fault. I suggest that potential customers should listen carefully to a good quality pre-recorded tape and see if there is any trace of "gargle" on sustained chords. If there is any sign at all of this effect, it is almost certain that it will be intermittently very obvious on recordings made and played back on the machine.

A. Tutchings.

ONE MAN'S MIXER CONTINUED

mentioned that, here is another thought that has escaped being committed to paper: in any mixing system steps should be taken so that at the post-mixing stage signals from different sources are at similar levels. The microphone channels should be the reference and other sources should be brought into line.

Two requirements for level indication were found to be necessary as experience was gained in using the mixer. The primary requirement in level indication was that the record outputs could be monitored in the mixer rather than on whatever tape recorder was being used to make the recording. Operating controls on the mixer and looking at the consequences as seen on the tape recorder's own level indicators requires a 'longer sight' than the author has got. Having magic-eye level indicators on the mixer and VU meters on the tape machine brings the expected anomalies. Although alarming at first, experience soon lessens the problem.

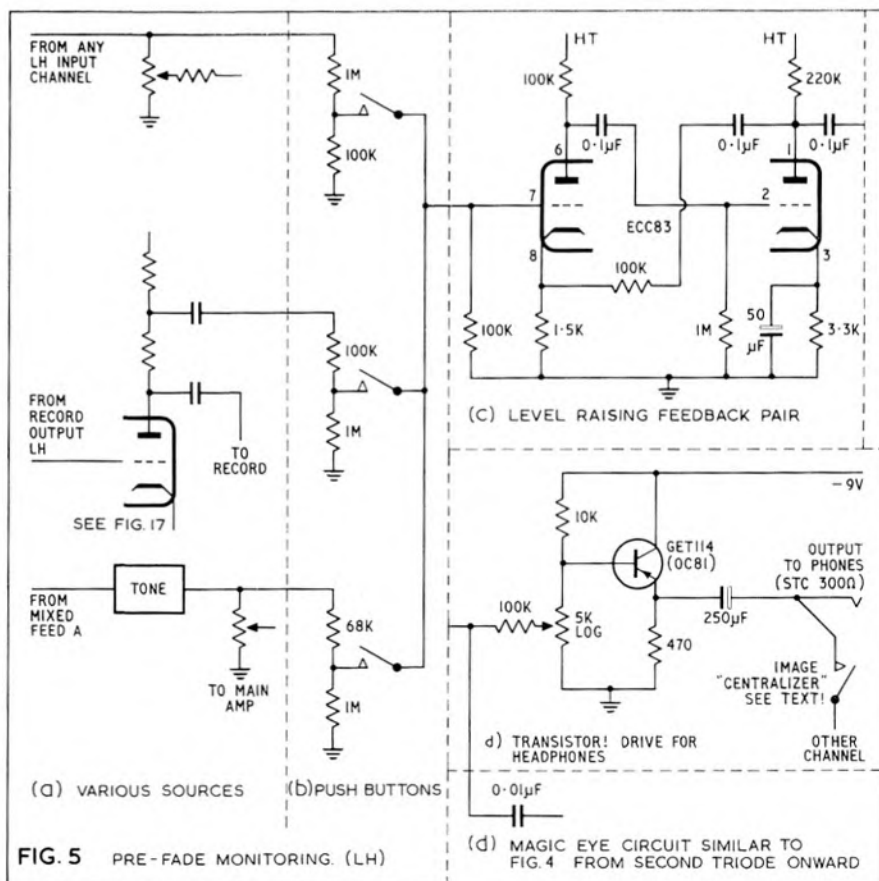
Fig. 4 shows the arrangements. Half-wave rectification is employed. It was interesting to discover in Mr. Robinson's articles that as much as 8 dB difference can exist between positive and negative parts of a complicated waveform, hence his use of full-wave rectification. The preset potentiometer is provided in an easily accessible position on the front of the mixer. The control has a large calibrated scale and note is made of which settings each machine requires. The circuit does not allow the single indicator to indicate the greater of the two signals. However, the difference is not great and when a mono recording is being made the preset potentiometer is moved round a further 1½ divisions of a 10 division scale.

Fig. 5 shows pre-fade arrangements. Apart from allowing access to all the input channels, monitoring of the record and main amplifier outputs is also possible. Channels which are normally used as LH channels are fed to the left headphone and channels which are normally RH are fed to the right headphone.

It is possible to provide two push buttons per channel and so be able to monitor it on either phone, or on both. In this case two sets of potential division resistors are required. The potential division reduces the loading on any channel being monitored. The inputs have 1 M and 100 K resistors and the outputs were found by experiment to require the values shown. The aim was to get the levels very

much the same, so that changing from monitoring the signal at an input channel to monitoring it after the mixing stage produces no change in level. This is comparatively easy for the outputs to the main amplifiers but difficult in the case of the record outputs. It was decided to set the level as required for the tape machine most frequently used.

(continued on page 333)



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The type of push button chosen—chosen is hardly the word, for the search for something suitable was long and eventually ended accidentally—had to meet the following requirements: (1) Small, (2) Cheap, (3) Visible indication when operated. Eventually a version of a push button mains switch usually used for table lamps was found. Usually the plunger on this type of push button is at the same full out position whether the contact is made or not. On this type the plunger stays down half way until re-pressed to break the contact. Ideally a latch release system would be a good idea. This would avoid the need to release a previously operated switch manually before another is operated. Operating more than one, especially if the second is the feed to the main amps, can be disastrous as the first monitored signal is added to the main amp feed! Incidentally, the same trouble cannot occur on the record outputs due to the 'buffer' effect of the valve stage in fig. 4.

Any system having capacitor coupling to fig. 5 level-raising amplifier would mean that clicks are produced as switching takes place. A transistorised version would need careful thought here. A possible solution could be to make use of the very high input impedance of a field effect transistor.

In fig. 5d on emitter-follower drive for the headphones is shown. The 100 K resistor is provided to give an impedance match by potential division from the valve circuit output to the transistor input. The signal loss is great but the sound from the STC headphones is still adequate.

Now the image 'centralizer': the usefulness of this switch has still to be fully investigated, but the indications are that here is a very handy way of checking stereo balance. Assuming reliability of the whole monitoring system, then playing a mono disc with a stereo pickup will produce a central image in the head. That is without the switch operated, but real proof comes when the switch is operated—the image should not move.

The 9 V supply for the pair of transistors can be from a battery. Originally this was so in the author's case, but now a zener regulated mains supply is used.

For the magic-eye on this switching arrangement, a circuit similar to the latter part of the magic-eye circuit already presented is used. The switchable magic-eye goes part of the way to finding out which individual channel is causing the record indicator to peak. On these occasions the headphone facility is not required so there is no difficulty in sharing the same push buttons.

Some words of warning regarding the screening required for the magic-eye circuits. Due to the high levels of signal in these circuits it is very easy to get this signal elsewhere, so the advice is to screen well the EM81's and all their circuitry.

No mention has been made of the HT decoupling that is necessary. Different parts of the circuits will suit different readers and therefore decoupling arrangements will differ. The principles involved can be gleaned by perusal of the arrangements in Mullard's *Circuits for Audio Amplifiers*.

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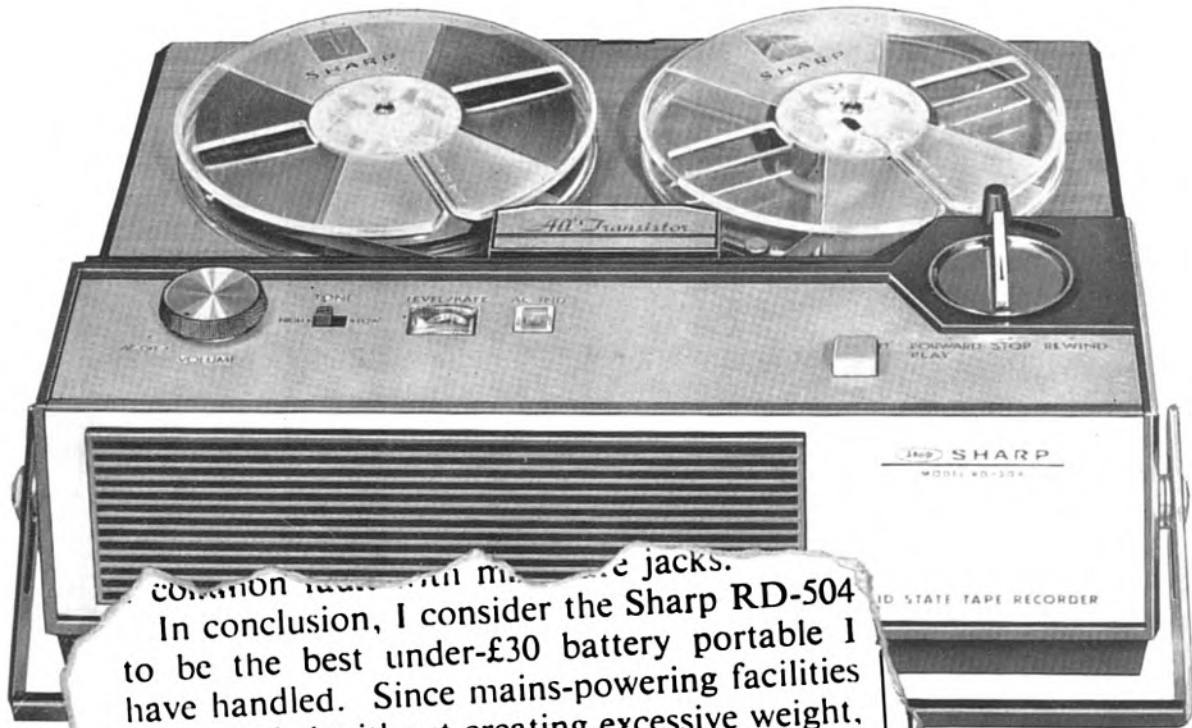
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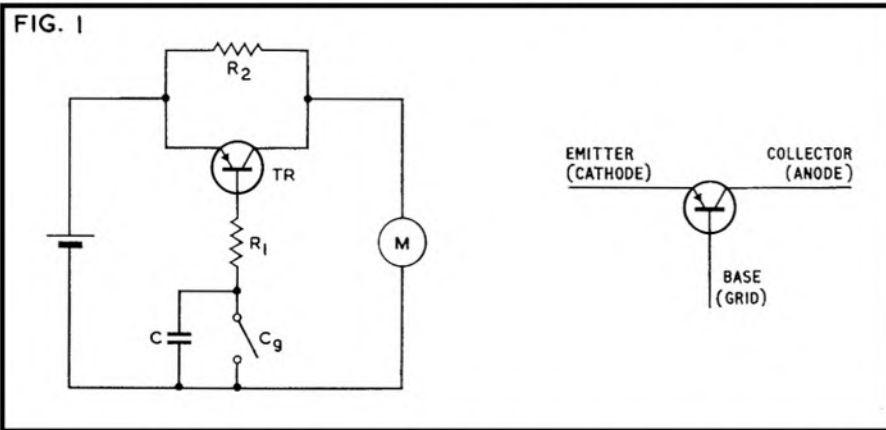
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TAPE TRANSPORT MECHANISMS



SPEED CONTROL AND DRIVE SYSTEMS



LAST month I explained the workings of the mains operated induction and synchronous motors and the battery driven DC motor. In the case of the DC motor it was pointed out that some means of control is necessary so that its speed stability can be brought to a standard which is good enough for a capstan drive. We have already looked at one way of doing this, that is by the use of a centrifugal switch which *directly* governs the current taken by the motor. This method however, has one serious drawback. When the switch makes and breaks at a very rapid rate and carries the relatively large current required by the motors, sparking of the contacts becomes a problem, causing rapid wear and producing undesirable noise in the amplifier. To overcome this a transistor circuit can be used which enables the switch to control the motor current *indirectly* and therefore carry a much smaller current. Let us start this month by considering a simple circuit of this kind.

The heart of the circuit, shown in **fig. 1**, is the transistor TR. This is a three-electrode device and in its simplest form consists of a *base* of semi-conductor material and two junction contacts known as the emitter and collector respectively (see inset). The emitter corresponds roughly to the cathode of an ordinary triode valve. Here the current is carried by electrons (see *Elements of Tape Recorder Circuits* Parts 4 and 5) whereas in the transistor the current is also carried by positive carriers called 'holes' and the positive charge of each 'hole' is numerically equal to the charge of the negative electron.

When the base of the transistor, which corresponds to the grid of a valve, is biased negatively with respect to the emitter, positive 'holes' can flow from the emitter to the base. If the collector is now biased negatively to the

base the excess positive 'holes' will be absorbed by it. In **fig. 1** the base of the transistor is biased by a very small current (provided by R₁) when the centrifugal switch is closed. The transistor then passes a larger current from the emitter to the base and then to the motor through the collector circuit. The motor speed therefore increases. When the motor tends to run fast, on the other hand, the switch contacts open and the bias to the base is removed. The transistor current to the motor then dies away as the current to the base discharges through the capacitor; the motor is then energised by the smaller current passing through R₂. The important thing to get clear from this circuit is that the current required to operate the base—the base bias—is only in the order of microamperes and this can be passed safely through the switch contacts, whilst the heavier motor current is supplied through the collector.

The long-term speed stability of the motor is kept pretty well in check by a governor of the type mentioned above, but this circuit can only do so much for the instantaneous speed stability. Unfortunately there is always a residual variation in speed which is inherent from the working of the motor. It is for this reason that DC motors with two-pole armatures are seldom used to power modern portable tape recorders, for the excess slowing and speeding as the poles are energised and de-energised would demand too much from an electrical speed control and from the mechanical design optimised for the lowest acceptable wow and flutter.

It was mentioned in Part 2 that the mechanical performance of a tape recorder depends on good design coupled with accurate and robust assembly. We also saw that the performance depends on a compromise

between a large slow capstan and a small fast one, and the final choice depends on such factors as size of the deck, the method of drive, weight and cost. In battery driven portables, where size and weight are usually kept to a minimum, the choice of capstan size is even more restricted. As we have seen, the DC motor has an inherent speeding and slowing as the brushes make and break contact with the armature windings, and the slower the motor the more serious is the effect of this on the wow and flutter. Therefore there is a minimum acceptable speed for the motor and this usually dictates the use of indirect drive methods and a capstan diameter small enough to get adequate speed stability from the flywheel.

In the expensive *Nagra* portable, which is a machine of the highest calibre, the arrangement is different. Here a direct method of drive is in fact employed and the capstan diameter is substantial—around one centimetre. The capstan motor itself is DC powered, but a very effective and extremely elaborate control system holds the wow and flutter well within current professional standards, even though the motor speed is much below that usually encountered in battery driven portables.

Like the circuit discussed earlier, the *Nagra* uses a feedback network where variations in motor speed cause opposite variations in the supply voltage. Briefly, the system consists of an electromagnetic pick-up which is placed close to the capstan flywheel. The flywheel has regularly spaced teeth machined at its periphery, rather like a gear wheel, and as the wheel rotates at constant speed a voltage of constant frequency is induced in the pick-up. This frequency, however, depending on the exact speed of the flywheel, will change as the tape speed changes and of course it will be doubled when the tape speed is doubled. The pick-up signal is then fed to a frequency sensitive amplifier or discriminator and this is accurately tuned to the frequency corresponding to the nominal tape speed selected. The amplifier is designed so that it supplies a motor control voltage which is inversely proportional to the frequency variation induced in the pick-up, and this voltage is then used to control within very close limits a servo amplifier the output of which is used to drive the motor.

A similar system is used in the mains-powered *Revox A77* recorder. Here a direct drive is used with a motor speed of 800 r.p.m. for 19 cm/s (7½ i/s) and the toothed flywheel induces a 1.6 kHz tone in the pick-up head. This signal is then fed to a discriminator which

(continued on page 303)