

FERROGRAPH



Logic Seven Handbook

FERROGRAPH

LOGIC SEVEN
HANDBOOK
500-072

NEAL

FERROGRAPH

SIMONSDALE WORKS, SOUTH SHIELDS, TYNE & WEAR NE34 9NX

FERROGRAPH SPARES & SERVICE

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LOGIC SEVEN RECORDER

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FOREWORD

The Logic 7 Ferrographs comprise a range of magnetic tape recorders having solid state electronics and logic controlled deck functions operated by light action push buttons. They are twin channel recorders, half or quarter track, and are available with or without output stages. Spools of up to 10½ in diameter can be used on all models and Dolby Noise Reduction processors are available on those recorders with suffix D.

Apart from the changes in the head line up and the optional Dolby N.R. processors, the recorders are basically identical and consequently one manual suffices for the whole range. It covers in detail one single channel, making special reference to the cross linking arrangements and special facilities of the double channel applications.

The handbook is divided into two parts. The first gives a comprehensive description of the operation of the recorder, and includes all the basic functions of the instrument. The second part contains more advanced operations and technical details which enable the enthusiast to utilise fully the facilities of the Ferrograph.

IMPORTANT NOTICE

To achieve the lowest possible noise levels from any magnetic tape recorder, it is essential that the record and replay heads be entirely free from residual (*i.e.* permanent) magnetism. In other words, the heads should not be allowed to become polarised, and therefore permanent magnets, or steel tools which may have become magnetised, should not be used near the heads.

Under normal operating conditions it is difficult to cause polarisation on the Ferrograph, since automatic demagnetisation is provided for the record head by arranging the supersonic bias current through the head to die away gradually on releasing the Record Button. Nevertheless, there are two things to be avoided. (a) the Record Track switch (Upper-Stereo-Lower) should not be turned when recording, *i.e.* while the Record indicator is lit. (b) large switching surges in the amplifiers should be prevented by turning the appropriate gain control to zero before removing or inserting an input plug.

Observing the above precautions will avoid the major factors which cause polarisation, but nevertheless, if it does occur and manifest itself by increased hiss, irregular thumping noises in the background and some distortion, the quickest and most convenient method of demagnetising the record and replay heads is to use the Ferrograph Defluxer (Appendix B). The pole tip should be held against the working face of each head in turn for one or two seconds, then the defluxer slowly withdrawn well clear of the recorder before releasing the energising button.

It is also essential to maintain the working face of each head scrupulously clean and free from dust or tape oxide deposit, which will seriously impair its performance. It will be found that this is particularly important when using new tapes, which often have a certain amount of surplus oxide tending to collect on the heads and capstan/pinch roller. Tapes having very glossy surfaces may deposit a film of lubricant on the head face when new, and although this may not be visible, it will reduce the treble response of the recorder. It is therefore advisable to clean the capstan and pinch roller more frequently when using a new reel of tape, as outlined in "Care and Maintenance", page 39.

Due to constant efforts to improve performance and consequent modifications, it may be found that minor differences exist between the actual instrument and that described in this manual. It is therefore essential to quote the serial number of the recorder when ordering any replacement parts.

GENERAL SPECIFICATION

RECORDING MEDIUM

Magnetic tape $\frac{1}{4}$ in (6.3 mm) wide, on reels of up to $10\frac{1}{2}$ in (270 mm) diameter.

TRACK WIDTH

$\frac{1}{2}$ track — .090 in (2.3 mm); $\frac{1}{4}$ track — .043 in (1.1 mm).

HEAD GAP WIDTH

Record head — 250μ in (6.3 μ); Replay head — 80μ in (2 μ).

OPERATING TAPE SPEEDS

Three (3) : 15, $7\frac{1}{2}$, $3\frac{3}{4}$ in/s (38, 19, 9.5 cm/s)

TAPE SPEED ACCURACY

Better than $\pm 1\%$ (at specified frequency).

PLAYING TIME PER TRACK

3,600 ft (1,080 m) of tape — 1 hr 36 min at $7\frac{1}{2}$ in/s (19 cm/s)
3 hr 12 min at $3\frac{3}{4}$ in/s (9.5 cm/s)

FAST WIND TIME

Continuously variable in either direction ;
at fast speed approx. 2 min for 1,800 ft (540 m) of tape,
approx. 3 min for 3,600 ft (1,080 m) of tape.

"WOW" AND "FLUTTER"

Less than 0.08% at 15 in/s (38 cm/s)
0.10% at $7\frac{1}{2}$ in/s (19 cm/s)
0.17% at $3\frac{3}{4}$ in/s (9.5 cm/s)

FREQUENCY RESPONSE

Record-Replay

15 in/s (38 cm/s) : 30-20,000Hz ± 2 dB
 $7\frac{1}{2}$ in/s (19 cm/s) : 30-17,000Hz ± 2 dB
 $3\frac{3}{4}$ in/s (9.5 cm/s) : 40-14,000Hz ± 3 dB

REPLAY CHARACTERISTIC — D.I.N.

15 in/s (38 cm/s)	:	35 μ sec	Test Tape
$7\frac{1}{2}$ in/s (19 cm/s)	:	50/3180 μ sec	38
$3\frac{3}{4}$ in/s (9.5 cm/s)	:	90/3180 μ sec	19H
			9.5

MAXIMUM OUTPUT (per channel)

10 Watts R.M.S. into 8-16 Ω loudspeaker.

AMPLIFIER DISTORTION

Less than 0.25% R.M.S. at all levels up to 10 Watts.

GENERAL SPECIFICATION—continued

SIGNAL TO NOISE RATIO

Unweighted, including hum, better than 60dB — ref. 2% distortion.

BASS CONTROL

Continuously variable; typically up to ± 15 dB at 50Hz, ± 20 dB at 20Hz.

TREBLE CONTROL

Continuously variable; typically up to ± 10 dB at 10kHz, ± 15 dB at 20kHz.

INTERNAL LOUDSPEAKERS

Two (2) — elliptical 7 in x 4 in (18 cm x 10 cm).

INPUT LEVEL (for full depth recording)

Microphone: 200 μ V-50mV, Recommended Source: 200-1000 Ω .

Line: 50mV-7V at 2M Ω , Recommended Source: any impedance.

OUTPUTS (for full depth recording)

600 Ω : 2V at 600 Ω

Low Level: 300mV into 10K Ω or greater

Loudspeaker: up to 10 Watts R.M.S. into 8-16 Ω

Phones: suitable for headphones of approx. 8-600 Ω .

METERS

Two, 65 x 40 mm ($2\frac{1}{2}$ x $1\frac{1}{2}$ in): approximately VU characteristic
full depth recording (320nWb/m): +4 VU continuous tone, 0 VU music

POWER SUPPLY

200-250V, 50Hz; Suffix A: 117V, 60Hz.

POWER CONSUMPTION

100 Watts approximately.

CHANNEL SEPARATION

Stereo operation — approx. 50dB;

Mono operation — better than 65dB at 1,000Hz.

OVERALL DIMENSIONS (with lid)

($20\frac{1}{4}$ in wide x $17\frac{1}{2}$ in x 10 in)

515 mm wide x 445 mm x 255 mm

WEIGHT

26 kgm (58 lbs).

GENERAL DESCRIPTION

The Logic 7 Ferrograph has a basic 3 motor system, and the solenoid-operated mechanics enable the deck to be fully controlled by remote switching.

The main functions of the deck (Wind, Pause, Run) are selected by light action push buttons, with a separate push button for Record. On fast wind the direction and speed of wind are governed by a single control. An automatic stop operates at the end of the reel and the 4-digit turns counter is driven from the take-up spool.

Reel retainers are fitted to the reel carriers, which accommodate all types of spool (up to 10½ in diameter) conforming to the international standards. Adaptors are available as accessories to convert the reel carriers from the "cine-centre" of the smaller spools to the "NAB centre" of the 10½ in spools. A switch is fitted to adjust the reel motor power to be suitable for either. Three tape speeds are available on each deck, and tension arms provide slur-free starting at all tape speeds. The easy access head block gives convenient tape loading, and the deck can be operated in either horizontal or vertical positions.

Each deck is fitted with separate Erase, Record and Replay heads, so that off-the-tape monitoring is possible whilst recording, and the source-tape buttons give instant comparison of the original and recorded signals. This can be done aurally from the internal loudspeakers or the signal levels can be checked visually on the meters, which can also read the record bias.

Up to 10 Watts is available from the output stage and this can be made subject to separate Bass and Treble controls giving boost or cut. Either internal or external loudspeakers may be used and a stereo headphones socket is available on the rear panel. An alternative Low Level output is provided, and there is also a 600 Ω emitter follower output which gives a signal independent of the Output, Bass and Treble controls. The tape can be monitored on fast wind (but muted to avoid discomfort) for accurate place location on the tape, or this can be silenced.

On record, mixing on each channel is given by separate gain controls for the Microphone input and the Line input (suitable for radio or crystal and ceramic pickups) with a 'master' control for the overall level. All connections (except the Microphone input) are on a panel at the rear of the recorder, and the instrument is mounted on a rigid metal frame which facilitates removal from the portable case for inclusion in alternative cabinets.

The Models 7622 (½ track) and 7624 (¼ track) are stereophonic recorders with each channel identical. The two internal loudspeakers are fed separately from two 10 Watt output stages and a Record switch allows stereo recording or mono recording on either track. Push buttons can be used to connect the output of either track to the Line input of the other track and this can be utilised to produce "multiplay" recordings, 4 input mixing on either track or echo, without external connections.

The Models 7602 and 7604 are similar to the Models 7622 and 7624, but do not have power amplifiers or loudspeakers, Models with Suffix D incorporate Dolby NR processors for record and replay, with in/out switch.

OPERATING INSTRUCTIONS

GENERAL

The carrying handle is at the rear of the recorder beside the connection panel. The transit lid is removed by sliding it backwards and lifting clear. It is replaced in the reverse manner.

When $10\frac{1}{2}$ in, $8\frac{1}{4}$ in or 7 in reels are fitted to the recorder, they overhang the deck slightly and must be removed when refitting the lid. Smaller reels of $5\frac{1}{2}$ in diameter or less can be left on the deck, but the instrument should not be operated with the lid in position, as this inhibits the ventilation arrangements. For the same reason, the square aperture on the underside of the cabinet should not be obstructed, as this would stop adequate air in-flow.

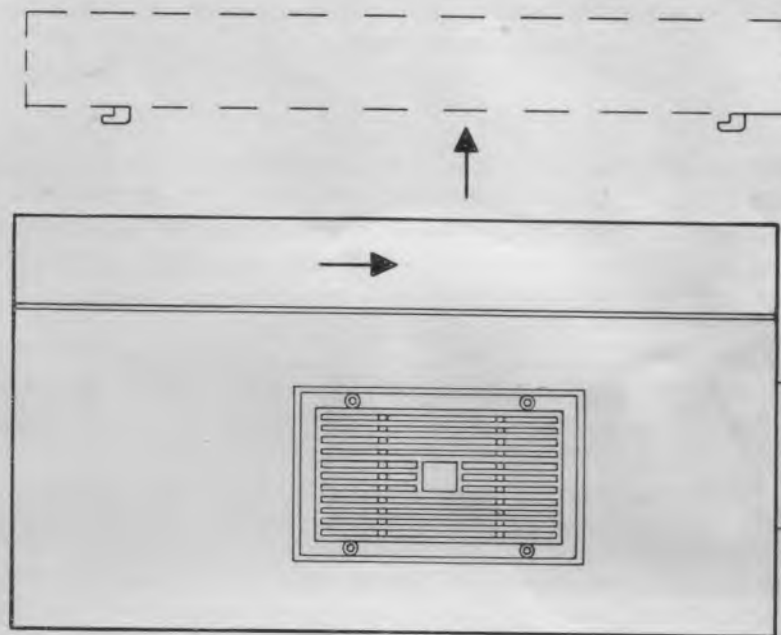


FIG. 1. REMOVAL OF LID

Installation

When the Ferrograph is to be operated vertically, the two studs at the front of the recorder case should be replaced by the two larger feet supplied with the recorder. The two "press-in" studs should be levered out of their positions and the new feet screwed into the same two places so that when the recorder is stood upright, its front face is inclined backward very slightly. Also, the auto stop control at the extreme right of the deck control panel should be turned so that the screwdriver slot is in line with "V" (see page 20).

CONNECTIONS

Except for the microphone input on the front panel, all connections are at the rear of the recorder *i.e.* Line input, $600\ \Omega$ output, Low Level output and Loudspeaker output. The power supply input is at the centre of the panel with the Power Supply and D.C. fuses either side. These are all 1A rating, size 20 mm long x 5 mm dia, except for the Power Supply fuse on the 117V model (Suffix A) which is 20 mm x 5 mm dia. rated at 2 Amp. Also at the rear are the Remote Socket (underneath the carrying handle) to provide operation of the recorder at a distance, and the Auxiliary Socket (on the rear panel) to give remote volume control, stop/start etc. (see pages 33 and 34).

Power Supply

The recorder should be connected to the power supply using the lead and socket provided, by inserting into the plug at the centre of the rear panel (Fig. 2). The other end of the lead should be fitted with a plug appropriate to the installation (brown — Live, blue — Neutral, green/yellow — Earth), and plugged into the 240V, 50Hz supply — 117V, 60Hz supply for models suffix A (for 220V or 200V, 50Hz supply see Page 42).

The instrument is energised by the switch at the rear centre of the deck, when the meters are illuminated.

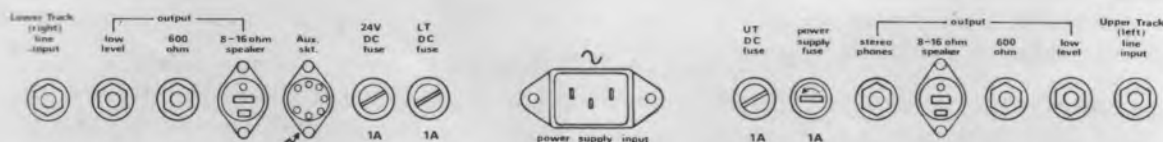


FIG. 2. REAR PANEL

Inputs

Microphone

Medium impedance microphones (200-1000 Ω) can be plugged directly into the Microphone input 200 μ V-50mV on the front panel and reasonably long leads used (the maximum length will depend upon local conditions *e.g.* sources of hum, interference, etc). When using a low impedance (30-50 Ω) microphone, a matching unit may be necessary (*e.g.* TA/30/ML in appendix A) if the sound level is low, and very long leads can be used.

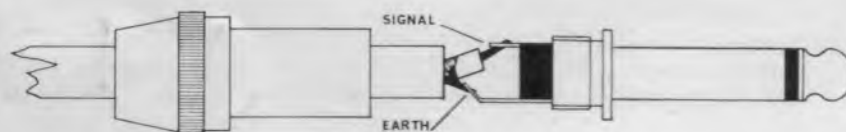


FIG. 3. STANDARD JACK PLUG WIRING

Tuner (radio)

The output from most tuner units may be fed directly into the "Line" input, which will accept signals from 50mV to 7V (input impedance 2M Ω), and this will also apply to the "Tape", "Tape Output" and "Tape Recorder" sockets on modern radios. Unless stated otherwise in the tuner instructions, screened lead should be used for this connection. In the unlikely event of the signal being too weak for the "Line" input, it may be plugged into the Microphone input.

When recording from V.H.F. (F.M.) stereo receivers, no extra filters are necessary.

Note:—Great care must be taken when connecting to a radio which operates from both A.C. and D.C. power supplies as the chassis is probably connected directly to the mains. In this case either a transformer or isolating capacitors are required in the signal leads and it is advisable to consult the manufacturer (or supplier) of the radio before attempting to connect to other equipment. This does not apply to a portable radio operating on its own internal batteries.

Pick-up Cartridge

Ceramic and crystal pick-ups can be fed directly into the Line input as this is high impedance (2M Ω) and is capable of accepting large signals (up to 10V). If a crystal pick-up with a very high output is used, such that the Line gain control is operating over a very small part of its control range, the output can be reduced as described in the Technical Section, page 42.

With magnetic pick-ups, some form of correction is necessary to produce a level response from their velocity characteristic output, and usually a small pre-amplifier is used. The circuit of a suitable pre-amplifier, powered from the Auxiliary Socket or a 48V D.C. supply, is available on request.

For record players, radiograms, etc., having their own pre-amplifiers, these should be used and connected as for a tuner/radio above.

Other Sources

When the signal is obtained from a source not mentioned above, the correct connection will depend on the signal strength and impedance. Normally most signals may be fed to the Line input (50mV-10V), but weak signals should be fed to the Microphone input (200 μ V-50mV). In cases where there is some doubt, the dealer or relevant manufacturer should be consulted.

Outputs

Loudspeaker

External speakers are connected by means of 2-pin DIN plugs which fit into the Speaker sockets on the rear panel. The stability of the amplifier is such that any length of lead may be used to connect the speakers without any effect on performance. However, as the amplifier can deliver more than 1A at full power, it is advisable to use wire of a sufficiently heavy gauge to prevent its resistance becoming a significant part of the load. Although no harm would result, the power available from the loudspeaker could be reduced. In general twin core lighting flex is adequate for most installations.

With stereophonic reproduction, it is conventional to have the Upper loudspeaker on the left and the Lower on the right (which is how the amplifier controls and output sockets are arranged), approximately 7-10 ft. apart depending upon circumstances and the acoustic environment. It is important with stereophonic reproduction to ensure that the speakers are in phase. For this reason, the leads to the plugs and speakers should be wired exactly the same on each channel. The use of twin lead with coloured cores makes this easy to arrange (see Fig. 4).

If coded wire is not used, an alternative is to carry out a check on the phasing by ear. The same signal should be fed simultaneously to both loudspeakers (situated fairly close to each other) and the bass response compared with that obtained when the leads to one of the loudspeakers are reversed. The loudspeaker connections giving the greater bass response should be used.

The Loudspeaker output provides up to 10 Watts undistorted output into a 15 or 8 Ω external loudspeaker for high fidelity listening. Normally, plugging into this socket (Fig. 5a) automatically disconnects the internal loudspeakers and the external loudspeaker signal is then governed by the Volume, Bass and Treble controls. Alternatively, plugging into the Speaker Socket with the plug reversed (Fig. 5b), the internal loudspeaker remains 'on' and the internal and external speakers are in parallel (see table).

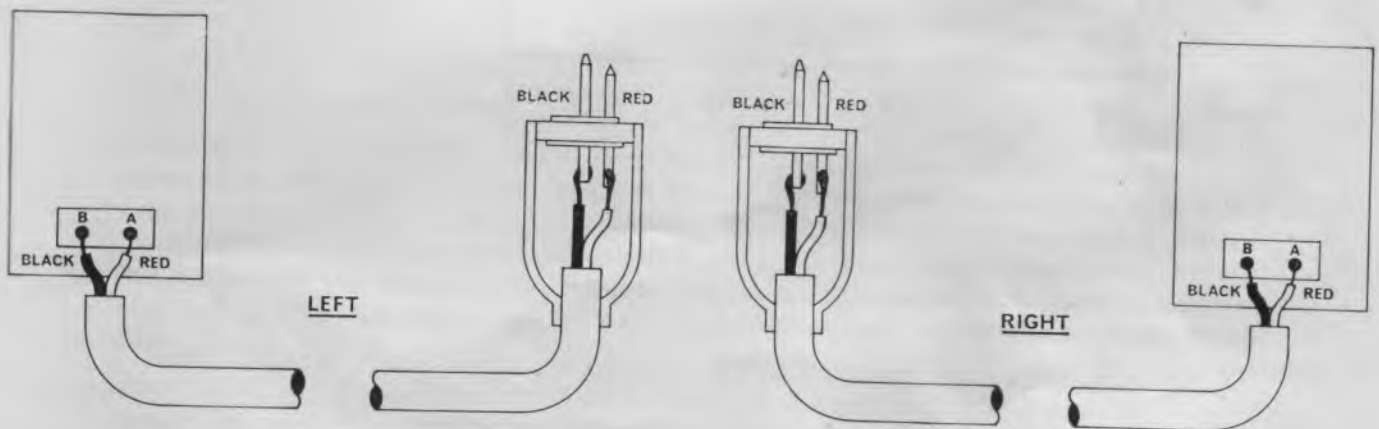


FIG. 4. LOUDSPEAKER WIRING

Note:—As with other transformerless power output stages, care should be taken not to short the speaker leads to each other, as this will probably overload the amplifier and blow the D.C. fuse.

The faulty connection must be corrected and the fuse replaced before the amplifier will function again. Being stereo models, there are two fuses — one for each channel — so that only one channel is inoperative when a fuse blows. However, the oscillator is powered through the Upper track fuse and should this blow, it is not possible to record (even on the Lower track) until the Upper track D.C. fuse is replaced. On no account should anti-surge or time-delay fuses be used.

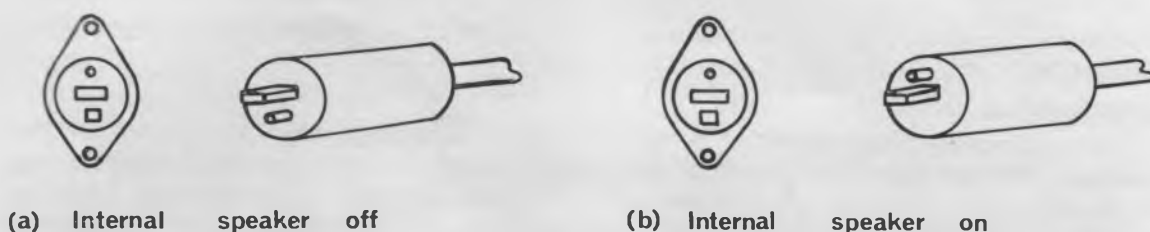


FIG. 5. LOUDSPEAKER CONNECTIONS

Headphones

If it is required to use headphones, these should be plugged into the 'Phones' output on the rear panel. Although their impedance is not critical, it is recommended that this be approx. 8-600 Ω . A stereo phones jack plug (3 contact, gauge A) should be used, wired as shown in Fig 6.

On model 7622 & 7624, plugging into the Phones socket disconnects the internal speakers, and also the external speakers if these are inserted as in Fig 5a. Details of the possible arrangements are given in the table.

Phones	Ext. Speaker		Int. Speaker
	Fig 5a	Fig 5b	
out	out		
	in		
		in	
in	out		
	in		
		in	

Signal Obtained

Amplifier

If it is required to use an external amplifier and loudspeaker, either instead of or together with the internal amplifier and loudspeakers, it may be fed from the 600 Ω output. This is an emitter follower giving approximately 2V signal at 600 Ω impedance from a full depth recording, and while the impedance into which it is fed is not critical, impedances of less than 600 Ω reduce the output available. If the internal loudspeakers are not required, the Volume control can be turned to zero as the 600 Ω output is independent of the Volume, Bass and Treble controls.

If it is required to utilise the internal tone controls, the amplifier may be fed from the Low Level output (300mV at 2.5k Ω) provided that the amplifier input impedance is 10K Ω or higher. Again, if the internal loudspeakers are not required, they can be silenced by turning down the Volume control. However, the signal is modified by the Bass and Treble controls and this is useful when replaying tapes recorded to a characteristic other than that of the recorder. On Models 7502 and 7504, the Low Level Adjustable output could be used, when the signal is also adjusted by the Volume control.

DECK OPERATION

When first switched on (at the rear centre of the deck) the recorder is in the Stop condition, with the amplifiers operative but all deck mechanics in the 'off' position. In all of the other deck conditions (Run, Pause, Wind/Rev) the motors are energised, and to obtain this 'shut-down' condition when using the recorder just as an amplifier, the Stop button must be pressed.

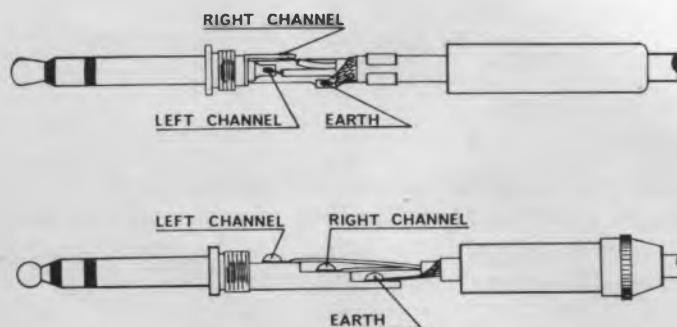


FIG. 6. STEREO PHONES PLUG WIRING

Reel Loading

When loading a reel of tape onto the recorder, it should be fitted to the left hand or supply reel carrier, and the empty spool placed on the right hand or take-up reel carrier. The fitting of the empty spool/reel of tape depends on its centre; cine-centred reels will fit directly and NAB centred using a special adaptor, as described below.

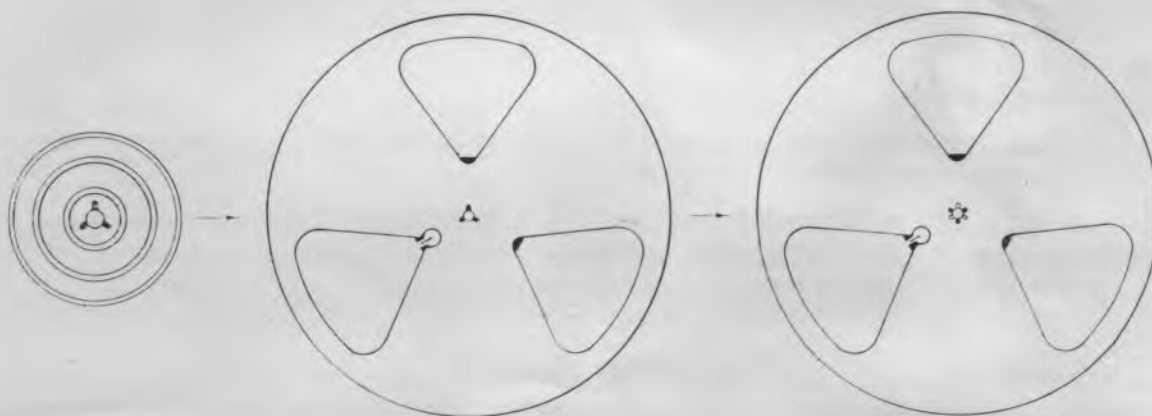


FIG. 7a. CINE-CENTRED REEL LOADING

Cine-centred Reels

To load the deck with tape using cine-centred reels, the knob at the centre of the reel carriers should be rotated so that the 'fins' of the knob locate over those of the trefoil centre. The reel of tape to be recorded or replayed should be fitted onto the left hand reel carrier and an empty spool on the right hand reel carrier. To hold the reels firmly in position the reel retainer knob is raised and rotated by approximately 60° (see Fig. 7a).

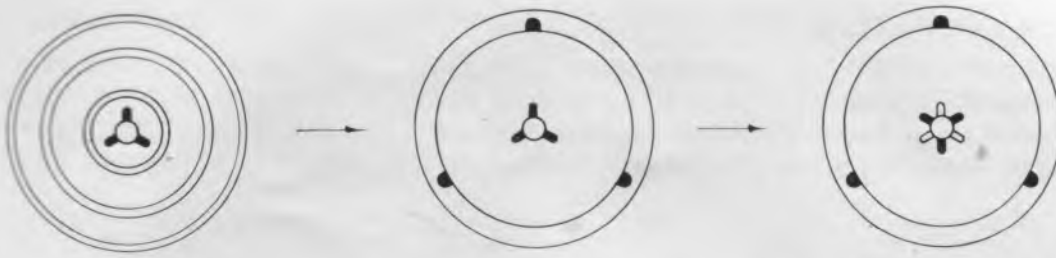


FIG. 7b. NAB ADAPTOR FITTING

Fitting of NAB Adaptor

To convert the 'cine' reel carrier to accept NAB centred spools the special NAB adaptors available with the recorder should be fitted. The NAB adaptor is inserted over the trefoil centre so that the adaptor rim locates in the reel carrier recess. It is then held in position by raising the reel retainer knob and rotating it by approximately 60° (see Fig. 7b).

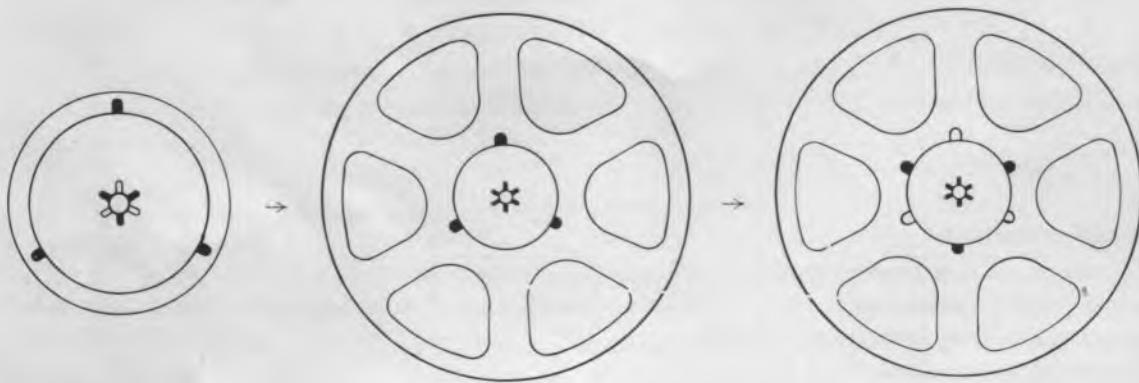


FIG. 7c. NAB-CENTRED REEL LOADING

NAB-centred Reels

To load the deck with tape using the NAB-centred reels, first of all the NAB adaptors must be fitted to the reel carriers as described above.

The reel of tape to be recorded or replayed should be fitted onto the left hand adaptor and an empty spool on the righthand adaptor. To hold the reels firmly in position, the upper part of the adaptor is raised slightly and rotated clockwise by approximately 60° as shown in Fig. 7c.

Tape Loading

The Load knob should be moved away from the head assembly, when the tension arms move back to give the convenient loading path as shown in Fig. 8a and the Check lamp lights. The tape should be threaded as shown and the end attached to the empty spool. After loading, the Load knob should be depressed slightly to allow it to move back to its normal position, when the tension arms return to their operating positions (Fig. 8b).

The Reel switch should be set to the appropriate position for the reels fitted, to the right for the large NAB-centred size ($10\frac{1}{2}$ in) or to the left for the smaller cine-centred size ($8\frac{1}{4}$ in or less) although with $8\frac{1}{4}$ in reels either position should give satisfactory performance.

The deck will not function in the Load condition.

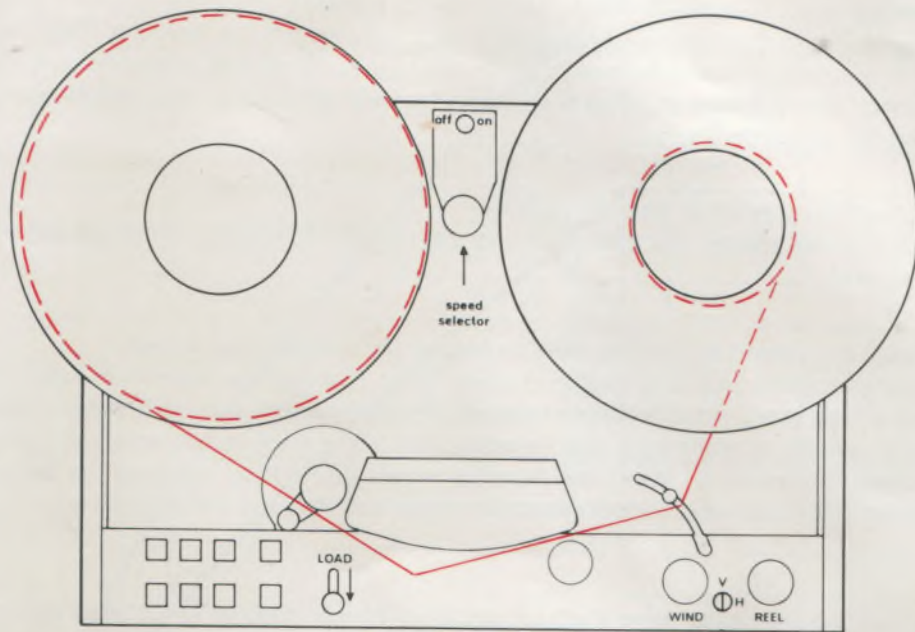


FIG. 8a. TAPE LOADING

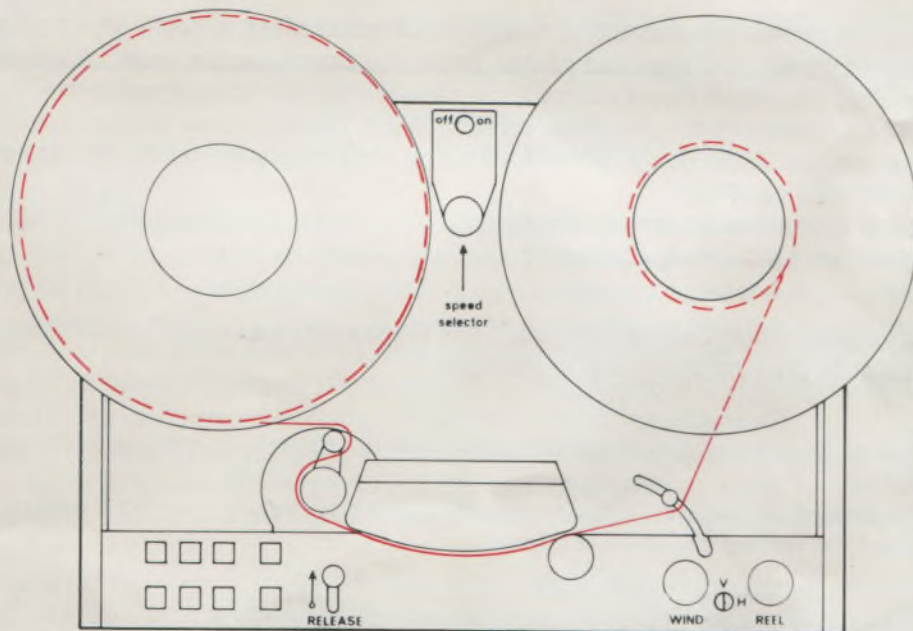


FIG. 8b. TAPE LOADED

Tape Speed

The Speed selector knob is at the rear centre of the deck and selects one of three tape speeds. To change speed, the deck should be in the Stop condition, then the Speed knob turned until the required tape speed is shown in the aperture.

Controls

The main functions of the deck are controlled by logic circuitry with tape motion sensing and memory to enable the recorder to move smoothly from each function to any other simply by pressing the appropriate control button, viz. Wind, Pause, Run & Record.

For example, with the tape winding rapidly from right to left, on pressing Run the recorder moves into Pause, thus applying the brakes. When the tape comes to rest, the recorder automatically moves into Run and the tape starts at the selected speed. Bright and clear indicators show the current condition of the deck logic.

Pause

Pause should be pressed to stop the tape.

In pause all three motors are energised and the capstan is rotating, although the brakes are applied to the reels.

Run

Run should be pressed to start the tape running at the selected tape speed.

When first switching on it is advisable to press Pause (causing the capstan to rotate) and then Run, when the tape starts virtually instantaneously. On moving directly into Run from Stop (when the capstan is normally stationary), a slight slurring may occur while the capstan picks up speed.

On pressing Run while in Wind, the recorder moves into Pause, applying the brakes. When the tape comes to rest, the recorder automatically moves into Run and the tape starts at the selected speed.

Wind

Wind should be pressed to wind the tape quickly or slowly in either direction as determined by the Wind control on the right.

The high frequency content of the signal is automatically reduced to avoid excessive shrillness when winding at high speed.

At the end of winding the tape is stopped either by pressing Pause or on moving to Run.

Rev

Rev should be pressed continuously to reverse the direction of fast winding (at the same speed).

This reverses the effect of the Wind control which still determines the speed of winding but in the opposite direction. When Rev is released, the normal Wind condition is restored.

Rev can be pressed without previously pressing Wind, when the tape is wound in the reverse direction as described. When Rev is released, whatever the previous operation, the recorder moves into the normal Wind condition.

This facility is provided for use on the Remote Unit, where the Wind control is not available to vary the direction (and speed) of winding.

Mute

The Mute switch should be pressed to the left to silence the monitor signal when tape winding. It is restored by pressing the switch to the right.

Record

Record must be pressed simultaneously with Run (or Pause) to erase and record on the track(s) selected.

Once the Record indicator is lit, the tape is stopped or started by pressing Pause or Run respectively, when the Record condition continues.

Cancel

Cancel should be pressed to stop erasing/recording (on Pause or Run).

The Record condition is cancelled automatically on pressing Wind, Rev or Stop.

Stop

Stop should be pressed to switch off the deck mechanics if the tape is to be stationary for more than a few minutes.

In Stop, the deck mechanics and all three motors are de-energised and the recorder is shut down, although the amplifiers are still operative.

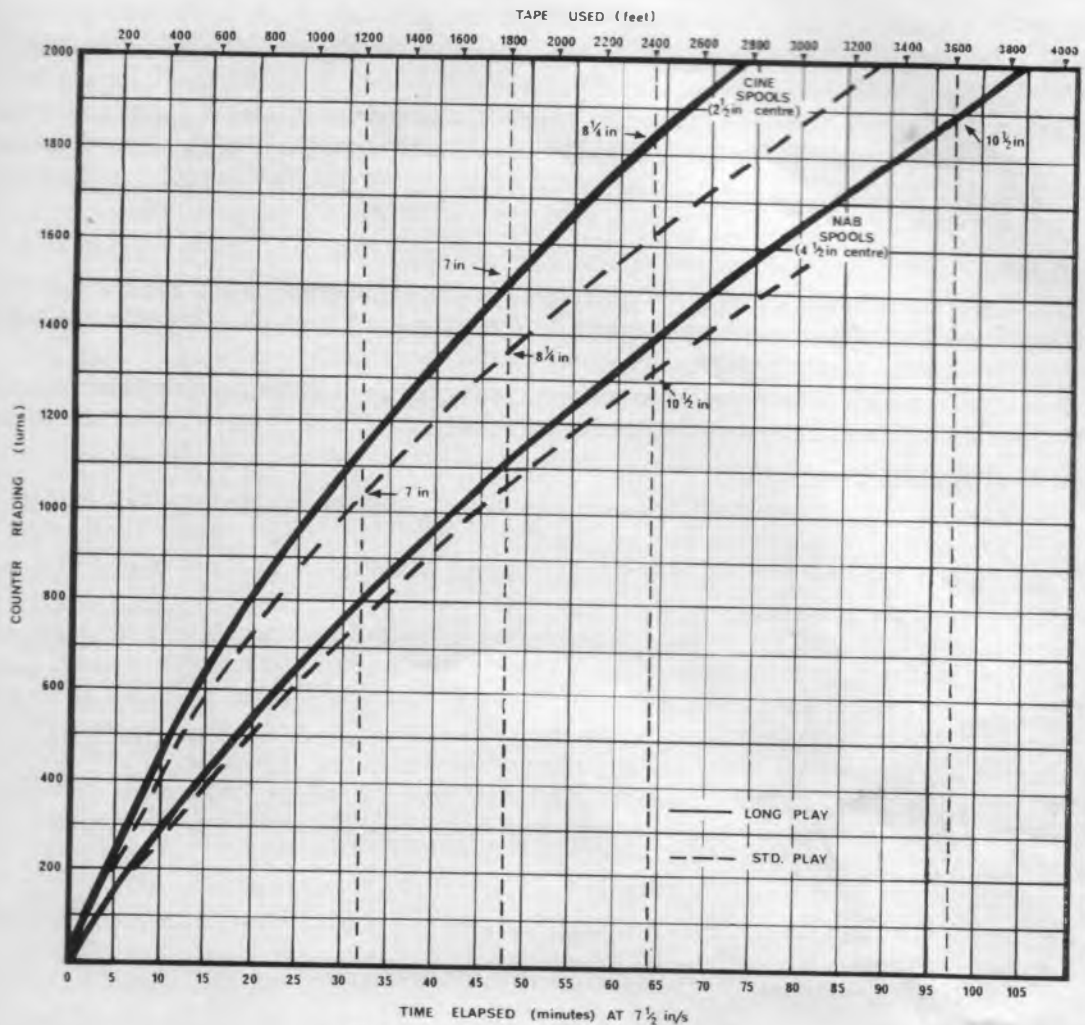


FIG. 9. TURNS COUNTER READING

Automatic Stop

The tape tensioning arm between the head assembly and the take-up reel is differentially damped to prevent any "snatch" on starting the tape. It also functions as an automatic stop and switches off the tape drive should there be a loss of tape tension *e.g.* at the end of a reel. Its operation has a built-in delay of approx. 1 second so that it does not stop the tape due to a momentary loss of tape tension. It does not require any special tape, but it should be set for optimum performance with the deck horizontal or vertical. This is done by turning the control at the extreme of the deck control panel so that the screwdriver slot is in line with 'H' or 'V' respectively.

Situated in the head assembly is the Foil Stop guide which switches the recorder to Stop when shorted to chassis by a piece of foil spliced into the tape. At the start of a tape with foil at each end, the foil should be wound past the foil stop either manually or using Wind (or Rev) before pressing Pause then Run.

When either stop operates, the Check lamp lights; the fault must be cleared, switching out the Check lamp, to restore normal operation. Neither stop operates while Wind (or Rev) is being pressed.

Fast Wind

On pressing Wind the tape is controlled by the 'Wind' knob, which governs the power fed to each reel motor. On turning it clockwise most power is fed to the right hand motor, on turning it anticlockwise most power is fed to the left hand motor, while in the central position the power is fed equally to both, and the tape remains stationary. By suitable manipulation the amount of back tension applied to the tape can be arranged so that a suitably tight wind is obtained in either

direction. In general, the more back tension applied the tighter the wind, while with little back tension, a fast but not so even wind is obtained. The actual smoothness of wind depends upon other factors such as the tape itself and the reels on which it is being wound.

The turns counter (if properly zeroed) can be used for place location, or the signal on the tape can be monitored as described on page 26. The Wind knob should be used to slow down the tape (or to stop it altogether) when the appropriate point is reached, before applying the brakes by pressing Pause.

REPLAY

The tape should be loaded as on Page 19 and the tape speed set to the required position. With the 'Tape' button depressed, on pressing Run the signal off the tape is heard on the loudspeaker, the volume being adjusted by the control on the front panel.

If required, the quality of the signal can be modified by the Bass and Treble controls as described below, their usual "flat" setting being at the central position.

Bass and Treble Controls

The Bass and Treble controls act independently of each other to provide a variable amount of cut or lift as required. At its extreme settings, the Bass control gives approximately 15dB boost or cut at 50Hz, and the Treble control gives approximately 10dB boost or cut at 10kHz (Fig. 24, page 44).

Their usual setting is at the central position, when an overall level response is obtained, and this is correct for most applications, particularly those of engineering and scientific interest. However, in the more general use of the recorder for listening purposes, it is advantageous to be able to make some allowance for the characteristics of the loudspeaker, its acoustic environment (which can alter the audible sound quality) and also the peculiarities of the human ear. In particular, the bass boost can be most useful in improving the sound from the smaller loudspeaker enclosures, on which the bass response is necessarily restricted by physical dimensions, to balance with the usually good high frequency response.

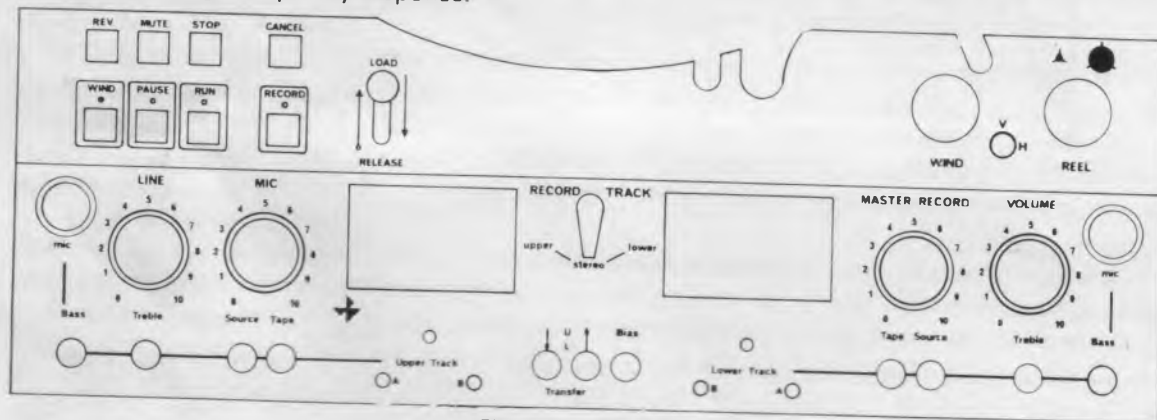


FIG. 10. CONTROLS

The "tone" controls can also be used to improve a recording by reducing hiss or noise, or by increasing the frequency response of a rather limited recording. In each case the other control can also be used to balance the overall sound quality.

While a level response is obtained at their central positions when replaying tapes recorded to the same characteristic as the Ferrograph, tapes recorded to other characteristics can be replayed satisfactorily by using the Bass and Treble controls as explained in the Technical Section, page 45.

Note :—The Bass and Treble controls do not affect the signals at the 600 ohm outputs.

Tape/Source

The Tape/Source push buttons select the signal which is fed to the three outputs, the loudspeakers and the signal level meter. When the 'Tape' button is pressed, it selects the replay signal off the tape, and when the 'Source' button is pressed, it selects the signal from the inputs (Line and/or Microphone).

Each channel can be operated completely independently of the other.

RECORD

The appropriate connections should be made as described on page 14, and the required tape speed selected. It is advisable to insert or remove the plugs only when the corresponding gain control is at or near zero (fully anti-clockwise) as this avoids switching surges in the amplifier causing loud "plops" in the output stages with possible damage to the loudspeakers.

Record Level

If at all possible, the gain control settings should be determined before commencing to record. To do this, the 'Source' button must be pressed, and if a microphone is being used, the loudspeaker must be silenced by turning the Volume control to zero.

The input signals can now be observed on the meter and when mixing two or more signals their combined level should not cause the meter to rise above 0 VU on the scale. With the master Record control set at about 8-10, the signal levels should be set using the Mic and Line controls (as appropriate) to give a good balance and then the overall level set using the Master Record control. This latter can be used during the recording to fade the combined signal in or out without altering the Mic or Line controls, giving approximately 5dB per scale division. It must be stressed that in general the Master Record control should not be turned below 6 when adjusting for peak recording level; any further adjustment should be made using the Mic or Line control to avoid input overload distortion.

The meter responds to the average value (approximate loudness) of the signal and should read up to the start of the red section on the loudest parts of a music recording. Since speech consists of short transients to which the meter will not respond fully, a speech recording should be made at a slightly lower level. Conversely, with relatively steady signals such as organ music, the controls may be set so that the meter peaks into the red section slightly. Because input signals vary in content and some makes of tape distort at a lower level than others, the maximum indication may sometimes be increased considerably before distortion can be heard.

Recording

After the gain controls have been adjusted on Pause, Run and Record should be pressed, when the tape starts immediately.

The record signal is still shown on the meter and if necessary the record level can be corrected by re-adjusting the gain controls. During the recording the tape can be stopped temporarily by pressing Pause, then back to 'Run'. At the end of the recording Record is released by pressing Cancel or automatically on pressing Wind (or Rev).

Interjection

If it is required to insert a recording into a particular part of the tape (interjection), the record signal level controls should be adjusted as above and the tape run through on replay (Record not pressed, 'Tape' button pressed). Holding down Run, at the required point Record should be pressed, when recording (and erasing) commence immediately. The 'record' signal can be monitored by pressing the 'Source' button. To end the recording Cancel should be pressed, then the tape eventually stopped by pressing Pause.

Record Mode

When recording stereophonically, the two channels should be adjusted independently, with the Record Track switch set to 'Stereo'. The usual convention is to use the Upper track for the Left signal and the Lower track for the Right.

When recording mono half track, it is usual to have the Record Track switch set at 'upper', when the tracks on the tape can be recorded individually as on a normal mono recorder. While it is in order to set the Record Track switch to 'Lower' and record on the lower track without reversing the tape, for the normal procedure (half or quarter track) see Fig. 13a & b 'Track Dispositions', Pages 29 & 30.

However, the Record Track selector must not be adjusted when actually on Record as this may cause polarisation of the heads, and the mode should be selected before pressing Record.

Radio

The radio should be connected as on page 14 and after the radio or tuner unit has been properly tuned in and its tone controls set to their normal or highest fidelity positions, the recording can commence. The meter should not read above 0 VU even on the loudest signals, but once the correct gain setting has been found, there should be no necessity to re-adjust it during the recording as the station or studio engineer will be monitoring the programme and correcting the signal level so as not to overload the transmitter.

Gramophone/Record Player

The connections are given on page 15, and the appropriate gain control should be adjusted for the correct record level. As the dynamic range on disc is very similar to that on tape, once the gain control had been set so that the meter does not quite rise above 0 VU on the loudest passages, it should not be necessary to re-adjust it during the transcription.

Microphone

When using a microphone in the same room as the recorder, it is essential that the internal (or external) loudspeaker be silent, or acoustic feedback can occur. This takes the form of a "howl" as the noise from the loudspeaker is picked up by the microphone, amplified and transmitted again by the loudspeaker in a vicious circle, gradually building up in volume. If it is required to listen to the signal, headphones must be used or the signal can be monitored visually on the meter (see page 25).

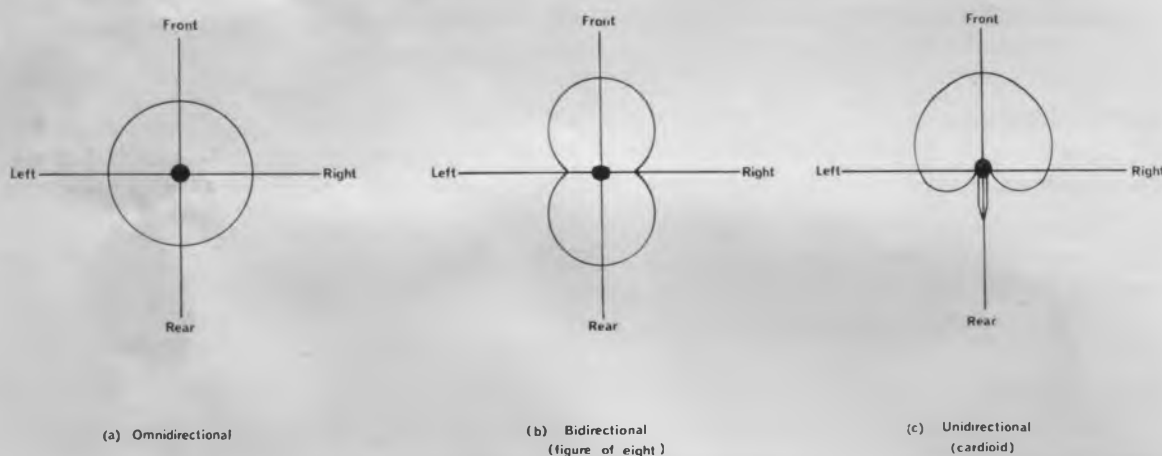


FIG. 11. MICROPHONE CHARACTERISTICS

The chief point of difference between live recording and recording from the radio is that the studio control of dynamic range in the latter is not present. This means that more attention must be paid to the signal level meter and the gain control settings. Depending upon the dynamic range of the programme material, a certain amount of volume compression may be necessary. This involves reducing the level of the loudest passages and increasing that of the weakest so that the former does not overload the tape nor the latter become lost in the background noise. However, too drastic use of the gain control should be avoided or the contrast between loud and soft passages may be lost altogether.

Microphone Characteristics

Making a "live" recording with a microphone requires close attention to detail for optimum results, as the quality of the recording is dependent, among other things, upon the type of microphone used, the location of the microphone and the acoustics of the room or surroundings. A primary property of the microphone is its directional characteristic, and there are three basic types.

The omnidirectional microphone picks up sounds equally from all directions and is very useful for recording sounds from several separated sources, *e.g.* a group of people sitting around a room. The bidirectional microphone has a "figure-of-eight" response and picks up sounds from the front and back, but is largely insensitive to sounds originating at the sides, and this can be very useful in eliminating unwanted background noises. The third type has a unidirectional or cardioid response, picking up sounds from the front and towards the sides (usually over a 180° arc) but being insensitive to sound originating towards the rear. This can be very useful for recording in locations with high background noise and also for stage and concert work in eliminating noises from the auditorium.

While most types of microphones, except high impedance and crystal types, can be used with the Ferrograph recorder, it is pointless to restrict the overall fidelity by using the very cheapest. Having regard to all the factors involved, the most suitable for general purposes are the moving coil (dynamic) and ribbon microphones. To match into the microphone input, they should be medium impedance (200-1,000 Ω), but low impedance microphones can be used with a low-to-medium matching unit (TA/30/ML, page 14). For the very highest quality recordings using more expensive microphones, condenser (or 'Electret') microphones could be used.

Microphone Placement

The above characteristics are for "free field" or open air conditions but when used indoors, reflections from plane surfaces such as walls and windows can modify the effective directionality of the microphone and by suitable placement each of the above types can be used in most situations. If desirable, the room reflections can be decreased by drawing curtains over windows, hard furniture, etc., or increased by removing cushions, soft furnishings, etc., and by rolling back the carpet. A certain amount of experimentation may be necessary to find the best position for the microphone, but as the tape recorded during this process can be used again for the recording proper, this is no great hardship. It is advisable to keep the microphone a reasonable distance from the recorder *e.g.* about 5 ft., or to orientate the microphone (if directional) so that the recorder is in an insensitive part of the microphone field, as a certain amount of mechanical noise from the moving parts (especially the tape) is inevitable, and for highest quality recordings all background noise should be avoided.

Stereo Microphones

When recording stereophonically using microphones, there are various techniques available, each of which has advantages for different types of recording. The simplest consists of a stereo microphone (or two 'mono' microphones placed close together), with the two parts of the microphone at right angles to each other. A variation of the two microphones close together is to space these farther apart, still picking up sound from the two halves of the sound stage but with possibly more cross pick-up from the other side to avoid any 'hole in the middle' effect. The most complicated technique is to have separate microphones for individual artistes or sections and to use a stereo mixer to blend the various signals together for the required sound. Which technique to use in any given circumstances is very much a matter of personal judgement.

Use of Microphones

With regard to the detailed use of a particular microphone, the individual manufacturer will issue appropriate instructions depending upon its type and directionality. However, it is usually undesirable to speak into any microphone unnecessarily closely (particularly if it has been kept in a cold room) as condensation may affect the performance and unless the microphone is specially treated may eventually cause corrosion. With ribbon microphones close talking should always be avoided as this causes bass accentuation, but should it be necessary, due to high local noise, speaking should be across the front at a minimum of 3 in. On no account should a ribbon microphone be blown into to check that it is functioning as this may damage the delicate ribbon, and for this reason, it should not be used out of doors on a very windy day. In general, all microphones should be treated with the care they deserve and severe shocks should be avoided.

Monitoring

As the Ferrograph recorder has separate record and replay heads, it is possible to monitor the signal off the tape whilst recording, and this can be done aurally (loudspeaker or headphones) by pressing the 'Tape' button.

On pressing the 'Tape' button, then 'Source', and back again, the replay and record signals can be compared aurally or visually. Their levels are normally set for BASF type LP35LH such that the meter indication on 'Tape' is the same as on 'Source' for easier comparison of the signal quality, and hence the record signal level can be checked on the meter even on 'Tape'. This applies to most of the standard good quality tapes, but if it is required to use tape which has an output markedly different from Ferrotape, it is possible to readjust the 'Tape' level as outlined in the Technical Section, page 44.

The recording can be monitored aurally by a loudspeaker (internal or external) or by headphones connected as on page 16, or alternatively an external amplifier and loudspeaker could be used. When using a microphone for recording, the loudspeaker must be silent to avoid acoustic feedback (see page 24), and audible monitoring must be done using headphones. If these are not available the meter can provide a useful check that the signal is being recorded by pressing the 'Tape' button.

On Wind, audible monitoring can also be used for place location on the tape ('Tape' button pressed), when the signal is heard as a high pitched gabble, depending upon the speed of the wind. To avoid a shrill, irritating sound when the tape is travelling at high speed, the high frequency response is automatically reduced on 'Fast', and consequently if the tape is slowed down to nearly normal speed it may seem a little muffled. If not required, the Mute switch should be pressed to the left, when the Tape signal is heard only on Run.

Bias

The meter can be used to read the record head bias instead of the 'Source' or 'Tape' signal, by pressing the 'Bias' push button at the centre of the panel. It should be pressed again to return to its normal 'out' position, when the meter again reads the 'Source' or 'Tape' signal (see page 43).

DOLBY NOISE REDUCTION SYSTEM (B)

The Dolby Noise Reduction System fitted to the Ferrograph Suffix D recorders enables tapes to be recorded and replayed with very much reduced levels of tape hiss and noise. With the Dolby Noise Reduction (NR) System in operation, the tape noise is reduced by up to 10dB without any loss of sound quality, and in consequence lower tape speeds and/or narrower track widths become acceptable for a wider range of programme materials. For instance, a recording made at $3\frac{3}{4}$ in/s with the NR System may have less background noise than one made at 15 in/s on a conventional recorder.

Application of the Dolby NR System is a two stage process, the first part taking place on record, the second on replay. The complete system is a complex circuit whose application depends upon the dynamics of the signal concerned, but basically those parts of the signal which are high frequency and at low levels are recorded at a higher level than normal. The amount of this extra boost can be as much as 10dB, the actual boost being both frequency and amplitude conscious and controlled by the Dolby NR circuitry to a specified set of response curves (Dolby B System). During replay an exactly complementary action takes place and the various sections of the signal are restored to their correct amplitude and phase relationships. However, during the process of reducing the level of the replay signals to normal, the tape noise is also reduced giving the improved noise performance associated with the Dolby System.

For correct operation, the record and replay processes must be exactly complementary, and for Dolby NR tapes to be compatible between Dolby recorders, these processors must also match the B System standard. For this reason the alignment of the Dolby boards in the Ferrograph Suffix D recorders has been undertaken with great care, and any adjustments on these boards should only be carried out by an engineer who is fully conversant with the system and who has recourse to adequate testing facilities.

Dolby NR System B Recordings

It will be appreciated from the preceding section that noise reduction is only possible if the tape has been recorded using the Dolby NR process: the system does not improve the signal to noise ratio of an existing, conventionally recorded tape. It is also important to note that the Dolby NR System only reduces noise introduced between the record and replay processors *i.e.* tape noise and some record-replay amplifier noise. Any noise fed to the recorder input as part of the incoming signal will be recorded and reproduced as normal, the Dolby NR System only reducing the noise added by the standard record/replay process.

A tape recording made with the Dolby NR System B in operation is suitable for replay on any Dolby B System instrument. If it is replayed on an instrument without Dolby B System circuitry, it will show pronounced and variable accentuation of the higher frequencies. This effect may be reduced by use of the treble control and, depending upon the programme content and the quality required, an acceptable result may be obtained. However, such an arrangement is not recommended for high fidelity results and should be avoided if possible. A Dolby B recording should always be replayed using the Dolby B System processor, and for this reason System B recordings should always be labelled very clearly.

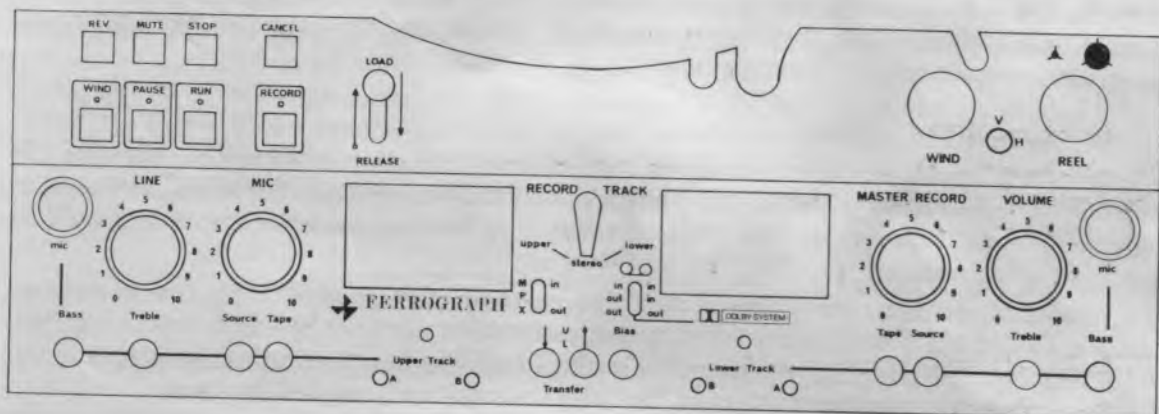


FIG. 12. CONTROLS (SUFFIX D MODELS)

Replay

With the Dolby switch set to "out", the recorder performs in all respects as a standard replay instrument.

To replay a Dolby System B recording, the Dolby switch must be set to "in" (or possibly to the centre position—Record 'out', Replay 'in'—if replay only is required), which introduces the noise reduction circuitry. No other operation or adjustment is required, and the controls and other switches function as described in pages 20 and 22.

Record

With the Dolby switch set to "out", the instrument performs in all respects as a standard recorder.

To record a tape to the Dolby System B characteristic, the 'Dolby' switch must be set to "in", which introduces the noise reduction circuitry. No other special settings or operations are required (pages 22-25) and the recorder facilities such as 'multiplay', mixing, echo, etc. (page 35) still function as described.

Note.—When a Dolby System B recording is to be made from an FM tuner, it is advisable to switch "in" the multiplex filter (MPX switch) to avoid the possibility of the stereo multiplex carrier frequency interfering with the correct operation of the Dolby B circuit.

Monitoring

Monitoring of a recording can be carried out as described on page 25 while making a normal recording (Dolby switch at "out") or a Dolby System B recording (Dolby switch at "in").

In certain circumstances it may be required to record a signal which has already been processed to the Dolby NR System B characteristic. This should be done in the conventional manner with the recorder's NR record processor out of circuit, when the resulting tape will be a Dolby B recording which must be replayed through the Dolby NR System B replay processor. It is therefore *essential* that the recording be made at the correct recording level to ensure correct operation of the Dolby NR processor. For example, when copying a tape by this method, the copy must be at the same record level as the original tape.

To enable this recording to be monitored aurally, the Dolby switch should be set to the centre position ('out-in'). The Dolby B System NR record processor is then out of circuit but the NR replay processor is in circuit. Thus the 'tape' signal can be monitored in 'decoded' form on a loud-speaker or headphones.

*Note:—*The normal A-B ('Source'—'Tape') comparison cannot be made in this case as the 'Source' signal is Dolby B System NR processed, whereas the 'Tape' signal is the decoded signal.

The above arrangement is useful for copying a Dolby NR System B tape which is being replayed on a tape recorder using the standard equalisation without the NR processor, or for recording the output from a standard FM tuner when a Dolby B System processed signal is being broadcast. In this latter case it may be necessary to switch 'in' the MPX filters.

MPX Switch

The MPX (multiplex) switch connects into the record amplifier filters which attenuate the high frequency response at 19kHz, and thus suppress the stereo multiplex carrier frequency which otherwise would falsely trigger the Dolby circuitry. It is recommended that the MPX switch be set to 'in' when making a recording from an FM tuner.

A steep roll-off notch filter is used in obtaining maximum attenuation at 19kHz, but nevertheless there is a slight attenuation below 19kHz and the response is restricted to -3dB at approximately 16.5 kHz. This will not affect the recording quality at $3\frac{3}{4}$ in/s but when using $7\frac{1}{2}$ or 15 in/s the MPX switch should be set to 'out' unless the filters are specifically required in circuit.

Distortion

While the primary purpose of the Dolby B System is the reduction of noise arising in the record/replay process, if required some of this improvement can be exchanged for a reduction in distortion. Either with or without the Dolby NR System, the best possible signal-to-noise ratio is obtained when the recording level rises to 0 VU as described in 'Record Level', page 23, as above this level distortion is increased on peaks in the signal.

With the increased signal-to-noise ratio conferred by the Dolby NR System (which can be as much as 10dB), should the peaks of the signal be adjusted to a reading of, say, -4dB , the signal-to-noise ratio improvement will be reduced by 4dB but the distortion on the peaks of the signal will also be reduced. The amount by which the available noise reduction is sacrificed to obtain reduced distortion is a matter of compromise depending upon circumstances and the particular type of recording being made.

Even without the sacrifice of any of the available noise reduction, the use of the Dolby B System NR processors on record and replay tends to reduce harmonic distortion on signals of medium to low levels in the mid-frequency band. Because of this, it is sometimes possible to observe an improvement in sound quality (as well as the usual improvement in signal-to-noise ratio) when using the Dolby NR System.

Compatibility

It should be stressed that the complete Dolby B NR System will improve the signal-to-noise ratio of a recording by as much as 10dB, without any loss of sound quality, and a Dolby B System

recording should always be replayed through the Dolby B replay processor, if available. However, it is a valuable feature of the system that if a 'Dolby B tape' is reproduced without the Dolby B replay processor, the result will still be acceptable for many purposes. As only the record process has been applied, the dynamic range of the signal is reduced and at the lower levels of signal there is accentuation of the high frequencies which, to some extent, can be compensated for by use of the Treble control. These effects are usually noticeable when listening critically to high quality sound reproduction or when a direct comparison is made with the original signal, but with more modest orders of sound quality and with less critical listening, the results are often found to be quite acceptable.

There is a similar compatibility when a recording made on an ordinary, non-Dolby-equipped recorder is reproduced through a Dolby NR replay processor, but this situation is much less likely to occur since all instruments incorporating Dolby B System processors possess an NR in/out switch.

GENERAL DETAILS

Half-track Recorders

The disposition of the conventional monophonic half track recording upon the tape is shown in Fig. 13a, the advantage of this system being that two tracks can be accommodated side by side on the tape, which doubles the length of playing time per reel. In practice, after a full recording has been made upon the top track in the normal way with the Record Track switch at 'Upper', the left hand spool is empty and all the tape on the right hand reel. They should each be removed and replaced on the opposite reel carrier, the tape being loaded in the usual way. The unrecorded lower half of the tape has now become the upper and may be recorded as usual. At the end of the reel the tape can be reversed again, when the first recording is again on the upper half and ready for replaying. Thus on a full $10\frac{1}{2}$ in reel of Long Play tape over 3 hours playing time is available at $7\frac{1}{2}$ in/s with a break of only a few seconds half way for the reel transposition.

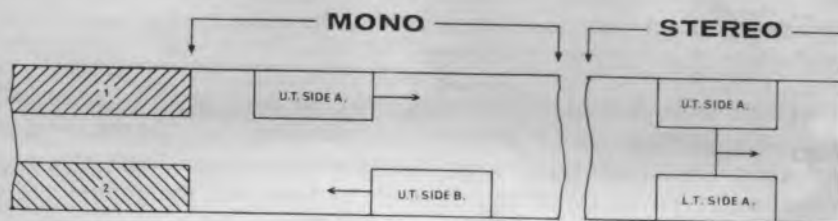


FIG. 13a. TRACK DISPOSITIONS—HALF TRACK

If required, the tracks may be reversed in the middle of a reel. After stopping and opening the loading gate, both reels should be removed and inverted. They can then be refitted to the opposite sides and the tape threaded through the heads in the usual way, with no twists. After loading the tape, the loading gate must be closed before the deck can become operational again.

When operating stereophonically, recording should proceed as usual (Fig. 13a), but since both tracks are recorded, the tape cannot be reversed at the end of the reel.

In general, quarter-track tapes cannot be replayed on a half-track recorder, although it is possible to get a low strength signal on the Upper track from track 1 (or track 4) of a mono tape provided track 2 (3) is not recorded.

Quarter-track Recorders

When recording monophonically on a quarter-track instrument, the usual track sequence is 1 - 4 - 3 - 2. This is obtained by first recording on 'Upper' on side A of the reel (track 1). At the end of the reel the tape is reversed and recorded on side B, still on 'Upper' (track 4). Reversing the tape at the end, recording takes place on 'Lower' on side A (track 3), leaving the final recording on 'Lower' on side B (track 2). This is shown in Fig. 13b.

The quarter track stereo arrangements is also shown in Fig. 13b; after recording on tracks 1 & 3, the tape can be reversed and another recording made on tracks 2 & 4 as shown.

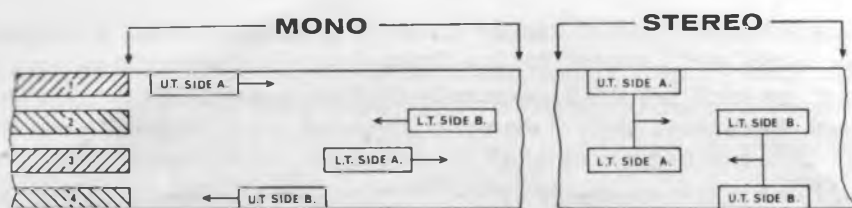


FIG. 13b. TRACK DISPOSITIONS—QUARTER TRACK

Standard mono half track tapes can be played on the Upper track, but if it is attempted to replay stereo half track tapes, the Lower track output will be low due to the track dispositions of the two systems (compare Figs. 25 & 26).

Due to the narrower tracks, quarter track recorders are more susceptible to "drop-outs" in the tape and to the effect of dust and dirt. For this reason it is recommended that Long or Double Play tapes be used as their more flexible backing gives a more intimate contact with the tape heads. Double Play tape is particularly recommended for the slower tape speeds. Particles of dust, dirt or tape oxide can cause poor contact and the tape path and faces of the heads should be cleaned frequently. If a particular tape produces this effect, it can often be improved by fast winding the tape directly between the reels in contact with a clean cloth folded over the tape.

Editing and Splicing

One of the advantages of a tape recording is that it is easily edited; unwanted passages may be cut out and the ends rejoined. In this way a composite programme of selected material may be built up. Of course, it is only possible to edit one mono track, as cutting out or splicing in pieces of tape obviously affects all of the tape. However, once the editing has been done for the single track, the composite tape may be put back on the recorder and the other track(s) recorded in the normal way with material which does not require editing.

For ease of editing, the hum wing on the replay head has been designed to hinge back at right angles to the tape path, where it locks in position. It is recommended that the Wind speed control be set to its centre position so that on pressing Wind the tape remains stationary with the brakes off. The tape can then be moved by turning the reels by hand and the appropriate place on the tape located by monitoring as on page 26. Stop should be pressed to engage the brakes before cutting the tape. The hum wing is returned to its operating position by pushing it back, the damped action ensuring a smooth return.

Splicing and joining the end of cut or broken tape is normally carried out by means of suitable adhesive tape applied to the back of the magnetic tape, which is usually the more polished side. For joining together two lengths of tape with as unobtrusive a joint as possible, a diagonal cut at 45° to the edges of the tape is used. This produces a "silent" joint and minimises any "drop-out" effect which may occur if the two ends of the tape do not meet quite accurately. When editing tapes, particularly when removing single words or noises, a vertical joint at right angles to the tape edge is often used, and this is also suitable for adding leader tapes and inserting stop foils. With either angle the joining procedure is the same, although in some cases more care may be needed to ensure that the cut is made at exactly the right point on the tape.

First of all, one of the pieces of tape should be placed, backing uppermost, along the channel in the splicing block and pressed gently into it, if necessary aligning the correct part of the tape opposite the appropriate slot. A very sharp cutter or razor blade should be drawn smoothly along the slot and through the tape. The unwanted part of the tape should be removed and the procedure repeated with the other piece of tape which is to be joined fed in from the other end. On removing the second unwanted length of tape, the two parts to be joined are left in the channel with their ends accurately butted together. The piece of splicing tape can now be pressed firmly on to the tape so as to cover the joint.

Two basic sizes of splicing tape are available and this determines the precise way in which each is applied. The $\frac{1}{2}$ inch wide splicing tape should be applied across the tape, which should be removed from the block and the surplus trimmed level with the edge of the tape. The trimmed splicing tape should not project over the edge as this may catch in the tape guides; on the other hand the trimming cut should not encroach too much into the magnetic tape as this will reduce the signal at that point, which is particularly important with quarter track tapes. The other size of splicing tape is the same width as the recording tape and a strip about $\frac{1}{2}$ inch long should be placed along the length of the tape. This must be laid very carefully and if it is not quite accurate, any overlap of splicing tape must be removed.

Note.—When removing the tape from the channel, it is advisable to “peel” the tape out at an angle, since to pull it out vertically may damage the edges of the tape.

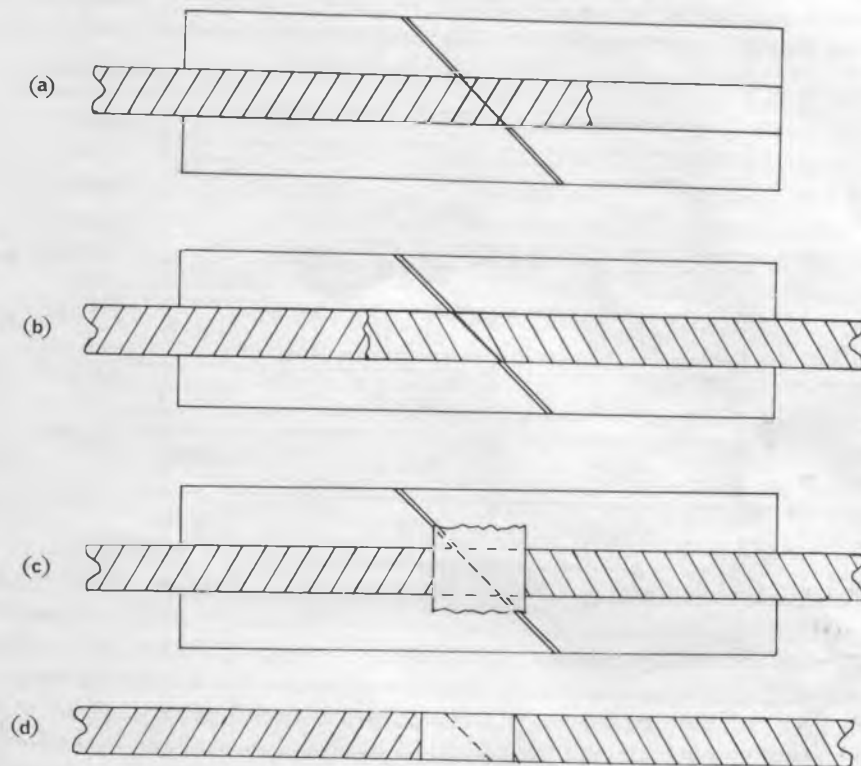


FIG. 14. TAPE SPLICING

If required, steps *a* and *b* can be combined by placing the two tapes one above the other before making the single cut. The top “unwanted” piece of tape should be removed immediately, the other being removed after the splicing tape has been applied.

If a splicing block is not available, the two pieces of tape should be held firmly together and the appropriate cut made using a pair of sharp scissors. The two ends should then be butted together accurately and the splicing tape applied to the backing, when it can be trimmed as usual.

Spools

The reel carriers on the Ferrograph recorders are specially designed so that any type of spool conforming to the international standard can be used. To cater for vertical operation of the deck, reel retainers are provided and these are also useful if it is required to leave the reels on the recorder during transportation.

Again, different sizes of spool can be used on the Ferrograph, from the maximum diameter of $10\frac{1}{2}$ in. to the very small, but while the performance may still be satisfactory when using the small “message” spools, the tape speed consistency cannot be guaranteed if those having an inside diameter of less than $1\frac{3}{4}$ in are used.

The reel carrier accepts spools with the conventional cine-centre, and a specially designed NAB adaptor can be fitted to cater for those spools with the 'professional' NAB centre, as described in 'Reel Loading' (Page 17) and shown in Fig. 7a, b & c.

The Reel switch selects the reel motor power suitable for either 10½ in spools (NAB centred size) or other sizes (8¼ in or less, cine centred size), and should be set accordingly, although with 8¼ in spools either position should give satisfactory performance. The brakes are adjusted for correct operation with spools of equal size and weight on each side. Should it be found necessary to use dissimilar spools, *e.g.* a small plastic spool with a large metal spool, this can be done satisfactorily on 'Run' but on Wind the tape should be slowed down (using the Wind knob) until almost stationary before pressing Pause or Run. This is particularly important if using very thin tapes.

It will be observed that the larger diameter spools overhang the deck slightly, and only those of 5½ in diameter or less can be left on the recorder with the cover fitted. The approximate lengths of tape which are normally accommodated on the various sizes of spool are given in the table.

<i>Approximate Length of Tape Per Reel</i>				
Size of Reel	Standard Play	Long or Extra Play	Double Play	Triple Play
3 in	150 ft	225 ft	300 ft	450 ft
3¼ in	200 ft	300 ft	400 ft	600 ft
4 in	300 ft	450 ft	600 ft	900 ft
4¼ in	400 ft	600 ft	900 ft	1,200 ft
5 in	600 ft	900 ft	1,200 ft	1,800 ft
5¾ in	900 ft	1,200 ft	1,800 ft	2,400 ft
7 in	1,200 ft	1,800 ft	2,400 ft	3,600 ft
8¼ in	1,800 ft	2,400 ft	3,600 ft	4,800 ft
10½ in	2,400 ft	3,600 ft	4,800 ft	7,200 ft

Tape

The manufacture of recording tape for optimum performance is always a compromise between noise level, maximum output (before distortion occurs) and high frequency response. Most brands and types of tape differ slightly from one another necessitating adjustment to the recorder to take advantage of this optimum performance, and these differences are more noticeable at the slowest tape speeds.

It is recommended therefore that the tape used with the recorder should be that for which the recorder is adjusted at the factory. Other brands of tape will rarely achieve a better performance although they can be used with satisfactory results when the bias is adjusted for optimum performance as outlined in The Technical Section, page 42.

In addition to Standard and Long Play Tapes, Double Play tape can be used with satisfactory results, particularly at the slower speeds where its more flexible backing gives a more intimate contact with the working face of the head, leading to a more constant output, especially at the higher frequencies. Triple and Quadruple Play tapes can also be used, but due to their different oxide formulation they give greater distortion at the higher recording levels and the recording should be made at a lower level than usual. They may also give excessive output at the higher frequencies.

Playing Time Per Track				
Length of Tape	15 in/s	7½ in/s	3¾ in/s	1½ in/s
150 ft (45 m)	2 min	4 min	8 min	16 min
200 ft (60 m)	2½ min	5 min	10 min	21 min
300 ft (90 m)	4 min	8 min	16 min	32 min
400 ft (120 m)	5 min	10 min	21 min	42 min
450 ft (135 m)	6 min	12 min	24 min	48 min
600 ft (180 m)	8 min	16 min	32 min	1 hr 4 min
900 ft (270 m)	12 min	24 min	48 min	1 hr 36 min
1,200 ft (365 m)	16 min	32 min	1 hr 4 min	2 hr 8 min
1,800 ft (545 m)	24 min	48 min	1 hr 36 min	3 hr 12 min
2,400 ft (730 m)	32 min	1 hr 4 min	2 hr 8 min	4 hr 16 min
3,600 ft (1095 m)	48 min	1 hr 36 min	3 hr 12 min	6 hr 24 min
4,800 ft (1460 m)	1 hr 4 min	2 hr 8 min	4 hr 16 min	8 hr 32 min
7,200 ft (2190 m)	1 hr 36 min	3 hr 12 min	6 hr 24 min	12 hr 48 min

Remote Socket

The Remote Socket is situated at the rear of the recorder (under the carrying handle) and consists of a 14 way socket carrying all the information and connections to facilitate remote control of all the main functions of the recorder push buttons. It accepts the Remote Control Unit described on page 34. The commands on pins 7, 8, 9, 10, 11, 12 & 14 are initiated by temporarily connecting the appropriate pin to pin 1 (Earth); the corresponding lamps (LEDs) are connected between pins 3, 4, 13 and pin 2 (+24V) and are limited to 20 mA. For pins 5, 6 (LED Pause/Run), reference must be made to the circuit diagram.

- | | | |
|-----------------|-------------|--------------|
| 1 Earth | 6 LED Pause | 11 Wind |
| 2 +24V dc | 7 Cancel | 12 Rev |
| 3 LED Record | 8 Record | 13 LED Check |
| 4 LED Wind | 9 Run | 14 Stop |
| 5 LED Pause/Run | 10 Pause | |



FIG. 15. REMOTE AND AUXILIARY SOCKET CONNECTIONS

Auxiliary Socket

The Auxiliary Socket is situated at the rear of the recorder and is intended to augment the facilities and capabilities of the Remote Socket. It is a 7 pin socket conforming to the DIN specification and into it can be inserted the standard 3 pin, 5 pin and 7 pin DIN plugs, connecting to pins 1 to 3, 1 to 5, and 1 to 7 respectively. **WARNING** : Standard DIN connecting leads should not be used.

The pin connections are shown in Fig. 15, pin 2 being earth. Pins 1 & 2 are used for remote starting and stopping of the tape (e.g. with a foot switch) with the recorder on Pause/Record; pin 3 provides up to 200 mA DC from the + 50 V supply for powering various ancillary units.

The Low Level outputs are wired to pins 4 (Upper) and 5 (Lower) and the 600 Ω outputs to pins 6 (Upper) and 7 (Lower). These output connections can be used for a remote volume unit, remote level indicators, Signal operated Switching Unit, etc.

EXTERNALLY CONTROLLED OPERATION

As the deck uses logic control circuitry, the instrument can be controlled externally to perform almost all of the deck functions as described below.

Remote Control Unit (see Accessories, Page i)

The Remote Control Unit plugs into the 14 way socket situated at the rear under the carrying handle. It duplicates the deck push buttons situated on the left of the control panel, and all their operations can be performed using the controls in the usual way — Run, Pause, Record/Cancel, Wind/Rev and Stop, the Mute switch being replaced by a duplicate Check lamp.

The variable speed Wind control is not duplicated on the remote unit and therefore it must be pre-adjusted to the required speed and direction. The use of Wind and Rev gives winding in either direction at this preset speed. Again, as the turns counter is not duplicated, unless the recorder can be seen from the remote position, location on the tape can be done by listening to the monitor signal.

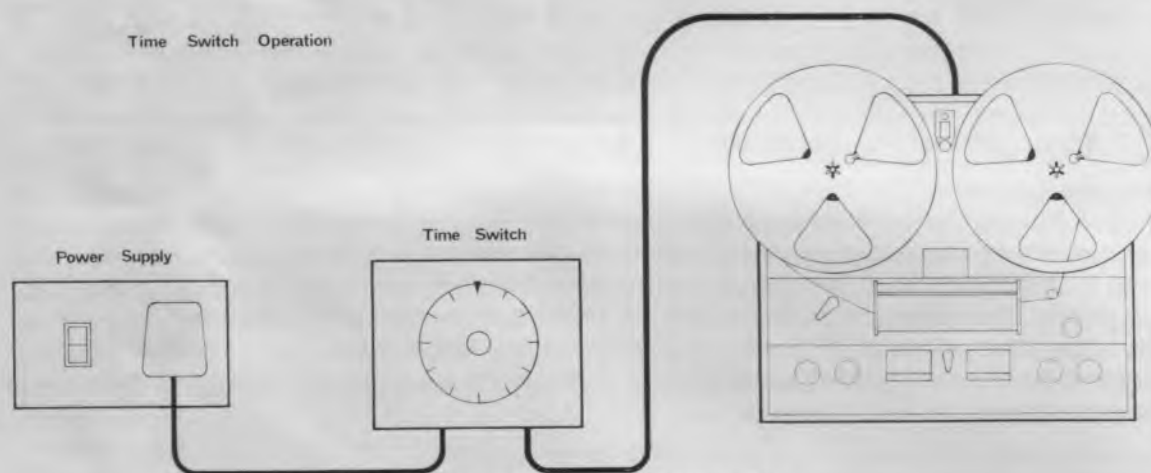


FIG. 16. TIME SWITCH OPERATION

Time Switch

Unattended control by time switch is a very useful facility and is achieved as follows :—

The recorder should be loaded with tape and if necessary wound on to the required point. The time switch should then be connected into the mains lead of the recorder and a special plug inserted into the Remote socket at the rear. For replay, this should have pins 9 & 1 linked together, and the Volume and tone controls should be set to pre-determined positions. For record, the plug should have pins 8 & 9 both linked to pin 1, and the Line and/or Microphone and Master Record controls should be set to pre-determined positions to give a suitable signal for recording (as on Page 23). *Check that the Power Supply Switch of the recorder is at 'On'.*

When the time clock switches on the mains, the tape starts up and replays or records as arranged. When the time clock switches off, the tape stops and this operation can be repeated as arranged on the timing device. Should the tape run out before the timer switches off, the auto stop operates and shuts off the tape drive, the recorder remaining energised until the timer switches off the mains.

Start/Stop

The recorder can be switched from Pause to Run by connecting a change over switch to the Remote socket; pole — pin 1, Pause contact — pin 10, Run contact — pin 9. On moving the switch from Pause to Run and back, the tape is started and stopped on replay or record (Record pressed). One example of this method is the use of a footswitch when the hands are otherwise engaged, and such a switch is available as an accessory.

The Ferrograph recorder can also be remotely started and stopped on Record by the closing and opening of a pair of contacts connected to pins 1 & 2 of the Auxiliary Socket, A 3, 5 or 7 pin D.I.N. plug can be used. The two leads (Fig. 17) should be wired to a switch (or pair of contacts) which is normally open, and the recorder left energised with 'Pause' and Record pressed. On closing the switch, the 'Run' solenoid is energised and the tape drive started. On opening the switch the tape drive stops and this can be repeated as required. The Aux. Socket (pins 1 & 2) can be used for replay but the fast wind muting is still operative and the sound is severely muffled.

Volume

The volume of the signal fed to the internal loudspeakers and the Loudspeaker outputs can be varied remotely by connecting a 5 k Ω logarithmic potentiometer as a variable resistance across each Low Level output. This could be on the jack sockets or on the Auxiliary Socket (Fig. 17) between pins 4 & 2 (upper) and 5 & 2 (lower), using separate earth leads for each channel to minimise crosstalk. A seven or five pin D.I.N. plug should be used.

The maximum volume (with the variable resistance at maximum) is still governed by the Volume control on the recorder, but adjusting the remote control varies the signal from this down to zero.



FIG. 17. EXTERNAL OPERATION CIRCUITRY (AUX. SKT.)

Signal Operation

The Auxiliary Socket on the rear panel is arranged to accept a Signal operated Switching Unit. This unit is designed to drive the tape only when a signal is present for recording and to switch off the tape drive when the signal ceases. To allow for short gaps in the signal *e.g.* pauses in speech, the Switching Unit has a built-in variable delay of 5-25 secs. before switching off. Thus by omitting the long silent periods when no signal occurs, messages, etc., spread over a long time can be recorded onto a single tape.

After plugging the Switching Unit into the Auxiliary Socket, Pause and Record should be pressed simultaneously and the record gain controls adjusted to predetermined settings. *The 'Source' button must be pressed on the appropriate track(s).*

SPECIAL APPLICATIONS

'Transfer' Switching

The 'Transfer' push buttons are situated at the centre of the amplifier control panel and are labelled 'U \rightarrow L' and 'L \rightarrow U'. They can be used in combination with the other push buttons and controls to give a variety of special applications as described below. **WHEN NOT SPECIFICALLY REQUIRED, THE 'U \rightarrow L' and 'L \rightarrow U' BUTTONS MUST BE 'OFF' (in the 'out' position).**

Multiplay

The 'Transfer' push button switching enables the replay signal from one track of the tape to be fed to the Line input of the other track and to be re-recorded. If required, a second signal can be mixed with the replay signal during the re-recording to give a combined recording on the other track. By repeating the process, but *replaying on the other track whilst re-recording on the first*

track (the original signal being erased), a third signal can be added. This technique can be used to introduce more signals as required, the result being a 'multiplay' recording.

For this procedure, great care should be taken to ensure highest quality recording as it must be borne in mind that each time a new signal is added the original signal is re-recorded, and unless great care is taken the quality of the recording suffers. Particular care must be paid to recording level as there is a build-up of background noise and tape hiss which can quickly become obtrusive if too low a recording level is used. Again, it is advisable to thoroughly clean tape oxide, etc., from the heads, capstan and pinch roller before commencing.

Upper to Lower (Fig. 18a)

To transfer a recording from the Upper to the Lower track the controls should be set to record on the Lower track and to replay on the Upper track (Record Track switch at 'lower', Lower 'Source' button and Upper 'Tape' buttons pressed). The 'U→L' button should then be pressed, when on commencing to record, the Upper replay signal is re-recorded on the lower track at a level set by the Lower Line and Master Record controls. The quality of this re-recorded signal can be modified by the Upper Bass and Treble controls.

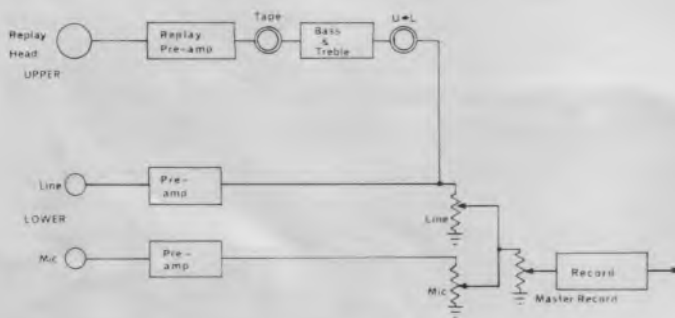


FIG. 18a MULTIPLAY - UPPER TO LOWER

If it is required to add a second signal to the re-recording, this should be fed into the Lower Mic input and its level adjusted by the Lower Mic gain control to give the required balance with the re-recorded signal (see page 25, 'Monitoring'). If this second signal is not suitable for the Mic input, it could be fed into the Line input but both signals are now adjusted by the Lower Line gain control and therefore some other control of the second signal must be used to set the balance.

When the recording is completed, the 'U→L' button must be pressed again to release it.

Lower to Upper (Fig. 18b)

To transfer a recording from the Lower to the Upper track, the controls should be set to record on the Upper track and to replay on the Lower track (Record Track switch at 'Upper', Upper 'Source' button and Lower 'Tape' button pressed). The 'L→U' button should then be pressed, when on commencing to Record, the Lower replay signal is re-recorded on the upper track at a level set by the Upper Line and Master Record controls. The quality of this re-recorded signal can be modified by the Lower Bass and Treble controls.

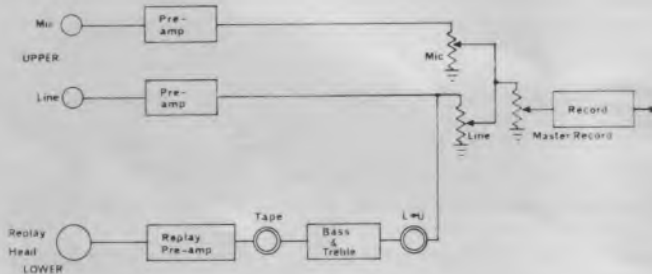


FIG. 18b MULTIPLAY - LOWER TO UPPER

If it is required to add a second signal to the re-recording, this should be fed into the Upper Mic input and its level adjusted by the Upper Mic gain control to give the required balance with the re-recorded signal (see page 25, 'Monitoring'). If the second signal is not suitable for the Mic input, it could be fed into the Line input but both signals are now adjusted by the Upper Line gain control and therefore some other control of the second signal must be used to set the balance.

When the recording is completed, the 'L→U' button must be pressed again to release it.

4 Input Mixing

The 'Transfer' push buttons can be used to provide 4 input mixing when using the recorder monophonically on the Upper or the Lower track. The usual technique, detailed in the 'RECORD' section commencing on page 23, should be followed but with the added mixing facility as described below.

Recording on Upper (Fig. 19a)

To mix the Lower track inputs with the Upper track inputs, the Lower 'Source' button and the 'L → U' button must be pressed. The signals from the Lower Mic and Line inputs are still adjusted by their individual gain controls and the Master Record control, and the combined signal as modified by the Lower Bass and Treble controls is connected to the Upper Line input signal. All three are

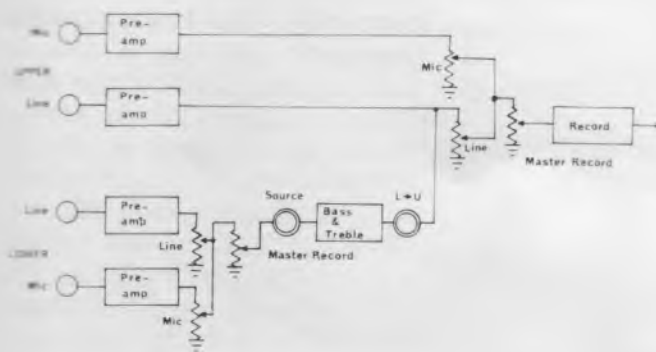


FIG. 19a 4 INPUT MIXING - RECORDING ON UPPER

adjusted simultaneously by the Upper Line gain control which acts as a master control and therefore the usual technique is to set it to a suitable level for the Upper Line input signal, when the levels of the Lower Mic and Line inputs are set by the Lower Master Record control. The Upper Mic input signal is adjusted by the Upper Mic gain control completely independently of the other signals, and the overall level is set by the Upper Master Record Control.

Recording on Lower (Fig. 19b)

To mix the Upper track inputs with the Lower track inputs, the Upper 'Source' button and the 'U → L' button must be pressed. The signals from the Lower Mic and Line inputs are still adjusted by their individual gain controls and the Master Record control, and the combined signal as modified by the Upper Bass and Treble controls is connected to the Lower Line input signal. All three are

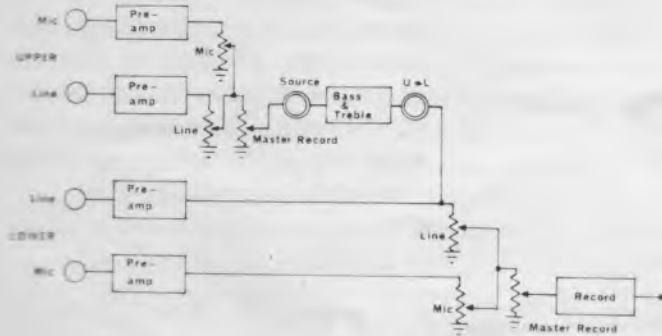


FIG. 19b 4 INPUT MIXING - RECORDING ON LOWER

adjusted simultaneously by the Lower Line gain control which acts as a master control and therefore the usual technique is to set it to a suitable level for the Lower Line input signal, when the levels of the Upper Mic and Line inputs are set by the Upper Master Record control. The Lower Mic input signal is adjusted by the Lower Mic gain control completely independently of the other signals, and the overall level is set by the Lower Master Record Control.

Echo Effect

Due to the physical spacing of the record and replay heads there is a finite delay between the record and replay signals which corresponds to the time taken for the tape to travel between the two heads. (At $7\frac{1}{2}$ in/s this is approximately $\frac{1}{5}$ s ($\frac{1}{10}$ s at 15 in/s, $\frac{2}{3}$ s at $3\frac{3}{4}$ in/s). Thus when recording if part of the replay signal is fed back into the record amplifier, it gives the effect of an echo whose magnitude depends upon the amount of signal fed back.

Upper (Fig. 20a)

The controls should be adjusted to record on the Upper track as usual, with the Record Track switch at 'upper'. The signal to be recorded should be fed into the Upper Mic input, with the Upper 'Source' button pressed, and the Mic gain control set for a suitable recording level. With the Upper Line gain control at zero, the Upper 'Tape' button and 'U → L' button should be pressed and recording commenced. On turning up the Upper Line gain control, echo is added to the recording, the level being set by the Upper Master Record control. Care should be taken not to set the Upper Line gain control too high as this may cause the echo to build up, leading to instability. The 'quality' of the echo can be altered by the Upper Bass and Treble controls if required.

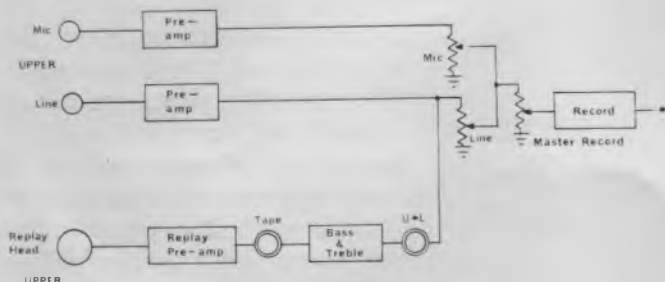


FIG. 20a ECHO EFFECT - UPPER

Lower (Fig. 20b)

The controls should be adjusted to record on the Lower track as usual, with the Record Track switch at 'lower'. The signal to be recorded should be fed into the Lower Mic input, with the Lower 'Source' button pressed, and the Mic gain control set for a suitable recording level. With the Lower Line gain control at zero, the Lower 'Tape' button and 'L → U' button should be pressed and recording commenced. On turning up the Lower Line gain control, echo is added to the recording, the level being set by the Lower Master Record control. Care should be taken not to set the Lower Line gain control too high as this may cause the echo to build up, leading to instability. The 'quality' of the echo can be altered by the Lower Bass and Treble controls if required.

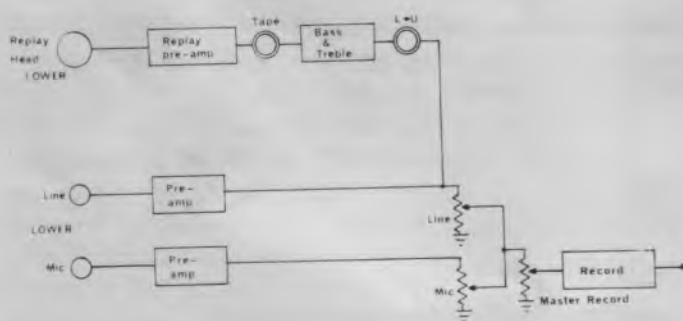


FIG. 20b ECHO EFFECT - LOWER

Stereo (Fig. 20a and 20b)

When recording on both channels simultaneously (Record Track switch at 'stereo'), echo can be added to one or both channels separately as described for 'Upper' and 'Lower' above. When applying echo to a stereophonic recording, care should be taken to adjust the controls to give approximately the same amount of echo to each channel unless an unbalance is intentionally required.

Use as an Amplifier

By pressing the 'Source' buttons, the Ferrograph recorder can be used as a "straight-through" amplifier, providing up to 10 Watts output to the internal or external loudspeaker(s). It can be used in conjunction with a tuner unit, radio or turntable, or it can be used with a microphone as a "public address" system. The mixing facilities can be used and the output signal modified by the Bass and Treble controls. Both channels could be used, feeding into two loudspeakers to give up to 2 x 10 Watts output.

Dual Mono

If it is required to use both output stages for the same signal, the Low Level outputs (or Aux. Skt. pins 4 & 5) could be connected together, when the volume of each channel is set by its Volume control. If a mono tape is to be replayed into both speakers, the other track 'Source' button should be pressed and the Mic/Line controls set at zero.

Alternatively, the 'transfer' switching could be used as illustrated in Fig. 18a or 19b (U→L) or Fig. 18b or 19a (L→U) as appropriate, but some loss of bass response may occur as the signals will be in anti-phase.



FIG. 21. HEAD BLOCK

Cabinet Mounting

The Ferrograph recorder can be fitted into consoles or cabinets with or without its standard case. When in the case it fits into a space $20\frac{1}{4}$ in. wide by $17\frac{1}{2}$ in. long and about $7\frac{3}{4}$ in. deep with 2 in. top clearance; space of at least 1 in. should be allowed at the rear for plugs.

To remove the recorder from its case, it should be stood vertically (handle at the top, amplifier at the bottom) and all connections to the rear panel removed, also all fuses. The handle should be lifted and first one end then the whole handle pushed down into the recess to take it clear of the inside of the case (Fig. 22), when the four bolts on the floor of the case can be unscrewed. The recorder chassis should be slid forward and the two loudspeaker leads unplugged, one at each side, when the chassis can be lifted clear of the case and the fuses replaced.

It is refitted into the case in the reverse manner. When doing so, a length of tape or string should be inserted between one end of the handle and its recess so that after insertion into the case, the handle can readily be pulled out of the recess by means of this loop.

When mounting the chassis in a cabinet, it should not be supported by the two aluminium side frames but the two steel "U" frames should rest on the floor (or supporting beams) and if required, it can be held in position by the four bolts used to hold it in the case. When fitting into the new cabinet, a clearance of at least $\frac{1}{8}$ in. should be left at the sides to ensure adequate ventilation; Fig. 22 gives the overall dimensions of the chassis. A metallic screen (e.g. aluminium foil) should be placed across the front of the amplifier and earthed to the chassis, as shown in Fig. 22, to prevent hum.

MODELS 7602 AND 7604

The preceding Operating Instructions apply to Models 7622 & 7624. Models 7602 and 7604 are identical but do not have power amplifiers or loudspeakers. The 'Loudspeaker' outputs are therefore omitted from the rear panel and are replaced by Low Level Adjustable outputs which provide the same signals as the other Low Level outputs but with the level of each adjusted by the appropriate Volume control (which also controls the Phones output).

CARE AND MAINTENANCE

Little actual maintenance is necessary with the Ferrograph beyond the periodic removal of dust and dirt from the head assembly. After a time, particularly when new tape is being used, loose coating from the tape accumulates on the working faces of the heads. This can lead to a reduction in the high frequency response of the replay head and sometimes to a reduction in the recorded signal level from the record head, and if allowed to accumulate for a long period on the erase head it can even affect the erasure. Normally this deposit is tape oxide, which is visible, but it can also be coating from the modern 'glossy' tapes, which is not always easy to see. A small non-abrasive brush can be used to clean the heads by moving it gently back and forth across the face of each head in turn, and with persistent deposits a small quantity of methylated spirit could be applied. For ease of access to the replay head, the hum wing can be hinged back at right angles to the tape path, where it locks in position. It is returned to its operating position by pushing it back, the damped action ensuring a smooth return.

The record and replay heads are vital parts and their working faces should be treated with great care; nothing abrasive should be allowed to touch them as they have been given a very high polish and this is a very desirable condition to maintain. The heads, tape guides and mounting plates should not be disturbed as the alignment of the head faces would be upset with subsequent loss of performance, nor should steel tools be used near the heads as any magnetisation in them may cause permanent magnetism in the heads with deleterious effect. Should this occur, it is necessary to use a defluxer (see Appendix A) as described on page 9.

Tape oxide also accumulates on the driving surfaces of the capstan and pinch roller, reducing the traction and leading to slip in the tape drive. This produces speed variations ("Wow" and "Flutter") which may become noticeable as variations in pitch. To avoid this the capstan and pinch roller should be cleaned regularly with a lightly damped fluff-free cloth; organic solvents must not be used, and care should be taken not to damage these driving surfaces as this could also cause "Wow" and "Flutter".

With the recorder switched off, the meter pointer should locate on the left hand mark on the scale (0%) and if necessary this can be reset by the mechanical set zero control (screwdriver adjust) below the meter on the front panel (see Fig. 10 or 12).

Should it be necessary to replace one of the fuses on the rear panel, these are type 20 mm long x 5 mm dia. rated at 1 Amp, except for Power Supply fuse on the 117V model (Suffix A) which is 20 mm x 5 mm dia. rated at 2 Amp. Any interior adjustments should be left to experienced service engineers who have the necessary specialised instruments for correct alignment.

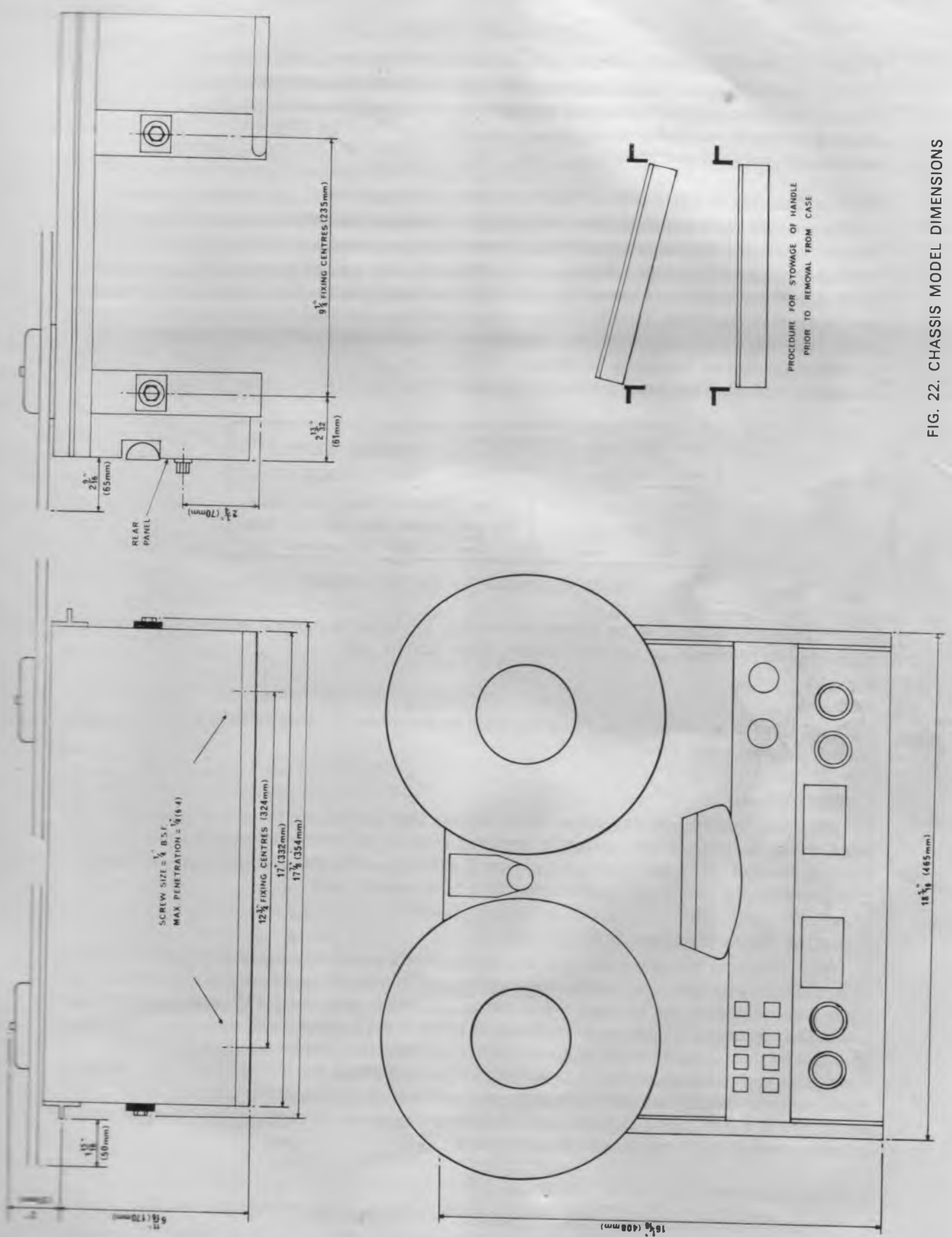


FIG. 22. CHASSIS MODEL DIMENSIONS

TECHNICAL SECTION

TECHNICAL DETAILS

This section contains technical information and descriptions of circuitry to enable the more sophisticated user to obtain maximum benefit from the instrument. However, while explanations are given in detail, re-adjustment of pre-set controls should not be attempted without adequate understanding of each operation.

Power Supply

The recorder can be operated from 200V, 220V or 240V, 50Hz power supply (recorder suffix A from 117, 60Hz supply). As supplied it will normally be set for 240V, but can be adjusted as follows.

The recorder should be removed from its case (Page 39) and the two plugs/sockets disconnected at the rear of the amplifier (P/SK700 & SK/P101). The lead(s) to the Line input socket(s) on the rear panel should be eased out of the clips on the side frame and then the four screws holding the Power Unit to the cross frames undone. The unit can now be eased sufficiently out from the frame to expose the top of the mains transformer TR700. One lead only (brown or grey) should be unsoldered from each tag 4 and soldered to the appropriate tag 3 (220V) or tag 2 (200V).

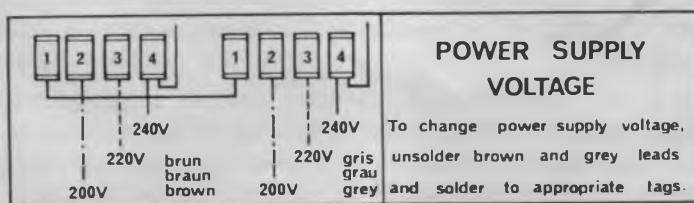


FIG. 23. POWER SUPPLY VOLTAGE WIRING

The Power Unit can then be refastened in place, the leads re-inserted into the clips, and two plugs/sockets re-connected and the recorder refitted into its case.

Record

The basic connections and recording functions are described on pages 14 & 23 but the following notes are apposite.

Crystal Pick-up

While overloading will not occur when feeding high output crystal pick-ups into the Line input, it may be that the gain control is operating over an inconveniently small part of its range. This can be obviated by connecting a capacitor (1,800 pF) across the leads *viz.* in parallel with the pick-up, when the output will be attenuated to a more suitable level.

Constant Tones (Frequency Response)

When recording constant tones (*e.g.* sine wave) from a source connected as in page 14, a level of recording higher than that suitable for audio signals is sometimes permissible. The signal level meter approximates to the standard VU characteristic which calibrates 0 VU on the scale as 4dB below peak recording level to allow for transient peaks in the average audio signal (*e.g.* orchestral music), and thus constant tones of up to 2000Hz approximately can be recorded at +3dB on the meter scale without overloading the tape. With frequencies above this it is necessary to record at a lower level to avoid tape saturation due to the pre-emphasis of the record characteristic. Accordingly, recordings of a wide range of tones such as a frequency response check should be made with a reference level of 20dB below peak recording level.

Bias Adjustment

The bias on each channel can be adjusted by the screwdriver pre-set control 'B' at the front of the recorder and its value can be observed on the meter by pressing the 'Bias' button. The recom-

recommended bias settings (at 15 in/s or $7\frac{1}{2}$ in/s) for various brands of tape are given below. These are intended as a guide and tapes not included in the list can also be used on the Ferrograph with average bias settings or with a suitable setting determined by experiment to give the best results.

Decreasing the bias improves the high frequency response but at the expense of increased distortion and probably a lower signal output, and the final adjustment of the bias is a compromise between these three factors. If a constant amplitude low frequency sine-wave is available (about 500Hz), the tape should be run at the $7\frac{1}{2}$ in/s tape speed and the bias set to slightly higher than that value which gives maximum output of the replay signal as shown on the meter ('Tape' button pressed). On pressing the 'Bias' button, the reading suitable for that brand of tape can be noted and recorded in the blank spaces of the table.

The best compromise between Signal/Noise ratio, distortion and frequency response is obtained with a slightly different bias value at each tape speed. Consequently, the circuit is arranged to adjust the bias automatically to the optimum value appropriate to each speed. It is for this reason that the meter bias readings should be noted or reset only when switched to 15 in/s or $7\frac{1}{2}$ in/s.

Brand	Type	Bias
Agfa	PE 36	-2
	*PER 525	+2
Ampex	407	-1
Audiotape	907	-1
B.A.S.F.	*LGR 30P	+2
	LP35LH	0
	LPR35LH	-1
	LP35LH Super	-2
E.M.I.	825	-1
	Hidynamic	-2
Ferro tape	B	-2
Maxell	UD35	-1
Memorex		-1
Scotch	Classic	0
	207	-2
	223	-2
	*262	+2
T.D.K.	Audua	+1
	SD	0

*These tapes are high output types intended for use at 15 in/s and with these the recording level should be allowed to rise to +3 VU.

Monitoring (Signal Level)

As the Ferrograph recorder has separate record and replay heads it is possible to monitor the signal off the tape whilst recording, and this can be done aurally from the loudspeaker and visually on the meter by pressing the 'Tape' button.

The record and replay signals are set so that the meter indication on 'Tape' is the same as on 'Source' for easier comparison of the signal quality. However, different brands of tape vary slightly in the strength of the replay signal obtained and if the brand in use is markedly different from that to which the recorder has been set, there will be an observable difference between the readings. If it is desired to correct for this, the two signals should be compared and the 'tape level' pre-set control 'A' (see Fig. 10) adjusted with a screwdriver until 'Tape' and 'Source' indications on the meter are the same (if recording constant tones see page 42).

Once this has been set correctly for the brand of tape in use, it should not be necessary to re-adjust the 'tape level' control 'A' again unless a tape is used which has an output level markedly different.

Speed	Characteristic	Bass	Treble
15 in/s (38 cm/s)	CCIR/IEC/DIN (35 μ sec.)	⊙	⊙
	NAB (50 μ sec.)	⊙	⊙
	USA (Ampex)	⊙	⊙
7½ in/s (19 cm/s)	DIN/NAB (50/3180 μ sec.)	⊙	⊙
	IEC (70 μ sec.)	⊙	⊙
	CCIR (100 μ sec.)	⊙	⊙
	USA (Ampex)	⊙	⊙
3¾ in/s (9.5 cm/s)	IEC DIN/NAB (90/3180 μ sec.)	⊙	⊙
	IEC (old) (140 μ sec.)	⊙	⊙
	CCIR (200 μ sec.)	⊙	⊙
	USA (Ampex)	⊙	⊙

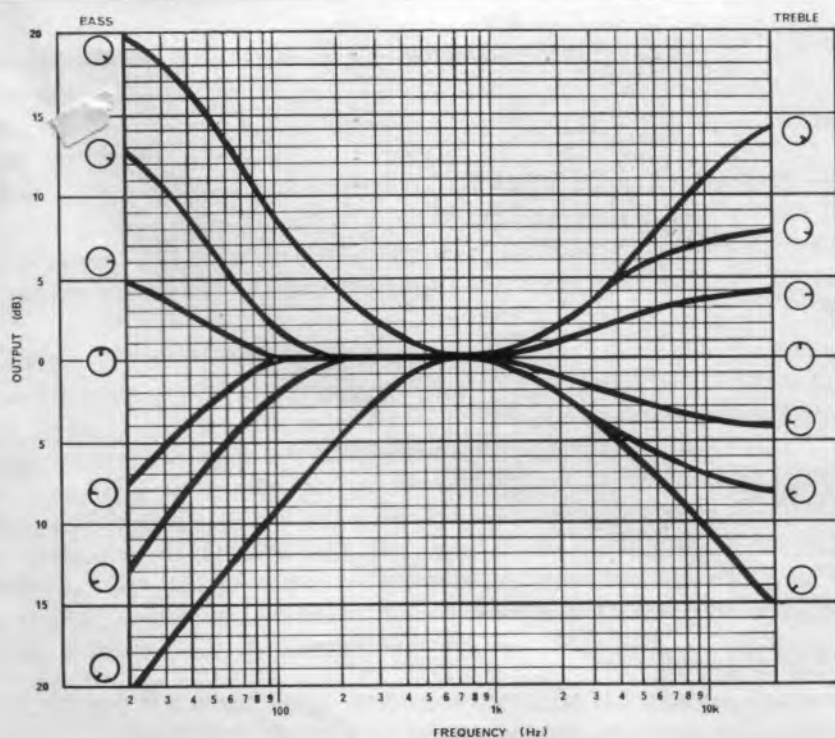


FIG. 24. EFFECT OF BASS AND TREBLE CONTROLS

Bass and Treble Controls

The Bass and Treble controls can be used independently of each other to provide a continuously variable amount of lift or cut as required (Fig. 24). When at their normal central position an overall level response (record/replay) is obtained.

When replaying tapes recorded on other instruments, the Bass and Treble controls can be utilized to give a level response on the loudspeakers or at the Low Level and Loudspeaker outputs. Their settings will depend upon the characteristic to which the tape was recorded. While their final positions may depend upon the judgement of the listener as explained on page 22, the recommended settings for a level response with various characteristics at each tape speed are given in the table.

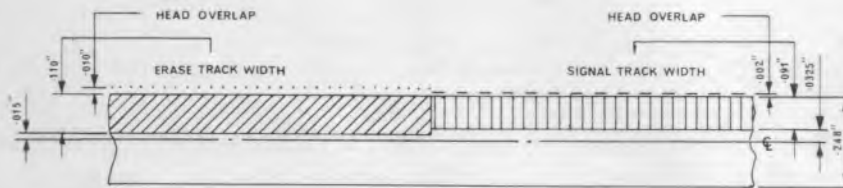


FIG. 25a. TRACK DIMENSIONS—HALF TRACK—MONO, STEREO

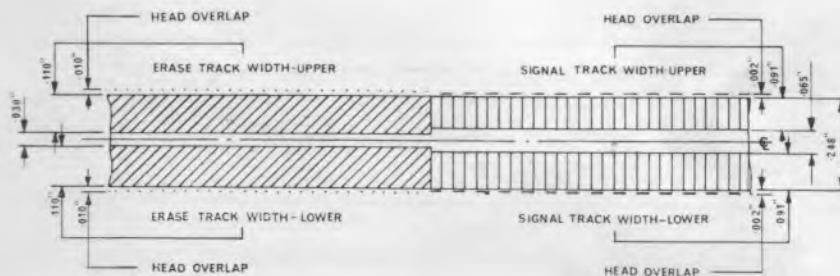


FIG. 25b. TRACK DIMENSIONS—HALF TRACK—STEREO



FIG. 26a. TRACK DIMENSIONS—QUARTER TRACK—MONO, STEREO

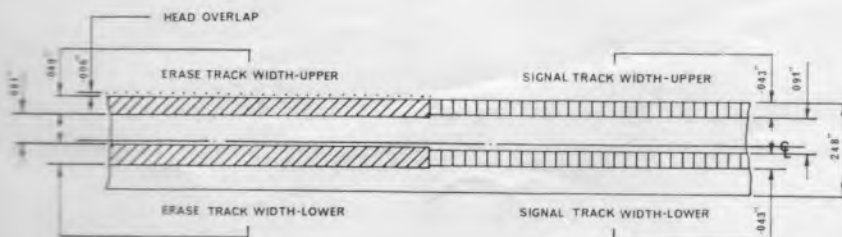


FIG. 26b. TRACK DIMENSIONS—QUARTER TRACK—STEREO

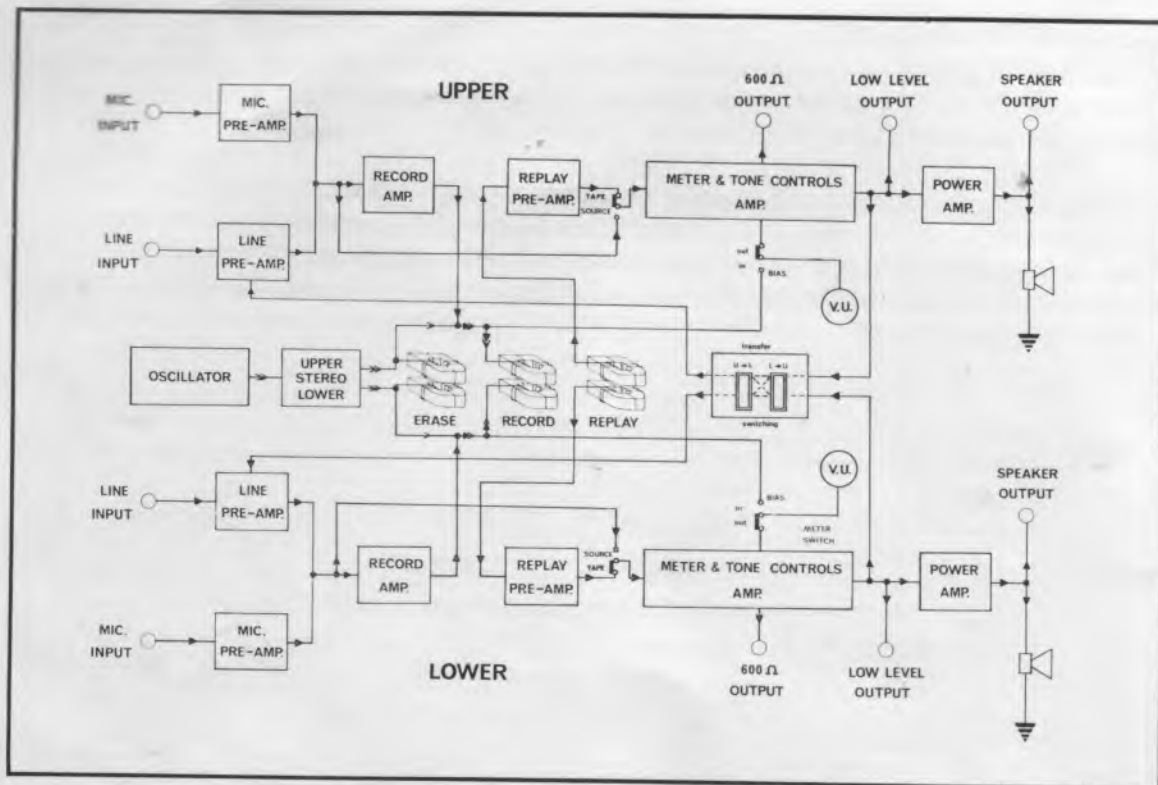


FIG. 27. BLOCK DIAGRAM

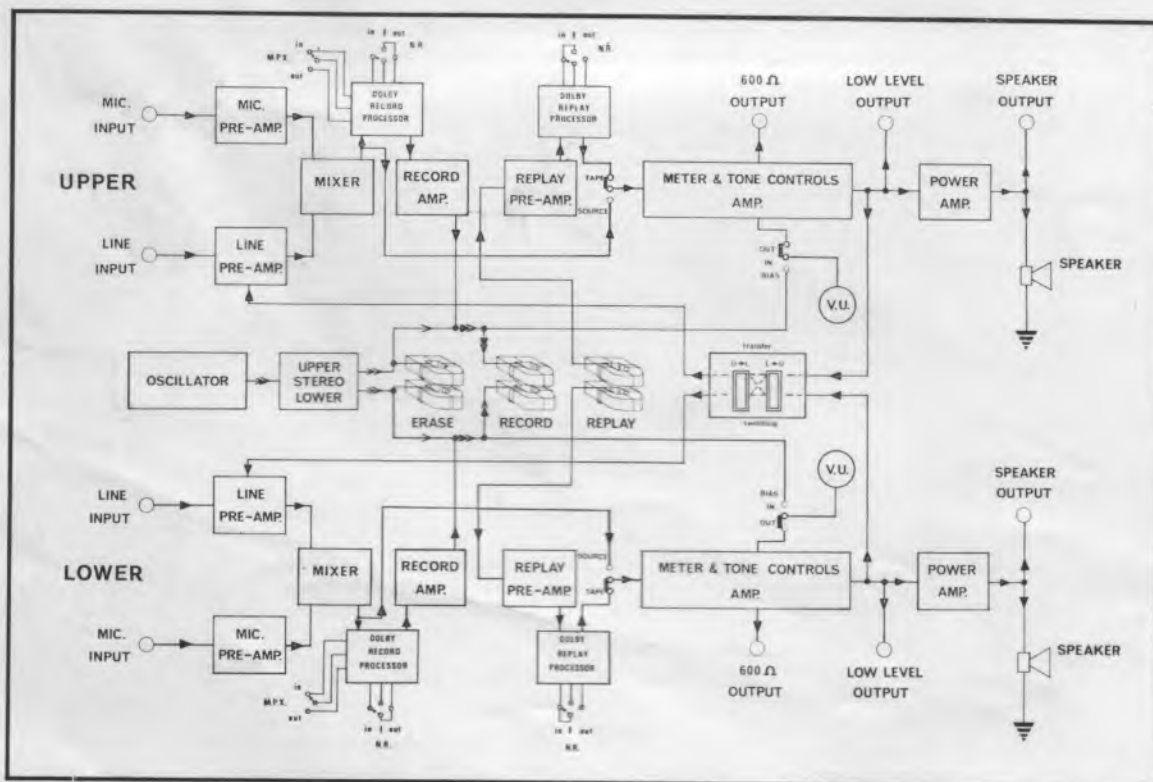


FIG. 28. BLOCK DIAGRAM—SUFFIX D MODELS

APPENDIX A

The following accessories are available for use with the Ferrograph.

Dust Cover

Attractive rigid transparent cover to protect the mechanism from dust, etc.

Deflexer

For demagnetising record and replay heads. Prevents hiss and protects tapes from cumulative background noise (see Note at front of Handbook).

Signal-Operated Switching Unit

As described in Handbook, page 35.

Foot Switch

Foot operated switch for start and stop of tape. Supplied with 6 ft. of lead with plug to fit Remote Socket (see page 35).

Remote Unit

As described in Handbook, page 34.

Microphone Matching Unit

Type TA/30/ML for use with 30/50 Ω microphone to match into medium impedance input.

Ferrotape

Long or Double Play magnetic recording tape supplied on full reels.

Low Noise—Extended Response

Type B oxide

BL7	7 in dia	1,800 ft (540 m)	BD7	7 in dia	2,400 ft (720 m)
BL8	8 $\frac{1}{4}$ in dia	2,400 ft (720 m)	BD8	8 $\frac{1}{4}$ in dia	3,600 ft (1,080 m)

Spare Tape Spools

Spools (empty)	7 in dia	—	SE7
	8 $\frac{1}{4}$ in dia	—	SE8

NAB Adaptor

Converts the reel carrier from cine-centred to NAB centred (see page 18).

Miscellaneous

The following spares can also be supplied.

Lamp Bulb	LES 14V	455—002
Fuse	1A (20 mm x 5 mm dia)	380—000
	2A (20 mm x 5 mm dia)	380—009
Set (turns counter)		060—002
(motion sensor)		060—004
Jack Plug, Screened		577—052
3 contact 'Phones'		577—011
Speaker Plug, DIN 2 pin		577—003
Auxiliary Socket Plug (7 pin DIN)		577—002
Remote Socket Plug (14 pin)		577—046

APPENDIX B

OPERATIONAL FAULT ANALYSIS

Symptoms	Possible Operational Causes
1. No meter illumination, tape does not run.	Power Supply fuse blown. Power Supply lead or plug not properly fitted.
2. Check lamp illuminated; tape does not run.	Load knob in loading position.
3. Check lamp illuminated, tape does not run; will wind but not latch.	Tape wrongly set round auto-stop.
4. Known, well recorded tape will not play; tape runs but no indication on meter.	Source button pressed. Tape incorrectly positioned in heads. Piece of splicing tape sticking on replay head. D.C. fuse blown. Replay control 'A' at minimum.
5. Tape runs, indication on meter but no sound from speaker.	Volume control at zero. Incorrectly wired plug in Speaker output. Short circuit plug in Low Level output.
6. Tape replays but with poor frequency response.	Bass and/or Treble controls incorrectly set. Accumulation of dirt or tape oxide over replay head gap.
7. With Record and Run pressed, tape erases but does not record.	Appropriate gain control incorrectly set. Input plug not properly inserted or in wrong socket. Connecting lead faulty.
8. Signal recorded but previous recording incompletely erased.	Piece of splicing tape or tape oxide covering working face of erase head.
9. Signal recorded weakly, with poor frequency response.	Tape coating outside instead of inside. Bias control 'B' turned to minimum — check by setting meter to read Bias (at 15 or $7\frac{1}{2}$ in/s).
10. Hum recorded on tape (check by changing replay speed — if hum is recorded its frequency will also change).	Microphone (and matching unit if used) in hum field. Microphone transformer or leads insufficiently screened. Microphone leads or stand not properly earthed or in contact with mains leakage paths.
11. Reel carrier appears to run hot.	It is normal for the reel carrier to feel hot to the touch.
12. Auto stop fails to operate (after built-in delay).	The contact has become covered with tape oxide. Clean the contact/guide at the end of the arm. With deck horizontal, tension control set to 'v' instead of 'h'.

APPENDIX B—continued;

Symptoms	Possible Operational Causes
13. Tape winds unevenly, especially during very fast wind.	Reels incorrectly set on carrier. Tape has stretched non-uniformly and is concave or wavy, leading to odd layers winding on at different heights.
14. Turns counter does not register or makes a clicking noise.	'Zero' button has not been reset correctly. Press button fully down.
15. When recording stereophonically, breakthrough of one track to the other.	'L→U' or 'U→L' button pressed (press again to release).
16. When recording monophonically, does not erase or record.	Record Track switch set to wrong position.

<i>Pressing</i>		<i>Gives</i>
Run	+ Pause + Wind + Rev	Pause Pause Pause
Pause	+ Run + Wind + Rev	Pause Pause Pause
Stop	+ any	Stop
Auto stop	+ Wind + Rev + any other	Wind Rev Stop
Run + Rec.	+ Wind	Pause + Rec.

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