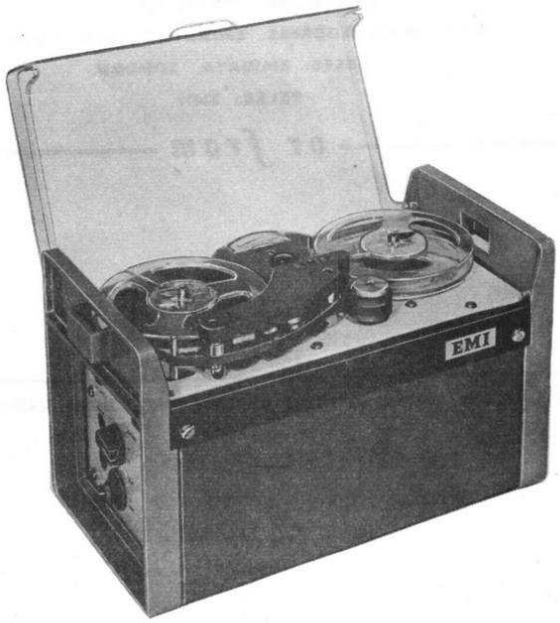
EMI

INSTRUCTION MANUAL

PORTABLE
TAPE RECORDER

TYPE L4 (SERIES)



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HAYES · MIDDLESEX · ENGLAND.

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DIAGRAMS

1. INTRODUCTION

The L4 series of tape recorders are lightweight battery operated recorders designed for applications where extreme portability is desired. The performance of these recorders is such that they can be used for high quality recording of speech and music associated with interview, television or film work.

Four separate models, designated by the suffix A, B, C or D are available as follows:-

L4A Half track machine to international standards.

L4B Full track machine to international standards.

L4C Full track machine to international standards with neopilotone synchronizing head.

L4D Half track machine to international standards with synchronizing signal recorded on lower half track.

Each of the four types listed above is also available with recording characteristics which comply with the N.A.B. recommendations, these recorders are identified by the further suffix of (N.A.B.)

The lightweight case of the machine is made of aluminium and plastic. A detachable "Terylene" shoulder strap is fastened to each end of the case.

The internal power supply for the recorder is a 14V accumulator. The machine may, however, be operated from an external 12V battery, provided the internal battery is disconnected. It may also be operated whilst the internal accumulator is being float-charged by the EMI Battery Charger Type AP403 or Type AP403A (see section 3.9). The battery charger may also provide the sync. signal source when used with the L4C and L4D models which are intended for film and television synchronous applications.

Separate record and replay channels are provided to facilitate monitoring from the tape during recording.

The tape spools are locked onto the spool platforms by two quick-release toggle levers which ensure that the spools are held firmly in place for all operating positions. Lacing the tape on the machine is kept as simple and straightforward as possible by not using pressure pads in front of the heads; the tape is brought smoothly into position

during record or replay by two ramp guides. A clear polycarbonate clip-on hinged lid is provided over the tape deck and the machine may be operated with this lid closed, thus protecting the tape deck.

The end panels of the recorder are recessed and carry all the controls while the level meter,and star indicator where applicable, are mounted on the tape deck and are visible through the transparent cover.

A single motor running at a nominal governed speed of 2450 r.p.m. provides the drive for both capstan and rewind. A choice of two speeds is provided by a stepped pulley fitted to the motor shaft and an intermediate drive idler between one of the pulley steps and the capstan flywheel. The final tape drive is achieved by using a pinch wheel and a rotating capstan.

2. SPECIFICATION

2.1 Tape Recorder

2.1.1 Physical

Height	7 in	18 cm
Length	11¾ in	30 cm
Width	5¾ in	14.5 cm
Weight	10¾ lb	4.75 Kg

2.1.2 Electrical

Power Supply	14V rechargeable battery consisting of two 6V and one 2V accumulators having a capacity of 1 ampere hour. The machine may also be operated from an external 12V battery or the special mains charger unit. (see section 4.8.a)
NOTE:	The internal battery must be disconnected when operating from an external 12V battery.
Power Consumption	The maximum operating current with the machine in the record condition is less than 300mA.
Operating Time	The machine may be operated for approximately 3 hours before the internal battery requires recharging.
Speed	7½ in/s (19 cm/s) and 3¾ in/s (9.5 cm/s) ± 1% at 14V.
Motor	14V high precision electro-mechanical governor controlled unit.
Rewind Time	Approximately 2 minutes for 4¼ in (11 cm) spool of standard tape.
Run-up Time	Approximately 1 second at 7½ in/s. (19 cm/s).

Temperature Range	+ 45°C to - 5°C. For operation down to - 10°C a lower viscosity oil should be used in bearings.
Tape	To DIN 45 513/3. issue 1962.
Tape Spools	Maximum spool diameter is 4¼ in (11 cm). The tape is wound 'oxide in'.
Recording Characteristic	To I.E.C. standard 70µs at 7½ in/s (19 cm/s) or to N.A.B. recommendations.
Overall Response	4dB envelope between 50c/s and 12Kc/s at 7½ in/s (19 cm/s).
Signal-to-Noise Ratio	Better than 50dB unweighted (30c/s to 15Kc/s), for a 200µV signal at the microphone input and the gain control set to give peak recording level, at 7½ in/s (19 cm/s).
Wow and Flutter	Better than 0.2% r.m.s. at 7½ in/s (19 cm/s). (When played back on same machine).
Input Impedance	MIC Suitable for microphones with impedance 20Ω to 60Ω.
	LINE IN Approximately 20KΩ.
Sensitivity	MIC 50µV for peak recording level.
	LINE IN 270mV for peak recording level.
Load Impedance	LINE OUT 600Ω or greater (suitable for feeding most power amplifiers).
	PHONES 50Ω or greater.

2.2 Battery Charger Type AP403 and Type AP403A

2.2.1 Physical

Length	5.5/16 in	13.5 cm
Height	2.9/16 in	6.4 cm
Width	2¾ in	7 cm
Weight	1 lb 6 oz	620 g

2.2.2 **Electrical**

Input	100V - 120V 190V - 250V	50c/s - 60c/s
Output	(i) 17V d.c.	
	(ii) Approx. 1.5V a.c. for camera sync. on L4C and L4D models	
Charging Time (Battery fully Discharged)	36 hours for full charge 12 hours for $\frac{3}{4}$ charge	
Ambient Temperature Range	-10°C to 45°C	

3. FACILITIES AND CONNECTIONS

3.1 Microphone Connections

The microphone input sockets and gain controls are located on the right-hand panel of the machine. Any low impedance (20Ω to 60Ω) microphone may be used in either position.

(a) Models with Remote Control

The MIC 1 position accommodates a microphone terminated by a balanced jack plug, the GAIN 1 control is associated with this input. The MIC 2 position accommodates a microphone terminated by a Cannon XLR-5-11C Cable socket, the GAIN 2 control is associated with this input. The MIC 2 position is intended for use with a microphone fitted with an auxiliary on/off switch which may be used to operate the tape transport from a remote position. The connections to the MIC 2 cable socket are as follows:-

Pin 1	-	Microphone lead
Pin 2	-	Microphone lead
Pin 3	-	Screen (earth)
Pin 4	-	Switch
Pin 5	-	Switch

Both microphone inputs may be used at the same time, thereby permitting the mixing of two sources.

(b) Models without Remote Control

The MIC 1 and MIC 2 positions accommodate microphones terminated by a Cannon XLR-3-31 three way cable plug. The connections to the microphone cable plugs are as follows:-

Pin 1	-	Screen (Earth)
Pin 2	-	Microphone Lead
Pin 3	-	Microphone Lead

The GAIN 1 and GAIN 2 controls adjust the gain of the MIC 1 and MIC 2 amplifiers respectively. Both microphone inputs may be used at the same time, thereby permitting the mixing of two sources.

3.2 Bass-Cut Switch

The BASS-CUT switch which is calibrated -5, -10 and 0, is located on the right-hand panel between the MIC 2 input socket and the GAIN 2 control. The switch controls the attenuation of the low frequencies recorded and is effective on both microphone inputs; the attenuation provided is 0dB, -5dB or -10dB at approximately 100 c/s, depending on the position of the slider. This facility provides compensation for the accentuated low frequency response obtained from some types of microphone when used at close range; it may also be used for reducing unwanted noises of traffic, wind etc. when making outside recordings.

3.3 Line In

The LINE IN jack is located at the centre of the right-hand panel and facilitates recording from a high level source such as radio, tape replay machine etc. The input impedance at this point is approximately 20KΩ and a 270mV signal is required to record to peak level. The GAIN controls and the bass-cut control are not operative on this input, hence the recording level must be controlled from the source.

3.4 Line Out

The LINE OUT jack, located on the left-hand panel, provides a floating output taken from the output of the replay amplifier. A pre-set gain control, within the machine, is associated with this output; this gain control has been adjusted during manufacture to provide 775mV into a 600Ω load (0dBm) when replaying a tape recorded to peak level (32mM/mm). The output at this point may be used to feed a high quality amplifier, a tape recorder input, a studio line etc.

3.5 Phones and Loudspeaker

The machine is fitted with an internal loudspeaker connected to the output of a 200mW amplifier. The gain of this amplifier is controlled by the L.S. GAIN control mounted on the left-hand panel.

The PHONES jack, located on the left-hand panel, is also connected across the output of the same 200mW amplifier.

Headphones or stethophones of 50Ω impedance, or greater, may be plugged into this jack; when the jack plug is inserted into the PHONES socket the internal loudspeaker is muted.

It should be noted that while the L.S. GAIN control affects the output at both the loudspeaker and the PHONES socket it does not control the output at the LINE OUT socket.

The output at the PHONES socket is unbalanced, it is therefore essential that the phones jack plug is wired accordingly. The plug connections are as follows:

Tip	-	inner
Ring	-	braid
Sleeve	-	braid

3.6 Function Switch

This switch, located in the centre of the left-hand panel, selects the particular function of the meter on the tape deck and of the loudspeaker amplifier. The positions on the switch are labelled BATTERY, A, B and BIAS, the particular functions of each are as follows:-

(a) Switch to BATTERY

When the switch is set to BATTERY, the state of charge of the battery is indicated on the meter on the tape deck. The pointer on the meter should be within the red section of the scale indicating a normal state of charge. If the pointer is below the red section of the scale the battery should not be used and must be recharged as soon as possible.

(b) Switch to A

When the switch is set to A the meter is switched to monitor the output from the record amplifier and indicates the recording level. The loudspeaker amplifier is also switched to monitor the output from the record amplifier.

(c) Switch to B

When the switch is set to B both the meter and the loudspeaker amplifiers are switched to monitor the output from the replay amplifier.

(d) Switch to BIAS

With the switch set to BIAS, the meter indicates the h.f. bias level when the machine is set to record.

3.7 Local/Remote or Motor On/Off Switch

(a) Models with Remote Control

The local/remote switch is located on the left-hand panel and is labelled L R. The switch should be set to L for local operation and to R for remote operation. When the switch is set to R, the auxiliary switch on the microphone connected to the MIC 2 socket may be used to control the tape transport. If the MIC 2 position is not being used then the local/remote switch may be used to control the tape transport. In this case the tape transport will be switched off when the switch is set to R, however the machine must always be switched off by means of the STOP key after recording, replaying or rewinding.

(b) Models without Remote Control

The MOTOR ON/OFF switch is located on the left-hand panel. This switch controls the power supply to the motor without affecting the supply to the electronic circuits. Care must be taken to ensure that the machine is always switched off by means of the STOP key after recording, replaying or rewinding.

3.8 Speed Switch

The SPEED switch is located on the left-hand panel and is used to select the desired tape speed. The switch is labelled 3.75 and 7.5 which indicates the tape speed in inches per second.

3.9 External Battery

The EXT.BATT. connector is located on the left-hand panel, on early models this panel mounted connector is a socket while on later models it is a plug. The internal battery may be recharged by connecting the E.M.I. Battery Charger Type AP403 or Type AP403A (see Note below) to this point. The machine may also be powered via this connector from an external 12V - 14V battery (e.g. car battery). It is essential that the internal battery be removed if the machine is to be powered from an external battery.

The EXT.BATT. connector is also used as an input point for the sync. signal on the L4C and L4D machines. The sync. signal may be derived from the battery charger; both types of battery chargers have a 1.5V secondary winding on the mains transformer for this purpose. The connections to the cable connector fitted to the battery charger are as follows:-

Pin 1	-	Sync. Input
Pin 2	-	Earth (Sync.)
Pin 3	-	Earth
Pin 4	-	- 14V
Pin 5	-	Not used
Pin 6	-	Not used

NOTE: The E.M.I. Battery Charger Type AP403 is designed for use with machines where the EXT.BATT. panel mounted connector is a socket. The Type AP403A charger is designed for use with machines where the EXT.BATT. panel mounted connector is a plug. The connections and operation are identical for both types of battery chargers.

CAUTION:- Damage may be done to the internal battery if this is not disconnected when the machine is operated from an external battery. If excessive current is passed by the internal battery, the soldered fuse link within the battery cassette will blow and must only be replaced by a single strand of 0.0076 in. tinned copper wire (36 s.w.g.).

WARNING:- The two way non-reversible plug on the battery charger is to be used only when charging the battery and must not be connected to the recorder lead.

4. OPERATING INSTRUCTIONS

4.1 Fitting the Battery Pack

The battery pack consists of a 14V "DRYFIT" accumulator fitted into a plastic case. The flexible output lead from the battery pack is terminated by a polarized connector. This connector should be mated to the similar connector located in the rectangular aperture on the underside of the recorder. When the battery connectors have been mated the battery pack should then be fitted into the rectangular aperture and secured in position by the two chromium plated captive screws. The machine is now ready for service.

4.2 Loading the Tape

The transparent plastic lid should be hinged open or completely removed and the machine positioned so that the tape heads are towards the operator.

Lift the spring-loaded levers, on the centre spindles of the spool platforms, to the upright position.

Place the reel of tape on the left-hand platform with the free tape end to the left-hand side.

Place an empty spool on the right-hand platform.

Press the spring loaded levers sideways so that they locate in one of the slots in the plastic spools.

NOTE: Failure to correctly locate these spring-loaded levers will result in erratic operation of the tape transport and may cause damage to the transparent plastic lid.

Lace the tape across the heads and between the capstan and the pinch wheel.

Locate the end of the leader tape in the slot on the right-hand spool hub and rotate the spool in an anticlockwise direction two or three complete turns so that the tape end is firmly secured.

Replace the lid.

Type L4A

The Type L4A recorder is fitted with half track heads and information is recorded on the top half of the tape only. When the recording on one track is completed the full and empty spools may be transposed on the machine and further recording made on the other track.

Type L4B

The Type L4B recorder is fitted with full track heads and information is recorded over the full width of the tape. The recording on any spool of tape is completed when all the tape has been wound onto the right-hand spool, the spools may NOT be transposed.

Type L4C

The Type L4C recorder is fitted with full track heads and information is recorded over the full width of the tape. A further neopilotone head superimposes the sync. signal on the audio recording. The recording on any spool of tape is completed when all the tape has been wound onto the right-hand spool, the spools may NOT be transposed.

Type L4D

The Type L4D recorder is fitted with a twin track record head, the audio information is recorded on the top half of the tape and the sync. signal is recorded on the lower half. The recording on any spool of tape is completed when all the tape has been wound onto the right hand spool, the spools may NOT be transposed.

4.3 Recording via Microphone

(a) Models with Remote Control

Set the function switch to BATTERY and check that the pointer on the meter is within the red section on the scale.

Load the machine with the tape to be used for the recording.

Set the L R switch to R.

Connect the microphones to the MIC 1 and/or MIC 2 inputs as required.

If the microphone connected to the MIC 2 input is fitted with an auxiliary switch, ensure that this is in the "off" position.

Set the SPEED switch to the required speed.

Set the bass-cut switch to the appropriate position, see section 3.2.

Set the function switch to A and turn the L.S. GAIN control fully anticlockwise.

Press the RECORD and REPLAY keys simultaneously and ensure that they lock down.

Apply a sample of the signal to be recorded to each microphone in turn and adjust the GAIN 1 and GAIN 2 controls so that the meter reads '0' on the signal peaks.

The machine is now ready for recording and may be used on either Local or Remote control. It is essential that the microphone connected to the MIC 2 input is fitted with an auxiliary switch if the machine is to be used on remote control.

NOTE:- The MIC 2 connector should not be inserted unless the STOP key is depressed.

(i) Local

Set the L R switch to L.
The machine is now recording.

(ii) Remote

Set the auxiliary switch on microphone 2 to the "on" position.
The machine is now recording.

If a recording is being made on local control (i.e. with the L R switch set to L) the L R switch may be used as a stop/start switch providing that the auxiliary switch on the microphone 2 is in the off position. However, when the recording is complete the machine should be switched off by pressing the STOP key.

(b) Models without Remote Control

Set the function switch to BATTERY and check that the

pointer on the meter is within the red section of the scale.

Load the machine with the tape to be used for the recording.

Set the MOTOR switch to OFF.

Connect the microphones to the MIC 1 and/or MIC 2 inputs as required.

Set the SPEED switch to the required speed.

Set the bass-cut switch to the appropriate position, see section 3.2.

Set the function switch to A and turn the L.S. GAIN control fully anticlockwise.

Press the RECORD and REPLAY keys simultaneously and ensure that they lock down.

Apply a sample of the signal to be recorded to each microphone in turn and adjust the GAIN 1 and GAIN 2 controls so that the meter reads '0' on the signal peaks.

Set the MOTOR switch to ON.

The machine is now recording.

When the recording is complete the machine should be switched off by pressing the STOP key.

Either the record signal or the replay signal may be monitored on the meter and the loudspeaker (or headphones) depending on the position of the function switch, see section 3.6. It is, however, advisable to use headphones or stethophones in preference to the loudspeaker for monitoring purposes, thus reducing the possibility of audio feedback between the loudspeaker and the microphones. It should be noted that when monitoring the replay signal (function switch to B) there will be a slight time delay between the record signal and the replay signal; the delay is the time taken for the tape to move from the record head to the replay head.

Both microphones may be used simultaneously when recording, thus making it unnecessary to pass the microphone from one person to another during an interview. If only one microphone is being used, it is essential that the gain control of the unused

microphone amplifier (GAIN 1 or GAIN 2) is turned fully anticlockwise; failure to take this precaution will result in unnecessary noise being recorded.

4.4 Recording via LINE IN

Set the function switch to BATTERY and check that the pointer on the meter is within the red section on the scale.

Load the machine with the tape to be used for the recording.

Set the MOTOR switch to OFF.
or
Set the L R switch to R.

Connect the line carrying the record signal to the LINE IN jack.

Set the SPEED switch to the required speed.

Set the function switch to position A.

Press the RECORD and REPLAY keys simultaneously and check that they lock down.

Inject a sample of the signal to be recorded and adjust the level of this signal so that the meter reads '0' on the signal peaks.

Set the MOTOR switch to ON.
or
Set the L R switch to L.

The machine is now recording.

Both the record signal and the replay signal may be monitored on the meter and the loudspeaker (or headphones) depending on the position of the function switch, see section 3.6.

The L R switch or the MOTOR switch may be used as a stop/start switch when recording via LINE IN but, when the recording is complete, the machine should be switched off by pressing the STOP key.

4.5 Erase

Erasure only takes place whilst the machine is recording i.e. when the RECORD and REPLAY keys have been pressed simultaneously.

Previous recordings are erased prior to recording by virtue of the fact that the tape moves across the erase head before the record head.

It is possible to erase recorded signals from a tape without making a further recording. This is achieved by removing all input connections, setting both GAIN 1 and GAIN 2 controls fully anticlockwise and setting the machine to the record mode.

4.6 Rewind

Set the MOTOR switch to ON

or

Set the L R switch to L.

Press the REWIND key and ensure that it locks down.

The machine will now rewind the tape from the right-hand spool to the left-hand spool. When the rewinding is complete the machine should be switched off by pressing the STOP key.

It is possible to switch the machine directly from RECORD or REPLAY to REWIND without first stopping the tape transport by means of the STOP key.

NOTE: In no circumstances should the machine be switched directly from REWIND to RECORD or REPLAY, without first stopping the tape transport by means of the STOP key.

4.7 Replay

Set the SPEED switch to the appropriate speed.

Press the REPLAY key only.

The machine is now replaying the tape and the output signal may be taken from the LINE OUT jack. Note that the replay amplifier takes approximately 5 seconds to start working, see section 5.1.5.

If internal monitoring is required:

Set the function switch to B, see section 3.6.

The output may now be monitored on the internal loudspeaker (or headphones) and on the meter.

The audio level of the signal from the loudspeaker (or headphones) may be adjusted by the L.S. GAIN control but this does not affect the signal level at the LINE OUT jack.

4.8 Battery Charging

WARNING: Irreparable damage is likely to be done to the "DRYFIT" sealed battery if it is recharged from a conventional battery charger as used for recharging car batteries etc.

It is recommended that the battery be recharged by the E.M.I. Battery Charger Type AP403 or Type AP403A. These charging units are fitted with two terminations as follows:

(a) A 6 pole connector which may be mated with the EXT.BATT. connector on the tape recorder. In the case of the Type AP403 battery charger the 6 pole cable connector is a plug, while on the Type AP403A battery charger it is a socket. The recorder may be operated whilst the charger is connected to the recorder in this manner provided that the internal battery is not removed or disconnected from the machine. In these circumstances the battery is being float-charged whilst still providing a reference voltage.

(b) A polarized two pole connector which may be mated with the connector on the battery, when it has been disconnected from the machine. In these circumstances the battery is being charged directly and the machine cannot be operated while the battery is disconnected.

4.9 Recording a Synchronizing Signal

The recorders Type L4C and L4D are equipped with the further facility of recording a sync. signal for film or television work.

The camera sync. signal, which may be at 50c/s or 60c/s, must be between 775mV and 1.5V. The signal may be derived from a suitable generator on the camera, a 3-phase rotary converter or a crystal controlled oscillator. The sync. signal must be connected between pin 1 and pin 2 (earth) on the EXT.BATT. connector. When the camera is started

the star indicator on the tape deck will close, indicating the presence of the sync. signal. The signal is then being recorded at the same time as the normal audio recording.

Alternatively, if cameras are used from a local mains supply, the E.M.I. Battery Charger Type AP403 or Type AP403A can be used as a source of the sync. signal. In this case the star indicator will close when the charger is connected, and the sync. and audio signals will be recorded simultaneously.

IMPORTANT NOTE:

When the battery charger is used as the source of the sync. signal, the charger must be disconnected as soon as the recording has been made. If the sync. signal is left connected when rewinding or replaying, the original recording of the sync. signal will be destroyed.

5. TECHNICAL INFORMATION

5.1 Circuit Description

Printed wiring cards are used throughout the machine and the latest semiconductor techniques are employed. Separate record and replay channels permit continuous monitoring of the recorded signal which may be derived from the microphone amplifier, a studio line, an f.m. tuner or other high level source. Two microphone inputs are provided and have separate gain controls for mixing the signals from two low impedance microphones.

5.1.1 Microphone Amplifiers (Fig. 7)

The two electrically similar microphone amplifiers are constructed on a common printed wiring board. Each amplifier consists of an input transformer and three d.c. coupled transistor stages which comprise two stages of voltage amplification and an output stage; overall feedback is provided between the output and the emitter of the first stage. The gain of the amplifier is controlled by a variable resistor mounted on the right-hand side panel of the recorder (GAIN 1 or GAIN 2 control); this control provides up to 30dB variation in the gain.

The outputs from the two amplifiers are taken from a common output point and fed to the record amplifier via the bass-cut circuits selected by the switch mounted on the right-hand panel. The bass-cut switch selects 0dB, 5dB, or 10dB of attenuation at approximately 100c/s and may be employed for reducing the bass emphasis inherent in certain types of microphone when used at close range.

5.1.2 Record Amplifier (Fig. 8)

The three transistor record amplifier is employed to amplify the signal derived either from the microphone amplifiers or the LINE IN jack and to provide the necessary equalization to feed the record head. An output is taken, via pin D3, from the emitter circuit of the first stage; this output provides the input signal to the monitor and meter amplifiers when the function switch on the left-hand panel is set to "A".

5.1.3 Bias and Erase Oscillator (Figs.11 & 13)

The oscillator frequency is approximately 50Kc/s on the early L4A models and approximately 55Kc/s on all other models. The actual frequency is determined by the capacitance of C2, the inductance of T1, and the inductance of the erase head. Tapped windings on the transformer are used to provide the optimum bias voltage for the record head and optimum erase voltage for the erase head. A pre-set potential divider and transistor (RV4 and VT1 Figs.21 & 22) in conjunction with the voltage stabilizer MR1 (Figs.11 & 13) enable the bias voltage to be varied. The current taken by the oscillator and hence the bias level may be monitored on the meter via the contacts D18 and D2 when the function switch is set to BIAS (see section 3.6).

5.1.4 Loudspeaker and Meter Amplifiers (Fig. 15)

The loudspeaker and meter amplifiers are built on a common printed wiring board. The input signal to these amplifiers is derived from either the record amplifier or the replay amplifier depending on the position of the function switch (see section 3.6.)

The L.S. GAIN control potentiometer mounted on the left-hand panel of the machine controls the level of the input signal to the three transistor loudspeaker amplifier. The single-ended, push-pull, class B output stage of the loudspeaker amplifier delivers 200mW into the 65Ω loudspeaker. Headphones of at least 50Ω impedance may be operated from this output stage by connecting them to the PHONES jack on the left-hand panel. It should be noted that the internal loudspeaker is muted when the headphones are connected to the PHONES jack.

The meter amplifier drives the level meter and has a pre-set gain control which is adjusted so that the meter reads '0' on the scale for a peak level signal (32mM/mm). The meter bridge-rectifier is connected in the feedback loop of the amplifier thus ensuring linearity of the meter scale for all signal levels.

5.1.5 Replay Amplifier (Fig. 17)

The replay amplifier derives its input from the replay head and, after amplification and equalizing, provides the output signal at the LINE OUT socket. The input circuit to VT1 is provided with

a long time-constant which ensures that the replay head does not become magnetized when the amplifier is switched on or off. The effect of this long time constant is that the amplifier must be switched on approximately five seconds before it is ready for use. Positive feedback is applied to the first stage at the higher frequencies, thus increasing the amplifier input impedance at these frequencies. The negative feedback provides the necessary equalization to the I.E.C. or N.A.B. recommendations, as appropriate, at a tape speed of $7\frac{1}{2}$in/s (19cm/s). A pre-set gain control RV1, permits the gain of the amplifier to be adjusted; this is normally set during manufacture to provide an output of 775mV into 600Ω (0dBm) when replaying a peak level tone at 1Kc/s at a flux of 32mM/mm on the tape.

5.1.6 Filter Unit (Fig. 19)

The filter unit incorporates two transistor filters, VT1 and VT2, which eliminate any hum or noise present on the supply lines to the replay and record amplifiers respectively. The circuit between D15 and D16/D14 is an adjustable bias rejection filter which ensures that the bias is not fed into the record amplifier.

The resistor R3 within the filter unit is connected between tags D18 and D2 on the bias and erase oscillator and stabilizer board and constitutes the meter shunt when the meter is switched to monitor the bias and erase oscillator current. The resistors R1 and R2 provide the series resistance for use in the meter circuit when the meter is used to check the state of charge of the battery.

5.1.7 Neopilotone Synchronizing System

The Type L4C tape recorder is designed for film and television applications where accurate synchronization is required. The signal from the microphone is recorded in the normal manner by a full track recording head. The sync. signal, derived from the camera and bearing a fixed relationship to the frame frequency, is superimposed on the recording of the audio signal by the neopilotone head. This recording head lays down two narrow tracks in antiphase near the centre of the tape.

When replaying the audio signal the magnetic flux from the two antiphase tracks cancel in the replay head and no output is produced by the sync. signal.

The sync. signal can be obtained from the tape by other equipment fitted with a neopilotone replay head, the signal is then used to synchronize the audio track on the tape with a film projector.

5.1.8 Twin Track Synchronizing System

The Type L4D tape recorder is designed for film and television applications where accurate synchronization is required. The signal from the microphone is recorded in the normal manner on the upper track of the tape. The sync. signal, derived from the camera and bearing a fixed relationship to the frame frequency, is simultaneously recorded on the lower track of the tape.

When the tape is later replayed on equipment fitted with a twin track replay head, the sync. signal is used to synchronize the audio track with a film projector.

5.1.9 Battery Charger Type AP403 and Type AP403A

The "DRYFIT" batteries fitted to these tape recorders are miniature lead-acid accumulators with a solidified jelly-like electrolyte. The batteries are fitted with electrolyte-proof gassing valves to prevent excess pressure inside the case if the battery is overcharged. Since the amount of water contained in the electrolyte is limited, the life and possible number of charging cycles of the battery depend to a very large extent on the use of a suitable charging system.

The Battery Chargers Type AP403 and AP403A have been designed for this purpose and will reduce the charging current to a few micro-amperes when the gassing voltage has been reached. This very low charging current compensates for any self-discharge under these conditions.

The 19V secondary winding on the mains transformer is bridge rectified and smoothed by MR1 and C1 respectively.

The zener diode, MR2, provides the reference voltage for VT1 in the stabilizer circuit. A sample of the output voltage, taken from the slider of the potentiometer RV1, is fed to the base of VT1 and thus controls the current through VT2. Any change in the output voltage therefore causes a signal to be fed to the base of VT2 in such a phase as to oppose the original change. The potentiometer, RV1, is adjusted during manufacture to accurately set the open circuit output voltage to 17.5V. The diode MR3 prevents the battery discharging through the battery charger if the mains supply is disconnected; the resistor R2 limits the charging current to a safe level when connected to a fully discharged battery.

A further 1.5V secondary winding is provided on the mains transformer. This winding provides a sync. signal when the battery charger is used with models L4C or L4D tape recorders.

5.2 Mechanical

The drive is provided by a 12V - 16V d.c. motor. The nominal operating speed of the motor is 2450 r.p.m. and this is controlled by an electro-mechanical governor.

The drive between the motor and capstan flywheel is achieved via an intermediate rubber drive idler. The drive ratios have been carefully selected to provide a mechanical servo action on the idler drive in order to reduce slip and compensate for any slight variations of load. Two tape speeds are provided and the particular speed required is selected by the SPEED switch on the left-hand side panel of the machine. A stepped pulley is fitted to the motor shaft and when the SPEED switch is operated the intermediate idler is brought in line with the upper or lower diameter of this pulley as required.

Power rewind is provided by means of a second drive idler. When the REWIND key is pressed a spring engages this idler with the motor pulley and the drive is transmitted to the left-hand spool shaft by means of a belt.

The final tape drive is achieved in a conventional manner using a pinch wheel and rotating capstan; this drive also utilizes the mechanical servo principle which reduces slip and

the operating pressure required on the key. The pinch wheel, which is constructed of a meterial possessing outstanding mechanical properties, has been accurately aligned with the capstan to ensure a positive drive to the tape.

The right-hand spool is driven at the appropriate speed by a belt drive from the flywheel via a slipping clutch. The clutch has been correctly adjusted during manufacture, and should not normally require further attention.

An automatic mechanical tape tensioning device is incorporated on the left-hand spool shaft. This control maintains a constant tape tension throughout the entire tape length and is actuated by sensing the change of lap angle made by the tape around a pin. As the tape runs off this spool the angle of lap around this pin increases causing it to be deflected sufficiently to release a mechanical brake on the spool shaft. The use of this method of tensioning obviates the need to use pressure pads on the heads, thus facilitating easy loading of the tape and greatly reducing the wear on the heads. The record and replay heads are fully adjustable for lap, tilt, height and azimuth, these are set to the correct working position during manufacture.

Oil loaded, sintered bronze, self aligning bearings are used for the capstan and spool shafts while dry plastic bearings are used for the drive idlers. The use of the dry plastic bearings, which do not require lubricating, removes the risk of any lubricant leaking onto the driving surfaces. Protective finishes applied to the components make the machine satisfactory for operation under tropical conditions.

The key switches on the right-hand side panel of the machine performs the following mechanical functions.

REPLAY	Engages pinch wheel and tension control.

RECORD	Engages electrical interlock. NOTE: In order to operate the machine in the record mode, both the REPLAY and RECORD keys must be pressed simultaneously.
REWIND	Engages rewind idler.
STOP	Engages flywheel brake. Engages clutch brake. Disengages main drive idler and pinch wheel to prevent flats forming on tyres.

6. MAINTENANCE

6.1 Test Equipment

The following equipment is necessary to carry out the tests and adjustments detailed.

1. An oscillator with an output that may be varied from -40dBm to 0dBm into 600Ω over the range 30c/s to 20Kc/s.
2. An a.f. voltmeter capable of measuring voltages over the range 1.5mV to 150V.
3. A high pass filter having its 1dB point at 30c/s with an ultimate slope of 30dB per octave. (Fig.1A). Alternatively a filter giving substantially correct results is given in Fig.1B.
4. A band stop filter tunable to the bias frequency (40 - 60Kc/s). Details of a suitable unit with Part Nos. are given in Fig.1C.
5. E.M.I. Frequency Test Tape Type SRT18/4, or to DIN 19, issue 1962). (For neopilotone type SRT22 will also be required).
6. A $4\frac{1}{4}$ in (11cm) spool of standard play tape to DIN 45 513/3 issue 1962.
7. A demagnetiser.
8. A spring balance or tension gauge capable of reading over a range of 300g - 500g.
9. A spring dial-gauge 0 - 50 g.

In order to facilitate some of the tests and adjustments, it may be found advantageous to use an oscilloscope with a maximum sensitivity of at least 1mV/cm, a high quality loudspeaker and an audio amplifier with a sensitivity of approximately 500mV for full output.

6.2 Electrical

6.2.1 General

The following instructions are intended to provide a check on the performance of the recorder at $7\frac{1}{2}$in/s (19cm/s) and to facilitate the resetting of any adjustment that may have become disturbed. The recorder has been accurately set up during manufacture and pre-set adjustments should not be disturbed unless it is definitely established that re-adjustment is required. The STOP key should

be depressed after each check. The BASS CUT switch should be set to the 0 position unless otherwise stated.

6.2.2 Care of the Test Tape

Before a test tape is used, the heads and any tools that may be required to adjust the heads should be de-magnetised. To ensure that a fault condition liable to damage the test tape does not exist, an unwanted recording should be played back and only if this tape is unaffected may the test tape be used.

6.2.3 Replay Amplifier

Connect a 600Ω load and a.f. voltmeter across the LINE OUT socket.

Load the recorder with the test tape.

NOTE: The appropriate corrections must be made when checking N.A.B. recorders (see section 6.2.15).

Play the 1Kc/s peak level band on the tape and check that the voltmeter reads 775mV (0dBm). If necessary adjust the pre-set gain control, RV1 on the replay amplifier, to obtain this level. Set the function switch to B and check that the level meter reads '0'. To correct, adjust RV1 on the loudspeaker and meter amplifier board; this control is accessible through a hole in the chassis. (Item 5 Fig.4).

Play the frequency response section of the test tape, recorded at 20dB below the peak level band, and check that the response over the band 30c/s to 12Kc/s lies within a 4dB envelope. If the response is not within these limits, particularly at high frequencies, the head alignment should be investigated.

6.2.4 Head Alignment

(a) Height

(i) Half track. Slacken the clamping nut Item 1 Fig.2 as required. Check that the head pole pieces extend 0.3mm above the top edge of the tape with the recorder in the replay mode. If necessary adjust by turning the three screws A, B, & C Fig.2 equal amounts in the same direction.

(ii) Full track and twin track. Set the head pole pieces visually by turning the three screws A, B, & C Fig.2 equal amounts in the same direction so that the tape covers the pole pieces symmetrically.

(iii) Neopilotone. Replay the neopilotone section of the test tape and adjust the height of the head by turning the three screws A, B, & C Fig.2 equal amounts in the same direction until the maximum reading is obtained on a meter connected between pins 6 and ET1 on TB1 (Fig.22).

NOTE: The reading should be not less than 40µV.

(b) Lap Angle

The lap angle of the record, replay, neopilotone and twin track heads is adjusted by rotating the head platform around its mounting stud. A special tool may be used for making this adjustment. The head should be set so that the angle at which the tape approaches the head is approximately equal to the angle at which the tape leaves the head, ensuring that the tape does not touch the head screening cover. Final lap adjustment of the replay head must be made when replaying the 10Kc/s azimuth band on the test tape. Likewise, the record head lap must be adjusted when recording at 10Kc/s. Lap is the only adjustment provided for the erase head which should be rotated about its centre fixing screw until the side of the head is parallel with the side of the mounting block.

(c) Tilt.

The record, replay, neopilotone and twin track heads may be adjusted for tilt by means of the screws A and B. Fig. 2 on each head platform. The replay head should be set so that its front face lines up with the capstan guide and the record head should then be aligned to the face of the replay head. Where a neopilotone head is fitted, the record head should be aligned to the face of the neopilotone head which must first have been aligned to the face of the replay head.

(d) Azimuth

The azimuth adjustment for the record, replay, neopilotone and twin track heads is provided by the single screw to the left of each platform clamping nut, screw C Fig. 2 . Replay head azimuth should be adjusted when replaying the 10Kc/s azimuth adjustment band of the test tape, for maximum output and minimum fluctuations. After an

initial setting has been found the lap angle should be adjusted to determine whether a further increase in level can be obtained, after which the azimuth should again be adjusted for maximum. These two adjustments are to some extent, interdependent and should therefore be made alternately until no further increase in output can be obtained. Finally, retighten the clamping nut. Only visual adjustment is necessary for azimuth alignment of the neopilotone head.

6.2.5 Replay Amplifier Response

Having carried out the procedure outlined in 6.2.3 and 6.2.4 the replay response should be rechecked. If the high frequencies are found to be outside the 4dB envelope, the capacitor C1 may be altered. Its value should be increased if the response is down and reduced if the response is up. If the response is out of limits the replay head should be examined.

6.2.6 Replay Noise

Connect the high pass filter between the LINE OUT socket and the a.f. voltmeter. The output impedance of the recorder is approximately 40Ω. If the high pass filter in question is a 600Ω device, the output impedance will have to be raised to 600Ω by connecting a 560Ω resistor between the recorder output and the input to the filter, see Fig.1A. If a high pass filter of the required characteristics is not available, substantially correct results will be obtained by using the resistance capacitance arrangement depicted in Fig.1B.

Play the 1Kc/s peak level section of the test tape and note the a.f. voltmeter reading. Remove the test tape and allow the recorder to run without tape. Check that the noise level indicated is more than 54dB below the level obtained from the peak level band of the test tape. Remove the filter.

6.2.7 Record Channel

Connect the bandstop filter between the LINE OUT socket and the a.f. voltmeter, see Fig.1C. Load the recorder with blank tape. Set the L R switch to R, or the MOTOR switch to OFF as applicable. Press the RECORD and REPLAY keys simultaneously. Set the function switch to BIAS. Set the bias level control (RV4 on the main chassis) to maximum, checking that the level meter

reading steadily increases when the control is advanced from minimum to maximum.

Tune the bandstop filter to give minimum bias breakthrough to the a.f. voltmeter.

Connect the a.f. voltmeter or an oscilloscope between pin D16 and pin D5 (chassis) on the filter unit. Adjust C1 on the filter unit for minimum bias breakthrough at this point.

Remove the oscilloscope or a.f. voltmeter and reconnect the a.f. voltmeter to the output circuit. Inject a 10Kc/s signal at a level of approximately 100mV at the LINE IN socket. Set the L R switch to L, or the MOTOR switch to ON as applicable.

Adjust the record head lap and azimuth (see 6.2.4) for maximum output. This critical setting of lap and azimuth produces minimum variation of the output meter reading. This is the correct setting.

Adjust the bias level for maximum output at 10Kc/s. Increase the bias level until the output has fallen by 5dB for full track or 8dB for half track and twin track.

6.2.8 Record Frequency Response

Load the recorder with blank tape and set to the record mode.

Set the function switch to B. Inject a 1Kc/s signal at the LINE IN socket. Adjust the level of the input signal to produce a reading of '0' on the level meter.

Check that the input level is now 270mV $\pm$ 30mV. Set the function switch to A and check that the meter reads approximately 0.

Reduce the level of the input signal by 20dB and maintaining this level make recordings at each test tape frequency from 60c/s to 12Kc/s. Compare the overall response with the replay resonse obtained in 6.2.3 to determine the record response which should be within a 4dB envelope.

6.2.9 Record Amplifier Adjustment

If the record response as measured in 6.2.8 is unsatisfactory at the highest frequencies, the capacitor C8 may be changed. A greater capacitance will result in increased high frequency response.

C8 will have little effect below approximately 8Kc/s. If the response in the region of 4Kc/s-8Kc/s needs to be adjusted, the value of C3 may be changed slightly, an increase of value again producing greater gain within this band.

R4 may be adjusted to compensate for small differences in head sensitivity in the event of a record head being replaced. The record head should be examined if the response is still out of limits at high frequencies.

All L4B, C and D and some L4A models are fitted with the bias and erase oscillator board 9A/C322014A. When replacing a record head it will be necessary to adjust the bias level tapping on the board as follows:-

Wire pin D15 on the filter unit initially to pin D4 on the oscillator board. If the bias level control reaches its maximum setting before the correct reading is obtained, pin D15 on the filter unit must be rewired to pin D5 on the oscillator board and the procedure repeated. Pin D9 and finally pin D13 on the oscillator board must be used if necessary to achieve this condition.

It is important for battery economy that the bias level control is as near to its maximum position as possible, hence the tapping used for the record head should be the lowest voltage tap possible consistent with the correct overbias being obtained. Following the above procedure should result in this.

Other L4A recorders use the bias and erase oscillator board 9A/C322014 on which there are no adjustable taps.

6.2.10 Microphone Amplifiers

Load the recorder with blank tape and set to the record mode with the function switch set to B.

Inject a 1Kc/s signal at a level of 500V at the MIC.1 socket and check that the meter reads '0' when the GAIN 1 control is at or near its maximum position. Repeat for MIC.2/GAIN 2.

6.2.11 Erase Check

Record a passage of music at peak level. Remove the input signal and terminate the LINE IN socket in 600Ω. Rewind the tape.

Set the recorder to the record mode. Check that the signal is erased to a level below that of the tape and amplifier noise.

6.2.12 Signal to Noise

Load the recorder with blank tape and set to the record mode. Connect the a.f. voltmeter via the high pass filter or alternative resistance capacitance network to the LINE OUT socket. Inject a 1Kc/s signal at a level of 200μV at the MIC.1 socket. Set the GAIN 2 control to minimum and with the function switch set to A adjust the GAIN 1 control so that the level meter on the deck reads '0'. Note the output on the a.f. voltmeter. Remove the input signal and terminate both MIC.1 and MIC.2 inputs with 30Ω resistors.

Record a length of tape under these conditions. Rewind and replay the noise section of the tape. Measure the noise at the LINE OUT socket with the a.f. voltmeter. It should be 50dB or more below the level of the recorded signal.

Repeat the above procedure with the input connected to MIC.2 socket and with the GAIN 1 control set to minimum.

NOTE: It is essential to use a suitable high pass filter when making all noise measurements in order to prevent the level meter reading noise components outside the audio spectrum.

6.2.13 Sync. Performance-Neopilotone

Ensure that the height of the head has been correctly set as described in 6.2.4.(a)(iii). Load the recorder with blank tape. Insert a signal of 1.5V, 50c/s on pins 1 and 3 (chassis) of the external battery connector and check that the star indicator closes.

Set the input signal to 1V and make a neopilotone recording. Remove the input signal. Rewind the tape and replay to ensure that a satisfactory recording has been made. The replay signal measured as in 6.2.4(a)(iii) should be greater than 40μV.

6.2.14 Sync. Performance - Twin Track

Load the recorder with blank tape and insert a signal of 1.5V 50c/s on pins 1 and 3 (chassis) of the external battery connector and check that the star indicator closes. Reset the 50c/s input

Signal to 1V and make a recording. Remove the input signal and transpose the spools. Replay the sync. signal, now on the upper track, to ensure that a satisfactory recording has been made. The replay signal at LINE OUT is nominally 12dB below peak level.

6.2.15 I.E.C. to N.A.B. Standard Conversion

The table below shows the conversion from a 70µs at 7½in/s (19 cm/s) tape to the equivalent N.A.B. standard. The readings shown are those which will be obtained from a correctly equalized N.A.B. replay amplifier when using a 70µs I.E.C. test tape.

Frequency c/s	Level dB
31.5	-4.9
40	-3.9
63	-1.8
125	-0.2
250	+0.2
500	+0.2
1K	0
2K	-0.7
4K	-1.6
6.3K	-2
8K	-2.2
10K	-2.3
12.5K	-2.4
14K	-2.4
16K	-2.5
18K	-2.5

6.3 Mechanical

6.3.1 Pinch Wheel Alignment

The correct alignment of the pinch wheel is achieved by adjusting the pinch wheel shaft Item 4 Fig.3 to be parallel to the capstan in both planes. This adjustment is made by means of the two screws which clamp the shaft to the pinch wheel arm assembly.

6.3.2 Pinch Wheel Adjustment

Set the drive idler kick-out spring Item 10 Fig.3 in the fourth hole from the pinch wheel shaft.

Set the drive idler engage springs Item 4 Fig.4 in the first and second holes from the tag fixing screw.

Connect the battery supply, select the lower tape speed and press the REPLAY key. Press the STOP key and check that the drive idler is fully disengaged from the motor pulley. Repeat for the higher speed.

NOTE: The flywheel brake should stop the flywheel in approximately 1 second when the machine has been running at $7\frac{1}{2}$in/s (19cm/s).

Press the REPLAY key.

Hold the pinch wheel off the capstan with the aid of a tubular spring balance hooked round the pinch wheel shaft and held perpendicular to the front edge of the deck.

Ease the pinch wheel towards the capstan and check that the reading on the spring balance is 400g $\pm$ 50g when the pinch wheel just starts to rotate.

The pinch wheel pressure and flywheel brake position may be adjusted by sliding the spring pillar Item 3 Fig.3 along its slotted mounting hole. The clearance between the REPLAY key and the top of the key slot is between 1/32in and 1/16in. (0.8mm and 1.6mm).

6.3.3 Tape Tension

(a) Take-up Tension

Connect the supply and set the speed to $7\frac{1}{2}$in/s (19cm/s).

Check the clearance visually between the top clutch plate and the upper deck bearing bush. This should be approximately 0.02in (0.5mm). Load an empty spool on the take-up platform. Set up the dial gauge in the spool tape loading slot approximately 1 in. (2.5cm) from the centre. Press the REPLAY key and take a reading on the gauge. The correct value lies between 12g and 15g. The tension can be raised or lowered by adjusting the collet Item 1 Fig.3 up or down on the take-up spool shaft.

(b) Back Tension

Press REPLAY key and check with the dial gauge that the maximum pressure exerted by the back tension pin Item 7 Fig.3 when fully deflected towards the head block is 36g ± 4g. The tension can be corrected by resetting the angle of the bracket Item 8 Fig. 3 . The pin should be approximately 1/16 in. (1.6mm) from the left hand side of the slot when at the start of a $4\frac{1}{4}$ in. (11cm) spool of tape. The back tension pin deflection can be adjusted by a screw Item 6 Fig.3.

6.3.4 Motor

The motor speed and tape speed have been accurately set during manufacture for operation at $7\frac{1}{2}$ in/s (19cm/s) and adjustment is not normally required. After 500 hours use, however, it is advisable to examine the brush gear as follows:-

Remove the two brass screws Item 4 Fig. 5 from the base moulding of the motor. Remove the connecting leads from their terminals and remove the moulding complete with the brushes, taking care not to damage adjacent components. If the wear has been such that the remaining visible portion of the brushes is less than 1/64 in. (0.4mm) the brush plate assembly should be renewed. If still in a satisfactory condition the original assembly may be refitted after removal of dust. When replacing the assembly two pins must be inserted in the holes in the end moulding to spread the brush arms clear of the commutator. Ensure that the brass screws align correctly with the motor body and that the electrical connections are replaced in their original positions.

The tape speed can be checked by means of a strobe tape of known accuracy.

If after long periods of use the tape speed is found to be outside the specified limits (± 1%) it can be corrected by replacement of the motor pulley with either of the alternatives given in the compcnents list.

NOTE: (i) Replacement of the pulley results in a change of speed of 1%. If the speed is showing excessive variation from end to end of the tape and no mechanical fault is present, the motor should be replaced.

(ii) All motor speed checks should be carried out with 14V input, measured under load conditions.

WARNING: Do not attempt to change the motor pulley unless it is certain that there is no other mechanical fault on the deck. Wrong clutch tension or oiling idlers may affect the tape speed. In no circumstances should the armature be removed from the motor, nor should the motor be brought under the influence of a strong magnetic field.

6.3.5 Wow and Flutter

Load the recorder with a $4\frac{1}{4}$in (11cm) spool of new tape.

Connect a wow and flutter meter to the LINE OUT socket. Inject a 3Kc/s signal at approximately 200mV at the LINE IN socket.

Set the L.S. GAIN control to minimum.

Set the recorder to the record mode and check the wow and flutter on the meter.

The reading should be better than 0.2% r.m.s. at $7\frac{1}{2}$ in/s (19cm/s) and better than 0.3% r.m.s. at $3\frac{3}{4}$in/s (9.5cm/s).

6.3.6 Lubrication

Great care should be taken when lubricating any of the following parts to ensure that any surplus lubricant does not get on to the rubber-tyred idler wheels, the capstan, the pinch wheel, the belts, and the drive drums. The drive will be seriously affected if all these items are not kept entirely free from oil and grease. The only parts which may need lubrication are listed below and under normal conditions only two or three drops of oil are necessary. The recommended oil is light oil with Bardahl additive E.M.I. Part No.2M/929.

(a) Capstan

The top bearing may be lubricated by laying the recorder on its side and injecting a few drops of oil into the felt pad retained by the bearing clamp.

If it should be necessary to lubricate the lower bearing, it should be removed from the chassis and oiled through the bearing hole.

(b) Motor

Under normal conditions it should not be necessary to lubricate the motor. However, if lubrication is necessary a few drops of oil should be injected into each bearing, the use of a hypodermic syringe is a convenient method of lubricating these bearings.

(c) Idler Wheels, Spindles and Pivots

The idler wheel bearings are made from a low friction plastic material and run virtually dry without the addition of a further lubricant.

The spindles and pivots have been lightly greased during manufacture and should not normally require further lubrication.

The grease used and recommended where necessary is Bardahl lithium based grease E.M.I. Part No.2M/1025.

6.3.7 Routine Cleaning

Before loading the tape, check that the heads, guides and capstan are clean and free from oxide. This may normally be removed with a soft, non-fluffy cloth. Methylated spirit may be used sparingly where necessary.

7. COMPONENT LIST

Reference		Description			Manufacturers Ref.	E.M.I. No.
7.1 Microphone Amplifiers						
Resistors						
R1	(H)	24K	1%	1/8W	Welwyn C20	25111-015-524
R2	(H)	1.2K	1%	1/8W	Welwyn C20	25111-015-412
R3	(H)	2K	1%	1/8W	Welwyn C20	25111-015-420
R4	(H)	1.5K	1%	1/8W	Welwyn C20	25111-015-415
R5	(H)	12K	1%	1/8W	Welwyn C20	25111-015-512
R6	(H)	39K	1%	1/8W	Welwyn C20	25111-015-539
R7	(H)	4.7K	1%	1/8W	Welwyn C20	25111-015-447
R8	(H)	4.7K	1%	1/8W	Welwyn C20	25111-015-447
R9	(H)	10	5%	1/8W	Welwyn C20	25111-013-210
R21	(H)	24K	1%	1/8W	Welwyn C20	25111-015-524
R22	(H)	1.2K	1%	1/8W	Welwyn C20	25111-015-412
R23	(H)	2K	1%	1/8W	Welwyn C20	25111-015-420
R24	(H)	1.5K	1%	1/8W	Welwyn C20	25111-015-415
R25	(H)	12K	1%	1/8W	Welwyn C20	25111-015-512
R26	(H)	39K	1%	1/8W	Welwyn C20	25111-015-539
R27	(H)	4.7K	1%	1/8W	Welwyn C20	25111-015-447
R28	(H)	4.7K	1%	1/8W	Welwyn C20	25111-015-447
R29	(H)	10	5%	1/8W	Welwyn C20	25111-013-210
		(H) = High Stability				
Capacitors						
C1		160µ		2.5V	Mullard C426AR/A160	26526-069-006
C2		Not used				
C3		160µ		2.5V	Mullard C426AR/A160	26526-069-006
C4		47p ± 2p		125V	Salford Elec.PF/AA	26634-507-247
C21		160µ		2.5V	Mullard C426AR/A160	26525-069-006
C22		Not used				
C23		160µ		2.5V	Mullard C426AR/A160	26525-069-006
Transformers						
T1		Transformer			E.M.I.	9A/B5690
T21		Transformer			E.M.I.	9A/B5690

Reference		Description			Manufacturers Ref.	E.M.I. No.
Transistors						
VT1					Texas Inst. D661	28381-001-072
VT2					Texas Inst. D661	28381-001-072
VT3					Texas Inst. 2N1302	28381-002-001
VT21					Texas Inst. D661	28381-001-072
VT22					Texas Inst. D661	28381-001-072
VT23					Texas Inst. 2N1302	28381-002-001

7.2 Record Amplifier

7.2.1 Type L4A

Resistors

R1	(H)	100K	2%	¼W	Electrosil TR5	25191-034-610
R2	(H)	100K	2%	¼W	Electrosil TR5	25191-034-610
R3	(H)	4.3K	2%	¼W	Electrosil TR5	25191-034-443
R4	(H)	1.3K	2%	¼W	Electrosil TR5	25191-034-413
R5	(H)	100	2%	¼W	Electrosil TR5	25191-034-310
R6	(H)	6.8K	2%	¼W	Electrosil TR5	25191-034-468
R7	(H)	6.2K	2%	¼W	Electrosil TR5	25191-034-462
R8	(H)	6.2K	2%	¼W	Electrosil TR5	25191-034-462
R9	(H)	1K	2%	¼W	Electrosil TR5	25191-034-410
R10	(H)	27K	2%	¼W	Electrosil TR5	25191-034-527
R11	(H)	27K	2%	¼W	Electrosil TR5	25191-034-527
R12	(H)	1K	2%	¼W	Electrosil TR5	25191-034-410
R13	(H)	10K	2%	¼W	Electrosil TR5	25191-034-510

(H) = High Stability

Capacitors

C1	(E)	40µ		16V	Mullard C426AR/E40	26526-065-840
C2	(E)	40µ		16V	Mullard C426AR/E40	26526-065-840
C3		0.015µ		160V	Mullard C296AR/A15K	26624-804-515
C4	(E)	6.4µ		2.5V	Mullard C426AR/F6.4	26526-069-764
C5	(E)	160µ		2.5V	Mullard C426AR/A160	26526-069-006
C6	(E)	40µ		16V	Mullard C426AR/E40	26526-065-840
C7		1µ	10%	160V	Mullard C281AB/A1M	9A/A15645
C8		1500p	2%	125V	Salford Elec.PF/AB	26634-502-415
C9	(E)	10µ		2.5V	Mullard C437	26526-099-810
C10		270p	5%	125V	Salford Elec.PF/AA	26634-503-327

(E) = Electrolytic

Reference		Description			Manufacturers Ref.	E.M.I. No.
Transistors						
VT1					Texas Inst. 2G387	28381-001-091
VT2					Texas Inst. 2G387	28381-001-091
VT3					Texas Inst. 2N1302	28381-002-001

7.2.2 L4A(NAB)

Same as Type L4A, see section 7.2.1., with the following exceptions:-

Capacitors						
C3		0.033μ	10%	160V	Mullard C296AA/A33K	26624-804-533
C8		680p	2%	125V	Salford Elec. PF/AB	26634-502-368

7.2.3 Type L4B

Same as Type L4A, see section 7.2.1, with the following exceptions.:-

Resistors						
R4	(H)	1.1K	2%	¼W	Electrosil TR5	25191-034-411
Capacitors						
C8		680p	2%	125V	Salford Elec. PF/AB	26634-502-368

7.2.4 Type L4B(NAB)

Same as Type L4A, see section 7.2.1., with the following exceptions:-

Resistors						
R4	(H)	1.1K	2%	¼W	Electrosil TR5	25191-034-411
R5	(H)	3.9K	2%	¼W	Electrosil TR5	25191-034-439
Capacitors						
C8		680p	2%	125V	Salford Elec.PF/AB	26634-502-368

7.2.5 Type L4C

Same as Type L4A, see section 7.2.1., with the following exceptions.

Resistors						
R4	(H)	1.1K	2%	¼W	Electrosil TR5	25191-034-411
Capacitors						
C8		680p	2%	125V	Salford Elec.PF/AB	26634-502-368

Reference		Description			Manufacturers Ref.	E.M.I. No.
7.2.6	Type L4C(NAB)					
	Same as Type L4A, see section 7.2.1., with the following exceptions:-					
Resistors						
R4	(H)	1.1K	2%	¼W	Electrosil TR5	25191-034-411
R5	(H)	3.9K	2%	¼W	Electrosil TR5	25191-034-439
Capacitors						
C8		680p	2%	125V	Salford Elec.PF/AB	26634-502-368
7.2.7	Type L4D					
	Same as Type L4A, see section 7.2.1.					
7.2.8	Type L4D(NAB)					
	Same as Type L4A, see section 7.2.1, with the following exceptions:-					
Capacitors						
C3		0.033µ	10%	160V	Mullard C296AA/A33K	26624-804-533
C8		680p	2%	125V	Salford Elec.PF/AB	26634-502-368
7.3	Loudspeaker and Meter Amplifiers					
Resistors (fixed)						
R1	(H)	22K	2%	¼W	Electrosil TR5	25191-034-522
R2	(H)	220K	2%	¼W	Electrosil TR5	25191-034-622
R3	(H)	820	2%	¼W	Electrosil TR5	25191-034-382
R4	(H)	1K	2%	¼W	Electrosil TR5	25191-034-410
R5	(H)	3.3K	2%	¼W	Electrosil TR5	25191-034-433
R6	(H)	120	2%	¼W	Welwyn C20	25111-014-312
R7	(H)	5.1K	2%	¼W	Welwyn C20	25111-014-451
R8	(H)	120	2%	¼W	Welwyn C20	25111-014-312
R9	(H)	5.1K	2%	¼W	Welwyn C20	25111-014-451
R10	(H)	10	5%	¼W	Welwyn C20	25111-013-210
R11	(H)	10	5%	¼W	Welwyn C20	25111-013-210
R12	(H)	10	5%	¼W	Welwyn C20	25111-013-210
R13	(H)	10	5%	¼W	Welwyn C20	25111-013-210
R14	(H)	13K	2%	¼W	Electrosil TR5	25191-034-513
R21		18K	10%	¼W	Dubilier BTT	25141-232-518

(H) = High Stability

Reference		Description			Manufacturers Ref.	E.M.I. No.
R22		1K	10%	¼W	Dubilier BTT	25141-232-410
R23		15K	10%	¼W	Dubilier BTT	25141-232-515
R24		390	10%	¼W	Dubilier BTT	25141-232-339
R25		330	10%	¼W	Dubilier BTT	25141-232-333
R26		3.9K	10%	¼W	Dubilier BTT	25141-232-439
Resistor (variable)						
RV1		1K	20%		Mullard E097AD/1K	9A/A15637
Capacitors						
C1	(E)	40µ		16V	Mullard C426AR/E40	26526-065-840
C2	(E)	160µ		2.5V	Mullard C426AR/A160	26526-065-006
C3	(E)	125µ		16V	Mullard C426AR/E125	26526-065-003
C11	(E)	10µ		2.5V	Mullard C426AR/A10	26526-069-810
C12	(E)	160µ		2.5V	Mullard C426AR/A160	26526-065-006
C13	(E)	160µ		2.5V	Mullard C426AR/A160	26526-065-006
C14	(E)	125µ		16V	Mullard C426AR/E125	26526-065-003
C15		1800p	2%	125V	Salford Elec.PF/AB	26634-503-418

(E) = Electrolytic

Transformer		
T1	Colne Transformer 13040	9A/A15649
Transistors		
VT1	Texas Inst.2G385	28381-001-089
VT2	Texas Inst.2G385	28381-001-089
VT3	Texas Inst.2G385	28381-001-089

Note: VT2 and VT3 constitute a matched pair.

VT11	Texas Inst. 2G387	28381-001-091
VT12	Texas Inst. 2G387	28381-001-091
Rectifier		
MR1	1mA Instrument Rect. Salford Elec.	9A/A15636

7.4 Bias and Erase Oscillator

7.4.1 Board 9A/C322014

Reference		Description			Manufacturers Ref.	E.M.I. No.
Resistors						
R1	(H)	510	2%	1/8W	Welwyn C20	25111-014-351
R2	(H)	4.3K	2%	1/8W	Welwyn C20	25111-014-443

(H) = High Stability

Reference	Description			Manufacturers Ref.	E.M.I. No.
Capacitors					
C1	(E) 250µ		16V	Mullard C437AR/E250	26526-075-008
C2	5600p	1%	250V	Mullard C295AB/D5K6	9A/A15635
C3	(E) 250µ		16V	Mullard C437AR/E250	26526-075-008
	(E) = Electrolytic				
Transformer & Choke					
T1	Transformer			E.M.I.	9A/B5623
L1	Choke			E.M.I.	9A/B7319
Transistors					
VT1				Texas Inst. 2G383	28381-001-087
VT2				Texas Inst. 2G383	28381-001-087
Diode					
MR1	Zener Diode			Texas Inst. 1S2091	28481-022-301

7.4.2 Board 9A/C322014A

Resistors					
R1	(H) 200	2%	1/8W	Welwyn C20	25111-014-320
R2	(H) 2K	2%	1/8W	Welwyn C20	25111-014-420
	(H) = High Stability				
Capacitors					
C1	(E) 250µ		16V	Mullard C437AR/E250	26526-075-008
C2	4700p	1%	500V	Mullard C295AB/D4K7	9A/A15623
C3	(E) 250µ		16V	Mullard C437AR/E250	26526-075-008
	(E) = Electrolytic				
Transformer & Choke					
T1	Transformer			E.M.I.	9A/B5811
L1	Choke			E.M.I.	9A/E7391
Transistors					
VT1				Texas Inst.2G383	28381-001-087
VT2				Texas Inst.2G383	28381-001-087
Diode					
MR1	Zener Diode			Texas Inst.1S2110A	28481-022-303

Reference		Description			Manufacturers Ref.	E.M.I. No.

7.5 Filter Unit

Resistors

R1	(H)	120K	2%	1/8W	Welwyn C20	25111-014-612
R2	(H)	18K	2%	1/8W	Welwyn C20	25111-014-518
R3	(W)	0.6	10%	3W	Radio Res. LG716	9A/A15647
R4	(H)	430	2%	1/8W	Welwyn C20	25111-014-343
R5	(H)	8.2K	2%	1/8W	Welwyn C20	25111-014-482
R6	(H)	430	2%	1/8W	Welwyn C20	25111-014-343
R7	(H)	8.2K	2%	1/8W	Welwyn C20	25111-014-482

(H) = High Stability (W) = Wire Wound

Capacitors

C1	var.	150p-700p		300V	S.S. Bird TP11	26857-622-370
C2		220p	5%	125V	Salford Elec.PF/AA	26634-503-322
C3	(E)	250u		16V	Mullard C437AR/E250	26526-075-008

(E) = Electrolytic

Inductor

L1	Choke				E.M.I.	9A/B7359

Transistors

VT1					Texas Inst.2G387	28381-001-091
VT2					Texas Inst.2G387	28391-001-091

7.6 Replay Amplifier

7.6.1 Type L4A

Resistors (fixed)

R1	(H)	47K	1%	1/8W	Welwyn C20	25111-015-547
R2	(H)	2.7K	1%	1/8W	Welwyn C20	25111-015-427
R3	(H)	10K	1%	1/8W	Welwyn C20	25111-015-510
R4	(H)	100	1%	1/8W	Welwyn C20	25111-015-310
R5	(H)	3.3K	1%	1/8W	Welwyn C20	25111-015-433
R6	(H)	47K	1%	1/8W	Welwyn C20	25111-015-547
R7	(H)	10K	1%	1/8W	Welwyn C20	25111-015-510
R8	(H)	3.3K	1%	1/8W	Welwyn C20	25111-015-433
R9	(H)	3.3K	1%	1/8W	Welwyn C20	25111-015-433
R10	(H)	2.7K	1%	1/8W	Welwyn C20	25111-015-427
R11	(H)	470	1%	1/8W	Welwyn C20	25111-015-347
R12	(H)	3.9K	1%	1/8W	Welwyn C20	25111-015-439

Reference	Description			Manufacturers Ref.	E.M.I. No.
R13	(H) 510	1%	1/8W	Welwyn C20	25111-015-351
R14	(H) 100	1%	1/8W	Welwyn C20	25111-015-310
R15	(H) 1K	1%	1/8W	Welwyn C20	25111-015-410
R16	(H) 8.2K	1%	1/8W	Welwyn C20	25111-015-482
R17	(H) 680	1%	1/8W	Welwyn C20	25111-015-368
R18	(H) 4.7K	1%	1/8W	Welwyn C20	25111-015-447
R19	(H) 560	1%	1/8W	Welwyn C20	25111-015-356

(H) = High Stability

Resistor (variable)				
RV1 Early Models	1K	20%	Mullard E097AD/1K	9A/A15637
Later Models	2.2K	20%	Mullard E097AD/2.2K	9A/A15637A

Capacitors						
C1		1300p	2%	125V	Salford Elec.PF/AB	26634-502-413
C2	(E)	40µ		16V	Mullard C426AR/E40	26526-065-840
C3	(E)	320µ		2.5V	Mullard C426AR/A320	26526-069-900
C4		0.1µ	10%	160V	Mullard C296AA/A100K	26624-804-610
C5	(E)	320µ		2.5V	Mullard C426AR/A320	26526-069-900
C6		0.033µ	5%	160V	Mullard C296AA/A33K	9A/A15734
C7	(E)	160µ		2.5V	Mullard C426AR/A160	26526-069-006
C8	(E)	320µ		2.5V	Mullard C426AR/A320	26526-069-900
C9	(E)	250µ		16V	Mullard C437AR/E250	26526-075-008
C10	(E)	125µ		10V	Mullard C426AR/D125	26526-066-003
C11	(E)	160µ		2.5V	Mullard C426AR/A160	26526-069-006
C12		100p	2%	125V	Salford Elec.PF/AA	26634-502-310
C13	(E)	80µ		16V	Mullard C426AR/E80	26526-065-880

(E) = Electrolytic

Transistors		
VT1	Texas Inst. D661	28381-001-072
VT2	Texas Inst. D661	28381-001-072
VT3	Texas Inst. 2N1302	28381-002-001
VT4	Texas Inst. 2G387	28381-001-091
VT5	Texas Inst. 2N1302	28381-002-001

7.6.2 Type L4A(NAB)

Same as Type L4A, see section 7.6.1., with the following exceptions:-

Resistors						
R10	(H)	2.4K	1%	1/8W	Welwyn C20	25111-015-424

Reference	Description			Manufacturers Ref.	E.M.I. No.

7.6.3 Type L4B

Same as Type L4A, see section 7.6.1 with the following exceptions:-

Capacitors

C1	620p	2%	125V	Salford Elec.PF/AB	26634-502-362

7.6.4 Type L4B(NAB)

Same as Type L4A, see section 7.6.1 with the following exceptions:-

Resistors

R10	(H) 2.4K	1%	1/8W	Welwyn C20	25111-015-424

Capacitors

C1	620p	2%	125V	Salford Elec.PF/AB	26634-502-362

7.6.5 Type L4C

Same as Type L4A, see section 7.6.1., with the following exceptions:-

Capacitors

C1	620p	2%	125V	Salford Elec.PF/AB	26634-502-362

7.6.6 Type L4C(NAB)

Same as Type L4A, see section 7.6.1, with the following exceptions:-

Resistors

R10	(H) 2.4K	1%	1/8W	Welwyn C20	25111-015-424

Capacitors

C1	620p	2%	125V	Salford Elec.PF/AB	26634-502-362

7.6.7 Type L4D

Same as Type L4A, see section 7.6.1.

7.6.8 Type L4D(NAB)

Same as Type L4A, see section 7.6.1, with the following exception:-

Resistors

R10	(H) 2.4K	1%	1/8W	Welwyn C20	25111-015-424

Reference		Description			Manufacturers Ref.	E.M.I. No.
7.7	Main Frame - Types L4A & L4B					
Resistors (fixed)						
R1	(H)	100K	2%	¼W	Electrosil TR5	25191-034-610
R2	(H)	68	2%	¼W	Electrosil TR5	25191-034-268
		(H) = High Stability				
Resistors (variable)						
RV1		1K			Morganite A	9A/A15672
RV2		1K			Morganite A	9A/A15672
RV3		5K			Plessey MH2	25633-302-109
RV4	(W)	2.5K	10%	3W	Colvern CLR901C	25711-430-101
		(W) = Wire Wound				
Capacitors						
C1	(E)	40µ		16V	Mullard C426AR/E40	26526-065-840
C2		0.015µ	10%	160V	Mullard C296AA/A15K	26624-804-515
C3		0.015µ	10%	160V	Mullard C296AA/A15K	26624-804-515
C4	(E)	500µ		2.5V	Mullard C426AR/A500	26526-069-012
C5	(E)	500µ		2.5V	Mullard C426AR/A500	26526-069-012
C6		0.03µ		500V	Erie K7004/CP3	26386-501-530
C7		0.03µ		500V	Erie K7004/CP3	26386-501-530
		(E) = Electrolytic				
Transformer & Choke						
T1		Transformer			E.M.I.	9A/B5543
L1		Choke			E.M.I.	9A/A322287
L2		Choke			E.M.I.	9A/A322287
Transistor						
VT1					Newmarket NKT304	28365-001-104
Miscellaneous						
SA		Switch Blade Assy.				9A/B322112
		Switch Key Assy. for SA				9A/B322096
SB		Slider Switch			Ariel Pressings 2301	9A/A15670
SC		Slider Switch			Ariel Pressings 2300	9A/A15669
SD		Rotary Switch			A.B. Metal 'Trolex'	9A/A15667
JKB-JKD		Jack Socket			Rendar Inst.J300/A0	9A/A15657
		Plug for JKB-JKD			Rendar Inst. JPS/300	9A/A15656

Reference	Description	Manufacturers Ref.	E.M.I. No.
SKTA	Socket	Cannon XLR-3-31	24413-120-062
SKTB	Socket	Cannon XLR-3-31	24413-120-062
	Plugs for SKTA/SKTB	Cannon XLR-3-12C	24403-120-061
PLC/SKTC	Battery Plug/Socket	Ariel Pressings RA2128	9A/A15654
PLA	BATTERY CHARGER Plug	Plessey T3402/1	9A/A15831
	Socket for PLA	Plessey T3401/1	9A/A15830
M1	Meter	Taylor Model 11	9A/B322199
	Motor	E.M.I.	9A/B322198
LS1	Loudspeaker	E.M.I.	9A/B322210
	2V Accumulator	Sonnenschein 1AX2/K	9A/A15663
	6V Accumulator	Sonnenschein 3AX2/O	9A/A15664
FS1	1A Fuse	Beswick TDC13/1A	9A/A15676
	Fuseholder	Ariel Pressings 1978	9A/A15665

NOTE: Some early models of Type L4A may require the following changes in the above list.

	SKTA replaced by JKA below		
	SKTB replaced by PLA below		
	PLA replaced by SKTB below		
JKA	MIC1 Jack Socket	Rendar Inst. J300/AO	9A/A15657
	Plug for JKA	Rendar Inst. JPS/300	9A/A15656
PLA	MIC2 Plug	Cannon XLR-5-14	24401-120-181
	Cable Socket for PLA	Cannon XLR-5-11C	24401-120-161
SKTB	EXT.BATT. Socket	Plessey T3403	9A/A15662
	Plug for SKTB	Plessey T3400/1	9A/A15661

7.8 Main Frame - Types L4C & L4D

7.8.1 Type L4C

Resistors (fixed)

R1	(H)	100K	2%	¼W	Electrosil TR5	25191-034-610
R2	(H)	68	2%	¼W	Electrosil TR5	25191-034-268
R3	(H)	7.5K	1%	¼W	Electrosil TR5	25191-035-475

(H) = High Stability

Resistors (variable)

RV1	1K		Morganite A	9A/A15672
RV2	1K		Morganite A	9A/A15672
RV3	5K		Plessey MH2	25633-302-109
RV4	(W)	2.5K	10%	3W	Colvern CLR901C	25711-430-101

(W) = Wire Wound

Reference		Description		Manufacturers Ref.	E.M.I. No.
Capacitors					
C1	(E)	40µ	16V	Mullard C426AR/E40	26526-065-840
C2		0.015µ 10%	160V	Mullard C296AA/A15K	26624-804-515
C3		0.015µ 10%	160V	Mullard C206AA/A15K	26624-804-515
C4	(E)	500µ	2.5V	Mullard C426AR/A500	26526-069-012
C5	(E)	500µ	2.5V	Mullard C426AR/A500	26526-069-012
C6		0.03µ	500V	Erie K7004/CP3	26386-501-530
C7		0.03µ	500V	Erie K7004/CP3	26386-501-530
C8		1000p 5%	125V	Salford PF/AB	26634-503-410
		(E) = Electrolytic			
Transformer & Choke					
T1		Transformer		E.M.I.	9A/B5543
L1		Choke		E.M.I.	9A/A322287
L2		Choke		E.M.I.	9A/A322287
Transistor					
VT1				Newmarket NKT304	28365-001-104
Miscellaneous					
SAa-SAc		Switch Blade Assy.			9A/B322112
SB		Slider Switch		Ariel Pressings 2301	9A/A15670
SC		Slider Switch		Ariel Pressings 2300	9A/A15669
SD		Rotary Switch		A.B. Metal 'Trolex'	9A/A15667
JKB-JKD		Jack Socket		Rendar Inst. J300/A0	9A/A15657
		Plug for JKB-JKD		Rendar Inst. JPS/300	9A/A15656
SKTA		Socket		Cannon XLR-3-31	24413-120-062
SKTB		Socket		Cannon XLR-3-31	24413-120-062
		Plugs for SKTA/SKTB		Cannon XLR-3-12C	24403-120-061
PLC/SKTC		Battery Plug/Socket		Ariel Pressings RA2128	9A/A15654
PLA		BATTERY CHARGER Plug		Plessey T3402/1	9A/A15831
		Socket for PLA		Plessey T3401/1	9A/A15830
M1		Meter		Taylor Model 11	9A/B322199
		Star Indicator		Radio Resistors 514	9A/A15653
		Motor		E.M.I.	9A/B322198
LS1		Loudspeaker		E.M.I.	9A/B322210

Reference	Description	Manufacturers Ref.	E.M.I. No.
	2V Accumulator	Sonnenschien 1AX2/K	9A/A15663
	6V Accumulator	Sonnenschien 3AX2/0	9A/A15664
FS1	1A Fuse	Beswick TDC13/1A	9A/A15676
	Fuseholder	Ariel Pressings 1978	9A/A15665

7.8.2 Type L4D

Same as Type L4C, see section 7.8.1, with the following exception.

Resistor (fixed)

R3	(H)	5.6K	1%	¼W	Electrosil TR5	25191-035-410

7.9 Head Assemblies

7.9.1 Type L4A

Erase Head	Miniflux LF6	9A/A15668
Record Head	Miniflux KN3T	9A/A15526
Replay Head	Miniflux WN3TL	9A/A15666

7.9.2 Type L4B

Erase Head	Miniflux LF6/V	9A/A15770
Record Head	Miniflux FM5	9A/A15768
Replay Head	Miniflux FM5L	9A/A15769

7.9.3 Type L4C

Erase Head	Miniflux LF6/V	9A/A15770
Record Head	Miniflux FM5	9A/A15768
Neopilotone Head	Bogen US1052e	9A/A15793
Replay	Miniflux FM5L	9A/A15769

7.9.4 Type L4D

Erase Head	Miniflux LF6/V	9A/A15770
Record & Sync. Head	Miniflux SKN4	9A/A15789
Replay Head	Miniflux WN3TL	9A/A15666

Reference		Description			Manufacturers Ref.	E.M.I. No.
7.10	Battery Charger Type AP403 & Type AP403A					
Resistors (fixed)						
R1		680	20%	¼W	Dubilier BTT	25141-231-368
R2	(W)	3.9	10%	1½W	Painton MV1A	25311-032-139
		(W) = Wire wound				
Resistor (variable)						
RV1		4.7K			Mullard E097AC	9A/A15776D
Capacitors						
C1	(E)	500µ		40V	Mullard C431BR	26526-041-012
Transformer						
T1		Transformer			Colne Elect.13027	9A/B15777
Transistors						
VT1					2G371A	28381-001-056
VT2					GP297-1	28381-001-101
Rectifier						
MR1a - MR1d					IN677	28485-021-032
Diodes						
MR2					IS2082	28481-022-300
MR3					IN2069	28481-021-149
Miscellaneous						
FS1		100mA Fuse			Belling Lee L1055	24301-111-310
PLA/SKTA		Battery Plug/Socket			Ariel Pressings RA2128	9A/A15654
PLB (Type AP403 only)					Plessey T3400	9A/A15661
SKTB (Type AP403A only)					Plessey T3401/1	9A/A15830
ILP1		Indicator Lamp			Carr Fastener 79.414	9A/A15775

7.11 Mechanical Components

Case Assembly	9A/C322220
End Moulding	9A/D322044
Cover Assembly	9A/D322005
Foot	9A/A15535
Carrying Strap	9A/C322163
Side Support	9A/B322041
Battery Box Half	9A/C322165
Battery 6 volt	9A/A15664
Battery 2 volt	9A/A15663
Deck Plate Assembly	9A/C322006

Reference	Description	Part No.
	Deck Surround (Rubber)	9A/A322020
	Cam Arm (Tape Guide)	9A/A322078
	Grip Ring	9A/A15660A
	Tape Guide (Moving)	9A/A322088
	Brake Arm Assembly	9A/A322075
	Washer	9A/A322209
	Grip Ring	9A/A15660A
	Bracket (Brake Arm)	9A/A322192
	Screw (Brake Arm)	9A/A322077
	Screw Retainer	9A/A322076
	Spindle (Pivot Pinch Wheel Arm)	9A/A322110
	Washer PTFE	9A/A322147
	Grip Ring	9A/A15660E
	Pinch and Kick-off Arm	9A/B322193
	Spindle (Pinch Wheel)	9A/A322127
	Brake Pad	9A/A322126
	Ball Steel	249
	Pinch Wheel Assembly	9A/A322125
	Oil Retaining Washer	9A/A322120
	Grip Ring	9A/A15660C
	Cover	9A/A322119
	Pillar (Pinch Wheel Tension Adjustment)	9A/A322191
	Support Pillar Assembly and Key Spindle	9A/A322031
	Support Pillar Right Hand	9A/B322032
	Key Spacer	9A/A322107A
	Key Spacer	9A/A322107B
	Latch Plate (Keys)	9A/B322029
	Latch Plate (Key)	9A/B322030
	Spring Brake Assembly (Stop Key)	9A/A322214
	Cam Latch Bar (Cranked Rod)	9A/A322035
	Washer	9A/A322209
	Grip Ring	9A/A15660A
	Bearing Retainers (Spool and Capstan Bearings)	9A/A322053
	Bearing Bush (Spool and Capstan Bearings)	9A/A322157
	Oil Retaining Washer (Take up Spool and Capstan)	9A/A322052
	Spool Platform Assembly	9A/A322060

Reference	Description	E.M.I. No.
	Pulley and Brake Drum	9A/A322067
	Ring	9A/A15800
	Collar	9A/A322084
	Washer	9A/A322123
	Spring (Take-up Clutch)	9A/A322085
	Clutch Driving Disc	9A/A322080
	Spindle and Pulley Assembly (Rewind)	9A/A322089
	Toggle (Rewind Idler Arm)	99907/2
	Grip Ring	9A/A15660G
	Washer	9A/A322123
	Grip Ring	9A/A15660C
	Washer	96159
	Grip Ring	9A/A15660B
	Belt (Rewind Drive)	9A/A322058
	Belt (Clutch Drive)	9A/A322057
	Spring (Rewind Return)	9A/A322179
	Spring (Rewind Engage)	9A/A322180
	Spring (Tape Tension Arm Return)	9A/A322181
	Spring (Tape Tension Arm Engage)	9A/A322182
	Spring (Pinch Wheel Engage)	9A/A322183
	Spring (Stop Key Return)	9A/A322184
	Spring (Record Key Return)	9A/A322185
	Spring (Idler Kick-out)	9A/A322186
	Spring (Latch Bar Return)	9A/A322187
	Guide Plate (Under Meter)	9A/A322190
	Tape Guide Bottom	9A/A322091
	Tape Guide Centre	9A/A322090
	Tape Guide Top	9A/A322111
	Screw Head Mounting	21431-512-082
	Screw Head Mounting	21431-142-055
	Guide (Heads)	9A/A322218
	Spring Washer	9A/A322208
	Bottom Bearing Assembly	9A/B322217
	Ball	249
	Register Plate (Speed Change Cam)	9A/A322155
	Spindle "	9A/A322156
	Cam Follower	9A/A322141
	Washer PTFE	9A/A322146

Reference	Description	E.M.I. No.
	Lever and Pin Assembly (Speed Change)	9A/A322152
	Washer PTFE (Capstan Idler)	9A/A322147
	Spring (Capstan Idler)	9A/A322056
	Toggle	99907/2
	Grip Ring	9A/A15660G
	Washer	96159
	Grip Ring	9A/A15660B
	Pulley Assembly (Capstan Idler)	9A/A322140
	Washer	9A/A322123
	Grip Ring	9A/A15660C
	Spring (Drive Idler Engage)	9A/A322188
	Cam Lever (Speed Change)	9A/C322153
	Spring (Speed Location)	9A/A322055
	Ball	3519
	Capstan and Flywheel Assembly	9A/B322073
	Fuse Holder	9A/A15665
	Pulley (Motor)	9A/A322061
	Screw	21818-004-433
	Pulley (For Slow Motors)	9A/A322291
	Pulley (For Fast Motors)	9A/A322292
	Knob	9A/B322115
	Terminal Standoff	C4581

8. RECOMMENDED SPARES KIT

Description	Quantity for one Machine	Quantity for 2 or 3 Machines	Quantity for 6 Machines	E.M.I. No.
Idler pulley & spindle assy.	1	2	3	9A/A322089
Idler pulley & spindle assy.	1	2	3	9A/A322140
Belt (rewind drive)	1	3	6	9A/A322058
Belt (clutch drive)	1	3	6	9A/A322057
Pinch wheel assembly	1	1	2	9A/A322125
Capstan & Flywheel assy.	-	1	1	9A/B322073
Fuse 1 amp	3	6	12	9A/A15676
Jack plug	2	4	6	9A/A15656
Cable Socket 5-way XLR 5-11C	1	2	4	24411-120-161
Plug 3-way XLR 3-12C (alternative)	1	2	4	24403-120-061
Plug 6-way	1	1	2	9A/A15661
Cable Socket 6-way (alternative)	1	1	2	9A/A15830
Gain control (microphone)	2	4	6	9A/A15672
Gain control (loudspeaker)	1	2	3	25633-302-109
Record head Half Track	-	1	2	9A/A322142
Record head Full Track	-	1	2	9A/A15768
Replay head Half Track	-	1	2	9A/A15526
Replay head Full Track	-	1	2	9A/A15769
Meter	-	1	1	9A/B15666
Motor 14V	-	1	1	9A/B322198
Transistor (Qty.1) NKT304	1 set	1 set	2 sets	28365-001-104
Transistor (Qty.6) D661	1 set	1 set	2 sets	28381-001-072
Transistor (Qty.7) 2G387	1 set	1 set	2 sets	28381-001-091
Transistor (Qty.5) 2N1302	1 set	1 set	2 sets	28381-002-001
Transistor (Qty.3) 2G385	1 set	1 set	2 sets	28381-001-089
Transistor (Qty.2) 2G383	1 set	1 set	2 sets	28381-001-087
Diode (Early L4A) 1S209	1	1	2	28481-022-301
Diode 1S2110	1	1	2	28481-022-303