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ROLA VARIABLE MESSAGE REPEATER MKII

1. DESCRIPTION & PERFORMANCE CHARACTERISTICS

(a) General -

The Rola Variable Message Repeater MKII is a magnetic drum recorder/reproducer designed to recycle a single message of up to 3 minutes duration with a maximum 'dead' time between messages of 6 seconds.

The modes of operation of the unit are controlled entirely by one lever key switch (S5) and the unit may be operated remotely by making connections to the appropriate external terminations. These terminations also enable the unit to be wired permanently into a system and the unit is designed to mount in a 19" rack or sit free standing on the two packing stands supplied. Not only has the unit been designed for ultimate simplicity of operation, but also for long term reliability. This is accomplished by using the following design principles :-

1. Ball races or needle rollers used on all moving parts.
2. Linear bearing ball bushings used on all sliding mechanisms.
3. Printed circuit techniques used where possible.
4. Low motor speed.
5. Tantalum capacitors utilized to a maximum.
6. All resistors are of the metal oxide or the wire wound type.
7. All iron cored components are encapsulated.
8. Silicon transistors and diodes are used.
9. All relays are covered.
10. Sealed trimming potentiometers are used in the two places where long term adjustment may be necessary.
11. Self-lubricating scroll and stylus used.
12. Floating rack mounting to minimise distortion of the main casting.
13. Epoxy glass printed circuit boards used.
14. Gold plated edge connectors are used on printed circuit boards.

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(b) Performance Specifications -

Power Requirements:	240V AC. .55A.
Output:	A centre tapped balanced line capable of delivering 500 milliwatts into a 6 ohm load. This will enable from 1 to 100 telephone lines to be connected across the unterminated output and causing a variation in the level of the message at the output of the unit of less than 3 db.
Frequency Response:	The frequency response is 200 c/s - 3500 c/s ± 4db (reference 1 Kc/s). A 1 Kc/s tone of constant level when recorded and reproduced does not vary more than ± 3db throughout the track.
Distortion:	The replayed distortion of a 1 Kc/s tone does not exceed 3% total. (reference 500 milliwatts into a 6 ohm load).
Signal to Noise Ratio:	The signal to noise ratio is better than 35db (reference 500 milliwatts into a 6 ohm load.)
Wow and Flutter:	The wow and flutter of a 3000 c/s tone when measured on a Gaumont Kalee Type No. 564 flutter meter does not exceed an average value of 1% r.m.s.
Carriage Return Tone:	The replayed tone is attenuated to at least 30db below the reference level of 500 milliwatts into a 6 ohm load.
Tracks:	Provision is made for one track of up to 3 minutes duration.
Recording Medium:	The recording medium is a Ferro Magnetic Impregnated Neoprene Band.
High Frequency Suppression:	During the record cycle (when the bias oscillator is energised) the replay amplifier is muted, whilst during replay, any bias frequency reproduced by the head is sharply attenuated by the replay amplifier.

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Recording Amplifier:

An automatic gain control is incorporated to allow the amplifier to adjust for the following input levels :

600 ohm input: +15dbm) into a 2db
-20dbm) replay level change

200 ohm input: -15dbm) into a 2db
-50dbm) replay level change

The unit provides two inputs -

(a) a balanced 600 ohm line of reference level at the external terminations.

(b) a balanced 200 ohm microphone input at the external terminations and at a 4 pin socket on the control panel. The microphone supplied is a good quality microphone insert (STC 29-SU-8A) in a standard APO handset moulding complete with cord.

Automatic Erasure:

Automatic erasure is incorporated such that all previous messages are erased from the recording band before a new recording is made.

Rack Mounting:

The equipment is suitable for mounting in a standard 19" telephone rack and does not protrude forwards or backwards more than 7" from the rack centre line. The height is $10\frac{1}{2}$".

Start/Stop Operation:

The equipment is designed to start on an earth signal from the telephone equipment and stop on the completion of the message after the signal has been removed.

Recycling Time:

Under continuous operating conditions, the delay between the end of one cycle and the commencement of the next ranges from .5 seconds to 6.5 seconds.

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Audio Failure Alarm:

The equipment includes an alarm lamp signal to indicate the following :-

(a) failure of the machine to start,
(b) failure of the machine during running,
(c) failure of the AC mains or internal DC supply,
(d) loss of audio programme.

The alarm also includes auxiliary contacts to be connected to the station's general alarm system and the system can in turn trigger the operation of a standby machine.

Environmental Conditions:

The equipment is designed to operate under Category B Environment, normally constructed buildings, possibly evaporated cooled, temperature controlled but humidity uncontrolled. The range of temperatures likely to be experienced in this category are +10°C to +45°C. The relative humidity range is likely to be 40% at 45°C to 70% at 20°C. Australian Post Office Specification No. 1001 refers.

Remote Operation:

Once the unit has been switched on, it may be completely controlled from a remote station.

Control:

For normal operation of the unit, only one lever key switch is required.

Fuses:

A 1A fuse is inserted in each mains lead for complete protection.

Weight:

65 lbs.

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2. INSTALLATION

(a) General -
Each unit is shipped in a sealed carton and contains :-
(i) the unit,
(ii) a handset,
(iii) a power cable,
(iv) a handbook.

The unit is stabilized in the carton by mounting it on two steel transporting brackets which are removed only if the unit is to be rack mounted.

(b) Removing Packing -
Remove the front and rear covers and carefully withdraw the five foam plastic packing blocks (4 in the front and 1 under the puck wheel at the rear). The covers can then be replaced.

(c) External Terminations -
When the unit has been placed in its operating position, the external system should be connected to the external terminations.

1,2,3,4,5,6,7,8,25 - no connection.
9, 10 - (10 earthed) record indicator 24V 20mA.
11,12 - Across erase decay lamp 18V 20mA.
13,14 - RL7 (carriage return) N/C.
14,16 - RL7 (carriage return) N/O.
15,24 - Carriage return (24 earthed).
17,19 - Remote record.
18,20 - RL1 (Alarm) N/O) Relay de-energised
18,22 - RL1 (Alarm) N/C) for a failure.
21,24 - AC indicator (24 earthed) 24V 20mA.
23,24 - Start on demand and remote monitor (24 earthed). Strap for continuous operation.
26 - Centre tap of output line.
27,28 - Balanced 600 ohm input.
29,30 - Balanced 200 ohm input.
31,32 - Earth shield between input and output terminations.
33,34 - Balanced output line.
35,36 - Monitor output.

When the unit is to be operated locally, connections to pins 1-12, 15, 17, 19, 21, 23-32, 35 and 36 are not required. The connection of pins 13, 14, 16, 18, 20 and 22 is optional.

(d) Power Connection -
The unit is connected to the 240V 50 c/s AC mains via a 3 pin socket (Soc10) on the rear of the unit. For safety, the mating plug must be removed before the rear cover can be withdrawn.

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(e) Handset -
If the handset is to be used for recording and monitoring, it must be plugged in to the handset socket on either the control panel of the VMR MKII (Soc 6) or the Remote Control Unit.

(f) Remote Control Unit -
If the unit is to be operated remotely it must be connected to a suitably wired Remote Control Unit. Connections to pins 9, 10, 17, 19, 23, 24, 29, 30,35 and 36 are necessary for remote operation.

3. OPERATION

(a) General -
Simplicity of operation is achieved by reducing the number of controls to one function key (S5).

The use of an automatic level control in the record amplifier obviates the need for a record level meter and control and so allows the operator more freedom whilst making a recording.

(b) Summary of Controls, Switches and Indicators -

Mains Switch:	2 pole switch breaking both of the AC mains leads.
Function Key:	Miniature level key switch with a non-locking Monitor position and a locking Record position.
AC Indicator:	A green bezel which indicates that the Power Supply is operational.
Record Indicator:	A red bezel which indicates that the unit is in the record mode.
Audio Fail Indicator:	A yellow bezel which indicates an audio failure.
Handset Socket:	A four pin socket which receives the standard handset.

(c) Summary of Remote Control Facilities:
With the exception of the mains switch, all of the abovementioned controls, switch and indicators are available for connection to a Remote Control Unit. The unit may also contain -
(a) a push button to return the carriage to the beginning of its message at any time during the cycling of a message,
(b) a 'Prepare' lamp to indicate that the unit is about to change to the record mode,
(c) a lamp to indicate the unit is in the standby mode,
(d) a balanced 600 ohm input.

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(d) Operating Instructions -

(i) Switch on the "Mains Switch". "Mains Indicator" lamp will light.

(ii) The unit must be switched on at least half a minute before making a recording. Insufficient delay will result in distortion of the beginning of the message.

(iii) To record, place the function switch in the Record position.

(iv) when the "Record Indicator" lights (14-21 seconds after the key is operated) the operator may begin recording the message immediately.

(v) At the end of the message the function switch is returned to the central position. The carriage will then return to its starting point and begin replaying the message, provided pins 23 and 24 on the termination strip are strapped. If these pins are not strapped, the carriage will remain in the standby position until either they are bridged by a start-on-demand circuit or the function key is placed in the monitor position. These operations place an earth on RL11 and the earth must be maintained for a minimum of 7 seconds. The unit will continue recycling for as long as the earth is maintained. If the earth is removed during a message, the message will be completed and the carriage will then return to the standby position.

(vi) If the unit is permitted to record for longer than 3 minutes, an over-run switch will operate and stop the drive motor. The unit may be re-started by returning the function key to the central position and the message may then be re-recorded correctly by repeating steps (iii) and (iv).

(vii) When recording a message via the 600 ohm input, ensure that the handset or microphone is disconnected, otherwise unwanted signals will be recorded. Similarly, ensure that the 600 ohm line carries no programme whilst the handset or microphone is in use.

(e) Audio Fail Alarm -

The alarm is muted during the prepare and record cycles and also when the unit is in the standby position. After an earth is applied to RL11 to start the unit replaying, the alarm will register a failure unless it detects audio across the output line within 7-12 seconds. Such a failure is indicated by the 'Audio Fail Indicator' on the control panel and a change-over contact (5, 6 and 7) connected to pins 18, 20 and 22 on the termination strip. RL11 is de-energised when a failure occurs.

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4. PRINCIPLES OF OPERATION

(a) Magnetic Recording Theory -

The Rola VMR MKII unit is designed to record a frequency range of 200 c/s to 3.5 Kc/s at a constant flux density on the band. This is achieved by using a record output stage which is a constant current drive to the record head and is equalised at high frequencies to compensate for head and band losses. However, a recording made with only the signal fed to the head will result in the replayed signal being very distorted due to the non-linearity of the hysteresis loop of the magnetic oxide in the band. This distortion is obviated in modern recording practice by superimposing on the signal current, a bias current at a frequency at least five times greater than the maximum signal frequency to be recorded and at a level considerably greater than that of the signal. Thus, as any part of the band passes under the gap in the head, the oxide particles in the band are taken through their hysteresis loop several times. However, the loops are biased either positively or negatively by the instantaneous value of the signal current and as the oxide particules move away from the gap (and the effect of the bias current) they are left with a remanent induction which is proportional to the instantaneous value of the signal that existed as they passed under the gap.

On replay, the passage of the oxide particles under the gap induces a voltage in the head winding proportional to the rate of change of flux that they represent. This means that if a gliding tone (recorded at constant level) is replayed, the output voltage from the head rises at the rate of 6db per octave increase of frequency. To obtain a flat response from such a system, the head must feed directly into a preamplifier which has a response which falls at the rate of 6db octave increase of frequency.

The preamplifier of the replay amplifier of the VMR has this equalisation, but its effect is reduced at the higher frequencies to compensate for head losses.

(b) Record Electronics Module -

The operation of the VMR is greatly simplified by the elimination of a record level control. This desirable simplification is achieved by incorporating in the record amplifier an automatic level control which has a control range in excess of 50db, i.e. the input signal can vary in level by $\pm$ 25db in relation to its nominal level and it will still be recorded at the correct level.

Inserted in the AC feedback loop of the input transistor of the record amplifier (TS301) is a light dependant resistor (R306), the resistance of which decreases with increasing light intensity. Following this stage are two low distortion amplifier stages to amplify the input signal to a sufficiently high voltage to drive the head.

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(b) Record Electronics Module (cont) -
The output stage of the chain is an emitter follower which acts as a power amplifier to drive the record head. Its low output impedance prevents any bias, which may leak through the bias trap (L301, C313 and C314) from overloading the output stage and so distorting the signal.

The output of TS303 is also fed to TS309 which provides power amplification so that the signal may be rectified by D302 to give a DC voltage level on the base of TS308 proportional to the level of the incoming AC signal.

TS305 and TS306 form a high gain DC amplifier to drive the 6V (LP301) globe. The globe is light coupled to the R306 by mounting both in a small light-tight cell mouned on the record amplifier circuit board. The 200 ohm trim pot (R239) is used to preset the 'zero signal' voltage across the globe to 0.8 - 1.0 volts. The pre-bias increases the life of the globe and increases the 'attack' time of the level control by preventing the globe from ever becoming completely cold.

TS307 and TS308 form a long tailed pair the purpose of which is to ensure that the level control operates only when the input signal rises above a certain threshold level.

When the DC voltage (which is proportional to the input AC signal) on the base of TS308 reaches the preset level of the long tailed pair, the DC amplifier comes into operation and energises the globe. Its increased light output reduces the resistance of R306 and consequently reduces the gain of the first amplifier stage. Thus the output level of the AC amplifier is clamped to the predetermined level by the action of the closed-loop system, and the degree of clamping is determined by the gain around the loop. In the VMR the gain has been designed sufficiently high to reduce a 50db increase in input level voltage above the threshold to a 2db change in output level fed to the record head.

The bias oscillator is a single transistor (TS310) low powered device with a maximum output voltage of 25V r.m.s. Trim Pot (R342) allows the required bias voltage to be fed direct to the head and a bias trap (comprising coil L301 and capacitors C313 and C314) prevents the bias from overloading the output transistor. Both the bias trap and the oscillator are tuned to 25 Kc/s.

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(c) Replay Electronics Module -

(i) Replay Amplifier

The replay amplifier consists of a 2 stage equalised pre-amplifier followed by a wide band voltage and power amplifier. The response of the pre-amplifier to 50 c/s is enhanced to increase the level of the 50 c/s tone burst prior to it being fed to the carriage return circuit. In the main amplifier 50 c/s is sharply attenuated to ensure that the tone burst is at an acceptably low level at the output. The main amplifier also contains sufficient AC negative feedback to ensure that the output level from the output transformer will vary less than 3db from no load to full load. (100 lines).

The output stages of the main amplifier are operated in class AB to reduce the average current loading of the amplifier.

Mounted on the replay amplifier circuit board is a miniature relay (RL10) which is energised when the VMR operates in the record mode. Its purpose is to connect the head to the appropriate amplifier and mute the replay amplifier during record and the record amplifier during replay.

(ii) Carriage Return

The carriage return circuit board is mounted on pillars above the replay amplifier and connected electrically to the amplifier via printed circuit edge connectors on each circuit board.

TS209 and TS210 comprise an amplifier tuned to 50 c/s and with a band width of approximately 3 cycles. The 50 c/s tone burst is amplified by TS211, rectified and the amplified DC operates RL7.

(iii) Audio Fail Alarm

The audio fail alarm is an optional facility and comprises a miniature plug-in relay and the alarm circuit board. The relay is plugged into its socket on the relay chassis and the circuit board is mounted on six silver plated pillars on the Carriage Return circuit board. As these pillars provide the electrical connections to the board as well as supporting it, all six screws must be tight to ensure correct operation of the alarm.

The audio input of the alarm, taken across the output line of the unit, is amplified, rectified and used to operate RL1 after amplification by TS214 and TS215. C232 provides a 7 second delay between the loss of audio signal and the operation of RL1. The alarm is muted by applying +12V to R254.

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(d) Power Supply Module -

(i) Power Supply

The power supply provides AC to the Drum Eraser, unregulated and partially filtered DC to operate the relays and solenoids (pin 9), unregulated, filtered DC to operate the main amplifier of the replay amplifier (pin 07) and a +12V regulated supply to operate amplifiers and timers (pin 10). The 2V winding on T401 supplies the 50 c/s for recording the end of message carriage return tone burst. A proportion of the output voltage of the regulated power supply is compared with the voltage drop across a zener diode (D405) by TS403. Any voltage difference is amplified by TS402 and TS403 and the negative feedback so applied to TS401 results in the output voltage remaining constant for various input and output conditions.

(ii) Timing Circuits

The timing circuit board contains two timers; a nine second timer which controls the start of the erase decay and a .25 second timer which controls the length of the carriage return tone pulse. In each case, the timer is energised by applying +12V to the appropriate electrolytic capacitor (C405 or C407) so turning on its associated transistor(s) and energising either RL2 or RL3. When the capacitor has charged to a predetermined voltage, the relay de-energises. The nine second timer has temperature compensation since its time delay is critical, but the .25 second timer, being non-critical, is much less complex.

(e) Relay Operation -

(i) Start on Demand

In this mode of operation, the unit is started by strapping external terminations 23 and 24. This energises RL11. Contacts 8 and 9 open and the stylus can now engage when the reed switch (S104) next operates. Contacts 5 and 6 bring the alarm circuit into operation.

(ii) Replay Cycle

When the 50 c/s carriage return tone is replayed or external termination 15 is momentarily earthed, RL7 is energised and locked up via own contacts 6 and 7 and the carriage sensing switch (S103). RL7 energises the solenoids (L101 and L102) via contact (15 and 16) and operates change-over contact (11, 12 and 13) connected to external terminations 13, 14 and 16. RL7 cannot be de-energised until both the carriage sensing switch (S103) and the reed switch (S104) are operated.

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(e) Relay Operation (cont) -

(iii) Record Cycle

		Relays energised
1.	Function Switch is placed in the record position.	
2.	When the reed switch is operated, RL5 is energised via D110 and the reed switch, and locks up via own contacts (15, 16.)	5
3.	RL2 is immediately energised via contacts RL5, (6 and 7) and it in turn energises RL9 via contacts RL2 (6 and 7).	5, 2, 9
4.	RL5 also opens contacts (8 and 9) so that the carriage can engage the scrolls to commence recording even if the unit is operating in the start on demand mode and RL11 is not energised.	5, 2, 9
5.	RL9 operates and contacts (21, 22, 23 and 24) prepare for the drum eraser (L103) to receive full voltage when it is switched on. RL9 energises RL7 via contacts (3 and 4) and RL7 energises the solenoids (L101 and L102) via contacts (15, 16) and locks up via own contacts (6, 7) and the Carriage Sensing Switch (S103). RL9 also energises RL6 via contact (1, 2) and RL6 locks up via contact RL6 (1, 2) and contact RL4 (5, 6).	2, 5, 7, 9
6.	RL6 switches on the Drum Eraser (L103) via contacts (21 and 22) and energises RL10 (on Replay Electronics Module) mutes the alarm and switches on the bias oscillator and record output stage via contacts (3 and 4). D113 prevents contacts RL11 (5 and 6) from energising RL10 and switching on the record stage and the bias oscillator.	2, 5, 6, 7, 9, 10.
7.	The Reed Switch (S104) operates. All relay states remain unchanged.	2, 5, 6, 7, 9, 10
8.	RL2 drops out 8-9 seconds after item 3. RL9 de-energises RL2 (6 and 7) and contacts RL9 (21, 22, 23 and 24) start the erase decay.	5, 6, 7, 10
9.	The reed switch (S104) operates - RL7 drops out and de-energises the solenoids via contacts (15 and 16)	5, 6, 10
	RL8 is energised via contacts RL9 (5and 6) and contacts RL6 (5 and 6) and locks up through contacts RL8 (1 and 2) and contacts RL4 (5 and 6)	5, 6, 8, 10
	The Record Indicator lights via contacts RL8 (3 and 4) The Drum Eraser (L103) is switched off via contact RL8 (21 and 22)	5, 6, 8, 10

(e) Relay Operation (cont) -

10. The Function Switch is returned to the central position. RL5 drops out and causes RL3 to be pulsed for 0.25 seconds by contacts RL5 (11 and 12) and records a 50 c/s tone on the band via contacts RL3(6 and 7). Capacitor C103 is charged via contact RL3 (9and10). 6, 8, 10 3, 6, 8, 10 3, 6, 8, 10
11. RL3 drops out and RL4 is pulsed by contact RL3 (8 and 9). RL6 and RL8 drop out when contacts RL4 (5 and 6) open. D109 across RL8 allows RL6 to drop out before RL8. 4, 6, 8, 10 4, 10
12. RL7 is energised via contacts RL4 (9 and 10) and locks up via contact RL7 (6 and 7) and the Carriage Sensing Switch (S103). 4, 7, 10
13. RL10 is de-energised and the bias oscillator and record output stage switched off when contacts RL6 (3 and 4) open. The solenoids (L101 and L102) are energised via contacts RL7 (15 and 16). 7, 4
14. RL4 de-energises. 7
15. Reed Switch (S104) operates - RL7 de-energises (provided RL11 is energised) i.e. either external terminations 23 and 24 are strapped or the Function Switch is held in the monitor position.

(iv) Erasure

Operation of RL9 (Contacts 21, 22, 23 and 24) prepares for the Drum Eraser (L103) to receive full voltage from the secondary of T401 via contacts RL6 (21 and 22).

When RL2 is de-energised by the nine second timer, it de-energises RL9 and contacts RL9 (21 and 22) open to insert the Drum Eraser Decay Lamp (LPR101) in series with the Drum Eraser(L103) and contacts RL9 (23 and 24) connect the thermistors RT401 and RT402, across the coil. The initially cold lamps has a low resistance, but this increases rapidly as the lamp filament heats and thus reduces the current through the erase coil without introducting any significant switching transients. The thermistors, on the other hand, decrease in resistance with rising temperature, and so further reduce the current flowing in the erase coil. When the Reed Switch (S104) operates to de-energise the Drum Eraser, the flux in the coil has dropped to a sufficiently low level to prevent an audible 'plop' being recorded on the band.

5. DRUM DRIVE & HEAD CARRIER MECHANISM

(a) Drum Drive -
The drum is driven by a low speed induction motor via a puck wheel. To ensure reliable traction, the motor driving shaft is acid etched, the rim of the drum is sand blasted, and correct positioning of the drum, puckwheel and motor allows the puck wheel to 'bite in' as the load on the drum increases. To ensure long life, the drum, puck wheel and motor spindle rotate on double ball races.

(b) Reed Switch -
The Reed Switch (S104) is a changeover switch which has a magnetic leaf as its moving arm. The contacts are enclosed in a glass envelope which is filled with an inert gas. As the magnet in the Magnet Carrier is moved past the Reed Switch by the rotation of the drum, the reed switch (S104) operates once per revolution.

(c) Head Drive -
The head is moved axially along the drum when the Indexing Arm stylus engages in the scroll attached to the drum. Correct engagement is achieved by adjusting the Magnet Carrier on the drum shaft to allow the Reed Switch to operate (and release solenoids L101 and L102) when the stylus is directly above the trough of a thread. To ensure long life, the Head Carriage Rod is supported at either end by a linear bearing ball bushing.

(d) Head Lift Solenoids -
The solenoid armatures are pivoted on needle rollers and the arms support the Solenoid Rod and its associated linear bearing ball bushing. The casing of this bearing slides in a fork attached to the Head Carriage Rod and allows the solenoids to lift the head off the drum and disengage the stylus, regardless of the position of the head on the drum.

(e) Head Lifter -
The head is pivoted in an assembly to allow for band variations. To prevent the head from dragging across the band when the solenoids operate to return the carriage, a head lifter is mounted on the head bearing block and adjusted to lift the head clear of the band.

(f) Carriage Return Damper -
When the solenoids operate and disengage the stylus, the carriage return spring quickly returns the carriage to the 'home' position. The Damper reduces the return speed of the carriage over the last inch of travel and prevents excessive noise and damage to the mechanism.

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6. MAINTENANCE AND TROUBLE SHOOTING

(a) General classification of possible faults -

No.	Fault	Symptoms
1.	Audio fail alarm operates when unit is in replay mode.	1, 2, 3, 4, 7, 8, 9, 10, 19, 20
2.	Replayed message has high flutter and wow content.	21.
3.	Replayed message has high level variations.	5.
4.	Replayed message is lacking in high frequencies.	6.
5.	Sound heard between end of message and beginning next replay cycle.	22.
6.	Unit keeps replaying for longer than 8 seconds after Function Switch is placed in the record position.	11, 12.
7.	Record Indicator fails to light 13-21 seconds after Function Switch is placed in record position.	11, 12, 13, 14, 15
8.	Audio fail alarm operates during record mode.	16.
9.	Record Indicator remains alight when function switch is returned to central position.	17.
10.	A message just recorded has high background noise and distortion.	18.
11.	A recurring 'hissing plop' is heard in the background every $6\frac{1}{4}$ seconds.	14.
12.	Previous message only partially erased.	13.

Sympton	Possible Cause	Remedy
1.When unit is switched on, the motor either fails to start or has low torque.	Failure of Carriage Over-run Switch (S102).	Replace S102.
	One winding of the motor has become open-circuited.	Replace motor winding.
	Failure of C101 or C102.	Replace.
	Motor not plugged in.	Plug in.
	Main fuse blown.	Replace fuse.
2.When unit is switched on, the motor starts but the AC Indicator fails to light.	Failure of AC Indicator (LP103) globe.	Replace globe.
	Power supply not plugged in correctly.	Plug in correctly.
	Failure of power supply.	Check components in Power Supply (Section 6(e)) (D401-404).
3.When the unit is switched, the AC Indicator lights but the unit will not perform the relay sequence and the electronic modules fail to operate.	Failure of Regulated Section of Power Supply.	Repair Power Supply (Section 6(e)).
4.Unit will not replay either a message or band background noise.	RL10 faulty.	Replace RL10. (Section 6(b)(ix))
	Failure of replay amp.	Repair or replace Replay electronics Module (section 6(c))
	Dirt has collected under head face.	Clean all driving surfaces with MEK solvent.
5. Excessive level variations on replay.	Head mis-aligned.	Re-align head. (Section 6(b)(vii)).
	Excess lubricating oil on the band.	Remove excess oil. (Section 6(b)(x)).
	Head Lifter out of adjustment.	Re-adjust Lifter. (Section 6(b)(viii)).
	One or both solenoid return springs has failed.	Renew both springs.
	Faulty stylus.	Replace stylus. (Section 6(b) (ii)).

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Symptom	Possible Cause	Remedy
6. Poor high frequency response on replay.	Excess oil on band.	Remove excess oil. (Sec. 6(b) (x)).
	Head mis-aligned.	Re-align head. (Sec. 6(b) (vii)).
	Faulty stylus.	Replace stylus. (Sec. 6(b) (ii)).
7. Stylus fails to engage in the scroll when the Reed Switch operates.	Fault in Reed Switch or Carriage Sensing Switch.	Replace faulty Switch. (sec. 6(b)(v)).
	Faulty stylus.	Replace stylus. (Sec. 6(b) (ii)).
	Failure of one or both solenoid return springs.	Replace both springs.
	Carriage mechanism is jammed.	Free mechanism.
8. Carriage fails to return at the end of message but the 50 c/s tone can be heard in the monitor.	Failure of carriage return circuitry.	Repair or replace carriage return electronics (Sec. 6(c) (iii)).
	Failure of RL7.	Replace RL7. (sec. 6 (b) (ix)).
9. Unit on standby but Audio Fail Indicator lights.	Dirty contact RL11 (5&6)	Replace RL11 (Sec. 6(b) (ix)).
	Faulty Pillar contacts on alarm board.	Check all contacts. (Sec. 6 (c) (ii)).
	Failure of alarm circuits.	Check all components. (Sec. 6 (c) (ii)).
	Failure of RL1	Replace RL1. (Sec. 6 (b) (ix)).
10. Audio Fail Indicator lights whilst unit is operating with signal in the replay mode.	Faulty pillar contact on alarm board.	Check all contacts. (Sec. 6 (c) (ii)).
	Failure of alarm circuit.	Check all components. (Sec. 6 (c) (ii)).
	Failure of RL1	Check RL1. (Sec. 6 (b) (xi)).

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Symptom	Possible Cause	Remedy
11. The unit will not start the erase cycle when the Function Switch is placed in the Record position and the reed switch has subsequently operated.	Faulty contact on Function Switch.	Repair or replace switch.
	Faulty Reed Switch.	Replace insert. (Sec. 6(b) (v)).
	Failure of D110, D111	Replace faulty diode.
	Failure of RL5	Check that RL5 is plugged in correctly and replace if faulty. (Sec. 6(b) (xi)).
	Failure of RL2 or RL9.	Check relays. (Sec. 6(b) (xi)).
	Fault in 9 second timer in power supply module.	Check circuit and replace faulty component. (sec. 6 (e)).
12. Carriage fails to return when unit is placed in the Record mode.	Failure of RL9 or contacts RL9 (3 and 4)	Replace or repair RL9. (Sec. 6(b)(ix)).
	Solenoids inoperative.	Check that solenoids are plugged in correctly, and not open circuited.
	Failure of RL7 or contacts (15 and 16)	Check RL7. (Sec. 6(b) (xi)).
13. Drum Eraser decay lamp is on for complete erase cycle.	Faulty contact RL9 (21&22)	Clean or replace contact. (Sec. 6(b) (xi)).
14. Drum Eraser decay lamp either does not light or is on for less than 4 seconds.	TS401 has failed.	Replace TS401.
	C405 has failed.	Replace C405.
15. Erase and decay cycle operates correctly but unit will not start recording.	Fault in RL8 or associated contacts.	Repair or replace RL8. (Sec. 6(b)(xi)).
	D109 is faulty.	Replace D109.
	Contacts RL6 (5&6) are faulty.	Repair or replace contacts. (Sec. 6(b) (xi)).
	Contacts RL9 (5&6) are faulty.	Repair or replace contacts. (Sec. 6(b) (xi)).

Symptom	Possible Cause	Remedy
16. Audio fail alarm operates during record.	D113 is faulty. (see points in 10 also).	Replace D113.
17. When Function Switch is returned to central position after making a recording, the unit fails to return to the replay mode.	Fault in 0.25 second timer on the Power Supply Slide.	Check operation of timer. (Sec. 6(e)).
	RL3 inoperative.	Check RL3. (Sec. 6(b) (xi)).
	Fault in RL4 pulsing circuit RL4, TS101, R101, R102, R103, C103.	Check pulsing circuit. (Sec. 6 (f)).
	Carriage return spring inoperative.	Check spring.
	Piston is fouling dashpot.	Clear any foreign matter and ensure there is clearance around piston.
	Contact RL4 (9 and 10) inoperative.	Check RL4. (Sec. 6(b) (xi)).
	RL7 inoperative.	Check RL7. (Sec. 6(b) (xi)).
	Contact RL7 (15 and 16) inoperative.	Check RL7. (Sec. 6(b) (xi)).
18. A new message contains high distortion and background noise.	Globe (LP301) in record amplifier light-cell has failed.	Replace light cell.
	Failure of automatic level control.	Check all components. (Sec. 6 (d)).
	Failure of ORP12 (R306) in record amplifier.	Replace light cell.
	Initial half minute delay not observed.	Repeat recording. (Sec. 3 (d) (ii)).
19. Unit performs record cycle correctly but fails to replay the message although band background noise is apparent.	No bias on head during recording.	Check components in bias oscillator particularly TS310. (Sec. 6 (d)).
	Replay & Record Electronics Modules not plugged in correctly.	Plug in correctly.
	RL10 inoperative.	Check RL10. (Sec. 6(b) (xi)).
	Insufficient pressure between head and drum.	Check spring.
	Head mis-aligned.	Re-align head. (Sec. 6 (b) (vii)).

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Symptom	Possible Cause.	Remedy
20. Unit will not recycle message after a new recording has been made, and the carriage return tone cannot be heard in the monitor.	Open circuit in 2V winding of T401.	Replace T401.
	Failure of R402.	Check R402.
	Faulty contacts RL3 (6&7)	Check RL3. (Sec. 6 (b) (xi)).
	Faulty connection on pins (5,6) of Soc 4 or (5,11) of Soc 9.	Plug modules in correctly.
21. High flutter and wow.	Motor spindle out of alignment.	Return to factory, for service.
	Puckwheel worn.	Replace puckwheel.
	Motor bearing fault	Return to factory for service.
	Dirty or oily drive surfaces causing slippage.	Clean all surfaces thoroughly with MEK solvent.
22. Sound heard between end of one cycle and beginning of next.	Head Lifter out of adjustment.	Re- adjust. (Sec. 6(b) (viii)).

(b) Adjustments -

N O T E -

Adjustment of the Head Lift Solenoids should be followed by adjustment of items (iii), (iv), (vii) and (viii) in this order.

Adjustment of the Stylus should be followed by adjustment of items (i), (iii), (iv), (vii) and (viii) in this order.

Adjustment of the Indexing Arm should be preceded by adjustment of items (i) and (ii) and followed by adjustment of items (iv), (vii) and (viii).

Adjustment of the Fork should be preceded by adjustment of items (i) and (iii) followed by adjustment of (vii) and (viii).

Adjustment of the Reed Insert should be followed by adjustment of item (vi).

Adjustment of the Magnet Carrier should be preceded by adjustment of item (v).

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(b) Adjustments (cont) -

Adjustment of the Head Carrier Assembly should be preceded by adjustment of items (i), (ii), (iii), and (iv) and followed by adjustment of item (viii).

Adjustment of the Head Lifter should be preceded by adjustment of items (i), (ii), (iii), (iv) and (vii) in this order.

(i) Adjustment of the Head Lift Solenoids (L101 and L102).

1. Release the grub screw in the arm of each solenoid to free the solenoid Rod.
2. Hold down the rod so that each solenoid is at the bottom of its travel (i.e. in its energised position).
3. Re-tighten the two grub screws.

(ii) Adjustment of the Stylus.

1. Loosen socket head screw in Indexing Arm.
2. Loosen stylus locknut.
3. Place the stylus in a groove and hold it firmly to enable the stylus to rotate and align itself correctly in the groove. Re-secure the stylus by lightly clamping the stylus lock nut.

NOTE: overtightening will fracture the cast stylus.

(iii) Adjustment of Indexing Arm.

1. Release the socket head screw in the Indexing Arm.
2. Slide the Indexing Arm along the carriage return rod until it is 4 5/8" from the right hand end of the rod.
3. Re-tighten the screw.
4. Release the two grub screws holding the air damper piston on the carriage return rod.
5. With the Indexing Arm against the right hand linear bearing block, slide the piston along the rod as far to the right as possible without it actually touching the end of the dashpot.
6. Re-tighten the two grub screws.

(b) Adjustments (cont) -

(iv) Adjustment of Fork on Carriage Return Rod.

1. Release the fork mounting screw.
2. Slide the fork along the rod until it is in such a position that the fork is 7 5/8" from the right hand end of the rod. Bend the actuator arm to allow the Carriage Sensing Switch to operate when the Indexing Arm is .2" from the right hand linear bearing block.
3. With the solenoids (L101 and L102) de-energised, rotate the fork on the rod in this position until the stylus seats correctly in a groove of the scroll. The stylus should be lifted 3/32" clear of the scroll when the solenoids are energised. (use drill shank as feeler guage).
4. Re-tighten the fork mounting screw.

(v) Adjustment of Reed Insert.

1. Remove magnet carrier from drum shaft.
2. With the Reed Insert Assembly removed from the Main Casting, release the grub screw retaining the Reed Insert.
3. Slide the insert through the slot in the Reed Insert Holder so that the glass moulding sits centrally in the block and the n/o contact is on the open side of the slot.
4. Re-tighten the grub screw (with the cushioning pad in position) until a slight resistance is felt.

NOTE: Overtightening will fracture the insert and render it inoperative.

5. Re-mount the assembly on the Main Casting with the double contact end facing the scroll.
6. Re-mount the magnet carrier on the drum shaft.

(vi) Adjustment of the Magnet Carrier.

1. Loosen the grub screw in the Magnet Carrier.
2. With the Indexing Arm against the Right Hand Bearing Block and the solenoids de-energised, rotate the drum in its normal direction until the stylus drops into the groove. Hold the drum stationary in this position and rotate the magnet carrier in the same direction until the Reed Insert operations.
3. Re-tighten the grub screw.

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(b) Adjustments (cont) -

(vii) Adjustment of the Head Carrier Assembly.

1. Release the Assembly mounting screw.
2. With the Indexing Arm against the Right Hand Linear Bearing Block, slide the assembly along the rod until the head laminations are 0.05" inside the right hand edge of the band.
3. With the stylus seated correctly in a groove, rotate the assembly on the rod until the head face lies tangential to the band surface.

4. Tighten the mounting screw slightly.
5. Align the head to allow the head gap to lie flat on the band. (arm may be twisted to facilitate this adjustment.)

6. Record a 1 Kc/s tone on the band.
7. Replay this tone and rotate the assembly on the rod for maximum replay level with minimum level variations.
8. Repeat 6 and 7 alternatively until maximum performance is obtained.
9. Repeat 8 using a 3.5 Kc/s signal.
10. Tighten the Head Carrier mounting screw.

(viii) Adjustment of Head Lifter.

1. Release the hexagonal screw holding the Head Lifting Plate.
2. With the solenoids de-energised, adjust the Head Lifting Plate so that the Head Lifting Stud sits 1/64" below the Head Arm.

NOTE: check that the head is lifted at least 1/64" clear of the band when the solenoids are energised.

3. Re-tighten the screw.

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(b) Adjustments (cont) -

(ix) Head Cleaning Procedure.
Lift the head off the band and clean the head face with a soft cloth or absorbent tissue.

(x) Band Cleaning Procedure.
The manufacturer recommends that the band be cleaned at intervals of between 6 weeks and 6 months depending on the environmental conditions. The recommended cleaning fluid is made up as follows -

Dissolve 3 parts of General Electric SF96 (300) Silicon oil or equivalent in 7 parts of Carbon Tetrachloride and dilute the solution with 90 parts of MEK (Methylethylketone).

1. Remove the Drum Lubricator and brush the leather and felt edges free of foreign matter.
2. Rotate the drum slowly in the normal direction and clean the band thoroughly with lint-free absorbant paper moistened with cleaning fluid.

NOTE: Care must be taken that oil does not contaminate the drive surface on the rim of the drum.

3. Replace the lubricator.

(xi) Adjustment of Relay Contacts.
Relays RL1, 2, 3, 4, 5, 7, 10 and 11 are Siemens-Halske Dust Proof Cradle Relays and the manufacturer recommends that a relay be replaced if found to be faulty.
Relays RL6, 8, and 9 are 3000 type relays and should be adjusted in accordance with Engineering Instruction-Telephone Relays AD1001.

(c) Servicing the Replay Electronics Module -

To facilitate testing of the replay Electronics Module a test jig, as shown, is necessary. The two voltage rails (+12V and +24V) may be obtained from batteries, a lab power supply or the VMR's own power supply (+12V pins 10 and 7). (Fig. 2) 12 - 0178)
(+24V pins 07 and 7). (Pin 7 earth)

1. Connect the attenuator pad to the unbalanced 600 ohm output of an audio oscillator.
2. Connect the amplifier's output to an amplifier voltmeter.
3. Switch on the supply.

(c) Servicing the Replay Electronics Module (cont) -

(i) Replay Amplifier.

NOTE: -2.2dBV is equivalent to 0dbm into a 600 ohm load.

4. Adjust the input level to give an output level of +7.8 dBV across a 600 ohm load. Should this be unattainable, check the DC and AC voltages in the circuit to ascertain the location of the fault. With the carriage return circuit board plugged in, the amplifier should deliver -2.2 dBV into a 600 ohm load with 4.3 V r.m.s. input to the attenuator pad.
5. Take frequency responses for a 600 ohm load and a 6 ohm load. These should lie within the limits shown in graphs. (Figs. 1a and 1b). (12-0178)
6. Feed a 1 Kc/s tone into the amplifier and note the level variation between a 600 ohm load and a 6 ohm load. This should be less than 3db.
7. Depress the head C/O switch, RL10 should energise.
8. Measure the distortion of the output signal at a level of 500 milliwatts into a 6 ohm load at 1 Kc/s (5.0 dBV). It should be less than 1% T.H.D.
9. Feed a 1V r.m.s. 50 c/s signal into the attenuator pad. The output level across a 600 ohm load should be less than -27.2 dBV.
10. Short the coaxial input lead and measure the output level across a 600 ohm load. It should be less than -37.2 dBV.

High noise may necessitate the replacement of either TS201 or TS202.

(ii) Audio Fail Alarm.

11. Check that the requirements of Item 4. are satisfied before attempting to check the alarm. If necessary, the replay amplifier should be checked first.
12. Feed a 1 Kc/s signal into the amplifier to obtain an output level of 0dbm in a 600 ohm load. The audio fail lamp should light.

NOTE: In this test jig, the lamp is energised when audio is present in the line. In the VMR unit, the lamp is extinguished when audio is present.

If the lamp fails to light, check the DC and AC voltages in the circuit to determine the location of the fault. (Refer to drawing 12-0173.)

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(c) Servicing the Replay Electronics Module (cont) -

(ii) Audio Fail Alarm (cont)

13. Operate the 'Head Change Over Switch'. After a delay of at least 7 seconds, the alarm fail light should be extinguished. A delay of less than 7 seconds may necessitate the replacement of C232.
14. Repeater Item 13 then operate the 'Alarm Mute' Switch. The audio fail lamp should light within 2 seconds.

(iii) Carriage Return.

15. Check that the requirements of Item 4 are satisfied before attempting to check the carriage return. If necessary, check the replay amplifier first.
16. Feed a 1V r.m.s. signal at mains frequency into the attenuator. The carriage return lamp should light. Sweep the oscillator across this frequency and note the two frequencies at which the total voltage across the lamp and resistor drops to 3.5V. These two frequencies should be at least 3 cycles apart.
If the carriage return fails to operate correctly, check the AC and DC voltages in the circuit to determine the location of the fault.

(d) Servicing the Record Electronics Module -

1. Plug the module into the test jig socket and connect up the oscillator, decade attenuator and amplifier voltmeter as shown (fig. 3). 12-0178)
2. Switch on the supply.
3. Disconnect the oscillator and adjust R329 until the voltage across the 6V Liliput globe (LP301) is 0.8 - 1.0 V. Measure the voltage across the two leads emerging from the bracket end of the light cell.

NOTE: The circuit board must be removed from the metal slide to facilitate this adjustment.

If this voltage cannot be obtained, check the voltages on transistors TS305 - TS309 to locate the fault. (Refer to drawing No. 12-0174).

4. With the decade attenuator set to give zero attenuation, feed a 1 Kc/s signal through it into the amplifer until the voltage across the lamp (LP301) reaches its maximum (less than or equal to 6V).

NOTE: for this test, ensure that the bias oscillator is inoperative.

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(d) Servicing the Electronics Module (cont) -

5. With this voltage on the globe, the voltage across the 100 ohm resistor should be approximately .017 Volts r.m.s.
6. Decrease the input voltage in 10db steps and note the change in output voltage. For a 30db change in input voltage, the output should drop no more than 2db. Failure of the amplifier to give this range of control will most likely be due to loss of loop gain, and nearly every component is suspect. When the input level is lowered by 10db, the output should drop and then slowly rise to its final value. Failure of C316 and R327 could cause the change to be instantaneous.
7. Set the globe voltage to approximately 4.0 volts by adjusting the input level.
8. With 1 Kc/s as reference, take a frequency response of the amplifier and check that it lies in the range shown on the graph in Fig 1C, 12-0178)
9. Disconnect the audio oscillator and switch on the bias oscillator. With the C.R.O. and voltmeter now connected directly across the head or inductor, check that the wave form is undistorted. Set the voltage to 20V by adjusting R342.
10. Tune the oscillation to 25 Kc/s by adjusting the oscillator coil slug. (L302).
11. Adjust the slug in the bias trap coil (L301) to obtain a minimum voltage on the emitter of TS304.

(e) Servicing the Power Supply Module -

1. Plug in the module and switch on. (fig. 4.) 12-0178)
2. Check that the following voltages are present -
   (a) 16V AC (3 and 4).
   (b) +12V DC (7 and 10 - 7 earthed),
   (c) +24V DC (7 and 9 - 7 earthed).
   (d) +24V DC (07 and 7 - 7 earthed).
   (e) 2V AC (measured on the circuit board itself)
3. Operate .25 second switch - appropriate lamp should pulse.
4. Operate 9 second switch and maintain - appropriate lamp should glow for 8 to 9 seconds.

(f) Servicing the Pulsing Circuit -

1. Unplug the motor, power supply and right hand solenoid.
2. Disconnect leads from the Drum Erase, the Drum Indexing Switch and the Carriage Sensing Switch.
3. Remove motor and Drum Erase.
4. Remove the four screws from each corner of the relay chassis and lift the relay chassis and outer frame clear of the Main Casting. The pulsing circuit is located on the circuit board below the chassis.
5. Plug in the power supply and switch on the unit.
6. Energise RL3 by earthing pin 02 on socket 5 with a jumper lead. C103 should charge to +24V.

   NOTE : adjacent pins 1,2 and 010 are at 240V AC.

7. De-energise RL3. RL4 should pulse.