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TECHNICAL DATA

HANDBOOK

FOR

TERMINAL, TELEPRINTER(BROADCAST)

TYPE T.T.11

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AMENDMENT

Handbook No. & Issue... 797 Issue 1
Handbook Title... Terminal, Teleprinter (Broadcast) T.T.11
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Page/Drg. reference	Details of Amendment(s)
FIG.2	Delete R57
WDA/6338/L	Delete R57. Amend value of RV51 to 1.5 k.

AMENDMENT

Handbook No. & Issue... Handbook No.797, Issue 1
Handbook Title... Handbook for Terminal, Teleprinter (Broadcast) Type T.T.11
Amendment Sheet No.... 2
Date of Issue... 24th September 1964

Page/Drg. reference	Details of Amendment(s)
Page 33	Part 2, Chapter 1, Paragraph 7, Sub-paragraph (3): amend table to read as follows:-

Test Point	Volts d.c.	Test Point	Volts d.c.
1	+2.1	9	6.4 - 7.5
2	2.80-3.05	10	35 - 41
3	2.75-3.25	11	69 - 75
4	6.1-7.4	12	18 - 25
5	6.0-7.3	13	7.9 - 10.3
6	0-0.15	14*	5.1 - 5.5
7	1.05-1.25	15*	4.6 - 5.7
8	10.7-11.3		

Page 34

Part 2, Chapter 1, Paragraph 9, Sub-paragraph (2): amend table to read as follows:-

Test Point No.	Level (mV)
2	6.5
3	1.6
4	45
5	57

Page 34

Part 2, Chapter 1, Paragraph 10: amend table to read as follows:-

Input Level		D.C. Volts at Test Point 6
dbm	voltage	
-19.8	158 mV	1.5-2.0 (= y*)
-10	245 mV	y + (0.4 to 0.9)
0	775 mV	y + (1.1 to 1.8)
+10	2.45 V	y + (1.1 to 2.3)

AMENDMENT

Handbook No. & Issue... Handbook No.797, Issue 1
Handbook Title... Handbook for Terminal, Teleprinter (Broadcast) Type T.T.11
Amendment Sheet No.... 5
Date of Issue... 24th September 1964

Page/Drg. reference	Details of Amendment(s)
Page 35	Part 2, Chapter 1, Paragraph 11, Sub-paragraph (2): amend table to read as follows:-

Test Point	Volts d.c.
7	1.45 - 1.75
8	0.7 - 1.3
9	33 - 41
10	5.9 - 6.9
13*	2.4 - 2.8
14	11.1 - 13.1
15*	2.05 - 2.55

NOTE

Due to this amendment, a few readings for the Table of Voltages, Part 2, Chapter 3, Paragraph 16, may differ slightly to those given.

H A N D B O O K F O R

TERMINAL, TELEPRINTER (BROADCAST) T.T.11

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INTRODUCTION

Designed primarily for use with the Creed Model 75 Teleprinter in naval installations, the Terminal, Teleprinter (Broadcast) T.T.11 converts incoming keyed-tone teletype signals to double-current d.c. pulses suitable for operating the electromagnet of a teleprinter receiver.

Use of the T.T.11 permits low-level a.f. signalling to be adopted between a receiver terminal and the teleprinter operating point, thus obviating the transient interference that is often induced in neighbouring circuits by d.c. signalling. The T.T.11, which has an input impedance of 600 ohms, operates with 1 kc/s input levels from -10 dBm to 0 dBm, and accommodates keying speeds exceeding 100 bauds; a simple internal adjustment allows a choice of Tone On for Mark or Tone On for Space keying sense.

Fully transistorised, the T.T.11 is suitable for operation on 100/125 V or 200/250 V 50/60 c/s supplies. It is constructed as a drawer assembly to fit underneath the teleprinter: a special mount carries the T.T.11 in runners and forms a table to support the teleprinter; the complete installation is suitable for bench mounting, and forms a compact operating point for the reception of broadcast teletype traffic.

The supply to the unit and to the teleprinter motor is controlled by a single switch on the front panel. A phone jack is provided for monitoring incoming signals - a facility that also permits audio reception of morse signals if so desired, with the mains supply switched off. An internal bell is fitted, to operate in conjunction with the normal bell contacts of the associated teleprinter.

I M P O R T A N T N O T I C E

TERMINOLOGY USED FOR KEYING CONDITIONS

Throughout the Summary of Data and Parts I and II of this handbook the terms ACTIVE and NON-ACTIVE are used instead of the terms SPACE and MARK. Active and Non-active conditions may also be referred to as conditions A and Z respectively. This terminology is employed to obviate confusion that may otherwise arise when taking into account the alternative keying senses that may be adopted.

The Active condition is defined as that state of the double-current output circuit of the T.T.11 in which the current supplied to the electromagnet coil of the teleprinter is in the same direction as the Start signal current; when the output current is in the same direction as the Stop signal current, the circuit is considered to be in the Non-active condition.

It is assumed throughout that the internal connections of the teleprinter receiver circuit are such that the signalling voltage convention of Positive for Space and Negative for Mark is observed. In that context, when using a Creed 75 (Admiralty No.12) Teleprinter, current flows through the electromagnet coil in the direction from teleprinter terminal J to teleprinter terminal G for the Active condition, and from G to J for the Non-active condition, i.e. the Active condition corresponds to Space and the Non-active condition to Mark; conditions are reversed if the teleprinter internal connections are altered to the opposite sense, and due allowance must be made in such circumstances.

Since the keying sense of the T.T.11 may be adjusted for either a Tone On for Active condition or a Tone Off for Active condition, the terms TONE ON and TONE OFF are employed when considering circuit conditions in relation to the input signal.

TERMINAL TELEPRINTER (BROADCAST) T.T.11

Application	To convert an incoming radio-teletype signal, consisting of a keyed 1 kc/s tone, into a double-current signal suitable for reception by a teleprinter.
Construction	Complies with British Inter-Service Specification K114A (Shipboard Equipment) for Climatic and Durability Testing of Service Telecommunication Equipment.
Maximum Signalling Speed	Greater than 100 bauds; normally 75 bauds for use with Creed 75 Teleprinter.
Input Level	For the Tone On condition, between -10 dBm and 0 dBm over the frequency range 900 - 1100 c/s; signals at a level of -10 dBm do not operate the equipment if the frequency is less than 750 c/s or greater than 1250 c/s.
Input Impedance	600 ohms resistive, $\pm$ 10%; decreased when the Receive Line Level Monitor jack is in use.
Bias Distortion	For a keyed 1 kc/s input tone, at a Tone On level of between -10 dBm and 0 dBm, the pulse duration of the output signal to the teleprinter is within 2 mS of the pulse duration of the input signal.
Coil Current	The current delivered to a 200 ohm electromagnet, such as that of a Creed 75 Teleprinter (Admiralty No.12), is adjustable over the range 25 - 45 mA d.c.
Coil Current Balance	The coil currents in the active and non-active conditions do not differ in magnitude by more than 1.5 mA.
Mains Supply	100/125 V or 200/250 V 50/60 c/s, single phase, 22 W. Maximum permissible voltage variation $\pm$ 6% Maximum permissible frequency variation $\pm$ 6%
Temperature Range	Operates over a range of ambient temperatures from 0^{o}C to 55^{o}C.
Monitor Points	Provision for monitoring incoming line and output circuits. Test points for setting up

teleprinter electromagnet coil current, and for monitoring voltages and waveforms at various stages.

Alarm Bell — Operates when alarm contacts of teleprinter close.

Traffic Indicator — When a signal corresponding to 13 mS duration of condition A is received, an indicator lamp lights and remains lit for at least 130 mS (typical figure: 500 mS).

Dimensions and Weights

5815 A.P.5802722 Terminal Teleprinter (Broadcast) T.T.11

Height	Width	Depth	Weight
$2\frac{3}{4}$ in (7 cm)	$9\frac{1}{4}$ in (23.5 cm)	$19\frac{1}{2}$ in (49.5 cm)	19 lb (8.6 kg)

5815 A.P.5806271 Mount Teleprinter Terminal

Height	Width	Depth	Weight
4 in * (10.2 cm)	$17\frac{1}{4}$ in (44 cm)	17 in (43.2 cm)	$10\frac{1}{4}$ lb (4.65 kg)

* This is the height to the top of the table on which the teleprinter is mounted. An additional 2 in (5 cm) should be allowed for the dimension over the spring-loaded retainers that secure the teleprinter.

PART 1

CHAPTER 1

OPERATING INSTRUCTIONS

CONTENTS LIST

CHAPTER 1

OPERATING INSTRUCTIONS

1. Proceed as follows:-

(1) Open the hinged protecting flap, by pulling its upper edge forwards, to gain access to the controls on the front panel (the flap is held closed by magnetic catches).

(2) Put the MAINS switch (S131), on the front panel, to the On position. This initiates the following:-

(a) The MAINS lamp (ILP131) lights.

(b) The supply is completed to the teleprinter motor.

(c) On receipt of an incoming code signal, the TRAFFIC indicator lamp (ILP121) lights and remains lit until a break in signalling occurs exceeding approximately $\frac{1}{2}$ second.

(3) Close the protecting flap over the front panel.

(4) Ensure that the RECEIVE LINE MONITOR GAIN control (RV1), at the right hand side of the equipment, is turned fully anti-clockwise.

(5) To switch the equipment off, it is necessary only to open the protecting flap, put the MAINS switch (S131) to the Off position, and close the flap again.

2. To carry out an audio check of the incoming signal, or to receive morse signals:-

(1) Plug a pair of high-impedance headphones into the RECEIVE LINE MONITOR jack (JKA) at the right hand side of the equipment.

(2) Rotate the RECEIVE LINE MONITOR GAIN control (RV1) in a clockwise direction to give a convenient audio level in the headphones

(3) If morse reception is intended, put the MAINS switch (S131) to the Off position to prevent the teleprinter operating.

(4) On completion of the audio check, or of morse reception, remove the headphones and reset the RECEIVE LINE MONITOR GAIN control (RV1) fully anti-clockwise.

3. The calling bell within the unit is connected to the teleprinter, and its use is described in the handbook for that equipment.

C H A P T E R 2

T E C H N I C A L D E S C R I P T I O N

CONTENTS LIST

C H A P T E R 2

T E C H N I C A L D E S C R I P T I O N

CONSTRUCTION

5815-99-580-2722

1. The 5815 A.P.5802722 Terminal, Teleprinter (Broadcast) T.T.11 is constructed in the form of a drawer assembly designed to fit under the table-shaped 5815 A.P.5806271 Mount, Teleprinter (Terminal), which in turn is intended to support the Creed Type 75 Teleprinter (Admiralty No.12).

5815-99-580-6271

2. Six rollers, three fitted to each side of the chassis, run in channels on the Mount; the rollers are staggered, to obviate the necessity to locate two rollers simultaneously when positioning the unit. Spring-loaded catches on the Mount secure the T.T.11, engaging the spindles of the two rollers nearest the front of the chassis.

3. A hinged protecting flap, held closed by magnetic catches, covers the front panel controls and the fuses. At the right hand side of the unit, near the front, is a Receive Line Level Monitor jack and an associated Gain control. The mains supply cable, and cables to associated equipment, are connected via sockets at the rear.

4. The top and underside covers of the unit are slotted for ventilation. A pivoted support bar is provided at the right side of the unit: when opened out, the bar permits the unit to be stood on its side on a bench; when not in use, the bar is held against the chassis by a spring clip.

CIRCUIT DESCRIPTION

GENERAL

5. Refer to the block diagram (Drawing No. SK.4842/M).

Circuit References

6. For ease of identification, the circuit reference numbers of all components are divided into groups that correspond to the various blocks shown on Drawing No. SK.4842/M; these groups of numbers are indicated against the appropriate component

groups on the circuit diagram. A similar grouping in the physical layout enables any component to be located speedily with the aid of the circuit diagram.

Mode of operation

7. The block diagram (Drawing No. SK.4842/M) illustrates the stages employed in the conversion of the keyed 1 kc/s input signal to double-current output pulses suitable for reception by the teleprinter. The keying sense of the input signal may be Tone On for Active condition or Tone Off for Active condition: the particular keying sense that is to be accepted is determined by pre-adjustment of connections within the T.T.11.

8. Incoming signals are fed via a band-pass filter and an attenuator to an amplifier. The loss introduced by the attenuator is controlled by an a.g.c. voltage; this reduces variations in signal amplitude, thereby minimising bias distortion, and also reduces the possibility of the teleprinter operating on noise received between tone pulses.

9. After amplification, the signal is passed to a tone-pulse/keying-pulse converter, which demodulates the signal to give an output consisting of single-current d.c. pulses. The a.g.c. voltage is derived from this part of the circuit.

10. A driver circuit samples and amplifies the d.c. keying pulses, which then trigger the electromagnet coil current switch; the latter is a monostable circuit delivering a double-current telegraph signal to the teleprinter. A voltage derived from this stage is applied to a traffic indicator circuit, which causes a lamp on the front panel to light whenever an input signal corresponding to condition A is received; it remains lit until a break in keying occurs exceeding approximately half a second in duration.

11. The a.c. mains supply is fed to two rectifier circuits, one of which provides a -75 volt supply for the electromagnet coil current switch, and the other a -12 volt supply for the remaining transistors.

DETAILED DESCRIPTION

12. Refer to circuit diagram (Drawing No. WDA/6338/L).

Input Circuit and Filter

13. Over an 850 c/s - 1150 c/s pass-band, the loss introduced by the input filter varies by less than 1.5 dB.

At 750 c/s and 1250 c/s the attenuation is at least 6 dB greater than that at 1000 c/s, while at frequencies below 500 c/s or above 1650 c/s it is at least 40 dB greater than at 1000 c/s. Two low-pass sections are employed (C1 - C5, in conjunction with L1 and L2) followed by two high-pass sections (C6 - C10, L3 and L4). The complete filter is terminated by an effective resistance of approximately 2.5 kilohms, transformer T1 being used to match the filter to the balanced 600 ohm line; R1 - R3 form a 600 ohm pad to swamp changes of input impedance resulting from variations of filter impedance over the pass-band. The use of a composite filter, comprising high-pass sections in cascade with low-pass sections, avoids excessive variation in time delay over the accepted frequency band, thus minimising distortion of the keying envelope.

14. A monitor jack JKA and an associated potentiometer RV1 are wired in parallel with the input circuit, to permit connection of a pair of headphones or a suitable meter. The shunting effect of the monitoring instrument on the input impedance of the T.T.11 is greatest when RV1 is set for maximum voltage at JKA.

A.G.C. Attenuator

15. The input signal voltage fed from the filter to the a.g.c. attenuator is adjusted by means of potentiometer RV11, the setting of which pre-determines the level of signal from line necessary for correct triggering of the electromagnet coil current switch.

16. Since C12 and C13 are virtual short circuits to chassis at 1000 c/s, the a.c. circuit of the a.g.c. attenuator may be regarded as a resistive pi-network: the first shunt arm is formed by R14 and R15, effectively in parallel, and the second shunt arm by R17; the series arm is the parallel combination of R18 and the diode MR11, the a.c. resistance of the latter being controlled by an a.g.c. voltage taken from VT32 emitter.

17. MR11 cathode is connected to the junction of R14 and R15, which are wired in series with R13 as a potential divider chain across the -12 volt supply; the a.g.c. current through MR11 is small compared with the bleed current through the divider chain, and thus does not appreciably affect the cathode potential of the diode as determined by the divider.

18. When the signal input level to the T.T.11 is lower than -11 dBm, the d.c. potential at VT32 emitter is positive with respect to that at MR11 cathode, and the diode MR12 in the a.g.c. line is biased in a reverse direction. A small forward bias exists across MR11, which thus has a relatively low a.c. resistance. When the signal rises above the -11 dBm level, VT32 emitter

potential becomes more negative, causing current to flow through MR12; C13 charges, driving the junction of R16 and R17 more negative; thus a reverse bias is applied to MR11, increasing its a.c. resistance. The effective a.c. resistance of the series branch of the pi-network therefore rises, increasing the attenuation of the signal.

19. As soon as the level of the incoming signal again falls below -11 dBm, MR12 becomes reverse biased and prevents the discharge of C13 via the a.g.c. line. C13 therefore discharges through R16, and through the series combination of R17, R18, and R15. The time constant of this circuit establishes an a.g.c. delay of approximately 3 seconds, which may be reduced to approximately $\frac{1}{4}$ second by completing link connection A to include R19 in circuit. The decay time is long with respect to the duration of signal elements, and ensures that the signal level is adequately controlled under normal keying conditions; the longer decay time is desirable when a high noise level accompanies the wanted signal. Owing to the low forward resistance of MR12, the time taken for C13 to charge is very short, giving an a.g.c. attack time of approximately 5 mS.

Receiver Amplifier

20. Amplification is provided by VT21 and VT22 stages in the receiver amplifier section, and by VT31 stage in the tone-pulse/keying-pulse converter. These three cascaded common-emitter stages are d.c. coupled to permit the application of both a.c. and d.c. negative feedback. The resistor R26, in VT21 emitter circuit, is not bypassed and thus provides negative current feedback to maintain a high input impedance, which is further increased by R21; an a.c. voltage from VT31 emitter and a d.c. voltage from the junction of R35 and R36 are applied as negative feedback to VT22 base circuit.

Tone-Pulse/Keying-Pulse Converter

21. The collector circuit of VT31 amplifier stage is transformer-coupled to a full-wave rectifier circuit, employing diodes MR31 and MR32, which converts the pulses of 1 kc/s tone into negative-going d.c. pulses. C33 - C35, together with L31, constitute a filter circuit to remove residual components of the 1 kc/s tone and its harmonics. The negative-going pulse output to the driver circuit and to the a.g.c. attenuator circuit is taken from VT32 emitter-follower stage, which presents the required low-resistance source of voltage to ensure a short a.g.c. attack time. R39 limits VT32 collector current, and hence the negative-going excursion of emitter potential, to prevent excessive a.g.c. voltage being developed during the first few milliseconds of a strong signal; thus R39 prevents a.g.c. overshoot.

Driver for Electromagnet Coil Current Switch

22. This section is a d.c. amplifier comprising VT41, VT42, and VT43 stages; it has a low-impedance output to provide adequate regulation of the drive voltage applied to the electromagnet coil current switch; its emitter is connected to the junction of a potential divider formed by R44 and R45, and is thus held at an adequate negative potential, with respect to chassis, to ensure that the transistor is cut off until the incoming pulse reaches a given amplitude. VT42 and VT43 are emitter followers. When a tone pulse is received, the negative-going d.c. pulse applied to VT41 base causes the transistor to conduct, and therefore to commence sampling the pulse; the collector potential becomes less negative with respect to the chassis, eventually bottoming at a value of approximately -1.5 volts, and a positive-going pulse is fed via VT42 and VT43 to VT51 in the electromagnet coil current switch. During Tone Off periods there is no output from the tone-pulse/keying-pulse converter: VT41 base potential becomes positive with respect to the emitter, and the transistor is cut off; the resulting negative-going pulse formed at the collector is passed, via the emitter followers, to VT51.

23. A thermistor TH1 is included in VT41 collector circuit to ensure that, over the working temperature range, collector current always starts to flow (i.e. the sampling of the pulse commences) when the leading edge of the input pulse reaches a given amplitude.

Electromagnet Coil Current Switch

24. Transistors VT51 and VT52 are connected as a monostable trigger circuit, which is itself triggered by the d.c. input pulses from VT43. To provide sufficient base current for VT52, the cross-connection from VT51 collector is made via VT53; the emitter current of the latter constitutes the base current of VT52.

25. During Tone On periods, VT51 is cut off and its collector assumes a large negative potential with respect to its emitter. Since VT51 collector is connected via R61 to VT53 base, VT53 conducts and base current flows in VT52. The latter also conducts, and the resulting voltage drop across R56 assists in maintaining the cut-off bias at VT51. In this condition, with VT52 conducting and VT51 cut off, the voltage drop across R59 is greater than that across R52, and test point 10 assumes a positive potential with respect to test point 9: a current thus flows in the cross-circuit from test point 10 to test point 9, through the electromagnet coil of the teleprinter. The connection to the teleprinter is made via socket SK1.

26. At the commencement of a Tone Off period, a negative-going pulse arrives at VT51 base and the transistor starts to conduct. VT53 base potential becomes less negative, and a reduction in VT52 base current ensues. The trigger circuit conditions change over to a state in which VT51 conducts heavily and VT52 is cut off, whereupon the current in the cross-circuit reverses to flow in the opposite direction through the electromagnet coil. On cessation of the Tone Off period, VT51 base potential becomes less negative, and the collector current collapses: circuit conditions revert to those for Tone On periods, with VT51 cut off and VT52 conducting.

27. Potentiometer RV51 affords adjustment of the output current. When the equipment is used in conjunction with a Creed Type 75 Teleprinter (Admiralty No.12), which has an electromagnet coil resistance of 200 ohms, the range of adjustment is from 25 to 45 mA. Test points are taken from each side of R53 to the front panel to facilitate the measurement of output current. A potential difference of 1 volt across R53 indicates 10 mA coil current.

28. Diodes MR51 and MR52 damp out switching transients induced in the electromagnet coil. This is achieved by limiting the negative-going excursions of VT51 and VT52 collector voltages to a potential determined by R54 and R55, which form a voltage divider across the -75 volt supply. C51 provides a low-reactance path for transient currents, bypassing R54.

Selection of Keying Sense

29. The keying sense for which the unit is adjusted depends upon the orientation of the connections between the electromagnet coil current switch and terminals G and J of socket SK1. With the connections as shown on the circuit diagram, the output current during the Tone On period flows through the electromagnet coil from terminal G to terminal J, and from J to G during the Tone Off period; this corresponds to the Tone Off for condition A keying sense. If the connections from G and J to the electromagnet coil current switch are interchanged, the keying sense is inverted to Tone On for condition A. A similar adjustment is required to be made to the traffic indicator circuit, as described in the next paragraph.

Traffic Indicator

30. The traffic indicator circuit operates when fed with a positive-going d.c. pulse corresponding to a condition A signal element. To accommodate the alternative keying senses, this input is derived either from the emitter circuit of VT43 or from that of VT53, depending on which of these stages provides a

positive-going pulse for condition A. Selection of the appropriate input circuit is effected by suitable connection of link B: when the keying sense is such that the Tone is On for condition A, link B is connected to the padding resistor R49 to accept an input from VT43; for the opposite keying sense, the link is connected to the junction of the voltage divider formed by R122 and R124 to select an input from VT53.

31. Diode MR121 conducts on receipt of the positive-going pulse, and C121 charges, thus driving the base potential of VT121 emitter follower less negative. The corresponding positive-going voltage appearing at VT121 emitter is fed to a monostable trigger circuit employing VT122 and VT123, whereupon VT122 cuts off and VT123 conducts. The collector current of VT123 lights the traffic indicator lamp ILP121.

32. A time delay of approximately 5 mS exists between the arrival of the leading edge of the positive-going d.c. pulse at the emitter of VT43 or VT53 and the lamp lighting. This delay is a function of the time taken for the voltage across C121 to rise as the capacitor charges; since it is well within the 13.3 mS pulse duration of a 75 baud signal, ample margin exists to ensure that the traffic indicator operates on a teleprinter Start signal.

33. At the end of the positive-going input pulse, the anode of MR121 is driven negative with respect to the cathode, putting the diode into a non-conducting condition. C121 then begins to discharge through R125, and the potential at the base of VT121 commences a negative-going excursion, starting at approximately -2 volts. A corresponding negative-going excursion occurs at VT121 emitter. The ratio of VT122 and VT123 collector loads imparts a wide backlash to the monostable trigger circuit, which consequently does not change its operating state until VT121 base potential attains a value of -6.5 volts. When that point is reached, VT122 conducts heavily and VT123 cuts off, extinguishing the indicator lamp; this occurs approximately 500 mS after the cessation of the positive-going input pulse.

34. Typical waveforms at various points of the traffic indicator circuit are illustrated in Fig.6. From these it can be seen that as soon as the monostable trigger circuit changes over to extinguish the lamp, the change of VT122 operating condition causes the potential at the emitter of that transistor, and that at VT121 base, to go less negative; these potentials settle at approximate values of -2.2 volts and -4.4 volts respectively. The circuit conditions then remain static until the next positive-going pulse again causes the traffic indicator to operate.

35. If further input pulses arrive during the 500 mS period

during which the lamp is lit, the charge on C121 increases correspondingly. However, unless the p.r.f. of these pulses is adequate to maintain the charge, the latter progressively decays until the monostable circuit changes over its operating condition; thereafter, the next input pulse triggers the circuit into operation once more. A typical waveform at VT121 base for such a sequence, with input pulses of 10 mS duration at a p.r.f. of 4 p.p.s., is shown in Fig.6B.

Power Supply Circuits

36. The 100/125 volts or 200/250 volts 50/60 c/s supply is connected via plug PL1, and is controlled by the Mains switch S131. The switch completes the supply circuit to the teleprinter motor and to transformers T131, T132. Anti-surge fuses FS131 and FS132 protect the teleprinter motor circuit, being rated at 1.0 A for 100/125 volts or at 0.5 A for 200/250 volts, according to requirements. Protection for the circuit to the transformers is afforded by fuses FS133 and FS134, which are rated at 0.4 A for the lower supply voltage or at 0.2 A for the higher voltage.

37. To accommodate the specified range of supply voltages, the primary windings of T131 and T132 are tapped so as to permit adjustment in steps of 5 volts; each primary winding is in two sections, which should be connected in series for the 200/250 volts range, as shown on the circuit diagram, or in parallel for the 100/125 volts range.

38. Series resistance-capacitance branches (R131, C131, R136, C135) are connected across the transformer secondary windings to protect the transistors from damage that may otherwise result from transient voltages induced in the supply.

39. The -75 volts d.c. supply for the electromagnet coil current switch circuit is obtained from the full-wave bridge rectifier formed by silicon diodes MR136-MR139. C136 acts as a reservoir capacitor, and smoothing is effected by R137 and C137.

40. A similar bridge rectifier circuit, employing diodes MR131-MR134, is used for the -12 volts d.c. supply. The Mains indicator lamp ILP131 is connected across a 6 volt section of T131 secondary winding, and the calling bell circuit is fed from a 4.5 volt section; connection to the bell contacts of the teleprinter is made via pins K and L of socket SK1. It is important that no earth connection be made, within the associated teleprinter to this circuit; when the Creed Type 75 teleprinter (Admiralty No.12) is used, the earth wire to terminal 4 of the 10-point ter-

minal strip under its base must be disconnected. Also, when using this teleprinter, links K and L of SK1 should be connected correctly to the corresponding K and L points of the teleprinter signal circuit without being reversed. As protection against damage when a teleprinter with its bell circuit still earthed is accidentally connected to the T.T.11, R132 limits the current through diode MR131. This resistor also forms part of the smoothing filter, in conjunction with C132, R133, and C133.

41. The voltage regulator circuit of transistors VT131 and VT132 stabilizes the -12 volts d.c. output, which is taken from VT132 emitter. A portion of this output is tapped off by the pre-set potentiometer RV131 and applied, via a Zener diode MR135, to the base of VT131. Any variation in output voltage causes the pre-set potential at MR135 cathode to vary, and since the reverse voltage across the diode is sensibly constant, a similar variation occurs in VT131 base potential. The latter controls VT131 emitter current, which also constitutes the base current of the series regulator transistor VT132, and thus readjusts the working point of VT132 to maintain the correct output voltage. The value of this voltage is pre-determined by the setting of RV131.

P A R T 2

C H A P T E R 1

S E T T I N G U P A N D T E S T I N G

CONTENTS LIST

CHAPTER 1

SETTING UP AND TESTING

GENERAL

1. The following adjustments and tests should be carried out during major inspections, or after replacement of components, to ensure efficient performance of the unit.

2. WARNING The full mains voltage is present on the equipment while the tests described in this chapter are being performed. Suitable precautions must therefore be observed.

TEST EQUIPMENT

3. The following test equipment is required:-

(a) Audio frequency test oscillator covering the frequency range 50 c/s to 40 kc/s, with an output impedance of 600 ohms (balanced). The harmonic distortion should be at least 50 dB down. Example:- Hewlett Packard Audio Signal Generator Model 206A. If the distortion is above the -50 dB level, a wave analyser covering the frequency range is also required.

(b) Valve voltmeter, a.c., with a response over the range 50 c/s to 40 kc/s and capable of measuring from 3 mV to 10 V; the scale should be calibrated in decibels. Example: Dawe Type 614B or Advance Type VM77 (Advac).

(c) Multimeter having a resistance of not less than 20,000 ohms/volt on its d.c. voltage ranges. Example: Avometer Model 8.

(d) Oscilloscope, Double Beam, having a d.c. range extending from 100 mV/cm to 10 V/cm and an a.c. range from 10 mV/cm to 10V/cm. The time scale must be calibrated and be adjustable from 100 µS/cm to 10 mS/cm, with expansion variable from X1 to X10. The width of the graticule must be not

less than 6 cm. Example: Solartron Type CD.1014.

(e) Pulse Generator having a pulse repetition frequency variable from 0.1 p.p.s. to 50 p.p.s. and a pulse duration that may be adjusted over the range 5 mS to 20 mS. The output voltage should be sufficient to drive a Carpenter relay. Example: Nagard Type 5001.

(f) Carpenter relay, polarised.

(g) Attenuator, 20 dB (fixed or variable), with input and output impedances of 600 ohms (balanced). For details of a suitable resistance pad, refer to Appendix 1. If such an attenuator is already built into the audio frequency test oscillator (as in the Hewlett Packard Model 206A) this separate attenuator is not required.

(h) Attenuator 2 dB (fixed or variable), with input and output impedances of 600 ohms (balanced). For details of a suitable resistance pad, refer to Appendix 1.

(j) Headphones, 1000 ohms impedance.

(k) Resistor, 600 ohms ± 1%, ¼W, non-inductive.

(l) Test leads for PL3, PL1, and SK1. For details of these leads, refer to Appendix 2.

(m) Resistor, 200 ohms ± 2%, ½W.

(n) Counter frequency meter covering the range 600 c/s to 2 kc/s, accurate to within 1 c/s, and sensitive to input voltages down to 300 mV or less.

4. Should it be desired to carry out a functional test of the unit under simulated operating conditions, additional test equipment is required as listed in Paragraph 20 of this Chapter.

PRELIMINARY SETTING UP

5. Make the following preliminary adjustments:-

(1) Check that the correct fuses are fitted.

(2) Remove the covers from the top and underside of the unit.

(3) Undo the four 4 B.A. screws securing the rear panel of the unit, and draw the panel clear, taking care not to damage the internal wiring to the rear plugs and sockets. Remove the insulated plate that covers the transformer taps.

(4) Set the taps on the mains transformers T131 and T132 to the appropriate supply voltage. The nominal voltages for the taps are indicated on the transformers; settings may be made in steps of 5 volts. The windings of each transformer are in two sections that must be wired in series for the 200/250 V range and in parallel for the 100/125 V range. If the windings are to be wired in parallel, they must be correctly phased with corresponding taps connected together at the start and finish of the windings. For example: if setting for a mains supply of 115 volts, link the two 5 volt taps together and join one wire of the mains input circuit to the joint tapping point so formed; link the two 110 volt taps together and connect the other mains input wire to them.

(5) Adjust the mains voltage indicator label, on the rear panel, to indicate the appropriate voltage range. When the screws securing the label are slackened, it may be moved sideways to display either of the voltage ranges engraved on it.

(6) Fit the insulating plate back into position to cover the mains transformer taps, and replace the rear panel.

(7) Ensure that no connections are made to plug PL3, or to socket SK4. Plug the appropriate test lead into socket SK1, with the 200 ohm resistor joined across the wires leading from pins G and J of the plug to simulate the electromagnet coil of the teleprinter; leave the ends of the wires from pins K and L free. Connect the mains supply via plug PL1.

the reading should be at least 40 dB below that at 1000 c/s.

NOTE:- Coils L2, L3, and L4 do not require re-adjustment once they have been set to their nominal values of inductance, shown on the circuit diagram, during factory test.

(6) Switch off the mains supply and disconnect the valve voltmeter (or wave analyser); remove the audio frequency test oscillator and the attenuator.

(7) Place strips of transparent adhesive tape over the tuning holes of the filter coils.

D.C. VOLTAGES

7. Check the d.c. conditions of the unit as follows:-

(1) Check that link A is set to include R19 in circuit, and that link B is connected to R122.

(2) Switch on the mains supply.

(3) Set the multimeter to a suitable range to measure 12 V d.c. Connect the positive side of the meter to chassis and the negative side to test point 1. Adjust potentiometer RV131 to give a meter reading of 12.1 volts. Lock the potentiometer and remove the multimeter.

(4) Switch off the supply. Set the multimeter to a suitable range to measure 50 mA d.c. and connect it in series with the 200 ohm resistor across the test lead from socket SK1. The relative polarity of pins G and J depends upon the particular keying sense for which the output circuit is set: the sense can be determined by reference to Fig.3 and inspection of internal connections. If the sense is set for Tone On for condition A, pin G is positive with respect to pin J; the polarity is reversed for the opposite keying sense. (These polarities are maintained only as long as no input tone is applied).

(5) Slacken off the lock nut of the E/M COIL CURRENT potentiometer (RV51) on the front panel. Adjust the potentiometer to its fully clockwise setting.

(6) Switch on the supply and record the current indicated on the multimeter: this should be not less than 45 mA. Switch off again, and transfer the multimeter to the E/M COIL CURRENT test sockets on the front panel (the lower socket is positive with respect to the upper socket). Leave the 200 ohm load resistor connected across SK1 test lead. Set the multimeter to a suitable range to read 5 V d.c. Switch on the supply and read the voltage indicated on the multimeter. Convert this voltage to a current reading on a basis of 1 volt being equivalent to 10 mA. The current so calculated should be not less than 45 mA, and should agree with that measured in the 200 ohm resistor to within ± 5%.

NOTE:- The same multimeter must be used for both the measurements in the foregoing paragraph.

(7) Adjust the E/M COIL CURRENT potentiometer (RV51) to its fully anti-clockwise setting and repeat the measurement of the current in the 200 ohm resistor; this should now be not greater than 25 mA. Repeat the voltage measurement across the E/M COIL CURRENT test sockets and check that the equivalent current, calculated as in Sub-paragraph 7 (6) of this Chapter, agrees with that measured in the 200 ohm resistor to within ± 5%.

(8) Readjust the E/M COIL CURRENT potentiometer (RV51) to give a voltage across the E/M COIL CURRENT test sockets of 3V (equivalent to 30 mA). Lock this potentiometer and re-check the reading to ensure that it has not changed.

(9) Use the multimeter to measure the d.c. voltages, with respect to chassis, at test points 1 to 15. For each reading, the multimeter range that gives the largest deflection of the pointer on the scale should be selected. The voltages measured should

agree with the limits quoted in the following table:-

Test Point	Volts d.c.	Test Point	Volts d.c.
1	12.1	9	6.2 - 7.3
2	2.80 - 3.05	10	34.5 - 42.5
3	2.65 - 3.20	11	72 - 78
4	6.0 - 7.3	12	18 - 23
5	5.85 - 7.15	13	8.5 - 9.5
6	0 - 0.15	14*	4.5 - 5.5
7	1.05 - 1.25	15*	4.25 - 5.25
8	10.8 - 11.4		

* The difference between the actual voltages at test points 14 and 15 must be less than 0.5 volt.

MEASUREMENTS WITH UNKEYED INPUT

Trigger Level

8. To check the correct triggering of the e/m coil current switch circuit, proceed as follows:-

(1) Connect the audio frequency test oscillator, via the 20 dB attenuator, to pins A and B of plug PL3; adjust the frequency to 1 kc/s. Set the multimeter to a suitable range to read 40 V d.c. and connect it between test point 10 (negative) and chassis (positive). Set RV11 fully clockwise.

(2) Starting with the 1 kc/s input voltage at zero (for which condition the TRAFFIC indicator lamp should be lit), slowly increase the input level, pausing after each alteration to allow the a.g.c. to settle down, until a value is reached at which the e/m coil current switch operates; this is indicated by a change of multimeter reading from approximately 40 V to approximately 7 V. After about half a second the TRAFFIC indicator lamp should be extinguished. The corresponding input level should be not higher than -20 dBm (78 mV).

(3) Set RV11 fully anti-clockwise and repeat the procedure described in the preceding Sub-paragraph 8 (2). The level corresponding to the changeover of the e/m coil current switch should not be below -12 dBm (195 mV).

(4) Readjust RV11 so that the e/m coil current switch changes over when the input level, increasing slowly from zero volts, reaches -14 dBm (155 mV). Slowly reduce the input voltage, and check that the changeover to the previous condition occurs at a level within 0.5 dB of that noted in the foregoing Sub-paragraph 8 (3), i.e. that the backlash does not exceed 0.5 dB. Lock RV11 and re-check the -14 dBm trigger level before proceeding to the next test. Remove the multimeter.

Signal Levels

9. To check the signal levels in the circuit, proceed as follows:-

(1) Set the audio frequency test oscillator to give a level of -20 dBm (78 mV) at the input to the T.T.11, at a frequency of 1 kc/s.

(2) Check the level at test point 6, with respect to chassis, using the a.c. valve voltmeter. This level must not exceed 15 mV; a typical reading is 2.2 mV. As a guide to the performance of the unit, the following are typical readings, taken on the valve voltmeter, at various test points:-

Test Point No.	Level (mV)
2	5.2
3	1.5
4	54
5	43

A.G.C. Check

10. Connect the multimeter to read the negative d.c. voltage with respect to chassis at test point 6, for various 1 kc/s input levels. The voltage readings should lie within the following limits:-

Input Level		D.C. Volts at Test Point 6
dBm	Voltage	
-13.8	158 mV	1.7 to 2.2 (= y*)
-10	245 mV	y + (0.6 to 1.1)
0	775 mV	y + (0.8 to 1.5)
+10	2.45 V	y + (1.0 to 2.2)

* The actual reading is taken as a reference "y" to establish the limits at the other three input levels.

D.C. Voltages for Dynamic Condition

11. Check the d.c. voltages for the Tone On condition by proceeding as follows:-

(1) Set the 1 kc/s input level at 0 dBm (0.775 V).

(2) Using the same multimeter as that used for the tests described in Sub-paragraphs 7 (6) to 7 (9) of this Chapter, check that the d.c. voltages at test points 7 to 10 and 13 to 15 are within the following limits (all voltages are negative with respect to chassis):-

Test Point	Volts d.c.
7	1.35 - 1.65
8	0.60 - 1.20
9	35 - 43
10	5.8 - 6.8
13*	2.4 - 3.0
14	11.9 - 12.1
15*	1.90 - 2.55

*The difference between the actual voltages at test points 13 and 15 must be less than 0.5 volt.

(3) Still using the same multimeter, determine the e/m coil current by measuring the voltage across the front panel test points and converting it to a current on the basis that 1 V d.c. is equivalent to 10 mA. The current must be 30 mA $\pm$ 1.5 mA.

Frequency Discrimination

12. Test the ability of the equipment to reject unwanted input frequencies, as follows:-

(1) Set the multimeter to a suitable range to read 40 V d.c., and connect it between test point 10 (negative) and chassis (positive). The reading should be approximately 7 V for a 1 kc/s input level of -10 dBm (245 mV).

(2) Retune the audio frequency test oscillator to 1250 c/s, maintaining the -10 dBm input level, and check that the e/m coil switch changes over, as indicated by a sudden rise in the multimeter reading to approximately 40 V. Check that a similar

changeover occurs when the input frequency is changed from 1 kc/s to 750 c/s. On completion of the check, remove the multimeter.

HUM LEVEL

13. To check that the hum level is not excessive, proceed as follows:-

(1) Remove the input signal.

(2) Connect the oscilloscope between test point 1 and chassis and measure the peak-to-peak value of the 100 c/s ripple voltage. This must not exceed 25 mV peak-to-peak.

(3) Transfer the oscilloscope to test point 11 and check that the ripple voltage at this point does not exceed 2.5 V peak-to-peak.

CALLING (ALARM) BELL

14. Perform the following check to ensure that the bell operates correctly:-

(1) Lay the T.T.11 horizontally in its normal working attitude.

(2) Short together the wires from pins K and L of the test lead that is plugged into socket SK1. The bell should ring.

(3) Adjust the bell to give the best possible sound, by slackening the dome retaining screw and rotating the dome as necessary. Re-check the bell after the screw has been re-tightened.

MEASUREMENTS ON KEYED INPUT SIGNAL

NOTE:- All input tone levels quoted for these tests are Tone On levels, i.e. those of the steady tone before it is keyed.

Distortion

15. To measure the telegraph distortion, proceed as follows:-

(1) If R19 is in circuit, unsolder the wire linking it to C13; leave R19 disconnected.

(2) Inject a keyed 1 kc/s voltage to the unit, at an input level of -10 dBm (245 mV), as shown in the Test Equipment Connection Diagram (Drawing No. SK.4843/S). The carpenter relay contacts (RLA1) are used to key the input tone. The relay should be driven from the pulse generator, and must be adjusted to be free from contact bounce. The 2 dB attenuator ensures that a suitable impedance is maintained across the input terminals of the T.T.11 when RLA1 contacts are open, to prevent ringing in the input circuit. For this test, do not connect the 2 kilohm potentiometer across RLA1.

(3) Connect one amplifier of the oscilloscope, set for d.c., across the input to the T.T.11. Since the input to the oscilloscope is unbalanced, care must be taken not to disturb the input level by earthing any other part of the test signal input circuit (such as may occur when using a valve voltmeter with an unbalanced input circuit to check levels at the output terminals of the audio frequency test oscillator or at the 60 dB attenuator).

(4) Connect the other amplifier of the oscilloscope, set for d.c., between test point 10 and chassis.

(5) Trigger the oscilloscope time base with a voltage taken from the pulse generator.

(6) Set the pulse generator output to a p.r.f. of 50 pulses per second, and the time scale of the oscilloscope time base to 5 mS/cm: the tone pulse duration at the input to the T.T.11 should then be adjusted to 10 mS, so that the pulse occupies 2 cm on the X-axis of one beam; it should also comprise 10 cycles of the 1 kc/s voltage. This pulse may be compared with the d.c. pulse at test point 10, displayed on the other beam. The leading edge of the d.c. pulse should follow that of the tone pulse with a time lag of approximately 4 mS.

(7) Adjust the expansion control of the oscilloscope time base to the X5 setting, so that 1 cm on the

X-axis is equivalent to 1 mS, and measure the difference in time between the leading edge of the tone pulse and that of the corresponding d.c. pulse. Record this reading.

(8) Reverse the polarity of the trigger voltage by suitable adjustment of the oscilloscope Trigger Selector control, so as to display the trailing edge of each pulse; measure the time difference between the trailing edge of the tone pulse and that of the corresponding d.c. pulse. The distortion (expressed in milliseconds) is the difference between the reading taken at the leading edges and the reading taken at the trailing edges; it is reckoned positive when the d.c. pulse at test point 10 is longer than the input tone pulse, and negative when the d.c. pulse is shorter than the tone pulse.

(9) Repeat the distortion measurement for input levels of -5, 0, +5, and +10 dBm (435 mV, 775 mV, 1.38 V, and 2.45 V respectively); then re-link R19 to C13 and repeat the measurements for the various levels as before. With and without R19 in circuit, the distortion must fall within the limits quoted in the following table:-

Input Level of 1 kc/s Tone		Permissible Limits
dBm	Volts	of Distortion (mS)
-10	0.245	-2.0 to +1.0
-5	0.435	-1.5 to +1.5
0	0.775	-1.0 to +2.0
+5	1.38	-1.0 to +2.5
+10	2.45	-1.0 to +4.0

NOTE:- Distortion measurements are facilitated if a voltage divider unit is used to divide the 1 kc/s oscillator output frequency by 20, and the 50 c/s voltage so derived is used to lock the p.r.f. of the pulse generator. This holds the tone pulse envelope stationary in relation to the 1 kc/s waveform on the oscilloscope display.

Traffic Indicator

16. Verify the correct operation of the traffic indicator

circuit as follows:-

(1) Set the audio frequency test oscillator to give a level of 0 dBm (0.775 V) at the input to the T.T.11, at a frequency of 1 kc/s.

(2) Adjust the pulse generator so that the 1 kc/s input tone is keyed by the Carpenter relay at a p.r.f. of 1 p.p.s., with a Tone Off pulse duration of 13 mS. To establish the pulse duration as accurately as possible, first set the p.r.f. to approximately 20 p.p.s. and use the oscilloscope, with one Y-amplifier connected as described in Sub-paragraph 15 (3) of this Chapter, to measure the Tone Off duration; then reduce the p.r.f. to 1 p.p.s.

(3) Connect the other Y-amplifier of the oscilloscope, set for a sensitivity of 2 V d.c./cm., between test point 14 and chassis. Adjust the time scale of the oscilloscope time base to 100 mS/cm.

(4) Check that the TRAFFIC indicator lamp lights for each 13 mS Tone Off input pulse, and that it remains lit for at least 130 mS: the start and the finish of the Lamp On condition are indicated by the edges of the positive-going pulse at test point 14, displayed on the oscilloscope.

(5) Disconnect link B from R122 and connect it to R49. Repeat the entire traffic indicator check with an input pulse duration of 13 mS for the Tone On condition: the lamp must now light when the Tone On pulse commences, and remain lit for at least 130 mS.

Signal/Noise Discrimination

17. (1) Connect the test circuit as shown in Drawing No. SK.4843/S, but with the oscilloscope trigger voltage taken from test point 10 of the T.T.11 instead of from the audio frequency test oscillator. Adjust the oscilloscope Trigger Selector control for positive polarity of trigger voltage. Connect the 2 kilohm potentiometer across the relay contacts for this test, and adjust it so that the 1 kc/s level at the input to the T.T.11 falls by 8 dB (i.e. to one quarter of its original value) when the relay contacts open. Thus, when the relay is driven by the pulse generator, a pulse train

with a simulated signal:signal-plus-noise ratio of worse than 8 dB is fed to the T.T.11.

(2) Adjust the pulse generator p.r.f. to 50 p.p.s., with a 10 mS tone pulse duration at the input to the T.T.11. Set the input Tone On level to -5 dBm (435 mV). Adjust the oscilloscope time scale to 1 mS/cm and observe the tone input pulse, which should occupy 2 cm on the X-axis of the appropriate beam. Now use the second beam to monitor the d.c. pulse at test point 10.

(3) Reduce the p.r.f. of the pulse generator to 20 p.p.s., then continue to reduce the p.r.f. slowly, still monitoring the waveforms on the oscilloscope: as the p.r.f. is reduced, the duration of the d.c. pulse at test point 10 will increase, because the d.c. pulse is being initiated by the simulated noise input instead of by the leading edge of the tone pulse. Observe the p.r.f. at which the d.c. pulse duration has increased by 5 mS. This p.r.f. must not exceed 7 p.p.s.

(4) Repeat the measurement described in the foregoing paragraph, for input tone levels of 0 dBm (0.775V) and +5 dBm (1.38 V). Then disconnect R19 from C13 and repeat the measurements at all three levels. The p.r.f. in each case must not exceed the appropriate figure given in the following table:-

Input Level of Tone Pulse		Max. permissible p.r.f. for 5 mS increase in pulse duration at test point 10 (pulses per second)	
dBm	Volts	R19 in circuit	R19 out of circuit
-5	0.435	7	0.6
0	0.775	14	1.8
+5	1.38	20	3

RECEIVE LINE MONITOR CIRCUIT

18. This should be checked in the following manner:-

(1) Apply a -10 dBm input voltage to the T.T.11, at a frequency of 1 kc/s.

(2) Plug a pair of high-impedance headphones into the RECEIVE LINE MONITOR jack (JKA) and check the

operation of the associated GAIN control (RV1): the volume in the headphones should increase as the control is turned clockwise. Leave the control set fully anti-clockwise when it is not in use.

FINAL ADJUSTMENTS

19. Before returning the unit to service, ensure that the following adjustments are carried out:-

(1) Ascertain whether R19 is required to be connected in circuit, and make or omit link A (the wire from R19 to C13) accordingly. The actual requirement will normally depend upon the nature of the system in which the unit is to be used. Do not make the link yet if the operational tests described in Paragraphs 20 to 22 of this Chapter are to be performed.

NOTE:- If an input signal level of between 0 dBm and -10 dBm can be assured, together with a signal:noise ratio of greater than 16 dB, it is recommended that R19 be connected in circuit to give a short a.g.c. decay time. If, however, a variation of input level between -10 dBm and +10 dBm is anticipated, the short a.g.c. decay time is recommended only if the signal:noise ratio is not expected to fall below 26 dB. For all other conditions, it is recommended that the longer a.g.c. decay time be selected by leaving R19 disconnected.

(2) Ensure that the output circuit to the e/m coil, via socket SK1, is set for the required keying sense. If necessary, the sense may be reversed by interchanging the connections of the twisted pair of wires that interconnect SK1 and the e/m coil current circuit. Any such alteration should be made at the tags of the e/m coil current switch component board, which is the right-hand (viewed from the top front of the unit) of the two boards mounted on the front side of the transverse support carrying the mains transformers. The actual connections required for individual keying senses are shown in Fig.3.

(3) See that the traffic indicator circuit is set for the appropriate keying sense: link B must be

connected to R49 if the Tone On for A sense is required; for the Tone Off for A sense, the link must be connected to R122.

(4) Adjust the mains transformer taps to suit the supply voltage on which the equipment is to be operated. Set the mains voltage indicator label to the appropriate range. If, however, operational tests are to be carried out before the unit is returned to service, leave the taps and the label set for the supply voltage at the test location until such tests have been completed.

(5) Replace the covers.

OPERATIONAL TESTS

Additional Test Equipment Required

20. If it is intended to perform a functional test of the unit prior to re-installation, the following additional test equipment is required:-

(a) Two teleprinters, Creed Type 75 (Admiralty No.12). Alternatively, one teleprinter and a Telegraph Distortion Measuring Set (T.D.M.S.) with a code-sending facility. The teleprinters should have been checked for correct adjustment, using a T.D.M.S.

(b) A Terminal, Teleprinter (Tactical) Type T.T.10 or similar tone sender capable of being keyed by the Creed Type 75 teleprinter (or by the T.D.M.S.) and of delivering a Tone On level of 0 dBm (0.775 V) to the T.T.11.

(c) Interconnecting leads to link one teleprinter to SK1 and SK4 of the T.T.11, and to connect the T.T.10 (or similar tone sender) to the other teleprinter (or code-sending T.D.M.S.).

Preliminary Adjustments

21. Before commencing the tests, make the following adjustments:-

(1) Set up the teleprinter associated with the T.T.11 for double-current working, and remove the earth connection from its bell contacts. If a T.T.10 is

used, the teleprinter associated with that unit also must be similarly adjusted.

(2) Ensure that both teleprinters (or the teleprinter and the code-sending T.D.M.S.) are adjusted for the same working speed.

(3) See that the spark quench unit is connected across the e/m coil of the teleprinter associated with the T.T.11. In the Creed 75 teleprinter (Admiralty No.12) this unit consists of a 330 ohm resistor in series with a 0.5 μF capacitor.

(4) Ensure that the T.T.11 is adjusted for the same keying sense as the T.T.10 (or similar tone sender); the internal connections of the output circuit from the e/m coil current switch and the connection of link B must be checked in this respect.

(5) Connect the T.T.10 (or tone sender) to its associated teleprinter (or code-sending T.D.M.S.), and the T.T.11 to the receiving teleprinter.

(6) Connect the output from the T.T.10 (or tone sender) to pins A and B of plug PL3 of the T.T.11.

Signalling Test

22. Perform the test as follows:-

(1) Adjust the T.T.10 (or tone sender) to give a Tone On input level of 0 dBm (0.77 V) to the T.T.11.

(2) Transmit signals over the circuit and check for correct reception. If a teleprinter is used at the sending end, make the following signal:-

THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG
1234567890

followed by three lines of RYRYRY... etc.

(3) On satisfactory completion of the test, make the final adjustments described in Paragraph 19 of this Chapter.

C H A P T E R 2

S E T T I N G T O W O R K

CONTENTS LIST

CHAPTER 2

SETTING TO WORK

INSTALLATION

Siting

1. Choice of site for the T.T.11 and its associated teleprinter is governed by installation requirements for the latter, since the units form an integrated operating station. The equipment should be sited in a clean, dry location, away from sources of heat; adequate operating space is essential, and sufficient clearance is necessary at the rear for external connections.

Installing the Mount, Teleprinter (Terminal)

2. Bolt the mount securely into position, using six $\frac{1}{4}$ in. bolts; before passing the bolts through the slots in the feet of the shock mounts, place the six mount clamps (provided separately) in position over the slots, so as to locate the bolts and clamp the feet. Dimensions between fixing-hole centres are given in Drawing No. SK.4824.

Cables

3. A 12-way cable (Redifon Type 6393/A) and a 3-way cable (Redifon Type 6394/A) are supplied with the T.T.11 to link the unit to the teleprinter. These cables are fitted with Plessey Mk.IV plugs and sockets; should a different type of connector be fitted to the teleprinter, care must be taken to ensure the correct connections between SK1 of the T.T.11 and the teleprinter circuit. The letters shown against the pins of SK1 on the circuit diagram (Drawing No. WDA/6338/L) must correspond to the lettered pins of the 12-point plug on the main base of the Creed 75 teleprinter, and connections must be made to corresponding pins without crossing the e/m coil circuit pair or the bell circuit pair.

4. Sockets are provided to terminate the mains supply cable and the signal input cable. Fig.4 illustrates the method of wiring the sockets. To facilitate maintenance of the equipment, sufficient slack should be made available at the terminations of these cables to enable the T.T.11 to be drawn forward in the mount with the supply and input signal circuits still connected. Cable to British Defence Specification DEF.10 Type 3C is recommended for connecting the mains supply.

Preliminary Adjustments to the Teleprinter

5. To enable the teleprinter to work in conjunction with the T.T.11, the following adjustments must be made:-

(1) Set the teleprinter for double-current working.

(2) Remove the earth from the bell circuit of the teleprinter.

(3) See that the spark quench unit is connected in parallel with the e/m coil of the teleprinter. In the Creed 75 teleprinter this consists of a 330 ohm resistor in series with a 0.5 µF capacitor.

Securing the Teleprinter

6. To secure the Creed 75 (Admiralty No.12) teleprinter to the mount, proceed as follows:-

(1) Stand the teleprinter on the table of the mount.

(2) Remove the three cover retainer screws from the teleprinter.

(3) Secure the three cover-springs of the mount to the cover of the teleprinter, using the cover-spring retainer screws that are provided separately: fit these screws into the holes from which the cover retainer screws were removed. The cover-springs may be set for two heights, to accommodate either the standard teleprinter or a machine with a paper-tape reperforator attachment.

Preliminary Adjustments to the T.T.11

7. Before installing the T.T.11, certain adjustments must be made to adapt the equipment to local operating conditions. Proceed as follows:-

(1) Remove the covers from the top and underside of the unit.

(2) Check that the correct fuses and indicator lamps are fitted.

(3) Ensure that the taps of the mains transformers T131 and T132 have been correctly set to within 5 V of the nominal mains voltage. To gain access to the taps, undo the four 4 B.A. screws securing the rear

panel of the unit and draw the panel clear, taking care not to damage the internal wiring to the rear plugs and sockets; remove the insulated plate that covers the transformer taps. Nominal voltages for the taps are indicated on the undersides of the transformers. See that the voltage indicator label on the rear panel is set to indicate the appropriate voltage range. The methods of wiring the taps and setting the label are described in Part 2, Chapter 1, Sub-paragraphs 5 (4) and 5 (5). Replace the insulated plate and the rear panel.

(4) See that the circuit is adjusted for the appropriate a.g.c. decay time. For a short decay time, link A (shown on the circuit diagram, Drawing No. WDA/6338/L) must be in position to connect R19 in circuit; the link must be omitted for the longer decay time (See also Part 2, Chapter 1, Sub-paragraph 19 (1) and subsequent Note).

(5) Check that the circuit is set for the appropriate keying sense. Details of the necessary connections for each sense are given in Part 2, Chapter 1, Sub-paragraphs 19 (2) and (3), and in Fig.3.

Installing the T.T.11

8. Before replacing the covers, proceed as follows:-

(1) Locate the rollers, at the sides of the unit, in the channels under the table of the mount. The rollers at the right engage before those at the left.

(2) Slide the unit into position under the mount, engaging the spring-loaded retaining latches at the front of the mount with the spindles of the rollers nearest the front of the unit.

(3) Connect the mains supply cable to plug PL1 at the rear of the T.T.11. Do not yet make any other connections.

(4) Lift the retaining latches and draw the unit forward to permit access to the circuit.

(5) Connect a multimeter, set to a suitable range to measure between 12 V and 13 V d.c., between test point 1 (negative) and chassis (positive). The multimeter must have a resistance of not less than

20,000 ohms/volt (Example: Avometer Model 8).

(6) Switch on the supply by closing the MAINS switch (S131) on the front panel, and check that a reading of 12.1 V is indicated on the multimeter. If necessary, adjust potentiometer RV131 to attain the correct voltage; re-lock the potentiometer after any such adjustment, and re-check the reading. Switch off and remove the multimeter.

(7) Disconnect the mains supply cable, withdraw the unit from the mount, and replace the covers.

(8) Re-locate the unit in the mount and make the connections to socket SK1 and plug PL1. Leave the signal input cable disconnected.

(9) Set the multimeter to a suitable range to read 5 V d.c. Connect the negative lead of the multimeter to the upper E/M COIL CURRENT test socket, and the positive lead to the lower socket.

(10) Switch on again, and check that the indicated voltage at the test sockets is 3 V $\pm$0.3 V; this corresponds to a current of 30 mA in the e/m coil of the teleprinter, the conversion factor being linear at 10 mA per volt. If necessary, slacken off the lock nut of the E/M COIL CURRENT potentiometer (RV51) on the front panel, and adjust the potentiometer for a meter reading as close to 3 V as possible; check the reading after re-locking the potentiometer. Remove the multimeter.

(11) Connect the signal input cable to plug PL3, and the teleprinter motor supply cable to socket SK4. The teleprinter should now operate on incoming signals.

C H A P T E R 3

M A I N T E N A N C E

CONTENTS LIST

C H A P T E R 3

M A I N T E N A N C E

WARNING:- Full mains voltage is present on the equipment as long as the mains input cable is connected to plug PL1. The covers should not be removed by persons other than skilled maintenance personnel, and suitable precautions must be observed when working on the equipment.

PREVENTIVE MAINTENANCE

CLEANING AND INSPECTION

1. The following routines are suggested:-

Daily Routine

2. (1) Dust the exterior of the equipment, using a soft brush; in humid conditions, wipe the surfaces with a clean, dry rag.

(2) Visually inspect all cables and plug-and-socket connections for damage or wear.

(3) Check that the equipment operates correctly on incoming signals, and that the MAINS and TRAFFIC indicator lamps light.

Weekly Routine

3. (1) Check the e/m coil current in the steady No Tone or Tone On condition by connecting a multimeter, set to a suitable scale to measure 3 V d.c., to the E/M COIL CURRENT test points on the front panel; the multimeter should have a resistance of at least 20,000 ohms/volt (Example: Avometer Model 8). The upper test point is negative with respect to the lower test point. A reading of 3 V $\pm$0.3 V should be obtained, indicating an e/m coil current of 30 mA.

(2) Check that all operational controls function correctly.

Monthly Routine

4. Check the D.C. voltages for the Tone Off condition, as follows:-

(1) Disconnect the signal input cable from plug PL3, and the teleprinter cables from sockets SK1 and SK4; leave the mains supply cable connected to plug PL1.

(2) Connect a test lead, as described in Appendix 2, to socket SK1; leave the test lead wires from pins K and L of the test lead plug free, and connect a 200 ohms + 2% $\frac{1}{2}$ W resistor across the other pair of wires (from pins G and J) to simulate the e/m coil of the teleprinter.

(3) Check the d.c. voltages, with respect to chassis, at test points 1 to 15. A multimeter with a resistance of at least 20,000 ohms/volt should be used; for each reading, the multimeter range that gives the largest deflection of the pointer on the scale should be selected. For units that are set for a keying sense of Tone On for Z, the voltages measured should agree with the limits quoted in Part 2, Chapter 1, Sub-paragraph 7 (9). If the keying sense is Tone On for A, the d.c. voltages at test points 13, 14, and 15 should agree with those quoted in Sub-paragraph 11 (2) of that Chapter (the voltages at test points 1-12 should be similar for both keying senses). It is recommended that a permanent record of these readings be kept, as an aid to fault diagnosis.

5. Before disconnecting the test lead from socket SK1, test the calling (alarm) bell as follows:-

(1) Short together the wires from pins K and L of the test lead plug: the bell should operate.

(2) If necessary, adjust the bell for a satisfactory sound by slackening the dome retaining screw and rotating the dome; re-check the bell after the screw has been re-tightened.

GENERAL MAINTENANCE

FAULT DIAGNOSIS

6. When a fault is reported, monitor the incoming signals by plugging a pair of high-impedance headphones into the RECEIVE LINE MONITOR jack (JKA). A suitable a.c. valve voltmeter may be plugged into the jack to check that the 1 kc/s Tone On input level is not below -10 dBm (245 mV); for this check, the GAIN control (RV1) must be set fully clockwise. Also measure the e/m coil current, as described in Paragraph 3 of this Chapter.

7. Having determined that the fault is in the T.T.11 and not in the associated equipment, check the d.c. voltages at various points in the circuit for agreement with the voltages quoted at the end of this Chapter. A voltmeter (or multimeter) with a resistance of at least 20,000 ohms/volt should be used for the measurements (Example: Avometer Model 8).

8. Check the a.c. levels throughout the circuit, using an a.c. valve voltmeter as specified in Part 2, Chapter 1, Sub-paragraph 3 (b), and compare the readings with the figures quoted at the end of this Chapter.

9. As a further aid to fault diagnosis, the voltage waveforms at certain points in the circuit may be observed, using an oscilloscope, and compared with those illustrated in Figs. 5 and 6.

10. The circuit may be systematically checked and adjusted for normal operation by following the Setting-up and Test procedure described in Part 2, Chapter 1.

LIST OF SEMICONDUCTORS AND THEIR EQUIVALENTS

11. The following table lists the transistors and diodes used in the T.T.11, with recommended commercial equivalents for each inter-services type.

Circuit Reference	Inter-Services Type	Commercial Equivalents
MR11, MR121, MR131-134, MR136-139	CV7028	OA210
MR12, MR122	CV7040	OA202, OA200
VT21, VT41, VT42, VT121, VT122	CV7043	OC200, OC202, OC203, OC205
VT22, VT31, VT32, VT43, VT53, VT131	CV7074	OC83, OC84, GET103
VT132	CV7084	OC35
MR135	CV7096	-
MR31, MR32, MR51, MR52	CV7130	OA81, OA91, OA85
VT51, VT52, VT123	CV7188	OC205

SPARES AND REPLACEMENTS

12. To ensure receiving the correct item, and to expedite delivery, when ordering spare and replacement parts please quote:-

(a) Type number of equipment, as shown on label.

(b) Serial number of unit.

(c) Circuit reference, as shown on circuit diagram, and full description of item.

13. Additional useful information is the number of the circuit drawing, or the full description contained in Spares Schedules.

D.C. VOLTAGES AND A.C. LEVELS

14. When referring to the information given in the accompanying tables, it should be appreciated that the voltage figures quoted are typical values, and are subject to certain spreads. The amount of spread that may accompany normal operation of the circuit depends upon how critical the operating conditions are for any particular stage. For example, collector voltages are not normally as critical as base or emitter voltages, and the operating conditions of an a.c. amplifier are not as critical as, say, those of a triggered stage; the a.c. voltages for VT21, VT22, and VT31 stages (from the junction of C11 and R12 through to test point 5) may vary by as much as ± 6 dB.

15. Unless otherwise quoted, the d.c. voltages listed were measured as negative potentials with respect to chassis. An Avometer Model 8 was used for the d.c. voltage measurements, and an a.c. valve voltmeter, as specified in Part 2, Chapter 1, Sub-paragraph 3 (b), for the a.c. voltage measurements.

16. The circuit conditions for the voltage values given in the tables are as follows:-

(a) Taps of mains transformers (T131 and T132) set to within 5 V of the nominal mains supply voltage.

(b) Teleprinter e/m coil circuit connected; alternatively, a 200 ohm $\pm 2\%$ $\frac{1}{2}$ W resistor connected across pins G and J of socket SK1. Current in e/m coil (or in 200 ohm resistor) set at 30 mA, except where stated otherwise.

Point of Measurement	Volts, D.C.		Millivolts, A.C. (R.M.S.) 1 kc/s input at -20 dBm
	No input signal	1 kc/s input at 0 dBm	
VT51 base	7.7	0.9	25
VT51 emitter	6.7	6.1	23
Test point 9	6.9	39	26
Test point 10	40.2	6.5	335
Test point 11	75.0	75.0	540
VT52 base	3.8	7.5	12
Junction MR51/MR52	57.5	58.0	550
VT53 emitter	3.5	12.1	12
VT53 base	3.7	12.3	12
VT121 base	4.35	1.30	
VT121 collector	3.9	11.6	
VT121 emitter	3.75	0.85	
Test point 13	2.7	9.1	
VT123 base	2.50	5.85	
Test point 14	12.10	5.05	
Test point 15	2.25	4.75	
VT131 base	12.4		
VT131 emitter	12.3		
Test point 12	19.9		

Point of Measurement	Volts, D.C.			
	E/M coil current set at maximum		E/M coil current set at minimum	
	No input signal	1 kc/s i/p at 0 dBm	No signal input	1 kc/s i/p at 0 dBm
Test point 8	10.9	0.93	10.9	0.93
VT51 base	8.2	0.93	7.5	0.93
VT51 emitter	7.15	6.65	6.5	5.9
Test point 9	7.36	28.5	6.7	46.7
Test point 10	27.9	7.2	45.5	6.26
Test point 11	74.6	74.6	76.3	77.0
VT52 base	3.77	8.1	3.41	7.21
Junction MR51/MR52	57.0	57.0	58.1	58.7
VT53 emitter	3.77	12.1	3.41	12.0
VT53 base	3.76	12.2	3.41	12.3

Variation of D.C. Voltage at Test Point 6 with 1 kc/s Input Level

Input dBm	-20	-19	-18	-17	-16	-15	-14	-13	-12
Volts D.C.	0.91	1.06	1.22	1.40	1.55	1.76	1.85	2.04	2.36
Input dBm	-11	-10	-9	-8	-7	-6	-5	-4	-3
Volts D.C.	2.53	2.70	2.87	2.98	3.02	3.11	3.14	3.18	3.20
Input dBm	-2	-1	0	+1	+2	+3	+4	+5	+6
Volts D.C.	3.22	3.25	3.26	3.30	3.33	3.39	3.43	3.47	3.52
Input dBm	+7	+8	+9	+10					
Volts D.C.	3.57	3.61	3.61	3.62					

APPENDIX 1

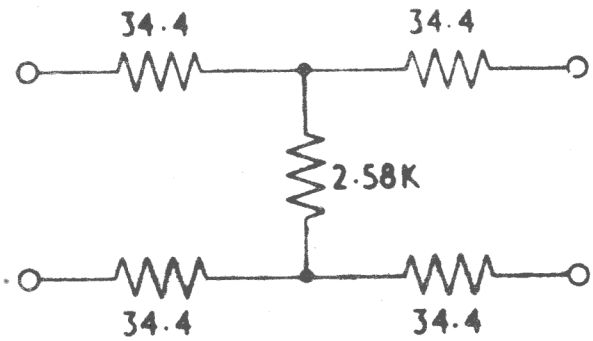
TEST ATTENUATORS

1. These attenuators are specified in the list of Test Equipment given in Part 2, Chapter 1, Paragraph 3.

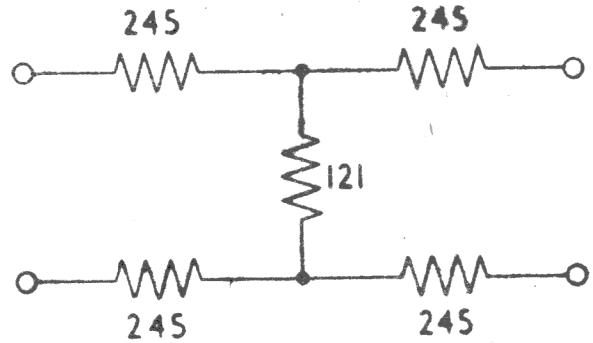
2. Each attenuator may be made up of ½ W non-inductive resistors soldered into position on a short length of component board; connection to the attenuator may then be made by test leads fitted with crocodile clips. The resistors should be selected, from available stock of 20% tolerance resistors of the nearest preferred values, to establish the correct nominal insertion losses as verified by measurement with a valve voltmeter.

3. The circuits of the attenuators are as follows:-

(a) 2 dB Attenuator



(b) 20 dB Attenuator



A P P E N D I X 2

T E S T L E A D S

Description

1. To perform the tests and adjustments described in Part 2, Chapter 1, test leads should be made up for connection to socket SK1 and to plugs PL1 and PL3 of the T.T.11.

2. Each test lead should be terminated at one end in a Plessey Mk.IV assembly to mate with the corresponding fitting on the T.T.11; this assembly comprises a plug (free) or socket (free), with an associated accessory kit, and a binding sleeve where necessary. The other end of each cable should be fitted with crocodile clips for connection to test equipment, or with a suitable plug for connection to the mains supply.

3. The accompanying table lists the items required for each lead, including the cable recommended for use with the particular plug or socket. Figure 4 illustrates the method of fitting Plessey Mk.IV plugs and sockets to the specified cables; the pole-to-conductor connections are tabulated in Appendix 3, and reference should be made to the circuit diagram (Drawing No. WDA/6338/L) to determine which poles are required to be connected. Unused cores in the cables should be cut back.

Requirements

Plug or Socket on T.T.11 to which Test Lead connects	PL1	PL3	SK1
Type of Plessey Mk.IV plug (free) or socket (free) to mate with the above	Socket 2CZ83283 "Red Splash" (Neutral 0)	Socket 2CZ83284 "Red Splash" (Neutral 0)	Plug 2CZ83302 "Red Splash" (Neutral 0)
Type of Plessey Mk.IV Accessory Kit	2CZ108765	2CZ108765	2CZ108773
Type of Binding Sleeve, 5 mm. x ¼ in. long (to British Specification DEF20A)	A2	A2	None required
Type of Cable (to British Specification DEF10)	3C	4C	12C
Approximate length of Cable	To individual requirement	2 ft (0.6 m)	2 ft (0.6 m)
No. of Cores used in Cable	3	2 (to poles A and B)	4 (to poles G,J,K,& L)
Method of Terminating end of Cable remote from T.T.11	To individual requirement for connection to mains supply	Crocodile clips	Crocodile clips

A P P E N D I X 3

WIRING OF PLUGS AND SOCKETS

1. The accompanying wiring tables show the recommended order of connection between the cores of miniature electric cables to British specification DEF10 and the poles of Plessey Mk.IV plugs and sockets; these tables should be followed to permit ease of soldering and to prevent crossing of cores.

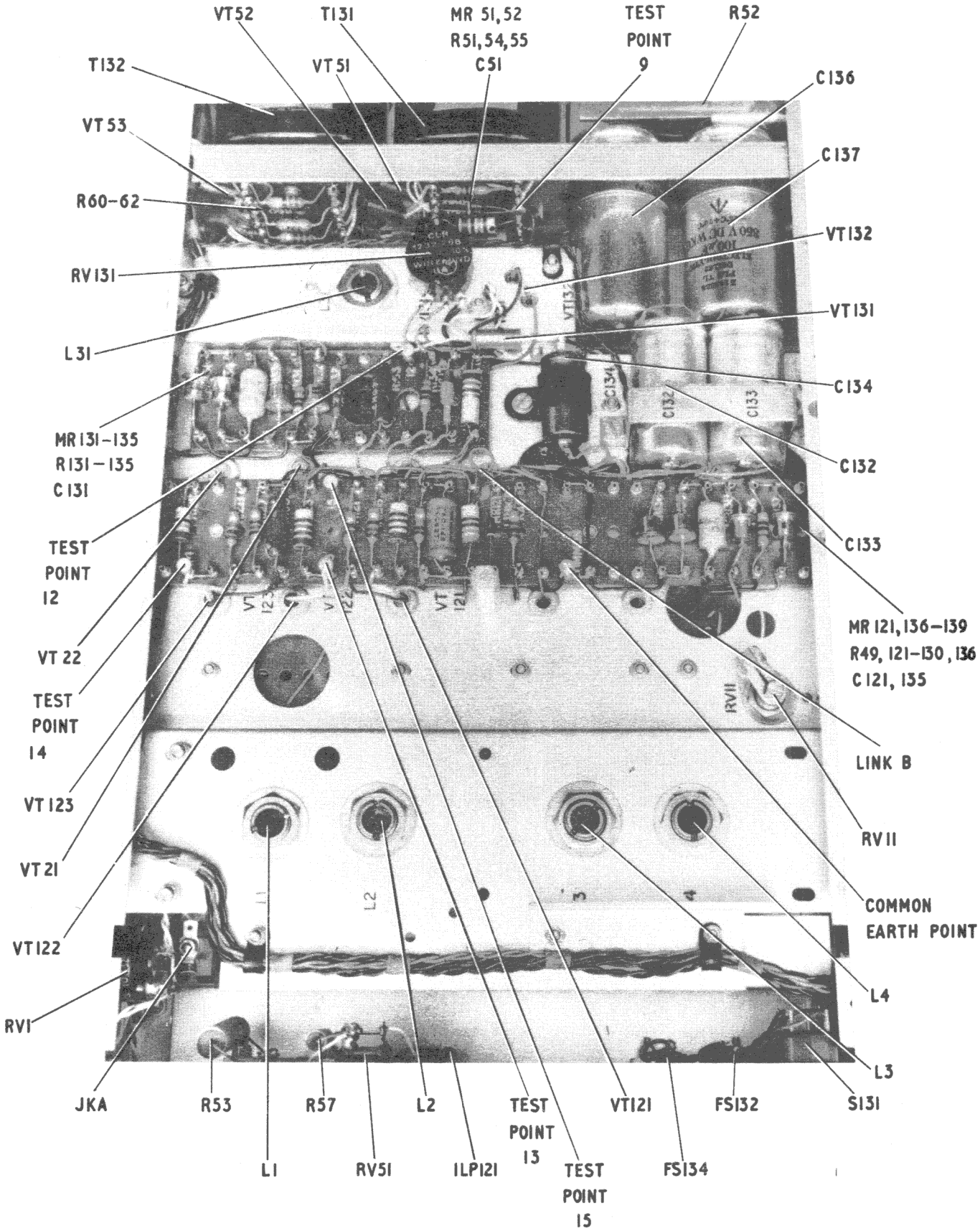
2. On examination of the cable, it will be seen that the core orientation viewed from one end is the mirror-image of the core orientation viewed from the other end; because of this, carefully examine the core orientation at each end in relation to the wiring tables, and in relation to the pole orientation of the plug or socket, before choosing the end of the cable at which to make the connection. This precaution is essential if unnecessary cross-overs are to be avoided.

3. The procedure for making the connection is illustrated in Fig.4.

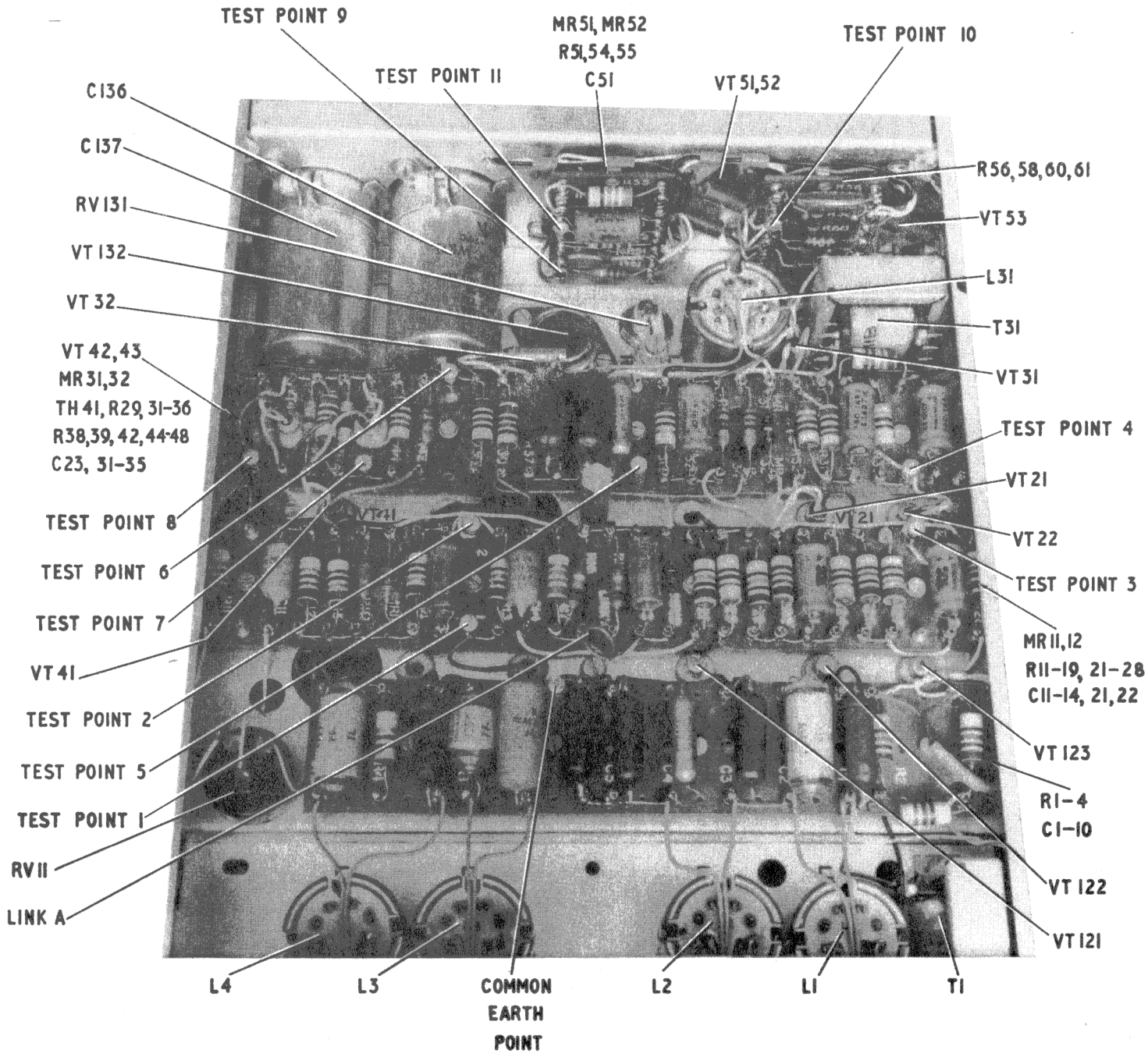
3-POLE	
Pole Letter	Core Colour
A	Red
B	Blue
C	Green

4-POLE	
Pole Letter	Core Colour
A	Red
B	Blue
C	Yellow
D	Green

12-POLE	
Pole Letter	Core Colour
A	White
B	Black
C	Yellow
D	Red
E	Blue
F	Brown
G	Natural
H	Lt. Green
J	Dk. Green
K	Mauve
L	Pink
M	Orange



797-1 TOP OF CHASSIS SHOWING COMPONENT LAYOUT Fig.1



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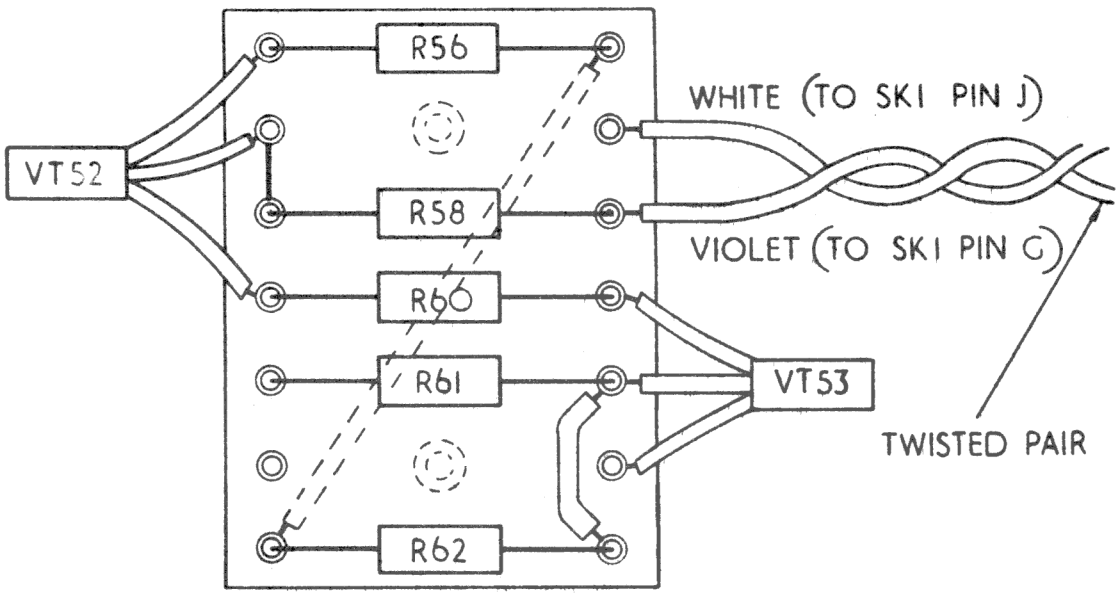
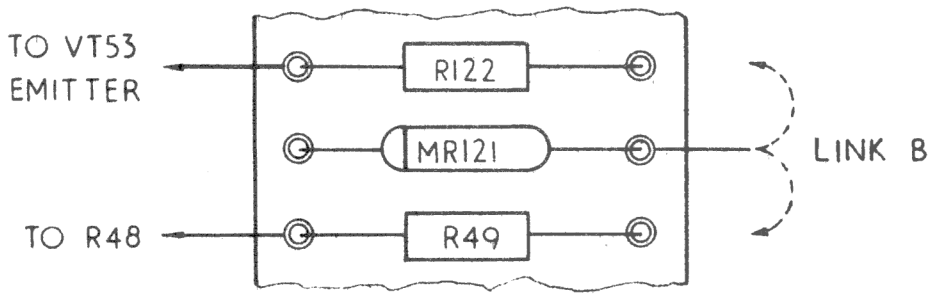
UNDERSIDE OF CHASSIS SHOWING COMPONENT LAYOUT

Fig.2



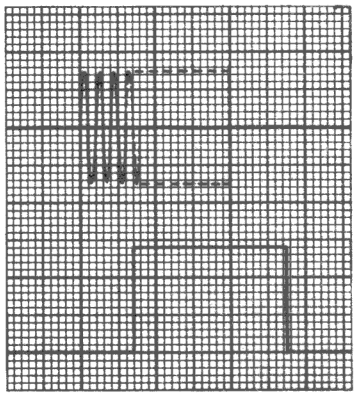
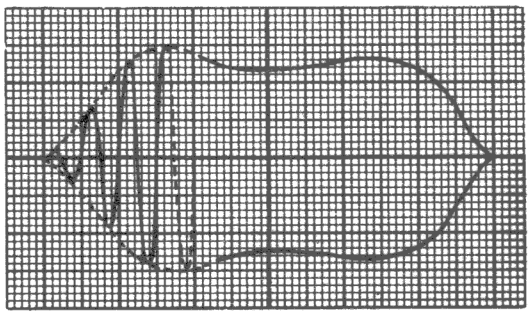
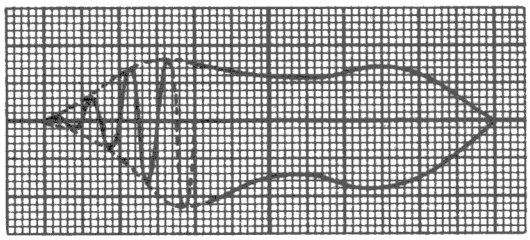
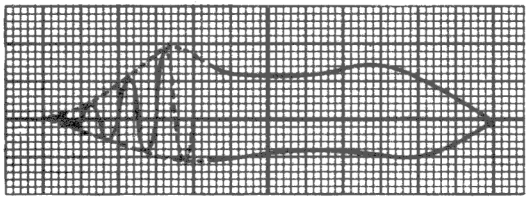
The output circuit connections shown above are those for the Tone On for Z and Tone Off for A keying sense. To alter the sense to Tone On for A, Tone Off for Z, interchange the connections of the twisted pair, i.e. connect the white lead to R58 and the violet lead to the tag between R56 and R58. Do not alter connections at socket SK1.



To adjust the traffic indicator circuit for Tone On for Z and Tone Off for A, connect link B from MR121 to R122; for Tone On for A, Tone Off for Z, connect link B from MR121 to R49.

ADJUSTMENT OF KEYING SENSE **Fig.3**

General conditions: -10 dBm 1 kc/s input tone, keyed at 50 p.p.s; pulse duration 10 mS; R19 in circuit; e/m coil simulated by 200 ohm load resistor.

Waveform	Point of Measurement	Oscilloscope Setting	
		Time Scale	Y-amplifier Sensitivity
	Input to unit (upper beam) with simultaneous pulse at test point 10 (lower beam)	5 mS/cm	500 mV/cm (d.c.) 20 V/cm (d.c.)
	Test point 2	2 mS/cm	20 mV/cm (a.c.)
	Test point 3	2 mS/cm	10 mV/cm (a.c.)
	Test point 4	2 mS/cm	500 mV/cm (a.c.)

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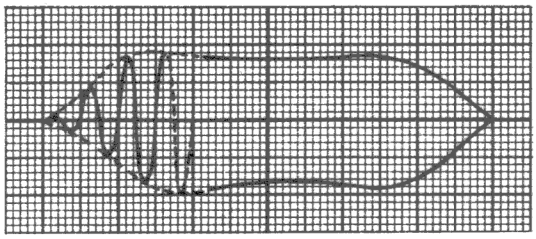
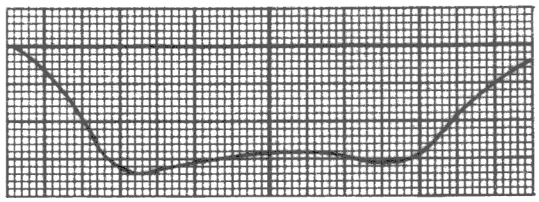
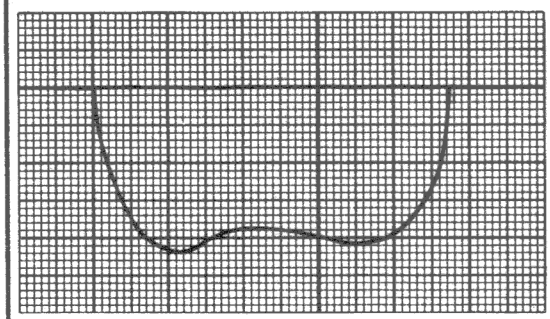
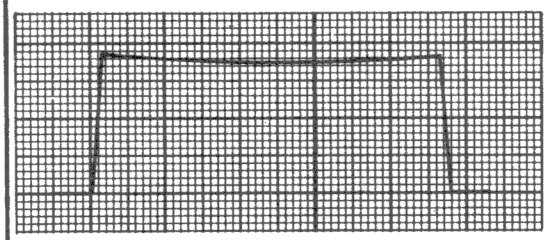
RECEIVER WAVEFORMS (I)

Fig.5A

General conditions: -10 dBm 1 kc/s input tone, keyed at 50 p.p.s; pulse duration 10 mS; R19 in circuit; e/m coil simulated by 200 ohm load resistor.

Waveform	Point of Measurement	Oscilloscope Setting	
		Time Scale	Y-amplifier Sensitivity
	Test point 5	2 mS/cm	200 mV/cm (a.c.)
	Test point 6	2 mS/cm	2 V/cm (d.c.)
	Test point 7	2 mS/cm	200 mV/cm (d.c.)
	Test point 8	2 mS/cm	5 V/cm (d.c.)

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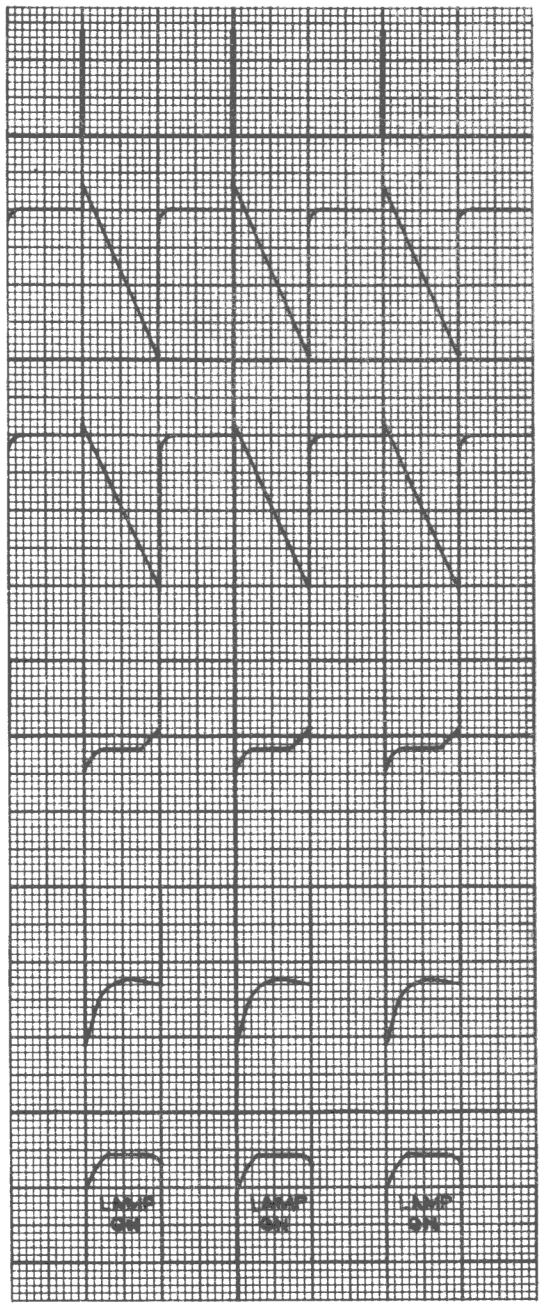
RECEIVER WAVEFORMS (II)

Fig.5B

General conditions: -10 dBm 1 kc/s input tone, keyed at 1 p.p.s; pulse duration 10 mS; R19 in circuit; e/m coil simulated by 200 ohm load resistor; link B connected to R49; oscilloscope time scale 500 mS/cm.

Waveform	Point of Measurement	Oscilloscope Y-amplifier Sensitivity
	Test point 8	Pulses not drawn to any particular amplitude scale
	VT121 base	1 V/cm
	VT121 emitter	1 V/cm
	Test point 13 VT122 collector	5 V/cm
	Test point 15 VT122 emitter	2 V/cm
	Test point 14 VT123 collector	5 V/cm

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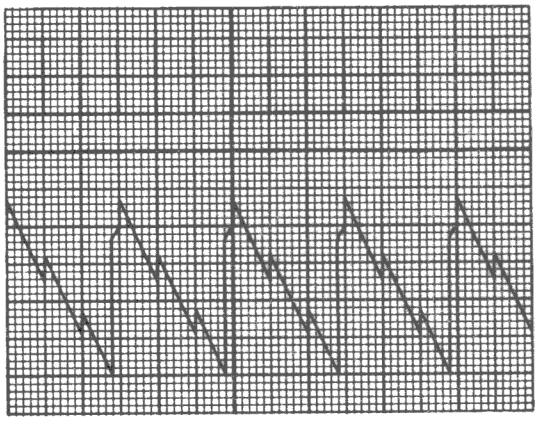
TRAFFIC INDICATOR WAVEFORMS (I)

Fig.6A

General conditions: -10 dBm 1 kc/s input tone, keyed at 4 p.p.s; pulse duration 10 mS; R19 in circuit; e/m coil simulated by 200 ohm load resistor; link B connected to R49; oscilloscope time scale 500 mS/cm.

Waveform	Point of Measurement	Oscilloscope Y-amplifier Sensitivity
	Test point 8	Pulses not drawn to any particular amplitude scale
	VT121 base	1 V/cm

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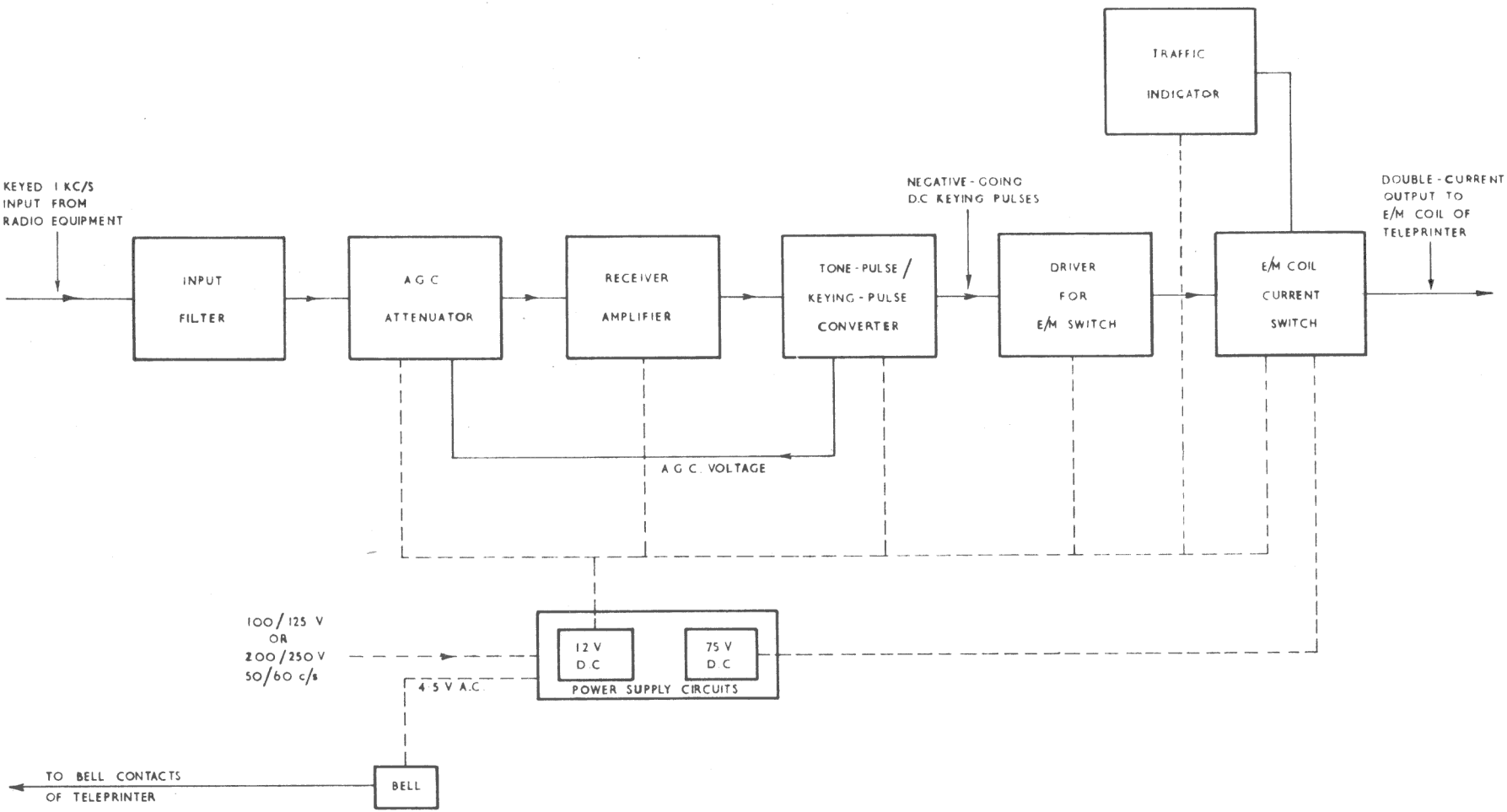
TRAFFIC INDICATOR WAVEFORMS (II)

Fig.6B



ISSUE No. 1

REDIFON LTD. LONDON.	TITLE. BLOCK DIAGRAM T.T.11	DWG. No. SK. 4842/M	SHEET. 1

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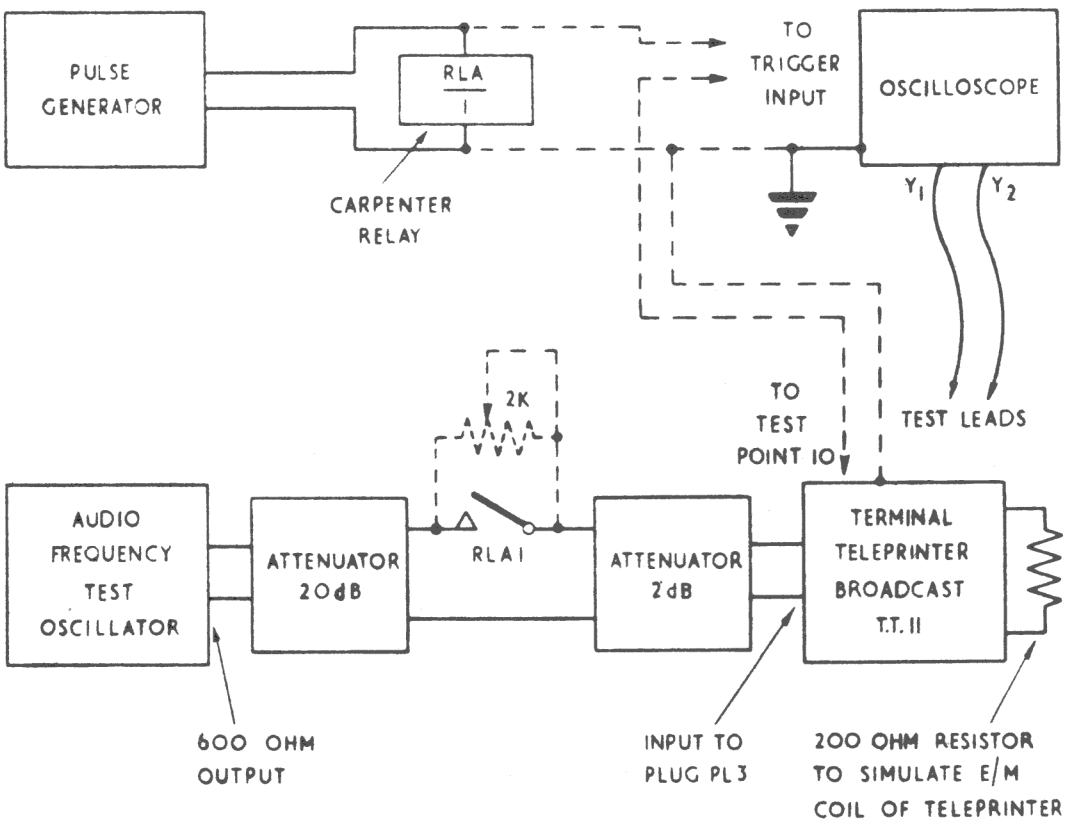
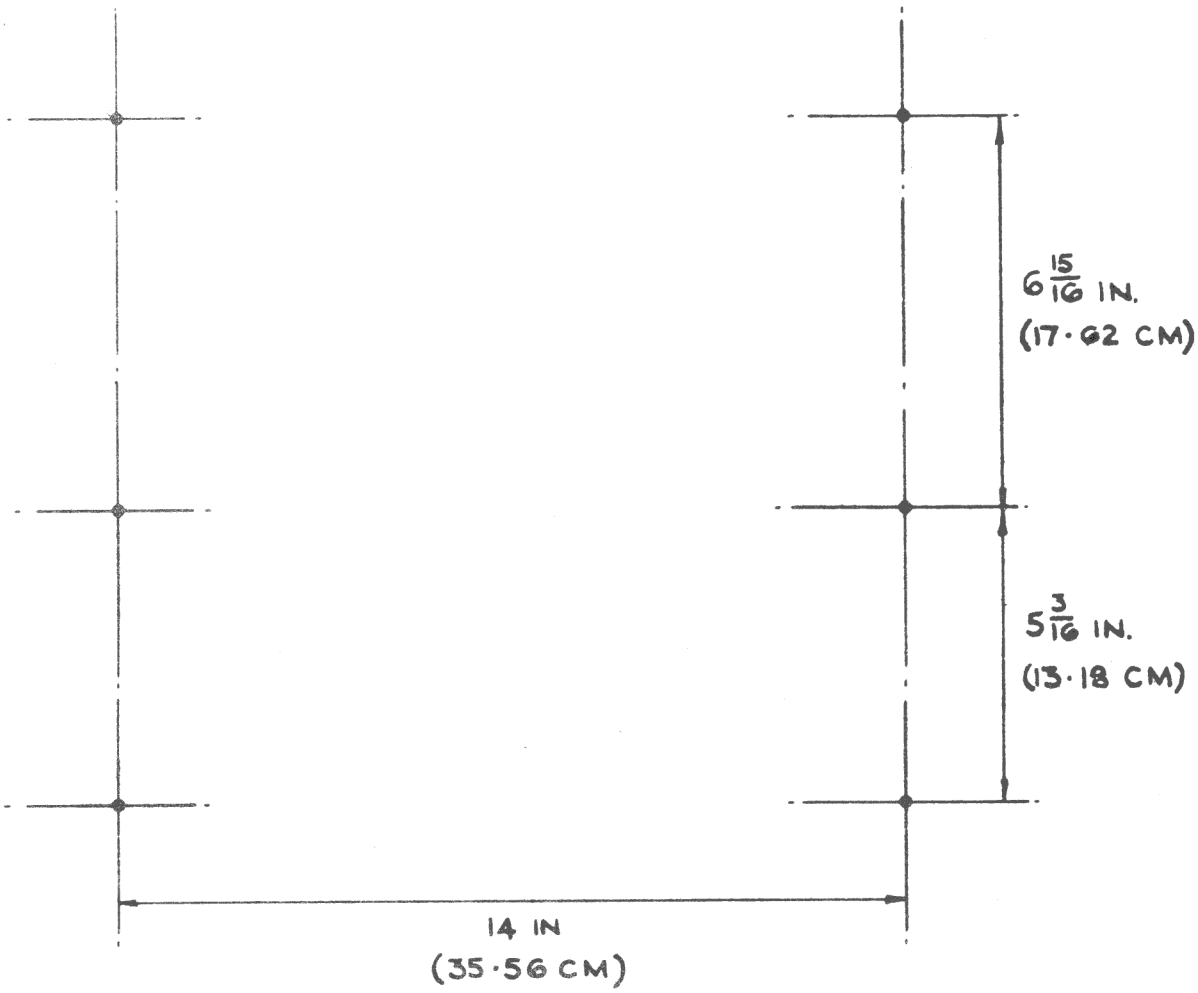


BROKEN LINE CONNECTIONS ARE MADE AS REQUIRED
(REFER PART 2 CHAPTER 1 PARAGRAPHS 15 TO 17)

TEST EQUIPMENT CONNECTION DIAGRAM, T. T. II

REDIFON LTD. LONDON	TITLE	DWG No. SK.4843/S	SHEET 1



DRAWN	TRACED B.P.B. 13·2·63.	ENGINEER	APPROVED	ISSUE No. 1.

REDIFON LTD. LONDON.	TITLE. DIMENSIONS BETWEEN FIXING CENTRES. MOUNT, TELEPRINTER (TERMINAL)	DWG. No. SK. 4824	SHEET 1