MA. 259
5Mc/s Precision Frequency Standard

Operating & Maintenance Manual

RACAL
THE ELECTRONICS GROUP

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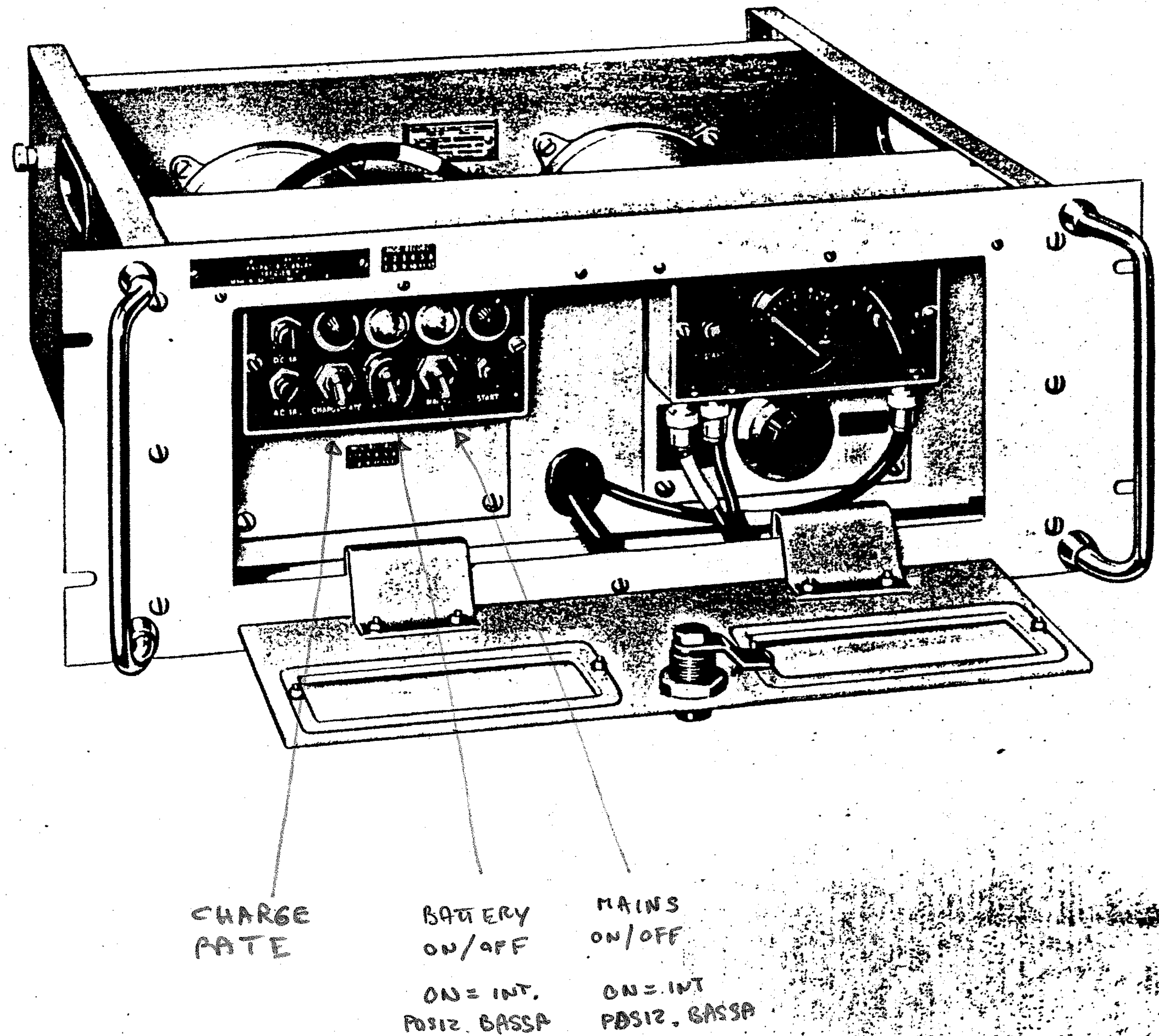

5 Mc/s PRECISION FREQUENCY STANDARD TYPE MA.259

TECHNICAL SPECIFICATION

Function:	To provide three stable sinusoidal outputs at 5 Mc/s, 1 Mc/s and 100 kc/s.
Output frequencies:	5 Mc/s, 1 Mc/s and 100 kc/s.
Load impedance:	50 ohms (unbalanced).
Output level:	1 volt (-20%, +50%).
Frequency stability:	(i) $\pm 5 \times 10^{-10}$ over 24 hours (at time of shipment). (ii) $\pm 2 \times 10^{-10}$ at 50 ohms load changed ±20%. (iii) $\pm 5 \times 10^{-10}$ at temperature 25°C changed ±30°.
Frequency Control:	
Range of front panel adjustment:	100×10^{-9} (approx. 1 in 10^{10} per division).
Range of internal adjustment:	Greater than 600×10^{-9}
Power supply:	To power supply unit: 100 to 125 and 200 to 250 volts a.c., 15W approx. To frequency standard: 22 to 32 volts d.c., 250 mA (800 mA starting from cold).
Dimensions (for rack mounting):	Height / Width / Depth: 7 / 19 / 13 in. 18 / 48.3 / 33 cm.
Weight:	20 lb (9 kg) approx.

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ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

General Description

1. The MA. 259 Precision Frequency Standard consists of an SA. 500 Oscillator Unit and PU. 525 Power Unit mounted in a frame. The Oscillator Unit generates high stability output signals at 5 Mc/s, 1 Mc/s and 100 kc/s. The output signals are derived from a 5 Mc/s crystal which, together with associated circuitry, is contained within a double-proportional oven. A highly stabilised feedback amplifier is used in conjunction with an a.v.c. system to maintain the crystal power at a low, constant level and hence maintain high frequency stability.

2. The equipment uses high quality silicon transistors and diodes throughout. Other component parts have been chosen for reliability and long life. Servicing by the customer is strictly limited (see Chapter 5), in the event of faults within the double-proportional oven, the units should be returned to the manufacturer.

3. A frequency control dial enables the frequency to be set to 1×10^{-10}. The average output level for each of the three frequencies is 1 volt r.m.s. into a 50-ohm load.

4. The Oscillator Unit includes a crystal oscillator stage, the a.v.c. system, the frequency dividers, the output stages and the inner and outer oven control stages. The Power Unit includes a mains voltage rectifying and smoothing stage, the batteries for emergency and normal mains operation, safety relays and indicating lamps.

5. Each unit is constructed within a cylindrical container mounted behind a 4½ in. square panel; each unit can then be fitted onto a conventional 19 in. panel for rack mounting.

6. If the enclosure containing the Precision Frequency Standard also contains other equipment, adequate ventilation should be provided to prevent the temperature from exceeding 60°C.

Variants

7. The three variants of the MA. 259 differ only in respect of the frame holding the two basic units; hence these can be summarized as follows:-

(a) MA. 259E: SA. 500, PU. 525 and MA. 601 Frame (Fig. 1).

(b) MA. 259F: SA. 500, PU. 525 and MA. 602 Frame (Fig. 2).

(c) MA. 259G: SA. 500, PU. 525 and MA. 603 Frame (Fig. 3).

CHAPTER 2

SETTING-UP INSTRUCTIONS

Introduction

1. As supplied by the manufacturer, the Power Unit will normally contain the battery pack. If for any reason the battery pack is not fitted, carry out the procedure in para. 5.

2. It is an advantage to fit a fully charged battery pack but if not available, an uncharged pack must be used. The battery cells are charged using the battery charging stage within the Power Unit. Under these conditions, the battery voltage will rise sufficiently for normal mains operation within thirty minutes; however, the battery capacity will not be normal for at least twenty-four hours even with the high charge-rate in use.

Normal Operation

3. If the battery pack that has been fitted is in an uncharged state, the procedure in para. 4 still applies but for the following:-

(1) The CHARGE RATE switch is set to HIGH (green indicator lamp glows).

(2) Operational use of the equipment cannot commence for 30 minutes.

NOTE: After a battery charging period of 48 hours, the CHARGE RATE switch can be reset to LOW, and the battery capacity will be normal.

4. Assuming the Unit is fitted with a fully charged battery pack:-

(1) Lower the hinged cover, on the front panel of the Power Unit, and check that the connections to the primary winding of the mains transformer are correct for the available supply voltage (fig. 8 facing page 22).

(2) Check that the CHARGE RATE switch is set to LOW.

(3) Check that fuses FS1 and FS2 are intact and of the correct value viz. 1 amp.

(4) Set the BATTERY ON-OFF switch to ON. This switch has a toggle guard to prevent accidental switching off.

(5) Switch on the main supply voltage to the equipment.

(6) Set the A. C. switch to ON and check that only the white (MAINS ON) lamp glows.

(7) Depress the START pushbutton (more than once if necessary) on the Oscillator. Position 9 of the meter switch provides an indication that the dividers are working correctly.

Fitting Battery Pack in Power Unit

5. The procedure for fitting a battery pack into a Power Unit is as follows:-

(1) Remove any front panel connections to the Frequency Standard.

(2) Remove the four panel securing screws and withdraw the Frequency Standard assembly from the cabinet or rack in which it is housed.

(3) Disconnect the free mains supply socket SKT1 to the Power Supply and also the free d. c. supply plug PL2 (fig. 7 facing page 19).

(4) Remove, from behind the front panel, the four 2B. A nuts which secure the front panel plate of the Power Unit to the panel.

(5) Loosen, but do not remove, the bolts which secure the rear of the Power Unit cylindrical cover.

(6) Withdraw the Power Unit and place on a bench.

(7) Remove, from behind the Power Unit panel, the three radially placed countersunk screws holding the cylindrical cover in position; withdraw the cover.

(8) Fit the 21 cells into the battery carrier assembly (page 31) and, using an AVO model 8 on the 25-volt range, measure the voltage between the output leads of the battery assembly; if the cells are in a charged state and also making good contact, the meter will indicate between 23 and 27 volts.

(9) Fit the battery assembly over the three rods within the cylindrical cover, and secure in position with the nuts and washers provided.

(10) Position the battery pack in proximity to the Power Unit chassis and solder the battery output leads to the pins on the component board (red is positive, violet is negative) the positive pin is nearest to VT2 (fig. 12 facing page 23).

(11) Carefully assemble the cover to the Power Unit chassis and refit the three countersunk securing screws.

(12) Refit the Power Unit to the front panel of the Frequency Standard assembly and reconnect PL2 and SKT1.

(13) Re-install the Frequency Standard into its cabinet or rack, making all necessary electrical connections; tighten the nuts and bolts referred to in operation (5).

Accuracy of Frequency

6. The Frequency Standard is now in a working stage but the ovens still require time to reach normal operating temperature; hence, initially the frequency of the output signal will differ from the specification frequency.

7. The operator should now refer to Chapter 3 (Operating Instructions).

CHAPTER 3

OPERATING INSTRUCTIONS

General Operating Notes

1. When a Frequency Standard is despatched by the manufacturer, the ageing rate of the 5 Mc/s crystal is less than 5 parts in 10^{10} per day; the frequency will have been accurately set to 5 Mc/s on an A1 time scale.

2. After an idle period of some days and when the Frequency Standard is first switched on, precise measurements of frequency are not worth taking until the crystal has recovered from thermal shock; this occurs generally, twenty-four hours after switching on. Even, now, the actual frequency and the crystal ageing rate will differ from the values stated on the calibration certificate accompanying the unit.

3. In a typical instance, the frequency after twenty-four hours may differ by several parts in 10^8, and the ageing rate during the first day or two may differ by several parts in 10^9 from figures on the calibration certificate. Within one month, the ageing rate will have fallen to about 5 parts in 10^{10} per day; this rate continues to fall and, after a few months, may be as low as one or two parts in 10^{10} per day. Hence, efficient use of the vernier fine frequency control can only be achieved by periodically measuring the crystal ageing rate.

Function of Oscillator Controls

4. There are three controls on the front panel of the Oscillator Unit. In addition to these controls there is a meter and three output sockets for the 5 Mc/s, 1 Mc/s and 100 kc/s signals.

5. START Pushbutton This is a manually-operated pushbutton switch that triggers the regenerative divider stages into operation. It may be necessary to operate this switch more than once in order to activate the stages.

6. Fine Frequency Control This control has a vernier scale and is adjusted to correct for the oscillator crystal ageing characteristic. The dial is of the multi-turn type with 1000 useful divisions in 10 turns. The tuning range is 1 part in 10^7 producing a frequency change of approximately 1 part in 10^{10} per division.

7. <u>Meter Switch</u> This switch selects the following functions for monitoring:

NOTE: The meter readings obtained on test at normal room temperature are marked on the front panel.

Position 1: INPUT VOLTS - the power supply h.t. voltage is measured; full-scale deflection = 50 volts.

Position 2: REG (regulated) VOLTS - the regulated h.t. voltage is measured; meter full-scale deflection = 25 volts. Normal indication is 17 ±1 volt.

Position 3: A.V.C. VOLTS - the voltage developed by the A.V.C. system is indicated; above half full-scale deflection is normal.

Position 4: TEMPERATURE - the inner oven temperature is indicated. Indication is zero at normal over temperature; f.s.d. represents approximately 10°C below normal working temperature.

Position 5: INNER OVEN - the voltage across the inner oven heater winding is measured; meter full-scale deflection = 15 volts. A reading of between 2 volts and 4 volts is normal after warm-up; prior to this, indication is close to f.s.d.

Position 6: OUTER OVEN - the voltage across the outer oven heater winding is measured; meter full-scale deflection = 25 volts. A reading of between 1V and 20V is indicated depending on ambient temperature.

Position 7: 5 Mc/s OUT - indicates the presence of a 5 Mc/s signal on the filter. Indication depends on load at output socket and adjustment of internal filter.

Position 8: 1 Mc/s OUT - indicates the presence of a 1 Mc/s signal on the filter. Indication depends on load at output socket and adjustment of internal filter.

Position 9: 100 kc/s OUT - indicates the presence of a 100 kc/s signal on the filter. Indication depends on load at output socket and adjustment of internal filter.

Function of Power Unit Controls

8. There are four switches on the front panel of the Power Supply. In addition to these switches there are two fuses and four indicator lamps. All the aforementioned items are mounted on the face of a cover which can be hinged down to reveal the taps on the primary winding of the mains transformer.

9. A. C. ON-OFF switch This is the mains supply switch and is set to 'ON' for mains operation (white lamp glows).

10. BATTERY ON-OFF switch This switch must be set to 'ON' for all modes of operation.

11. START pushbutton switch This switch is pressed to bring the battery into operation when mains supplies are non-existent.

12. CHARGE RATE switch This switch selects the high or low charging rate for the battery. It is normally set to the low position (green lamp extinguished) during mains operation and should be set to the high position if battery operation has been employed for a sustained period.

13. MAINS ON lamp This lamp has a white lens and glows to indicate the presence of a.c. mains supplies when the A. C. switch is set to 'ON'.

14. MAINS FAIL BATTERY ON lamp This lamp has an amber lens and glows to indicate a failure of the mains supply followed by battery take-over.

15. BATTERY FAIL lamp This lamp has a red lens and glows to indicate a failure of battery e.m.f. during either mains or battery operation.

16. CHARGE RATE HIGH lamp This lamp has a green lens and glows when the battery CHARGE RATE switch is set to the 'HIGH' position.

17. Fuses FS1 and FS2 These are 1 amp fuses fitted in the d.c. output lead and the mains input line respectively.

Operating Procedure

18. It is assumed that the Setting-up Instructions (Chapter 2) have been carried out. The ovens will warm-up in about one hour, but it is desirable to wait at least 48 hours before making precision measurements in order to allow the crystal time to recover from thermal shock.

19. In position 4 (TEMP), 5 (INNER OVEN) and 6 (OUTER OVEN) the meter indication will be abnormally high until the oven temperature begins to approach the normal level. After approximately one hour, the indication in positions 4 and 5 will approximate to the values marked on the plate above the meter. The indication in position 6 will also fall but the final value will depend on the ambient temperature; hence, the indication obtained will only be of the order of that marked on the plate.

20. When the Frequency Standard is known to be operating normally in every respect, a periodic check of the indication in all positions of the meter switch can be made, and the results compared with the values marked on the test plate.

21. Position 3 (A. V. C.) of the meter switch provides a fairly reliable indication (zero reading) of oscillation failure in the 5 Mc/s crystal oscillator stage. The meter switch should not be left indefinitely in the A. V. C. position; the switch should normally be set to the TEMP position.

22. If a mains failure occurs, the battery will automatically take over, the amber lamp glows and the white lamp is extinguished. Do not reset the A. C. switch to OFF.

23. If the battery voltage falls below 23. 0V, a relay removes the voltage from the oscillator to avoid the possibility of an incorrect frequency being obtained; the red lamp comes on and glows continuously until the battery is fully discharged. It is undesirable to allow the battery to discharge without restraint as this may result in some of the cells being reverse-charged. In this event the capacity of the battery peak should be checked after it has been recharged.

Crystal Ageing

24. Adjustments to compensate for crystal ageing are explained in Chapter 5.

CHAPTER 4

TECHNICAL DESCRIPTION

BRIEF DESCRIPTION

Oscillator Unit

1. A 5 Mc/s signal is generated by a very stable crystal-controlled oscillator the output frequency of which is the fundamental from which all the output frequencies are derived. To assist in maintaining the high degree of stability required, the components of the oscillator stage are temperature-controlled within a double-proportional oven (para. 6).

2. Referring to the block diagram Fig. 4 facing page 10 the output from the 5 Mc/s oscillator is applied to a three-stage a.g.c. amplifier from which two outputs are taken; one is an amplified 5 Mc/s output and the other a direct current proportional to the amplitude of the 5 Mc/s signal. The direct current output is fed back to the oscillator stage in order to maintain a low constant power level of oscillation and thus improve stability.

3. The 5 Mc/s output is fed to a buffer stage, one output of which is applied to the 5 Mc/s output stage. A second output is taken to a regenerative divider producing a 1 Mc/s output, then this signal is applied to a 1 Mc/s output stage.

4. The 1 Mc/s output is also applied to a further regenerative divider producing a 200 kc/s signal which is then fed to a third divider stage producing 100 kc/s. The 100 kc/s signal is fed to a 100 kc/s output stage.

5. The 5 Mc/s, 1 Mc/s and 100 kc/s output stages are single transistor amplifiers feeding into band-pass filters whose outputs are connected to output terminals mounted on the front panel.

6. The double-proportional oven is in two sections, one inside the other (Fig. 5 facing page 11). Each oven assembly has a temperature control circuit which governs the current through a heater element which is wound around the appropriate oven body. The two control circuits are identical in function and design, each comprising an oscillator coupled to a bridge circuit. One arm of each bridge circuit is a thermistor which is bonded to the body of the oven being controlled. The current through the bridge is thus varied in accordance with temperature fluctuations of the oven body. The bridge circuit current, via a feedback loop, controls the amplitude of the oscillator output which in turn governs the current through the power stages and thus the current through the heater windings.

7. The inner oven maintains a constant working temperature for the oscillator and crystal. The outer oven, in addition to maintaining a stable ambient temperature for the inner oven, provides a constant working temperature for the components associated with the A.G.C. amplifier and the inner oven control stages.

8. The outer oven assembly is partly insulated from the surrounding ambient temperature by a vacuum flask. Under normal working conditions, the inner and outer ovens are warmed from the heat dissipated by the power transistors in the oven control stages, the power transistors being clamped to the oven framework. The heater windings supplement this energy and assist in maintaining the oven temperature at a constant level.

9. Components mounted to the rear of the front panel of the Oscillator are enclosed in a tubular cover assembly. The cover fits over a flange and butts against the rear face of the panel. An 'O' ring seal is fitted on the flange and thus the cover forms a sealed compartment enclosing the major assemblies of the Oscillator. The h.t. supply filter components are mounted on the outside of the front panel and housed under a hinged cover.

10. Only the front panel of the Oscillator Unit is at a true earth potential. Following a d.c. supply filter, all stages within the unit operate between the positive and negative (common) supply lines from the Power Unit.

Power Unit

11. The Power Unit is designed to enable the Frequency Standard to be operated from 110 to 120 or 220 to 240 volts, 48 - 400 c/s power supplies. The Oscillator Unit requires a supply of 22 volts d.c. (minimum) at a maximum current of 0.8 amp., and the Power Unit is designed to meet this requirement. The value of the voltage output from the Power Unit is dependent upon the state of charge of an internal battery; the battery potential is used as a reference voltage to stabilize the output, the Oscillator load current being drawn from the mains supply.

12. The internal battery is also employed to energise the Oscillator in an emergency and is automatically brought into operation in the event of a mains supply failure. Under normal operating conditions, the Power Unit is used to maintain the battery in a fully charged condition but in the event of the battery voltage falling below 22 volts, the supply is interrupted and a warning lamp glows.

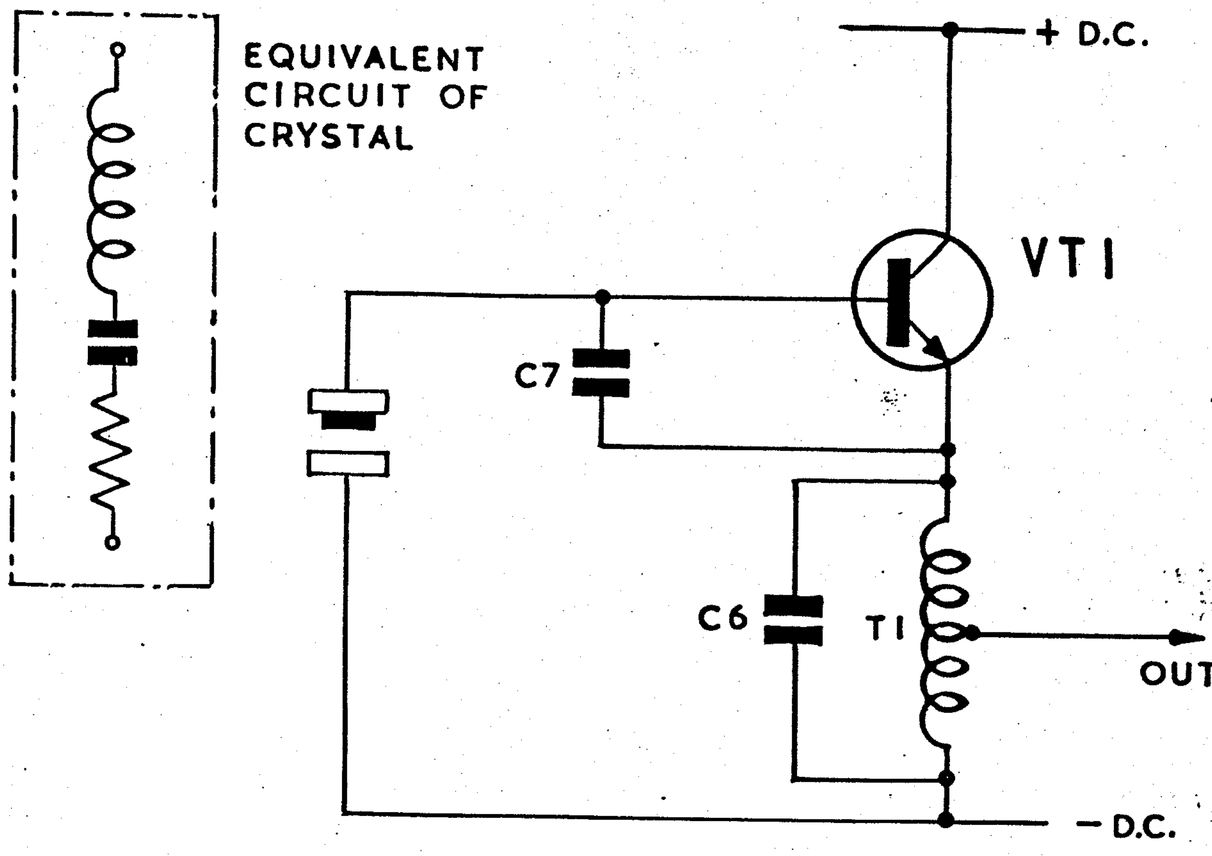
DETAILED DESCRIPTION OF OSCILLATOR UNIT

5 Mc/s Oscillator

13. Considering the simplified oscillator circuit (fig. 4.1), transistor VT1 functions in a modified Pierce circuit.

14. Capacitor C6 and the primary winding of T1 form a capacitive load at 5 Mc/s; the emitter circuit resonates at a frequency between 4 and 5 Mc/s. Resulting from the feedback and capacitive emitter load, the input impedance to the stage, at 5 Mc/s, contains a negative resistance component.

15. At the frequency of oscillation, the total resistance and reactance in the crystal circuit must be zero. At this frequency, the reactance of the crystal is positive, that is, it consists of a small resistance in series with a small inductance. Hence, the crystal reactance is neutralised by the emitter circuit reactance (para. 14) and the stage oscillates.



Simplified Circuit: 5Mc/s Oscillator-SA500 Fig.4.1

16. Referring now to the main circuit diagram Fig. 6 facing page 18 the remaining components in the oscillator stage function as follows. Resistor R3 and capacitor C9 decouple the h. t. supply to the grounded-collector transistor VT1. Components R2 and C8 provide emitter bias and decoupling respectively. If the crystal unit, when new, resonates a few cycles above 5 Mc/s, the small inductor LX 'pulls' the resonant frequency to the correct value. MR1 is a Zener diode which, in conjunction with R7 and C12, stabilises the collector voltage to VT1.

17. The capacitors C1 to C5 can be regarded as part of the crystal equivalent circuit. Capacitor C1 is ganged to the FINE FREQUENCY control on the front panel of the Oscillator. The preset trimmer C3 is adjusted to make the range of C1 equal to 100 ±10 parts in 10^9 for the 1000 divisions on the vernier scale on the front panel. The preset trimmer C5 is a coarse frequency control accessible from the inside of the unit; capacitor C4 determines the range of C5 which is greater than 600 parts in 10^9.

18. The output from VT1 is taken from the tap on T1 in order to prevent loading on this part of the circuit by the input impedance of the following stage.

A. G. C. Amplifier

19. Transistors VT2, VT3 and VT4 of Fig. 6 form a three-stage direct-coupled amplifier with negative-feedback from the collector of VT4 to the emitter of VT2; the feedback network consists of R11 and R9 and the voltage gain of the amplifier between VT2 and VT4 collector is determined by the ratio of R11 to R9. The components R8 and C13 provide bias and decoupling for the emitter of VT2.

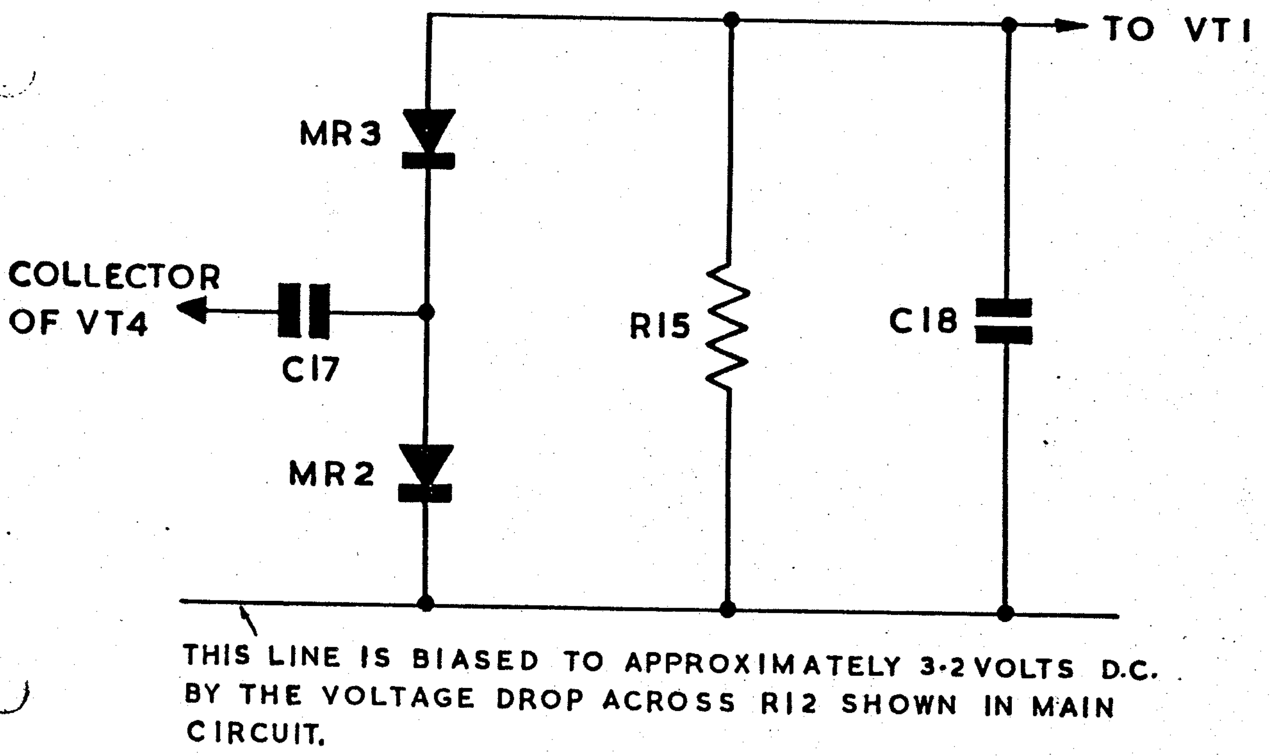
20. There are two outputs from VT4; a 5 Mc/s output from the secondary winding of the collector transformer T2 is applied to the following buffer stage VT101; a 5 Mc/s signal at the collector of VT4 is also applied to a voltage doubler circuit comprising MR2 and MR3 (see also Fig. 4.2). The purpose of these amplifier and rectifier stages is to keep the crystal power low and constant and hence improve the frequency stability of the stage. This is achieved by feeding a positive bias current back to the base of VT1.

21. Referring to Fig. 4.2, the 5 Mc/s signal is fed via C17 to the voltage doubler circuit, and twice the peak value is developed across C18. The amplitude of the voltage is always less than 3.2 volts and its polarity is the reverse of that developed across R12 (+3.2V); therefore, the voltage applied to the base of VT1 is positive.

22. Hence the effect of any increase in output from VT4 is to reduce the direct current fed to the base of VT1; this in turn decreases the transconductance of VT1 and hence the amplitude of oscillation. A reduction in output from VT4 has the reverse effect.

23. Direct-current negative-feedback is provided by the connection from the junction of MR2 and C16 to the base of VT2 via R5.

24. The 5 Mc/s output (approx. 80 mV r.m.s.) from the secondary winding of T2 is applied via C101 to the base of VT101.



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Simplified Circuit: A.V.C. Stage–SA500 Fig.4.2

Buffer Amplifier

25. Transistor VT101 of Fig. 6 is a buffer amplifier with a collector load tuned to 5 Mc/s by T101 and C194. Two outputs are taken from the secondary winding of T101; one is fed to the base of VT103 and VT104 which form part of a regenerative divider; the second output is applied to the 5 Mc/s amplifier which is described in para. 36.

5 Mc/s to 1 Mc/s Regenerative Divider

26. The 5 Mc/s signal from the buffer stage VT101 is applied in push-pull, via transformer T101, to the base electrodes of VT103 and VT104; the collector load on this stage is the 1 Mc/s tuned transformer network T106, C113. A 4 Mc/s signal is applied to the emitter electrodes of VT103 and VT104 from the secondary winding of transformer T104. The 5 Mc/s and 4 Mc/s signals are mixed by VT103, VT104 to produce the required 1 Mc/s output signal across the secondary winding of T106. This signal is applied to the following divider stage and also the 1 Mc/s output amplifier (para. 37).

27. The 1 Mc/s output across T106 is also applied in push-pull, via C114 and C115, to VT105 and VT106. This stage functions as a harmonic generator with its collector load (T104, C111) tuned to 4 Mc/s. As stated in para. 26, the 4 Mc/s output from T104 is applied to the mixer stage VT103, VT104.

1 Mc/s to 200 kc/s Regenerative Divider

28. The transistors VT108 to VT111 function in exactly the same manner as VT103 to VT106 (paras. 26 and 27); the following differences exist between this and the first divider. The collector load T110, C122 for the push-pull mixer stage VT108, VT109 is tuned to 200 kc/s; the collector load T108, C121 for the push-pull harmonic generator stage VT110, VT111 is tuned to 800 kc/s.

29. The 1 Mc/s output signal from the secondary winding of T106 is applied to the mixer stage VT108, VT109. The 800 kc/s signal produced by the harmonic generator (VT110, VT111) is applied to the mixer and the difference frequency of 200 kc/s is developed across the secondary winding of T110. This 200 kc/s signal is used as the output to the next stage, and also as the drive to the harmonic generator.

200 kc/s to 100 kc/s Regenerative Divider

30. The 200 kc/s signal from the previous divider stage is applied in push-pull to VT113 and VT114. The principle of operation of this stage is similar to that of the previous dividers. The collector load is the 100 kc/s tuned transformer network T113, C130. A voltage from the secondary winding of T113 is fed back to the emitter of VT113 and VT114; this 100 kc/s voltage is mixed in the push-pull stage with the 200 kc/s signal from the previous divider.

31. Part of the 100 kc/s signal across the secondary winding of T113 is applied to the divider-starter stage VT115 (para. 32); part of the 100 kc/s signal is also applied to the 100 kc/s output amplifier (para. 38).

Divider Starter

32. The first two divider stages have to be excited into operation, and this is achieved by reinstating the h.t., after it has been momentarily removed, to the push-pull mixer stages of each divider.

33. The START pushbutton switch SB, transistor VT115 and associated components form the divider starter stage, the action being as follows. While switch SB is momentarily depressed, VT115 conducts and relay RLA/2 is energised; this action is also made possible by the positive potential, via R141, on the base of VT115. Relay contacts RLA1 and RLA2 momentarily close; the action of opening produces the excitation impulse for the two divider stages.

34. The divider stages are now functioning, and a 100 kc/s signal is applied to the voltage-doubler rectifier C132, MR104, MR105 and C134; a negative potential is produced which overrides the positive potential, via R141, at the base of VT115. This negative potential ensures that after dividing action has commenced, a subsequent and inadvertent depression of the START switch cannot interrupt the action of the divider stages since VT115 is held in a cut-off state and therefore relay RLA/2 cannot be energized.

35. It may be necessary to operate the START pushbutton more than once in order to excite the regenerative dividers.

Output Stages

36. The 5 Mc/s signal from the secondary winding of T101 is fed via R104, C106, to the base of the 5 Mc/s amplifier VT102. This is a common-emitter stage with negative feedback from collector to base through R108. The collector circuit is a band-pass filter consisting of the components C107, T102, C110, T103, C112, T105 and R117; the 5 Mc/s output across R117 is fed via a coaxial lead to a coaxial socket SKT3 on the front panel. The metering components MR101, C109, R113 are described in para. 54 (position 7).

37. The 1 Mc/s signal from the secondary winding of T106 is fed via R118, C116 to the base of the 1 Mc/s amplifier VT107. This is a common-emitter stage with negative-feedback from collector to base through R121. The collector circuit is a band-pass filter consisting of C117, T107, C120, T109, C123, T111 and R132; the 1 Mc/s output across R132 is fed via a coaxial lead to a coaxial socket SKT4 on the front panel. The metering components MR102, C119, R127 are described in para. 54 (position 8).

38. The 100 kc/s signal from the secondary winding of T113 is fed via R133, C126 to the base of the 100 kc/s amplifier VT112. This is a common-emitter stage with negative-feedback from collector to base through R134. The collector circuit is a band-pass filter C127, T112, C131, T114, C133, T115 and R142; the 100 kc/s output across R142 is fed via a coaxial lead to a coaxial socket SKT5 on the front panel. The metering components MR103, C129, R149 are described in para. 54 (position 9).

Inner Oven Controller

39. The function of the control circuit is to maintain the inner oven temperature constant to within 0.02°C. The actual working temperature (between 70°C and 80°C) is set to within 0.2°C for each individual crystal.

40. The inner oven controller stage comprises transistors VT14, VT16, VT22 and VT23. Transistors VT14 and VT16 form a two-stage directly-coupled amplifier with a tuned transformer load (T9, C21) in the collector circuit of VT16. The secondary winding of T9 is centre-tapped and forms two arms of a bridge circuit, the other two arms being the thermistor TH1 and RV1 in series with R24. Thermistor TH1 is mounted on the outer surface of the inner oven cover; being a temperature sensitive device, its resistance is affected by the surface temperature of the oven.

41. A positive-feedback voltage from the bridge network is applied to the base of transistor VT14 causing the two-stage amplifier to oscillate. The state of balance of the bridge network, viz. zero feedback voltage, is arranged to occur at a temperature which is slightly above the required oven working temperature. This is achieved on production test by adjusting the preset potentiometer RV1.

42. Hence, the two-stage amplifier oscillates continuously and there is always an output voltage at the collector VT16; the magnitude of this voltage is dependent on the amount of unbalance in the bridge network.

43. The signal at the collector of VT16 is fed via R22, C24 to the voltage doubler and smoothing network MR4, MR5, C25, R25. The positive current fed into the base of VT22 is amplified and fed to the base of the power transistor VT23; the collector load for VT23 is the inner oven heater element HR1.

44. The magnitude of the current through HR1 is dependent on the amount of unbalance in the bridge network which is also dependent on the deviation of the oven temperature from the required crystal working temperature.

Outer Oven Controller

45. The outer oven controller comprises the transistors VT17, VT19, VT24 and VT25. The circuit is identical and hence functions in the same manner as the inner oven controller. Transistors VT17 and VT19 are the two-stage direct-coupled amplifier. The thermistor bridge circuit consists of T10 secondary winding, RV2 and the thermistor TH2. Rectification of the signal is made by MR6 and MR7, the transistors VT24 and VT25 are the two-stage d.c. amplifier feeding the outer oven heater winding HR2.

D.C. Supply Filter

46. The frequency standard unit is fitted with an efficient d.c. supply line filter consisting of L10A, L10B, L11A, L11B and electrolytic capacitors C76 to C79. The purpose of the filter is to remove any high frequency voltages which might interfere with the operation of the unit.

Voltage Regulator

47. The supply voltage for all stages, except the outer oven controller, is stabilized against variation in load by a high gain voltage regulator stage comprising transistors VT20, VT21 and VT26. The voltage (9 volts) developed across the Zener diode MR15 is used as a reference potential which is compared with the voltage across R76; C75 decouples random noise originating in MR15. The comparison is performed by VT20 and the magnitude of the direct current output from this stage depends on the difference between the two voltages. Any change in this current is amplified by VT21, and applied to the base of the series control transistor VT26.

48. The stabilized output voltage is developed across R76 and R77; C74 maintains a high loop gain. Resistor R79 determines the required operating current for MR15.

49. The current through R80 is the sum of the base current to V21 and the collector current to VT20. If there is a slight fall in output voltage, the base of VT20 becomes less positive resulting in a reduction of collector current through VT20. This occurrence produces an increased base current to VT26 and hence a rise in output voltage to compensate for the original drop across R76.

Thermal Switch

50. A thermal switch SA, is connected in series with the unregulated d.c. supply to the outer oven control circuit. The switch is mounted outside the outer oven enclosure and serves as a safety device against excessive rise in oven ambient temperature.

Metering

51. In the following paragraphs the function of each position of switch SC is described. The meter has a 100 μA movement.

Position 1: Measures the unregulated d.c. supply. Resistor R84 (499 kΩ) produces a meter f.s.d. (full-scale deflection) of 50 volts d.c.

Position 2: Measures the regulated d.c. supply. Resistor R85 (249 kΩ) produces a meter f.s.d. of 25 volts d.c.

Position 3: Indicates that a.g.c. is being applied to VT1. The meter is connected directly across the resistor R14 in the a.g.c. circuit.

Position 4: Measures inner oven temperature. This is detected by the bridge circuit formed by the components R81, R82, thermistor TH3 and preset potentiometer RV3. Thermistor TH3 is mounted on the outer surface of the inner oven cover and situated near to thermistor TH1. The sensitivity of the meter is approximately one degree centigrade per major division on the meter scale; this is only sufficient to indicate a gross malfunction of the temperature control system. Potentiometer RV3 is set-up such that a high meter reading corresponds to a low oven temperature. The meter reads zero at the preset oven temperature.

Position 5: Measures the voltage developed across the inner oven heater winding. Resistor R86 (150 kΩ) produces a meter f.s.d. of 15 volts d.c. and the meter, in series with R86, is connected across HR1.

Position 6: Measures the voltage developed across the outer oven heater winding. Resistor R87 (249 kΩ) produces a meter f.s.d. of 25 volts d.c. and the meter, in series with R87, is connected across HR2.

Position 7: Measures the output level of the 5 Mc/s signal. Resistor R113 (33 kΩ) is the meter series resistor, and the 5 Mc/s signal from transistor VT102 is rectified and smoothed by MR101 and C109.

Position 8: Measures the output level of the 1 Mc/s signal. Resistor R127 (33 kΩ) is the meter series resistor, and the 1 Mc/s signal from transistor VT107 is rectified and smoothed by MR102 and C119.

Position 9: Measures the output level of the 100 kc/s signal. Resistor R140 (33 kΩ) is the meter series resistor, and the 100 kc/s signal from transistor VT112 is rectified and smoothed by MR103 and C129.

DETAILED DESCRIPTION OF POWER UNIT

52. The Power Unit enables the Frequency Standard to be operated from a mains supply, or in emergency, from a 21-cell battery incorporated in the Power Supply. In the fully charged condition, the battery voltage is about 30V. Part of the Power Unit d.c. output is employed to maintain the battery fully charged. The charging current rate can be altered by means of a two-position switch (para. 60).

For clarity, the power supply circuit will be considered under four headings:-

(a) Normal Mains operation

(b) Battery charging stage

(c) Emergency battery operation

(d) Battery failure

Normal Mains Operation

53. Referring to the circuit diagram Fig. 8 facing page 22, the mains supply is connected via PL1 (pins A, B and C), the mains on/off switch SA, a line fuse (FS2) and a voltage selector panel to the primary winding of transformer T1; the voltage selector panel is located behind the hinged cover on the front panel. T1 primary has eight tappings which can be connected to suit mains voltages of 110V, 115V, 120V, 220V, 230V and 240V.

54. The secondary winding of T1 is connected to a full-wave bridge rectifying circuit MR1 to MR4, the output being smoothed by the electrolytic capacitor C1. The voltage across C1 is applied to the collector of transistor VT1 which functions as an emitter-follower with a base voltage stabilized by the battery; note that relay contacts RLA1 and RLB2 are closed during normal mains operation.

55. The components R6, RV1, R8, MR8, VT1 and relay RLA/2 form a battery cut-off stage. Future references in this description to the term 'battery failure' imply a discharge state of the batteries which must not be exceeded, viz. 23 volts. If this voltage is reached, the batteries are disconnected by a relay contact.

56. The potentiometer RV1 is preset to produce a collector current through VT3 which just operates relay RLA/2 from a battery voltage of 23 volts. Should a 'battery failure' occur, the voltage across the potential divider R6, RV1, R8 is reduced; as the potential across MR8 is constant, the proportion of voltage drop at the wiper of RV1 appears at the base of VT3; relay RLA/2 is de-energized, contact RLA/2 changes over to light the BATTERY FAIL lamp ILP3 (red), and contact RLA1 changes over to isolate the battery. Resistor R11 determines, suitable operating current for MR8.

57. The BATTERY ON-OFF switch is permanently set to the ON position for both normal mains and emergency battery operation; this switch is only set to the OFF position when it is required to isolate the battery and carry out servicing on the unit.

58. After operating the mains ON-OFF switch, relay RLB/4 is energized and contact RLB2 closes; this contact overrides the BATTERY switch in the event of a failure to set it to the ON position.

59. The voltage across C1 is applied to the collector of VT1; since the base of VT1 is connected to the positive supply line via R4 and VT2, current will flow from the emitter of VT1 to energize relay RLA/2. Contact RLA1 closes to connect the battery, through MR7, to the base of VT1; hence, the emitter (output) voltage of VT1 is now stabilized by the battery to a value slightly less than the battery volts. The output voltage is fed to pin A (negative) and B (positive) of socket SKT2: the positive output line is fused by FS1 (1 amp).

Battery Charging Stage

60. It is necessary to charge the batteries at a substantially constant current when their state of charge is low; when fully charged, an excessively high charging current must be prevented. Transistor VT2 forms the basis of a battery charging stage. The collector current is the charging current, and it is varied (using switch SD) to provide a low and high charging rate. Zener diode MR6 ensures a base potential to VT2 which is sensibly constant with respect to the junction of R4 and MR7; hence, R4 largely determines the magnitude of the low rate charging current (approx. 50 mA). Switch SD, when in the HIGH CHARGE RATE position, connects R5 across R4 to increase the charging current to a maximum of about 200 mA. However, when the battery voltage rises towards its maximum, there is insufficient voltage across the battery charging stage to produce full Zener action in MR6; this results in a reduction of the charging current, in the high-charge state, to a value of about 150 mA, and thus the danger of overcharging the battery does not exist.

61. The CHARGE RATE switch is only set to the HIGH position when it is known that the battery voltage is low or when the Frequency Standard has been working on emergency battery operation for a prolonged period of time.

62. The charging current is applied to the battery via MR9 and relay contact RLB2. The purpose of MR9 is to allow the passage of a charging current to the battery and to isolate the battery from the remainder of the circuit under battery failure conditions (para. 55). During normal operation, relay contact RLB2 is closed.

Emergency Battery Operation

63. If a mains failure occurs during normal mains operation, the battery is automatically brought into use as follows. Relay RLB/3 is de-energized; contact RLB2 opens; contact RLB1 closes to light the amber MAINS FAIL BATTERY ON lamp ILP4. The d.c. collector supply to VT1 fails but the battery cut-off stage VT3 remains in its original state by virtue of the battery voltage on the base of VT1 which now functions as a diode.

64. The Frequency Standard may have to be operated from the internal battery when a mains supply is unavailable. The BATTERY ON-OFF switch SB is still set to the ON position and the START switch SC is momentarily depressed; this overrides RLA1 and connects the battery to the base of VT1. Relay RLA/2 is energized and held-on by the closing of contact RLA1.

CHAPTER 5

ROUTINE MAINTENANCE AND FAULT LOCATION

General Remarks

1. The only routine maintenance required is:

   (a) Checking the state of discharge of the battery, and

   (b) The regular adjustment of the crystal ageing control on the front panel of the Oscillator.

2. The procedure for checking the battery pack is given in paragraph 14.

3. Adjustments to the crystal ageing control should only be carried out if the application demands an accuracy of better than a few parts in 10^8 over a period of 3 months.

4. In order to make periodic adjustments to the crystal ageing control, a reference source, such as a V. L. F. Transmission, must be available for measuring and recording changes in the crystal ageing rate. When the limit of the front panel adjustment is reached, an adjustment to the internal coarse trimmer must be made (refer to paragraph 13).

Fault Location - Oscillator

5. Faults within the Oscillator result in the following external responses:

   (a) Inadequate or complete loss of output voltage, or

   (b) Incorrect frequency of output.

The particular location of a fault within the Oscillator can be arrived at by intelligent interpretation of meter readings provided by the meter switch. The Fault Location Tables 5.1 and 5.2 have been included as a guide to fault finding along the above lines.

6. In Tables 5.1 and 5.2, references are made to high and low indications on the Oscillator meter; these indications are with respect to the normal readings shown on the engraved plate fixed to the hinged cover.

7. Having located the fault to a specific area - not within the outer oven, - conventional fault finding techniques must be employed; here, familiarity with the technical description in Chapter 4, is essential. Table 5.3 gives typical static voltage levels for the frequency divider and output stages; these voltages were measured using a 20 000 ohms per volt multi-range meter (e.g. AVO Model 8).

8. Although indications are given for determining faults in stages within the outer oven, adjustments to these stages by the customer is deprecated; hence, it is recommended that the unit be returned to the manufacturer who is equipped with the special facilities for repairing, re-aligning and testing these stages. The above remarks do not apply to the preset coarse frequency trimmer (see paragraph 13).

9. Information for dismantling and reassembly is contained in Chapter 6. Note that if the Oscillator has been dismantled, it may be necessary to replace the dessicator before reassembly.

10. Instructions for aligning the frequency dividers are given in Chapter 3.

Fault Location - Power Supply

11. A useful aid to fault finding within the Power Supply is provided by the Technical Description (Chapter 4). Figure 8 facing page 22 gives some voltage levels under conditions of normal mains operation. Conventional techniques for tracing a component failure are employed. Dismantling and reassembly instructions are contained in Chapter 6.

Routine Adjustment of Front Panel Frequency Control

12. As previously stated (paragraph 3 and 4), adjustments to the frequency control on the front panel should not be attempted unless facilities exist for comparing the output frequency with either an atomic standard or a V.L.F. transmission; this comparison would have to be made every few months.

Routine Adjustment of Internal Coarse Frequency Control

13. If the user is equipped with the facilities for making routine adjustments to the front panel frequency control, then the following procedure can be carried out when the limit of adjustment of this control is reached.

(1) Carry out the dismantling instructions in paragraph 1 and 2 of Chapter 6, reconnecting power as soon as possible to reduce thermal shock. Allow the frequency to stabilize.

(2) Return the front panel fine tuning control to within 100 divisions of the scale end to give maximum scope for adjustment.

TABLE 5.1

FAULT LOCATION - NO OUTPUT SIGNALS

- A. No 5 Mc/s output
  - A. No indication in Pos.1 of Meter switch.
    B. Faulty Power Unit.
  - A. Normal indication in Pos.3 and zero indication in Pos.7 of Meter switch.
    B. Faulty 5 Mc/s buffer (VT101) or 5 Mc/s output (VT102) stage, in Oscillator Unit.
  - A. Abnormal indication in Pos.2 of Meter switch.
    B. Faulty regulator stage in Oscillator Unit (VT20, 21 and 26).
  - A. No indication in Pos.3 of Meter switch.
    B. Faulty 5 Mc/s oscillator (VT1) or a.v.c. (VT2, 3 and 4) stage, in Oscillator Unit.
- A. 5 Mc/s output but zero 1 Mc/s output
  - A. Divider starter stage (VT115) in Oscillator Unit fails to operate.
    B. Faulty START pushbutton or stage.
  - A. Normal indication in Pos.7 and 9, and zero indication in Pos.8 of Meter switch.
    B. Faulty 1 Mc/s output amplifier (VT107) in Oscillator Unit.
  - A. Normal indication in Pos.7 and zero indication in Pos.8 and 9 of Meter switch.
    B. Faulty 5 Mc/s to 1 Mc/s divider stage (VT103-106) in Oscillator Unit.
- A. 5 Mc/s and 1 Mc/s output but no 100 kc/s output
  - B. Faulty divider starter stage (VT115) in Oscillator Unit.
  - A. Zero indication in Pos.9 and normal indication in Pos.7 and 8 of Meter switch.
    B. Faulty 100 kc/s output amplifier (VT112) in Oscillator Unit.
  - A. Zero indication in Pos.9 and normal indication in Pos.7 and 8 of Meter switch.
    B. Faulty 1 Mc/s to 100 kc/s divider stages (VT108-111 and VT113 and 114) in Oscillator Unit.

LEGEND: A = Fault Symptom
B = Possible Cause

TABLE 5.2

FAULT LOCATION - INCORRECT FREQUENCY

- B. Insufficient warming-up time.
- B. Oscillator frequency requires adjustment. See para. 12 and 13.
- A. Abnormal indication in Pos.2 of Meter switch.
  - B. Faulty regulator stage in Oscillator Unit (VT20, 21 and 26).
- A. Abnormal indication in Pos.3 of Meter switch.
  - B. Faulty 5 Mc/s oscillator (VT1) or a.v.c. stage (VT2, 3 and 4) in Oscillator Unit.
- A. Crystal operating temperature incorrect
  - A. Inner oven over-driving. Low indication in Pos.4 and 6 and high indication in Pos.5 of Meter switch.
    - B. Faulty outer oven control stage (VT17, 19, 24 and 25) in Oscillator Unit.
  - A. Inner oven under-driving. High indication in Pos.4 and 6 and low indication in Pos.5 of Meter switch.
    - B. Faulty outer oven control stage (VT17, 19, 24 and 25) in Oscillator Unit.
  - A. Outer oven under-driving. High indication in Pos.4 and 5 and low indication in Pos.6 of Meter switch.
    - B. Faulty inner oven control stage (VT14, 16, 22 and 23) in Oscillator Unit.
  - A. Outer oven over-driving. Low indication in Pos. 4 and 5 and high indication in Pos. 6 of Meter switch.
    - B. Faulty inner oven control stage (VT14, 16, 22 and 23) in Oscillator Unit.

LEGEND: A = Fault System

B = Possible Cause

(3) Adjust the coarse tuning trimmer C5 to bring the oscillator to the required frequency ±10 parts in 10^9.

(4) Adjust to the exact frequency using the fine tuning control.

(5) Reassemble the oscillator with a dried dessicator in accordance with para. 3 of Chapter 6.

(6) Check that the oscillator is still on frequency.

Routine Battery Check

14. This test gives an indication of the state of charge of the battery pack. Set the MAINS switch to OFF and note the time. Six hours later, the amber lamp should still be glowing and the red lamp should be out. If the red lamp glows within six hours, a new battery pack is required.

NOTE: If the A.C. switch is put to ON within two or three minutes of the red lamp glowing, then the frequency of the Oscillator will recover within about 30 minutes; the START pushbutton on the Oscillator must again be operated.

Routine Meter Checks

15. The built-in meter indication for each position of the selector switch should be periodically noted for comparison with the values engraved on the hinged cover plate. Small discrepancies are acceptable in positions 1, 3, 5, 6, 7 and 9.

TABLE 5.3

Typical Static Voltage Levels - Frequency Divider and Output Stages

MEASURING POINT	DIVIDERS ON	DIVIDERS OFF
VT101 (Base)	2.8	2.82
VT101 (Collector)	15.7	15.9
VT103 & 4 (Collector)	15.7	15.9
VT105 & 6 (Collector)	10.5	17.0
VT108 & 9 (Collector)	13.5	17.0
VT110 & 11 (Collector)	12.5	17.0
VT113 & 4 (Collector)	14.5	17.0
VT102 (Base)	1.62	1.62
VT102 (Collector)	15.5	15.5
VT107 (Base)	1.45	1.95
VT107 (Collector)	14.5	15.2
VT112 (Base)	1.94	2.05
VT112 (Collector)	15.5	15.9

CHAPTER 6

DISMANTLING AND REASSEMBLY

Introduction

1. The complete Frequency Standard assembly is withdrawn from the cabinet or rack as follows:-

(1) Remove all connections on the front and/or rear panel of the frame.

(2) Remove the front panel securing screws (four) and chrome strips (two).

(3) Withdraw the frame assembly and place upright on a bench, removing any rear connections which may exist.

NOTE: For the MA. 259F and MA. 259G (Figs. 2 and 3 respectively facing page 2) assemblies, it will be necessary to remove the front panel by withdrawing the fixing screw A.

Oscillator Unit Dismantling (Fig. 5 facing page 11)

2. (1) Remove the free socket mating with PL1 (Figs. 1, 2 and 3), behind the front panel.

(2) Remove, from behind the front panel, the four nuts which secure the front plate of the Oscillator to the panel.

(3) Loosen, but do not remove, the five sets of nuts and bolts which secure the rear of the Oscillator cover.

(4) Withdraw the Oscillator and carefully place on the bench.

(5) Remove, from behind the Oscillator front plate, the three radially placed pan-head screws holding the cover in position.

(6) Position the Oscillator so that it rests on the front plate and very carefully withdraw the cover complete with the vacuum flask and place in a position which will avoid breakage.

CAUTION: Dismantling beyond this stage should be carried out by the manufacturer.

Oscillator Unit Reassembly

3. The procedure for reassembling the Oscillator is the reverse to that of paras. 1 and 2. However, the following points should be carefully observed.

(1) When fitting the vacuum flask and cover into position, ensure that the cable to plug PL1 is correctly seated within the recess in the chassis and plate (fig. 5).

(2) If the cover does not seat correctly against the rear face of the front plate, do not use force as this may result in breakage of the vacuum flask.

(3) If the effect in (2) occurs, withdraw the cover and flask and clear the obstruction before proceeding any further.

Power Unit Dismantling

4. (1) Remove the free plug and free socket mating with SKT2 and PL1 behind the front panel (figs. 1, 2 and 3).

(2) Remove, from behind the front panel, the four nuts which secure the front plate of the Power Unit to the panel.

(3) Loosen, but do not remove, the five sets of nuts and bolts which secure the rear of the Power Unit cover.

(4) Withdraw the Power Unit and place on the bench.

(5) Remove, from behind the Power Unit front plate, the three radially placed pan-head screws holding the cylindrical cover in position.

(6) Withdraw the cover and unsolder the two leads (red and violet).

5. Access is now provided to the one component board (fig. 12 facing page 23) and all major components (fig. 7 facing page 19). The remainder of the electrical components are revealed by raising the hinged cover on the front plate (fig. 7).

Removal of Battery Framework from Power Unit

6. (1) Place the Power Unit cylindrical cover, open end upwards, on the bench.

(2) Using a 5/16 in box spanner, remove the three sets of nuts and washers holding the battery framework inside the cover. (Remove the nuts with green paint under them).

(3) Using the nylon cord, withdraw the battery framework from the cover.

Power Unit Reassembly

7. The procedure for reassembling the Power Supply is the reverse to that of paras. 1, 4, 5 and 6.

Fitting Cells into the Battery Pack

8. The following procedure, in conjunction with figure 13 facing page 22, explains the method for assembling a complete set of 21 cells into the battery framework within the Power Unit cover. It is assumed that the Power Unit has been dismantled in accordance with paras. 1, 4, 5 and 6. This procedure can be suitably interpreted for the instance when only one, or less than twenty-one of the cells has to be replaced.

9. The battery framework, when withdrawn from the Power Unit cover, is complete with the exception of the leads required for interconnecting the battery cells etc. Hence, the first requirement is to prepare the interconnecting leads as follows:-

(a) Using black P.V.C. covered, 7/0.0076 in strands, wall thickness 0.012 in (Type 2), cut fourteen pieces of $1\frac{1}{2}$ in length and stripped bare by 3/8 in at each end.

(b) Using red P.V.C. covered, 14/0.0076 in strands, wall thickness 0.012 in (Type 2), cut one piece of $2\frac{1}{2}$ in length and stripped bare by $\frac{1}{2}$ in at each end.

(c) Using violet P.V.C. covered, 1/0.036 in wire, wall thickness 0.012 in (Type 2), cut one piece of $10\frac{1}{2}$ in in length and stripped bare by $\frac{1}{2}$ in. at each end.

NOTE: The leads called up in (b) and (c) above may already be fitted to the tagboard assembly at the top of the battery framework.

(d) 12-inches of 34 s.w.g. 5-amp fuse wire, cut into six 2 in pieces.

NOTE: On later versions of the MA.259, the bottom end connections in the battery pack are made with ordinary wire not 5-amp fuse wire.

10. Having extracted the battery framework from the cover (para. 6), proceed to completely dismantle the framework as follows:

(1) Remove the 4B. A. nut and washer from each of the three studs.

(2) Slide off the tagboard the compensating pad and the three battery cups; each cup holds seven battery cells.

(3) With reference to figure 13, fit seven of the cells to battery cup No. 1; note the disposition of the cells, in respect of polarity, to the feed hole for the violet lead (view A, figure 13). The cells in the remaining two battery cups are fitted in the same manner.

(4) As illustrated in view A of figure 13, the inside surface of each battery cup is grooved as shown by the broken lines. Solder the violet lead to the negative end of cell E and feed the lead through the small adjacent hole.

(5) Feed, in turn, each of the three pieces of fuse wire through grooves in the cup as follows (see view A).

(a) negative of centre cell to position of cell F.

(b) negative of cell A to positive of cell B.

(c) negative of cell C to positive of cell D.

(6) Slide cup No. 1 over the three studs to rest on the insulating pad against the stud plate.

(7) Assemble the cells into cup No. 2 and solder a black lead, through the holes in the base of the cup, to the base of each cell.

(8) Slide cup No. 2 over the three studs, ensuring that it is orientated correctly with respect to cup No. 1 (figure 13); pass the violet lead through the lead hole.

(9) Solder the black leads from cup No. 2 to the corresponding cells in cup No. 1.

(10) Repeat operations (7) to (9) for cup No. 3.

(11) Press cups Nos. 2 and 3 against cup No. 1 and ensure that the black interconnecting leads are folded to lay in the holes in the base of cups Nos. 2 and 3.

(12) Solder the remaining three fuse links as follows (see view A):

(a) negative of cell B to positive of cell C.

(b) negative of cell D to positive of cell E.

(c) negative of cell F to positive of cell A.

(13) Solder the red lead to the positive terminal of the centre cell.

(14) Fit the compensating pad over cup No. 3.

(15) Solder the red and violet leads to the positive (+) and negative (-) terminals on the underside of the tagboard.

(16) Slide the tagboard over the studs and secure using the washers and 4 B. A. nylon nuts.

(17) Fit the battery pack into the cylindrical cover.

CHAPTER 7

ALIGNMENT OF FREQUENCY DIVIDERS

Test Equipment

1. The following test equipment is required to perform the tests and alignment procedures given in this chapter. Servicing is restricted on the Oscillator to testing and re-alignment on that part of the assembly revealed by removing the cylindrical cover only. Repairs beyond this stage should be carried out by the manufacturer.

(a) Valve milli-voltmeter to measure up to 3 volts at 5 Mc/s e.g. Philips Type GM 6014.

(b) Signal Generator with an output over the range of 100 kc/s to 4 Mc/s and up to 2 volts r.m.s. e.g. Marconi TF. 144H/I/S.

(c) Oscilloscope, general purpose e.g. Solartron CD 513.

(d) Extension Cable Box (available to order).

NOTE: Item (d) contains three extension cables. Cable (i) makes it possible for both units of the Frequency Standard, held in one of the three available frames, to be withdrawn from the cabinet and operated on an adjacent bench. Alternatively, both units can be withdrawn from the frame, in which case, items (ii) and (iii) are required. The details of the cables are as follows:-

(i) One cable for connecting Power Supply (PL1), (fig. 8 facing page 22) to the front or rear of the frame; this cable carries mains voltage.

(ii) One cable for connecting Power Supply (SKT2, fig. 8) to Oscillator (PL1, fig. 6 facing page 18); this cable carries the direct voltage for operating the Oscillator.

(iii) One cable for connecting the front or rear adaptor of the frame to the cabinet; this cable carries main voltage.

General

2. Refer to figure 9 facing page 23 for location of components. It may be convenient to solder short lengths of lead to the points where test equipment is to be connected; when doing this, use a heat shunt if necessary. Figure 9 also shows a convenient common line point (one end of R126) to which the earth leads of test equipment can be permanently connected.

Frequency Divider Alignment

3. (1) Disconnect end A (fig. 9) of C101 to remove the 5 Mc/s signal from the dividers.

(2) Set the A.C. switch on the Power Supply to ON.

(3) Connect the signal generator output lead to the base of VT109. Connect the oscilloscope to the base of VT113 and set the sensitivity to 1 volt/cm.

(4) Set the frequency of the signal generator to 200 kc/s and the voltage output to 1 volt r.m.s. Adjust the core of T110 for maximum output.

(5) Transfer the probe of the oscilloscope from VT113 to the emitter of VT109 and adjust the core of T108 for maximum 800 kc/s signal.

(6) Transfer the probe of the oscilloscope from VT109 to the junction of T113 and R139. Adjust the core of T113 for maximum 100 kc/s output.

(7) Transfer the signal generator output from the base of VT109 to the base of VT103 and set the frequency to 1 Mc/s.

(8) Transfer the probe of the oscilloscope from the junction of T113 and R139 to the junction of T106 and R125. Adjust the core of T106 for maximum 1 Mc/s signal.

(9) Transfer the probe of the oscilloscope from the junction of T106 and R125 to the base of VT113.

(10) Transfer the signal generator output from the base of VT103 to the junction of T106 and R125.

(11) Start the frequency dividers by operating the START push-button on the oscillator. Check that a 200 kc/s signal appears on the oscilloscope.

(12) Reduce the signal generator input until the signal disappears, then increase the input by 2 dB and restart the frequency dividers. Adjust the cores of T110 and T108 for maximum signal on the oscilloscope.

(13) Repeat operation (12).

(14) Set the signal generator input to 1 volt r. m. s. and restart the frequency dividers.

(15) Slowly reduce the signal generator frequency until the signal on the oscilloscope disappears. The frequency indicated on the signal generator should not be greater than 975 kc/s.

(16) Start the frequency dividers again and increase the signal generator frequency until the 200 kc/s signal reappears on the oscilloscope. Continue to increase the frequency slowly until the signal disappears. The frequency indicated on the signal generator should not be less than 1025 kc/s.

(17) Transfer the signal generator output from T106 to the base of VT103 and set the frequency to 1 Mc/s. Transfer the probe of the oscilloscope from VT118 to the emitter of VT104. Adjust the core of T104 for maximum 4 Mc/s signal.

(18) Transfer the signal generator output from the base of VT103 to the free end of capacitor C101. Set the frequency to 5 Mc/s and the output voltage to 100 mV.

(19) Transfer the probe of the oscilloscope from the emitter to the base of VT104. Adjust the core of T101 for maximum 5 Mc/s signal.

(20) Transfer the probe of the oscilloscope from VT104 to the junction of R125 and T106.

(21) Start the frequency dividers by operating the START button. Check that a 1 Mc/s signal appears on the oscilloscope.

(22) Reduce the signal generator input until the signal disappears, then increase the input by 2 dB and restart the frequency dividers. Adjust the cores of T101, T104 and T106 for maximum signal.

(23) Repeat operation (22).

(24) Set the signal generator input to 1 volt r. m. s. and restart the frequency dividers.

(25) Slowly reduce the signal generator frequency until the signal on the oscilloscope disappears. The frequency indicated on the signal generator should be not greater than 4.875 Mc/s.

(26) Start the frequency dividers again and increase the signal generator frequency until the 1 Mc/s signal re-appears on the oscilloscope. Continue to increase the frequency slowly until the signal disappears. The frequency indicated on the signal generator should be not less than 5.125 Mc/s. Set the signal generator frequency to 5 Mc/s.

(27) Transfer the probe of the oscilloscope from the junction of R125 and T106 to the junction of T113 and R139.

(28) Start the frequency dividers by operating the START button. Check that a 100 kc/s signal appears on the oscilloscope.

(29) Reduce the signal generator frequency until the signal on the oscilloscope disappears. The frequency indicated on the signal generator should be not greater than 4.9 Mc/s.

(30) Re-start the frequency dividers and increase the signal generator frequency until the 100 kc/s re-appears on the oscilloscope. Continue to increase the frequency slowly until the signal disappears. The frequency indicated on the signal generator should be not less than 5.1 Mc/s. Set the signal generator frequency to 5 Mc/s.

(31) Transfer the probe of the oscilloscope from R139 to the junction of R125 and T106.

(32) Start the frequency dividers by operating the START button. Check that a 1 Mc/s signal appears on the oscilloscope.

(33) Repeat operation (25).

(34) Repeat operation (26).

(35) Reconnect end A of C101.

(36) Disconnect signal generator and oscilloscope.

Output Amplifier Alignment

4. 100 kc/s Amplifier

(1) Set the meter switch on the Oscillator to position 9 (100 KC/S OUT).

(2) Connect the valve voltmeter to the 100 kc/s output socket SKT5 on the Oscillator.

(3) Adjust the core of T114 for a minimum indication on the Oscillator meter.

(4) Adjust the core of T115 for a maximum reading on the valve voltmeter.

(5) Adjust the cores of T112, T114 and T115, in this order, for a maximum indication on the valve voltmeter, repeat these adjustments until no further increase is obtainable.

5. 1 Mc/s Amplifier

(1) Set the meter switch on the Oscillator to position 8 (1 MC/S OUT).

(2) Connect the valve voltmeter to the 1 Mc/s output socket SKT4 on the Oscillator.

(3) Adjust the core of T109 for a minimum indication on the Oscillator meter.

(4) Adjust the core of T111 for a maximum reading on the valve voltmeter.

(5) Adjust the cores of T107, T109 and T111, in this order, for a maximum indication on the valve voltmeter, repeat these adjustments until no further increase is obtainable.

6. 5 Mc/s Amplifier

(1) Set the signal generator frequency to 5 Mc/s and set the output level to 1 volt r.m.s.

(2) Set the meter switch on the Oscillator to position 7 (5 MC/S OUT).

(3) Connect the valve voltmeter to the 5 Mc/s output socket SKT3 on the Oscillator.

(4) Adjust the core of T103 for a minimum indication on the Oscillator meter.

(5) Adjust the core of T105 for a maximum indication on the valve voltmeter.

(6) Adjust the cores of T102, T103 and T105, in this order, for a maximum indication on the valve voltmeter, repeat these adjustments until no further increase is obtainable.

(7) Disconnect the valve voltmeter and set the A. C. switch on the Power Supply to OFF.

CHAPTER 8

COMPONENTS LIST

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer

OSCILLATOR UNIT TYPE SA.500

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
Resistors					5905-99-	
R1	4.7k	Composition	1/8W	10	012-1668	Dubilier BTR
R2	1k	"	1/8W	10	012-1644	Dubilier BTR
R3	1k	"	1/8W	10	012-1644	Dubilier BTR
R4	1k	"	1/8W	10	012-1644	Dubilier BTR
R5	4.7k	"	1/8W	10	012-1668	Dubilier BTR
R6	1k	"	1/8W	10	012-1644	Dubilier BTR
R7	1.5k	"	1/8W	10	012-1650	Dubilier BTR
R8	2.2k	"	1/8W	10	012-1656	Dubilier BTR
R9	47	"	1/8W	10	946-4458	Erie 15
R10	4.7k	"	1/8W	10	012-1668	Dubilier BTR
R11	10k	"	1/8W	10	012-1680	Dubilier BTR
R12	1k	"	1/8W	10	012-1644	Dubilier BTR
R13	1k	"	1/8W	10	012-1644	Dubilier BTR
R14	470	"	1/8W	10	012-1632	Dubilier BTR
R15	10k	"	1/8W	10	012-1680	Dubilier BTR
R16	47	"	1/8W	10	946-4458	Erie 15
R17	6.8k	"	1/8W	10	012-1674	Dubilier BTR
R18	10k	"	1/8W	10	012-1680	Dubilier BTR
R19	DELETED					
R20	1k	"	1/8W	10	012-1644	Dubilier BTR
R21	470	"	1/8W	10	012-1632	Dubilier BTR
	(15k	"	1/8W	10	012-1686	Dubilier BTR)
	(22k		1/8W	10	012-1692	Dubilier BTR)
R22	(33k		1/8W	10	012-1698	Dubilier BTR)
	(47k	Value Selected	1/8W	10	012-1704	Dubilier BTR)
	(68k	on Test.	1/8W	10	012-1710	Dubilier BTR)
R23	DELETED					
	(1k	Film	1/4W	5	012-2676	Welwyn C81)
	(1.2k		1/4W	5	012-2682	Welwyn C81)
R24	(1.3k		1/4W	5	012-2685	Welwyn C81)
	(1.5k		1/4W	5	012-2688	Welwyn C81)
	(1.6k	Value Selected	1/4W	5	012-2691	Welwyn C81)
	(1.8k	on Test.	1/4W	5	012-2694	Welwyn C81)
R25	100k	Composition	1/8W	10	012-1716	Dubilier BTR
R26	1k	"	1/8W	10	012-1644	Dubilier BTR
R27	47	"	1/8W	10	946-4458	Erie 15
R28	6.8k	"	1/8W	10	012-1674	Dubilier BTR
R29	10k	"	1/8W	10	012-1680	Dubilier BTR
R30	DELETED					
R31	1k	"	1/8W	10	012-1644	Dubilier BTR

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
<u>Resistors</u> continued					5905-99-	
R32	470	Composition	1/8W	10	012-1632	Dubilier BTR
R33	1k	"	1/8W	5	012-2676	Welwyn C81
	(15k	"	1/8W	10	012-1686	Dubilier BTR)
	(22k		1/8W	10	012-1692	Dubilier BTR)
R34	(33k		1/8W	10	012-1698	Dubilier BTR)
	(47k	Value Selected	1/8W	10	012-1704	Dubilier BTR)
	(68k	on Test.	1/8W	10	012-1710	Dubilier BTR)
R35	100k	Composition	1/8W	10	012-1716	Dubilier BTR
R36	1k	"	1/8W	10	012-1644	Dubilier BTR
R37	47	"	1/8W	10	946-4458	Erie 15
R38 to R75 DELETED						
R76	4.7k	Film	1/8W	1	012-0754	Welwyn C20
R77	3.3k	"	1/8W	10	012-0740	Welwyn C20
R78	470	Composition	1/8W	10	012-1632	Dubilier BTR
R79	2.2k	"	1/8W	10	012-1656	Dubilier BTR
R80	10k	"	1/8W	10	012-1680	Dubilier BTR
R81	22k	Film	1/4W	1	012-2774	Welwyn C81
R82	22k	"	1/4W	1	012-2774	Welwyn C81
R83	DELETED					
R84	499k	Film	1/4W	1	972-0227	Welwyn C81
R85	249k	"	1/4W	1	972-0228	Welwyn C81
R86	150k	"	1/4W	1	913-4092	Welwyn C81
R87	249k	"	1/4W	1	972-0228	Welwyn C81
R88	DELETED					
R89	4.7	Composition	1/8W	10	972-1076	Erie 15
R90 to R100 DELETED						
R101	22k	Composition	1/8W	10	012-1692	Dubilier BTR
R102	4.7k	"	1/8W	10	012-1668	Dubilier BTR
x R103	10	"	0.1W	10	972-1082	Erie 15
R104	2.2k	"	1/8W	10	012-1656	Dubilier BTR
R105	10k	"	1/8W	10	012-1680	Dubilier BTR
R106	220	"	1/8W	10	012-1620	Dubilier BTR
R107	470	"	1/8W	10	012-1632	Dubilier BTR
R108	15k	"	1/8W	10	012-1686	Dubilier BTR
R109	100	"	1/8W	10	012-1608	Dubilier BTR
R110	150	"	1/8W	10	012-1614	Dubilier BTR
R111	470	"	1/8W	10	012-1632	Dubilier BTR
R112	470	"	1/8W	10	012-1632	Dubilier BTR
R113	33k	"	1/8W	10	012-1698	Dubilier BTR
R114	100	"	1/8W	10	012-1608	Dubilier BTR
R115	470	"	1/8W	10	012-1632	Dubilier BTR
R116	470	"	1/8W	10	012-1632	Dubilier BTR
R117	470	"	1/8W	10	012-1632	Dubilier BTR
R118	2.2k	"	1/8W	10	012-1656	Dubilier BTR

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
<u>Resistors</u> continued					5905-99-	
R119	10k	Composition	1/8W	10	012-1680	Dubilier BTR
R120	10k	"	1/8W	10	012-1680	Dubilier BTR
R121	15k	"	1/8W	10	012-1686	Dubilier BTR
R122	100	"	1/8W	10	012-1608	Dubilier BTR
R123	150	"	1/8W	10	012-1614	Dubilier BTR
R124	1k	"	1/8W	10	012-1644	Dubilier BTR
R125	1k	"	1/8W	10	012-1644	Dubilier BTR
R126	100	"	1/8W	10	012-1608	Dubilier BTR
R127	33k	"	1/8W	10	012-1698	Dubilier BTR
R128	470	"	1/8W	10	012-1632	Dubilier BTR
R129	470	"	1/8W	10	012-1632	Dubilier BTR
R130	10k	"	1/8W	10	012-1680	Dubilier BTR
R131	10k	"	1/8W	10	012-1680	Dubilier BTR
R132	470	"	1/8W	10	012-1632	Dubilier BTR
R133	2.2k	"	1/8W	10	012-1656	Dubilier BTR
R134	15k	"	1/8W	10	012-1686	Dubilier BTR
R135	100	"	1/8W	10	012-1608	Dubilier BTR
R136	150	"	1/8W	10	012-1614	Dubilier BTR
R137	220	"	1/8W	10	012-1620	Dubilier BTR
R138	470	"	1/8W	10	012-1632	Dubilier BTR
R139	220	"	1/8W	10	012-1620	Dubilier BTR
R140	33k	"	1/8W	10	012-1698	Dubilier BTR
R141	100k	"	1/8W	10	012-1716	Dubilier BTR
R142	470	"	1/8W	10	012-1632	Dubilier BTR
<u>Potentiometers</u>					5905-99-	
RV1	500	Wirewound			971-9139	Painton 224L-1-501
RV2	2k	"			945-9193	Painton 224-1-202
RV3	2k	"			945-9193	Painton 224-1-202
<u>Capacitors</u>					5910-99-	
C1	1-18pF	Variable, Plastics			972-1069	Racal AD 20901/2
C2	47pF	Glass	500V	10	648-8028	Corning CY10C470K
C3	1-28pF	Variable Plastics			972-1068	J.F.D.Mc603, Agents S.T.C. or Painton
C4	(33pF or	Glass	500V	10		Corning CY10C330K
	(22pF	Value Selected on Test.	500V	10	643-8746	or 220K
C5	1-28pF	Variable,Glass			972-1068	J.F.D.MC603, Agents S.T.C. or Painton

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
Capacitors continued					5910-99-	
C6	220pF	Glass	300V	5	807-3839	Corning CY10C221K
C7	680pF	"	300V	10	648-8638	Corning CY15C681K
C8	0.022uF	Plastic	100V	20	972-0760	T.C.C. PMX2
C9	0.005uF	"	150V	20	972-0235	S.E.I. Type PFT
C10	0.005uF	"	150V	20	972-0235	S.E.I. Type PFT
C11	0.001uF	Mica	100V	5	972-0772	Erie EDM 15-100V
C12	0.005uF	Plastics	150V	20	972-0235	Salford Type PFT
C13	0.005uF	"	150V	20	972-0235	Salford Type PFT
C14	0.005uF	"	150V	20	972-0235	Salford Type PFT
C15	220pF	Mica	500V	5	972-0774	Erie EDM 15-500V
C16	0.005uF	Plastics	150V	20	972-0235	Salford Type PFT
C17	0.001uF	Mica	100V	5	972-0772	Erie EDM 15-100V
C18	0.005uF	Plastics	150V	20	972-0235	Salford Type PFT
C19	0.005uF	"	150V	20	972-0235	Salford Type PFT
C19A	4.7uF	Electrolytic	35V	20	580-9994	Plessey S402/8/50832/023
C20	1uF	Electrolytic	35V	20	946-4295	Plessey S402/8/50831/069
C21	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C22	1uF	Electrolytic	35V	20	946-4295	Plessey S402/8/5083/069
C23	3.3uF	Electrolytic	10V	20	946-4294	Plessey S402/8/50831/113
C24	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C25	3.3uF	Electrolytic	10V	20	946-4294	Plessey S402/8/50831/113
C26	4.7uF	"	35V	20	580-9994	Plessey S402/8/50832/023
C27	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C28	1uF	Electrolytic	35V	20	946-4295	Plessey S402/8/50831/069
C29	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C30	1uF	Electrolytic	35V	20	946-4295	Plessey S402/8/50831/069
C31	3.3uF	"	10V	20	946-4294	Plessey S402/8/50831/113
C32	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C33	3.3uF	Electrolytic	10V	20	946-4294	Plessey S402/8/50831/113
C34	4.7uF	"	35V	20	580-9994	Plessey S402/8/50832/023
C35 to C72 DELETED						
C73	1uF	Electrolytic	35V	20	946-4295	Plessey S402/8/50831/069
C74	1uF	"	35V	20	946-4295	Plessey S402/8/50831/069

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
Capacitors continued					5910-99-	
C75	1uF	Electrolytic	35V	20	946-4295	Plessey S402/8/50831/069
C76	4.7uF	"	35V	20	580-9994	Plessey S402/8/50832/023
C77	4.7uF	"	35V	20	580-9994	Plessey S402/8/50832/023
C78	4.7uF	"	35V	20	580-9994	Plessey S402/8/50832/023
C79	4.7uF	"	35V	20	580-9994	Plessey S402/8/50832/023
C80 to C100 DELETED						
C101	100pF	Mica	100V	5		Erie EDM 15-100V
C102	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C103	4.7uF	Electrolytic	35V	20	580-9994	Plessey S402/8/50832/023
C104	220pF	Mica	500V	5	972-0774	Erie EDM 15-500V
C105	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C106	150pF	Mica	500V	5	972-1070	Erie EDM 15-500V
C107	220pF	"	500V	5	972-0774	Erie EDM 15-500V
C108	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C109	0.022uF	"	100V	20	972-0760	T.C.C. PMX2
C110	220pF	Mica	500V	5	972-0774	Erie EDM 15-500V
C111	220pF	"	500V	5	972-0774	Erie EDM 15-500V
C112	220pF	"	500V	5	972-0774	Erie EDM 15-500V
C113	330pF	"	500V	5	972-0775	Erie EDM 15-500V
C114	220pF	"	500V	5	972-0774	Erie EDM 15-500V
C115	220pF	"	500V	5	972-0774	Erie EDM 15-500V
C116	330pF	"	500V	5	972-0775	Erie EDM 15-500V
C117	0.001uF	"	100V	5	972-0772	Erie EDM 15-100V
C118	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C119	0.022uF	"	100V	20	972-0760	T.C.C. PMX2
C120	0.001uF	Mica	100V	5	972-0772	Erie EDM 15-100V
C121	330pF	"	500V	5	972-0775	Erie EDM 15-500V
C122	0.0015uF	"	500V	5	972-0777	Erie EDM 20-500V
C123	0.001uF	"	100V	5	972-0772	Erie EDM 15-100V
C124	0.005uF	Plastics	150V	20	972-0235	S.E.I. Type PFT.
C125	0.005uF	"	150V	20	972-0235	S.E.I. Type PFT.
C126	0.001uF	Mica	100V	5	972-0772	Erie EDM 15-100V
C127	0.0082uF	"	300V	5		Erie EDM 20-300V
C128	1uF	Electrolytic	35V	20	946-4295	Plessey S402/8/50831/069
C129	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
Capacitors continued					5910-99-	
C130	0.0056uF	Mica	300V	5		Erie EDM 20-300V
C131	0.0082uF	"	300V	5		Erie EDM 20-300V
C132	0.005uF	Plastics	100V	20	972-0235	S.E.I. Type PFT
C133	0.0082uF	Mica	300V	5		Erie EDM 20-300V
C134	0.022uF	Plastics	100V	20	972-0760	T.C.C. PMX2
C135	0.022uF	"	100V	20	972-0760	T.C.C. PMX2
Metal Rectifiers						
MR1					CV7142	T.I. 1N757A
MR2					CV5868	T.I. 1N662
]					CV5868	T.I. 1N662
MR4					CV5868	T.I. 1N662
MR5					CV5868	T.I. 1N662
MR6					CV5868	T.I. 1N662
MR7					CV5868	T.I. 1N662
MR8 to MR14 DELETED						
MR15					CV7142	T.I. 1N757A
MR16 to MR100 DELETED						
MR101					CV5868	T.I. 1N662
MR102					CV5868	T.I. 1N662
MR103					CV5868	T.I. 1N662
MR104					CV5868	T.I. 1N662
MR105					CV5868	T.I. 1N662
MR106					CV5868	T.I. 1N662
T nsistors						
VT1						Fairchild 2N916
VT2						Fairchild 2N916
VT3						Fairchild 2N916
VT4						Fairchild 2N916
VT5 to VT13 DELETED						
VT14					CV5644	T.I. 2N697
VT15 DELETED						
VT16					CV5644	T.I. 2N697
VT17					CV5644	T.I. 2N697
VT18 DELETED						
VT19					CV5644	T.I. 2N697
VT20					CV5644	T.I. 2N697
VT21					CV5644	T.I. 2N697
VT22					CV7372	T.I. 2N697 Selected
VT23					CV5644	T.I. 2N697
VT24					CV7372	T.I. 2N697 Selected

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
Transistors continued						
VT25					CV7454	RCA 2N1485
VT26					CV7454	RCA 2N1485
VT27 to VT100 DELETED						
VT101						Fairchild 2N916
VT102						Fairchild 2N916
VT103						Fairchild 2N916
VT104						Fairchild 2N916
VT105						Fairchild 2N916
VT106						Fairchild 2N916
VT107						Fairchild 2N916
VT108						Fairchild 2N916
VT109						Fairchild 2N916
VT110						Fairchild 2N916
VT111						Fairchild 2N916
VT112						Fairchild 2N916
VT113						Fairchild 2N916
VT114		9057980				Fairchild 2N916
VT115						Fairchild 2N916
Inductors, Transformers					5950-99-	
LX		Coil - select on test			972-1592 to 1604	Racal AA 26963A to N
L1 to L9 DELETED						
L10A		D.C. Supply Filter			972-1022	Racal AA20395
L10B		" " "			972-1022	Racal AA20395
L11A		" " "			972-1022	Racal AA20395
L11B		" " "			972-1022	Racal AA20395
T1		5 Mc/s Oscillator			972-1034	Racal AA20396
T2		A.G.C. Amplifier			972-1024	Racal AA20397
T3 to T8 DELETED						
T9		Inner Oven Control			972-1023	Racal AA20884
T10		Outer Oven Control			972-1023	Racal AA20884
T11 to T100 DELETED						
T101		5 Mc/s Buffer			972-1032	Racal BA27636
T102		5 Mc/s Output Filter			972-1027	Racal BA27633
T103		" " " "			972-1027	Racal BA27633
T104		5 Mc/s to 1Mc/s Divider			972-1029	Racal BA27638
T105		5 Mc/s Output Filter			972-1027	Racal BA27633
T106		5 Mc/s to 1 Mc/s Divider			972-1033	Racal BA27637
T107		1 Mc/s Output Filter			972-1028	Racal BA27632
T108		1 Mc/s to 200 kc/s Divider			972-1025	Racal BA27639

Cct Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
Inductors, Transformers continued					5950-99-	
T109		1 Mc/s Output Filter			972-1028	Racal BA27632
T110		1 Mc/s to 200 kc/s Divider			972-1030	Racal BA27635
T111		1 Mc/s Output Filter			972-1028	Racal BA27632
T112		100 kc/s Output Filter			972-1031	Racal BA27631
T113		200 kc/s to 100 kc/s Divider			972-1026	Racal BA27634
T114		100 kc/s Output Filter			972-1031	Racal BA27631
T115		" " " "			972-1031	Racal BA27631
Miscellaneous						
[illegible]		Crystal, 5 Mc/s				Racal AD23289
M1	100uA	Meter, Moving Coil			6625-99-972-0229	Racal BD22030
RLA	4800 ohms	Relay, Armature 24V			5945-99-580-1770	Fortiphone G100
SA	S.P.	Switch, Thermostatic			5930-99-972-1077	Otter Controls Type G50
SB	S.P.	Switch, Push Biased Off, START			5930-99-971-7642	Rendar PSB/1/M
SC	2 Pole 9 Way	Switch, Rotary Wafer, Meter			5930-99-972-1078	NSF Type 43855 A2
TH1	10K Ohms	Resistor, Thermal 10mW			5905-99-972-1605	Victory 41A46
T[illegible]	10K Ohms	" "	10mW		972-1605	Victory 41A46
T[illegible]	10K Ohms	" "	10mW		972-1605	Victory 41A46
PL1		Plug fixed			5935-99-972-0222	Electro-Methods MRE 7P-G/V
PL2		"			5935-99-972-0225	Electro-Methods MRE 7P/JTC/H
SKT1		Socket free			5935-99-972-0220	Electro-Methods MRE 7S-GH/VL
SKT2		" fixed			5935-99-972-0226	Electro-Methods MRE 7S/J
SKT3		" coaxial			5935-99-972-9144	UG1094/U
SKT4		" coaxial			5935-99-972-9144	UG1094/U
SKT5		" coaxial			5935-99-972-9144	UG1094/U
		Knob			5355-99-942-5772	Painton/K6

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
Miscellaneous continued						
		Ring, Sealing, Toroidal			5330-99-972-9136	Dowty/List 5 Mk.11 (PP-49-B)
		Flask, Dewar			6640-99-972-0212	Racal BD24356

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O. No.	Manufacturer
		POWER UNIT TYPE PU.525				
Resistors					5905-99-	
R1	680 Ohms	Wirewound	1.5W	5%	011-3251	Painton MV1A
R2	680 Ohms	"	1.5W	5%	011-3251	Painton MV1A
R3	1K Ohms	"	1.5W	5%	011-3255	Painton MV1A
R4	100 Ohms	"	3W	5%	011-3296	Painton 306A
R5	33 Ohms	"	3W	5%	011-3284	Painton 306A
R6	6.8K Ohms	Composition	1/8W	10%	012-1674	Dubilier BTR
R7	DELETED					
R8	4.7K Ohms	"	1/8W	10%	012-1668	Dubilier BTR
[illegible]	680 Ohms	Wirewound	1.5W	5%	011-3251	Painton MV1A
R10	680 Ohms	"	1.5W	5%	011-3251	Painton MV1A
R11	4.7K Ohms	Composition	1/8W	10%	012-1668	Dubilier BTR
RV1	2.5K Ohms	Variable	½W		971-9140	Reliance Type W050
Capacitor						
C1	250 uF	Electrolytic	50V	-20 +100	5910-99- 014-5517	Hunt JE 105 AKZ
Switches					5930-99-	
SA	DP ST	A.C. On/Off			580-2594	Arrow 81-058-BT-33
SB	SP ST	Battery On/Off			971-9141	Arrow 8040-BT-33
SC	SP Biased	Start				Bulgin MP/6/BLM
SD	DP ST	Charge Rate			580-2594	Arrow 81-058-BT-33
Diodes						
MR1					CV 7030	T.I. 1N538
MR2					CV 7030	T.I. 1N538
MR3					CV 7030	T.I. 1N538
MR4					CV 7030	T.I. 1N538
MR5					CV 7030	T.I. 1N538
MR6					CV 7100	T.I. 1N751A
MR7					CV 7030	T.I. 1N538
MR8					CV 7142	T.I. 1N757A
MR9					CV 7030	T.I. 1N538
Plugs and Sockets					5935-99-	
PL1	Plug, fixed (Mains)				972-0219	Electro-Methods MRE-7P-G/V
PL2*	Plug, free (D.C. Supply)				972-0223	Electro-Methods MRE-7P-GH/VL
SKT1**	Socket, free (Mains)				972-0220	Electro-Methods MRE-7S-GH/VL

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O.	Manufacturer
Plugs and Sockets continued					5935-99-	
SKT2		Socket, fixed (D.C. Supply)			972-0225	Electro-Methods MRE-7S/G/V
		Plug, free			972-9110	Plessey MkIV 2CZ84424
		Adaptor, bulkhead			971-6103	Plessey MkIV 2CZ84434

* PL2 forms, with SKT1 of SA.500, an interconnecting cable.

** SKT1 forms, with the free Plessey plug listed above an interconnecting cable which mates with the appropriate side of a Plessey adaptor (listed above). The adaptor is mounted on the front or rear of one of the frame assemblies MA.602 or MA.603.

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O.	Manufacturer
Miscellaneous					5950-99-	
T1		Transformer Power			972-0245	Racal CT20155
VT1		Transistor			CV7454	R.C.A. 2N1485
VT2		Transistor			CV7454	R.C.A. 2N1485
VT3		Transistor			CV5644	T.I. 2N697
					5945-99-	
RLA	4800 Ohms.	Relay, Armature, 2 Pole			580-1770	Fortiphone G100
RLB	2400 Ohms.	Relay, Armature, 4 Pole			972-1074	Fortiphone G100
					5920-99-	
FS1		Fuse	1A		945-7711	Belling Lee L562/1
FS2		Fuse	1A		945-7711	Belling Lee L562/1
					6240-99-	
1LP1		Lamp Mains On	28V 0.04A		995-9118	DEF DL-1
1LP2		Lamp, Charge Rate	28V 0.04A		995-9118	DEF DL-1
1LP3		Lamp, Battery Fail	28V 0.04A		995-9118	DEF DL-1
1LP4		Lamp, Mains Fail Battery On	28V 0.04A		995-9118	DEF DL-1
					6135-00-	
Battery, Dry (21 cells used)					850-9846	Sonotone Type S103 Size D

Cct. Ref.	Value	Description	Rat.	Tol. %	N.A.T.O.	Manufacturer

FRAME ASSEMBLY TYPE MA.601

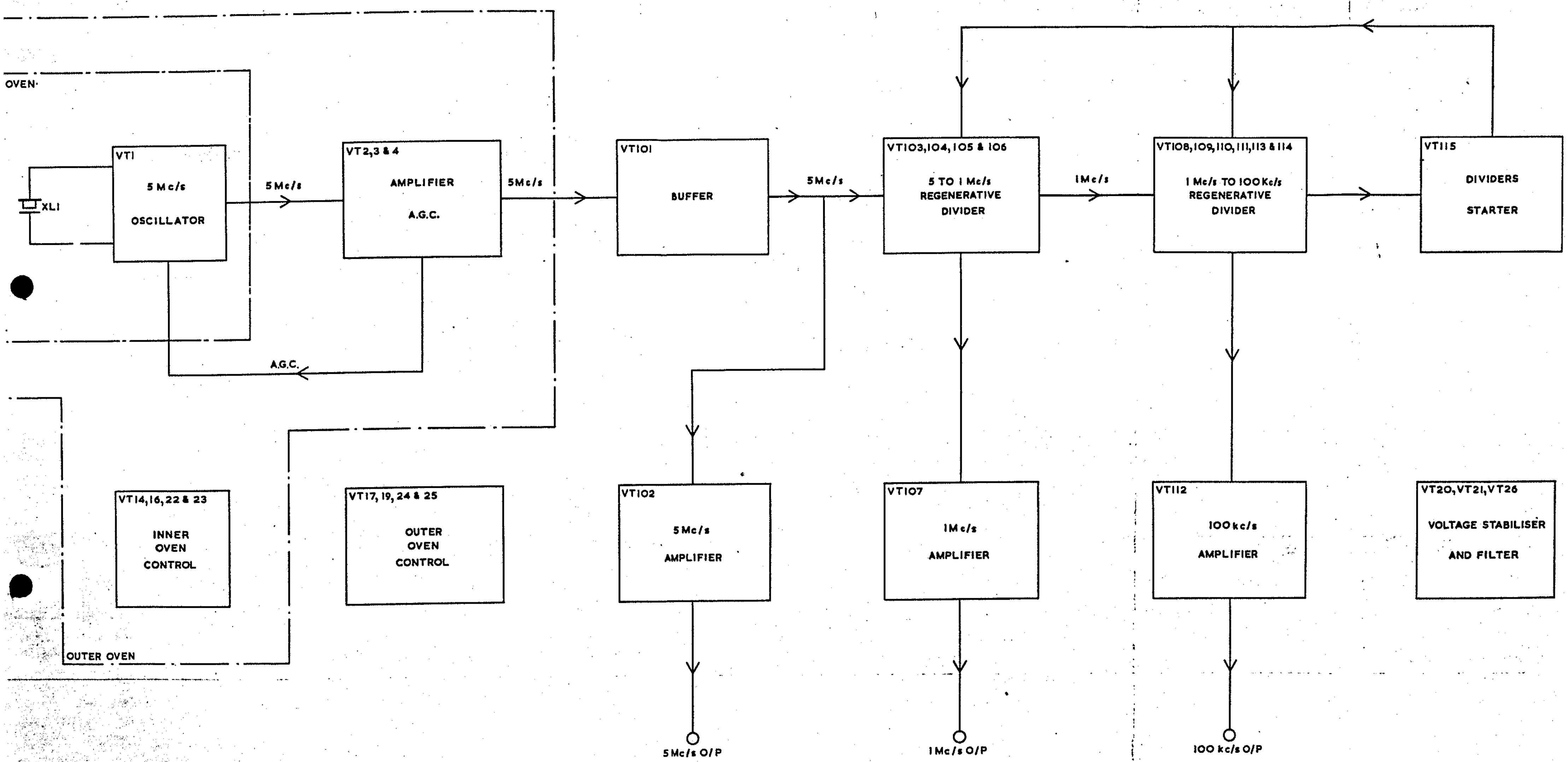
Bulkhead plug/socket - main input	Plessey Mk.IV 2CZ84434
Cable assembly - a.c. supply	Racal BA.22021/A
Cable assembly - d.c. supply (PL1/SKT2 - fig. 1)	Racal BA.22022/B
Tools:	
Box spanner	Racal AD.27485
Box spanner - 6 B.A.	Welwyn Tool Co. Champion Short Series
Allen key	Unbrako 0.05 A/F

FRAME ASSEMBLY TYPE MA.602

Bulkhead plug/socket - mains input	Plessey Mk.IV 2CZ84434
Cable assembly - a.c. supply	Racal BA.22021/A
Cable assembly - d.c. supply (PL1/SKT2 - fig. 2)	Racal BA.22022/B
Cable assembly - 2 off - 1 Mc/s and 100 kc/s outputs.	Racal AA.25678/19
Tools:	
Box spanner	Racal AD.27485
Box spanner - 6 B.A.	Welwyn Tool Co. Champion Short Series
Allen key	Unbrako 0.05 A/F

FRAME ASSEMBLY TYPE MA.603

Bulkhead plug/socket - mains input	Plessey Mk.IV 2CZ84281
Cable assembly - a.c. supply	Racal BA.22021/B
Cable assembly - d.c. supply. (PL1/SKT2 - fig. 3)	Racal BA.22022/A
Cable assembly - 3 off - 5 Mc/s, 1 Mc/s and 100 kc/s outputs.	Racal AA.25623/19
Tools:	
Box spanner	Racal AD.27485
Box spanner - 6 B.A.	Welwyn Tool Co. Champion Short Series.
Allen key	Unbrako 0.05 A/F



Block Diagram: Oscillator Unit Type S A.500

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Fig.4

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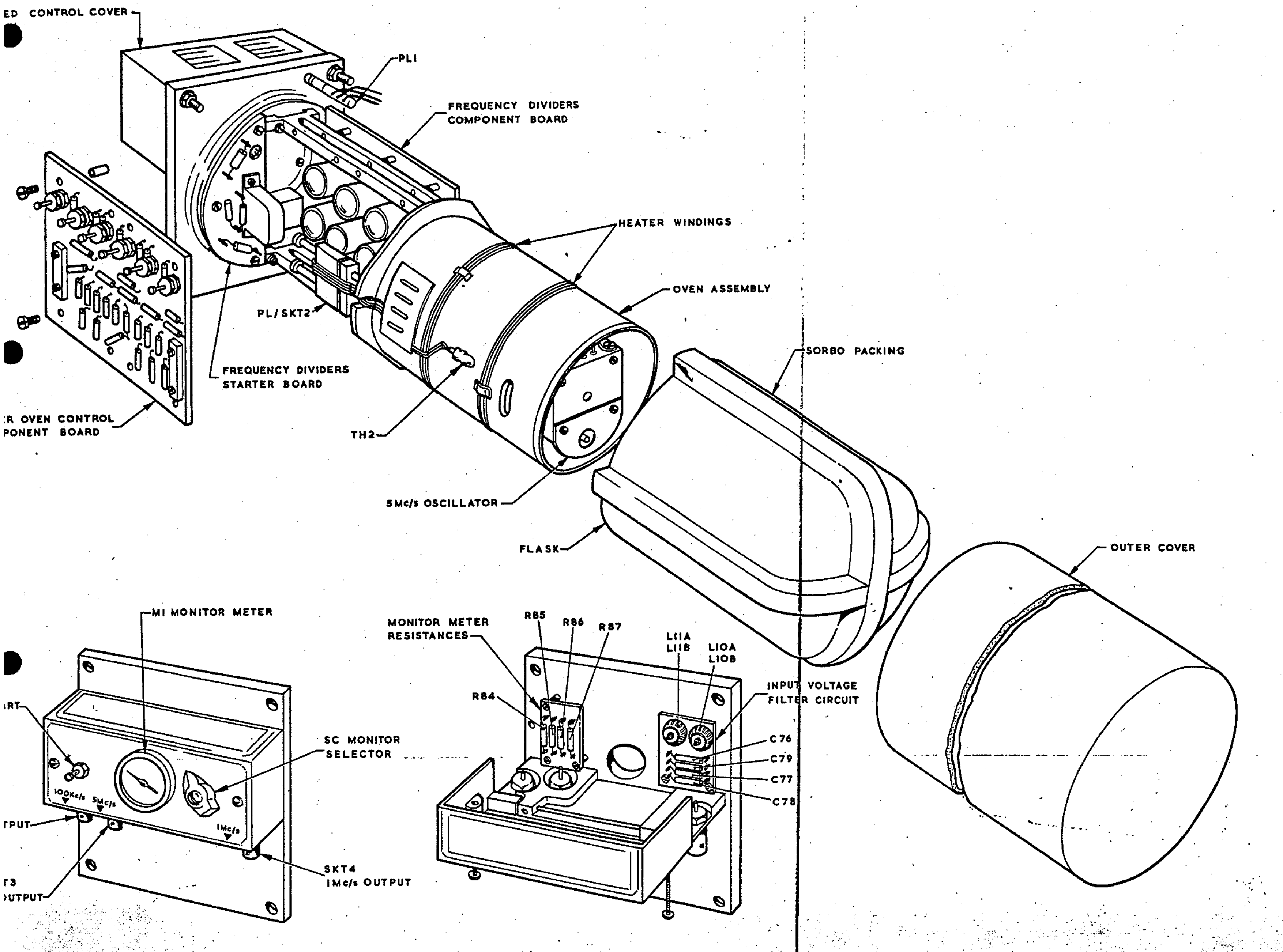

Exploded View-Oscillator Unit Type SA.500

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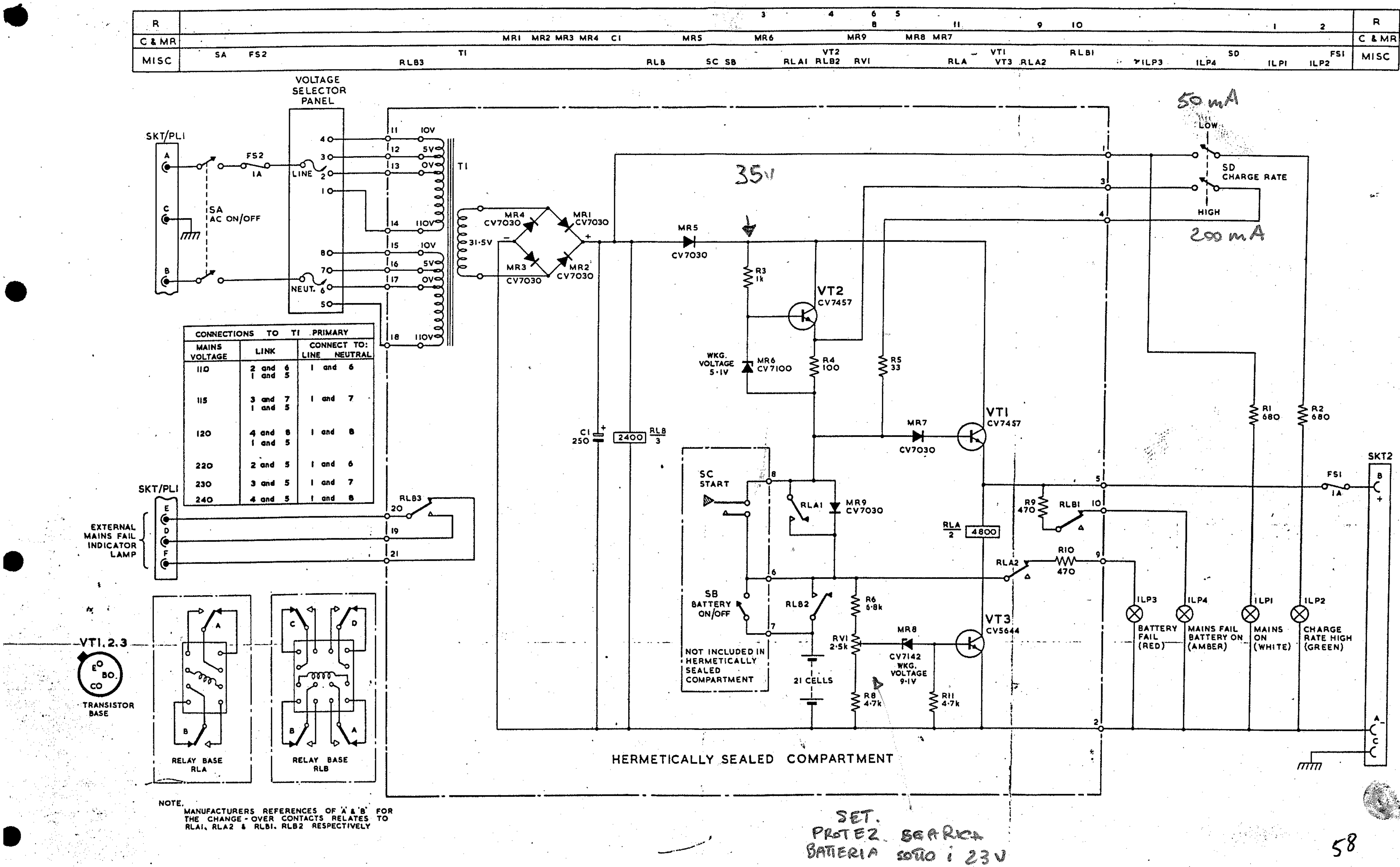
Fig.5



CONNECTIONS TO T1 PRIMARY			
MAINS VOLTAGE	LINK	CONNECT TO: LINE	NEUTRAL
110	2 and 6, 1 and 5	1 and	6
115	3 and 7, 1 and 5	1 and	7
120	4 and 8, 1 and 5	1 and	8
220	2 and 5	1 and	6
230	3 and 5	1 and	7
240	4 and 5	1 and	8

NOTE. MANUFACTURERS REFERENCES OF 'A' & 'B' FOR THE CHANGE-OVER CONTACTS RELATES TO RLA1, RLA2 & RLB1, RLB2 RESPECTIVELY

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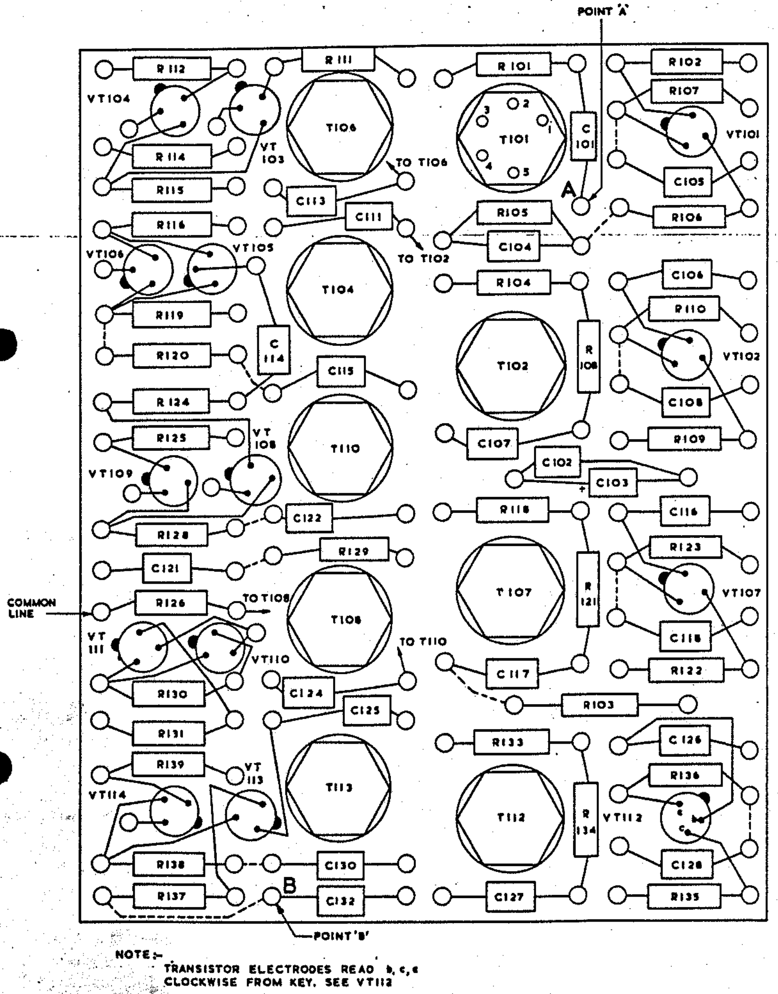
Circuit: Power Unit-PU.525

Fig.8



R	C	MISC.
112 111		
101 102		VT104
107		VT103
		T106
	101	T101
		VT101
114		
115	105	
	113	
116 105	111	
106		
		VT106
		VT105
104	106	T104
119 110		
120 108	114	VT102
	115	T102
124	108	
125 109	107	T110
	102	VT109
	103	VT108
118	122 116	
128		
129 123		
		T107
126		VT107
		T108
		VT111
	118	VT110
122	117	
130	124	
103	125	
131 133	126	
		T113
139 136		T112
		VT114
		VT113
134		VT112
138	130 128	
137 135	132 127	

Fig.9 Component Layout: Frequency Divider and Output Amplifiers–SA.500 178/10

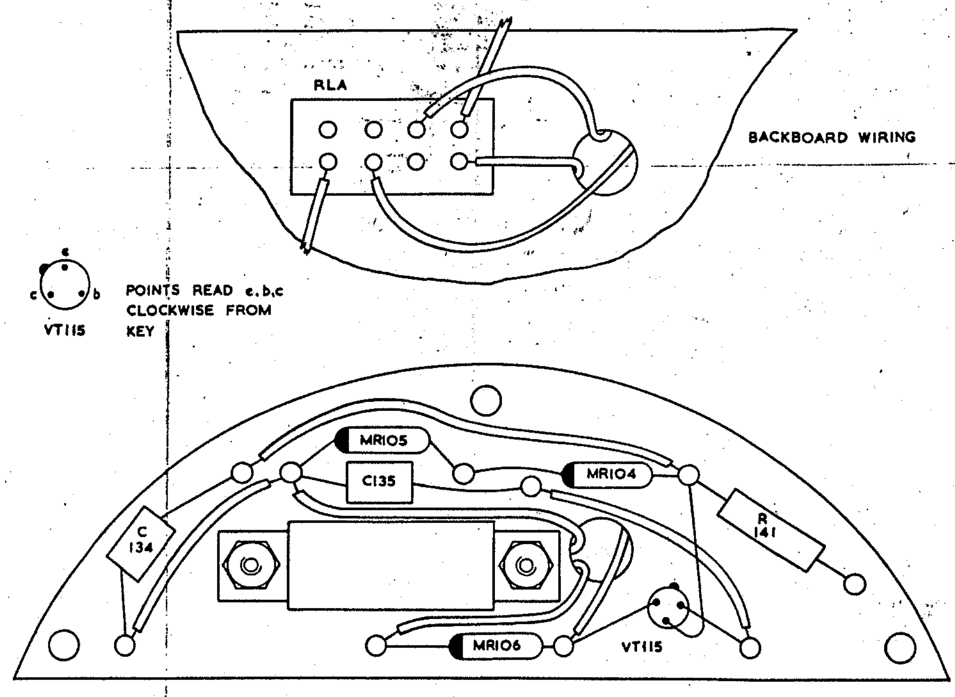
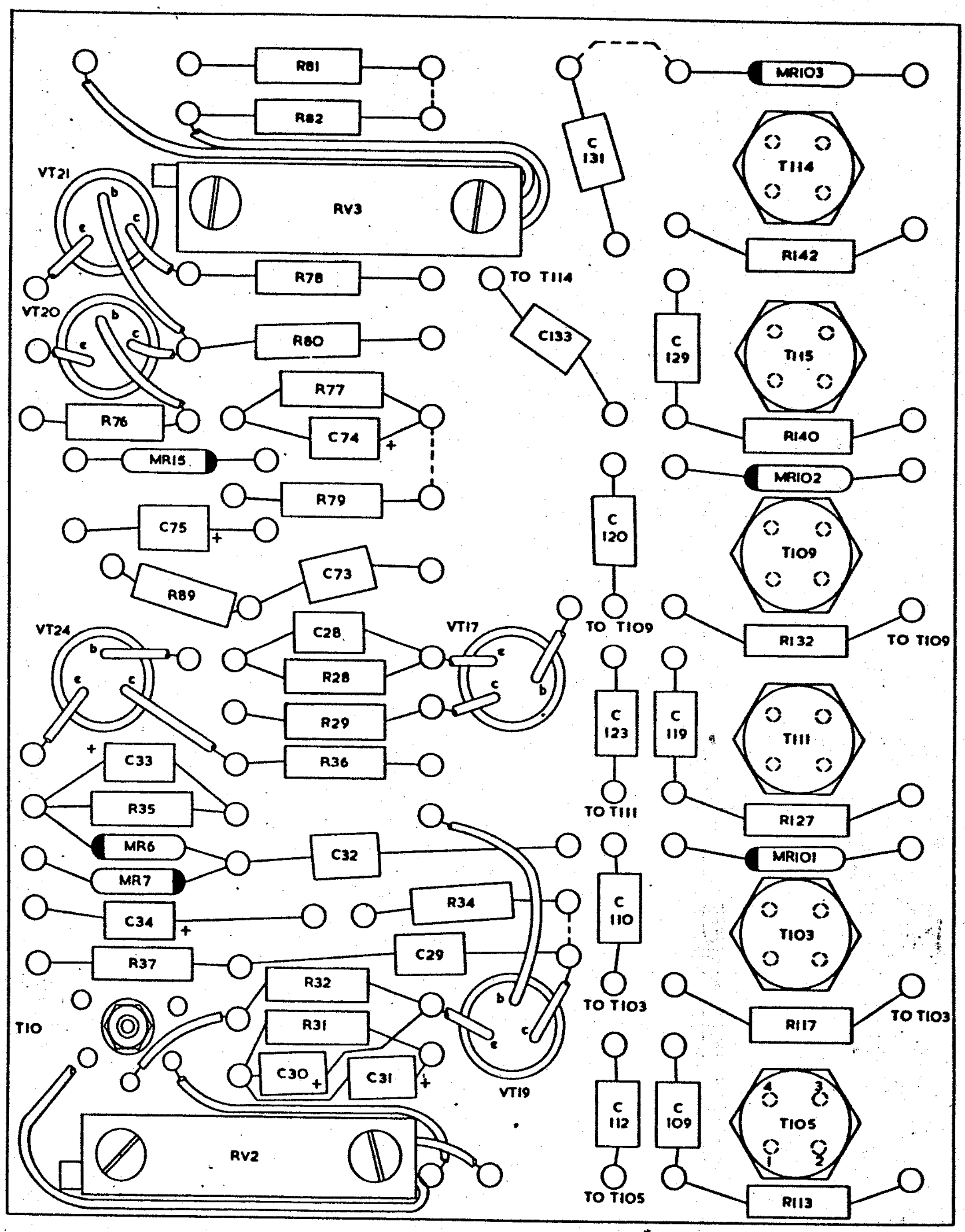


Fig. 10 Component Layout: Frequency Dividers Starter - SA.500 178/11



NOTE :- FOR COIL BASE PIN NUMBERS SEE T105

R	C+MR	MISC
81	MR103	
82		
	C131	VT21 T114
RV3		
142		
78		
		VT20
80	C133	
	C129	T115
77		
76 140	C74	
	MR15	
	MR102	
79		
	C75	
	C120	T109
	C73	
89		
132	C28	VT24 VT17
28	C123	
29	C119	
36	C33	
35 127		T111
	MR6	
	C32	
	MR101	
34	MR7	
	C110	T103
	C34	
37	C29	
32		
31 117		T10
	C30	VT19
	C31	
	C112	T105
RV2	C109	
113		
R	C+MR	MISC

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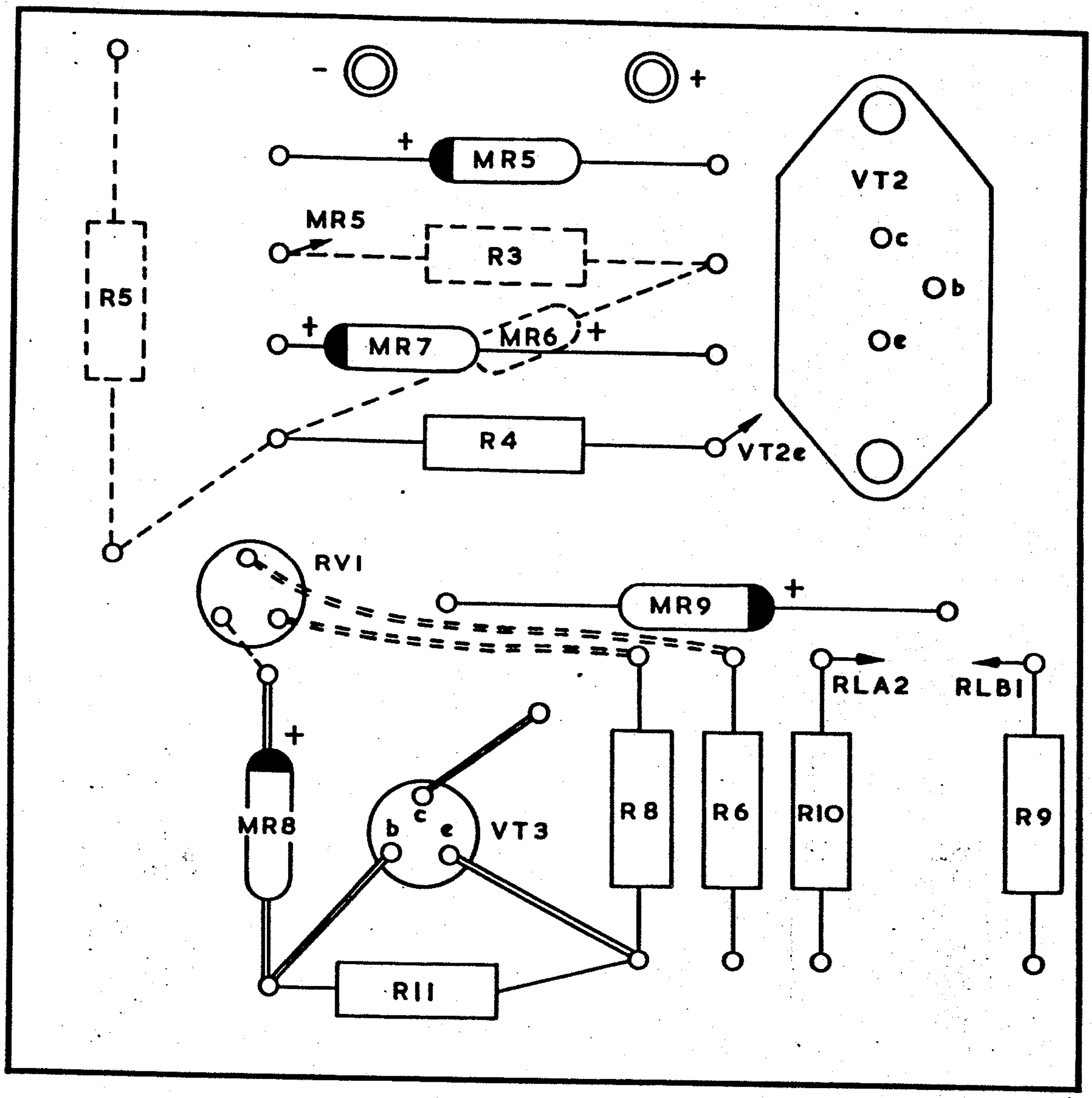
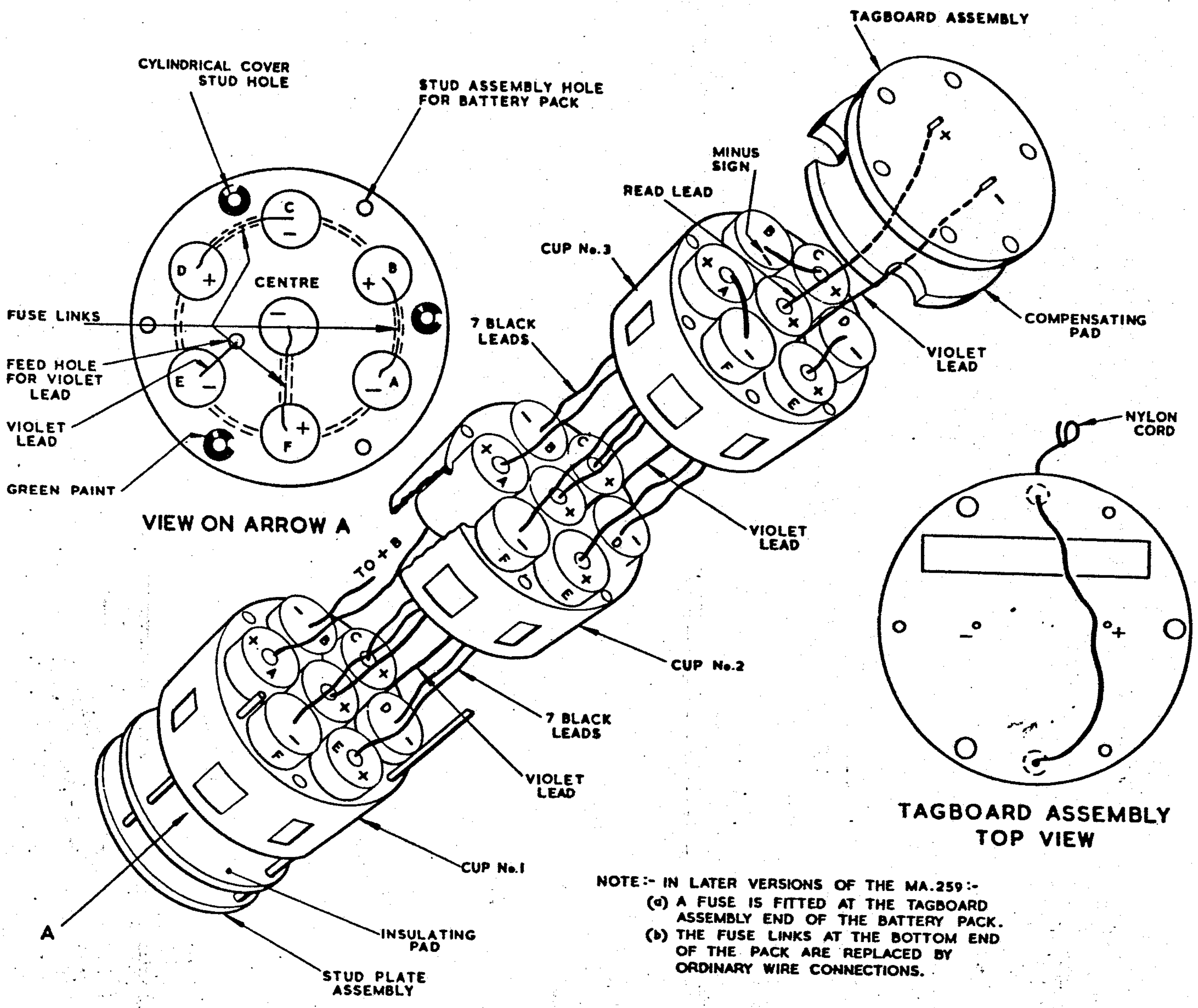
Component Layout: Outer Oven Control, Regulator and Output Filters – SA.500

Fig.11



.12 Component Layout: Power Unit Component Board–PU.525 178/13



NOTE:- IN LATER VERSIONS OF THE MA.259:-
(a) A FUSE IS FITTED AT THE TAGBOARD ASSEMBLY END OF THE BATTERY PACK.
(b) THE FUSE LINKS AT THE BOTTOM END OF THE PACK ARE REPLACED BY ORDINARY WIRE CONNECTIONS.

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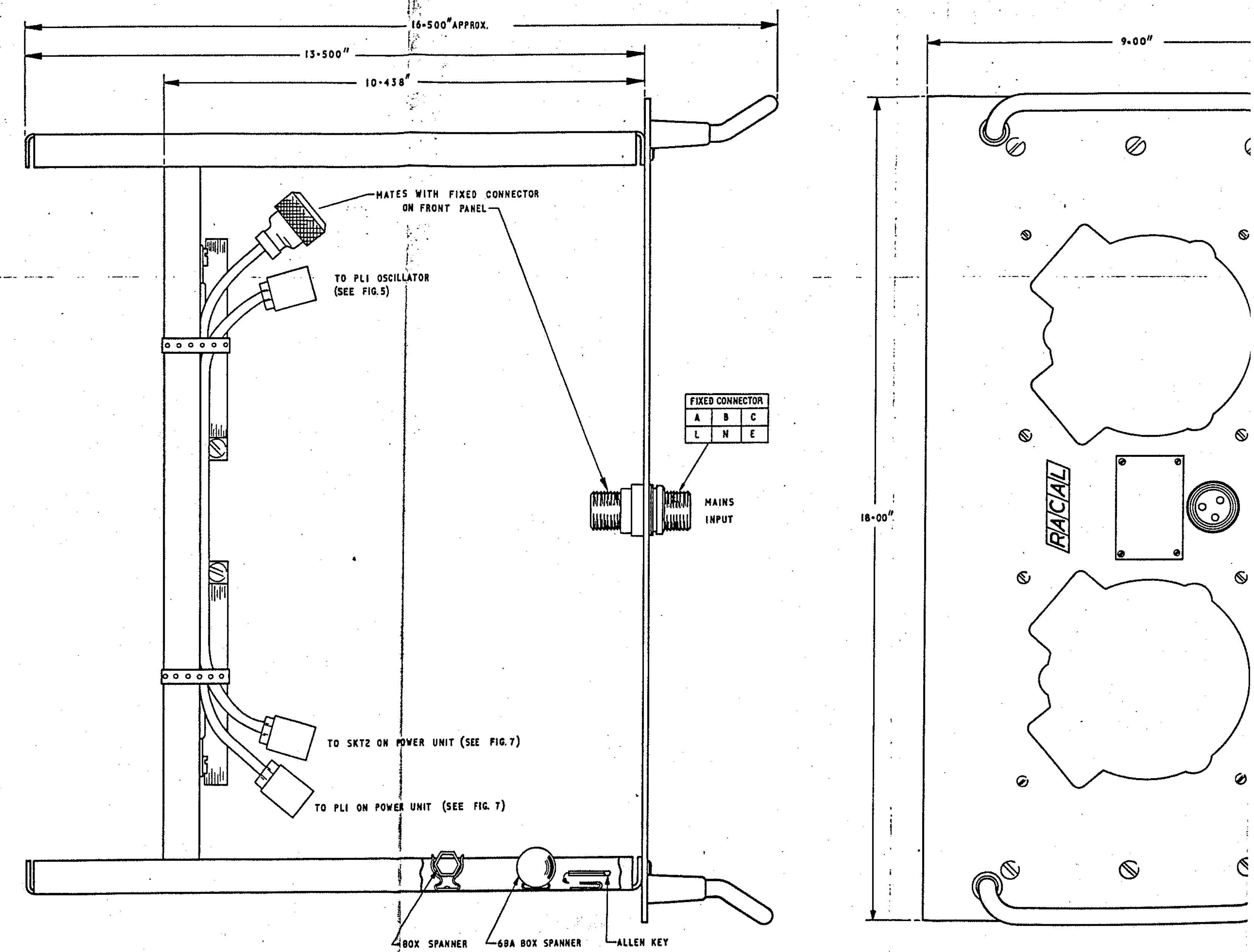
Exploded View: Battery Pack - PU.525 Fig.13



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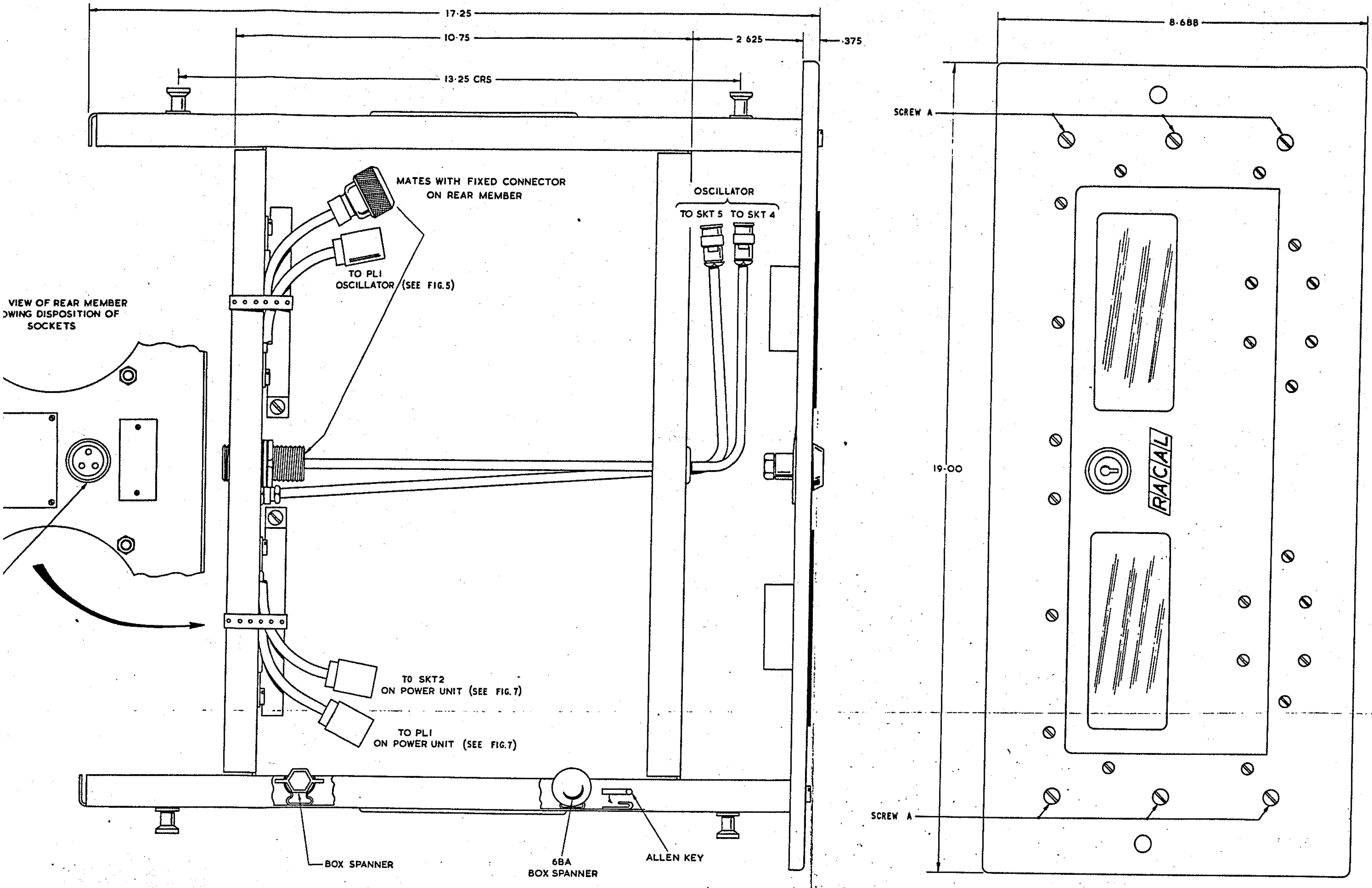
MA.259E: Frame Assembly



MA.259F: Frame Assembly

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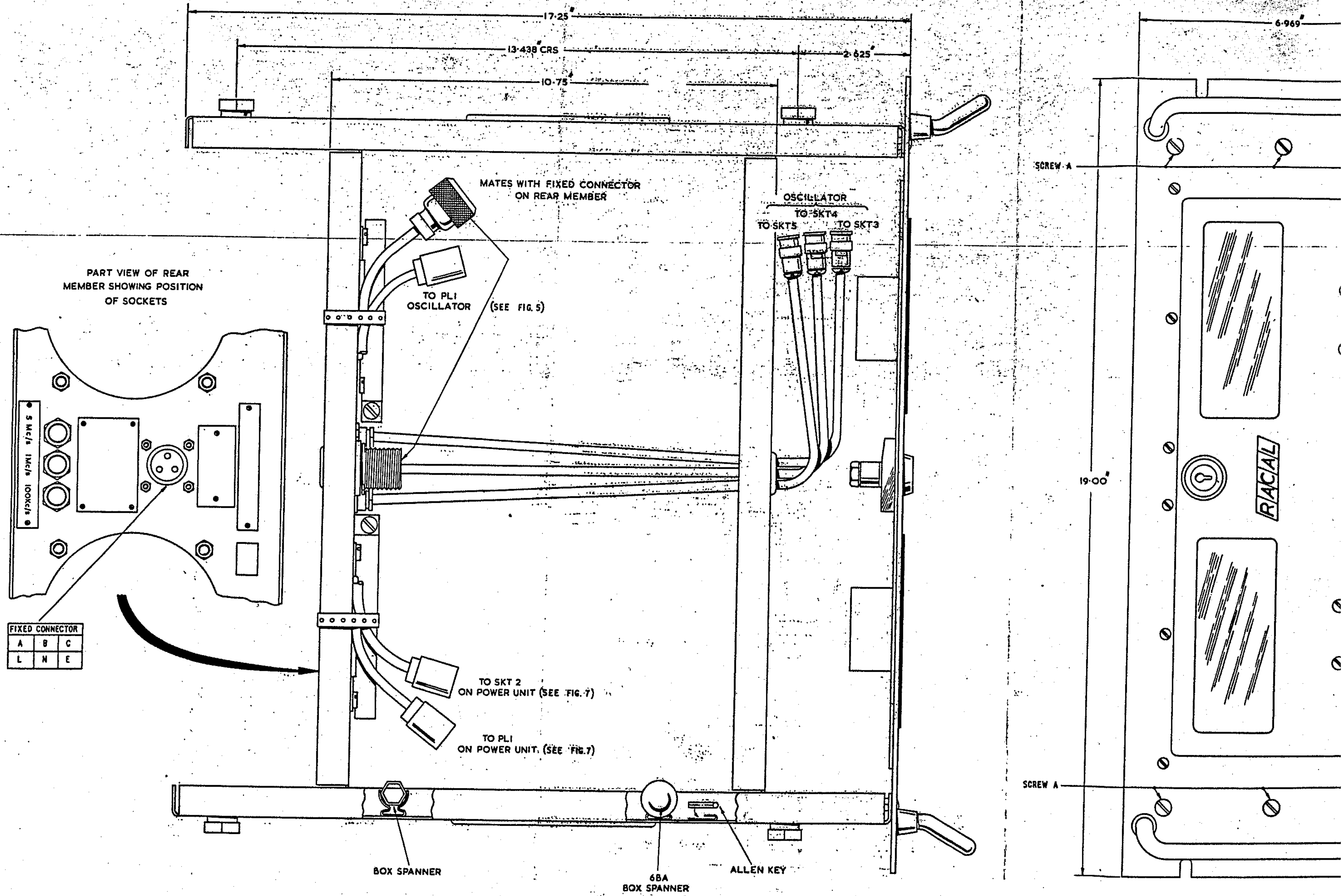

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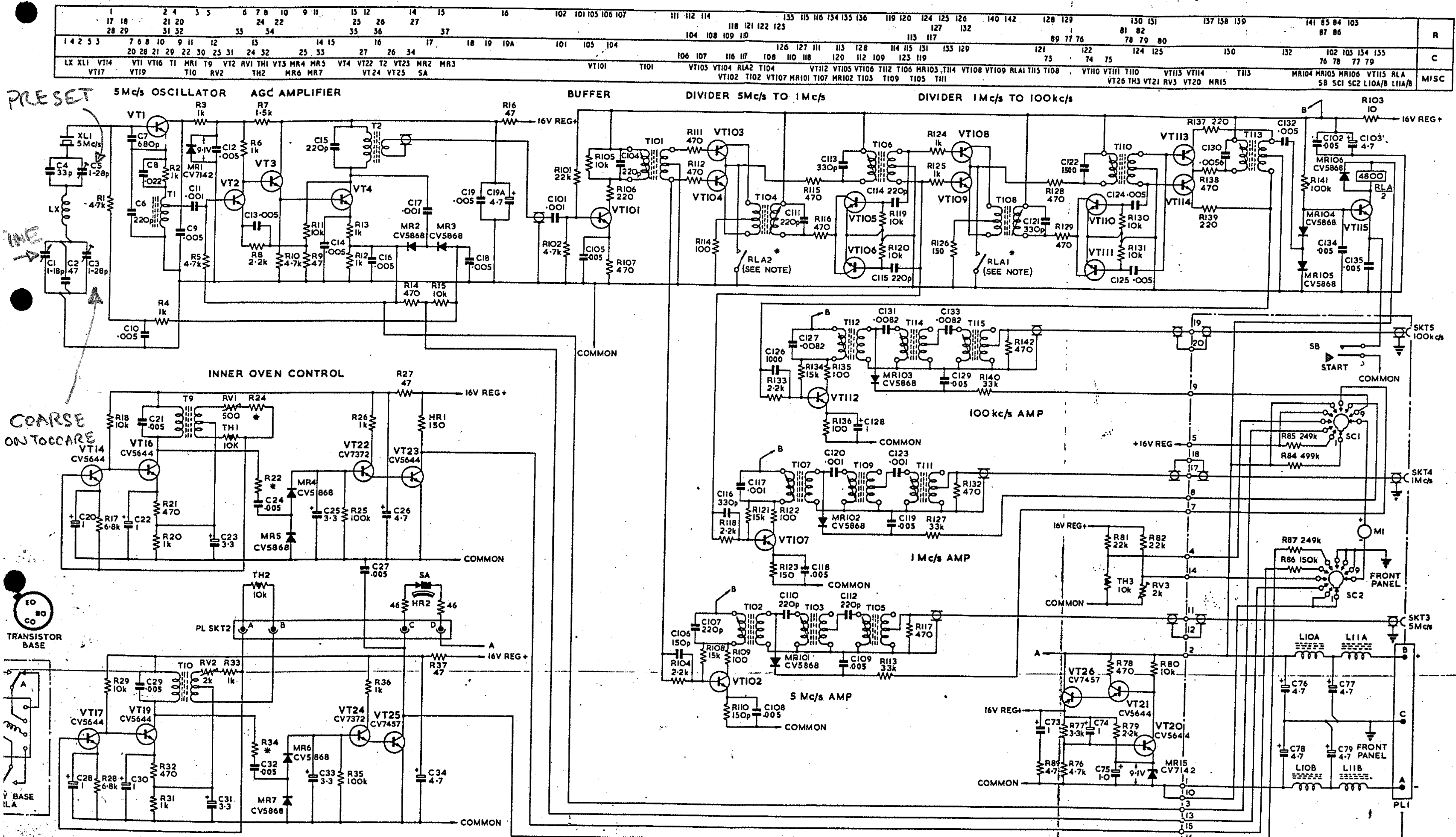
MA. 259G: Frame Assembly



MANUFACTURERS REFERENCE OF 'A' & 'B' FOR THE TWO CHANGE-OVER CONTACTS RELATES TO RLA1 & RLA2 RESPECTIVELY ON THIS CIRCUIT

NOTES:
CAPACITORS VALUES IN μF UNLESS OTHERWISE STATED
INDUCTOR LX USED TO SET FREQUENCY MAY BE CAPACITOR CX
* RESISTORS R22, R24 & R34 SELECTED ON TEST

THESE NUMBERS REFER TO PINS OF THE HERMETIC HEADER THROUGH THE FRONT PANEL.

Circuit: Oscillator Unit - SA.500

Fig.6

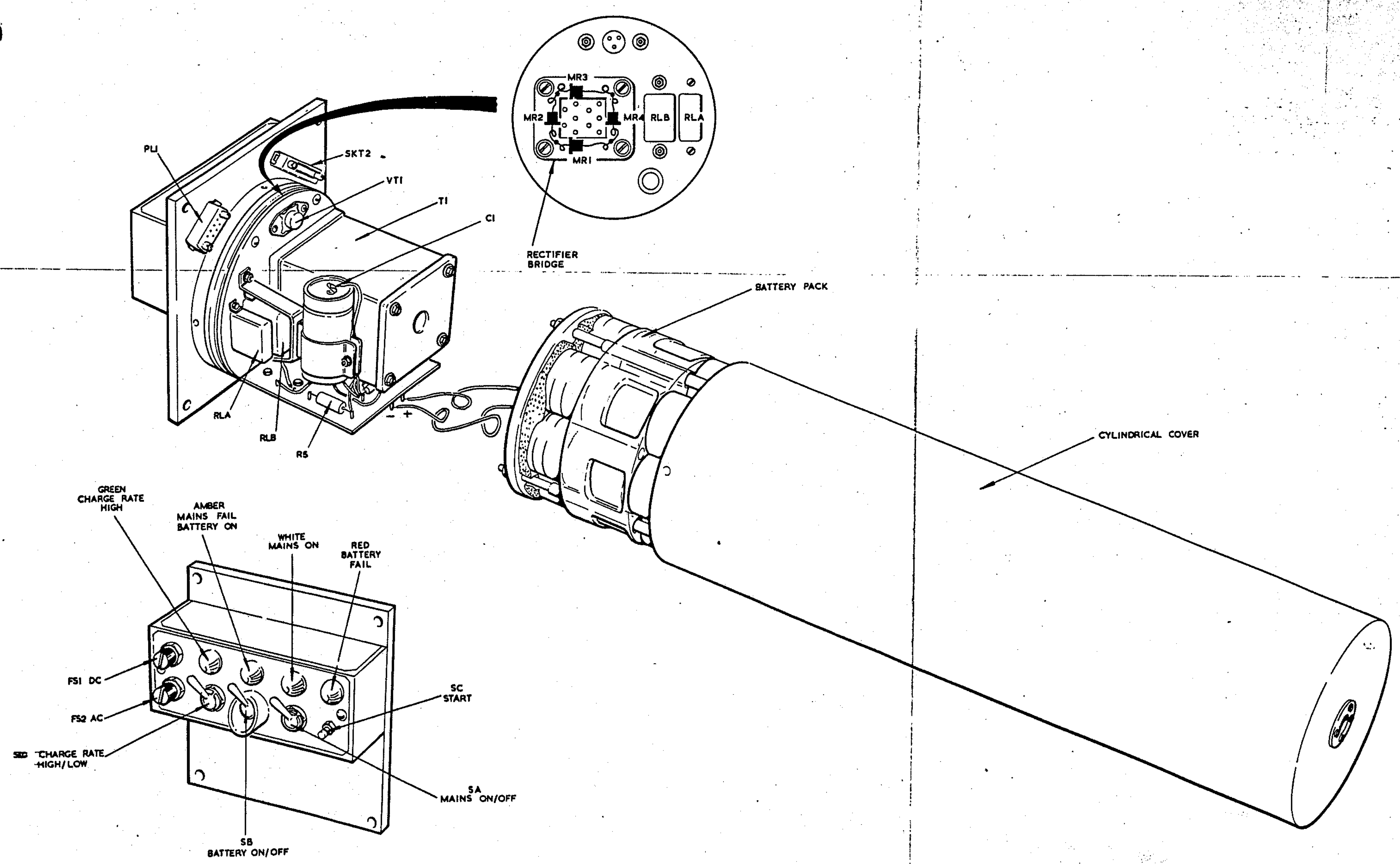


Fig.7 Exploded View: Power Unit - PU.525

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