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Chapter 1

ELECTRONIC REGULATOR, TYPE 2B

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LIST OF ILLUSTRATIONS

RESTRICTED

LEADING PARTICULARS

Electronic regulator, Type 2B ... ... Ref. No. 5UC/6042
Weight ... ... 26½ lb.

Introduction

1. The electronic regulator, Type 2B controls the output voltage and frequency of an inverter, Type 201. The latter comprises a 25 to 28-volt d.c. motor, driving an inductor type alternator having an output of 1·75 KVA at 115 volts, 1,600 cycles, with a shaft speed of

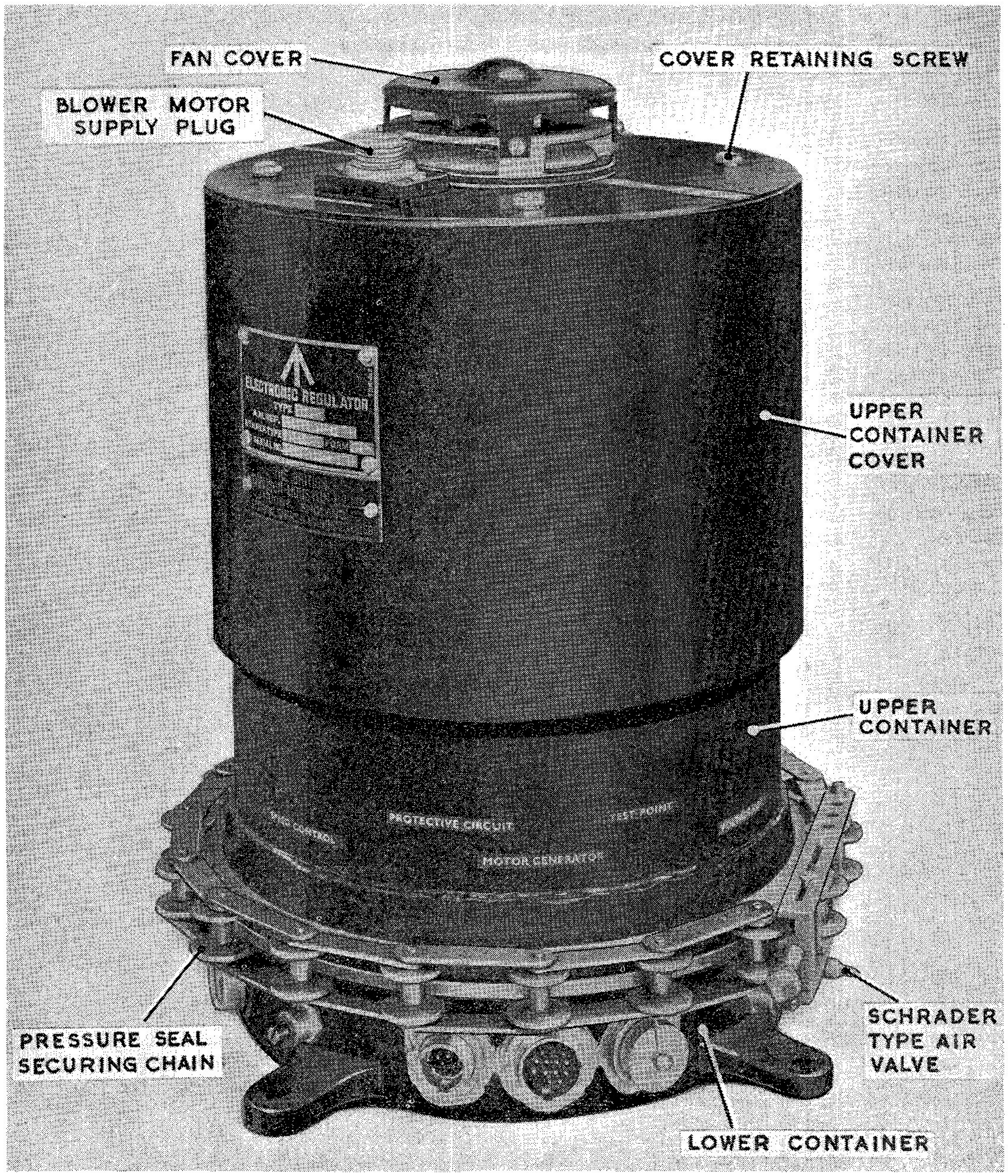


Fig. 1. Electronic regulator, Type 2B

8,000 r.p.m. The regulator performs satisfactorily when operating at ambient temperatures between −40 deg. and +50 deg. C., and at altitudes not exceeding 50,000 ft.

2. In addition to the main field windings excited from the d.c. supply, both the a.c. generator and the driving motor have auxiliary field windings. These auxiliary windings are of high impedance, and are connected to the regulator for the purpose of controlling the alternator voltage and, through the alternator frequency, the speed of the motor.

3. By this means it is possible to maintain the R.M.S. voltage within ± 1 per cent and the frequency of the alternator within ± 1·5 per cent under normal operating conditions. The voltage setting is variable over a small range about the normal setting (115 volts a.c.). The voltage setting (115 volts a.c.), and motor speed (8,000 r.p.m., 1,600 cycles) are adjustable on externally accessible spindles.

4. A protective relay is set to operate when either the voltage or the frequency of the alternator rises in excess of 25 per cent above normal.

Note . . .
◄ *Type 2B differs from the earlier Type 2A (Ref. No. 5UC/5243) in having a blower motor, Type LK604–A6 (Ref. No. 5UD/6120) instead of Type LK604–A4 (Ref. No. 5UD/3856). In other respects it is identical.* ►

DESCRIPTION

5. The regulator (*fig.* 1) is enclosed in a cylindrical pressure-tight container, with the components mounted on a removable chassis. The container is divided into two parts by a pressure joint formed by a Neoprene ring partially embedded in a groove running round a flange at the top of the lower container. The ring is compressed against a similar but ungrooved flange on the upper container, and the flanges are clamped together by a special roller chain. The chain encircles the container and may be tightened or released by the adjusting screw. The regulator, with the upper container removed, is shown in fig. 2.

Upper container

6. The upper container has a fabricated structure with a recessed top for the accommodation of a blower unit. A cover is fixed to this structure, the gap between the cover and the container forming a duct through which cooling air is drawn by the blower unit. The blower unit has a 3-phase motor which operates on a separate supply of 115 V. 400 cycles. A description of this motor will be found in A.P.4343D, Vol. 1, Book 4, Sect. 22.

Lower container

7. The lower container (*fig.* 3 and 4) is a shallow casting with four mounting lugs protruding from its base. It has the control spindles, air valve, desiccator unit and connecting plugs disposed round its periphery.

Chassis

8. The regulator chassis is located in the lower container and is secured by four screws. Electrical connections from the chassis to the lower container are made through an 18-pole plug and socket interconnector.

9. The chassis is divided into two horizontal decks, the upper deck (*fig.* 5 *and* 6) carries the valves, with capacitors and resistors mounted on its underside, and the lower deck (*fig.* 7, 8 *and* 9) carries the transformers. Several other components are fitted beneath the lower deck. Five pillars rising from the lower deck support the upper deck which is hinged to two of the pillars. The removal of the fixing nuts from the tops of the other three pillars enables the upper deck to be opened out.

10. Two potentiometers, one for voltage (right hand) and the other for frequency (left hand), are located in the lower container. The spindles of the potentiometers pass through the pressure seals on the walls of the container. The ends of the spindles are slotted for screwdriver operation.

Note . . .
When making adjustments do not disturb the hexagon nuts of the pressure seals, or air pressure will be lost.

Air valve

11. A Schrader type air valve enables air to be applied for pressurizing the container to approximately 5 lb. per sq. in. above atmospheric pressure at ground level.

Desiccator unit

12. The desiccator unit is intended to absorb any moisture that may seep into the container. A window at the end of the container enables

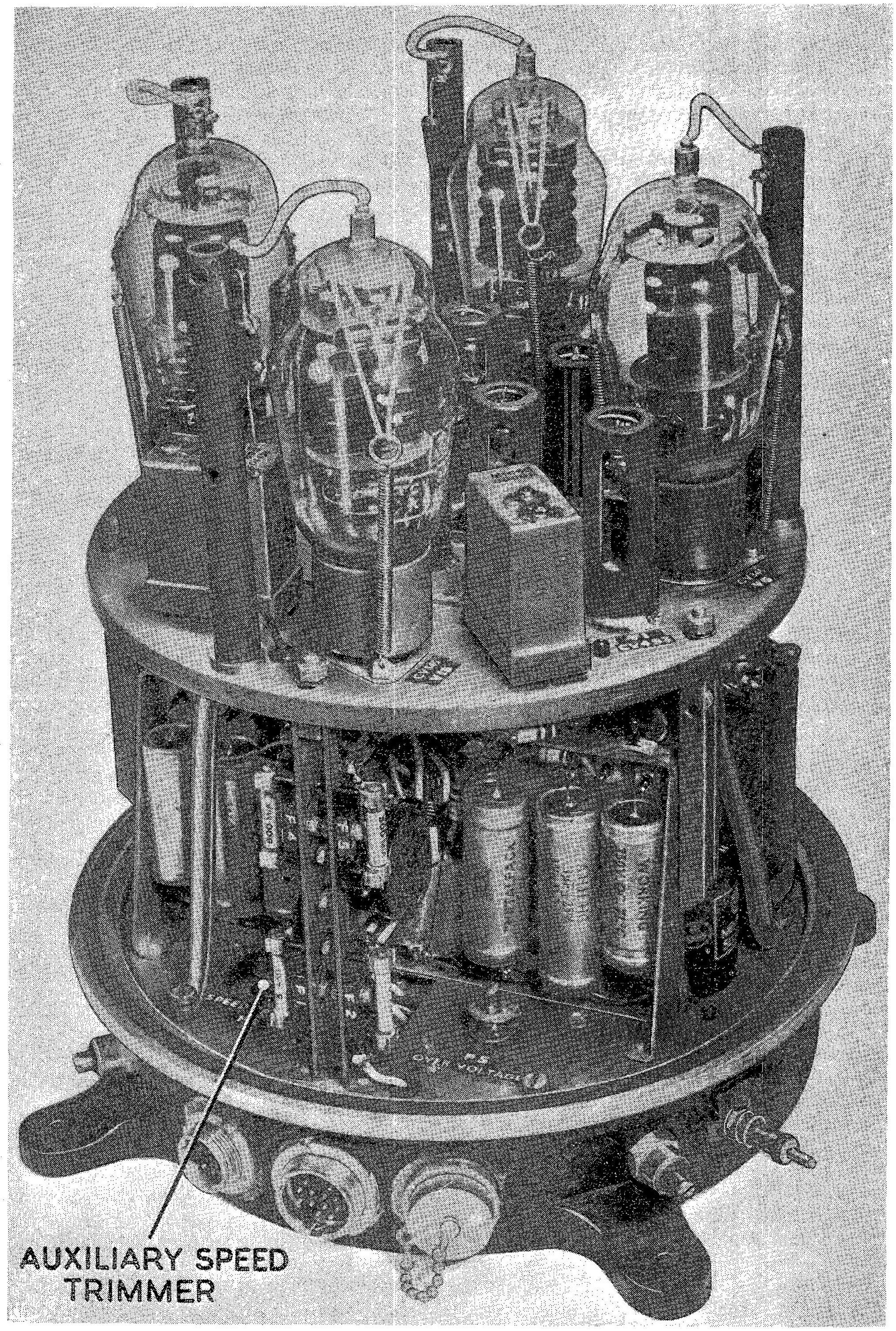


Fig. 2. Regulator with upper container removed

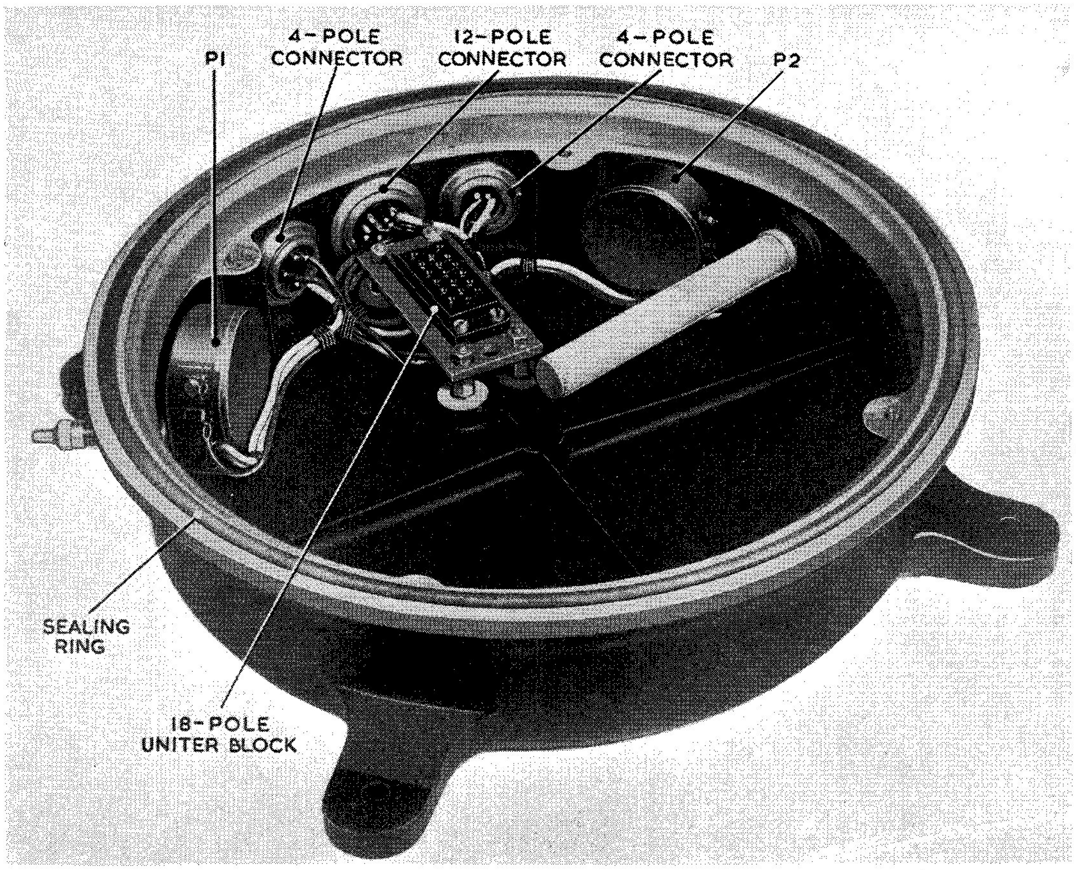


Fig. 3. Lower container

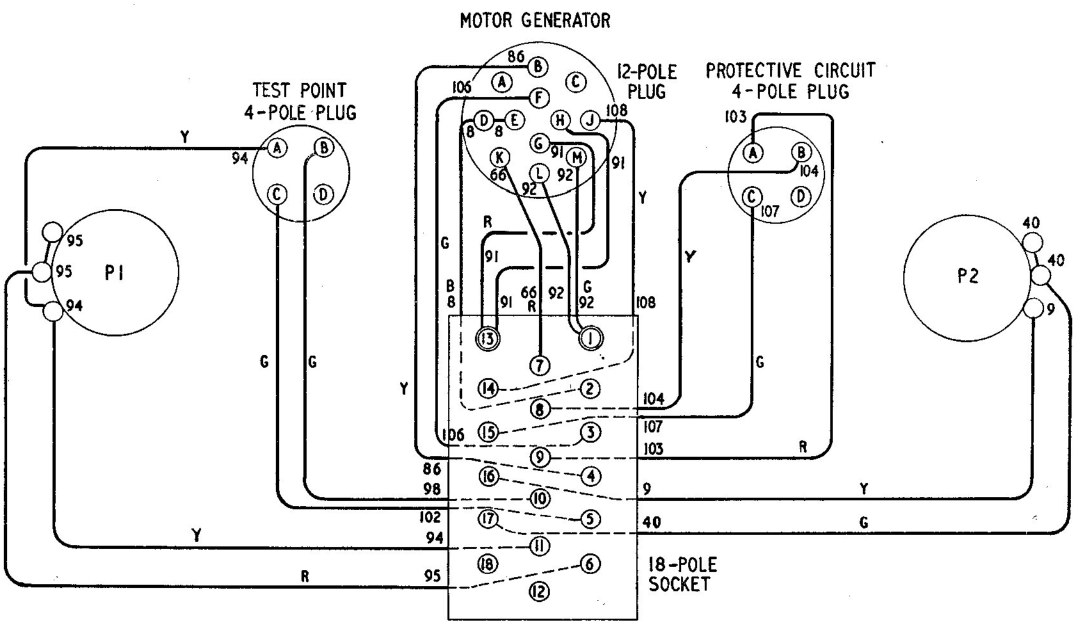


Fig. 4. Wiring diagram, lower container

the crystals to be viewed; they should be azure blue when dry and salmon pink when damp.

FUNCTIONING

13. A theoretical circuit diagram is given in fig. 16. The voltage regulator occupies the top third of the diagram, the speed or frequency regulator the centre third, and the inverter and starting gear the bottom right-hand side of the diagram. The overspeed relay and the overvoltage relay are located at the bottom left-hand side of the diagram.

Voltage regulator

14. It will be seen (*fig.* 16) that the alternator voltage is connected to the regulator through fuses F1 and F2. The functioning of the voltage section of the regulator depends upon the special diode V2, which has its filament connected to the alternator supply by transformer T5. The potentiometer P1 acts as a voltage control.

15. V2 is connected to an amplifier V3, the 250-volt d.c. supply for the amplifier being obtained from the alternator supply via the rectifier V1, with a choke input filter L1 (a) and C1. In the event of an internal fault in the amplifier supply, the transformer T1 is protected by the fuses F3 and F6.

16. The current passed by V2 is sensitive to the voltage applied to its filament, i.e.,

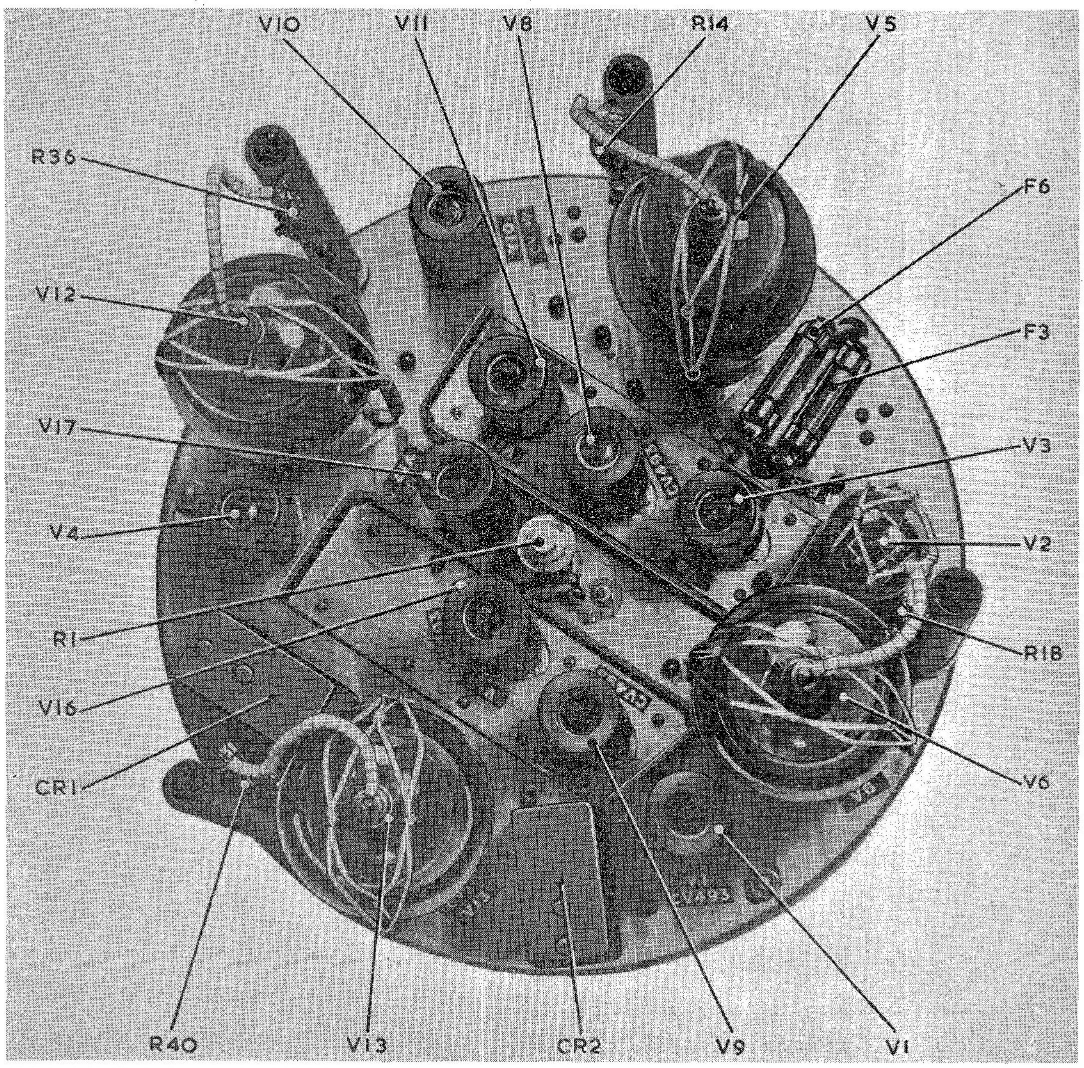


Fig. 5. Plan of upper deck

NOTE
RESISTORS MUST BE WIRED
UNDER LARGE WIRING BUNDLES

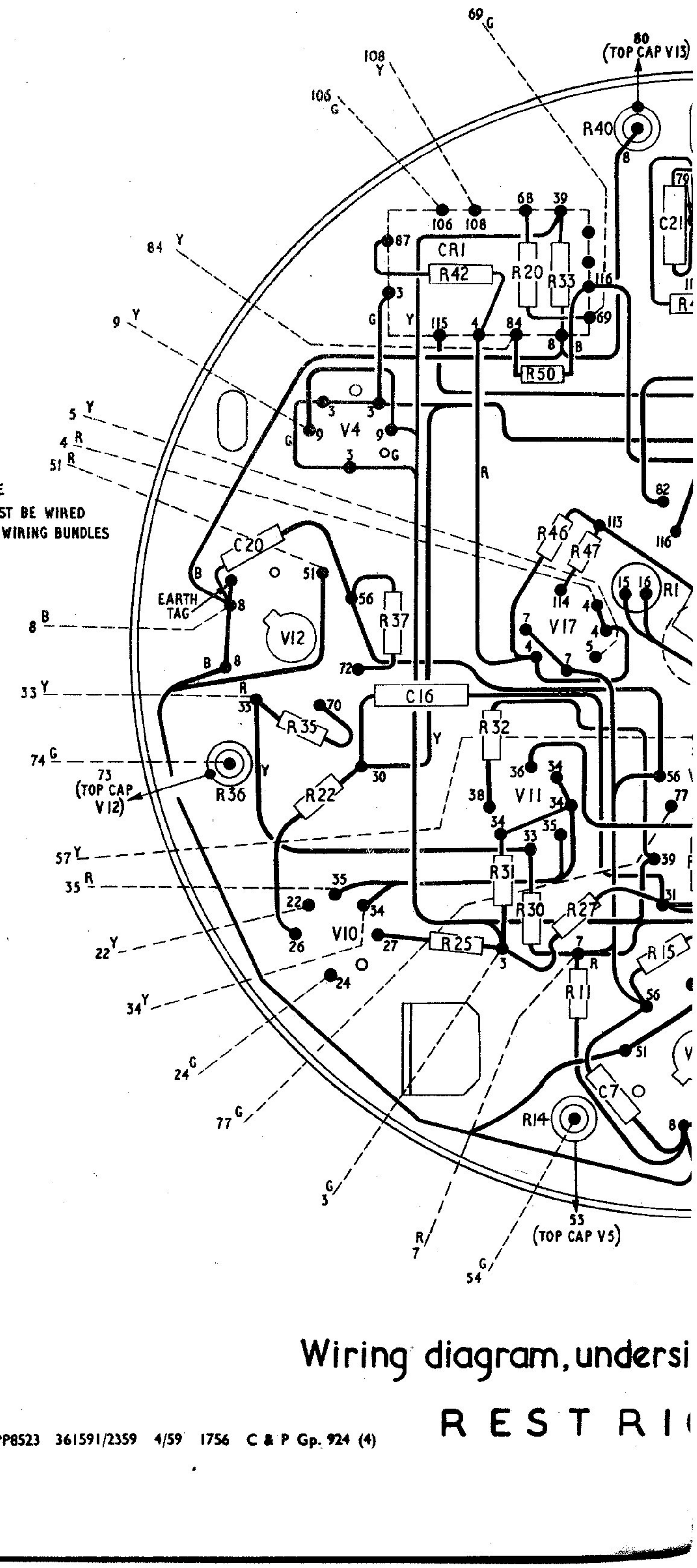
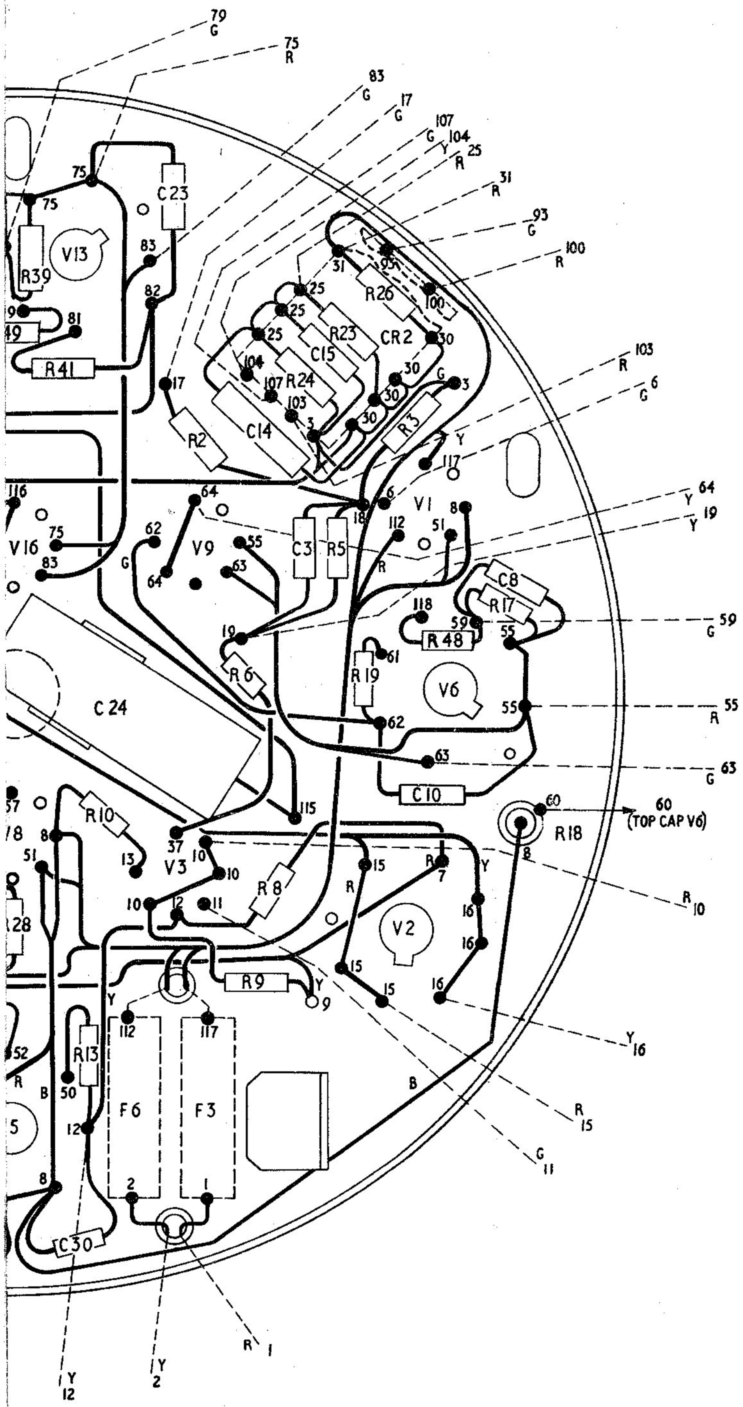


Fig. 6 Wiring diagram, undersi

F.S./4

PP8523 361591/2359 4/59 1756 C & P Gp. 924 (4)

R E S T R I



de of upper deck

Fig.6

C T E D

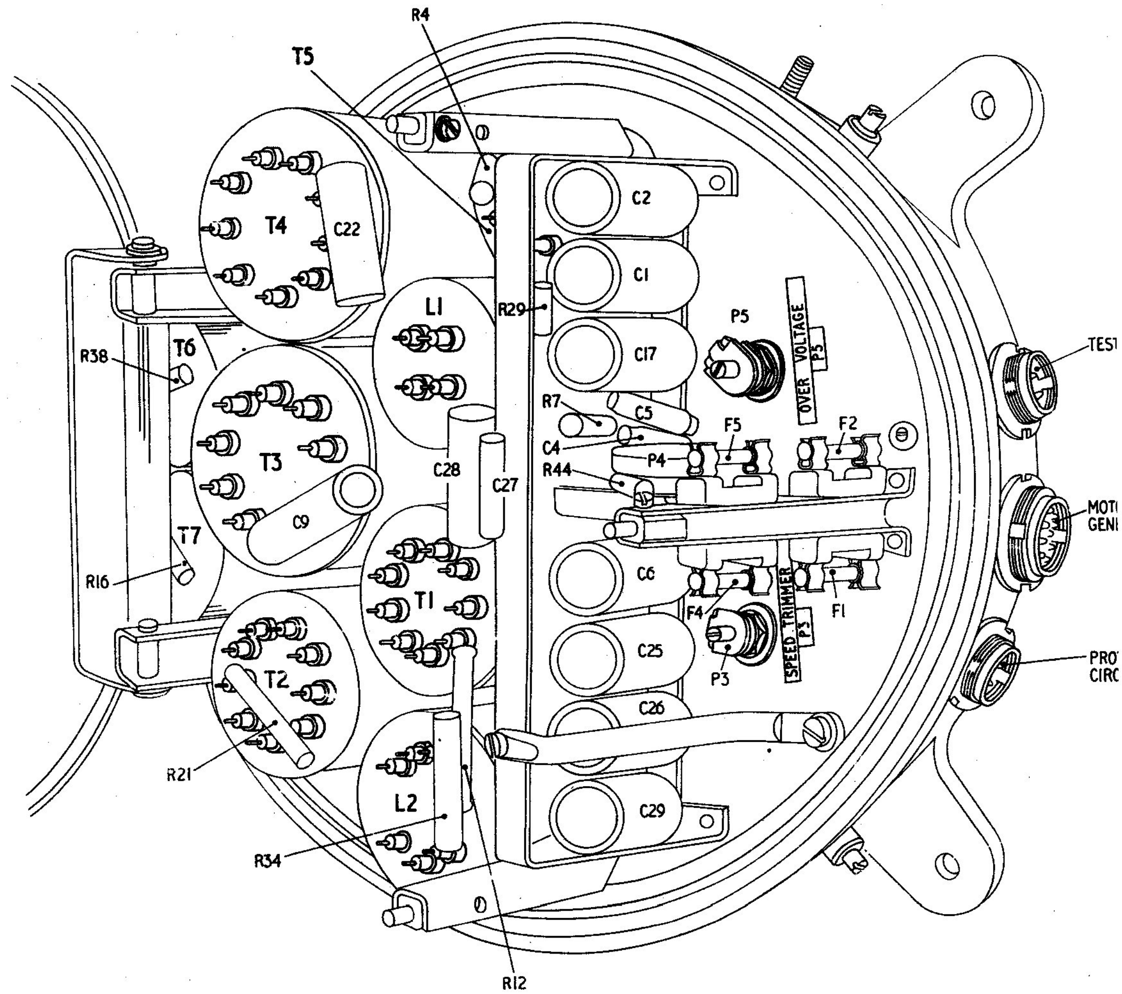
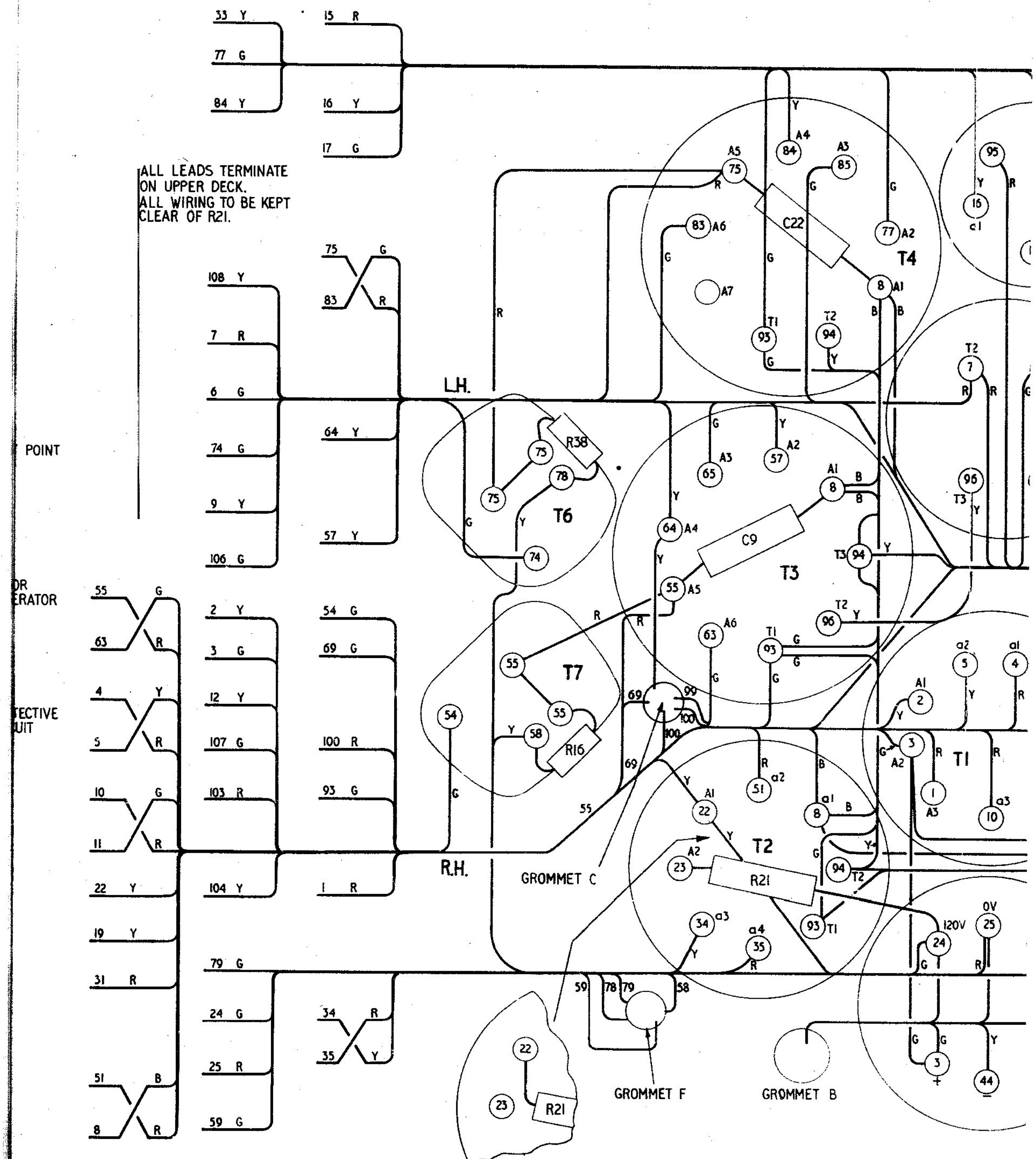


Fig. 7

F.S./5

PP8277 .248586/3746 12/57 1250 C & P Gp. 959 (4)



PLAN VIEW

Component and wiring diagrams, lower deck

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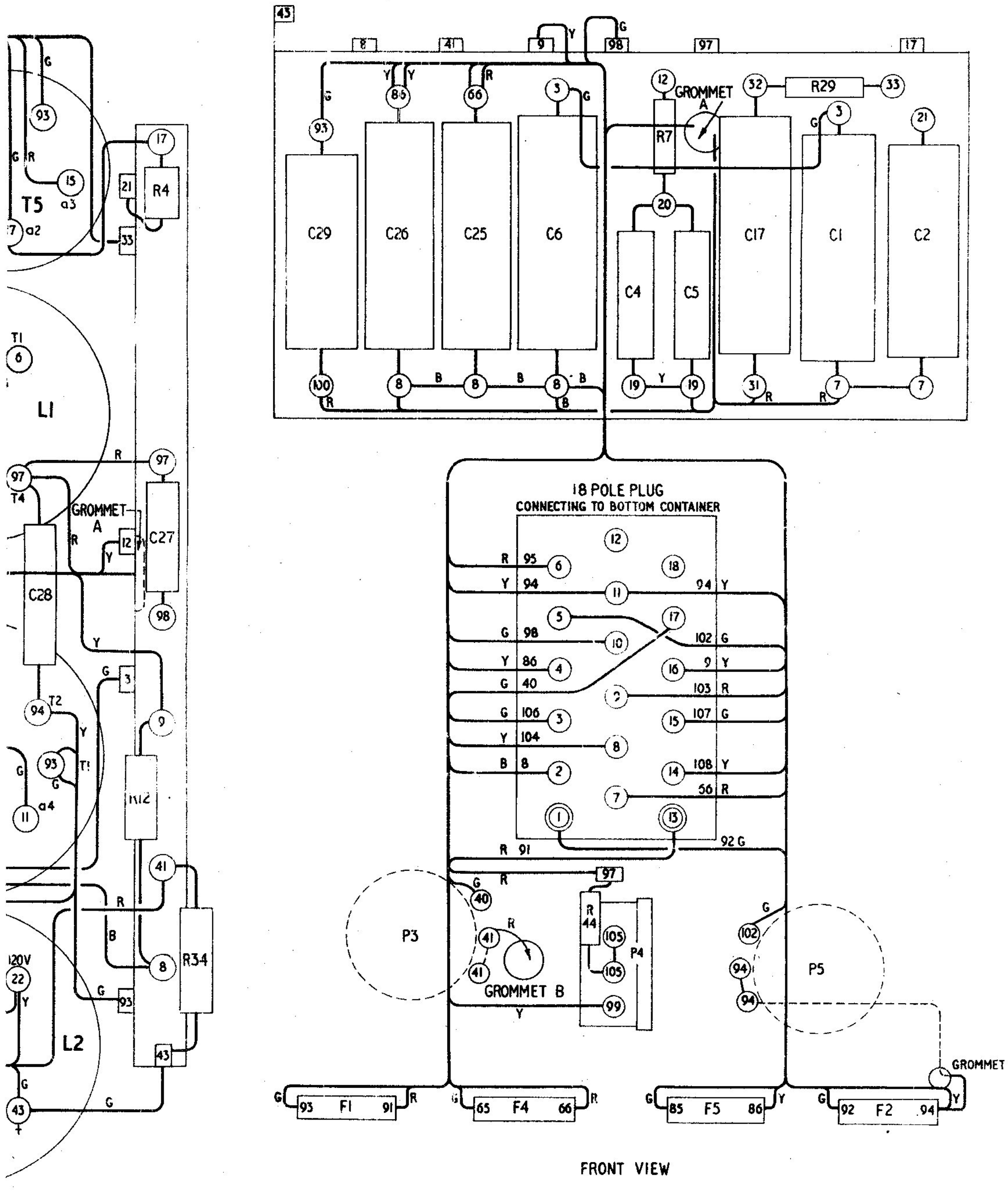


18 POLE PLUG
CONNECTING TO BOTTOM CONTAINER
GROMMET A
GROMMET B
GROMMET
C29
C26
C25
C6
C4
C5
C17
C1
C2
R29
R7
R4
C27
C28
R12
R34
R44
T5
T1
L1
T4
T2
L2
P3
P4
P5
F1
F4
F5
F2
120V
FRONT VIEW

Fig. 7

diode current is a function of the R.M.S. value of alternator voltage. The characteristics of this valve are such that anode current is only slightly affected by variation of the amplifier d.c. supply voltage. The current, therefore, passing through resistors R2 and R3 is predominantly a function of the R.M.S. value of alternator voltage, a small change in alternator voltage occasioning a much larger change in current.

17. The voltage developed across R3 is compared with that across the voltage stabilizer V4, the difference voltage being applied to the control grid of amplifier V3. R11 and R12 are in series with V4 across the 250-volt H.T. supply. An anode load for V3 is formed by R8; the screen grid of V3 (which is a pentode) is supplied through R10. The lower end of R11 is connected to the cathode of V5 in the output stage of the regulator, and the anode of V3 is connected to the control grid of V5. This arrangement enables the error in the R.M.S. value of alternator voltage to be amplified by V3 and then applied to the control grid of V5 which, in the output stage, feeds excitation current to a winding in the alternator.

18. Referring again to fig. 16, the main field X1, X2 of the alternator is constantly excited from the d.c. supply, voltage control being obtained by buck-boost excitation of the auxiliary field winding X3, X4, this excitation current being supplied from the electronic regulator.

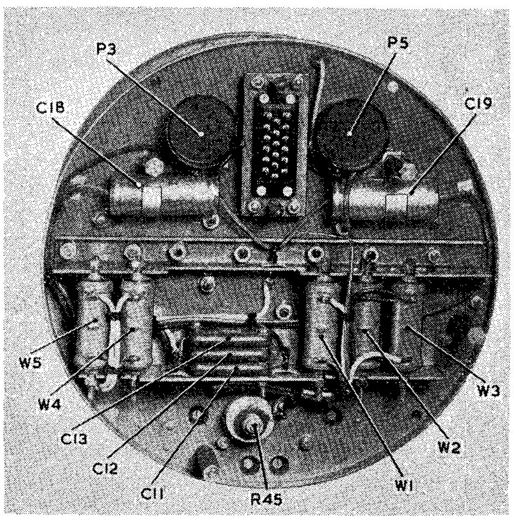


Fig. 8. Underside of lower deck

19. The power valves V5 and V6, in the output stage, are connected in inverse parallel and are in series with the transformer secondary T3 S2 which provides the power source for this stage. This arrangement allows either bucking or boosting current to be passed through the auxiliary field of the inverter. T6, in the anode circuit of V5, provides a voltage across R16 which is proportional to the anode current of V5. It is rectified by W4, appears across R17, and is applied to the control grid of V6. By this means current through V6 is reduced to cut-off when current in V5 is increased to full conduction. Alternatively, V6 will conduct freely when V5 is biased to cut-off. It follows that by controlling the grid voltage of V5, current in the alternator auxiliary field may be varied smoothly from a maximum in one direction to a maximum in the reverse direction, resulting in buck-boost control of the alternator field excitation. Half wave voltages for the screen grids of V5 and V6 are supplied by rectifier valves V8 and V9 respectively.

20. Assuming that, due to some external cause, the alternator voltage falls, an ensuing decrease in emission from the filament of V2 will reduce the voltage across R3, and a more negative voltage will then be applied to the grid of V3. There will be a reduction in the anode current of V3, and the voltage on the control grid of V5 will become less negative. It follows that there will be an increase in anode current of V5 and an increase in the negative voltage applied to the grid of V6, the current through the latter being consequently reduced. The resultant change in auxiliary field current will increase the alternator voltage and compensate for the initial fall in voltage.

21. In practice it will be found that a deviation of approximately 0·5 per cent in alternator voltage will cause a complete reversal from maximum boosting to maximum bucking current in the alternator auxiliary field. Thus the alteration of the R.M.S. value of alternator voltage, under normal operating conditions, would not exceed 0·5 per cent. Manual voltage control is obtained by the use of trimmer P1.

22. In order to minimize hunting, and at the same time to allow a rapid recovery from transient disturbances, the voltage stabilizing circuits R4, R5, R7, and C2, C3, C4, C5 are associated with the amplifier circuits.

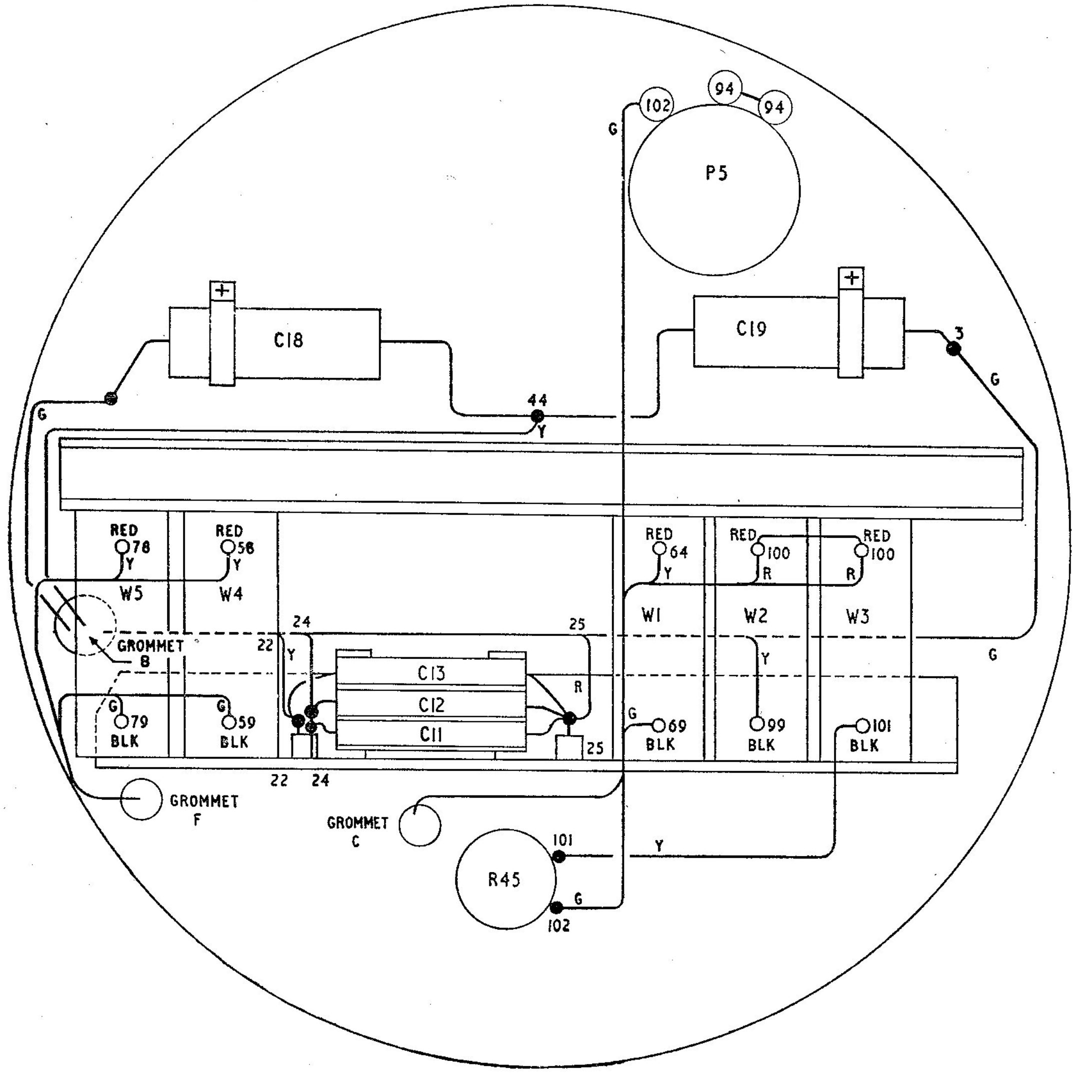


Fig. 9. Wiring diagram, underside of lower deck

Speed regulator

23. By applying the alternator voltage to a frequency sensitive circuit, giving zero voltage output at one particular frequency (which can be adjusted by P2), the voltage of the alternator is utilized for obtaining a measure of the motor speed. The regulator maintains this balance frequency by controlling the field excitation on the driving motor. The frequency of the alternator voltage is employed to control the motor speed; it is therefore important that the voltage itself be accurately regulated.

24. The frequency sensitive circuit is applied from the transformer winding T2S1 and consists of the resistor R21 in series with two parallel resonant circuits. One of the resonant circuits is formed by the inductor L2 (b) in parallel with capacitor C13, and the other by the inductor L2 (a) in parallel with capacitors C11 and C12.

25. Rectified voltages proportional to the a.c. voltages in the resonant circuits are obtained by means of V10 across resistors R23 and R24, the output from the frequency sensitive circuit being the difference voltage appearing across R23 and R24. This voltage is applied to the grid of V11.

26. The circuit employing inductor L2 (b) has a higher resonant frequency than that

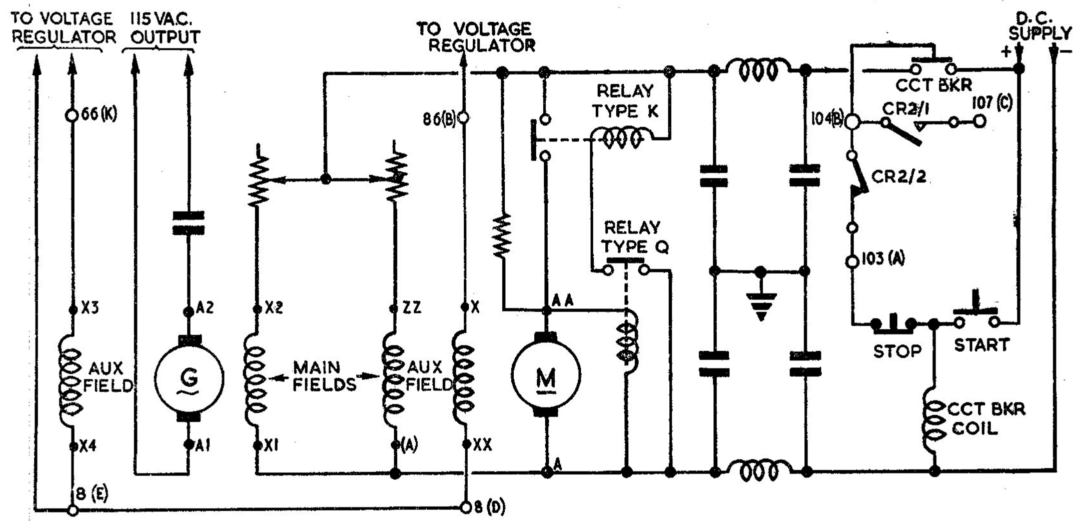


Fig. 10. Circuit diagram of inverter and starting gear

employing L2 (a), the balance frequency being between the two resonant frequencies, at the point where the voltages across L2 (a) and L2 (b) are equal. Adjustment to the balance frequency is obtained by joint variation of the inductance of L2 (a) and of L2 (b); this is achieved by adjustment of the current in their associated d.c. coils, L2 (a/1) and L2 (b/1). An increase of current in these d.c. coils will decrease the inductance of L2 (a) and L2 (b), increase the resonant frequencies and thereby increase the speed of the motor. Speed control is obtained by adjusting either potentiometer P2 or P3.

27. The output voltage from the frequency sensitive circuit amplified by V11 is applied to the control grid of V12. The output circuit is similar to that of the voltage section of the regulator. V12 and V13 are the power valves of the circuit which is connected to the auxiliary field winding X–XX of the driving motor, thus providing a buck-boost control of the motor auxiliary field. The main field Z–ZZ is connected to the d.c. supply.

28. If for any reason the motor speed has fallen, there will be a decrease in the supply frequency, a consequent increase in voltage across L2 (a) and a decrease in voltage across L2 (b). It follows that a less negative voltage will be applied to the control grid of V11 which therefore will pass more anode current and apply a greater negative voltage to the control grid of V12. This results in V12 passing less current, and consequently V13 will pass more current; the resultant change in auxiliary field current weakens the motor field and the initial fall in speed is corrected. As a deviation of about 0·5 per cent will cause a complete reversal from maximum bucking to maximum boosting current in the auxiliary field winding, the speed regulation will, under normal operating conditions, be better than 0·5 per cent.

29. The stabilizer network, comprising R26, R27, and R29, together with C16 and C17, associated with the amplifier circuit is employed to reduce hunting to a minimum.

Starting circuit

30. In the starting circuit, a delay of 20 to 30 seconds is allowed for, before the regulator takes full control.

31. During this period, whilst the valves of the regulator are warming, bucking current is passed through the auxiliary field of the alternator in order to reduce alternator voltage to just below normal. The circuit by which this is achieved comprises the rectifier W1, the resistor R20 and a normally closed contact (CR1/3) of relay CR1 connected in series and wired to S2/64 of transformer T3.

32. While the regulator valves are warming, the speed regulator is rendered partly insensitive by the normally open contacts

(CR1/4 and CR1/5) of CR1 in the screen grid circuit of V11 and the anode of V16. About 30 seconds after starting, CR1 operates and the regulator becomes fully operative; the possibility of momentary overspeed is thus avoided.

Time delay circuit

33. To obtain the 20 to 30 seconds delay before the regulator takes full control, an electronic time delay circuit is used. V17 will commence to conduct a few seconds after voltage is applied to the regulator, but the current conducted will at first be small because of the negative voltage applied to the valve grid by virtue of the charging of C24 through R46. The current in CR1 will rise in proportion to the build-up of voltage across C24, until (after CR1 has operated) V17 becomes fully conductive, with its grid connected to its cathode through R46.

34. The initial voltage bucking circuit comprising W1 and R20 is opened by CR1, which also connects the anode of V16 to the screen grid of V11. Pins F and J of the 12-pole plug are connected to a normally open contact (CR1/6) of CR1 which acts as a pilot for a load relay in the alternator output circuit.

Overvoltage and overspeed relay

35. In the event of the alternator voltage or the motor speed becoming excessive, CR2 becomes energized, and its normally closed contacts are tripped. These contacts are connected to pins A and B of the 4-pole plug located on the left-hand side of the 12-pole plug.

36. Referring to fig. 11, relay CR2 is connected to two circuits, one being voltage sensitive, and the other frequency sensitive; the overvoltage and overspeed settings being adjusted on trimmers P5 and P4 respectively. The Metrosil resistance R45, which has a non-linear characteristic, is responsible for the voltage sensitivity of the relay.

37. A capacitor C27 is included in the circuit for test purposes only. The connection of pins A and B of the 4-pole test plug joins capacitor C27 in parallel with capacitor C28 in order to simulate in the series resonant circuit a frequency of about 125 per cent.

38. The resonant frequency of C28 and L1 (b) in the frequency sensitive circuit is higher than the normal frequency (1,600 cycles). The voltage across C28 is approximately equal to that of the supply voltage at normal frequency, and if the frequency rises above normal, the voltage applied to the coil of CR2 rapidly increases, and CR2 becomes energized through W2 and the trimmer resistors.

39. The relay is set to trip at 125 per cent. normal voltage (143V) at normal frequency of 1,600 cycles, 8,000 r.p.m., and at 125 per cent normal frequency (2,000 cycles) with normal voltage (115V).

Additional and variable components

40. A component R7A or R7B is included in parallel with the existing R7, as and if required. This arrangement is necessary in some regulators in order to obtain the desired voltage stability.

41. In most of the early models, the polarity of T2S1 transformer winding is connected as shown in the inset view in fig. 7. Regulators of serial number 4271 onwards have the T2S1 transformer winding connected as shown in the complete wiring diagram (*fig.* 7). This arrangement was found to be necessary in order to improve frequency stability.

42. Some regulators have R44 short-circuited by a soldered wire jumper. During

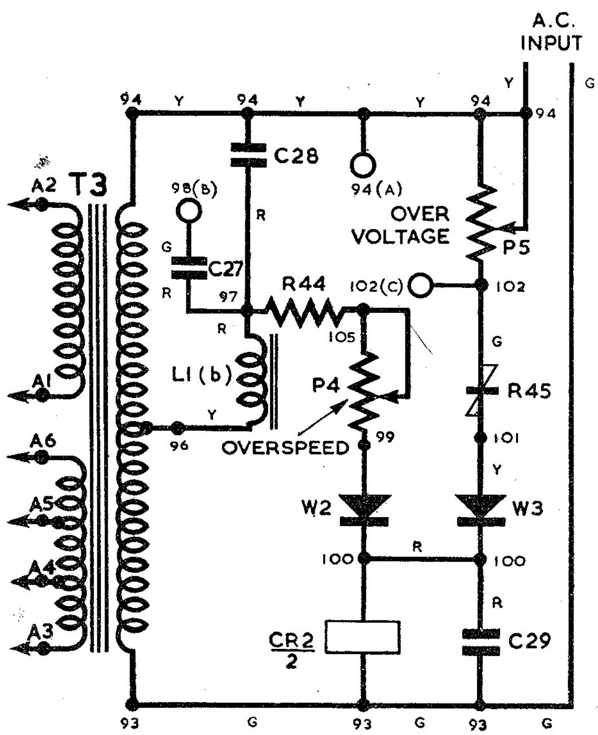


Fig. 11. Circuit diagram of overvoltage and overspeed relay

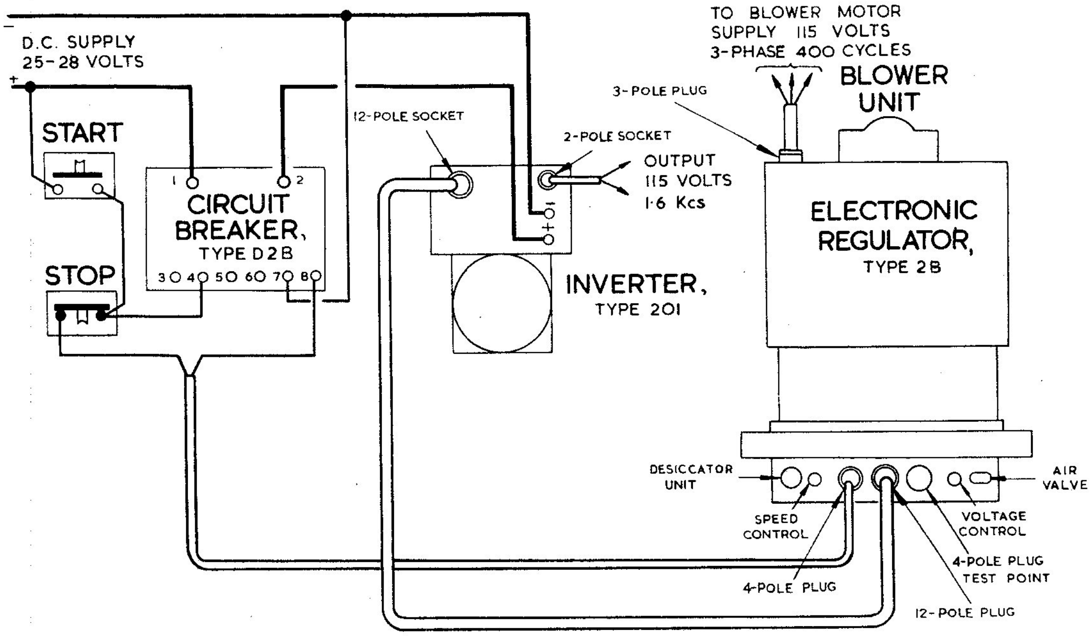


Fig. 12. Inter-connection diagram

manufacture the wire jumper is removed only if the overspeed protective circuit component tolerances all add up in such a way that the protective circuit cannot otherwise be set correctly.

43. Early versions of the regulator had components P4, R44 and C28 with values as follows:—

(1) P4, 10,000 ohms, 2 watt.

(2) R44, 10,000 ohms, $\frac{3}{4}$ watt.

(3) C28, 0·01 μF $\pm$ 20 per cent, 1,000V.

If difficulty is experienced in correctly setting the overspeed protective circuit, these components should be changed to the other values.

INSTALLATION

Before mounting

44. Before mounting, the regulator should be inspected to ensure that all valves are correctly inserted in their holders and that the top caps are connected. This necessitates the removal of the top portion of the container and when re-assembling, care must be taken to avoid damaging the large valves on the upper deck. These valves protrude into cavities in the container, and there is no mechanical guide for protection during assembly.

Mounting

45. The regulator must be secured on anti-vibration mountings bolted to the four lugs on the base casting. It must be mounted with the lugs in the horizontal plane and the axis of the cylinder vertical. The casting carrying the lugs, plugs, etc., must be at the bottom. It is important that this condition is observed or serious overheating will result.

Location

46. To permit free ventilation, the unit must be situated in a position allowing adequate free space round the container.

Connections

47. The plug connections between the regulator and its associated equipment are shown in fig. 12. Two miniature pressurized plugs located round the base casting are used for inter-unit connections; the third is a test plug for overspeed relay. The cable between the 12-pole plug and the inverter must be kept as short as practicable and must not exceed 10 ft.

48. A 3-phase, 400-cycle, 115-volt supply for the blower unit must be connected to the 3-pole plug located on the top of the container (*fig.* 1).

Note . . .
Serious overheating will occur if the regulator is used without the blower unit in operation.

OPERATION

Starting

49. With the regulator and its associated equipment connected as illustrated in fig. 11 the inverter should be started on no load, using the starter-button connected to the circuit breaker.

50. The regulator becomes fully operational approximately 30 seconds after starting has been initiated, and the inverter must not be loaded until this has been achieved. The motor speed will first fall away, and will then rise to the pre-set value, whilst at the same time the voltage will stabilize at 115 volts, R.M.S.

SERVICING

Air conditioning

51. Periodic inspection should be made to ensure that the pressure in the container is maintained at 5 lb. per sq. in., and, when necessary, clean, dry air may be introduced through the air valve, using a hand pump which should incorporate a desiccating unit. It is important that the pressure does not exceed 5 lb. per sq. in. gauge. Excess air may be released by depressing the plunger in the valve.

Desiccator unit

52. When the desiccator unit is in a damp condition (salmon pink), it should be unscrewed from the container. After removal of the Neoprene sealing gasket the unit can be re-activated by heating to approximately 150 deg. C. for a period of two hours.

Voltage and speed settings

53. After initial installation, or subsequent re-installation, attention must be given to the voltage and speed setting.

54. The alternator output must be 115 volts R.M.S. ±1 volt, and the motor frequency 1,600 cycles ±16 cycles, or speed 8,000 r.p.m. ±80 r.p.m.

55. If the voltage or the frequency is outside the limits quoted in the preceding paragraph, adjustment must be made by the use of the external voltage and speed controls which are located at the lower end of the unit just below the securing chain. They may be identified by appropriate labels affixed to the upper container just above the controls. If insufficient adjustment is obtained when using the external speed control, this control should be set to approximately its mid-position and further adjustment made by use of the auxiliary "speed trimmer" which may be seen in the foreground (*fig.* 2).

Voltage

56. Since the regulator controls the R.M.S. value of the alternator voltage, measurements should be taken on a R.M.S. voltmeter (Stores Ref. 5Q/462).

Speed

57. A tachometer on the motor shaft, or a frequency meter on the alternator output may be used to measure the motor speed. As access to the motor shaft entails partial dismantling of the inverter, the use of a frequency meter (Stores Ref. 5Q/181) is preferable.

58. If the regulator is functioning satisfactorily the carrying out of the instructions given in para. 51 to 57 is all that should be necessary.

Transformers

59. Any transformer showing signs of oil leakage must be removed immediately, and a new one fitted. The old transformer should be returned to the appropriate depot for repair.

Valves

60. After fitting new valves it is advisable to carry out tests described under Testing (*para.* 82 *to* 90).

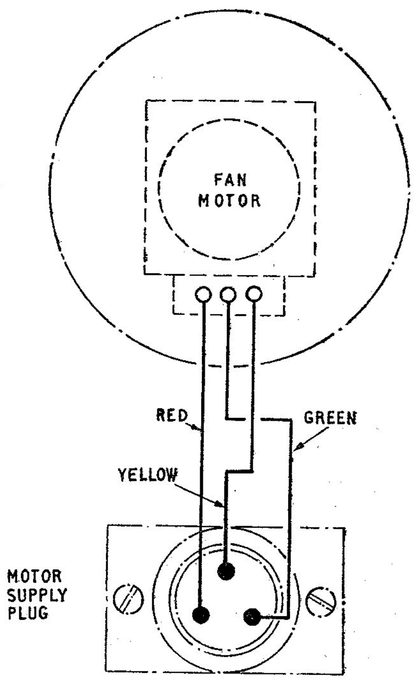


Fig. 13. Electrical connections to fan motor

Fan and fan motor

61. No servicing of the fan is necessary except to fit new parts in place of those which may become damaged.

62. To service the motor it will be necessary to remove it from the upper container cover. Instructions regarding the servicing that should be carried out on the motor will be found in A.P.4343D, Vol. 1, Book 4, Sect. 22. A wiring diagram (*fig.* 13) shows the electrical connections to the fan motor.

FAULTS

63. Should a fault develop, the following paragraphs on Faults and Test Procedure will be found useful. In many cases the fault may be corrected by fitting a new valve or fuse, but it may be necessary to fit new transformers, relays, capacitors, resistors, valveholders, etc. When unsoldering the connections to such components, a soldering iron with a pencil bit must be used. A complete list of components is given in Table 2.

Location of faults

64. When tracing a fault it should be appreciated that the electronic regulator controls both the speed of the motor and also the voltage of the 1,600 cycle alternator. Whilst it is possible for the speed regulator to be defective and at the same time for the voltage regulator to be normal, it is improbable that control of the inverter will be normal if the voltage regulator is defective.

65. A fault in any one of the fourteen valves will upset the performance of the regulator and these are the most probable causes of trouble. Fitting a new valve in place of that which is defective will usually restore performance to normal.

66. In the event of a failure of supply it should not be automatically assumed that the regulator is at fault; the inverter and its associated control box should also be suspect.

Valves

67. Table 1, used in conjunction with fig. 16, will be found helpful when locating defects in the regulator due to valve failure.

Circuit breaker

68. If the circuit breaker connecting the d.c. supply trips as soon as the set gains speed, the d.c. supply connected to the inverter may be of wrong polarity. Should the circuit breaker trip at approximately 10 to 20 seconds after starting, check V1 and F3, and finally the other valves listed in Table 1 (2).

Fluctuating voltage

69. Fluctuations in voltage and speed may be caused by arc flutter in the neon stabilizer V4; it may also result from intermittent shorting of the field windings in the inverter.

General fault finding

70. When the cause of failure is not immediately obvious, it will assist in tracing the fault if the large valves V12 and V13 are removed. By removing these valves the speed regulator is rendered inoperative, and the voltage regulator can be checked on its own. If the voltage regulator functions satisfactorily, the fault probably lies in the speed regulator. Replace V12 and note the performance, and then replace V13 and again note the performance. Should either valve prove faulty a new one should be fitted.

71. When a fault is not easily located, the regulator should be removed from the installation and subjected to tests as described under Testing (*para.* 82 *to* 86).

TABLE 1
Faults and their probable causes

Defect	Possible cause	
	Valve open-circuited	Valve short-circuited
(1) Voltage low, with increase of speed	V5 or V8	V2, V3, V4, V5 or V6
(2) High voltage	V1, V2, V3, V4, V6, or V9	V5 or V6
(3) Low speed with normal voltage	V11, V12, or V16	V12 or V13
(4) High speed with normal voltage	V8, V10 or V12	V11, V12 or V13

Internal short circuits in valves V5, V6, V12 or V13 will blow either F4 or F5

Note . . .
Valves and fuses must not be removed or re-fitted whilst the regulator is alive. Always switch off the inverter before handling any of the regular components.

DISMANTLING

Containers

72. To gain access to the components inside the containers, loosen the adjusting screw at the end of the securing chain and remove the chain. The upper container may then be removed by withdrawing it vertically upwards. Care must be exercised to avoid damaging the electronic valves as there is no mechanical guide for their protection.

73. To remove the chassis from the lower container, remove the four screws which clamp the lower deck of the chassis to the lower container, and withdraw the chassis upwards. In so doing, first ease the front of the chassis upwards in order to disengage the interconnector plug and socket which carries the electrical connections between the chassis and the lower container.

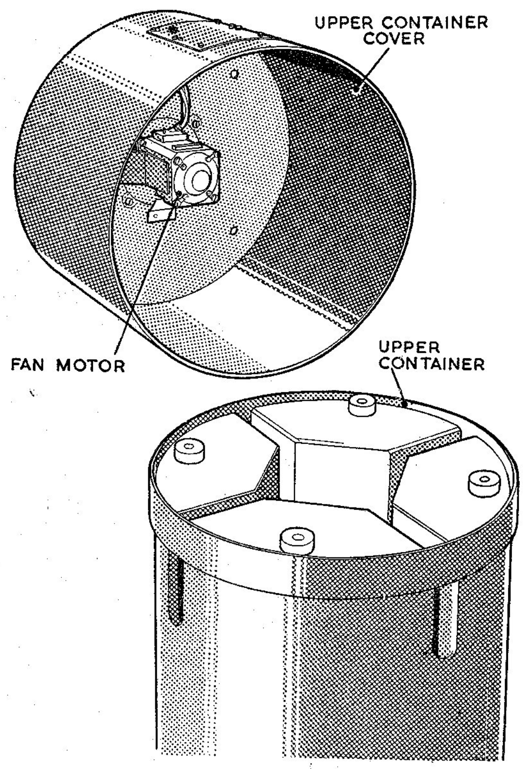


Fig. 15. Upper container with cover removed

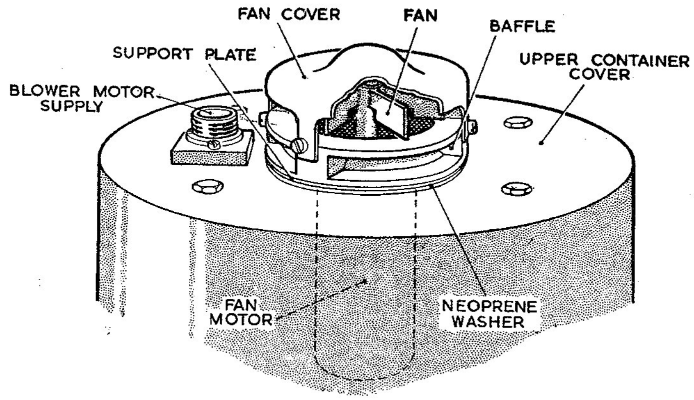


Fig. 14. Blower unit and upper container cover

Upper and lower decks

74. To gain access to the underside of the upper deck and to the transformers on the lower deck, the upper deck is arranged to hinge backwards about two of its supporting pillars when the fixing nuts have been removed from the top of the other three pillars. Flexible cabling is used throughout the regulator to facilitate hinging of the upper deck.

Blower unit and upper container cover (*fig. 14*)

75. To remove the upper container cover complete with the blower unit (*fig.* 15) it is only necessary to remove the four screws from the top of the container; the cover may then be lifted from the container.

76. To remove the blower unit, first remove the fan cover which is secured by four screws. The baffle, which is in two halves, may then be removed by unscrewing the two screws clamping the two halves together, and removing the four screws (inside the container cover) which hold the baffle on to the container cover. The motor, support plate and fan can then be withdrawn from the top of the upper container cover, and the electrical leads should be unsoldered from the motor terminals to enable these parts to be completely detached from the cover.

77. Remove the 2 pins securing the fan to the motor shaft, and pull the fan from the shaft. This will enable the support plate to be removed from the end of the motor.

REASSEMBLING

78. The regulator should be reassembled in the reverse order of the dismantling procedure.

79. When reassembling the blower unit ensure that the Neoprene gasket is fitted between the support plate and the container cover.

Desiccator unit

80. The desiccator unit is removed by unscrewing it from the side of the lower container.

81. When reassembling the unit, ensure that the Neoprene gasket is in position before screwing the unit firmly into the container.

TESTING

82. The following tests are intended to be carried out with the inverter disconnected from the regulator. The provision of a 115-volt, 1,600 cycle supply and a 1,800-ohm load resistance rated at 50 watts is necessary. Such tests as laid down are of assistance in locating faults, checking the regulator before installation after storage, or checking after a complete refit with new valves.

Starting test

83. With the upper container of the regulator removed, connect a 1,800 ohm 50 watt load to pins E and K of the 12-pole plug, with a 250–0–250 milliammeter in circuit. Remove valves V5, V6, V12 and V13 and with all other valves in position apply 115 volts, 1,600 cycles to pins G and M of the 12-pole plug. A direct current of approximately 40 mA. should flow in the load circuit from the instant of application of voltage until relay CR1 operates after about 20 seconds.

Voltage regulator test

84. Leave the connections as for para. 83 but refit valves V5 and V6. With 115 volts, 1,600 cycles applied as before, it should be possible, after approximately 30 seconds, to swing the current in the load circuit over a range of about $+120$ mA to -120 mA by means of the voltage control trimmer P1.

Speed regulator test

85. Disconnect the load from pins E and K of the 12-pole plug (*para.* 83) and re-connect to pins D and B. With valves V5 and V6 removed, and all other valves in position, apply 115 volts, 1,600 cycles to pins G and M of the 12-pole plug. After 30 seconds, it should be possible, by adjustment of the speed control trimmers P2 and P3 (see also para. 55), to swing the current in the load circuit over a range of approximately $+120$ mA to -120 mA.

Overvoltage and overspeed relay setting

86. Test the settings of the overspeed and overvoltage relays as follows:—

(1) Remove all valves from the regulator and connect a 1,600 cycle supply from a variable source to pins G and M of the 12-pole plug, and a continuity meter to pins A and B of the 4-pole plug located on the left-hand side of the 12-pole plug.

(2) Join pins A and B of the 4-pole plug on the right-hand side of the 12-pole plug and check that relay CR2 operates when the voltage is slowly raised to 115 volts. Adjust the trimmer P4 if necessary. An operating voltage of between 105 and 115 volts is permissible if the higher value cannot be obtained by adjusting P4. The reason for adjusting P4 at this stage is explained in para. 37. It is important that for this test the frequency of the supply is 1,600 cycles $\pm$ 1 per cent.

(3) Remove the connections between pins A and B, and with the frequency again at 1,600 cycles $\pm$ 1 per cent, check that CR2 operates when the voltage is raised to 144 volts R.M.S. To obtain the correct operating voltage, adjust, using trimmer P5. It is important that the voltage should not be allowed to exceed 115 volts for more than a few seconds.

(4) Repeat tests (1) and (2) until the accuracy of the setting is within $\pm$ 1 per cent of the required value for applied voltage.

Air seal test

87. To test the container to ensure that it is air-tight, protective caps should be screwed over the plugs in the base, the pressure seal securing chain firmly tightened up, and the container charged with clean, dry air to a pressure of 20 lb. per sq. in.

88. To test the pressure seal and the lower portion of the container, lower the regulator (in an upright position) into water until the water level rises to an inch above the securing chain. When thus submerged, there should be no visible signs of leakage from the regulator.

89. When checking the upper portion of the container for leakage, take out the four fixing screws on the top of the cover and remove the cover, together with the blower unit. The whole container may then be submerged in water.

90. After the test has been completed, release the air pressure to 5 lb. per sq. in.; it is dangerous to fly the regulator with an internal pressure greater than 5 lb. per sq. in. (gauge) measured at ground level.

Note . . .

The greatest care must be taken to ensure that no moisture enters the regulator. If, during the tests, it is suspected that any moisture has entered, the unit must be thoroughly dried out and re-tested before it is put into service.

COMPONENT VALUES

91. The information contained in Table 2 is for reference only; it does not necessarily follow that all the quoted components are included in the R.O.S.

TABLE 2

Components and their values

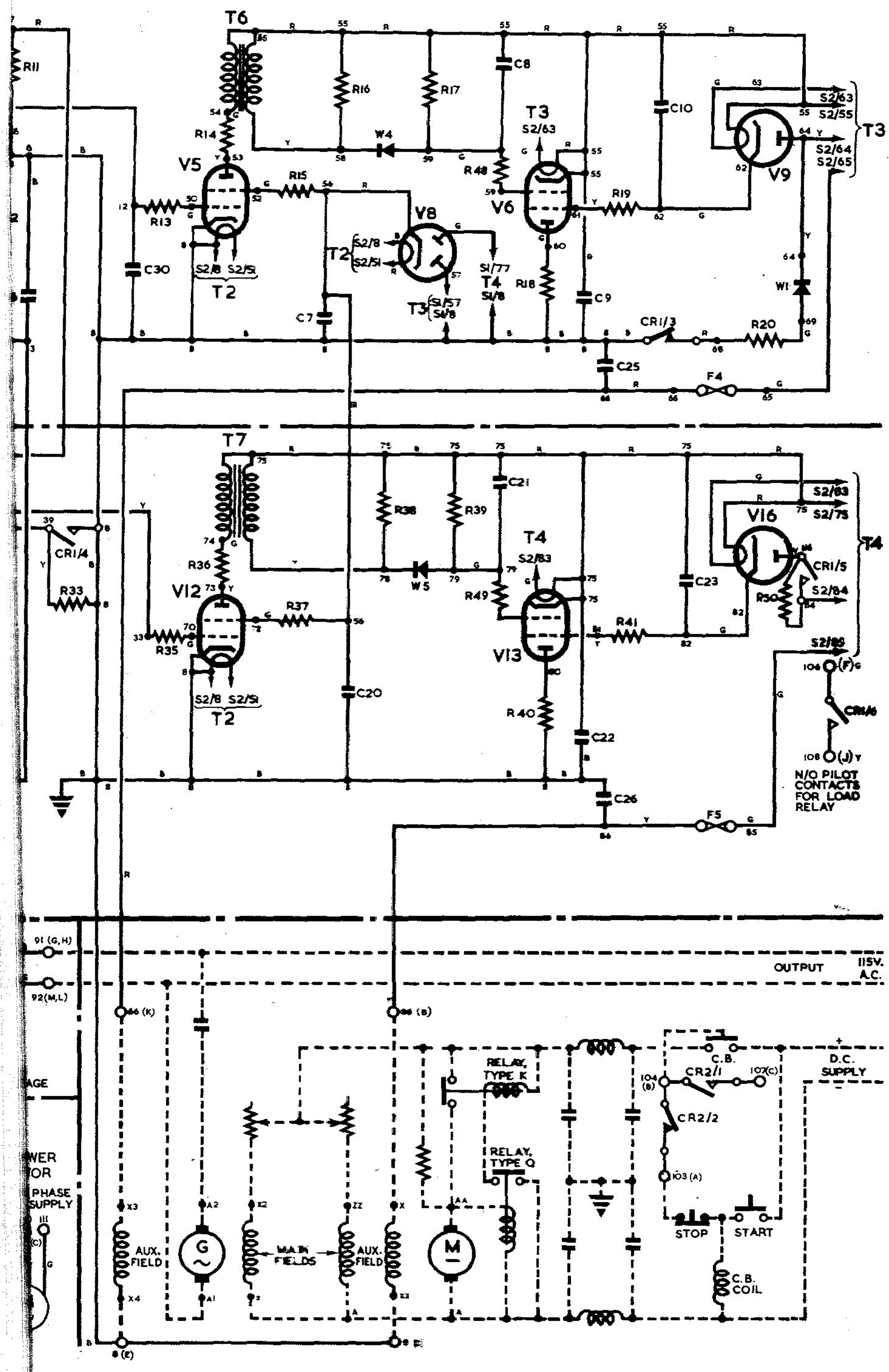
Components	Component No.	Type	Ref. No.
Transformers	T.1	MD342C	5UC/5246
	T.2	MD343C	5UC/5247
	T.3	MD344C	5UC/5248
	T.4	MD345C	5UC/5249
	T.5	MB447C	5UC/5250
	T.6, T.7	Parmeko	5UC/5251
Choke	L.1	MR361C and MR362C	5UC/5531
Saturable reactor	L.2	MR363C	5UC/5530
Rectifiers	W1, 2, 3, 4, 5	T5D42	10D/9752191
Relays	CR1	M1102	5UC/5407
	CR2	M1068	5UC/5244
Condensers	C1, 6	1 μF 350 V	10C/9115571
	C2	0·25 μF 350 V	10C/9115589
	C3, 4, 5, 14, 15	0·05 μF 350 V	10C/9115596
	C7, 10, 20, 23	0·01 μF 500 V	10C/9115546
	C8, 21	0·02 μF 350 V	10C/9115595
	C9, 22	0·005 μF 1,000 V	10C/9115582
	C11, 12, 13	0·0033 μF 350 V	10C/9124725
	C16	0·5 μF 150 V	10C/9115566
	C17, 24	0·5 μF 350 V	10C/9115591
	C18, 19, 29	0·2 μF 150 V	10C/9115572
	C25, 26	0·25 μF 500 V	10C/9115590
	C27	0·005 μF 500 V	10C/9115545
	C28*	0·01 μF ±5 per cent 1,000 V	10C/19930
	C30	0·001 μF 500 V	10C/9115543
Potentiometers	P1	500 ohms 3 W	10W/18302
	P2	30,000 ohms 3 W	10W/18303
	P3	30,000 ohms 2 W	10W/18301
	P4*	30,000 ohms 2 W	10W/18301
	P5	10,000 ohms 2 W	10W/18300
Resistors	R1	9 ohms	5UC/5218
	R2, 3	51,000 ohms ±2 per cent ¾ W RC2–C	10W/9216382
	R4, 8, 26	100,000 ohms ½ W RC7–J	10W/9223938
	R5, 7, 23, 24, 29	220,000 ohms ½ W RC7–J	10W/9223080
	R7A*	1 megohm ¼ W RC7–K	10W/9223163
	R7B*	470,000 ohms ¼ W RC7–K	10W/9223121
	R6, 28, 47	10,000 ohms ¼ W RC7–K	10W/9222130
	R9	3,900 ohms ½ W RC7–J	10W/9222080
	R10, 22, 25, 32	4,700 ohms ½ W RC7–J	10W/9222215
	R11	8,200 ohms ½ W RC7–J	10W/9222122

TABLE 2—*continued*

Components	Component No.	Type	Ref. No.
	R12	33,000 ohms 6 W RWV4–L	10W/9244141
	R13, 35, 48, 49	100,000 ohms $\frac{1}{4}$ W RC7–K	10W/9223037
	R14, 18, 36, 40	22 ohms 3 W RWV4–J	10W/9243317
	R15, 19, 37, 41	1,500 ohms 3 W RWV4–J	10W/9244209
	R16, 38, 50	82,000 ohms $\frac{3}{4}$ W RC7–H	10W/9223030
	R17, 39	82,000 ohms $\frac{1}{2}$ W RC7–J	10W/9223029
	R20	680 ohms 6 W RWV4–J	10W/9243178
	R21	47,000 ohms 6 W RWV4–L	10W/9244150
	R27	1 megohm $\frac{1}{4}$ W RC7–K	10W/9223163
	R30	100,000 ohms $\frac{3}{4}$ W RC7–H	10W/9223039
	R31	2,200 ohms $\frac{1}{4}$ W RC7–K	10W/9222046
	R33	470,000 ohms $\frac{1}{4}$ W RC7–K	10W/9223121
	R34	33,000 ohms ±5 per cent $\frac{1}{2}$ W RC3–M	10W/9219222
	R42	3,300 ohms $\frac{3}{4}$ W RC7–H	10W/9222069
	R44*	15,000 ohms $\frac{3}{4}$ W RC7–H	10W/9222153
	R45	2·5 mA at 50 V (Metrosil)	5UC/5673
	R46	1·5 megohms $\frac{3}{4}$ W RC7–H	10W/9223186
Fuses	F1, 2	5 amp.	10H/9590112
	F3, 6	100 mA	10H/10152
	F4, 5	500 mA	10H/9590108
Rectifier valves	V1, 8, 9, 16	CV493	
Control diode	V2	CV430	
Pentode valves	V3, 11, 17	CV138	
Voltage stabilizer	V4	CV449	
Tetrode valves	V5, 6, 12, 13	CV345	
Double diode	V10	CV140	
Fan motor		B.T.H. LK604–A6	5UD/6120

***Note . . .**
For information regarding these components refer to para. 40 *to* 43.

P29356 361590/2358 5/59 1875 C & P Gp 375



regulator, Type 2B Fig. 16

T E D

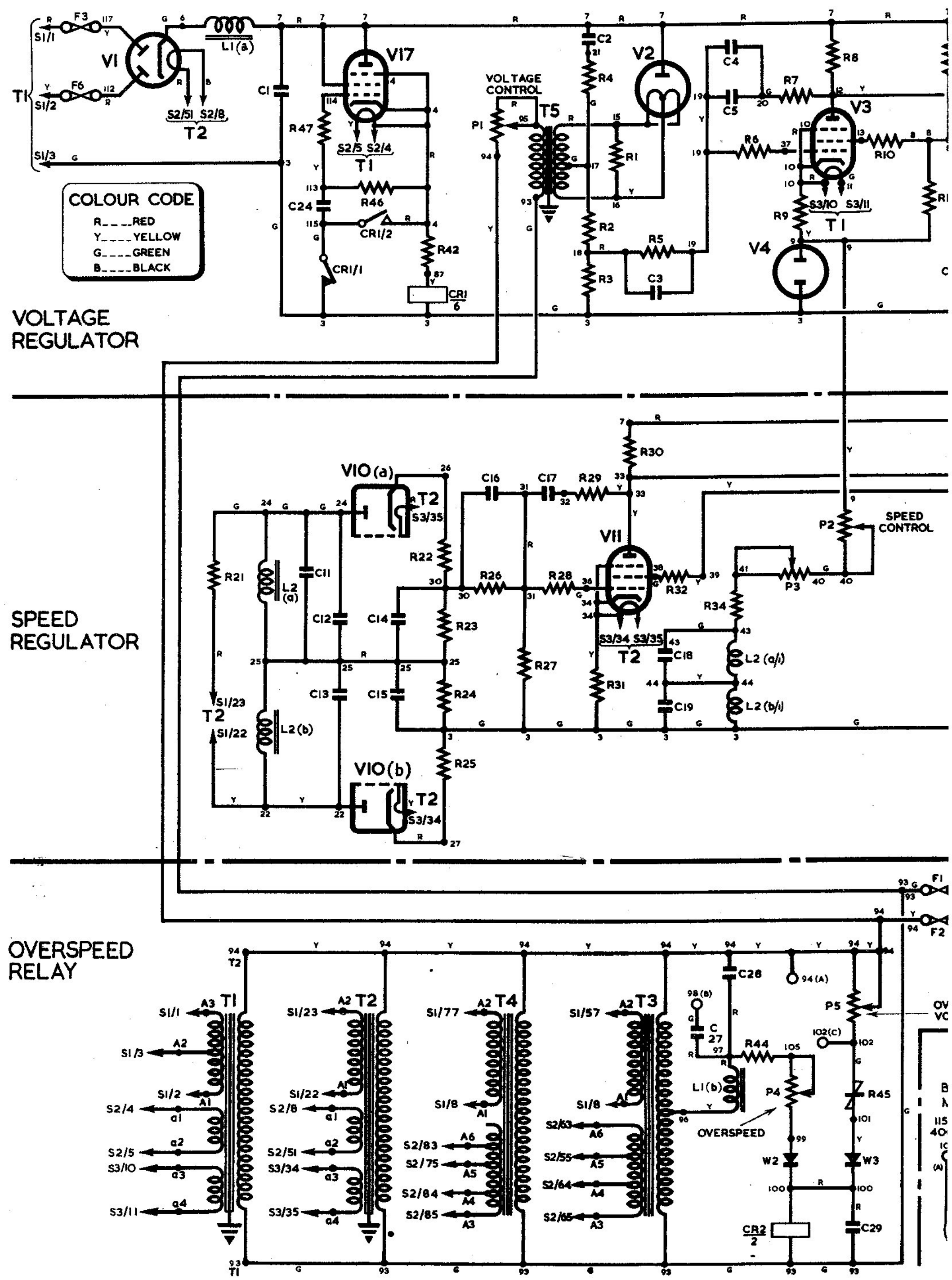


Fig.16 **Circuit diagram - Electroni**

F.S./12 **R E S T R I**

PP8523 361591/2359 4/59 1756 C & P Gp. 924 (4)