Chapter 1

SINGLE CHANNEL TESTER, TYPE ET.60.1

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LEADING PARTICULARS

Single channel tester, Type ET.60.1 .... **Ref. No. 26DM/95105**

Dimensions:

Height	5 *ft.* 5 *in.*
Width	6 *ft.* 0 *in.*
Length (towbar up)	14 *ft.* 0 *in.*
Length (towbar down)	17 *ft.* 0 *in.*

Introduction

1. This unit is designed to simulate one of the aircraft electrical generating systems normally powered by a main turbine. It enables the electrical equipment in the aircraft to be functionally checked under subnormal, normal and overspeed conditions without the need of running the aircraft turbine. It also provides facilities for aircraft a.c. generator testing and for operating a suspect TRU.

DESCRIPTION (*fig.* 1 *and* 2)

General

2. The test rig is mobile and consists of a six-wheeled chassis upon which are mounted the d.c. main driving motor and its associated mains rectifiers, a control and instrument panel, two separate air blowers, a separate motor generator set, aircraft generator mounting and drive. The equipment is protected by a sheet metal canopy which is provided with steel roller shutters.

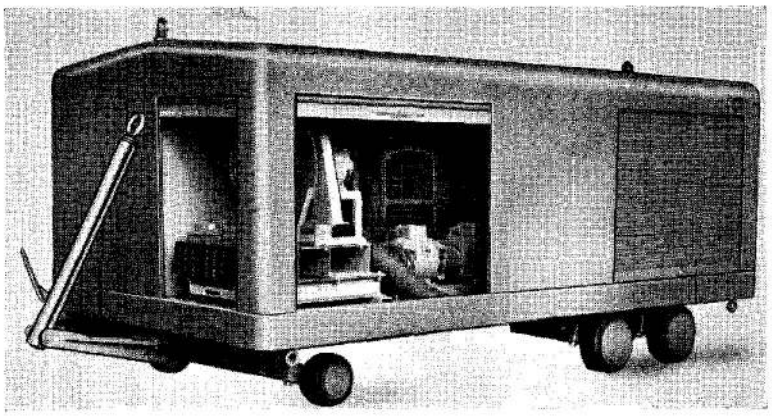

Fig. 1. Single channel tester, left-hand side

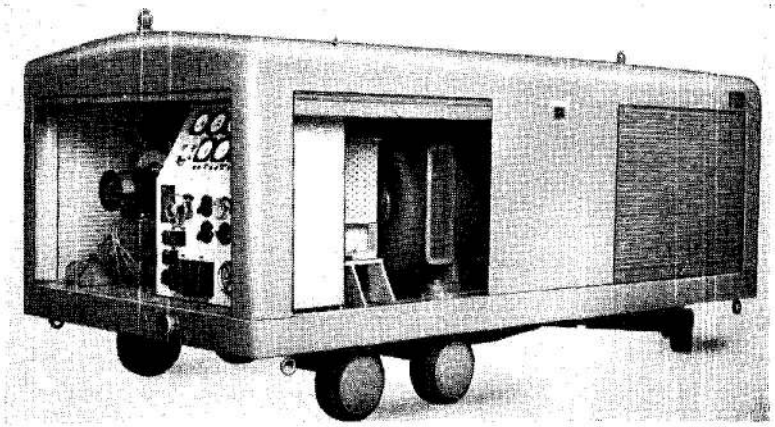

Fig. 2. Single channel tester, right-hand side

Chassis

3. The trailer is of fabricated steel construction and has turntable steering and a towing arm on the front pair of wheels. Suspension is by torsion rubber mounted stub axle units, with fabricated steel wheels and solid tyres. The rear wheels have internal expanding brakes operated from a hand brake on the front right-hand side of the trolley.

Canopy

4. The sheet metal canopy is surmounted by obstruction lights, one at each end. The steel roller shutters, fitted two on each side and one at each end, roll up to give access to the equipment. Both shutters on the right-hand side of the machine can be bolted in the lowered position and should normally be secured in this manner whilst power is supplied to the trolley.

Mains supply

5. The 400V, 3-phase, 50 c/s, supply is introduced to the unit via an industrial type plug mounted on the rear of the trolley, and a mating free socket. In the trolley it is conducted via a mains rotary isolator and protecting fuses to the rectifier equipment, motor-generator set and the two cooling air fans.

Rectifier bank (*fig.* 3 *and* 4)

6. The rectifier bank and its associated control gear is situated on the front right-hand side of the trolley within a rectangular angle iron frame. This rectifier bank employs six Nevitron Single Anode mercury arc rectifier tubes mounted on the bulb tray and connected in a 3-phase bridge to produce the d.c. supply for the main driving motor.

7. Associated with the bulb tray and mounted within the frame work of the rectifier bank are a number of ancillary units.

(1) Auxiliary transformer
(2) Anode and cathode exciter units
(3) Grid control unit
(4) Control circuit rectifier
(5) Bias rectifiers
(6) Over-voltage relay panel
(7) Main contactor panel

Bulb tray

8. The bulb tray, accessible through the front right-hand shutter, is surmounted by the six symmetrically disposed mercury arc rectifier bulbs. Between the bulbs is a cooling air fan. On the side of the tray are mounted the excitation current limiting resistors, the dipper current limiting resistors, the six anode fuses and four exciter cathode fuses (exciter cathode fuse CF4 being common to bulbs 4, 5 and 6).

Mercury arc rectifiers (*fig.* 5)

9. Each individual tube is retained on the

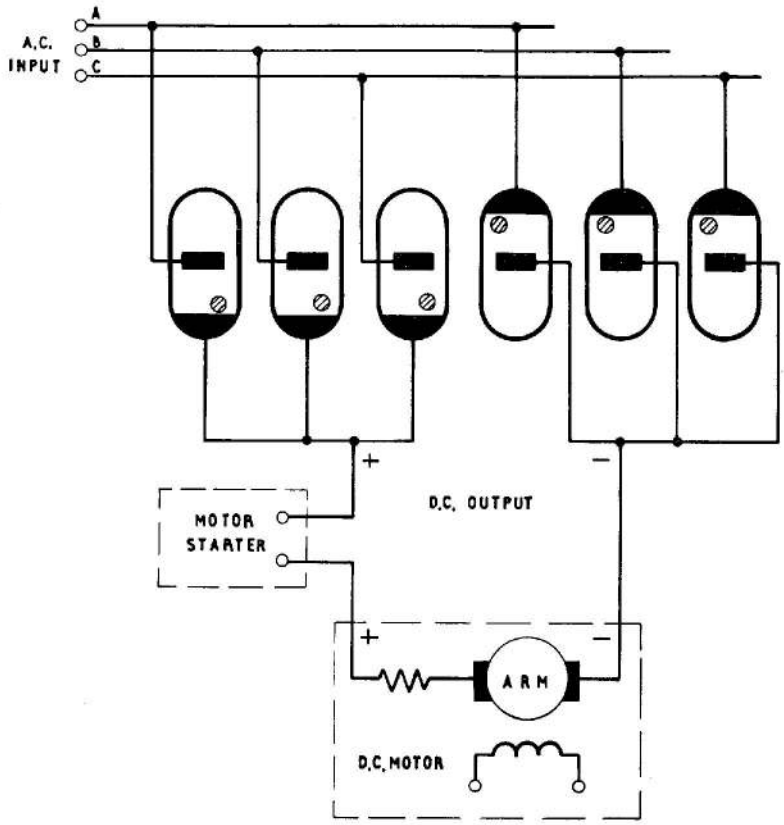

Fig. 3. Rectifier connections, schematic

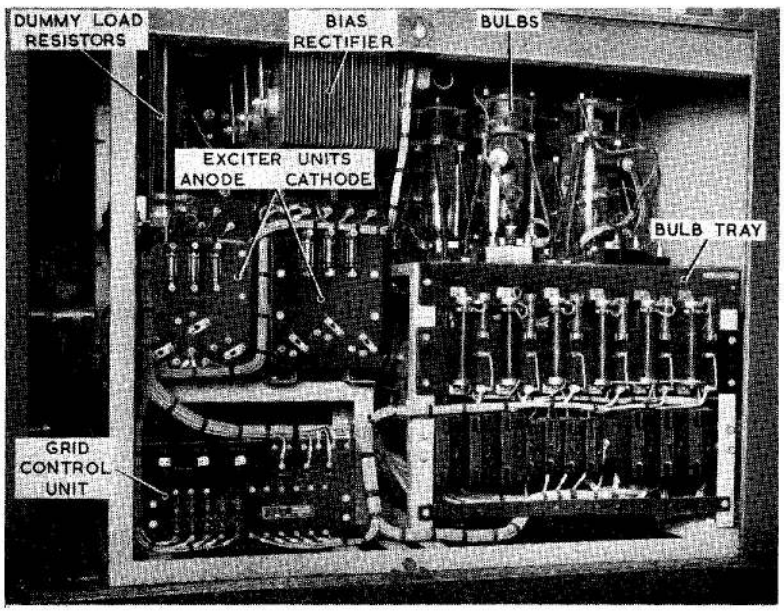

Fig. 4. Rectifier bank

bulb tray by means of an insulated socket. The starting and holding coil on each bulb is retained by three supporting legs.

10. The electrical leads for the control circuits are contained in a harness, the free end of which is terminated in a four-pole plug mating with a socket on the bulb tray. Both the main anode and main cathode connections are by short braided flexible copper leads connected to terminals on the bulb tray.

Auxiliary transformer

11. The auxiliary transformer is situated on the lower inboard side of the rectifier bank. It is a 3-phase transformer with a primary and eight secondary windings providing a 3-phase electrical supply of the appropriate voltage for the rectifier cooling fan, exciter units, grid control unit, control circuit rectifier, bias rectifiers, and the motor control circuit rectifiers on the main contactor panel.

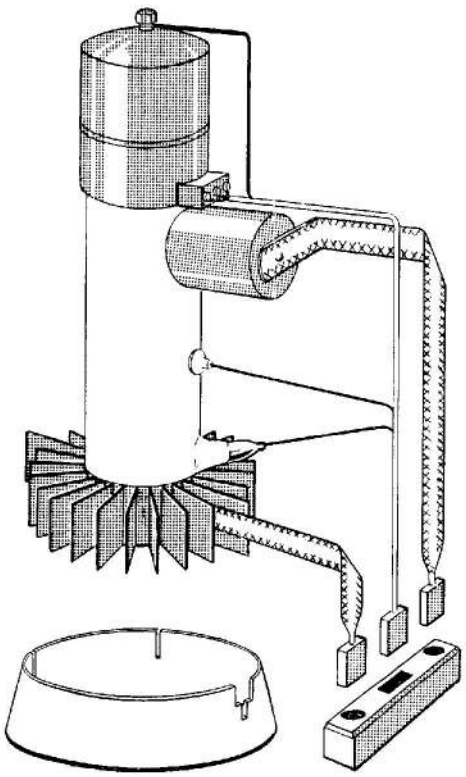

Fig. 5. Rectifier tube

Anode and cathode exciter units

12. These units, situated on the right-hand side of the rectifier bank, are transformer rectifiers. One unit provides a d.c. supply for the excitation of the three rectifier bulbs forming the anode in the bridge (bulbs 1, 2 and 3), whilst the other performs a similar function for bulbs 4, 5 and 6 which are the cathode of the bridge.

Grid control unit and bias rectifiers

13. The grid control unit governs the positive pulses to the grids of the tubes from the bias rectifiers. The mode of control employed is that of the peaking transformer fed from the auxiliary transformer. The peaking transformers have control coils by means of which the relative phase of the grid impulses with respect to the a.c. input waveform can be varied to alter the mean d.c. output voltage of the rectifier bank.

Control circuit rectifier (CCF)

14. This rectifier provides a d.c. supply for the control windings on the peaking transformers in the grid control unit. The voltage levels from the rectifier bank to the control windings and hence the relative phase and mean d.c. output voltage from the main mercury rectifiers, is controlled by means of the grid control potentiometer STARTER REC. GRID CONTROL, mounted on the control panel. The need to incorporate this facility, by means of which the mean d.c. is variable from almost zero to maximum, is discussed in para. 41.

Over-voltage relay panel (fig. 6)

15. This panel is situated on the inboard side of the rectifier bank. In the event of an over-voltage condition arising in the main d.c. output to the driving motor, the over-voltage relay causes the motor speed to remain virtually constant at the desired value.

Main contactor panel (fig. 6)

16. This panel, also situated on the inboard side of the rectifier bank, mounts the main contactor for controlling the d.c. supply to the motor, the auxiliary relay referred to in para. 15, the main contactor, overload protection device and a single phase bridge rectifier (MCCR) and its associated fuses for the auxiliary and main relays.

Driving motor

17. The main driving motor is a d.c. con-

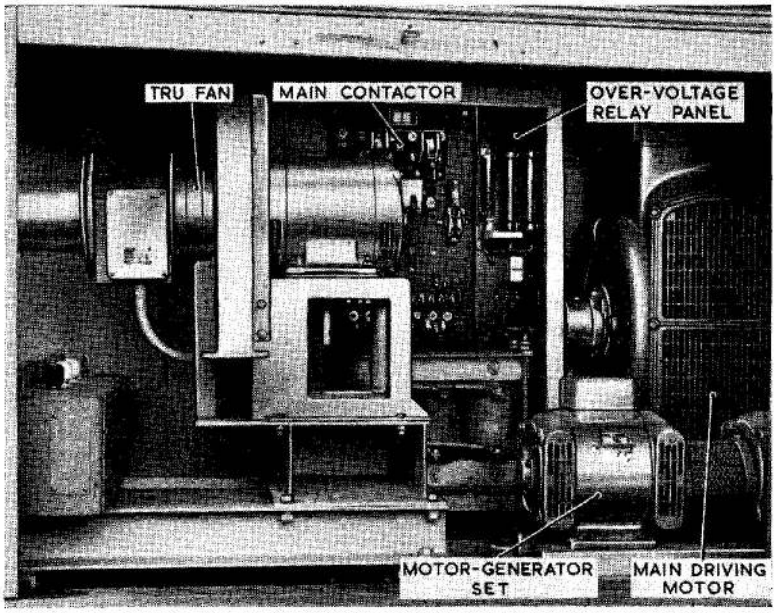

Fig. 6. Rectifier bank, inboard side

pound wound, totally enclosed machine, designed for use with the rectifier. The speed of the motor is varied between 750 and 1500 rev./min. by means of the shunt field regulator mounted on the control panel. It is rated at 50 b.h.p. for one hour and 70 b.h.p. for ten minutes throughout its speed range.

18. The motor is foot mounted on the right-hand side of the trolley and has a tachometer generator mounted on the non-drive end. On the drive end a six pin flexible coupling connects the motor to the low speed shaft of the speed increasing unit.

Speed increasing unit (*fig.* 7)

19. The speed increasing unit utilises pulleys and belt. On the motor shaft the pulley is 18 in. in diameter, the high speed shaft pulley is of $2\frac{1}{2}$ in. diameter giving a final rated maximum speed of 10,800 rev./min.

20. The distance between centres of the pulleys is of necessity very short and consequently, to make the belt drive, the static tension on the high speed shaft bearings is greater than is desirable to apply to the shaft continuously when standing. Further, there is very little automatic accommodation of belt stretch with the short centred pulleys. To overcome these difficulties a pivoted high speed shaft is used, designed to provide automatic adjustment of the belt tension according to load. This gives the high speed bearings the least possible load under any condition of speed and power, and accommodates belt stretch due to load changes and climatic variations.

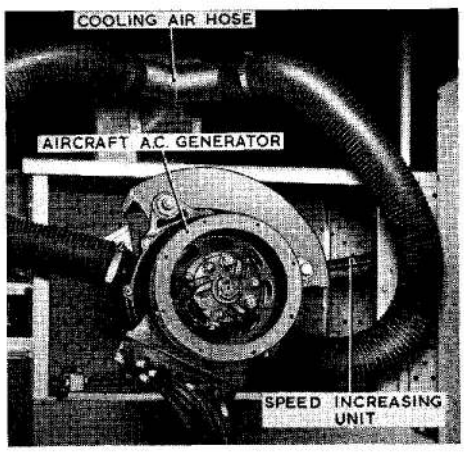

Fig. 7. Speed increasing unit

21. The high speed shaft terminates in a high speed coupling suitably broached to receive the splines of the aircraft a.c. generator drive shaft. Two bolts are attached to the high speed shaft bracket to facilitate mounting the aircraft a.c. generator, and a manacle clamp secures the flange of the generator to an oil reservoir which lubricates the a.c. generator driving-end oil seal.

Terminal boxes

22. A terminal box (*fig.* 8) on the floor on the left-hand side at the rear of the trolley is fitted to accommodate the electrical connections from the aircraft a.c. generator The terminals of this box are directly connected to a similar fused terminal box (*fig.* 9) at the front of the trolley which also houses two current transformers; one for 208V line current and the other for the 104V line current.

23. The terminal box at the front of the trolley is provided for connecting the aircraft TRU to the trolley. The TRU may be fitted in the aircraft or mounted on a withdrawable tray situated below the terminal box.

Cooling air fans

24. Two cooling air fans are fitted to the trolley. One, mounted above the speed increasing unit, provides air for the aircraft a.c. generator, replacing the natural draught available when the aircraft is flying. It has an output of 300 cu. ft./min. at 6 in. s.w.g., being connected to the alternator by means of two flexible hoses joined at the fan by a Y connection.

25. The other fan, mounted forward on the left-hand side cools the aircraft TRU and operates on the suction principle, drawing air at 350 cu. ft./min. at 3 in. s.w.g. through the TRU. A length of flexible air hose is provided, with adapters, to enable the fan to be connected to a TRU either in the aircraft or on the trolley mounting tray.

26. Both cooling fans are fitted with air failure switches and relays connected in the operating coil circuit of the main motor starter. In the event of an air supply failure of the aircraft a.c. generator fan, or of either fans when a TRU is being used, the main motor will be stopped or be prevented from starting if stationary, thereby giving

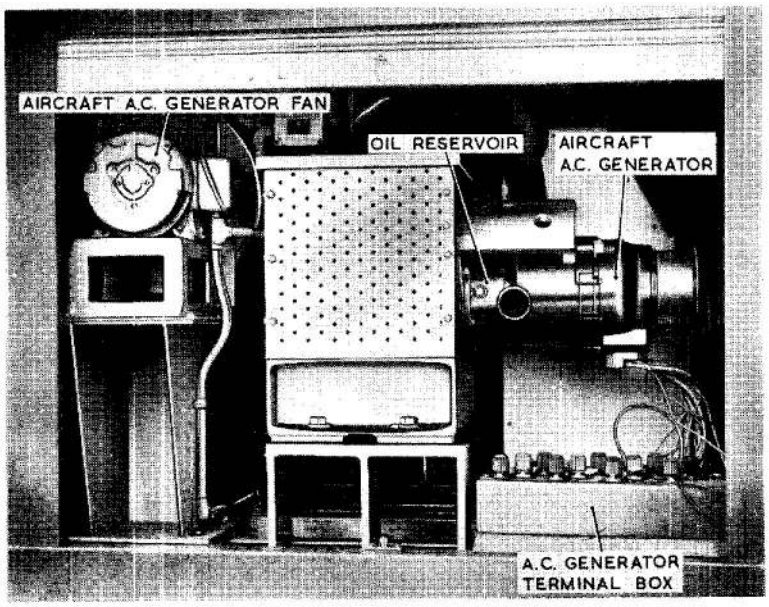

Fig. 8. Aircraft generator mounting facilities

protection against overheating of either the alternator or TRU.

Motor generator set

27. When it is required to run an aircraft a.c. generator on the trolley, but it is not required or convenient to use a TRU for excitation, a separate source of excitation must be used. To meet this requirement a motor generator set (*fig.* 9) is mounted on the left-hand side of the trolley and provides a 28V d.c. supply. The output from the generator is controlled by means of a hand operated shunt field regulator mounted on the control panel.

Lights

28. Four lights are fitted under the canopy for illumination and two obstruction lights are fitted on the outside of the canopy, one at each end. All the lights are supplied from a single-phase 400V/25V transformer mounted in the control panel and fed via 2-pole switch and fuses from two lines of the mains input supply on the live side of the ISOLATOR. The interior lights are connected in parallel to the secondary of the transformer and are controlled by a separate single-pole switch on the control panel. The two obstruction lights are connected in series to the transformer secondary and in addition to a single-pole on/off switch have a flasher unit incorporated in the circuit; both the switch and flasher unit are mounted on the control panel.

Control panel (*fig.* 10)

29. The control panel, of sheet metal construction, is situated at the rear of the trolley and mounts the manual controls for the electrical equipment, the main fuses, isolator, fan and motor-generator set circuit breakers, instruments and indicators. The main controls and instruments are:—

(1) Ammeter 0-60A, ALTERNATOR EXCITATION, measures the d.c. excitation in the windings of the aircraft a.c. generator.

(2) Ammeter 0-150A, MAIN MOTOR, indicates the d.c. current consumption of the driving motor.

(3) Ammeter 0-100A, 208V WINDING, measures the 200V output line current and is operated from a current transformer situated in the TRU terminal box.

(4) Ammeter 0-100A, 104V WINDING, performs a similar function in the same manner as (3) but for the 104V output from the a.c. generator.

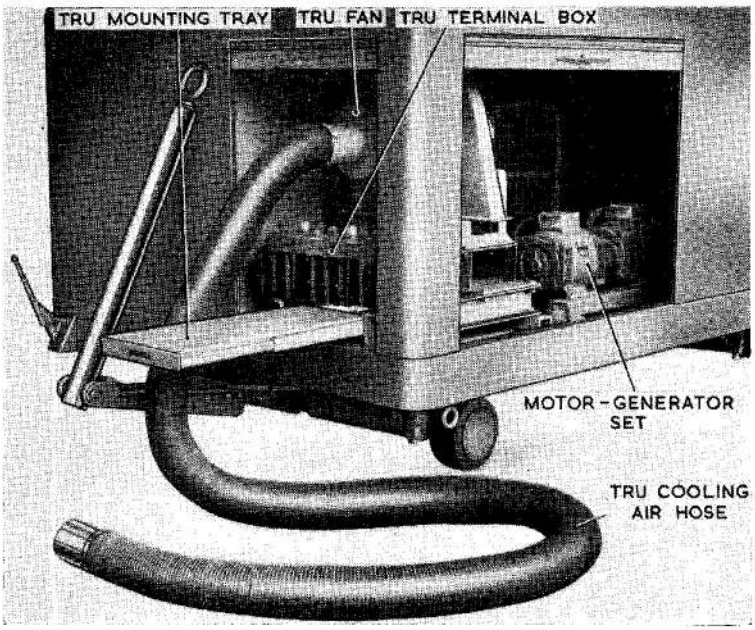

Fig. 9. TRU mounting facilities

(5) TACHOMETER, calibrated 150-650 c/s and 3,000 to 13,000 rev./min. is driven by the output from the tachometer generator fitted to the non-drive end of the main driving motor.

(6) Voltmeter and fuses, 0-600V, MAIN MOTOR, measures the main rectifier d.c. output voltage to the driving motor.

(7) Voltmeter and fuses, 0-250V, 208v WINDING, indicates the output voltage of the 200V a.c. generator windings.

(8) Voltmeter and fuses, 0-120V, 104v WINDING, performs a similar function but for the 104V windings as (7).

(9) Four neon indicating lights are mounted on the control panel with their associated fuses and are marked:

(a) DRIVE RUNNING, fitted with an amber lens, indicates when burning that the voltage output from the main rectifiers has been increased sufficiently, by means of the grid control potentiometer, to start the driving motor.

(b) MAINS ALIVE, fitted with a clear lens, indicates when lit that the main isolator is closed.

(c) ALT. AIR, fitted with a red lens, indicates when lit that the a.c. generator cooling air fan is inoperative.

(d) TRU. AIR, fitted with a red lens, performs the same function as (c) for the TRU cooling air fan.

(10) Push buttons START and STOP for the main contactor.

(11) The light switches on the control panel for the interior lights and obstruction lights are marked INT. LIGHTS and OBSTRUCTION LIGHT respectively.

(12) The motor speed is adjusted by means of the MOTOR SPEED controls, two con-

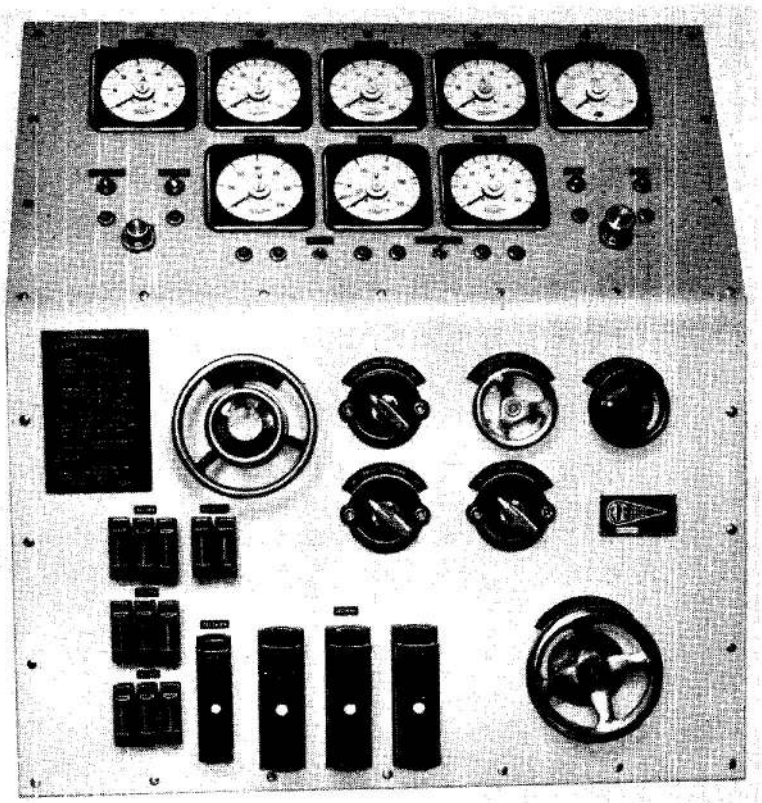

Fig. 10. Control panel

centrically mounted hand wheels, the larger being the coarse and the smaller the fine or vernier control, operating potentiometers CFR and VFR respectively.

(13) EXCITER SELECTOR, this switch determines whether the motor generator or the TRU cooling air fan operates depending upon the switch position, INT. or TRU respectively.

(14) The STARTER REC. GRID CONTROL, connected to potentiometer GCP, adjusts the output voltage of the main rectifiers and is used for increasing the voltage to start the motor.

(15) When the motor-generator set is running the d.c. voltage output is controlled by the generator field regulator marked INT. ALT. EXCITATION.

(16) BOOST EXCITATION switch, connected in the aircraft a.c. generator booster winding circuit; the anticipated design requirement for this switch has not arisen and it should be left in the ON position.

(17) The LIGHT SUPPLY switch is a 2-pole on/off switch and is connected in the primary circuit of the lighting transformer and must be put in the ON position before either the internal or obstruction lights will light.

(18) The incoming mains supply to the trolley is controlled by the 3-pole rotary switch designated ISOLATOR.

(19) On the side current transformers for short circuit zero power factor tests on a.c. generators are fitted; these are for use in conjunction with a test meter Type F.

Protective devices

30. In additon to the main input fuse individual sections of the circuit are protected by fuses, see Table 1. Other protective devices include an interlock on the STARTER REC. GRID CONTROL potentiometer such that the main contactor cannot be closed unless GCP is in the minimum position; failure of cooling air to the a.c. generator on test or the TRU when used, will stop or prevent the starting of the main motor. All rotary equipment have no-volt releases and over-current trips in their respective control circuits.

Table 1

List of fuses

Circuit reference	Designation	Situated	Type	Rating A
	Incoming	Control panel	Slydlock G	100
	Output 208V	TRU terminal box	Slydlock G	100
	Output 104V	TRU terminal box	Slydlock G	100
	Output 65V	TRU terminal box	Slydlock G	60
	Excitation	Control panel	Slydlock G	60
	Alternator fan	Control panel	Slydlock H	15
	TRU fan	Control panel	Slydlock H	15
	M/G set	Control panel	Slydlock H	15
	Auxiliary lights	Control panel	Slydlock H	15
	Instruments	Control panel	B. Lee	0·5
	Indicator lights	Control panel	B. Lee	0·5
AF	Anode fuse	Bulb tray	E.E. TC100	100
Ex. UF	Exciter unit fuse	Exciter units	E.E. T1A10	10
CF	Exciter cathode fuse	Bulb tray	E.E. T1A15	15
FF	Rectifier fan fuse	Bulb tray	E.E. T1A15	15
CFF	Control circuit fuse	Rectifier contactor panel	Rewireable	10
	250V a.c. (A.B.C.)	Grid control unit		
	125V a.c. (D.E.)	Grid control unit		

OPERATION (*fig* 16)

Mains supply

31. With the electrical mains connected to the input plug a supply is available to the ISOLATOR and to the light supply switch. Closing the ISOLATOR conducts the mains input via the incoming fuses to the main rectifier bank, the alternator fan circuit breaker, the TRU fan circuit breaker, the motor generator set circuit breaker, and to the MAINS ALIVE indicator lamp causing it to strike.

Mercury arc rectifiers (*fig*. 15)

32. With the mains supply connected to the main rectifier bank the starting electrode in each of the tubes is lifted clear of the mercury pool to establish an arc to the exciter anode. By pressing the START button, provided certain circuit conditions prevail, the main contactor will close and the arc in the tubes will transfer on load to the main anode.

3. The voltage output from the main rectifier is low under these conditions as the GCP is in the minimum position retarding the instant of application of the grid impulses. Rotating the GCP in the increase volt direction, causes the voltage in the control coils of the peaky transformers to rise advancing the instant of application relative to the incoming a.c. waveform of the grid impulse. This effectively increases the d.c. ouput on the rectifier which is applied via the main contactor to the main driving motor causing it to rotate. With the GCP in the maximum position the maximum d.c. output of 490V from the rectifiers is achieved.

Main contactor panel (*fig*. 11)

34. The main contactor can be closed when the START button is pressed only if the safety interlock contacts (operated by GCP being in the minimum position) are closed, and if the air fail contacts (operated by the air draught from the TRU and/or the a.c. generator cooling air fans) are closed. The overload relay contacts must also be closed.

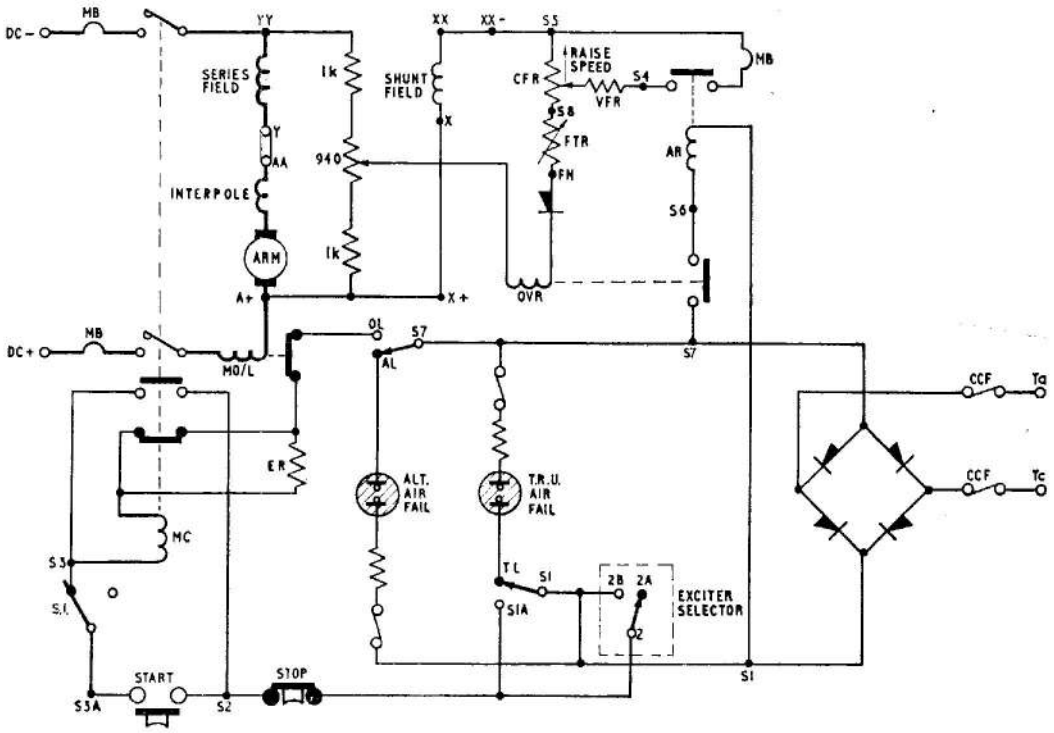

Fig. 11. Motor control circuit

35. With the correct conditions the START button completes a circuit from MCCR through the closed STOP button, START button, closed safety interlock (SI), the main contactor coil, the closed main overload relay contacts, the closed air fail contacts back to MCCR. The auxiliary relay AR, also energised from MCCR, is operated as soon as the mains isolator is closed.

36. The main contactor is now energised closing the two d.c. main contacts and three retaining contacts in parallel with the START button and SI contacts. The START button can now be released.

Over voltage

37. In the event of an over voltage condition arising, the forward resistance of OVRR is overcome sufficiently to conduct a current that will energise OVR. The OVR contacts will open interrupting the auxiliary relay (AR) coil circuit which will become de-energised to open its contacts in the VFR circuit.

38. Opening the VFR circuit causes CFR to be inserted in the shunt field circuit. This weakens the field causing the armature voltage to drop again, thereby once more cutting out the resistance CFR. This process is repetitive and the effect is to progressively reduce the speed to the value determined by the setting of the shunt field regulator.

39. The rate at which the speed falls is determined by the stored energy of the equipment as a whole, and the combined effect of the electrical load and frictional load applied to it. Consequently if the equipment is running at maximum speed with a very light electrical load, the over-voltage protection relays will vibrate many times before the equipment stabilizes at the lower speed; on the other hand if operating at a comparatively low speed with only part of the shunt field regulator in circuit and with a heavy electrical load, it may not be required to operate at all.

Over-load relay

40. In the event of a sustained overload, the over-load relay MO/L is energised opening contacts in the main contactor coil circuit which in turn breaks the main contacts.

Motor

41. The d.c. motor is started by applying a gradually increasing armature voltage to avoid excessive currents, for this reason also all speed changes should be made gradually.

42. With the motor running the d.c. output from the rectifier is also sufficient to strike the DRIVE RUNNING neon indicator. With maximum d.c. voltage further increase of the motor speed is achieved by operating the SPEED INCREASE controls; weakening the shunt field by increasing the effective resistance of CFR and VFR in the shunt field circuit.

Alternator fan

43. The alternator cooling air fan circuit breaker has its operating coil connected between two lines of the mains supply. In series with the operating coil are normally closed contacts which open in the event of over load. When the ISOLATOR is closed the circuit breaker is energised and starts the fan running. The draught of air from the fan impinges on a vane and moves the air fail contacts from AL to OL and by so doing prepares the main contactor circuit for operation (see para. 34).

44. In the event of a cooling air failure, the air fail contacts will return to their normal position causing the ALT AIR neon indicating lamp to strike and the main contactor operating circuit to be broken.

TRU fan

45. The circuit breaker for the TRU cooling air fan is similar to that for the alternator fan except that the operating coil is connected through the EXCITER SELECTOR switch. With this switch in the TRU position the operating coil will close the circuit breaker starting the TRU cooling air fan.

46. The air fail contacts operate on this fan in a similar manner and are in series with the alternator air fail contacts; when the EXCITER SELECTOR is put to INT however they are short circuited.

Motor generator set

47. The operating coil of the motor generator set circuit breaker is also connected to the EXCITER SELECTOR switch but is energised in this instance with the switch in the INT position.

48. With the circuit breaker closed the motor generator set runs. The generated e.m.f. is controlled by the potentiometer, INT. ALT. EXCITATION, in the shunt field cir-

cuit and applied via the EXCITER SELECTOR switch to the excitation windings of the aircraft a.c. generator.

EXCITER SELECTOR **switch**

49. The EXCITER SELECTOR, a 6-pole two position switch, connects the d.c. excitation to the aircraft a.c. generator from either a TRU or the motor generator set dependent upon the switch position, i.e., TRU or INT respectively.

50. In the TRU position also the operating coil circuit of the TRU cooling air fan circuit breaker is closed. Similarly, when in the INT position, the operating coil circuit for the motor generator set circuit breaker is closed, but in addition the air fail contacts for the TRU fan are shorted out.

OPERATING INSTRUCTIONS

Fitting an a.c. generator

51. (1) Connect the coded jumper leads to the a.c. generator; the a.c. generator end connecting tags are not interchangeable.

(2) Slide the a.c. generator over the supporting bolts at the same time turning the rotor so that the coupling engages. The supporting bolts must be prevented from sliding back through their rubber mounting bushes.

(3) When the a.c. generator is fully located on the flange of the oil reservoir, fit the manacle clamp and tighten down the supporting bolts.

(4) Remove the top (filling) and side (level) taper plugs on the oil reservoir and check that the bottom (drain) plug is tight.

(5) Fill the reservoir with oil OC-600 until it flows from the side hole. Replace the plugs.

(6) Connect the a.c. generator jumper leads to the a.c. generator terminal box.

(7) Connect the two cooling air hoses to the ducts on the generator.

(8) Connect the TRU terminal box to a TRU, to an external load or to an aircraft.

Removing an a.c. generator

52. The a.c. generator should be removed using the reverse order of operations given in the previous para. Particular care should be taken to drain the oil in the reservoir through the drain hole before removing the manacle clamp.

Fitting a TRU

53. Mount the TRU on the mounting tray and connect to the TRU terminal box and to the external load or aircraft. Fit the cooling air hose to the air exhaust end of the TRU.

Starting

54. The trolley should be parked on firm level ground and the brake applied. With the ISOLATOR in the OFF position the 50 c/s, 3-phase and earthed supply should be connected to the mains input plug.

55. With the TRU and/or the aircraft a.c. generator correctly mounted and connected to the trolley proceed in the following manner.

(1) Move the ISOLATOR to the ON position energising the rectifier and auxiliary equipment.

(2) Select TRU or INT as appropriate on the EXCITER SELECTOR switch and ensure that the motor speed control hand wheels are in the minimum position.

(3) Check that the ALT. AIR and if the EXCITER SELECTOR switch is to TRU, the TRU AIR indicator lights are out.

(4) Push the START button and start the motor by slowly turning the STARTER REC. GRID CONTROL as far as possible in the raise volts direction. The DRIVE RUNNING indicator should come on.

(5) Adjust the speed/frequency to the required value by means of the MOTOR SPEED control hand wheels.

(6) If the motor generator set is being used adjust the excitation of the aircraft a.c. generator to the required value by means of the INT. ALT. EXCITATION hand wheel.

Stopping

56. (1) If used reduce the a.c. generator excitation to a minimum using the INT. ALT. EXCITATION control.

(2) Reduce the main motor speed to zero using the MOTOR SPEED and the STARTER REC. GRID CONTROL hand wheels.

(3) Press the STOP button.

(4) Move the ISOLATOR to the OFF position. If the tester is to be used again within a short period it is not necessary to put the ISOLATOR off; it is recommended however that the EXCITER SELECTOR be put to the TRU position to stop the motor generator set running when in use.

Note . . .

The main motor must be stopped before changing the position of the EXCITER SELECTOR *switch.*

SERVICING

General

57. The chassis and canopy of the tester should be examined periodically for signs of damage and deterioration. The wheels, turntable steering and brake linkage mechanism should be lubricated using grease XG-271; the brakes being adjusted if necessary to ensure that they operate satisfactorily. A light machine oil should be applied sparingly to the run-ways of the shutters.

Rectifier bank

58. Clean and examine the rectifier bank for security and signs of deterioration of components and connections. Check that the cooling air fan rotation is such that air is blown upwards through the fins of the tubes.

WARNING . . .

If the direction of rotation is incorrect two of connections Ta, Tb, Tc should only be reversed after ensuring that the main input phase rotation L1, L2, L3 is correct.

Mercury arc rectifiers

59. *Removing a defective tube.*—With the mains supply ISOLATOR switched OFF disconnect the electrical connections from the rectifier tube by removing the plug and unscrewing the two braided connections. Also disconnect the connections for the starting electrode on the top cap. Remove the starting and holding coils from their supporting legs by unscrewing the three retaining nuts. Lift the bulb from its insulated socket on the tray.

60. *Renewing a tube.*—The replacement tube should be installed in the reverse order to that detailed in the previous paragraph; particular care being taken to avoid striking the start and holding coils on the neck of the tube.

61. Ensuring that the ISOLATOR is OFF, remove the anode fuses (AF) and start the rectifier. The starting electrode should lift clear of the mercury and an arc be established to the auxiliary exciter anode. Initially the starting electrode may move rapidly up and down for a few seconds before lifting permanently clear of the mercury. When the exciter arc is established in all tubes the rectifier should be left running for at least 30 minutes. After this period, ensuring that the ISOLATOR is OFF replace the anode fuses; the rectifier is then ready for normal operations.

Auxiliary transformer

62. In the event of a fault and should it be desired to check the output voltages of the transformer, with the phase rotation L1,L2 and L3 connected to Ax, Bx and Cx respectively, the outputs given in Table 2 should be obtained.

Table 2

Auxiliary transformer, secondary outputs

Secondary	Voltage V	Between	Current A
1	115	Ta, Tb and Tc	9
2	250	Ga, Gb and Gc	1·5
3	196	Cd, Ce and Cf	1·25
3	100	Ca, Cb and Cc	1·25
4	115	B4, B5 and B6	0·2
5	115	B7, B8 and B9	0·2
6	115	B10, B11 and B12	0·2
7	115	B1, B2 and B3	0·2
8	220	Fn and Fa, Fb or Fc	3·27

Main contactor panel

63. Inspect the main and auxiliary contacts for signs of pitting or burning. Burnish the contacts using contact cleaners (Ref. No. 1H/139-141); should the contacts be burnt or pitted clean as necessary using grade 00 crocus paper (Ref. No. 33C/540) taking care to remove all dust and swarf from the vicinity of the contacts afterwards.

Driving motor

64. Examine the motor periodically for security. Remove the ventilation grills and clean them with the aid of lead-free gasoline. Clean the interior of the motor, particularly the commutator end, using a vacuum line or blast of clean dry air. Lift and measure

the brushes, new size $1\frac{3}{4}$ in. $\times$ $1\frac{1}{4}$ in. $\times$ $\frac{5}{8}$ in. grade EGA, and renew them if less than $\frac{1}{2}$ in. long or likely to wear down to this value before the next inspection.

65. Inspect the commutator and ensure that it is free from brush dust, dirt, oil, grease, etc. If examination reveals that the commutator is excessively worn, the armature should be removed from the machine and skimmed. If necessary, before skimming the commutator mica should be undercut; maximum finished depth of undercut should not exceed $\frac{1}{32}$ in. The diameter of the commutator when new is 12 in. and this should not be reduced by skimming to less than $10\frac{5}{8}$ in.; concentricity of the commutator relative to the shaft should be within $\pm$ 0·001 in.

Lubrication

66. At six monthly intervals 4 cc. of grease XG-271 should be applied to the bearings through the grease nipples. After two years the bearings should be cleaned and repacked with fresh grease (see para. 74).

Dismantling

67. Disconnect all external cables to the motor and remove the tachometer generator from the commutator end. Uncouple the drive end from the speed increasing unit and remove the motor from the chassis.

68. Disconnect the internal field leads in the terminal box and the interpole lead to the brush arm. Lift the brushes. Remove the outer bearing caps and the endcover bolts. Ease the endcovers off the frame spigots, preventing the armature from dropping heavily on the poles, then gently pull each endcover off the bearing. The ball bearings will remain on the shaft and the roller bearing outer race will probably slide off the rollers and remain in the housing. The bearing outer races are a push fit in the housings. Force must not be applied for withdrawing the endcovers.

69. Withdraw the armature from the driving end taking care not to pull it along the pole tips.

70. Bearings are a light interference fit on the shaft. At the commutator end the bearing is secured by a nut locked by a cheese-headed screw. Remove the locking screw and the locking nut and draw the bearing from the shaft using a suitable tool.

71. A withdrawing tool need not be used to remove the driving end bearing; the inner bearing cap which is specially strengthened may be used instead.

(1) Take out the screws of the outer bearing cap and remove the cap.

(2) Fit withdrawing screws of suitable length through the tapped holes in the inner cap and rotate them alternately until each screw is resting on the recess in the fan hub and until the face of the inner cap touches the inner roller race.

(3) Further even tightening of the screws will draw the bearing off the shaft.

72. Main poles and interpoles may be detached complete with coils by removing the external set screws. Note the position of any liners between the poles and the magnet, these must be replaced on assembly exactly as fitted. Coils can be lifted off the poles when the pins in the pole ends nearest the face are pulled out. Take care of the insulating packing, handle the coils gently keeping them free from grease and oil.

73. Clean and inspect all the components, renewing defective parts as necessary.

Reassembly

74. *Bearings.*—The inner race of the bearings are a shrink fit on the shaft and should be replaced by employing the hot oil bath method using oil OM-170 heated to 77 deg. C. When the endcovers have been assembled, the bearings should be packed one-third full of grease which should then be evenly distributed around the bearing. Smear grease over the shafts where the caps will fit, and over the spigots of the bearing caps to establish a seal. Fill the bottom half only of each cap so that when it is pressed into final position the grease is squeezed into the bearing, there must not be so much excess grease in the cap that it is forced into the empty half. Each cap must be slipped back after first being pressed into position to ensure that this condition is achieved, if necessary the grease quantity must be adjusted.

75. *Brush gear.*—The correct brush gear position is indicated by an indented painted

line on the brush rocker and painted arrow-mark lines on the endcover. The direction of arrow indicates the armature rotation looking at the commutator end. Set the line on the rocker to the appropriate arrow-marked line on the endcover corresponding to the required rotation. An endcover non-arrow-marked line indicates the neutral position.

76. Brushes should slide easily and smoothly in their holders. The brush spring tension should be adjusted to $3\frac{1}{4}$ lbs. If new brushes have been fitted or if the commutator has been skimmed, the brushes should be bedded in as detailed in A.P.4343, Vol. 1. Also ensure, particularly when the commutator has been skimmed, that the distance between the brush holders and the commutator does not exceed $\frac{1}{8}$ in. Liners should be removed from under the carrier arm in the rocker and transferred to the upperside to achieve this.

Speed increasing unit

77. *Belt changing.*—(1)◀Proceed as follows with reference to fig. 17.▶Remove the pick-up flange and the flange from the pivoting high speed assembly.

(2) Remove the lock nuts and the collar. The high speed shaft may now be extracted in the direction of the coupling by tapping the non-driving end of the shaft with a soft drift.

(3) Remove the plummer block caps from the low speed shaft bearing and the locating ring from the driven end plummer block.

(4) Remove the retaining bolts from the non-driven-end plummer block.

(5) Lift the low speed pulley and remove the bottom half of the non-driven end plummer block.

(6) Protect the bearings to prevent ingress of dirt.

(7) Slide the belt out between the pulley edge and the underframe. The new belt may now be slid into place and the unit reassembled in the reverse order.

Note . . .

The opportunity should be taken when changing belts to renew the grease in the bearings.

78. *Adjustment.*—The drive belt of the speed increasing unit should, in view of the automatic tensioning device, require little adjustment. If adjustments have to be made however, great care must be taken to preserve the alignment. After adjustment the drive should be run slowly and then in progressively increasing speeds to ensure that the belt remains in alignment on the pulley.

79. When the drive is correctly set up the angle between the top surface of the drive base frame and the line joining, the centres of the high speed shaft and the pivot point approximates to 45 deg. under full load conditions.

Cooling air fans

80. The cooling air fans are 1 h.p. induction motors operating from the 440V, 3-phase, 50 c/s mains supply and running at 2,820 rev./min. The motors should be lubricated through the nipples, one at each end, at six monthly intervals with 4 cc. of grease XG-271. At approximately two yearly intervals the bearings should be removed, cleaned and repacked one-third full with fresh grease which should then be evenly distributed within the bearing. The lower half of the bearing caps should also be packed with grease and assembled to the motor as detailed in para. 74.

81. The motors are similar in construction to the motor shown in fig. 12 (the motor generator set motor). To dismantle the machine the non-drive-end endcover should first be removed and the rotor withdrawn from the drive end complete with the drive-end endcover. Removal and replacement of the bearings may be achieved as generally described in para. 70 and 71.

Motor generator set

82. *Motor.*—A sectional view of this 3·5 h.p. induction motor operating from the 440V, 3-phase, 50 c/s mains supply and running at 2,880 rev./min. is shown at fig. 12. Servicing of the machine is generally as detailed for the cooling air fan motors, para. 80 and 81.

83. *Generator.*—The generator is a shunt wound machine and will provide 55A at a nominal 30V when driven at its rated speed of 2,880 rev./min. A sectional view of the machine is given in fig. 13.

84. Examine the generator periodically for security. Remove the ventilation grills and clean them with the aid of lead-free gasoline.

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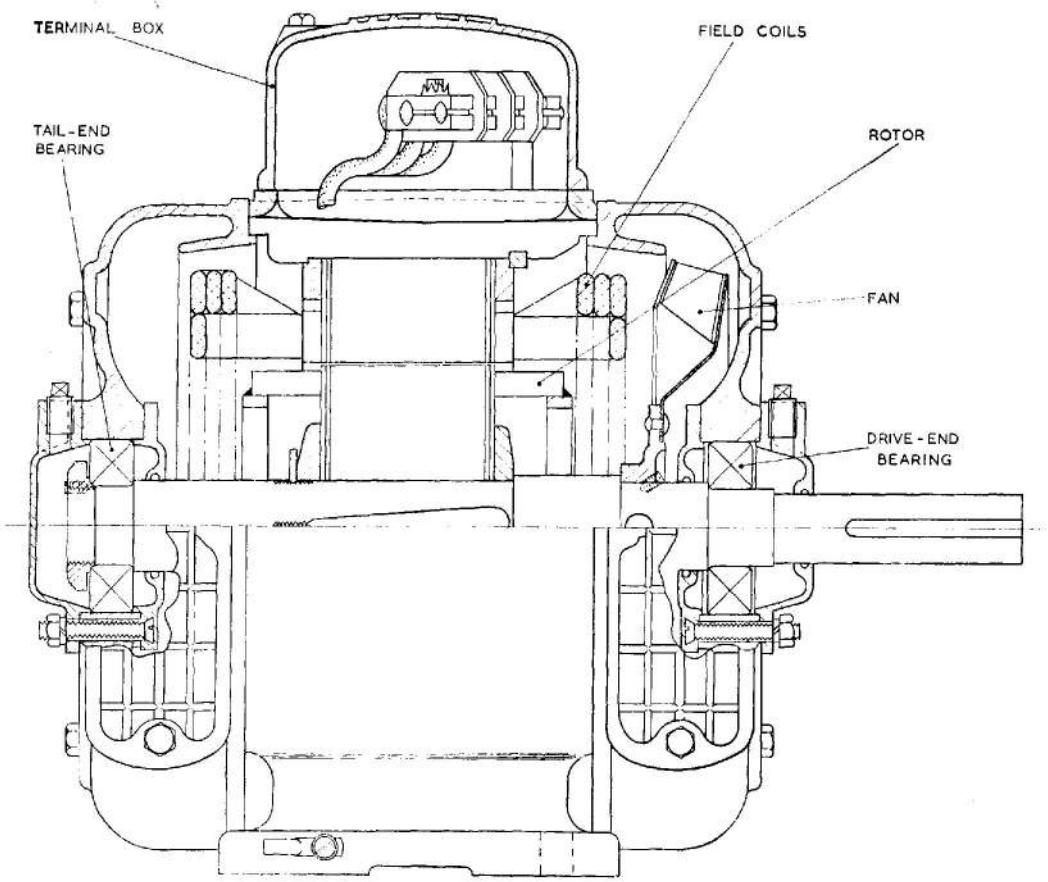

Fig. 12. Motor generator set, motor

Clean the interior of the motor, particularly the commutator end, using a vacuum line or blast of clean dry air. Lift and measure the brushes, new size $\frac{5}{8}$ in. $\times$ $\frac{5}{8}$ in. $\times$ $1\frac{3}{8}$ in. long grade CM3H, and renew them if less than 0·75 in. long or likely to wear down to this value before the next inspection.

85. Inspect the commutator and ensure that it is free from brush dust, dirt, oil, grease, etc. If examination reveals that the commutator is excessively worn, the armature should be removed from the machine and the commutator skimmed. If necessary before skimming the commutator the mica should be undercut, the maximum finished depth of undercut should not exceed $\frac{1}{32}$ in. The diameter of the commutator should not be reduced to less than 3 in., concentricity of the commutator relative to the shaft should be maintained within $\pm$ 0·00025 in.

Lubrication

86. At six monthly intervals 4 cc. of grease XG-271 should be applied to the bearings via the grease nipples; after two years the bearings should be cleaned and repacked using the method generally described in para. 74.

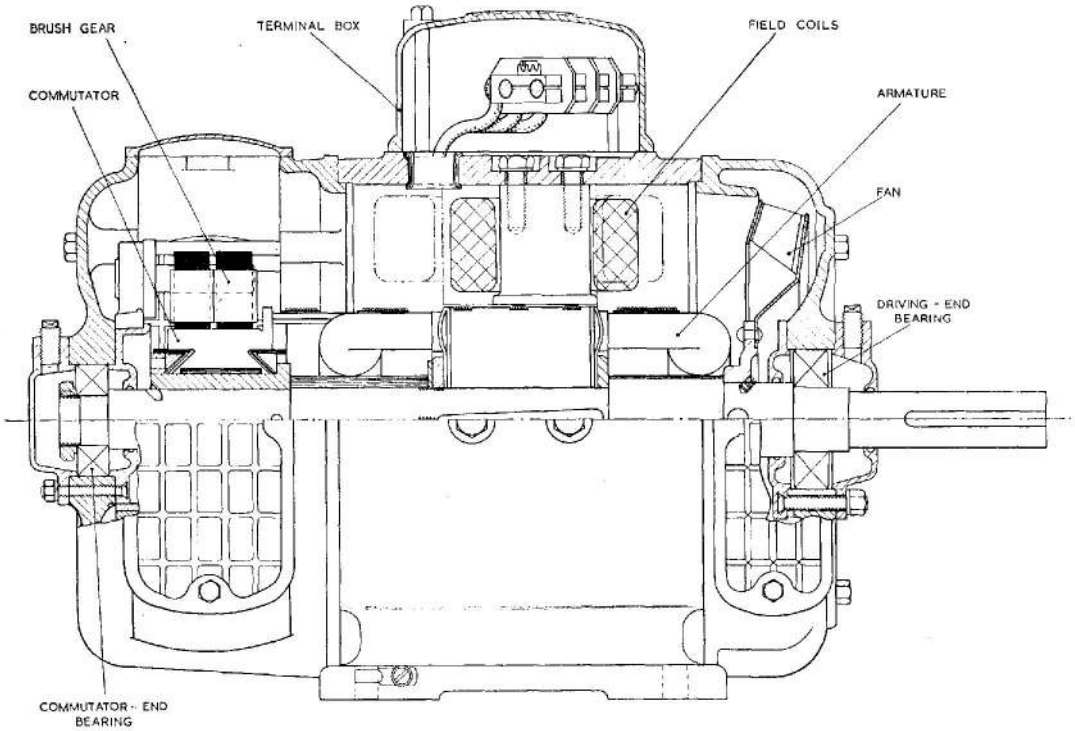

Fig. 13. Motor generator set, generator

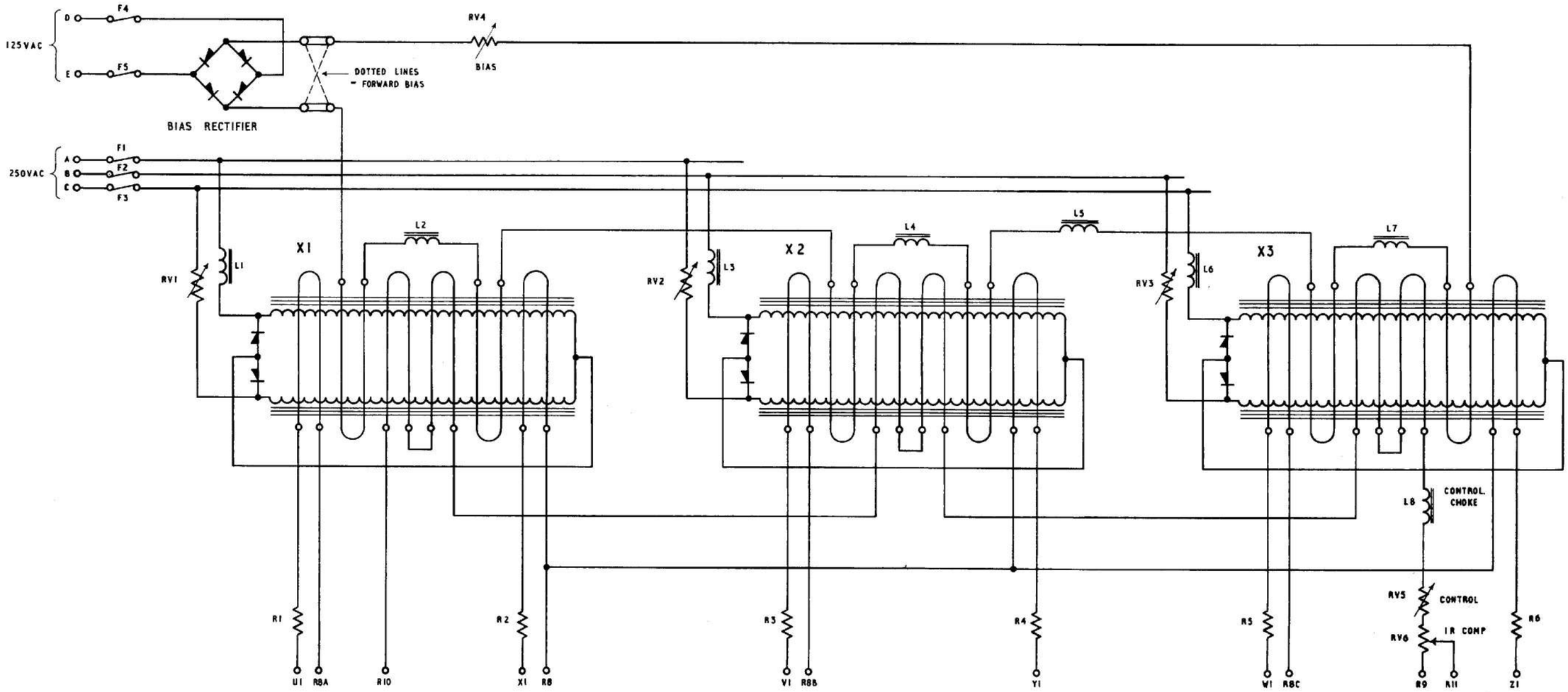

Fig.14 Grid control unit : circuit diagram Fig.14

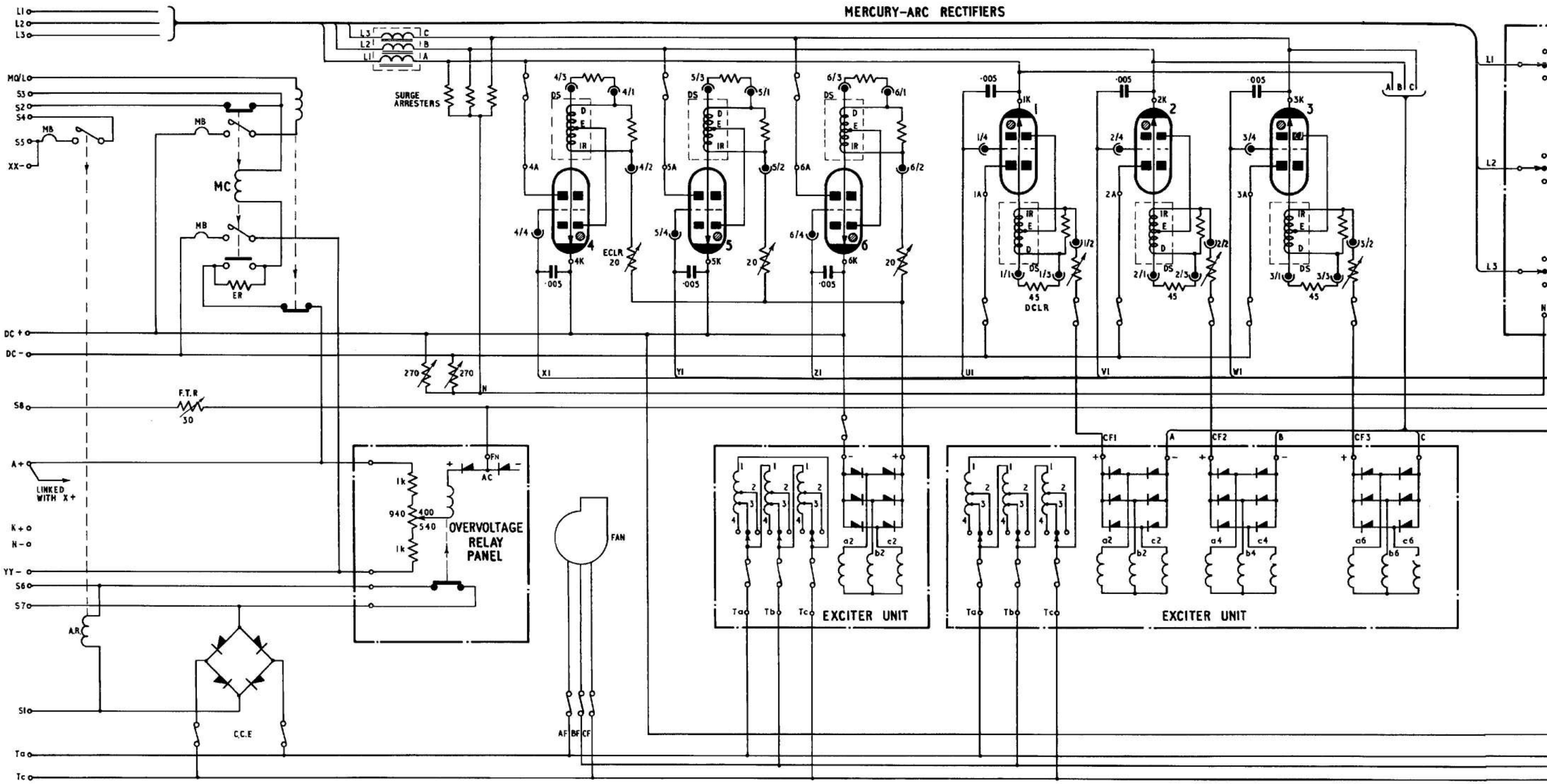

Fig.15

Rectifier unit: circuit diagram

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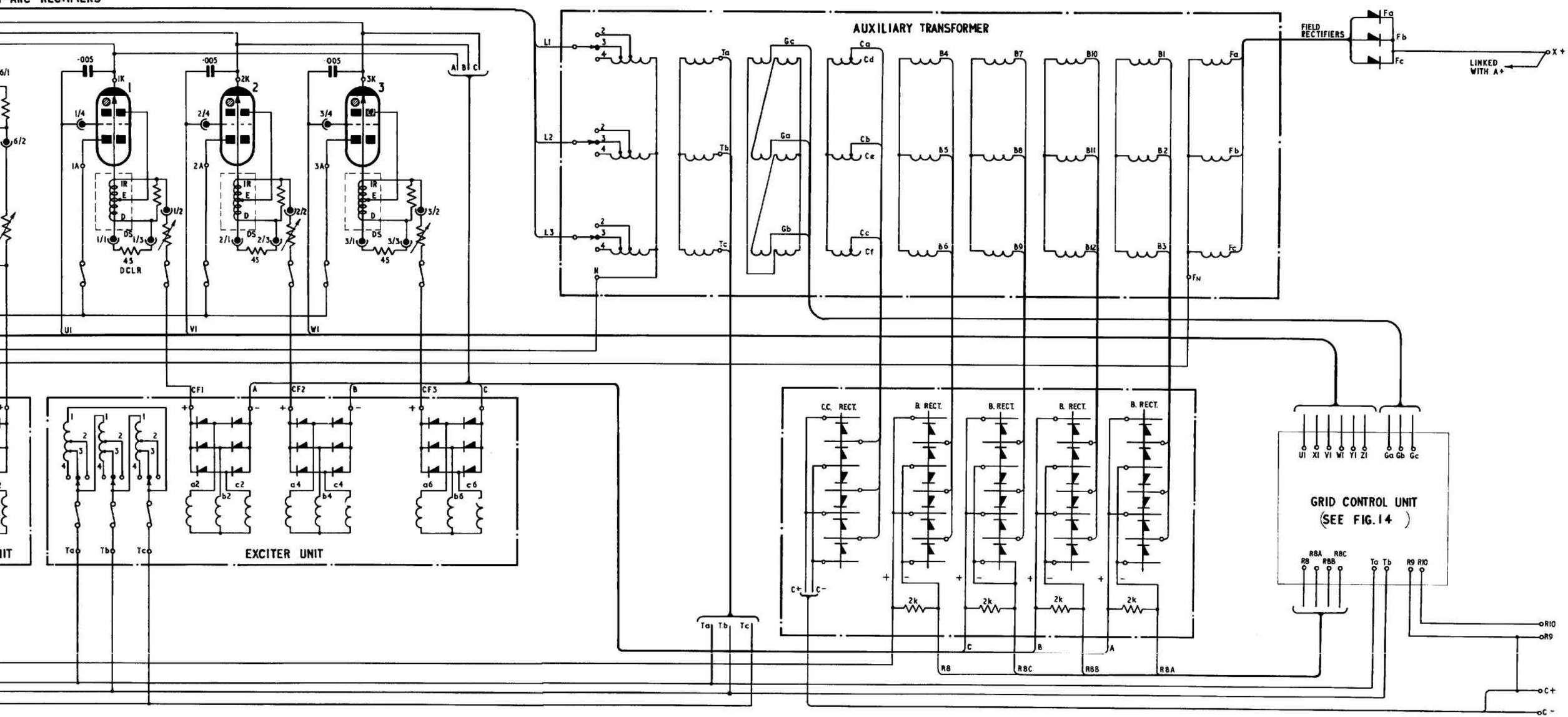


Rectifier unit: circuit diagram

RESTRICTED

Fig. 15

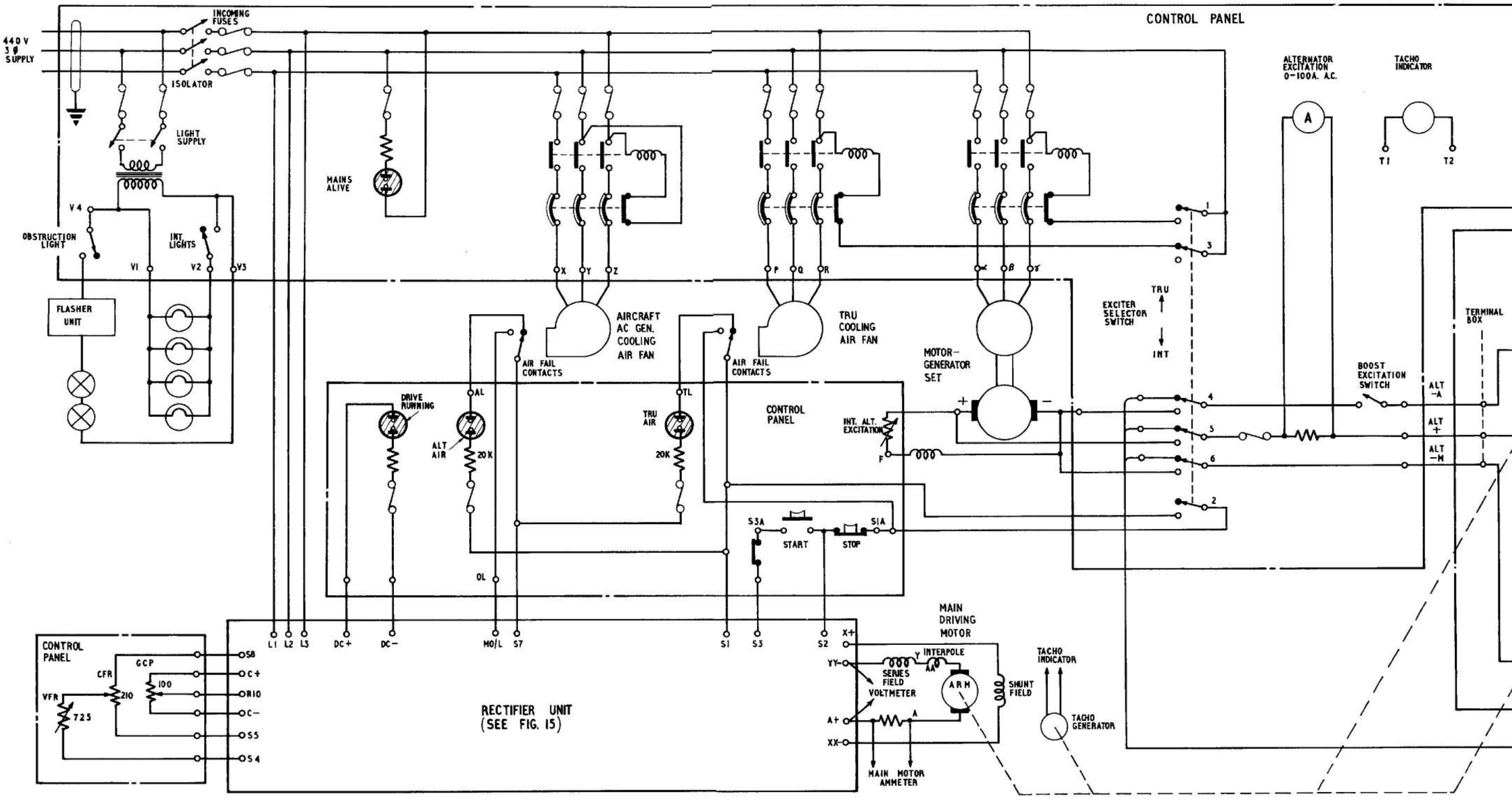
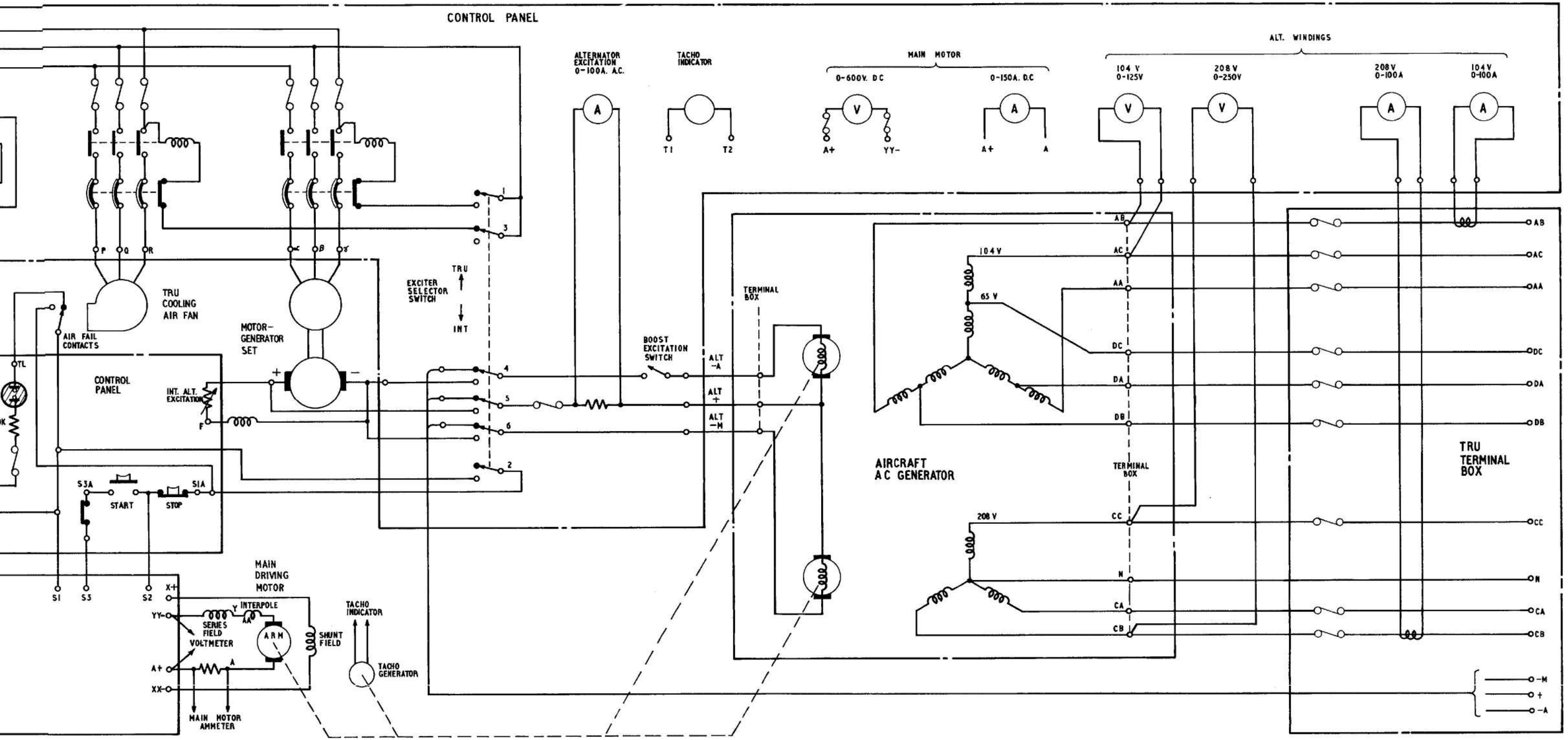


Fig 16

Single channel tester: circuit diagram



Single channel tester: circuit diagram

Fig.16

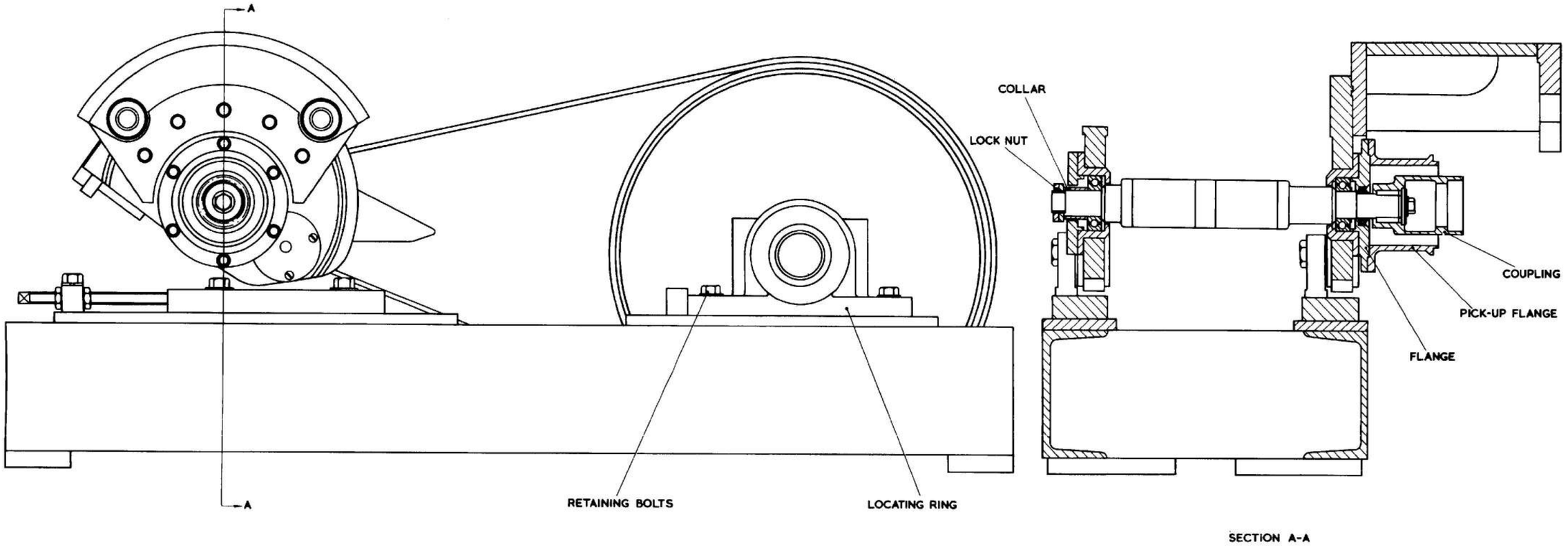


Fig. 17

Speed increasing unit

Fig. 17

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