SECTION 2 PART 1

200 VOLT A.C SUPPLIES

1. Introduction

The complete aircraft electrical system obtains its power from a source supplied by four engine driven 3 phase, star connected, rotating field, 40 kVA alternators (known as primary alternators). Each of these generate 200 Volts at a frequency of 400 c.p.s. when driven at a constant speed of 6,000Rpm. This speed requirment is met and maintained during flight and and ground running of the engines, by the drive units to which the alternators are coupled. Excitation in each case is by DC. obtained from a generator rotating on a common shaft with th alternator field. The generator output (D.C) being maintained at the required level by constant voltage regulation. The electrical loads imposed by the entire aircraft requirements occur at widely dispersed points, and a system of distribution panels,which contain the necessary supplies is employed to serve the loads, The panels are conveniently placed for this purpose and may feed various circuits, each with fuse protection From the main source to the panels a bus bar system of supply is used, which caters for the following alternative method of supply manipulation.

a. Single running alternators (four running simultaneously), each feeding a portion of the entire load.

b. All four alternators running synchronised, sharing the entire load connected in parallel. Utilising the synchronising section of the bus bar network.

c. Any number of available alternators, synchronised and paralleled to feed the entire load in the event of one or more alternator failures.

d. In the event of total failure, i.e. lossof four primary alternators, a standby auxiliary Airborne power pack (AAPP) can be started up and switched on to the bus bar system to supply the entire load. It should be noted if contrary to the conditions stated, any single primary alternator is still feeding the synchronising bus bar, this cannot be done.

e. If for any reason the AAPP is unavailable the air-borne standby is provided by the Ram Air Turbine (RAT). This when lowered into the slipstream will generate sufficient power to feed that portiononly of the entire load, necessary,for safe handling of the aircraft. The shedding of the non-essential loads occurs automatically when the RAT is lowered into the slipstream.

Full control of the electrical system is remotely effected and facilities for this purpose are centred at the AEOs position in the crews compartment.All relevant information regarding system operating conditions is indicated, and the controls necessary for implementing any desired state of operation is provided on the panel at the AEOs position. The panel concerned is 10P.

For ground functioning of the electrical system a six pin plug which connects a 200v 3 phase ground power unit supply to the synchronising bar is provided. The GPU produces a supply, characteristically the same as the aircraft alternator supply

2. A.E.O's Control Panel 10P

The alternator control panel 10P is situated on the port side of the crews compartment, in a position accessible to the AEO when he is seated at his crew station.

/Control

Control switches and indicators situated on 10P are listed below, full details of individual components are given in the following paragraphs.

a. Two A.C. volt meters and 2 frequency meters.

b. An EXTRA SUPPLIES TRIP button.

c. A synchronising and selector switch.

d. A R.A.T. test for volts and frequency push button.

e. An A.A.P.P. test for volts and frequency push button.

f. A mimic diagram with dolls eye indicators showing when alternators or the R.A.T. or A.A.P.P. are connected to the synchronising bus bar.

g. A red light alternator failure indicator which flashes when two or more alternators have failed.

h. Four ISOLATE push buttons to isolate alternators from the synchronising bus bar, i.e. trip "S" breaker.

j. A NON ESSENTIAL SUPPLIES RESET SWITCH.

k. Four alternator failure warning amber lights part of the mimic diagram referred to in f.

l. Four alternator field RESET push buttons.

m. Four kilowatt/kilovar meters normally reading KW.

n. A push for KVAR button.

o. Four alternator ON/OFF control switches.

3. <u>Volts and Frequency Meters.</u>

Two Sangamo Western A.C. voltmeters and two Sangamo Western frequency meters are situated on the top left and top right of panel 10P. The volt meter and frequency meter nearest the top of the panel are labelled INCOMING ALTERNATOR and will indicate volts and frequency of an alternator selected on the SYNCHRONISING AND SELECTOR SWITCH or alternatively the volts and frequency of the R.A.T. or A.A.P.P. when either of the R.A.T. or A.A.P.P. TEST buttons are pushed. The lower Volts and frequency meters are connected to the synchronising bus bar and will indicate any volts or frequency on this bus bar.

4. <u>Extra Supplies Trip Button</u>

When this button is pushed in its contacts "make" an electrical circuit to TRIP the contactors of either the R.A.T., A.A.P.P. or G.P.U. and thus disconnect their output from the synchronising bus bar.

5. <u>Synchronising and Selector Switch.</u>

This four position switch has a push button in the centre of the selector. When a selection is made (1 to 4) on the switch, the YELLOW phase output from the selected alternator will be fed to the INCOMING ALTERNATOR volts and frequency meters. To connect the selected alternator to the synchronising bus bar, or to parallel the selected alternator with an alternator already connected to the bus bar, the push button in the centre of the selector switch should be held in until the appropriate dolls eye indicator on the mimic diagram shows line continuity, indicating that the selected alternator has been connected to the synchronising bus bar.

6. R.A.T. - A.A.P.P. Test Buttons

The R.A.T. Test Button is on the left and the A.A.P.P. Test Button is on the right of the Synchronising and selector switch on 10P. The volts and frequency outputs from either alternator can be measured on the incoming alternator volts and frequency meters by pressing the appropriate Test Button.

7. Mimic Diagram.

The white line mimic diagram on 10P shows pictorially the possible connections between alternators. The line continuity is broken by dolls eye indicators in their de-energised condition when the alternators are not running in parallel. The R.A.T. and A.A.P.P. dolls eye indicators break the line continuity when the R.A.T. and A.A.P.P. are not connected to the synchronising bus bar. Alternator amber failure warning lights are in the line between the alternators and their respective load bus bars. When an alternator is running and switched on, the amber light will be out. Any malfunction of the system which causes the alternator to be disconnected from its load will cause the amber light to be on.

8. Red Light Failure Indicator

A red light situated between the A.A.P.P. and R.A.T. dolls eye on 10P has a "push to test" facility. The light will glow red whenever any one alternator is off line. When more than one alternator is off line, this light will "flash". When the R.A.T. is lowered into the slipstream this automatically "sheds" the non-essential loads and as the red failure light is connected to the non-essential portion of the 28V bus bar this facility is no longer available.

9. Isolate Push Button

Four isolate push buttons are fitted on the panel adjacent to the dolls eye indicators. Operation of any of the buttons will cause its appropriate alternator to be isolated from the synchronising network and its associate dolls eye to break the line continuity as indication.

10. Non-Essential Supplies Reset Switch

This switch is situated in the middle of the panel. Normal operating procedure is for the switch to be left on "NORMAL". Following emergency procedure when the Ram Air Turbine has been lowered into the slipstream, if it is found necessary to re-connect the non-essential loads, operation of the non-essential supplies Reset switch to "Reset" will achieve this.

11. Alternator Failure Amber Lights

These four amber lights work in conjunction with the Alternator circuit breaker. Whenever this circuit breaker is "open" disconnecting the alternator output from its load bus bar the failure light will glow.

12. Alternator Field Reset Button.

Adjacent to the Amber failure warning lights are the RESET buttons. It will be seen in the circuit description in Part 2 that under certain fault conditions the "field" of the alternator exciter is broken. To "remake" this field circuit following a fault condition, providing the alternator Control Switch is in the OFF position, pressing the RESET button will achieve this.

13. Kilo Watt/Kilo Var Meters.

Four meters with readings of 0-50 are situated directly below the mimic diagram on the panel. The meters normally read the "real" power in Kilo watts being used from each alternator. A push button situated centrally between the meters is marked "Push for K.VARS" and when held in will change the indication in all four meters to read reactive power in Kilovars from each alternator.

/14. Alternator

14. Alternator Control Switches.

Four alternator control switches, one for each alternator are situated at the bottom of the panel. The function of the switches is that, when in the ON position and assuming that the alternator output is normal, the relevant alternator circuit breaker will be closed and the output will be connected to its appropriate bus bar. The switch when placed in the OFF position will cause the "A" breaker to open and disconnect the alternator output from its bus bar.

15. A.A.P.P. On Push

The A.A.P.P. On Push is fitted beside the A.A.P.P. indicator. After the A.A.P.P. has been started and its volts and frequency checked, depressing the On Push will transfer the A.A.P.P. output to the synchronising network.

NOTE:- Before the A.A.P.P. output can be transferred to the synchronising network certain circuit functions must be performed (See Part 3 of this Section).

SECTION 2 PART 2

ALTERNATOR TYPE 158B AND CONTROL CIRCUIT

1. General Description

The type 158B English Electric alternator is driven at a constant speed of 6,000 ± 60 R.P.M. by a Constant Speed drive unit fitted to the H.P. compressor stage of the aircraft engine. The alternator is a conventional rotating field machine using a D.C. excitor unit driven on the same shaft as the rotating field. Voltage regulation is carried out by a regulator unit in the Excitor field circuit.

The alternator STATOR is wired in STAR arrangement. The stator ends being taken out from the alternator housing individually, connected together and "earthed" at a point on the engine housing wall.

Ram air cooling is employed when the aircraft is at altitude, and engine air is used when the undercarriage is selected down.

Control and protection of the alternator is afforded by a Type 450 control unit situated, one for each alternator, on the forward face of the aircraft Power Compartment. The switching and indication arrangement is at the A.E.O's station on panel 10P. Further control and protection is afforded to the alternator by the Type 450 control unit, when the machine is connected in parallel with other machines, but although mention of such controls may be made in this section, full details will be explained in the paragraphs on Alternator parallel operation.

The 3 phase output line voltage from the alternator is 200 volts (i.e. $115\sqrt{3}$). Frequency is maintained at 400 C.P.S. under steady state conditions of load and speed by the Constant speed drive basic governer. Trimming of the basic governer is carried out by a 2 phase Servo motor, controlled from a frequency sensing circuit, in a FREQUENCY AND LOAD CONTROL BOX. The power output of the alternator is 40 K.V.A. at a POWER FACTOR of 0.75.

2. Type 158B Alternator.

The stator is made up of a number of fixed coils wound around the rotating field. The ends of each phase are brought out of the housing to six terminals on the A.C. Terminal block on the top of the machine. Three ends are connected together and "earthed" at a point on the engine housing wall to allow a differential protection system to be incorporated. The other three ends are taken into the bomb bay where each phase feeder is split into two feeders, fed through separate ducts for safety, and eventually connected to the relevant contacts on the Alternator circuit breaker.

/The rotor

The rotor assembly consists of a D.C. exciter armature and the alternator rotating field operating on the same shaft. The rotor is driven by a quill drive from the output of the constant speed drive unit, via a clutch assembly. The alternator rotor field is mounted on the driving end of the shaft and is made up of eight poles wound in such a way to give the poles alternate polarity. The rotation speed is 6,000 r.p.m. each pair of poles will therefore induce voltage into the stator at 100 C.P.S. and as there are four pairs of poles the operating frequency is 400 C.P.S.

The excitor armature is mounted on the shaft adjacent to the rotor field and the coils of the armature terminate at the commutator fitted near the tail end of the shaft. The carbon brushes used are type PEG 11.

Two slip rings are mounted on the shaft to the rear of the commutator assembly. PEG 11 brushes feed the D.C. from the excitor armature via the slip rings to the alternator rotor.

The excitor generator is basically a compound wound machine, its field comprising of a main shunt winding, a differential shunt winding and a series winding. Compensating windings are fitted to maintain the excitor characteristics under transient load conditions. Six interpoles, fitted alternately with the six field windings and wired in series with the armature neutralise the normal effect of armature reaction.

3. Voltage Regulators

Four type 125 voltage regulators (English Electric type AE 7306) are fitted on the forward bulkhead of the power compartment. The regulators control the excitation of the alternator by feeding the excitor field with a continuous series of unidirectional pulses. Variation of the pulse width alters the average current in the excitor field and hence the output of the alternator.

The pulses to the excitor field are fed from an SCR bridge, which is controlled by Zener diodes ZD5 and ZD6. The breakdown of ZD5 and ZD6 is dependent on the voltage developed on R14 and R15. Variations of current in R14 and R15 will alter the voltage developed and as this voltage is of sine wave shape, will alter the time at which ZD5 and ZD6 break down. The current in R14 and R15 is controlled by a transductor T6. As the pulse width is dependent on when ZD5 and ZD6 break down, then variation of current in T6 will alter the pulse width delivered by the SCR's to the excitor field.

The control of transductor T6 is from two sources, one for voltage control, the other for reactive load sharing. The voltage is controlled by sensing the alternator output on a voltage reference bridge fed from the output of a transformer rectifier unit. As the output voltage changes so the voltage on the reference bridge will change, to cause variations in the control winding of T6. This in turn will alter the pulse width and hence field strength to correct the output of the alternator.

Fitted in the field circuit is relay S.1. Until the output of the alternator reached approx 150V S.1 is de-energised. In this state A+ is connected to F terminal allowing the alternator to build up. At approx 150V relay S.1 energises, by the breakdown of ZD7, which disconnects the field from A+ and connects it to the S.C.R. circuit.

Stabilisation is carried out by feeding A+ and A- onto C3. Under normal conditions C3 is charged and no current flows. Under transient conditions C3 will either charge or discharge, causing current to flow through R5. The voltage developed on R5 is in opposition to the change of voltage on the reference bridge. Thus damping any oscillation that may occur.

4. Frequency and Load Controller.

Basically the alternator output frequency is controlled by the Constant Speed Drive mechanical governer. However, for fine adjustment is is necessary to "trim" the system for frequency stability, and to allow real load sharing

/when

when alternators are connected in parallel. Four load sharing units, one for each alternator are situated on the forward bulkhead of the power compartment below the voltage regulator units.

The constant speed drive is "trimmed" by means of a two phase servo motor adjusting the datum setting of the basic governor. The servo motor is controlled from the Frequency and Load Controller unit by the output from a frequency discriminator circuit operating into a magnetic amplifier for frequency control, and from a frequency discriminator monitor circuit, into the same magnetic amplifier when alternators are running in parallel for real load sharing.

The frequency discriminator circuit as shown consists of two tuned circuits L1, C1 and L2, C2, tuned for resonance at the upper and lower frequency limits of 450 and 350 C.P.S. respectively.

Assuming similar response characteristics for each L.C. circuit, at 400 C.P.S. the voltage across each coil and hence across R1 and R2 will be equal and opposite and no D.C. current will flow through the magnetic amplifier control coil. If the alternator output frequency drifts towards the resonant frequency of L1, C1, the voltage across R1 will be greater than that across R2 and current will flow through the magnetic amplifier control coil from R1 to R2. Similarly, if the frequency tends towards the lower limit current will flow in the opposite direction.

The single phase transformer feeding the tuned circuits has its primary between the alternator RED phase and earth. The current in the magnetic amplifier control coil circuit is rectified to D.C. by D1 and D2 respectively.

The magnetic amplifier consists of two transductors working in push pull. The A.C. coils on each transductor are split into two sections, one half of the coil of one transductor being in series with one half of the coil in the other transductor, to form a circuit across the primary winding of a reference transformer. A bridge rectifier network consisting of D7 and D5 is used to channel the current from the positive going half cycle through these coils. The coils are wound in such a way as to ensure that the magnetising flux in each transductor iron is in the same direction. The other two halves of the A.C. coils are also connected in series across the primary winding of the reference transformer, and the bridge rectifier network consisting of D6 and D8 channels the current from the negative going half cycle through them. The arrangement of the second set of coils is such that the current through them magnetises the transductor irons in the same polarity as the first set of coils. This arrangement gives the transductors a certain magnetising level which conventionally would be done by means of D.C. bias coils.

Both sets of A.C. coils are centre tapped and fed via the servo motor control winding to the centre tap of the primary winding of the reference transformer. Under conditions where the alternator frequency is stable at 400 C.P.S. there will be no D.C. component in the magnetic amplifier control windings. As the A.C. coils of the transductors are connected in push pull across the primary winding of the reference transformer, the centre tap of the coils and the transformer will be electrically, zero potential, due to the fact that both transductors have the same inductive impedance. No current will be present in the Servo Motor control winding.

When a D.C. component from the frequency discriminator circuit is present in the magnetic amplifier control windings it can be seen that the magnetising effect in one transductor will be to assist the magnetising effect of the A.C. component and to decrease the effect in the other. Direction of flow of the D.C. will determine the increase or decrease.

As the flux density of one transductor is increased, so the inductive impedance of that circuit will be decreased, and as the flux density of the other is decreased, so its inductive impedance is increased. This means that more current will flow in one transductor circuit than in the other and so the centre tap of the coils in the magnetic amplifier is no longer zero potential. Current will flow in the servo motor control coil.

/The servo

The servo motor trims the C.S.D. governer which in turn alters the output speed, the C.S.D. is adjusted and hence the alternator frequency is corrected to 400 C.P.S.

5. Type 450 Control Unit

Four type 450 control units, one for each alternator are fitted on the bottom of the forward bulkhead of the power compartment. Each unit contains the following components:-

a. TRI/REI Transformer/Rectifier unit to supply D.C. for alternator control relays.

b. TR2/RE2 Transformer/Rectifier unit to sense the alternator output voltage for Over/Under volt protection.

c. Trigger tube T.1 working in conjunction with overvoltage slave relay OVSR/2 for overvolt protection.

d. Undervolt and phase sequence unit operating in conjunction with Time Delay relay TD1 for under-volt protection.

e. Exciter control relay EC/6 to break the exciter field circuit in the event of an alternator fault developing.

f. Lock Out Relay LO/5, working in conjunction with EC/6 for field resetting when RESET push is operated.

g. Master Relay M/5, operating in conjunction with the alternator control switch on 10P.

h. Paralleling relay P1, operating in conjunction with the "synch" selector switch and push button for parallel operation of the alternators.

j. Differential protection relays DPA/1, etc., which are part of the MERZ PRICE system.

k. Rectifier RE4, a D.C. blocking rectifier to prevent the output from TR1/RE1 from being fed on to the aircraft essential bus bar.

l. Mutual reactor MR which is part of the Over/Undervolt protection available when the alternators are connected in parallel.

The control and operation of the above components are described in the following paragraphs in conjunction with further components which go to make up the complete alternator circuit.

6. Alternator Control and Operation (Single Running Alternator).

As stated in Part 1 alternators may be connected in parallel on the synchronising bus bar, or may be run singly. To connect the three phase output from the alternator to its respective load bus bar the 'A' breaker is closed. Closing of the 'S' breaker will connect the alternator output, if the 'A' breaker is closed, to the synchronising bus bar.

Circuit arrangements are made so that should an alternator failure occur, or if the alternator is not running and a 28V D.C. supply is available from the aircraft D.C. supply (Essential Bus-Bar), the 'A' breaker will open and the 'S' breaker close. This ensures that the individual load bus bar will be disconnected from the alternator and connected to the synchronising bus bar.

/7. D.C. Control

7. D.C. Control

With the alternator not running and assuming that a 28V D.C. supply is available from the aircraft essential bus bar, this supply is passed from an essential bus bar fuse via rectifier RE4 to the Control Unit D.C. bus bar. This supply is passed via the OFF position of the alternator control switch and via the normally closed Master Relay contact M5 to the coil of the 'A' breaker pilot relay. The relay is energised and its bottom contacts close to connect the 28 D.C. supply from the control Unit bus bar to the trip coil of the 'A' breaker. The 'A' breaker opens and disconnects the alternator from its load bus bar. At the same time the 'A' breaker auxiliary contact A5 closes to connect the 28V D.C. supply via the normally closed master relay contact M3, and the normally closed top contact of the 'S' breaker pilot relay to the 'CLOSE' coil of the 'S' breaker. The 'S' breaker closes and connects the load bus bar to the synchronising bus bar.

8. Exciter Control Relay

The exciter control relay EC/6 is a latched contactor and is primarily concerned with breaking the exciter field circuit under fault conditions. Contacts EC4, EC5 and EC6 are related to opening the 'A' breaker under fault conditions and will be dealt with later in this section.

The lock out relay LO/5 is designed to be instrumental in ensuring that, following fault conditions, if fault conditions remain whilst resetting action is being taken, the exciter control relay will not cycle whilst the RESET button is held in.

Any of the following fault conditions will cause the exciter relay to be tripped:-

a. Undervolting of the alternator.

b. Overvolting of the alternator.

c. Line to earth or line to line fault.

d. Crash switch operation.

When the exciter control relay trips its contacts EC2 two contacts in series - opens to open circuit the main shunt field of the exciter. The rotor field current is reduced and consequently the output of the alternator drops. Indication that exciter control relay has tripped is given by the fact that the 'A' breaker fail light on 1OP comes on and, if a selection is made on the 'synch' selector switch to the suspected alternator, no volts or frequency will be registered.

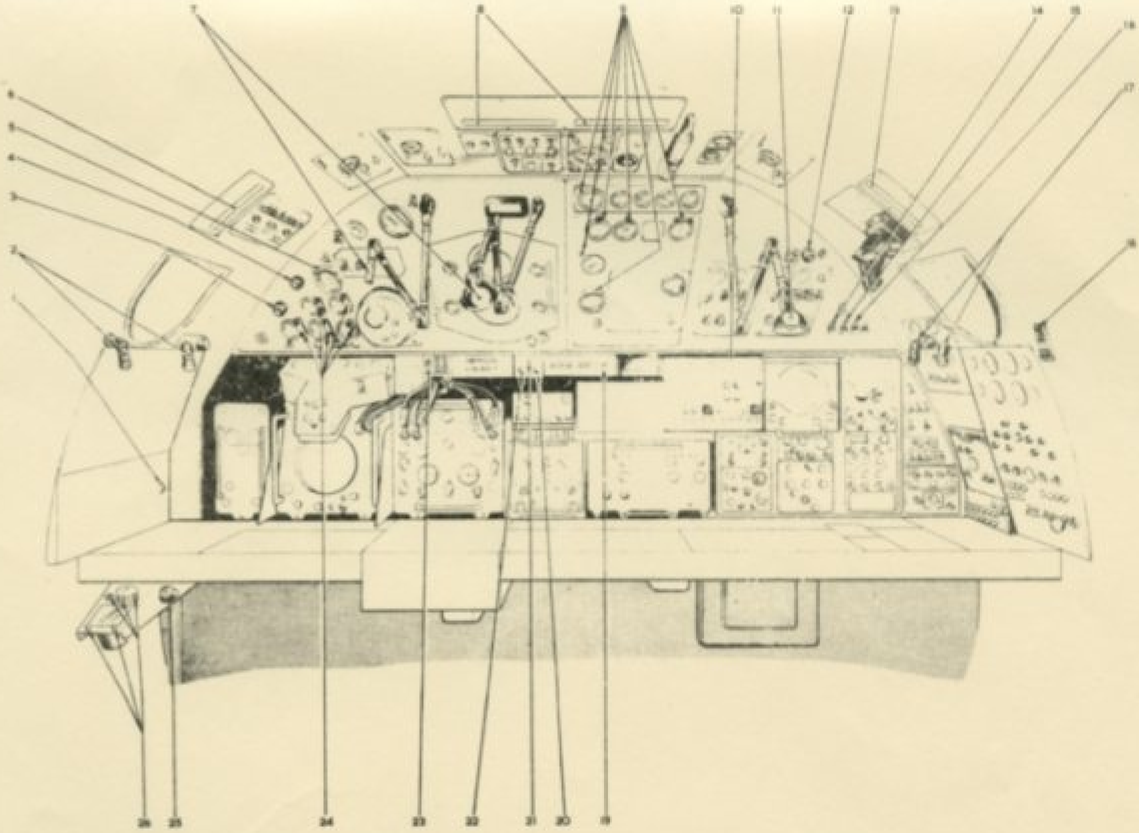
9. Resetting Action

To reset the exciter relay, the alternator control switch must be in the OFF position. When this is so, a D.C. supply from the Control unit bus bar is passed via the alternator control switch contacts to the Reset button. Pressing the Reset button will pass this D.C. supply via the Lock out relay contacts LO1 and LO4, in series, to close coil of the exciter control relay.

The relay is energised and contact EC1 closes to prepare the 'fault sensing' circuit, EC2 (both) close to complete the exciter field circuit and EC3 closes to pass the same D.C. supply from the Reset button to the coil of the Lock Out relay LO/5. Relay LO/5 is energised and its contact LO2 closes to make a 'hold in' circuit to the coil of its own relay, thus ensuring that the relay remains energised should the exciter control relay again trip whilst the Reset button is held in.

LO1 and LO4 open to remove the D.C. supply from the close coil of the exciter control relay, but as this relay is a latched contactor it remains closed until a further fault condition allows a supply to be made to the trip coil.

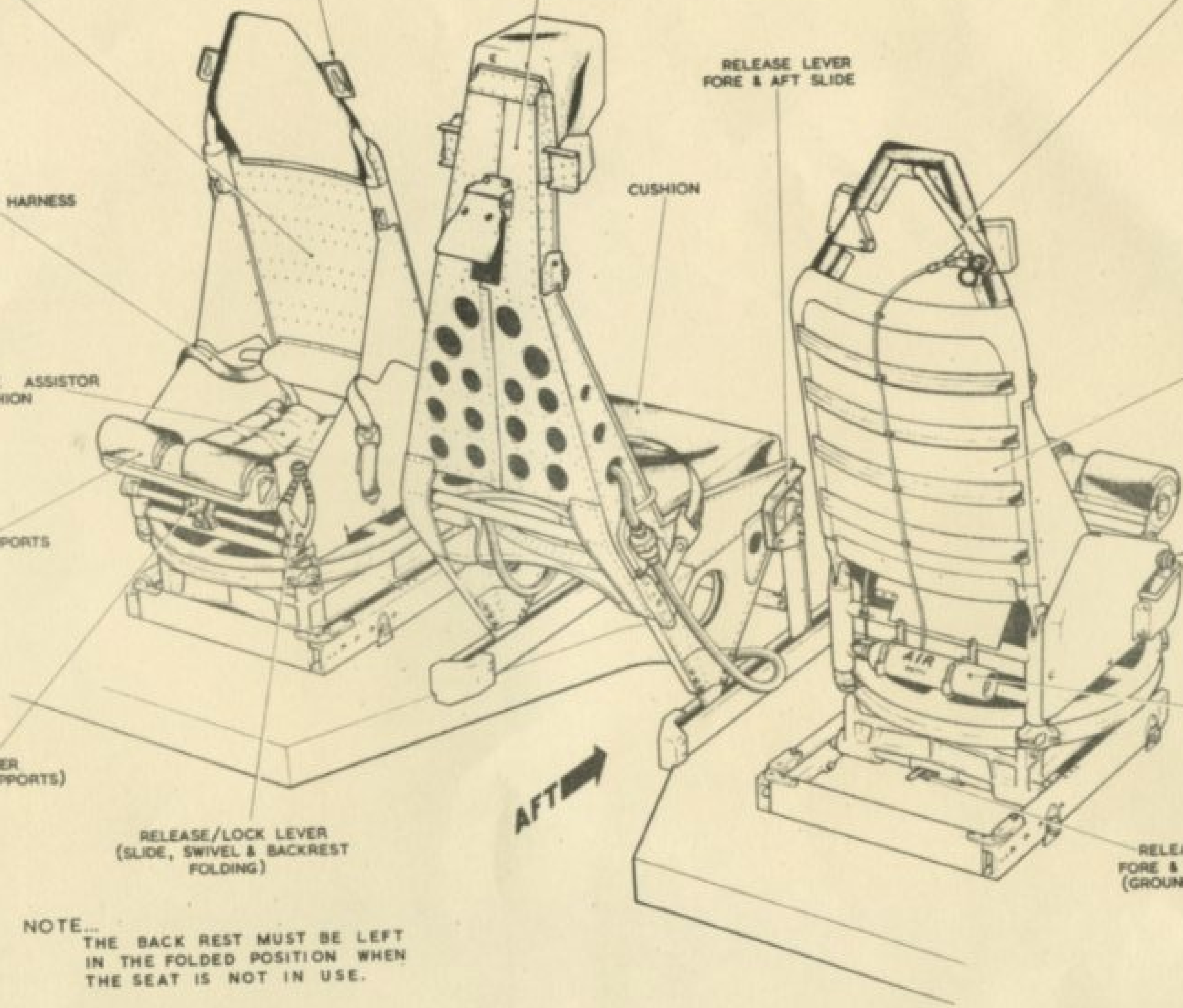
/10. Transformer



KEY TO DIAGRAM NO. 23:16
Location of Components

1.	Lamp Switch	Nav. Bomber
2.	Lamp and Dimmer Switches	9P
3.	Dimmer Switch	Nav. Bomber's Chartboard Lamp
4.	Dimmer Switch	Temperature Gauge Lamps
5.	Gauge Lamp	Bomb Bay Temperature
6.	U/V Red Fluorescent Lamps	Roof (Starboard)
7.	Chartboard Lamps	Nav. Plotter and Nav. Bomber
8.	U/V Red Fluorescent Lamps	Roof (Centre)
9.	Pillar Lamps	Nav. Plotter's Inst. Panel
10.	Diffused Lighting	94P
11.	Chartboard Lamp	A.E.O.'s Station
12.	Dimmer Switch	(Item 11)
13.	U/V Red Fluorescent	Roof (port)
14.	On/Off Switch	(Item 13)
15.	On/Off Switch	Main Cabin Lamp
16.	On/Off Switch	Lamp Under Nav.'s Table
17.	Lamps and Dimmer Switch	Above 70P
18.	Lamp	I.L.S. and Auto Throttle Supply Panel
19.	On/Off Switch	(Item 6)
20.	Dimmer Switch	(Item 10)
21.	Dimmer Switch	Nav. Plotter's Chartboard Lamp
22.	Dimmer Switch	(Item 9)
23.	Off/Bright Switch	Anti Dazzle Lamps
24.	Gauge Lamps	Nav.'s Radar Panel (Blue Steel)
25.	Dimmer Switch	Pillar Lamps (Control Unit Type)12580 Mountings
26.	Pillar Lamps	Control Unit Type 12580 Mountings

F.S./5



NOTE...
THE BACK REST MUST BE LEFT IN THE FOLDED POSITION WHEN THE SEAT IS NOT IN USE.

Fig. 4. Crew Seats.

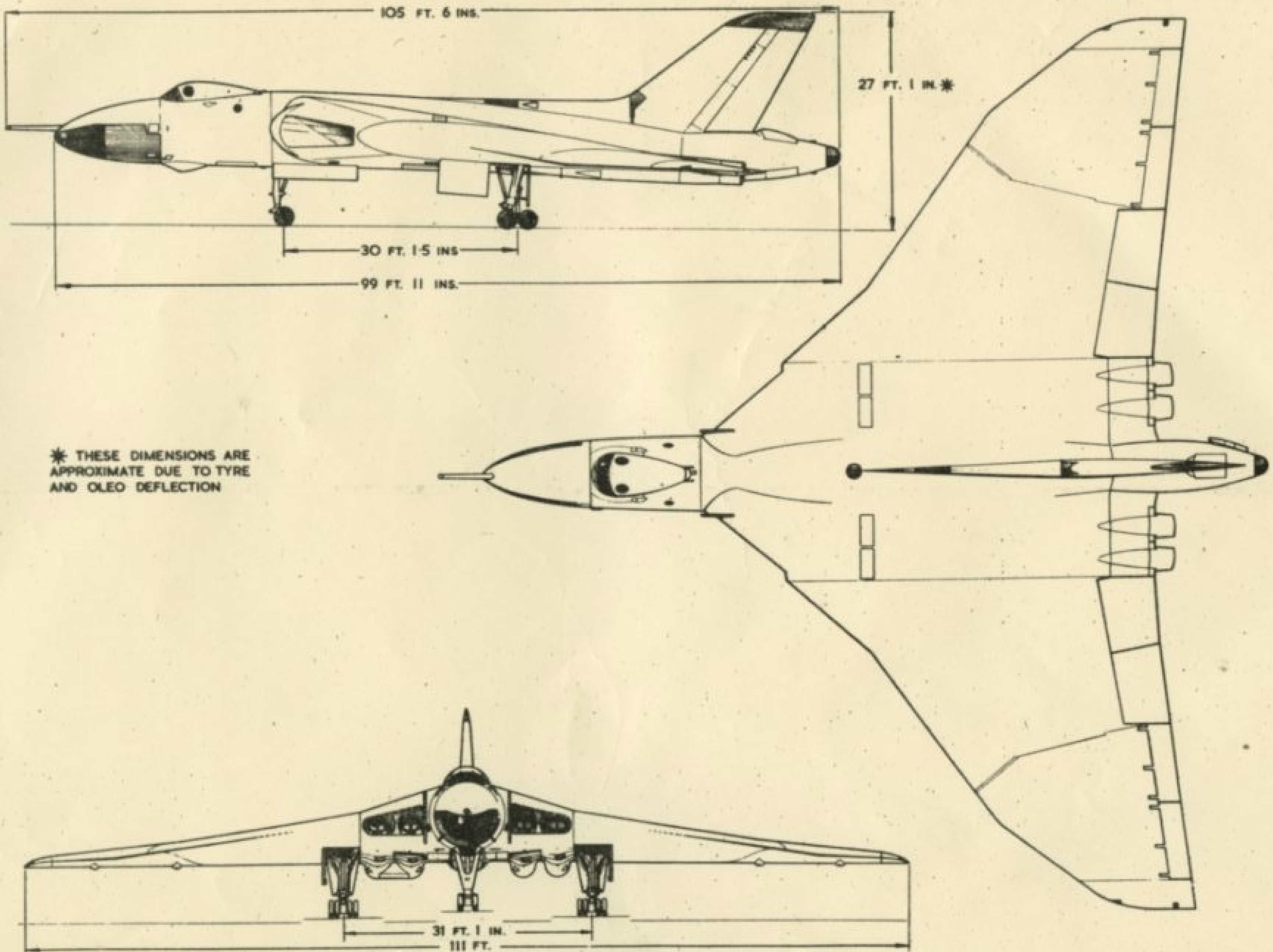
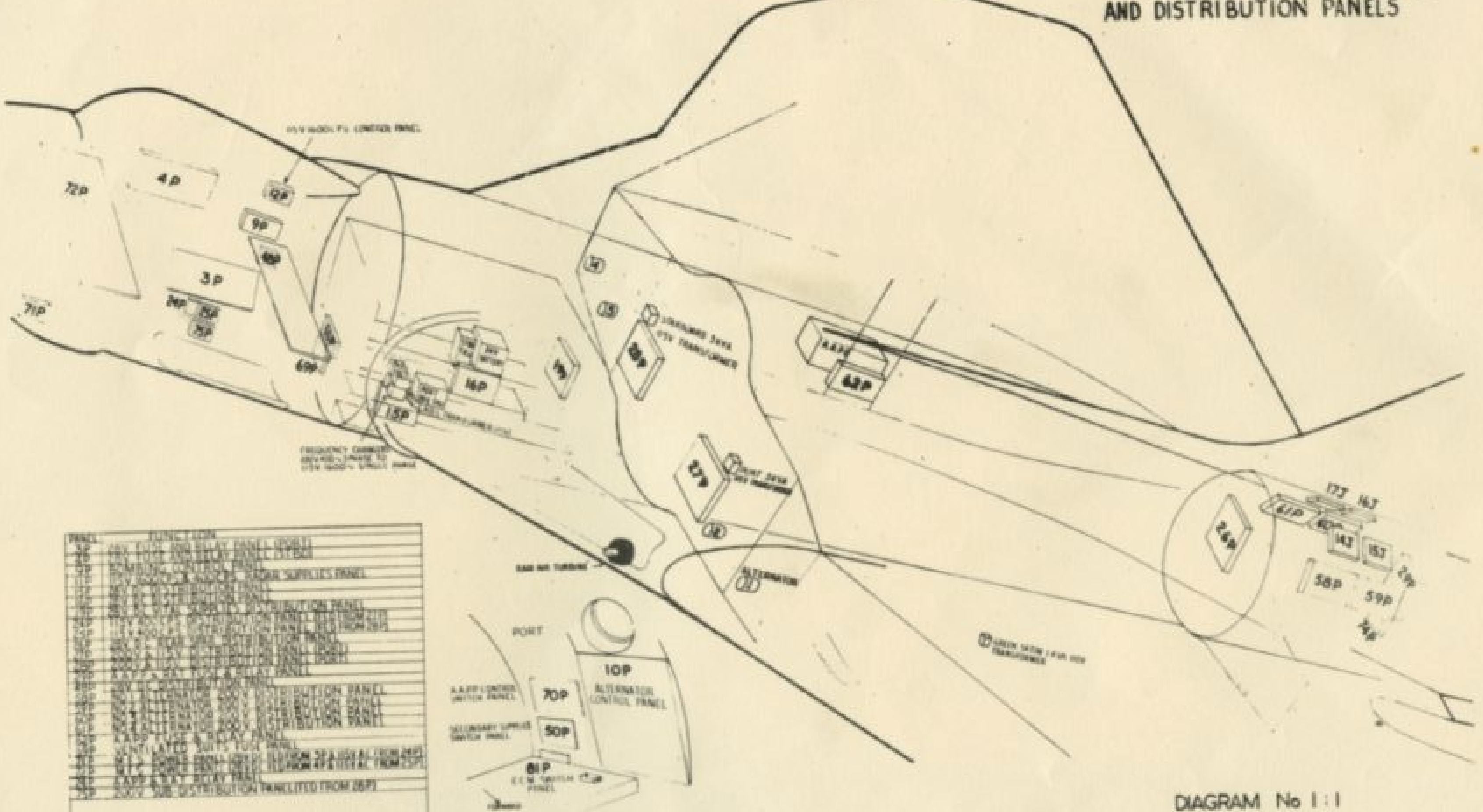


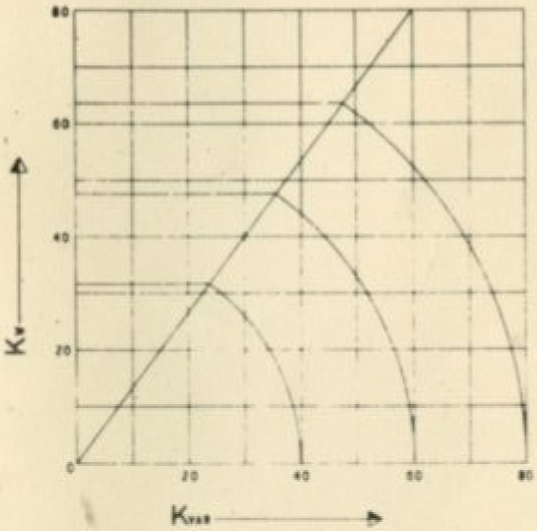
Fig. 1. General arrangement.

VULCAN MK2 MAIN CONTROL AND DISTRIBUTION PANELS



PANEL	FUNCTION
3P	28V FUSE AND RELAY PANEL (PORT)
4P	28V FUSE AND RELAY PANEL (STBD)
9P	[illegible] PANEL
[illegible]	BOMBING [illegible] RADAR SUPPLIES PANEL
12P	115V 1600C/S CONTROL PANEL
[illegible]	28V DC DISTRIBUTION PANEL
[illegible]	28V DC VITAL SUPPLIES DISTRIBUTION PANEL
[illegible]	115V 400C/S DISTRIBUTION PANEL (FED FROM 27P)
[illegible]	115V 400C/S DISTRIBUTION PANEL (FED FROM 28P)
[illegible]	28V DC REAR [illegible] DISTRIBUTION PANEL
[illegible]	200V A.C. [illegible] DISTRIBUTION PANEL (PORT)
[illegible]	200V A.C. [illegible] DISTRIBUTION PANEL (STBD)
[illegible]	200V A.C. FUSE & RELAY PANEL
[illegible]	A.A.P.P. A.C. DISTRIBUTION PANEL
[illegible]	NO 1 ALTERNATOR 200V DISTRIBUTION PANEL
[illegible]	NO 2 ALTERNATOR 200V DISTRIBUTION PANEL
[illegible]	NO 3 ALTERNATOR 200V DISTRIBUTION PANEL
[illegible]	NO 4 ALTERNATOR 200V DISTRIBUTION PANEL
[illegible]	A.A.P.P. FUSE & RELAY PANEL
[illegible]	VENTILATED SUITS FUSE PANEL
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	A.A.P.P. [illegible] RELAY PANEL
75P	200V SUB DISTRIBUTION PANEL (FED FROM 28P)
142	NO 1 ALTERNATOR LOAD SHARING JUNCTION BOX
[illegible]	NO 2
[illegible]	NO 3
[illegible]	NO 4
[illegible]	NO 4

DIAGRAM No 1:1



GREEN		CONTINUOUS RATING
PINK		5 MINUTE RATING
RED		5 SECOND RATING

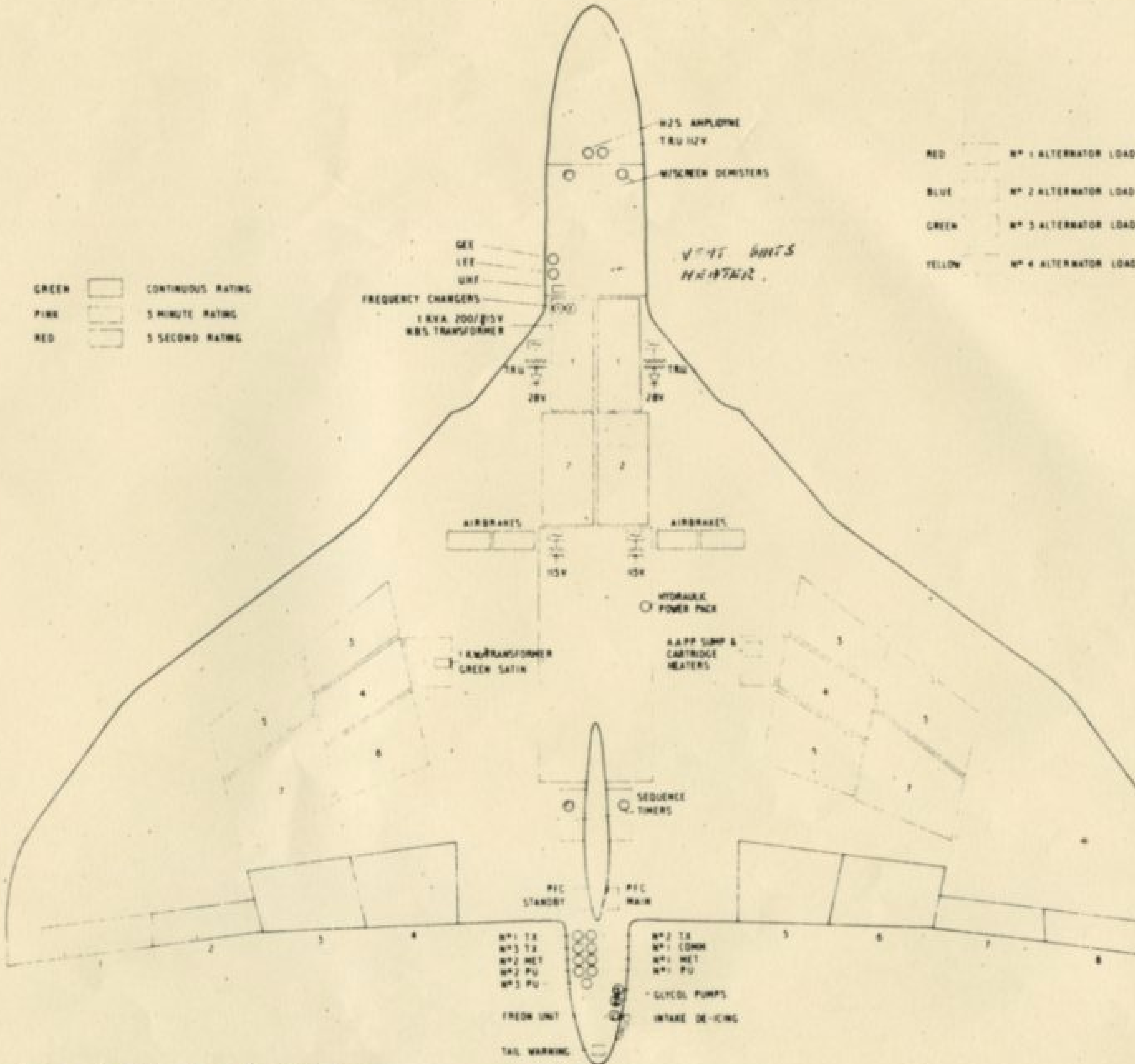


FIG N°

PLAN VIEW AIRCRAFT.

10. Transformer/Rectifier TRI/REI

The three phase output from the alternator is taken to the primary winding of the DELTA/STAR step down transformer TR1. The STAR connected secondary winding output, is rectified by the bridge rectifier RE1 and passed to the control unit D.C. bus bar.

This supply is now paralleled with the aircraft D.C. supply but is prevented from feeding the aircraft D.C. bus bars by the rectifier RE4.

11. Switching on the Alternator

When the Constant Speed Drive reaches an output of 5,400 r.p.m. the limit governer operates the DRIVE UNDERSPEED/OVER-SPEED PRESSURE SWITCH and the switch closes to prepare a path to the alternator master relay.

When the alternator control switch is placed to the "ON" position, a D.C. supply is passed from the control unit bus bar, via the switch contacts, the underspeed/overspeed switch contacts, relay contact EC4 and relay contact UV1, to the MASTER RELAY. Contact M4 closes to energise the 'S' breaker pilot relay and its bottom contact closes to pass a supply to the TRIP coil of the 'S' breaker.

The 'S' breaker opens and a supply is passed via the master relay contact M2 and the 'S' breaker auxiliary contact S5 to the CLOSE coil of the 'A' breaker. The 'S' breaker is now OPEN and the load bus bar is disconnected from the synchronising bus bar. The 'A' breaker is closed and the alternator output is connected to the load bus bar.

12. Over and Undervolt Protection

To ensure against the possibility of some defect causing the alternator to give excessive and persistent under/over-volt output, an undervolt and phase sequence unit working in conjunction with a time delay network and relay, and a cold cathode trigger tube with a resistor network and slave relay, are fitted to make the alternator inoperative under such conditions.

A DELTA/STAR transformer fed from the same fuses as TR1/RE1 has two separate voltage tapping points on its secondary winding. One voltage of 115V is taken to the undervolt and phase sequence unit, and the other voltage of 170V is fed to the rectifier bridge RE2. The D.C. output from the rectifier is fed across a Resistance Condenser network to the anode and trigger of the trigger tube.

When the alternator output starts to build up, and providing the phase sequence is correct, at an output line voltage of 178V $\pm$ 11.3 volts the contacts of the undervolt unit relay close to prepare the path to the alternator MASTER relay. Should the alternator output drop below 17 3 $\pm$ 7.7 volts at any time, contacts of the unit will open to break the path to the Master Relay. Contact M1 will pass 28V to the TIME DELAY resistance/capacity network and relay TD/1. The master relay being de-energised has no immediate effect on the control circuit as all its contacts except M1 are in circuits which are non-effective until the exciter control relay EC/6 has tripped.

After a delay of .26 - .36 seconds the condensers in the delay network are charged and the potential developed cause relay TD/1 to be energised. The contact TD1 closes to connect a D.C. supply to the trip coil of the exciter relay. Relay contact EC6 closes to connect a D.C. supply to the 'A' breaker pilot relay, whose bottom contact closes to connect a supply to the TRIP coil of the 'A' breaker. The 'A' breaker opens and dis-connects the alternator from its load bus bar and its bottom auxiliary contact A5 closes to pass a supply via the master relay closed contact M3 to the CLOSE coil of the 'S' breaker.

The 'S' breaker closes to connect the alternator load bus bar to the synchronising bus bar. When the exciter control relay EC6 was de-energised its contacts EC2 opened to break the exciter field circuit.

/Should

Should the alternator line voltage increase to 220V and persist, the D.C. output from RE2 will increase to charge condensers C1 and C2 in the overvolt resistance/capacity network. After a delay which has an inverse time/voltage characteristic, the resultant potential will cause the trigger tube to "strike" and the anode current produced will energise the overvolt save relay OVSR2. Contact OVSR2 closes to connect a 28V D.C. supply to the TRIP coil of the exciter control relay EC/6. The other contact, OVSR1 closes to make an earth return for its own relay coil thus ensuring the relay remains energised until the exciter control relay operates.

When relay EC/6 is de-energised the exciter field circuit is broken and the 'A' breaker tripped. Contact EC5 opens to remove the D.C. supply from the trigger tube circuit.

13. Under/Overspeed Protection

Should excessive over or underspeed conditions exist in the CONSTANT SPEED DRIVE, the Drive Underspeed/overspeed Pressure switch will operate and trip its associated switch. The main contacts of the s/w will de-energise the master relay and the back contacts of the s/w will make a supply circuit via the relay contact M5 to the 'A' breaker pilot relay. The pilot relay bottom contacts close and pass a supply to the TRIP coil of the 'A' breaker to disconnect the faulty alternator from its load bus bar. The 'S' breaker closes to connect the load bus bar to the synchronising bus bar. The exciter field circuit is NOT broken under such conditions.

If an underspeed fault is cleared, the alternator may again be switched on, but should the fault be an overspeed condition, hydraulic arrangement in the governer system will create a lock out condition on the pressure switch, which cannot be broken whilst the aircraft engine is rotating. Consequently the alternator is inoperative whilst the condition exists.

14. Differential Protection (Kerz Price)

This system detects line to line and line to earth faults on the alternator feeder system from the STAP point to the load distribution fuses. A current transformer round each alternator neutral lead is looped in series to a similar current transformer round each phase feeder and a A.C. operated relay is connected across each loop.

Consider one loop, under normal conditions current in each transformer will be of equal value and as they are basically connected to form a series loop, current will flow in the loop. The A.C. relay is wired across the loop so under normal conditions no current will pass through its coil. However should a fault develop on the phase feeder the current in the transformer in the neutral line will be increased and no current will flow in the phase feeder transformer. The high current from the transformer in the neutral line will pass through the A.C. relay and it will operate. Its contact closes to energise the exciter control relay trip coil and the exciter field circuit will be broken and the 'A' breaker opened.

15. Crash Switch Operation

Should the aircraft experience a forward decelleration of 3G, the crash switch, situated in the crew cabin will operate A 28V D.C. supply from the aircraft vital bus bar will be passed via the crash switch to the TRIP coil of the exciter control relay. The field circuit of the exciter is broken, and the alternator is taken off line by the action of the 'A' breaker opening.

16. Indication

As described in Part 1, a mimic diagram of the alternator connections to the bus bar is depicted on the A.E.O's control panel 10P. When the 'A' breaker is open the auxiliary contact A3 passes a D.C. supply to the amber failure light on the mimic diagram on 10P. The same supply is passed to the ALTERNATOR

FAILURE circuit arrangement and the red light situated in the centre of the mimic diagram on 10P will light. When the 'A' breaker closes the supply is removed from these circuits and the lights go out.

Volts and frequency indication for a particular alternator is given in the INCOMING MACHINE Meters if the alternator is selected on the 'synch' selector switch on 10P. It must be remembered that the voltage indicated will be 115V as the voltmeter is connected between YELLOW phase and earth.

'Real' load being supplied by the alternator is indicated on that particular machines K. Watt meter on 10P. To read 'Reactive' load the push marked 'PUSH FOR K.VAR' on 10P is pushed and circuit changes occur in the meter circuit to allow KVARS to be indicated. A Kwatt/KVAR ratio chart is fitted at the A.E.O's station to allow comparisons to be made for correct operation.

Parallel Running of Alternators

17. General Description

Alternators operating in parallel must be controlled to ensure that the load divisions are maintained inside the prescribed limits. The load Sharing circuits are capable of sensing and correcting to meet this necessity providing the unbalanced load conditions are of a transient nature, due to normal load switchings and speed changes. Should the unbalanced load conditions be sustained, and therefore deemed to be a fault condition, the Protection Circuits will be required to discriminate between the alternator outputs to ensure that only the faulty alternator is 'tripped' and the serviceable alternators are not subject to 'nuisance tripping'. The protection circuits are set to operate as for single running alternator.

The primary control systems used for a single running alternator, (i.e. Voltage Regulation and Frequency Discrimination circuits) are still used for alternators operating in parallel, but require a further monitoring system to allow the necessary selective functioning. When alternators are connected in parallel their terminal voltages will be the same, but a difference of excitation or of speed can create a condition where one or more alternators will attempt to supply most of the power. Monitoring circuits fed from current transformers on the phase feeders are used to correct the condition. A 90° phase shift transformer circuit fed from a current transformer on the BLUE phase makes corrections to the excitation level of the faulty machine and a frequency discriminator monitor circuit fed from a C.T. on the RED phase feeder will trim the speed. Thus the out of phase lagging current i.e. reactive component, is used to correct excitation and the inphase real component is used to correct speed.

These monitoring circuits are only effective for those alternators whose outputs are connected in parallel, the relevant circuits being rendered inoperative if an alternator is running on its own.

Differential Protection, Over and Underspeed protection are unaffected in the case of alternators operating in parallel, and will therefore, afford the protection inside the same limits as for a single running alternator.

The Over and Undervoltage Protection, like the voltage Regulation Control System, requires a monitoring system to meet the requirement of Alternators operating in parallel.

18. Switching Requirements for Parallel Running

All the switching that is necessary for parallel running is a means whereby the 'S' breaker may be closed with the 'A' breaker already closed. Hence energising the Paralleling relay in one of the type 450 control units will automatically close the appropriate 'S' breaker. These paralleling relays can only be energised via the Push Switch of the Alternator-Selector and

/Synchronising

Synchronising Switch. To meet the standby/failure Condition of Alternators an extension to the above has been made with regard to No. 2 Alternator only, and this will be explained more fully later in this Section.

When the Synchronising Network is not being fed from any source, transferring an Alternator output on to the network, is simply a case of closing a breaker to connect 2 Bus-Bars. Should an Alternator output be feeding the Synchronising Network, another alternator output can only be connected to this network when the voltage waves of the two outputs are in step with one another. A Synchronising Monitor Unit, is introduced into the system to ensure that this condition is met, and an Interlock Circuit is used to feed the supply to the Synchronising push button, thereby ensuring that it is possible only to parallel the Main Engine Alternators with each other. The standby Supplies Alternators (i.e. A.A.P.P., R.A.T. and G.P.U.) cannot be paralleled with a Main Engine Alternator, nor with each other. (See Section 2, Part 3).

19. Alternator Switching for Parallel Running

With no Alternator supplying the Synchronising Network, any of the Main Engine Alternator outputs can be transferred to the network. On selecting that particular Alternator on the Alternator Selector and Synchronising Switch, the incoming Alternator Instruments will indicate its phase voltage (i.e. 115 Volts R.M.S.) and Frequency (i.e. 400 cycles per sec.) and providing these readings are within the accepted limits, the Push Switch of the Alternator Selectro and Synchronising Switch can now be pushed. The interlock circuit will prove the Synchronising Network to be free of any other supply and the Paralleling Relay in the Control Panel of the selected Alternator will operate to close its 'S' Breaker.

In the case of No. 2 Alternator a slight extension to the circuit has been made. This ensures that if there is no supply, feeding the Synchronising Network and No. 2 Alternator is Running and supplying its own load (i.e. it is Switched 'ON') the Interlock Circuitry will energise the Paralleling Relay of No. 2 Alternator Control Panel and therefore the 'S' breaker of No. 2 Alternator will close.

NOTE:- With a Main Engine Alternator feeding the Synchronising Network and the Alternator Selector and Synchronising Switch still Selected to the same Alternator both the Incoming Alternator and the Bus-Bar instruments will be indicating the voltage and frequency of the same supply. This will afford the opportunity of comparing the two sets of instruments for accuracy.

To synchronise the output of one Main Engine Alternator with another, the second alternator must be selected on the Alternator Selector and Synchronising Switch. This means Incoming Alternator Instruments will now be reading the Second Alternator volts and frequency and providing these are within limits, the Push Switch can be pushed until the Dolls Eye indicator of the 'S' breaker of the second Alternator shows the breaker to be closed. This is accomplished by the automatic action of the Synchronising Monitor Unit.

20. Synchronising Monitor Unit

This unit compares the yellow phases of the Synchronising network with the yellow phases of the Incoming Alternator by means of a bridge rectifier RE1. A phase difference is necessary to operate the unit, and if there is none, it can be induced by a speed or load change to the incoming alternator. The phase difference produces a D.C. output from RE1 which energises RLB connecting a condenser C1 across the output and charging it up. When the yellow phases subsequently get in phase again there will be no output from RE1, and RLB will be de-energised. C1 discharges through the top contact of RLB and energises RLA. The bottom contact of RLA passes a supply to the Synchronising Push Switch and the paralleling relay is energised. The normally closed top contact of RLA can only make a supply to the synchronising push switch if there is nothing on the Synchronising Network.

21. Reactive Load Sharing

Since the Voltage Regulation Control system depends on voltage sensing, and alternators in parallel will share the fault voltage, a current sensing monitor is necessary for load sharing. If an alternator output should tend to rise it will take more than its normal share of the available load, hence an increase in the phase current of that particular alternator. The remaining alternators in parallel, between them, must of course, be shedding this amount of load, and therefore their phase currents will be reduced.

By using a current transformer these current phase changes can be used to develop a voltage signal to be fed into the voltage regulator control system. The voltage is developed across resistor R1 connected in a transformer resistance circuit. If there is no unbalance between alternators then there will be no voltage developed on R1.

When an unbalance of alternators takes place a voltage will be developed on R1. This causes an unbalance of the resistance network on transformer T2 and current will flow in the control winding of transductor T6. This will cause a change in field pulse width, as in voltage control, and hence a change of output of the alternator. When the alternators balance then again no voltage on R1 and the circuit has no effect on regulation.

When an alternator is in single running conditions, a short circuit is placed across the current transformer thus rendering this circuit inoperative.

22. Real Load Sharing

Changes of phase between alternators running in parallel will cause alternator real outputs to vary so the load sharing between alternators must vary. If one alternator is ahead of phase relative to the others in parallel with it, it will be supplying most of the power to the consumers. As the outputs are connected together, and have the same frequency, the frequency controllers of each machine cannot distinguish between them. Therefore a real load sharing monitor circuit is included in the frequency and load controller units.

These load sharing monitor circuits feed a further set of control coils in the frequency discriminator magnetic amplifiers which control the constant speed drive trimmer motors and these control coils are connected between two ring mains only when their respective 'A' and 'S' breakers are closed. When either an 'A' or 'S' breaker is open the relevant control coil from this monitor circuit is open circuited and thus ineffective.

Detection of phase change is by a current transformer on the Red phase feeder and is used to develop a voltage on resistor R7 in the resistive network supplied by the transformer. This causes a voltage to be developed across P1.

This voltage is then connected via the control windings of the Nos 1 and 2 transductors, the ring main circuit to the output of a second detector, which is also developing a voltage on its P1 relative to phase current of its alternator.

If the outputs of the alternators are balanced then no current will flow between the detectors as the two outputs will be equal. If however the outputs are unbalanced then current will flow between the detectors due to unequal outputs.

This current flows through the control windings of the magnetic amplifiers thus causing the two phase servo motors to run in order to balance the outputs of the two alternators.

23. Over and Under Reactive Protection

Should the Reactive Load Sharing circuit be unable to cope with a condition of Reactive Load unbalance, large circulating reactive currents would give overheating in the armature. To prevent this the Over and Under Voltage Protection must operate in a selective manner to remove the faulty alternator only.

/This protection

This protection system like the Voltage Regulation Control system will, during parallel running, receive incorrect voltage signals should fault conditions arise, unless a further monitoring circuit is introduced. This is similar to the Reactive Load Sharing Circuit and uses the Reactive Component to operate the over or undervolt protection system.

The same components are used when alternators are connected in parallel as for single running machines, but as both the trigger tube and torque switch are voltage controlled all alternators would react to a faulty voltage from one machine. To ensure selectivity, current transformers on the yellow phase feeder from each alternator feed one winding of a mutual reactor in the yellow phase to the over/under volt transformer and are connected in a series ring (double ring for safety). When a particular alternator is running singly the relevant 'A' or 'S' breaker auxiliary contacts will place a short across the secondary winding of the current transformer rendering it inoperative.

When two or more alternators are connected in parallel, should the load division between alternators exceed 21 KVAR the reactive load sharing arrangements can no longer make the necessary corrections. In this case the over/under volt current transformer will sense the high or low current from the faulty machine and inject such a signal via its mutual reactor into the primary winding of the over/under volt transformer TR2.

This current undergoes a 90° phases shift in the mutual reactor and will increase or decrease the primary winding voltage of TR2. If the output voltages from TR2 come outside the operating limits the over or undervolt protection circuits will operate to open circuit the exciter field of the faulty alternator and switch it off line.

24. Over and Underspeed Protection

This protection as previously stated is not affected by parallel running and therefore will operate to remove the faulty alternator should its Drive output speed fall below 5,400 r.p.m. or above 6,300 r.p.m. The hydraulic lock on the Drive governor assembly will be operative in the case of overspeed just as it was for the single running alternator.

Speed fluctuations inside these speed limits will of course bring about unbalance of real load divisions between alternators, but this will be sensed by the Real Load Sharing circuits, which will operate to correct it.

25. Alternator Failure Flashing Circuit

Apart from the normal alternator amber failure light in the mimic diagram on 10P, a further indication of alternator failure is given by a red light fitted above the mimic diagram on 10P and by a further red light connected in parallel with it fitted on the pilots coaming. When any one alternator is off line, i.e. its 'A' breaker is open, both red lights will be lit.

Should more than one 'A' breaker be open at the same time the red lights will 'flash'. To ensure that the A.C. system is not overloaded when two or more alternators are off line the system is designed to load shed part of the E.C.M. equipment.

Assuming that all alternators are switched on, the auxiliary contacts of their 'A' breakers will be open and no D.C. supply will be fed to the failure flashing circuit. Should one 'A' breaker open the auxiliary contact closes and a 28V D.C. supply is fed from the type 450 control unit bus bar via a silicon rectifier diode and the closed contacts of relay 559 (load shedding relay) to the alternator failure warning lamps. The negative return for the lamp is made via the normally closed contacts of the multivibrator relay.

In the event of two or more alternator 'A' breakers being open at the same time a 28 volt D.C. supply is passed via the auxiliary contacts and the silicon rectifiers to the Base and Emitter of at least one of three transistors. The transistor conducts and a voltage is applied to the Base of a further transistor, which has its collector/emitter connected to a 28V supply from fuse 479/26P via the coil of the multi vibrator relay. This transistor conducts and the Emitter current will cause the relay to be energised.

Two of the relay contacts break the earth return for the E.C.M. Another contact connects the 28V D.C. from the 'A' breaker auxiliary contacts via suitable resistors to the bases and one emitter of two transistors forming a multi-vibrator circuit, and a further contact of the relay connects the warning lamps negative return via a 1 K. ohm resistor to reduce the filament current sufficiently to give a 'light out' impression.

The multi vibrator 50 micro farad condenser charge and discharge in sequence to allow the transistors to conduct in push pull. When the left hand transistor of the multi-vibrator circuit is conducting it makes a short circuit across the 1 k.ohm resistor in the lamp circuit and the light goes bright, but as soon as the transistor base voltage is removed by the action of the 50 micro farad condenser the transistor stops conducting and the resistor is again inserted in the lamp circuit to reduce the filament current.

When the R.A.T. is lowered into the slipstream No. 2 micro-switch will cause the 28V D.C. Non Essential bus bar to be disconnected from the 28V supply, thus relay 559 will be de-energised and the warning lamp circuit will be broken. The failure warning lights circuit will be operative again if during the above condition the NON ESSENTIAL SUPPLY RESET SWITCH on 10P is placed to RESET.

26. A.C. Bus Bar Loads

The aircraft 200 volt 3PH, 400 C.P.S. distribution to consumers is mainly from the four A.C. main distribution panels 58P, 59P, 60P and 61P on the port and starboard side walls of the Power Compartment. The sub-distribution panels 27P and 28P on the front bulkhead of the bomb bay are fed from the main distribution panels VIZ: 58P and 59P each feeding a portion of 27P, and 60P and 61P each feeding a portion of 28P.

A further panel 75P situated in the crews cabin and carrying mainly the N.B.S. 200V fuses is fed from No. 4 Alternator via 28P, whilst 69P, also situated in the crews cabin and carrying the 200V fuses for ventilated suits is fed from No. 3 Alternator via 28P. The fuses on 69P are not 'live' until the ventilated suit master switch is put to the 'ON' position.

A further panel 14P located in the E.C.M. compartment and carrying the 200V fuses for the E.C.M. is fed from Nos 1, 2, and 3 alternators via 58P, 59P and 60P.

27. Fuses

Two types of fuses are used on both the main and subdistribution panels, they are the 'shrouded' type fuse and the 'end on' screw in type fuse. Each phase of the three phase system to a consumer has the same fuse number, i.e. 100 Red, 100 Yellow and 100 Blue. Fuse identification in the aircraft is by colour as well as number. A list of fuses on each panel is listed on the inside of the panel doors.

28. Interconnection of Panels

When alternators are running in parallel panels 58P, 59P, 60P and 61P are interconnected through the triple feeder network system to the synchronising bus bar. (See Section 2 Part 3). The connection from the 'A' breaker to the load bus bar is made via three 50 amp fuses for each phase. The connection from the main distribution panels to the sub-distribution panels is made via three 40 amp fuses for each phase, and each feeder is fused at both ends. Three feeders for each phase make the connection and the feeders are routed through different

/troughs

troughs in the bomb bay. This is to ensure that should damage occur to one cable at a particular place, continuity to the sub-distribution panel will be maintained.

SECTION 2 PART 3

SYNCHRONISING NETWORK

29. General Description

The synchronising network is a bus bar and feeder network situated in the aircraft power compartment. The network is an arrangement of TRIPLE FEEDERS connecting each phase from each alternator 'S' breaker via three different routes, and by separate fuses, to the synchronising bus bar proper, which is situated on 29P on the rear bulkhead of the power compartment. Each feeder is fused by a 50 amp fuse at each end.

The phases fuses, relative to each alternator, are rated at 50 amps each and are fitted on 58P, 59P, 60P and 61P respectively. The 12 interconnecting fuses on the 'synch' bus bar are also rated at 50 amps and are fitted on 29P on the left rear face of the power compartment, facing rearwards.

The synchronising bus bar has no consumer load connected to it and is used only as a medium for paralleling alternators. The G.P.U. R.A.T. or A.A.P.P. may be connected to the synchronising bus bar if no supply is already connected to it.

Although all four aircraft alternators may be paralleled together on the 'synch' bus bar, they cannot be paralleled with either the R.A.T., A.A.P.P. or G.P.U. Further, any of the extra services cannot be paralleled with each other. This arrangement is ensured by operation of a VOLTS PICK UP UNIT fitted to the 'synch' bus bar.

The Volts Pick Up Unit consists of two 200 volt operated relays, one connected via a half wave rectifier between the Red and Yellow phases of the 'synch' bus bar and the other via another half wave rectifier, between the Blue and Yellow phases. Each relay has four normally closed contacts and the contacts of each relay are connected in series with each other. When a 200V A.C. balanced supply is connected to the 'Synch' bus bar, both relays will be energised and their contacts open to ensure that if the main alternators are supplying the synch bus bar, the R.A.T., A.A.P.P. or G.P.U. breakers cannot be closed, or alternatively if one of the standby supplies is connected to the bus bar, the main alternators or the other standby supplies are held off.

30. Ground Power Unit and Interlock Network

To allow testing and running of aircraft electrical equipments without utilising the aircraft alternators, a mobile ground power unit trolley (G.P.U.) is available. The G.P.U. is fitted with a 60 KVA 3 phases 400 C.P.S. alternator, which may be connected via a plug and socket arrangement to the aircraft synchronising bus bar. The aircraft plug has six pins and is fitted on the port side of the fuselage beneath the power compartment.

The synchronising bus bar consists of a bus bar on 29P to which the paralleling fuse network for the main alternators is connected. The alternators for the A.A.P.P., the R.A.T. or the G.P.U. may also be connected to it. The interlock circuit is designed to ensure that although the main alternators may be connected together to run in parallel none of the standby supplies i.e., A.A.P.P., R.A.T. or G.P.U. may be paralleled with each other, or paralleled with any of the main alternators. The system further ensures that should No. 2 alternator be running, switched on and connected to the synchronising bus bar, pushing the A.A.P.P. 'ON' button will automatically isolate No. 2 alternator from the 'synch' bus bar, or alternatively if the G.P.U. supply is on the 'synch' bar, pushing the A.A.P.P. 'ON' button will isolate the G.P.U. and in both cases this operation will replace the isolated supply with the output from the A.A.P.P. if it is running.

The interlocking circuit consists of four 28V D.C. operated relays and a synchronising bus bar Volts Pick Up Unit (S.V.P.U.). Relay 389/74P is the Ground Power Unit interlock relay, 392/74P the A.A.P.P. interlock relay and relay 390/74P the Extra Supplies Trip relay. Relay 391/74P is energised whenever No. 2 alternator 'A' breaker is closed and its function is to trip the R.A.T. breaker under such conditions.

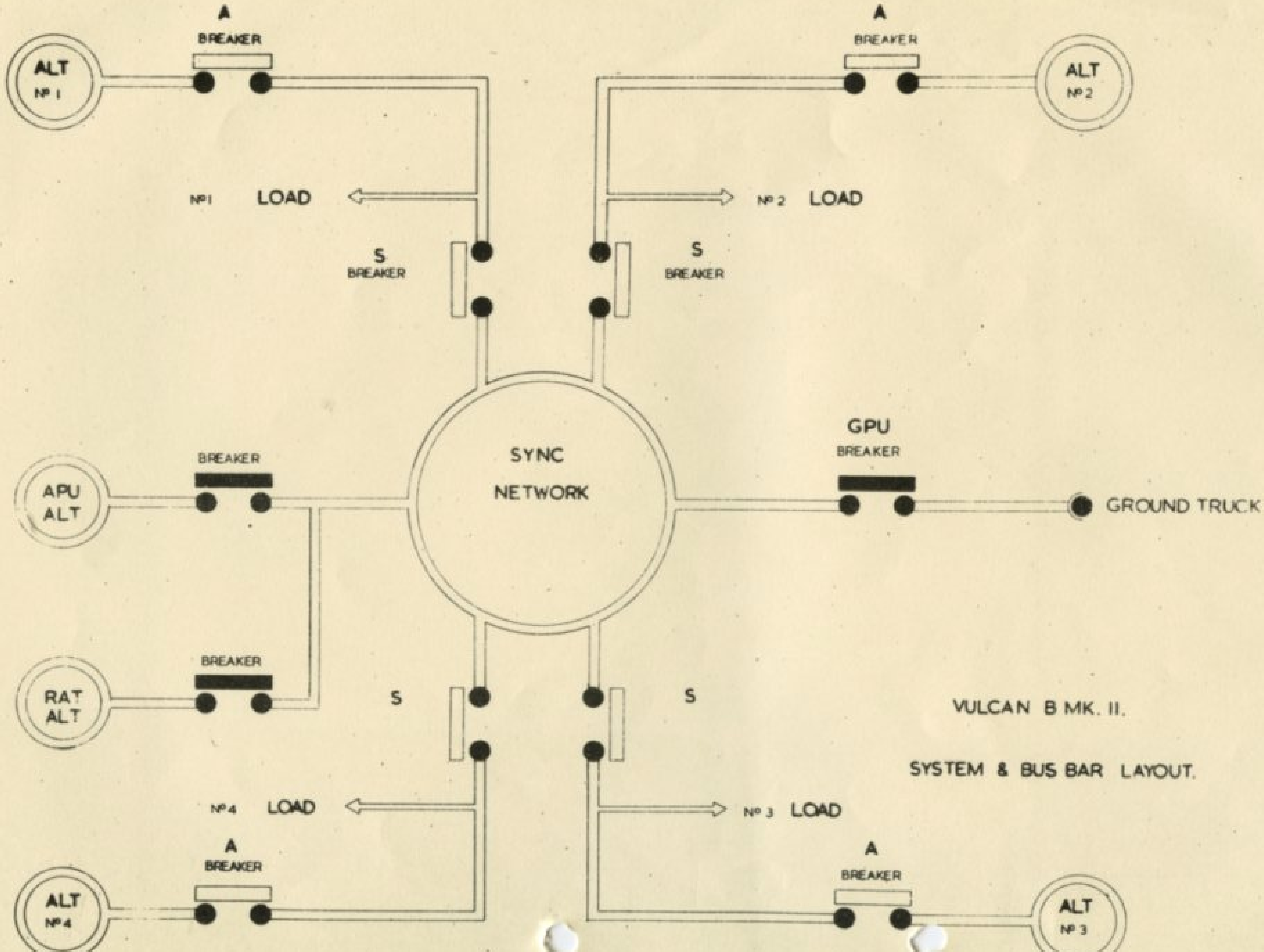
The Synchronising Volts Pick Up Unit consists of two 200V operated relays connected between Red and Yellow and Blue and Yellow phases of the synchronising bus bar. The four contacts on each relay are wired each one in series with the equivalent contact of the other relay. Either of the two relays when energised will cause the system to function normally. The series contacts are in the CLOSE coil circuits to the A.A.P.P., R.A.T. and G.P.U. circuit breakers respectively; thus should the S.V.P.U. be energised from a supply from the main alternators the A.A.P.P., R.A.T. or G.P.U. breakers are prevented from closing. The fourth contacts on the S.V.P.U. is to prevent any of the main alternator paralleling relays from being energised should a supply from either the A.A.P.P., R.A.T. or G.P.U. be causing the S.V.P.U. relays to be energised. An extension of this is applied in respect to No. 2 alternator insomuch that if it is switched ON whilst the R.A.T. is connected to the synch. bus bar the operation of relay 391 will trip the R.A.T. circuit breaker to allow No. 2 alternator supply to take over.

Component	No.	Location
Primary Alternator A.C. Generator Type 158B	4	Engines Stbd. Side
Constant Speed Drive Unit	4	Engines Stbd. Side
Switchbox Generator Control English Electric type AE.450 Mk. 3 or 4.	4	Forward bulkhead of Power Compartment
Frequency & Load Controller	4	Ditto
Voltage Regulator Type 125	4	Ditto
A & S Breakers	8	No. 1 Alt. 58P No. 2 Alt. 59P No. 3 Alt. 60P No. 4 Alt. 61P
Current Transformer	36	<u>Load Sharing CT's</u> No. 1 Alt. 14J (3 off) No. 2 Alt. 15J (3 off) No. 3 Alt. 16J (3 off) No. 4 Alt. 17J (3 off) <u>Merz Price</u> No. 1 Alt. 58P (3 off) No. 2 Alt. 59P (3 off) No. 3 Alt. 60P (3 off) No. 4 Alt. 61P (3 off) No. 1 Alt. 22J (3 off) No. 2 Alt. 23J (3 off) No. 3 Alt. 24J (3 off) No. 4 Alt. 25J (3 off)
Current Transformer	4	Bomb bay in pairs just aft of Bomb Arch 44
Alternator failure warning unit	1	74P
Synch. Monitor Unit	1	Port Wall Crews Compartment
Synch. Voltage Pick Up Unit	1	74P
R.A.T., G.P.U. & A.A.P.P. Breakers	3	29P

	No.1 LOAD BUSBAR	No.2 LOAD BUSBAR	No.3 LOAD BUSBAR	No.4 LOAD BUSBAR
ESSENTIAL SERVICES	No.1 Elevon P.F.C.U. No.8 Elevon P.F.C.U. No.1 Port fuel pump Port 115 volt main Tfmr R.A.T. blower motor	No.3 Elevon P.F.C.U. No.6 Elevon P.F.C.U. No.2 Port fuel pump Port 28 volt T.R.U. Gold film windscreens (low heat only) A.A.P.P. heaters	No.4 Elevon P.F.C.U. No.5 Elevon P.F.C.U. Main rudder P.F.C.U. No.2 Stbd.fuel pump Stbd. 28 volt T.R.U.	No.2 Elevon P.F.C.U. No.7 Elevon P.F.C.U. No.1 Stbd.fuel pump Stbd. 115 volt main Tfmr G.E.E. (Blower and channel) change are non-essential) I.F.F. & S.I.F. U.H.F.
NON-ESSENTIAL SERVICES	No.4 Port fuel pumps No.5 Port fuel pumps No.7 Port fuel pumps Windscreen de-mist E.C.M. (See Sect.20) No.2 Frequency changer Blue Steel Bomb bay fuel pump:- No.3 forward Starboard	Gold film windscreens (medium and high heat) Aux. Rudder P.F.C.U. (Becomes an essential service if main unit not working) No.3 Port fuel pumps No.6 Port fuel pumps Port fuel sequence timer. Port fuel transfer N.B.S. Tfmr. Standby supply. Emergency Hyd. power pack. Air brake motor (Port) E.C.M. (See Sect.20) Bomb bay fuel pumps:- No.3 Forward Port No.3 Aft Port	No.3 Stbd. fuel pumps No.6 Stbd. fuel pumps Stbd. fuel sequence timer. Stbd. fuel transfer E.C.M. (See Sect.20) Airbrake motor (Stbd) Bomb bay fuel pumps:- No.1 Forward Starboard No.1 Aft Port No.1 Aft Starboard No.1 Forward Port A.V.S. heaters	No.4 Stbd. fuel pumps No.5 Stbd. fuel pumps No.7 Stbd. fuel pumps Scanner T.R.U. and amplidyne. No.1 Frequency changer Green Satin Warning Receivers Bomb bay fuel pump:- No.3 Aft Starboard

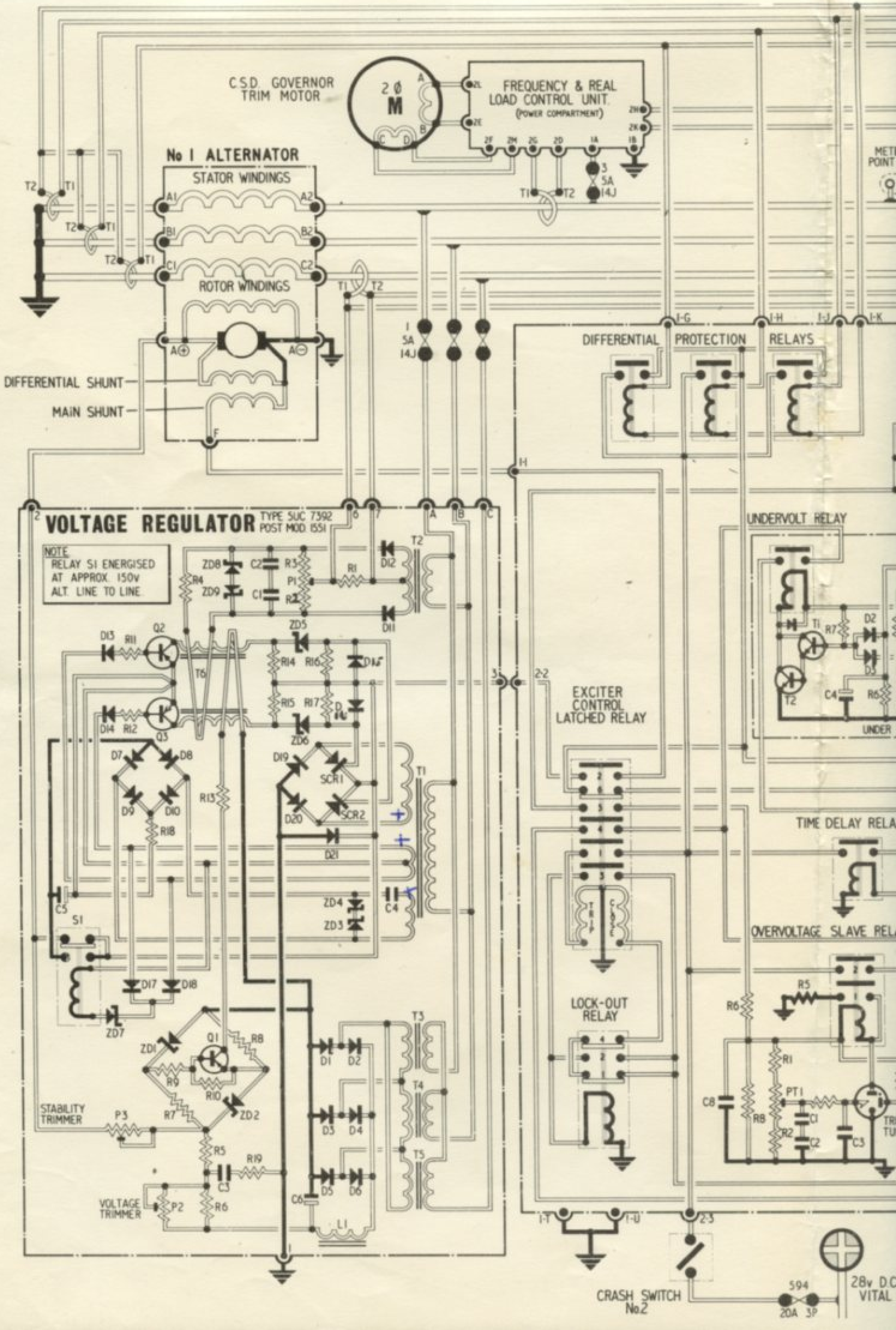
LOAD DISTRIBUTION (POST MOD 1552) DIAGRAM 4:1A

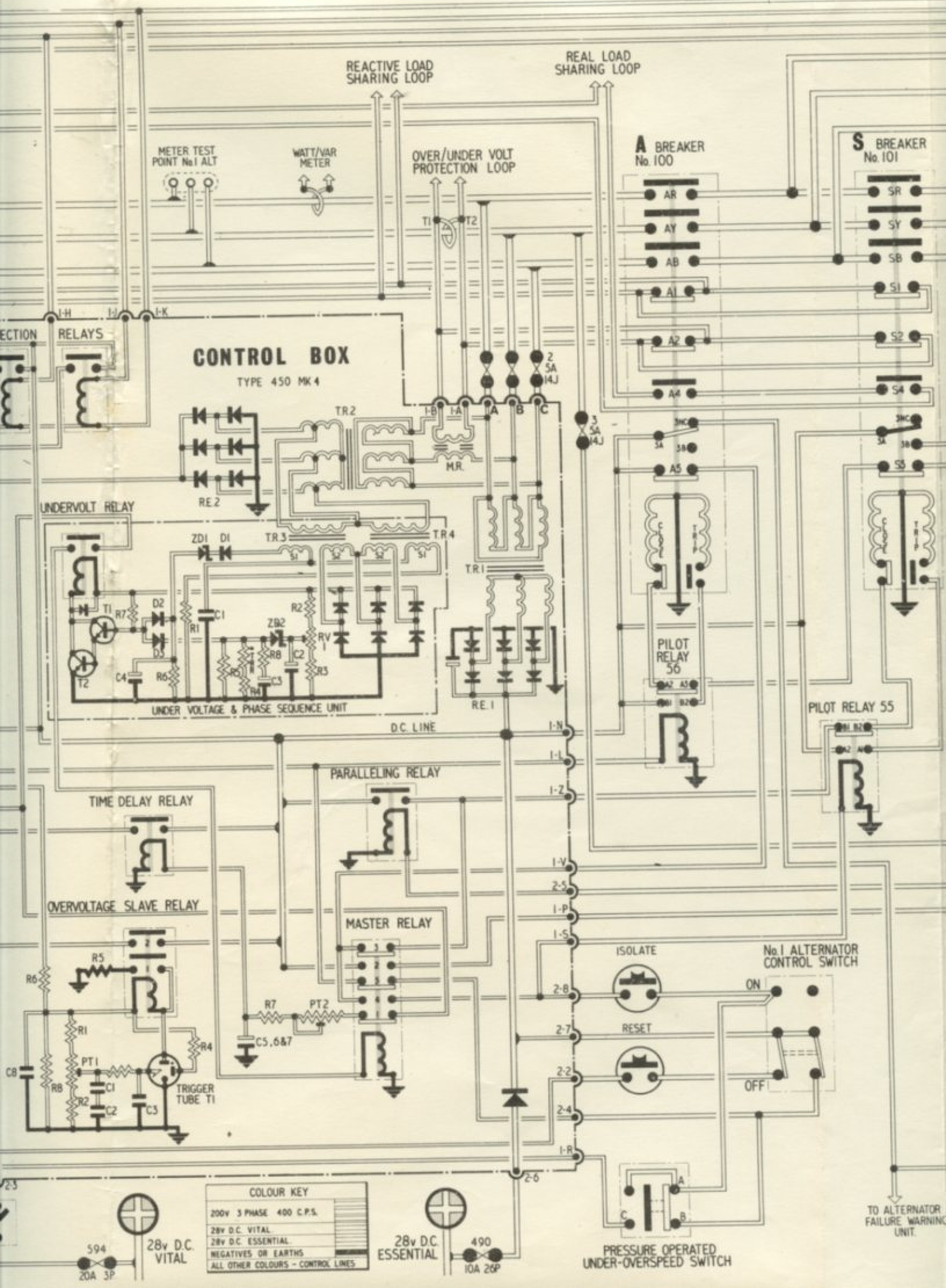
A.L.12



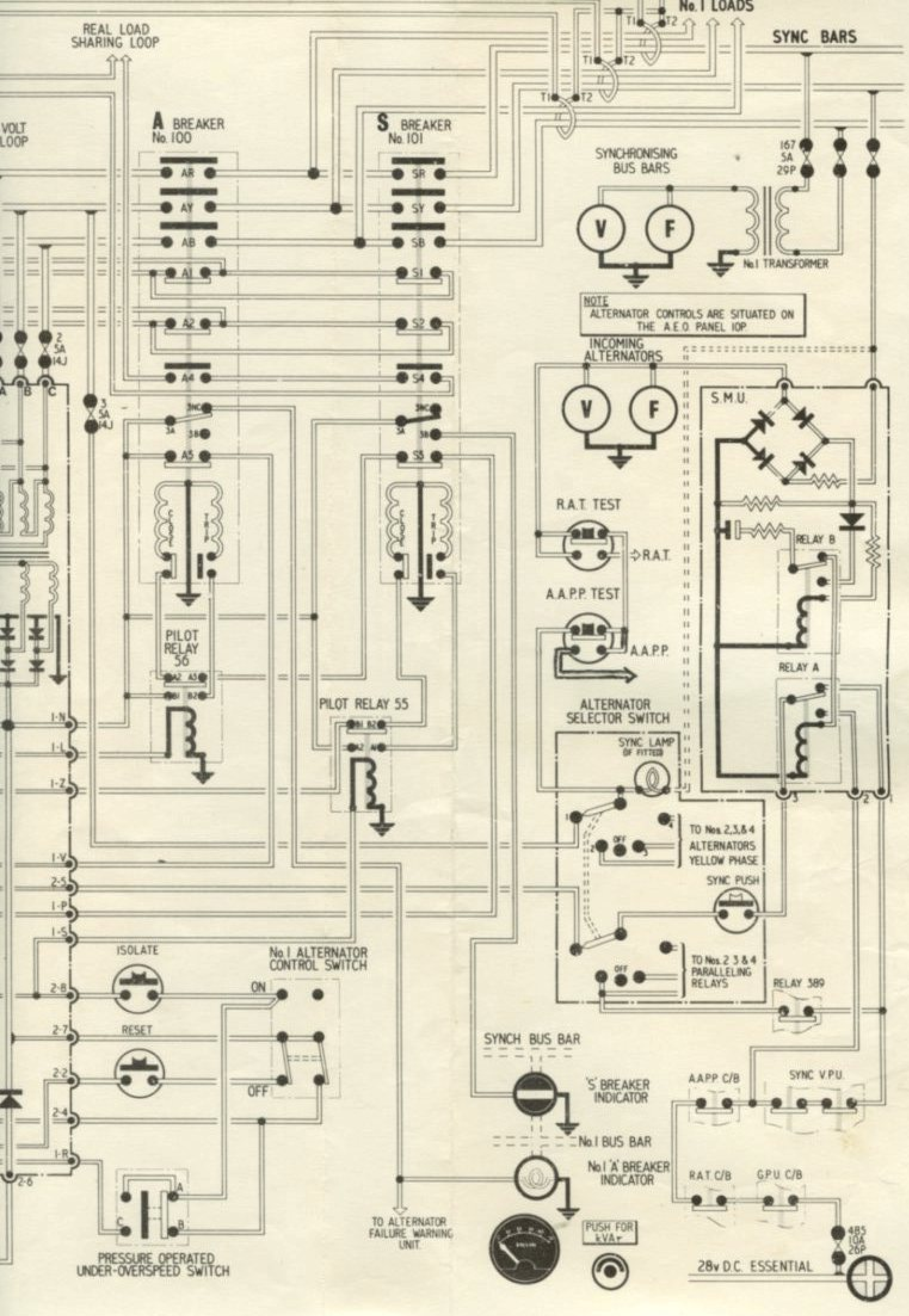
VULCAN B MK. II.

SYSTEM & BUS BAR LAYOUT.


C.S.D. GOVERNOR TRIM MOTOR
2 Ø M
FREQUENCY & REAL LOAD CONTROL UNIT (POWER COMPARTMENT)
No 1 ALTERNATOR
STATOR WINDINGS
ROTOR WINDINGS
DIFFERENTIAL SHUNT
MAIN SHUNT
DIFFERENTIAL PROTECTION RELAYS
VOLTAGE REGULATOR
TYPE SUC 7392 POST MOD. 1551
NOTE. RELAY S1 ENERGISED AT APPROX. 150v ALT. LINE TO LINE.
EXCITER CONTROL LATCHED RELAY
TRIP
CLOSE
LOCK-OUT RELAY
UNDERVOLT RELAY
TIME DELAY RELA
OVERVOLTAGE SLAVE RELA
STABILITY TRIMMER
VOLTAGE TRIMMER
CRASH SWITCH No2
28v D.C. VITAL
METI POINT



REACTIVE LOAD SHARING LOOP
REAL LOAD SHARING LOOP
METER TEST POINT No.1 ALT
WATT/VAR METER
OVER/UNDER VOLT PROTECTION LOOP
T1
T2
A BREAKER No. 100
S BREAKER No. 101
AR
AY
AB
A1
A2
A4
A5
SR
SY
SB
S1
S2
S4
S5
CLOSE
TRIP
1-H
1-J
1-K
RELAYS
CONTROL BOX
TYPE 450 MK4
T.R.2
M.R.
RE.2
1-B
1-A
A
B
C
2
5A
14J
3
5A
14J
UNDERVOLT RELAY
ZD1
D1
T.R.3
T.R.4
T.R.1
R7
D2
D3
R1
C1
ZD2
R2
RV1
R8
C2
R3
R5
R4
C3
C4
R6
UNDER VOLTAGE & PHASE SEQUENCE UNIT
RE.1
PILOT RELAY 56
PILOT RELAY 55
D.C. LINE
1-N
1-L
1-Z
PARALLELING RELAY
TIME DELAY RELAY
1-V
2-5
1-P
1-S
OVERVOLTAGE SLAVE RELAY
MASTER RELAY
ISOLATE
No.1 ALTERNATOR CONTROL SWITCH
ON
OFF
2-8
RESET
2-7
2-2
2-4
1-R
2-6
PT1
PT2
C5,6&7
C8
TRIGGER TUBE T1
2-3
COLOUR KEY
200v 3 PHASE 400 C.P.S.
28v D.C. VITAL
28v D.C. ESSENTIAL
NEGATIVES OR EARTHS
ALL OTHER COLOURS - CONTROL LINES
28v D.C. VITAL
594
20A 3P
28v D.C. ESSENTIAL
490
10A 26P
PRESSURE OPERATED UNDER-OVERSPEED SWITCH
TO ALTERNATOR FAILURE WARNING UNIT.



No. 1 LOADS
SYNC BARS
REAL LOAD SHARING LOOP
VOLT LOOP
A BREAKER No. 100
S BREAKER No. 101
SYNCHRONISING BUS BARS
No.1 TRANSFORMER
NOTE
ALTERNATOR CONTROLS ARE SITUATED ON THE A.E.O. PANEL 10P
INCOMING ALTERNATORS
S.M.U.
RELAY B
RELAY A
R.A.T. TEST
R.A.T.
A.A.P.P. TEST
A.A.P.P.
PILOT RELAY 56
PILOT RELAY 55
ALTERNATOR SELECTOR SWITCH
SYNC LAMP (IF FITTED)
TO Nos. 2,3,& 4 ALTERNATORS YELLOW PHASE
SYNC PUSH
TO Nos. 2 3 & 4 PARALLELING RELAYS
RELAY 389
ISOLATE
RESET
No.1 ALTERNATOR CONTROL SWITCH
ON
OFF
SYNCH BUS BAR
'S' BREAKER INDICATOR
No.1 BUS BAR
No.1 'A' BREAKER INDICATOR
A.APP. C/B
SYNC V.P.U.
R.A.T. C/B
G.P.U. C/B
TO ALTERNATOR FAILURE WARNING UNIT
PRESSURE OPERATED UNDER-OVERSPEED SWITCH
PUSH FOR kVAr
28v D.C. ESSENTIAL

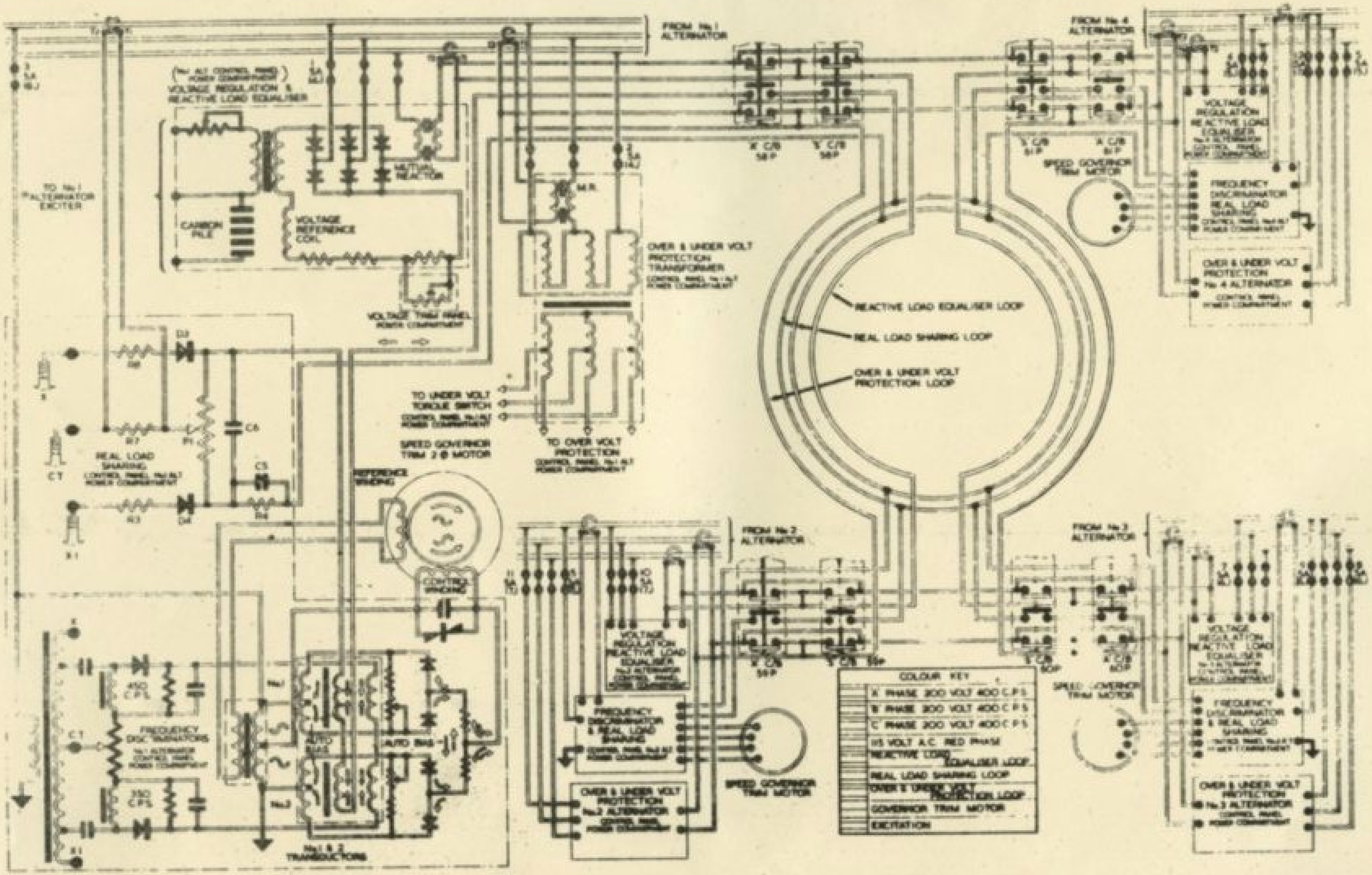


DIAGRAM NO. 6.3

FREQUENCY CONTROL UNIT.

VULCAN B. MK. II. - ALTERNATOR PROTECTION.

MERZ - PRICE DIFFERENTIAL PROTECTION PRINCIPLE.

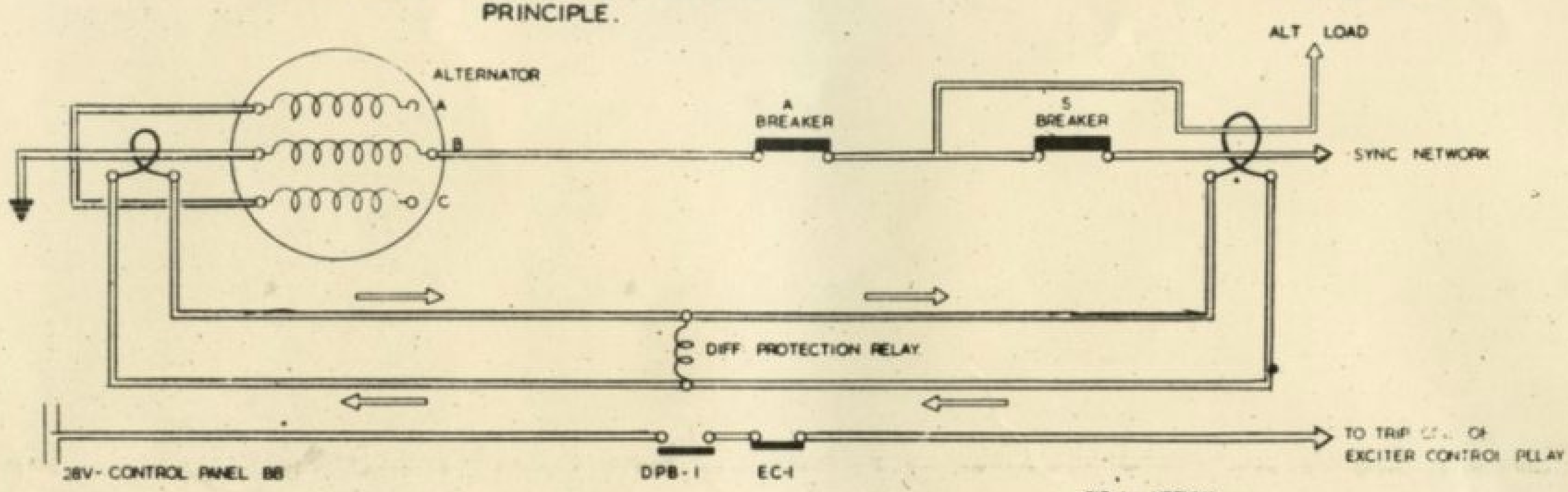


FIG I. - NORMAL

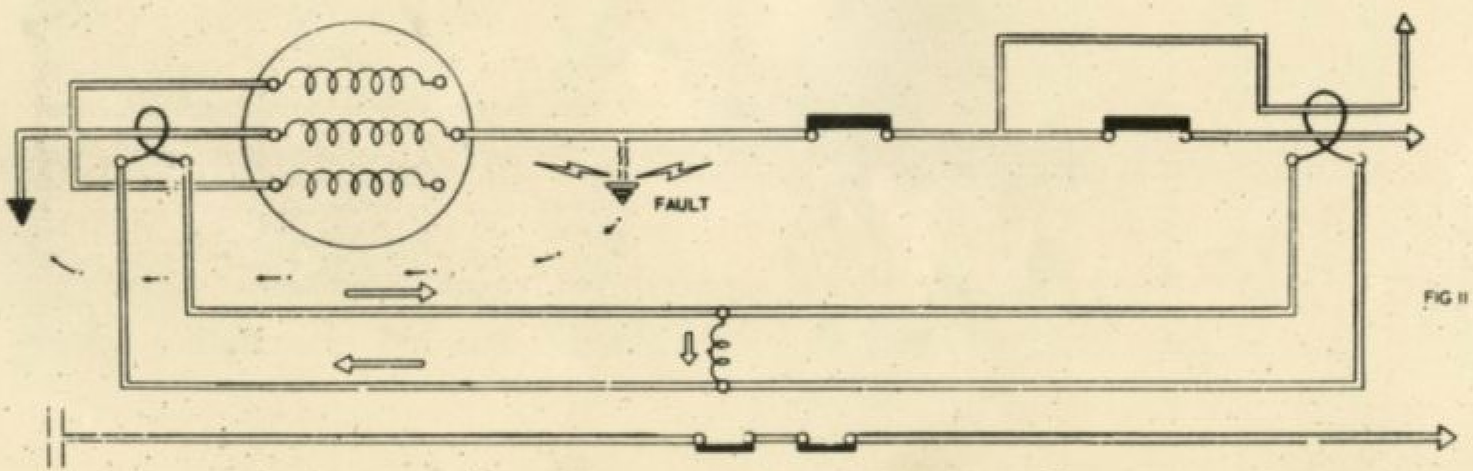
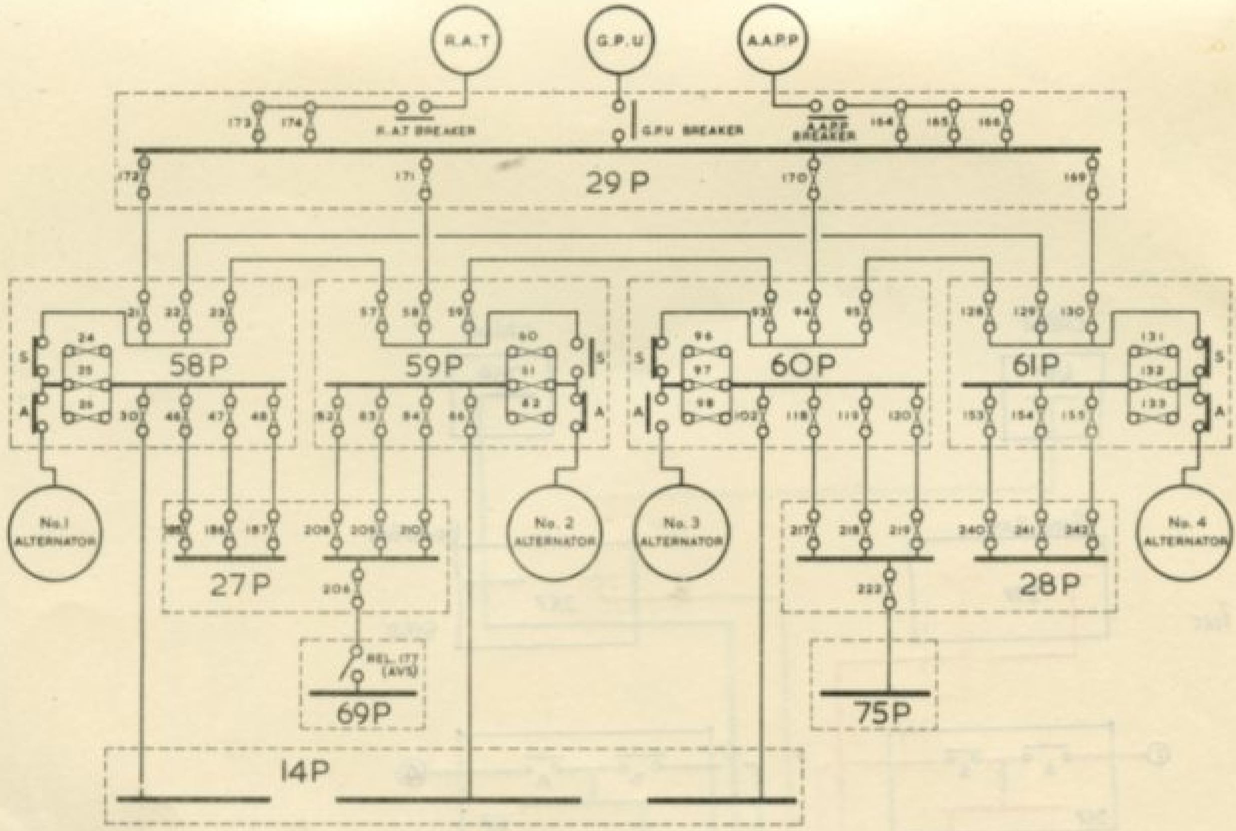


FIG II - PHASE 'B' TO EARTH



PRE-MOD 1553.

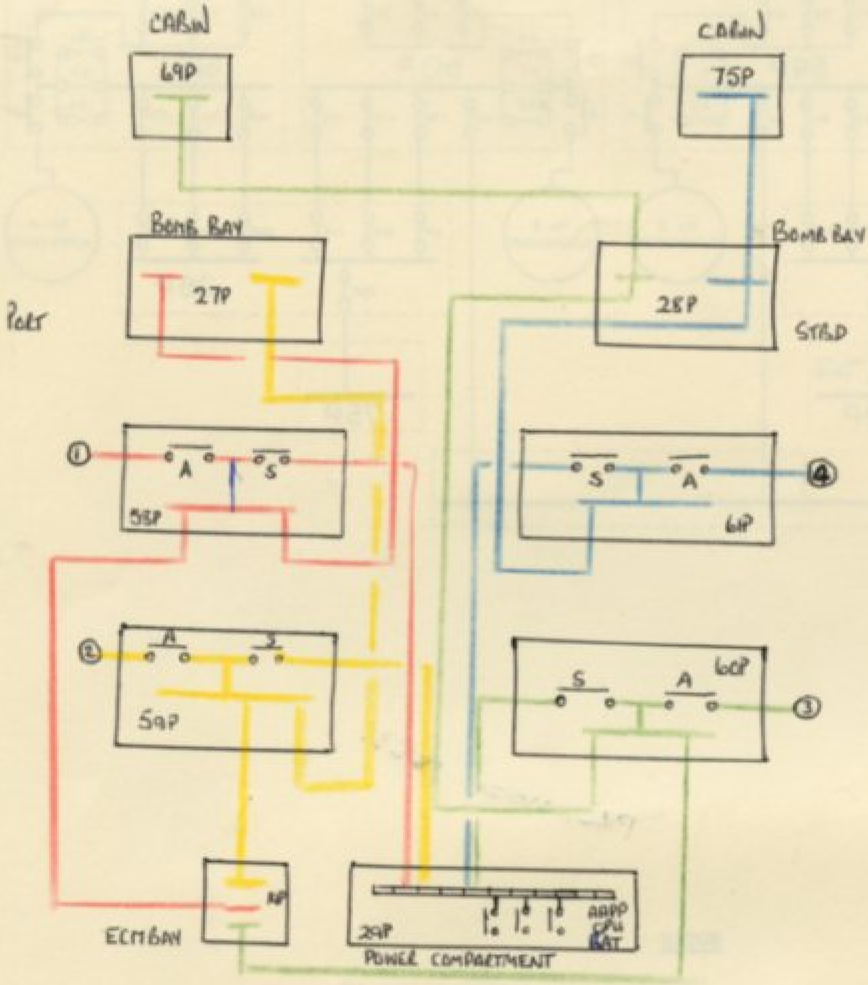
NOTES

1. FUSES
One phase only shown for clarity, distribution applies equally to all three phases. Three-phase fuses have the same number but are distinguished by a colour suffix eg. 100(R), 100(Y) & 100(B).

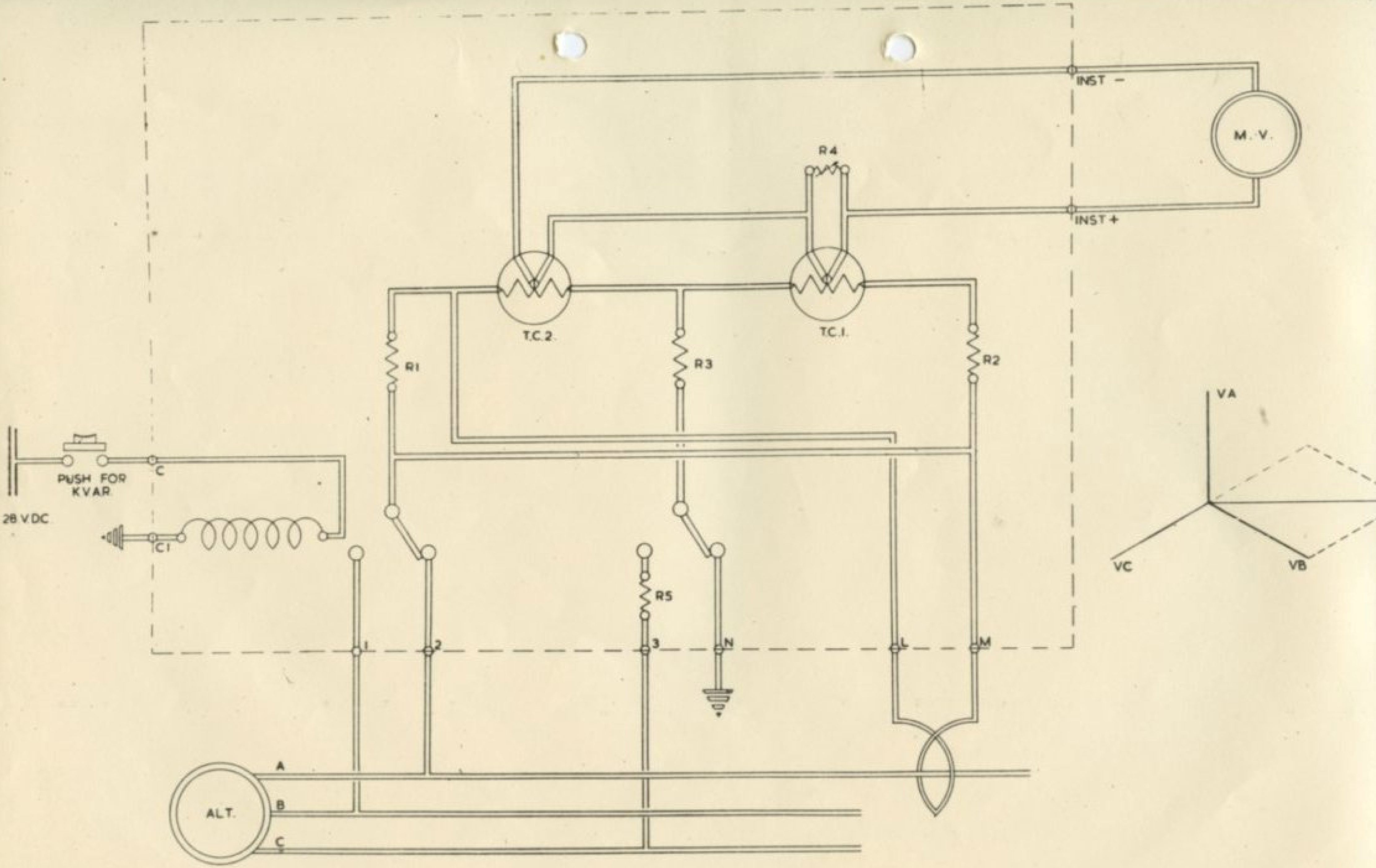
2. 200 VOLT DISTRIBUTION PANELS

PANEL	LOCATION	FUNCTION
58P	Power comp. Port wall. Fwd end.	No.1 Load busbar main distribution.
59P	Power comp. Port wall. Aft end.	No.2 Load busbar main distribution.
60P	Power comp. Stbd wall. Aft end.	No.3 Load busbar main distribution.
61P	Power comp. Stbd wall. Fwd end.	No.4 Load busbar main distribution.
29P	Power comp. rear face.	Synchronising busbar.
27P	Bomb bay. Fwd face. Port side..	Port fwd Sub-distribution (has also 115volt section)
28P	Bomb bay. Fwd face. Stbd side.	Stbd Fwd Sub-distribution (has also 115volt section)
69P	Pressure cabin. AEO's position, below Nav. table.	Air-ventilated suit heaters. Busbar only live when AVS master switch on and Rel.117 energised
75P	Pressure cabin. Stbd side below floor by the entrance door.	Extreme Fwd Sub-distribution (scanner 112volt T.R.U. and amplidyne, and warning receivers)
14P	ECM compartment. Port side. Fwd.	ECM power supplies.

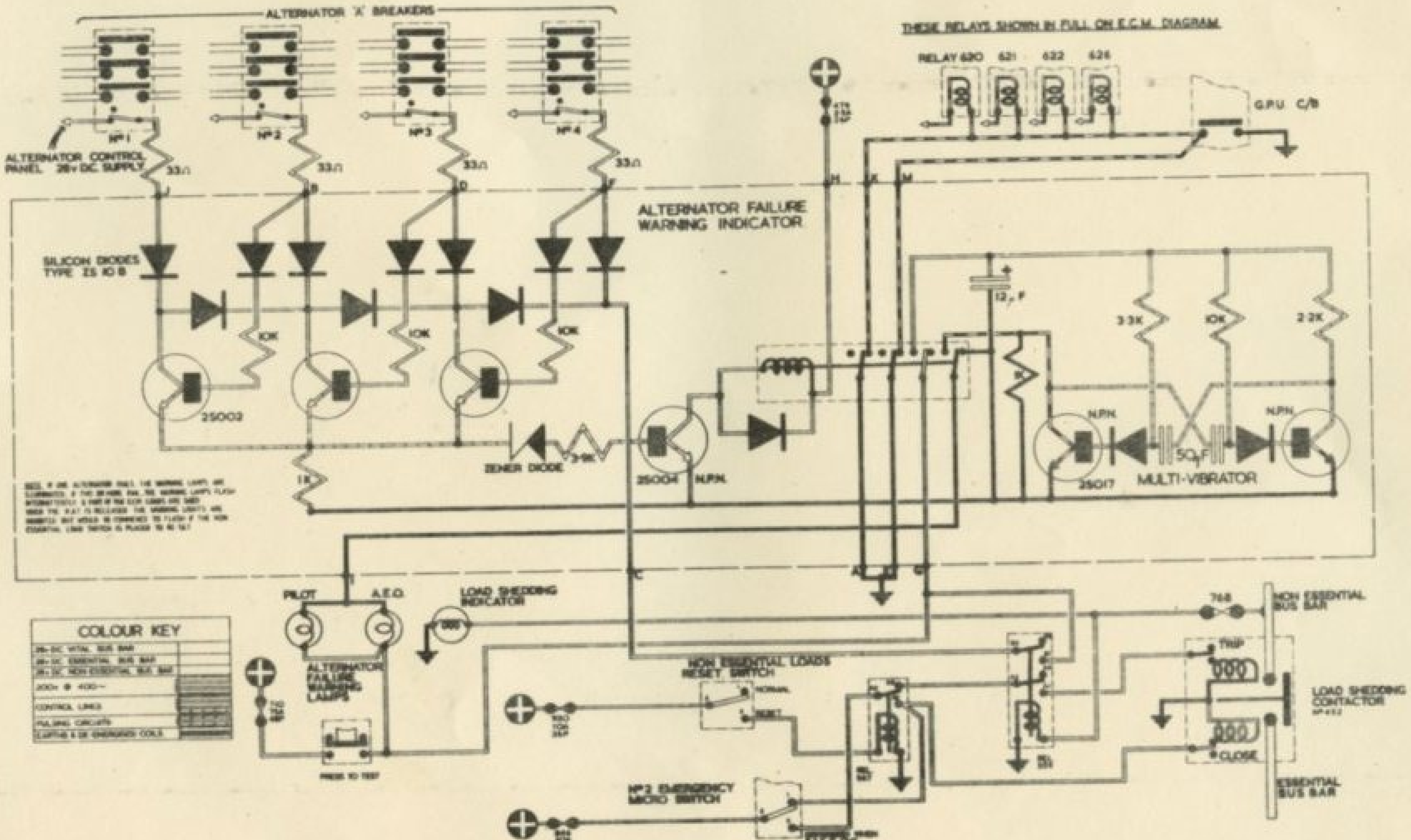
3 Post Mod 1553 [illegible] 75P [illegible] (F237)



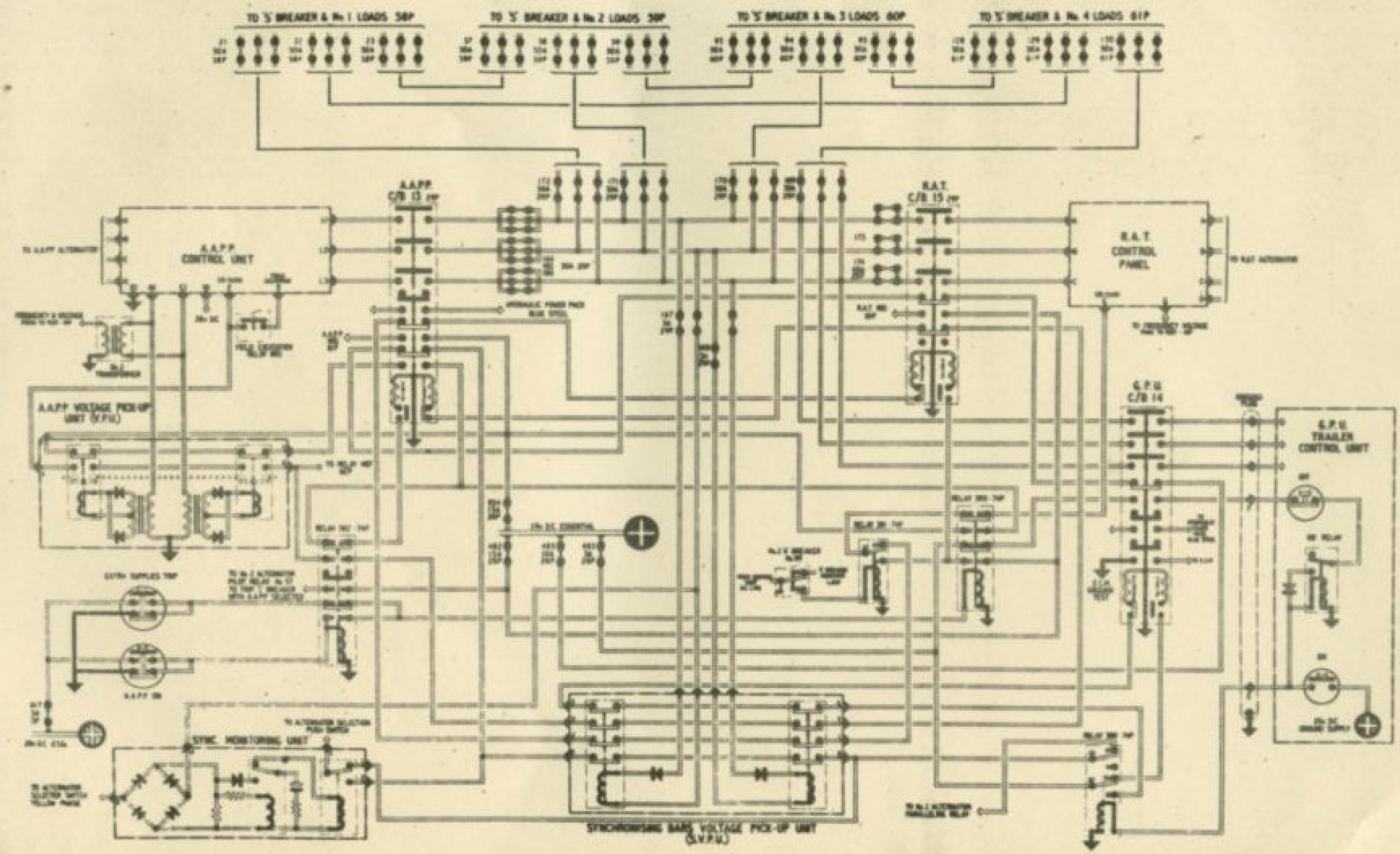
200V DISTRIBUTION



VULCAN B.MK.II. K.WATT./K.V.AR. METER.



ALTERNATOR FAILURE WARNING



TO 'S' BREAKER & No. 1 LOADS 58P
TO 'S' BREAKER & No. 2 LOADS 59P
TO 'S' BREAKER & No. 3 LOADS 60P
TO 'S' BREAKER & No. 4 LOADS 61P
A.A.P.P. C/B 13
A.A.P.P. CONTROL UNIT
A.A.P.P. VOLTAGE PICK-UP UNIT (V.P.U.)
R.A.T. C/B 15
R.A.T. CONTROL PANEL
G.P.U. C/B 14
G.P.U. TRAILER CONTROL UNIT
EXTRA SUPPLIES TRIP
A.A.P.P. ON
SYNC. MONITORING UNIT
SYNCHRONISING BARS VOLTAGE PICK-UP UNIT (S.V.P.U.)


TRUE COURSE
NORTH
SOUTH
V.S.C.
EAST
WEST