

Group 4

ENGINE INSTRUMENTS

LIST OF CONTENTS

	Para.
Introduction	1
DESCRIPTION AND OPERATION	
Engine tachometers	4
Oil pressure indicators	6
Power supplies	8
Exhaust gas thermometers (pre-Mod. 294)	11
Thermocouples and leads	12
Servo-potentiometers	15
Pilot's indicators	17
Fuel contents system	18
Pilot's fuel contents gauges	21
Navigator's fuel contents gauges	23
C.G. indicator	24
Fuel flowmeters	29

	Fig.
Location of engine instruments	1
Jet pipe temperature equipment	2
Jet pipe temperature controls	3
Jet pipe temperature controls (post Mod.714, 803 and 2003)	3a
Routing charts	
Engine tachometers	4
Oil pressure indicators	5
Exhaust gas thermometers (pre Mod.279)	6

Introduction

1. This group contains descriptive and servicing information for the engine instruments and associated control circuits. These instruments serve to indicate engine conditions and performance during flight and consist of the following:-

- (1) Engine tachometers.
- (2) Oil pressure indicators.

	Para.
Control switches	30
Power supplies	32
Flowmeter transmitters	34
Amplifier	36
Pilot's indicator	37
Navigator's Indicator	39
Jet pipe temperature system	41
Exhaust gas thermometers	42
Thermocouples	43
Servo-potentiometers	45
Indicators	48
Jet pipe temperature limiters and r.p.m. governors	50
Power supplies	60
Equipment location	61
Circuit operation	62
Engine bearing temperature indicators	69

LIST OF ILLUSTRATIONS

	Fig.
Fuel flowmeters Mk.3	7 (1) and (2)
Exhaust gas thermometers (E.C.U.10201 and E.C.U.10401)	8
Jet pipe temperature limiters No.1	9
Jet pipe temperature limiters No.2	10
Jet pipe temperature limiters No.3	11
Jet pipe temperature limiters No.4	12
R.P.M. governors	13
J.P.T. override switching	14

- (3) Exhaust gas thermometers.
- (4) Fuel contents gauges.
- (5) Fuel C.G. indicator.
- (6) Fuel flowmeters.

Electrical circuit routing charts for the instruments are provided and the location of components is illustrated in fig.1. This

SERVICING

	Para.
Engine tachometers	71
Oil pressure gauges	73
Exhaust gas thermometers (pre-Mod.294)	77
Fuel gauges	80
Fuel flowmeters	82
Jet pipe temperature system	83
Test equipment and procedure	85
Amplifier datum setting resistors	86
Engine bearing temperature indicators	87

REMOVAL AND INSTALLATION

	Para.
General	89
Jet pipe temperature system	91
Thermocouples	92

	Fig.
Jet pipe temperature limiters No.1 (post Mod.714)	15
Jet pipe temperature limiters No.2 (post Mod.714)	16
Jet pipe temperature limiters No.3 (post Mod.714)	17
Jet pipe temperature limiters No.4 (post Mod.714)	18
Engine bearing temperature indicators (Mod.1996 S.O.O.)	19

Amendment List covers the following modifications:-

- Mod.279 Introduction of E.C.U.10201 in lieu of E.C.U.10101.
- Mod.294 Introduction of jet pipe temperature limiting system (concurrent with Mod.279).
- Mod.413 Introduction of E.C.U.10401 in lieu of E.C.U.10201.

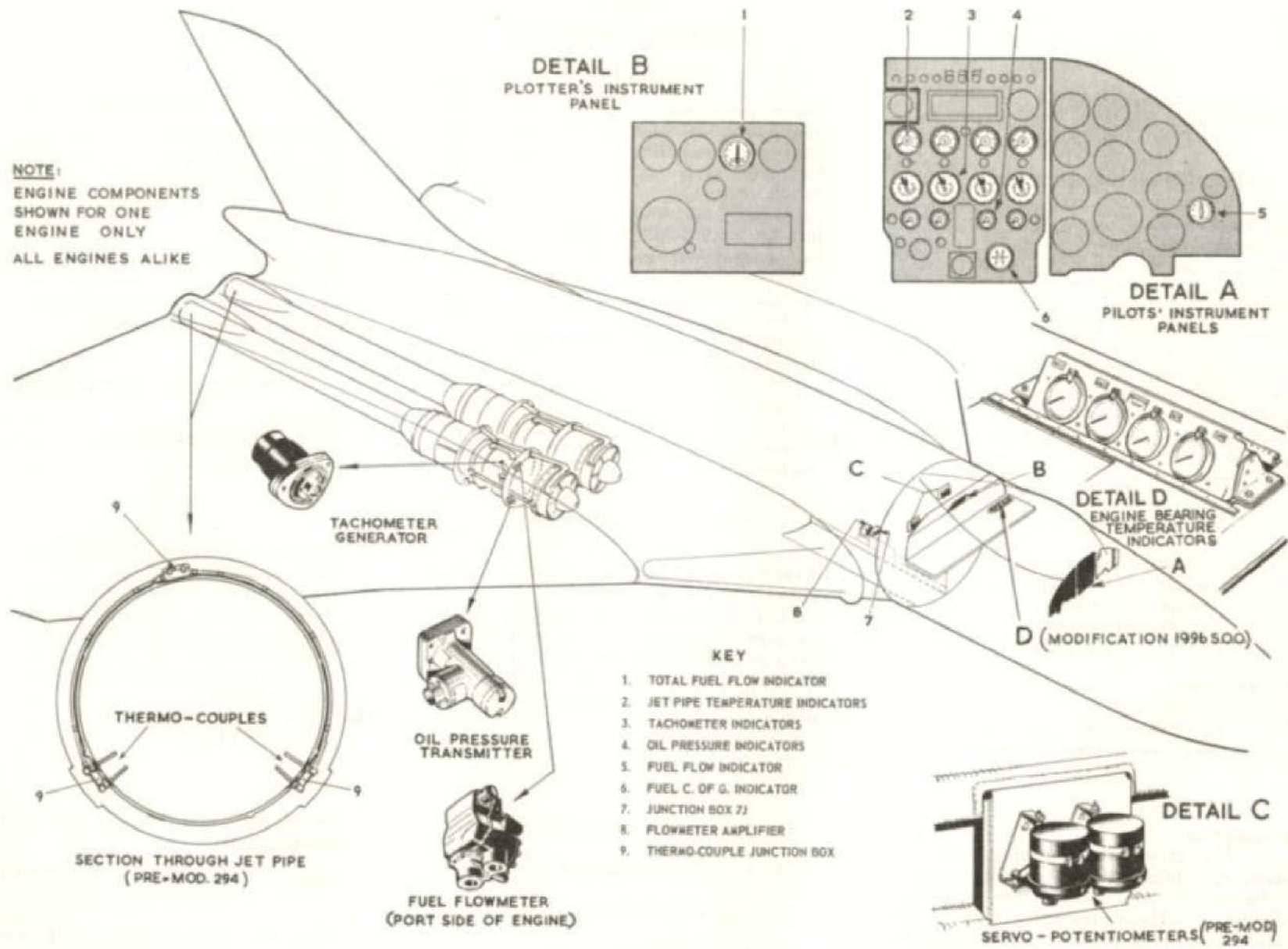


Fig.1. Location of engine instruments
(← Mod 1996 S.O.O. embodied →)
RESTRICTED

- Mod.544 Introduction of muting and ground test switches for the jet pipe temperature limiting system.
- Mod.714 Simplifying of cables at jet pipe junction box.
- Mod.803 Introduction of datum setting resistor 5CZ/6160 and disconnection of cables to double datum solenoids

- Mod.903 Introduction of amplifier Type A431 in lieu of amplifier Type A430/1.
- ◀ Mod.1996 Introduces four engine bearing temperature indicators for certain aircraft only.
- Mod.2003 Reconnects the double datum solenoids to test switches which were previously disconnected by Mod.803. ▶

2. The C of G indicator and fuel contents gauges are described briefly in the group. More detailed information will be found in Book 2, Chap.1, Group 5 and 5A.

3. Where necessary references are given in the paragraphs that follow to the Air Publication where a more detailed description of the instrument under consideration may be found. Engine components are dealt with in the Olympus engine handbook, A.P.4501B.

ENGINE TACHOMETERS

4. Four Mk.11 indicators are fitted in the pilots' centre panel to provide engine speed information for both pilots. The instruments are of the synchronous motor type and indication is by means of a main scale graduated in divisions of 10 per cent, and a subsidiary scale in divisions of 1 per cent, of the maximum engine speed.

5. A tachometer generator, Ref.No.6A/3252 is fitted on each engine and is connected to its respective instrument on the pilots panel by means of a self-contained circuit. When the engines are running, 3-phase a.c. is developed by the generators, at a frequency proportional to the engine speed, and fed to the indicators which record the engine speed according to the rise and fall of the generator output frequencies. A full description of the tachometer and its associated generator will be found in A.P.1275A, Vol.1, Sect.26, Chap.12.

OIL PRESSURE INDICATORS

6. The Smith type oil pressure gauge is employed to measure the engine oil pressure in flight. Inductor type indicators and transmitters are used, and the system is operated on 26-volt, single-phase a.c. A routing chart of the circuit is contained in fig.3.

DESCRIPTION AND OPERATION

7. The indicators, Type 2/ACR, are fitted on the pilot's centre panel and are calibrated for a range 0-60 lb. per sq.in.; the associated pressure transmitters, Type 480 PG/SB are mounted, one on the starboard side of each engine as shown in fig.1. A full description of the components, including operating details of the system, will be found in A.P.1275A, Vol.1, Sect.3.

Power supplies

8. The supply from No.3 inverter, Type 350, is transformed down to 26-volt, single-phase a.c. to accommodate the oil pressure gauge system. A transformer, Type Rotax 446/1, is used for this purpose, and is located in the a.c. supplies panel (11P). The input side of the transformer is fed from the 115-volt, 3-phase, 400 c/s inverter supply, from fuses 199 and 200 in 11P, one phase wire of the transformer being connected to the earthed bus-bar.

9. The indicator circuits are connected across the three phase wires and earth on the output side of the transformer and are individually fused from 11P. The fuses for the indicators from port to starboard number 204, 611, 201 and 203 respectively.

10. A single-phase a.c. supply is also taken from the transformer to the circuit for flowmeters described in para.32. The

supplies from No.3 inverter are dealt with in Chapter 1, Group 3 of this section.

EXHAUST GAS THERMOMETERS (pre Mod.294)

11. The temperature of the exhaust gasses from each engine is measured by a set of four thermo-couples in parallel, used in conjunction with a servopotentiometer and indicator. The system is fed from the 28-volt d.c. supply, and is used to give accurate temperature readings by amplifying the low output from the thermo-couples. A routing chart for each engine circuit is contained in fig.4; fully descriptive details for each component will be found in A.P.1275A, Vol.1, Sect.4.

Thermo-couples and leads

12. Four thermo-couples, Type B6, are positioned near the end of each jet pipe at right angles to the exhaust stream. The thermo-couples are connected in parallel from three junction boxes, one on the top and two on the lower half of the jet pipe. Removable panels are provided on the outer skin for access to the junction boxes.

13. Glass braided chromel-alumel leads are used for connection to the thermo-couple circuit, and are fed from the top junction box in each case into conduits which terminate in the compartment. At this position each pair of

chromel-alumel leads connects to a pair of ducralvin cables via a resistance unit, and runs forward to the nose wheel bay. The resistance units formed part of the circuit prior to Mod.166, which introduces the present system, and now serve as connector blocks only.

14. From terminal blocks in the nose wheel bay the leads change and enter the cabin as ducunvin. Here, the leads again differ and take the form of 7/012 glass braided chromel-alumel where they connect to their associated servo-potentiometer.

Servo-potentiometers

15. The servo-potentiometers, Type S144-3, are located in the cabin on the rear pressure bulkhead. The units are each equipped with a 7-pin plug in the base, and are fitted to anti-vibration mountings with the plugs face downwards, as illustrated in fig.1.

16. The "servo-pot" is an essential part of each circuit and its function is to provide a sufficiently high output to operate an accurately calibrated indicator for a low millivolt input. The 28-volt d.c. supply to each unit is made from the port and starboard fuse and relay panels 3P and 4P. The fuses number 77, 99, 178 and 182 for engines 1, 2, 3 and 4 respectively.

Pilot's indicators

17. The four indicators for the exhaust gas thermometer system are installed on the pilot's centre panel. These indicators, Type S78-3, provide an accurate reading of the jet pipe temperatures and are calibrated over a range 0 to 800 deg.C. Unipren cable is used to connect each instrument to its associated servo-potentiometer, the necessary connections being made from a 2-way terminal block at the back of the instrument.

FUEL CONTENTS SYSTEM

18. Fourteen fuel tanks are fitted in the

aircraft, five to each wing and four in the front section. The tanks are numbered port and starboard 1 to 7 in each case, and are divided into four groups for weight balancing purposes. Groups 1 and 2 comprise the port tanks numbered 1, 4, 5, 7 and 2, 3, 6 respectively; Groups 3 and 4 comprise the starboard tanks in the same sequence.

19. The Smith Waymouth type fuel contents system is installed, and is connected to the 28-volt d.c. supply. The system calculates the contents of a fuel tank by the use of capacitor units integral with the tank. The capacitance value (in pico-farads) of these units vary with the amount of fuel and air between the plates, and is thus proportional to the mass of fuel in the tank.

20. The capacitor units are fitted upright inside the tanks and connected via co-axial cables to a trimmer box and amplifier in each case. The output from each amplifier will vary according to the tank capacitance, and this condition for each tank or tank group will be indicated on the associated fuel contents gauges. A description of the system, including details of operation, is contained in A.P.1275A, Vol.1, Sect.3, Chap.14. The complete system of fuel controls is dealt with in Chap.1, Group 5 of this section.

Pilot's fuel contents gauges

21. Four fuel contents gauges, one to each tank group, are fitted on the pilot's panel (2P), located forward of the throttle controls. The gauges, Type A.O., have an inner and outer scale calibrated in thousands of pounds of fuel.

22. The inner scale of each instrument automatically records the total amount of fuel contained in the respective tank group; the outer scale is used to indicate the fuel content of any tank within the

group. Tank selector push-switches, labelled CONTENTS, are provided on the retractable centre console (5P), and when any one is pressed, the fuel contents for that particular tank can be read on the outer scale of the associated instrument.

Navigator's fuel contents gauges

23. Four gauges, Type A.O., are also provided at the navigation station, and are fitted below the plotter's instrument panel. These are single-scale instruments and give indication of the tank group contents only.

C.G. indicator

24. A fuel C.G. indicator, Type S128-5, is fitted on the pilot's centre panel (1P). This indicator comprises two separate scale movements, and is designed to give indication of fuel disposition relative to the centre of gravity, for each side of the aircraft.

25. The fuel C.G. lies between the fuselage tanks and the wing tanks. The scale on the left side of the instrument provides indication of C.G. movement for the port tanks (1 to 7); the right-hand scale gives the same indication for the starboard tanks.

26. Each scale is divided into three sectors. The safe margin of fuel C.G. movement is shown by a central green sector, and a red sector at each end is marked NOSE HEAVY and TAIL HEAVY respectively. The instrument pointers lie in the bottom red sectors in the normally OFF position.

27. The indicator movements are controlled by the fuel tank amplifier outputs. These outputs can be switched out of the fuel contents gauge circuits by operating the push-switch, labelled C.G., CHECK, fitted adjacent to the indicator. The amplifiers will then be connected to the indicator via a resistance network, and, providing the fuel C.G. is being maintained, the instrument

pointers will take up a centre scale position. Should NOSE HEAVY or TAIL HEAVY be indicated, the C.G. can be corrected by transferring the fuel between Nos. 1 and 7 tanks. Note that while the C.G. check switch is held pressed, the fuel contents gauges will indicate zero.

28. The C.G. indicator will also be brought into operation during flight refuelling conditions, when the flight refuelling master switch on the starboard console (7P) will be on. A full description of the C.G. indicator system, including the necessary routing charts, will be found in Chap. 1, Group 5 of this publication.

FUEL FLOWMETERS

29. The Mk. 3 fuel flowmeter system is installed, and is designed to give the following continuous indications:—

- (1) The rate at which fuel is being consumed by each engine.
- (2) The total rate at which fuel is being consumed by all the engines.
- (3) The total amount of fuel consumed by all the engines.

The installation is electrically operated, and the main equipment consists of four engine transmitters, an amplifier, and two flowmeter indicators. The indicators are installed at the pilots' and navigator's positions respectively. A full description of the Mk. 3 system, including operating details, will be found in A.P.1275A, Vol. 1, Sect. 18. A routing chart of the circuit is contained in fig. 5.

Control switches

30. An electrically operated automatic selector switch is provided in the circuit, and is used for individual selection of engine fuel flow indication on the pilot's instrument. The switch is mounted inside a junction box (7J) on the port side of the nose wheel bay. Four engine selector push-switches control the action of the automatic switch, and are situated on the retractable centre console (5P).

F.S./3

31. A toggle switch, labelled RESET-NORMAL, is fitted on the plotter's main panel. The switch is spring-loaded to the normal centre position and is used in conjunction with the navigator's indicator (para. 40).

Power supplies

32. Single-phase, 400 cycles a.c. at 115-volt and 26-volt is required to operate the system, and is supplied by No. 3 inverter from the respective fuses in the a.c. supplies panel (11P). The 26-volt supply is obtained from a transformer in 11P (para. 8-10), and is connected via fuse 202 to the pilots' indicator and the engine transmitters. The 115-volt supply is fed from fuse 267 and is taken to the amplifier.

33. A 28-volt d.c. supply for the operation of the automatic selector switch is taken from the port fuse and relay panel (3P). The supply is fed from fuse 60 via the associated push-switches.

Flowmeter transmitters

34. Four flowmeter transmitters, Type 3D 121/1, provide the necessary signal information for the indications detailed in para. 29. The transmitters are mounted, one on each engine, and are directly connected in the engine fuel lines.

35. A measuring vane integral with each unit is moved against a calibrated spring to positions according to the rate of flow of fuel. Two Autosyn transformers, coupled to the vane, produce the signals used to indicate the rate of flow according to the movement of the vane. The signal from one of the transformers is fed to the flow rate indicator on the 2nd pilot's panel and the signal from the other transformer is fed into the amplifier, where it is used to derive the total flow rate as indicated by the navigator's instrument.

Amplifier

36. Amplification of the signals from one transformer in each transmitter is effected

by an amplifier unit, Type 3D 122/1, situated on the port side of the nose wheel bay. The amplifier is fitted to a mounting frame, Type 3B 1031/1, which provides for easy removal of the unit.

Pilot's indicator

37. A fuel flow indicator, Type 3D 123/1 is fitted on the second pilot's instrument panel. This instrument reproduces the movement of the flow-measuring vane in any selected transmitter and thus provides indication of the rate at which fuel is being consumed by any one engine. An expanded type of scale is used, which is calibrated at 5 lb./min. intervals on the compressed part, and at 50 lb./min. intervals on the expanded part.

38. Indication of the fuel flow rate for any one engine is made by operating the appropriate push-switch on the centre console. The instrument will continue to give indication for the engine last selected until another push-switch is pressed.

Navigator's indicator

39. A total fuel flow indicator, Type 3D 124/1, is fitted on the plotter's instrument panel at the navigation station. This instrument provides indication of the total rate at which fuel is being consumed by all the engines. The scale has two pointers and is calibrated to read in 10 lb./min. and 100 lb./min. at each major division.

40. An indication of the total weight of fuel consumed is given on a counter which is recessed into the indicator dial. The counter will register the fuel consumption continuously, and can be reset to zero by using the switch, labelled RESET-NORMAL, located on the plotter's main panel.

JET PIPE TEMPERATURE SYSTEM

41. An exhaust gas thermometer system, Type D, and a jet pipe temperature limiting

(A.L.37, Dec. 58)

RESTRICTED

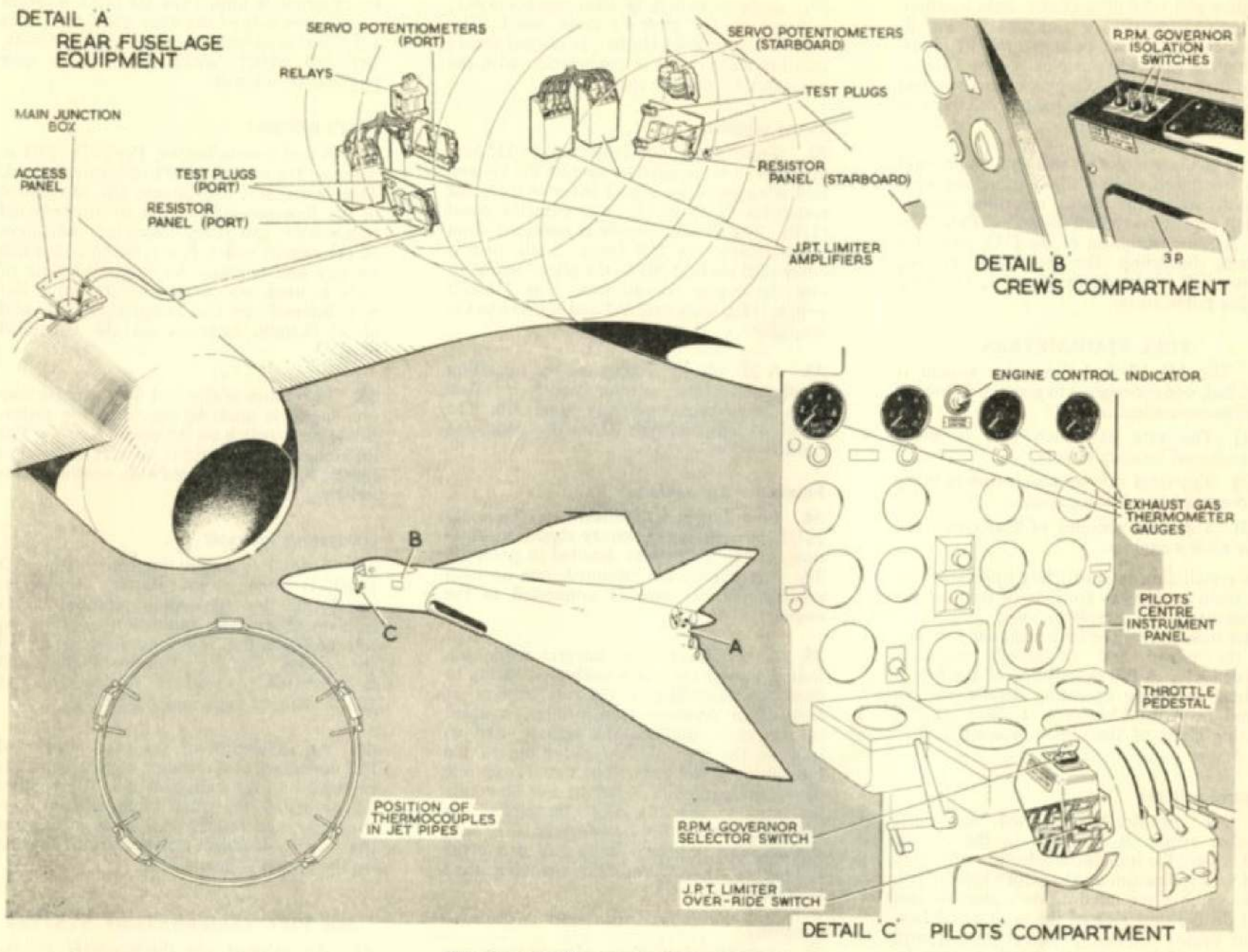


Fig. 2. Jet pipe temperature equipment

RESTRICTED

system are introduced on the aircraft by embodiment of the following modifications:-

- Mod.279 Introduction of E.C.U.10201 in lieu of E.C.U.10101.
- Mod.294 Introduction of jet pipe temperature limiting system (concurrent with Mod.279).
- Mod.413 Introduction of E.C.U.10401 in lieu of E.C.U.10201.
- Mod.544 Introduction of muting and ground test switches for jet pipe temperature limiting system.

Exhaust gas thermometers

42. The Type D exhaust gas thermometer system is used to provide an indication of the temperature of the exhaust gases in order that the engine may be operated under conditions of maximum efficiency, and to ensure that the safe working temperature under certain conditions is not exceeded. The thermometer system consists of the following major components:-

Thermo-couples (8 per engine)	Ref.6A/3578
Servo-potentiometer (1 per engine)	Ref.6A/4725
Mounting A.V. "Servo-pot" (1 per servo pot)	Ref.6A/4727
Indicator (1 per engine)	Ref.6A/4723

The system is fed from the aircraft 115-volt, 400 c/s, a.c. supply.

Thermo-couples

43. Eight thermo-couples are fitted in pairs at the rear end of each jet pipe, at right-angles to the exhaust stream. Two pairs are located at either side of the jet pipe, one above and the other below the horizontal centre line. Each pair of thermo-couples is connected to a junction box, and each junction box is connected by a metal harness to a common junction

box mounted on a platform on the top of the jet pipe.

44. Glass-braided chromel-alumel leads are taken from the common junction box, via conduits, into the compartment behind the aft power compartment in the rear fuselage. At this position, the chromel-alumel leads are connected to their respective servo-potentiometers, jet pipe temperature limiting amplifier units and ground test plugs. When Mod.714 is embodied the cabling at the jet pipe junction box is simplified, as shown in fig.3a.

Servo-potentiometers

45. The servo-potentiometers are located in the aft compartment, each being clamped to an anti-vibration mounting bracket as shown in fig.2.

46. The servo-pot is an essential part of each circuit, and functions to provide a high output from a low millivolt input supplied by the thermo-couple cluster for the operation of the calibrated indicators. Basically the servo-pot is a self-balancing potentiometer in the form of an electronically balanced measuring bridge circuit with negligible input current.

47. The 115-volt, 400 c/s, single-phase, a.c. input to the servo-pots is obtained from the No.1 and 3 (Type 350) inverters in the nose-wheel bay, via distribution fuses in 22P in the bomb bay. It should be noted that the No.1 and 4 servo-pots are fed from the No.3 inverter. Full details of the control and switching of the inverters, including emergency change-over operation, are included in Sect.5, Chap.1, Group 3 of this book.

Indicators

48. The four indicators are installed on the pilots' centre instrument panel as shown in fig.2. They are millimeters suitably calibrated over a range of 0 to 800 deg.C. Preen cables are employed to connect the indicators to the servo-pots.

49. Descriptive details for the exhaust gas thermometers, Type D, are contained in A.P.1275A, Vol.1, Sect.17, Chap.16; the thermo-couples are described in Chap.10 of the same Section. Details of the engine jet pipes and the arrangement of the thermo-couples are given in A.P.4501E, Vol.1, Sect.1, Chap.1.

J. P. T. limiters and r.p.m. governors

50. The jet pipe temperature (j.p.t.) limiter and r.p.m. governor systems form a basic part of the BOL.102 and 104 engine fuel systems, and the ensuing notes should be read in conjunction with A.P.4501E, Vol.1, and A.P.4343K, Vol.1, Sect.3. General information on jet pipe temperature limiting systems is contained in A.P.4343K, Vol.1, Sect.3.

51. A datum selector switch on the engine control pedestal in the pilots' compartment, labelled CRUISE/TAKE-OFF, is used to avoid the necessity of making frequent throttle adjustments in order to maintain the engine speed within the combined j.p.t. and r.p.m. limitations for either take-off or cruise. The selector switch serves to control a solenoid-operated servo isolator in the lines between the two L.P. compressor governors on the engines, when the throttles are open, i.e., by selecting either a driven governor (take-off) or a static governor (cruise).

52. In addition, on aircraft where Mod.294 and 544 are embodied, the selector switch also selects the corresponding cruise or take-off datum for the j.p.t. limiter; therefore, notwithstanding the r.p.m. selected by the throttles, the actual engine speed will be decreased, when necessary, sufficiently for the jet pipe temperature not to exceed the selected datum.

53. Control of the j.p.t. is provided at cruise and take-off selections by electro-pressure control units, mounted one on

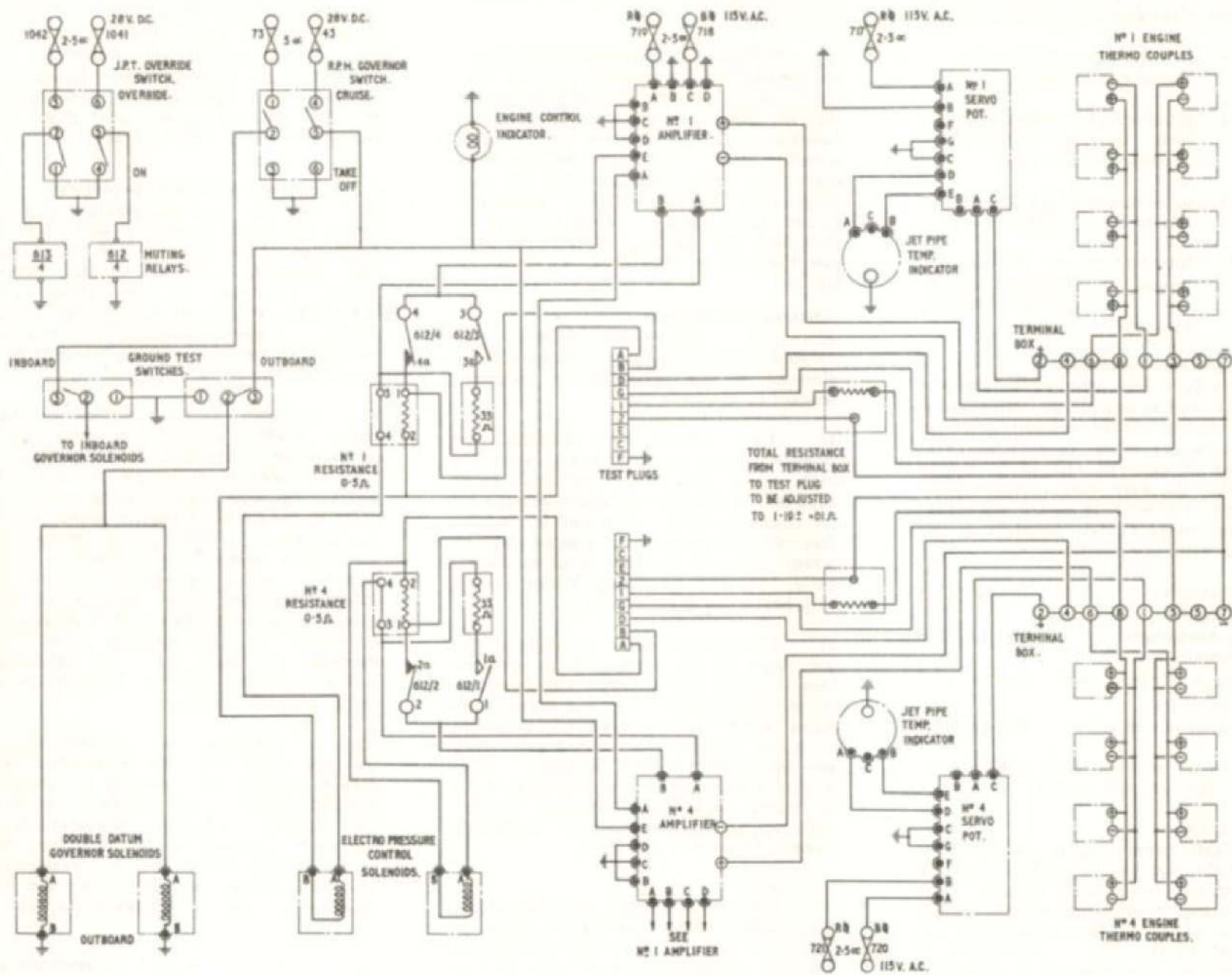


Fig. 3. Jet Pipe Temperature Controls

RESTRICTED

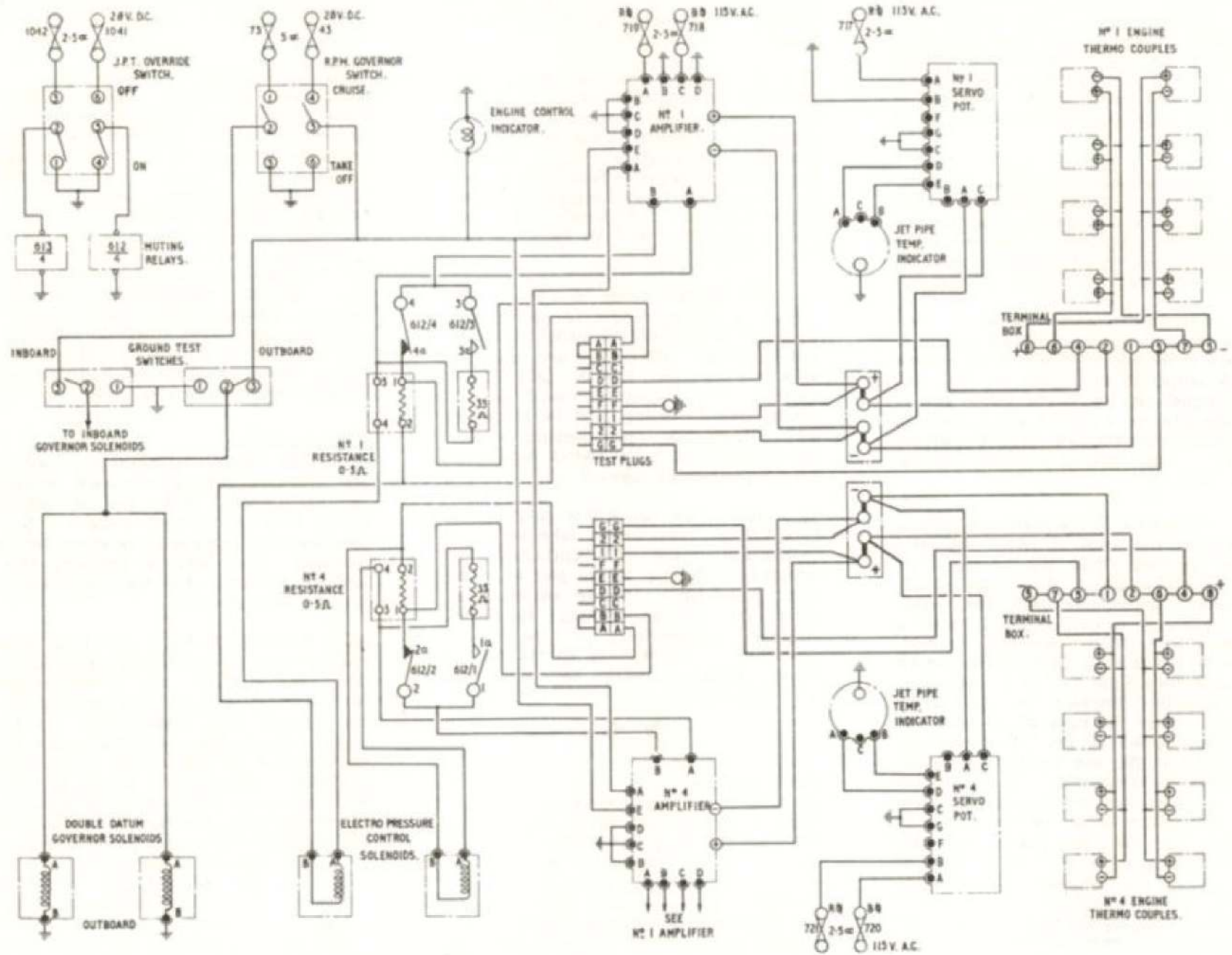


Fig. 3A Jet Pipe Temperature Controls (Post Mod. 714, 803 & 2003)
 (= Mod. 2003 embodied =)
RESTRICTED

each engine. Each unit is controlled by a j.p.t. limiter amplifier Type A430/1 (pre Mod.903) or Type A431 (post Mod.903). Basically the j.p.t. limiter system reduces fuel flow by the action of the electro-pressure solenoid-operated ball valve when the j.p.t. rises above the selected datum level.

54. The temperature signal obtained from the thermo-couple cluster on the engines is passed to the amplifier, and the output of the amplifier is passed to the solenoid-controlled electro-pressure valve which regulates fuel flow to the engine.

55. The thermo-couple output is compared with a highly stabilized reference voltage in the amplifier, and if the thermo-couple output is the higher, the resulting error signal appears at the output end of the amplifier as a current which operates the solenoid-controlled electro-pressure valve. Fuel flow is reduced, and the j.p.t. falls.

56. Adjustment of the reference voltage determines the level at which the error signal appears, thus limiting j.p.t. at any datum level within the ranges of adjustment. Temperature datum level within the amplifier is controlled by relays and a datum setting resistor network; connections to the R.P.M. GOVERNOR switch are made via a 5-pin plug on the amplifier. The amplifier provides for triple-datum setting, but in the case of the BOL.102 and 104 engines on the Vulcan aircraft, only the CRUISE and TAKE-OFF datums are used, consequently only one of the two relays in the amplifier is employed. The temperature datum of the system is defined as the jet pipe temperature corresponding to a solenoid current of 200 mA. If the temperature is below the datum, the solenoid current is below 200 mA, falling rapidly to a standing level of about 20 mA, over the first few degrees below datum. If the temperature rises above datum, the solenoid current in-

creases rapidly to about 400 mA, and remains at that level for higher temperatures.

57. A discriminator is arranged to suppress the amplifier output at temperatures below the selected datum, thus preventing solenoid operation until the desired temperature is reached. Application of negative feed back ensures that the system is self-stabilizing at the selected datum. Full details of the j.p.t. limiter amplifiers will be found in A.P. 4343E, Vol.1, Sect.12.

58. On aircraft where Mod.544 is embodied, a muting device is provided by means of an OVERRIDE switch, guarded, and labelled ON-OFF, and mounted adjacent to the R.P.M. GOVERNOR switch. The OVERRIDE switch is used during ground testing, and is placed to OFF should the j.p.t. limiting system fail during flight. The switch must be in the ON position for take-off.

59. In addition, two R.P.M. GOVERNOR ISOLATION switches, labelled ON-OUTBOARD and ON-INBOARD, are situated on the top of the port fuse and relay panel 3P. These switches are used for ground testing the j.p.t. limiters independent of the r.p.m. governors. Instructions on the use of these switches will be found in A.P.4505A-G.H.N.



Power supplies

60. A.C. supply at 115 volts, 3-phase, 400 c/s. for the j.p.t. limiter amplifiers is fed from the No.1 and 3 (Type 350) inverters in the nose-wheel bay. The amplifiers are fed in pairs, No.1 and 4 (outboard) from the No.1 inverter, No.2 and 3 (inboard) from the No.3 inverter, via suitable supply fuses in 22P in the bomb bay. Full details of the control and switching of the inverters, including

emergency changeover operation, are included in Sect.5, Chap.1, Group 3 of this book.

Equipment location

61. The amplifiers, Type A430/1, along with the test plugs and resistances are installed in the compartment aft of the power compartment in the rear fuselage, as shown on fig.2. The guarded ON-OVERRIDE switch, and the r.p.m. governor CRUISE/TAKE-OFF switches are fitted to the engine control pedestal in the pilots' cabin. Both these switches are of the double-pole changeover pattern. The R.P.M. GOVERNOR isolation switches, spring-loaded to their "closed" positions, are of the single-pole pattern, and installed on the top of 3P. The muting relays (No.612 and 613) are installed along with the amplifiers.

Circuit operation

62. The circuit operation outlined in the following paragraphs should be read in conjunction with the theoretical circuit diagram provided in fig.3. Note that the circuit operation is given for the outboard (No.1 and 4 engines) only, circuit operation for the No.2 and 3 engines being similar.

63. Referring to fig.3, it will be seen that with the J.P.T. OVERRIDE switch in the ON position, the muting relays (612 and 613) are completely isolated from the 28-volt d.c. system and, via the linked contacts 1 and 4 of the switch, the feed side of the relay coils are at earth potential. Also, with the R.P.M. GOVERNOR switch at the TAKE-OFF position, the double datum governor valve solenoids are completely isolated from the supply, in a similar manner to the muting relays. Note also that the ENGINE CONTROL magnetic indicator is isolated and de-energised, presenting a black image. Under these conditions, the datum level relay within the amplifier (fed from pin E on the 5-pin plug), is also de-energised

and isolated from the supply; thus the datum setting resistance will be set for take-off j.p.t. limitation.

64. On the output side of the amplifier (2-pin plugs, pins A and B) the operating current for the electro-pressure solenoid valve will be fed (in the case of the No.1 engine) via relay contacts 612/4, the No.1 resistance to pin B on the solenoid. The return path being from pin A on the solenoid via the straight link on the resistance back to pin A on the amplifier 2-pin plug.

65. If the throttle lever is advanced slowly, the speed and j.p.t. will rise. If conditions are such that the speed limitation is reached first, the temperature limiter remains quiescent. On the other hand, should the temperature limit be reached first, the current to the electro-pressure valve solenoid will rise as the temperature approaches datum and the fuel system will be adjusted to reduce fuel flow. If the throttle lever is opened further, there will be a small additional rise of temperature and the fuel system is again adjusted to reduce fuel flow. On throttling back, the system returns to normal.

66. With the OVERRIDE switch still at the ON position, and the R.P.M. GOVERNOR switch at the CRUISE position, it will be seen that:-

- (1) 28-volt d.c. supply will now be connected via the R.P.M. GOVERNOR switch, and the GOVERNOR ISOLATION switches, to energize the solenoids of the engine double datum governors.

ENGINE TACHOMETERS

71. Servicing of the Mk.11 indicators is limited to checking the instruments for

This action will now provide an r.p.m. control on the engine fuel system with a cruise r.p.m. maximum.

- (2) At the same time, the same d.c. supply is directed (via pin E, 5-pin plug) to the datum level control relay within the amplifier. The relay will be energized, and the changeover of its contacts will select the CRUISE temperature datum setting resistor.
- (3) Finally, the d.c. supply will be directed to the ENGINE CONTROL magnetic indicator, which will now present a white image, thus informing the pilot that CRUISE j.p.t. and r.p.m. control are selected.

The engine r.p.m. and j.p.t. will now be automatically controlled to the engine cruise limitations.

67. Should fault conditions develop in flight, and the j.p.t. limiter system is suspect, muting conditions can be applied to the system by use of the J.P.T. OVERRIDE switch. Operation of the OVERRIDE switch to the OFF position will cause the muting relays (612 and 613) to be energized by the 28-volt d.c. supply.

68. In the case of the No.1 engine (the other three being similar), relay contacts 612/3 and 612/4 will change over, and the following circuit action will take place:-

- (1) Operation of relay contact 612/4 to open will isolate the amplifier

output from the electro-pressure valve solenoid.

- (2) Closure of relay contacts 612/3 will insert the 33-ohm. resistor across the amplifier output. (The resistance is a dummy to represent the coil of the solenoid).

This action will cause the j.p.t. limiter amplifier to be isolated, and the electro-pressure valve will be inoperative. Under these conditions, j.p.t. limitation must be carried out manually by observation of the j.p.t. gauges and manual throttle adjustment.

ENGINE BEARING TEMPERATURE INDICATORS

69. Four engine bearing temperature indicators, Type S.149/1/483, are fitted to the navigators' table on certain aircraft as shown in fig.1. The indicators provide the A.E.O. with advance information, indicated by a rising temperature, to warn of impending bearing failures. This in turn would demand corrective measures to be taken in the form of supplying additional cooling and lubrication to the overheating bearings.

70. The temperature sensing elements, Type S.110, are fitted to the engines when the complimentary Bristol Olympus Mod. 1452 is embodied. The 28-volt d.c. supply is derived from fuses 80, 81, 82 and 83 in panel 3P and energise the No.4, No.3, No.2 and No.1 engine temperature indicators respectively. A routing chart is contained in fig.19.

SERVICING

signs of damage and security of attachment during the normal inspection periods. The generators should be inspected for security and the outer cases kept clean.

72. Lubrication instructions for the instruments will be found in A.P.1275A, Vol.1, Sect.26, Chap.12 and the Standard Serviceability Test (S.G.55), to be applied

when their serviceability is suspect, is contained in Appendix 1 to the same chapter. Defective components should be returned to stores and replaced by serviceable items.

OIL PRESSURE GAUGES

73. The oil pressure indicators and transmitters should be checked periodically for tightness of connections and security of fixings. The transmitters should be examined for signs of oil leakage. Nothing else can be done in the way of minor servicing of the components. Defective items should be removed and new ones fitted.

74. It is important that the power supplies are checked for correct operating value, as a preliminary measure, should the serviceability of an instrument or any part of the circuit be suspect. In this event, the No.3 inverter should be switched on, and suitable testmeters connected across the 26-volt output side of the 3-phase transformer in the a.c. supplies panel (11P). This can be done conveniently, by connecting the test meters between the indicator fuses and earth. The fuse numbers are given in para.9.

75. The tests to be applied to indicators or transmitters whose accuracy is suspect is given in the Standard Serviceability Tests, A.P.1275A, Vol.1, Sect.3, Chap.27, Appendix 1. These tests are carried out with a Mk.2 or Mk.3 portable calibrator.

76. The testing of any oil pressure gauge circuit in situ is made by removing the respective transmitter from the engine sump and connecting it to the portable calibrator. With the No.3 inverter switched on, the test can be carried out in the normal manner. Descriptive details and full instructions for the operation of the calibrators are contained in A.P.1275T, Vol.1, Sect.3, Chap.8.

EXHAUST GAS THERMOMETERS

(Pre. Mod.294)

77. Servicing instructions for the exhaust gas thermometers are confined to checking the security of components and wiring connections, and to testing the system as laid down in the aircraft servicing schedule. The connections on the leads between each set of thermocouples and associated servo-potentiometer must be kept clean and tight because of the low output from the thermocouples.

78. Information on faults which may develop in the circuit, together with possible causes and remedies, will be found in A.P.1275A, Vol.1, Sect.17, Chap.16. Serviceability tests and the scale for temperature-millivolt equivalents will be found in the appendix to the same chapter. The exhaust gas thermometer test set (Stores Ref.6C/966) is used for testing the thermometer and is fully described in A.P.1275T, Vol.1, Sect.4, Chap.6.

79. As a matter of convenience the test set may be connected in the circuit at the appropriate terminal blocks on the rear pressure bulkhead in the cabin. Direct testing of the thermocouples can be made from the junction boxes located at the end of each jet pipe.

FUEL GAUGES

80. The gauges in the fuel contents system should be inspected periodically for correct operation. The fuel contents for each tank group will be indicated on the appropriate gauges when the battery isolation switch, located on (10P), is on. Checks should be made to ensure that the tank group readings on the navigator's gauges agree with the pilots' gauges on (2P). The operation of the pilots' contents gauges and C.G. indicator should also be tested by pressing the associated push-switches as detailed in para.22 and 27.

81. Servicing instructions for the components in the fuel system as a whole are contained in Chapter 1, Group 5 of this section. The Smiths-Waymouth test set, Type QAA, is used for testing the fuel contents system and is fully described in A.P.1275T, Vol.1, Sect.5, Chap.2.

FUEL FLOWMETERS

82. The components in the fuel flowmeter system should be checked for security and tightness of connections during the normal inspection periods. Full servicing instructions for the system, including details of tests to be applied to instruments suspected of being defective will be found in A.P.1275A, Vol.1, Sect.18. The test set will be described in A.P.1275T.

JET PIPE TEMPERATURE SYSTEM

83. In order to maintain a high degree of serviceability for the jet pipe temperature system, it is essential that the greatest co-operation be maintained between the instrument, electrical and engine tradesmen, during servicing periods, or when the system is suspect of fault.

84. Provided that the system is operating satisfactorily, servicing is restricted to normal routine inspection of the components, as laid down in A.P.4505A, Vol.1, Sect.17, Chap.16, App.1.

Test equipment and procedure

85. Tests on the jet pipe temperature system are made with the aid of the Ultra QT.2230 test equipment. This equipment consists of a test set, Type QT223, and two associated test cables, QY2212 and QY2216. A detailed description of the test equipment will be found in A.P.4343S, Vol.1, Sect.23, Chap.20, together with details of the

RESTRICTED

possible tests and associated procedures. The aircraft test plugs to which the test set connects, when in use, are located in the compartment aft of the power compartment as shown in fig.2.

Amplifier datum setting resistors

86. The j.p.t. limiter amplifiers on aircraft equipped with E.C.U.10201 are fitted with plug-in datum setting resistors Type M, Ref.No.5CZ/5394. The amplifiers on aircraft with E.C.U.10401 are fitted with datum setting resistors Type R, Ref. No.5CZ/6006. It is essential therefore to ensure that:-

- (1) When fitting a replacement ampli-

fier to an engine j.p.t. limiting system, the datum setting resistor is removed from the unserviceable amplifier, and plugged into the replacement amplifier.

- (2) When Mod.413 is embodied, or should any change from E.C.U.10201 to E.C.U.10401 occur on the aircraft, the correct resistors must be fitted to the amplifiers.

Following an engine or amplifier change, the j.p.t. limiting system must be tested and re-calibrated as described in A.P.4343K, Vol.1, Sect.3. Note that on aircraft with Mod.803 embodied, a datum setting resistor,

Ref.No.5CZ/6160, replaces the type M or R datum setting resistor in the amplifier.

ENGINE BEARING TEMPERATURE INDICATORS

87. The indicators and temperature bulbs require little in the way of normal servicing. Where possible the indicators and bulbs should be checked for signs of external damage and all plugs and sockets examined for security and ingress of dirt and moisture.

88. Items which are suspected of being unserviceable should be tested in accordance with the instructions given in A.P.1275A, Vol.1, Sect.17.

REMOVAL AND INSTALLATION

General

89. No detailed instructions are required for the removal of the various engine instruments and components. The indicating instruments described in the group can be removed when the associated instrument panels are detached as outlined in Group 1, para.31-34. It is emphasized that special care should be taken to prevent damage to instruments during the removal and replacement of these items.

90. Access to the engine components is gained by lowering the hinged panels

underneath the engines. Information for the removal of engine components will be found in the Olympus engine handbook A.P.4501B, Vol.1. Defective jet pipe thermo-couples should be changed as directed in Vol.6 of the same publication.

JET PIPE TEMPERATURE SYSTEM

91. No difficulty should be experienced in removing any of the major components of the jet pipe temperature system. De-

fective jet pipe thermocouples should be changed as directed in Vol.6 of the appropriate engine handbook (A.P.4501 series).

Thermo-couples

92. Access to the jet pipe thermocouple main junction boxes on the upper surface of each jet pipe is afforded by suitable access panels on the outside of the jet pipe tunnel structure (fig.2). The chromel-alumel leads from the conduit passing into the rear compartment should be disconnected at the jet pipe junction box prior to engine jet pipe removal.

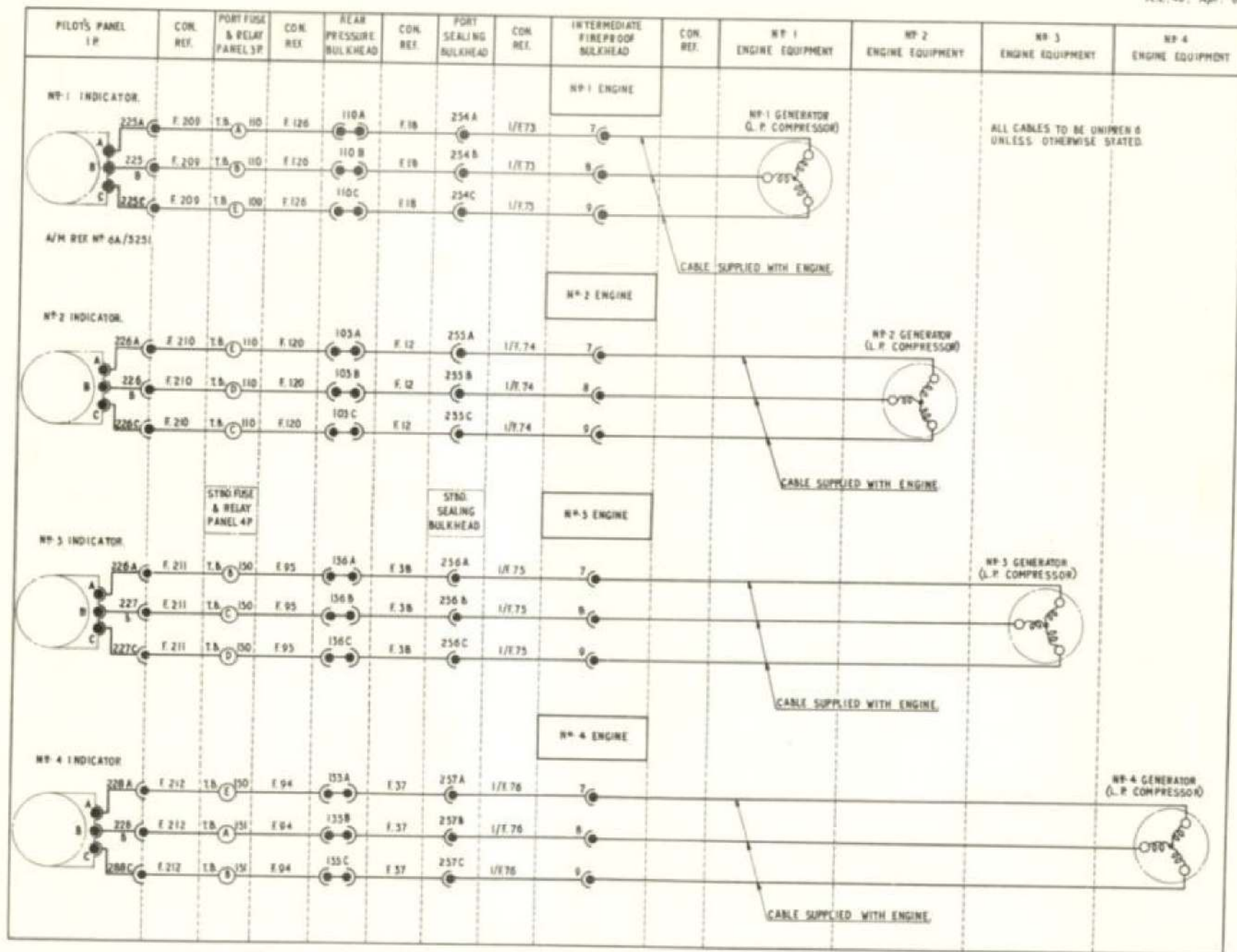


Fig. 4. Engine Tachometers
RESTRICTED

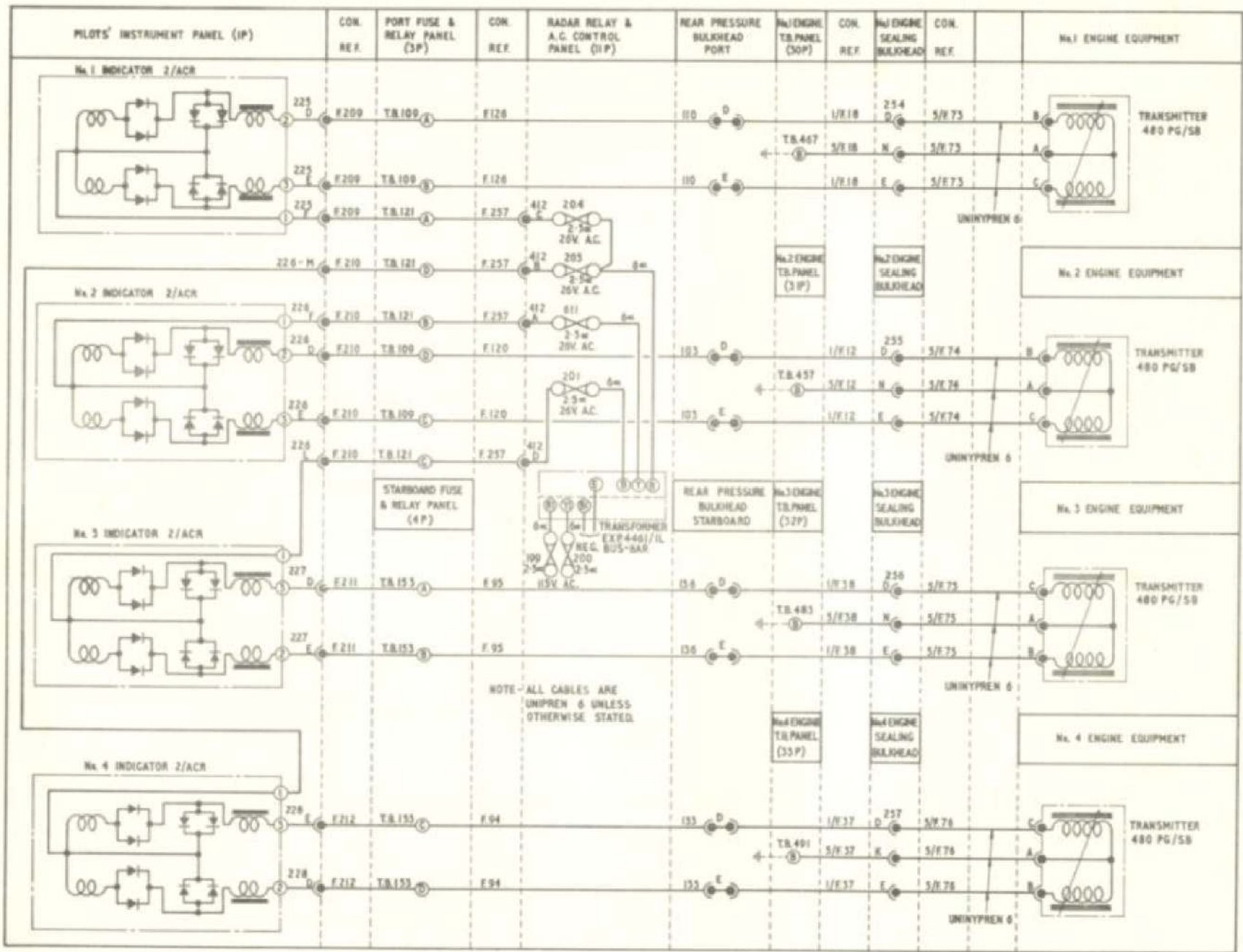


Fig. 5. Oil Pressure Indicators

RESTRICTED

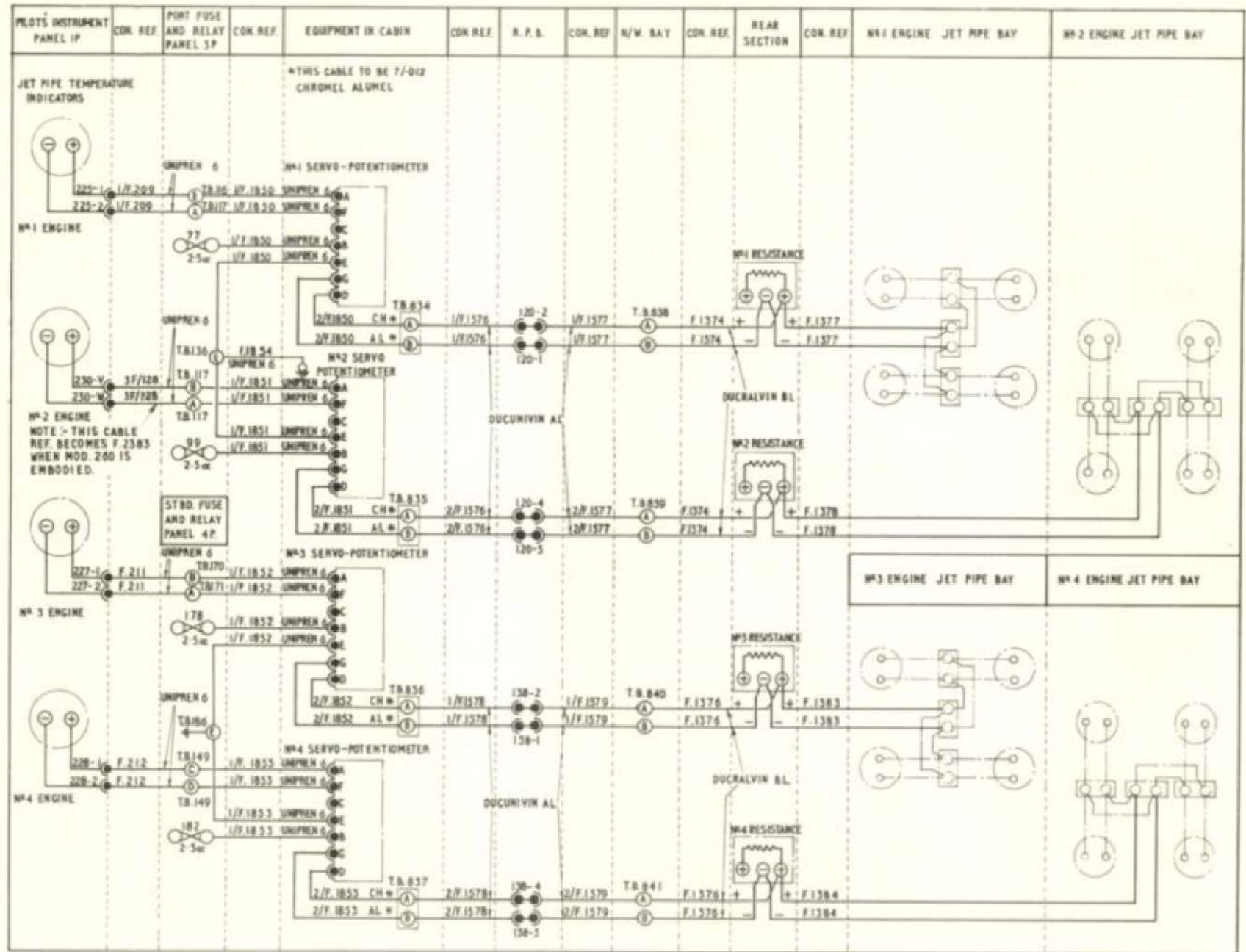


Fig. 6. Exhaust Gas Thermometers (Pre Mod. 279)

RESTRICTED

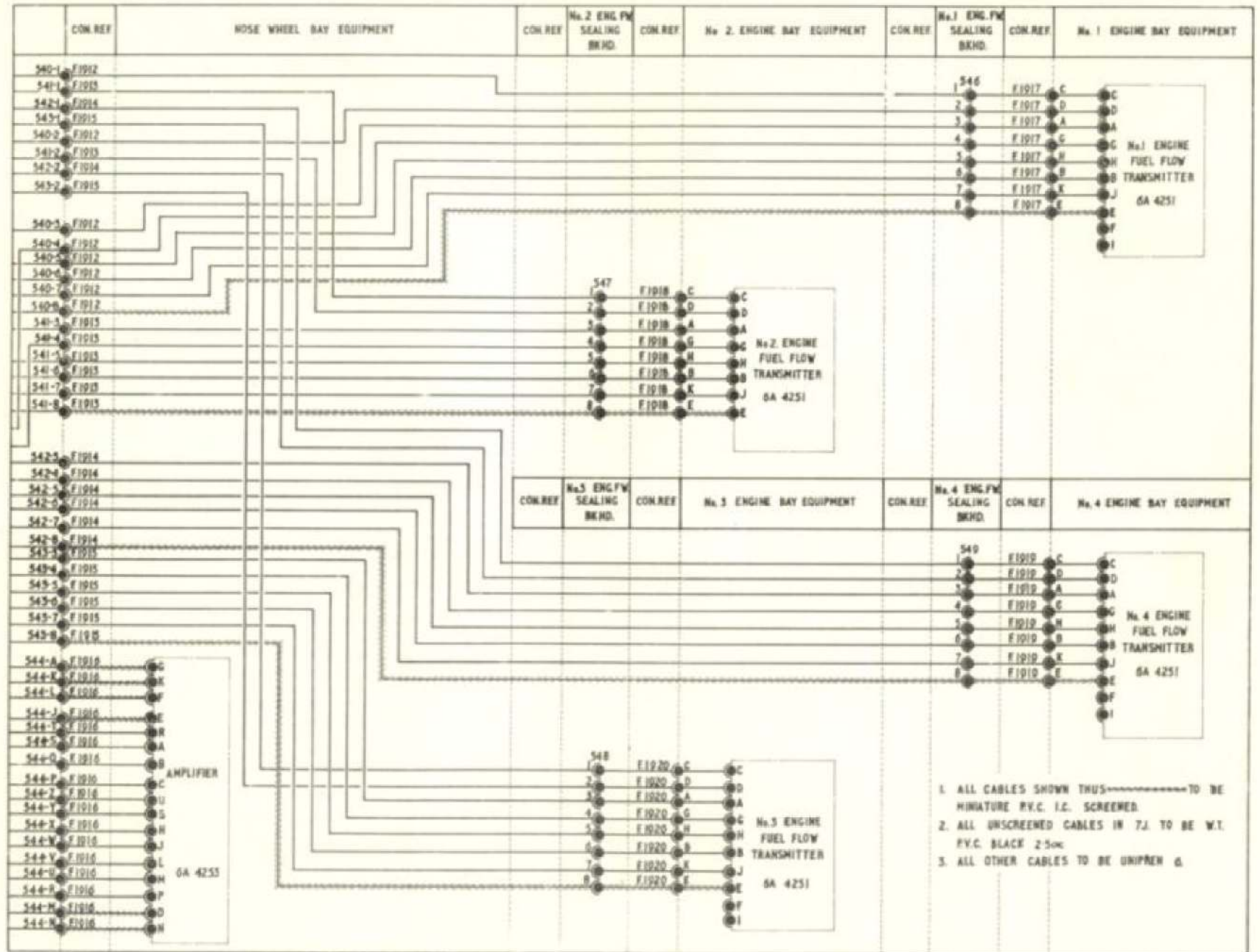


Fig. 7.(2) Fuel Flowmeters Mk.3.

RESTRICTED

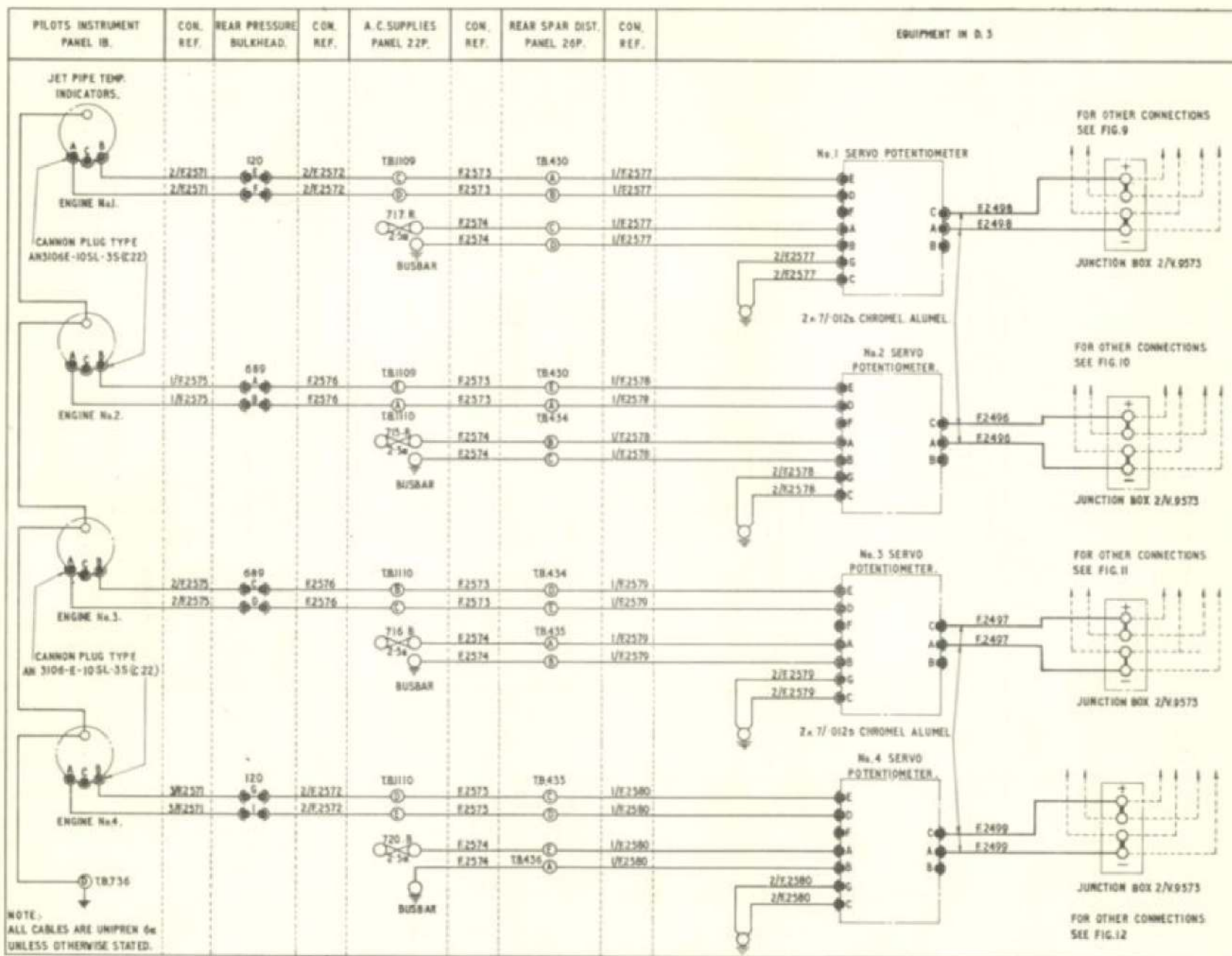


Fig. 8. Exhaust Gas Thermometers (E.C.U. 10201 & E.C.U. 10401)

RESTRICTED

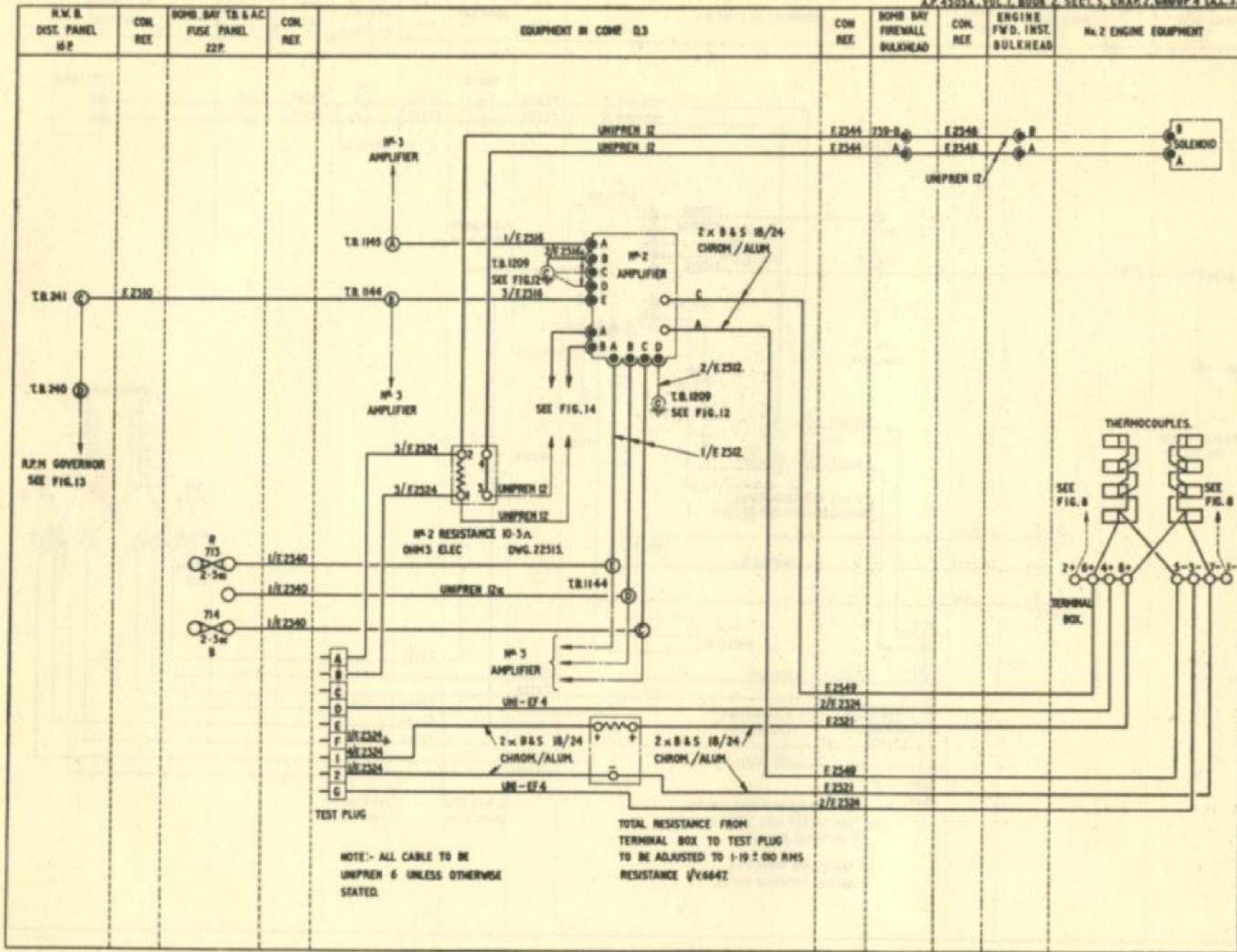


FIG. 10 JET PIPE TEMPERATURE LIMITERS No. 2

RESTRICTED

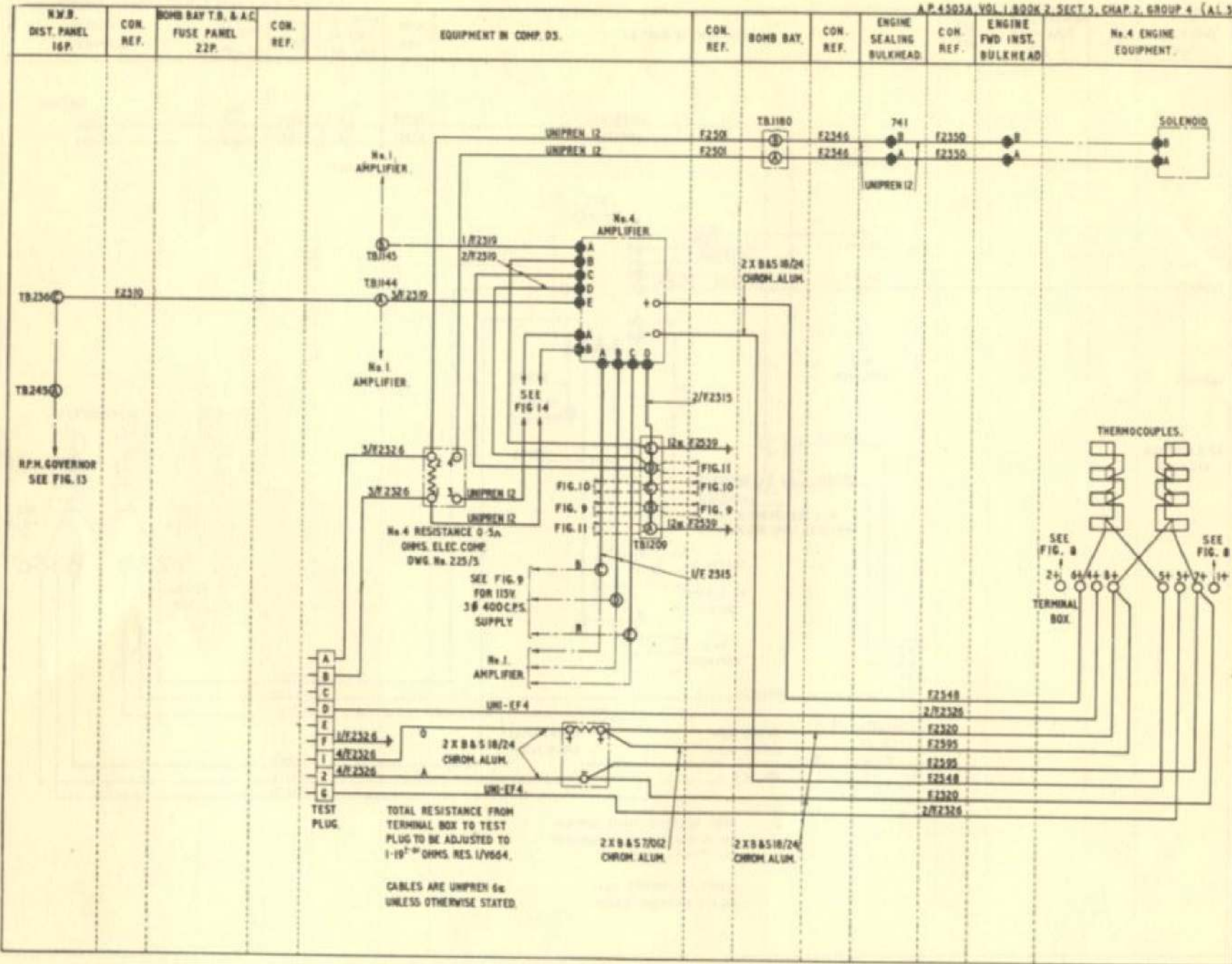


FIG. 12 JET PIPE TEMPERATURE LIMITERS No. 4

RESTRICTED

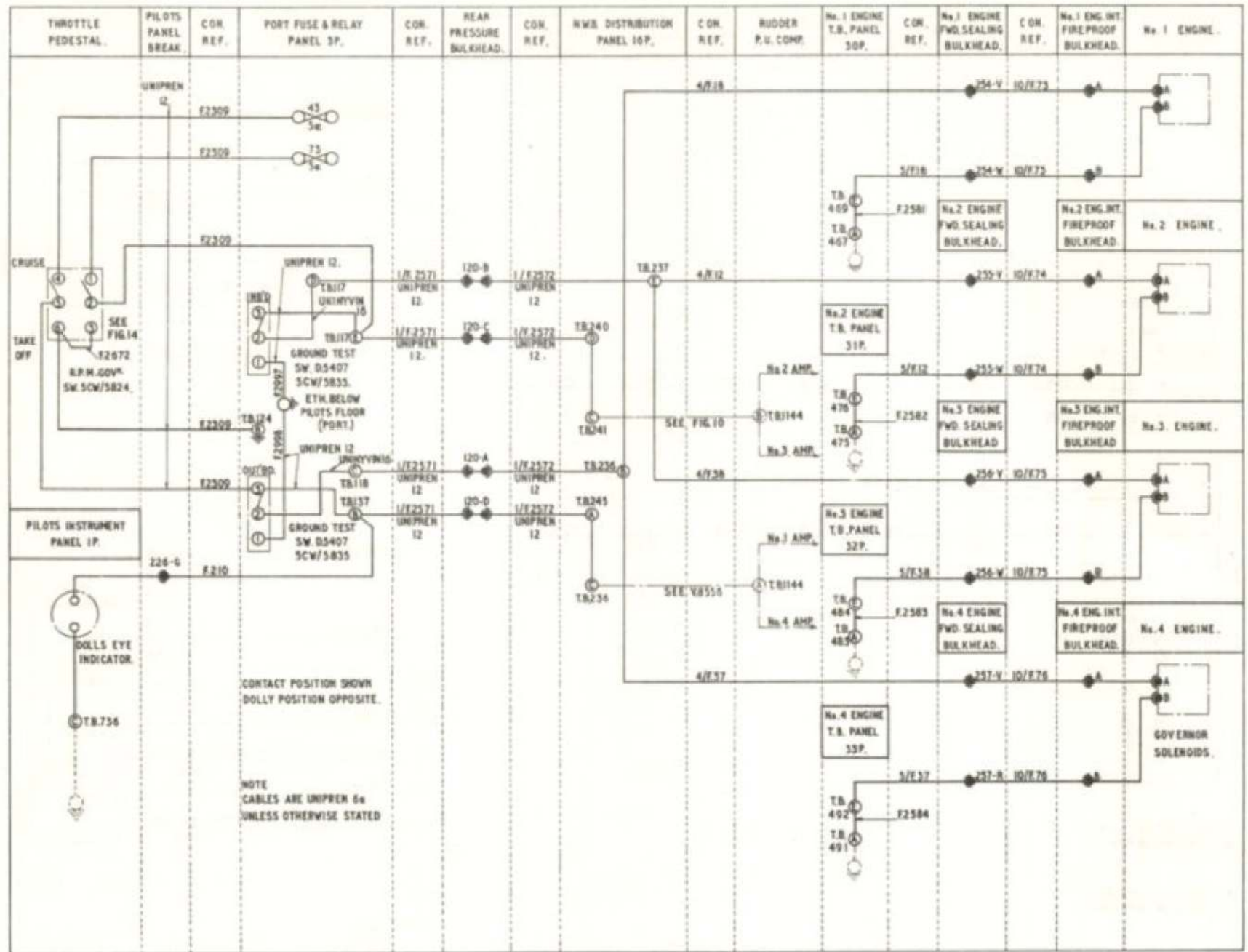


Fig. 13. R.P.M. Governors
 (Mod 2003 embodied)
RESTRICTED

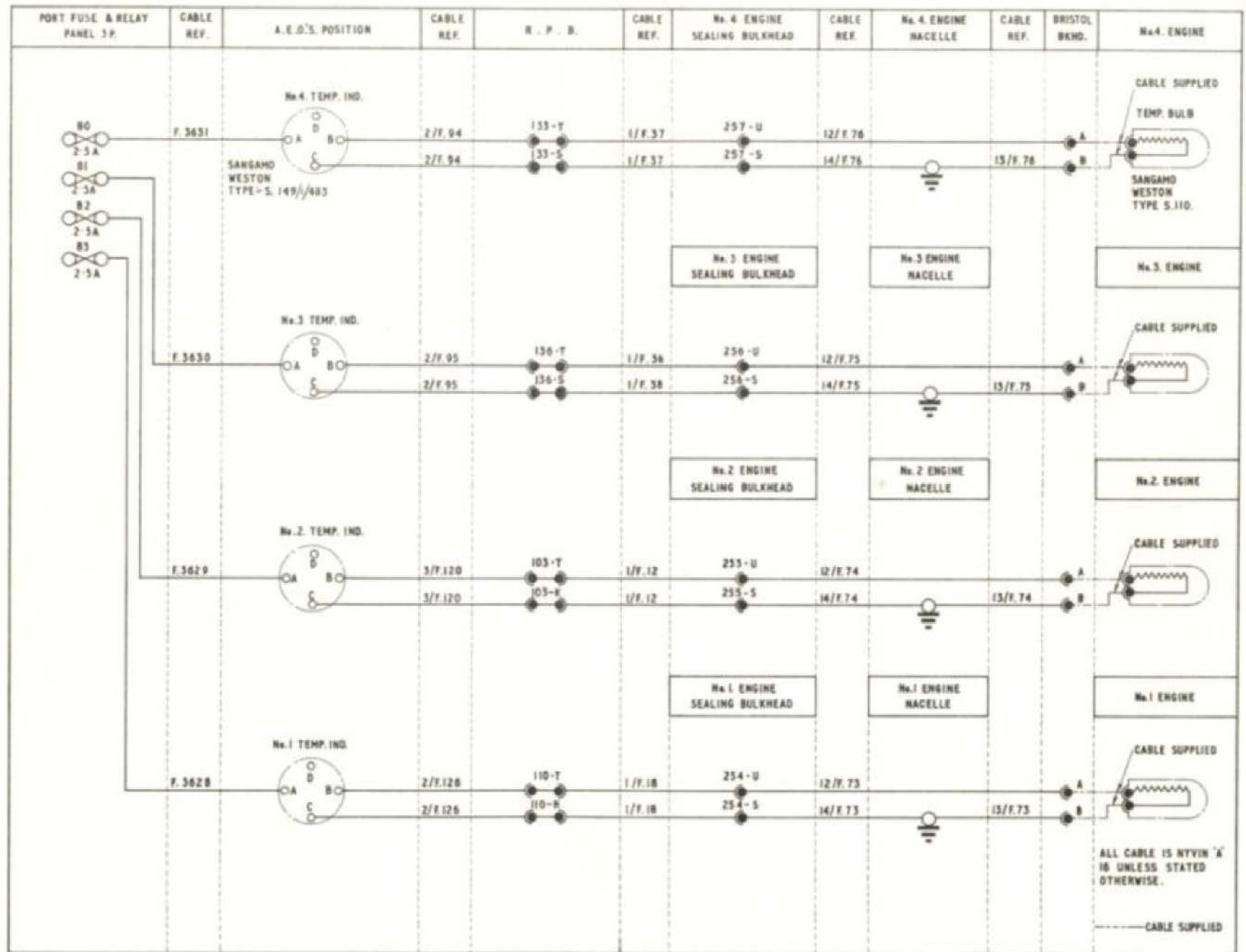


Fig. 19 Engine bearing temperature indicators (Mod. 1996 S.O.O.)

This file was downloaded
from the RTFM Library.

Link: www.scottbouch.com/rtfm

Please see site for usage terms,
and more aircraft documents.

