

Group 4—ENGINE INSTRUMENTS

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Warning

Voltages in excess of 100 volts a.c. or d.c. can be dangerous under certain circumstances. Personnel should therefore ensure that the electrical system is electrically safe before any servicing is attempted. Where it is essential that tests or adjustments are to be carried out with the electrical power switched on, the greatest care must be exercised.

DESCRIPTION AND OPERATION

Introduction

1. This Group contains brief descriptive and servicing notes on the engine instruments installations. For detailed information on all items of equipment reference should be made to the relevant Air Publications.

2. Information on the layout and interpretation of the schematic diagrams can be obtained from the General Information group placed immediately after Section 5 marker card. Also to be found in the General Information group are all the general modifications applicable to all types of Valiant aircraft.

TACHOMETERS (fig. 1)

3. Each engine has a separate but identical tachometer system, comprising a 3-phase

generator mounted near the oil filter on the starboard side of each engine and directly connected to an indicator mounted on the instrument centre panel. The indicator contains a self-starting 3-phase synchronous motor which moves the pointer of the dial by means of a magnetic drag element. The circuit is entirely self contained and is not connected in any way with the aircraft general electrical system.

OIL PRESSURE GAUGES (fig. 2)

4. Each engine has a separate but identical oil pressure gauge system, operating on the ratiometer principle. A change of oil pressure alters the value of the inductances in the transmitter causing unbalance of the ratiometer in the indicator which in turn moves the indicating mechanism. Thus a

continuous indication of oil pressure is obtained. Each system operates at 26 volts single phase a.c., obtaining its supply from the secondary side of a transformer, whose primary is supplied at 115 volts single phase a.c. from the instrument supplies torque switch box behind the radio crate. The indicators are mounted on the pilots' instrument centre panel and the transformers in the starboard console.

FUEL CONTENTS GAUGES

(fig. 3 to 6)

Note . . .

Aircraft fitted with Mod. 779 have fuel contents recorded in terms of mass units instead of volumetric units. The tank units, cable assemblies, rectifiers and power units remain the same, the only difference being the indicators which are now calibrated in mass units.

5. A Pacitor system of contents indication is used, whereby the variation in the ratio of fuel/air as a dielectric alters the capacitance of the tank unit which forms one arm of a bridge circuit in the rectifier unit. The two measuring arms are coupled to rectifier systems and the output is applied to the indicator.

6. The port and starboard systems are similar. The port and starboard wing tanks operate from separate oscillator units and the fuselage tanks from a common one. One oscillator supplies the two reserve tanks and the transfer tank and a further oscillator unit supplies both underwing tanks. The outer wing tanks have a tank unit in each of the three cells working in parallel, giving one indication on one indicator only, similarly, the two cells of the inner wing tanks indicate on one indicator. Each

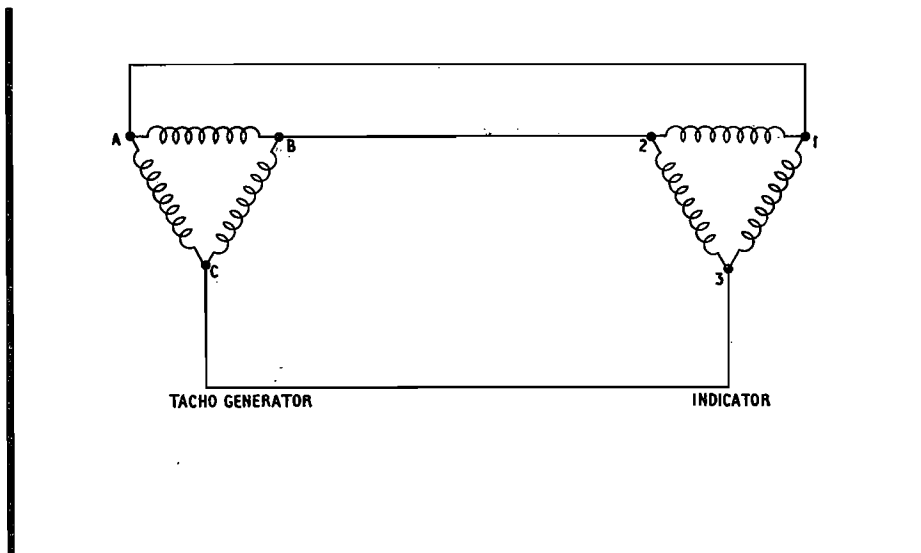


Fig. 1. Tachometer

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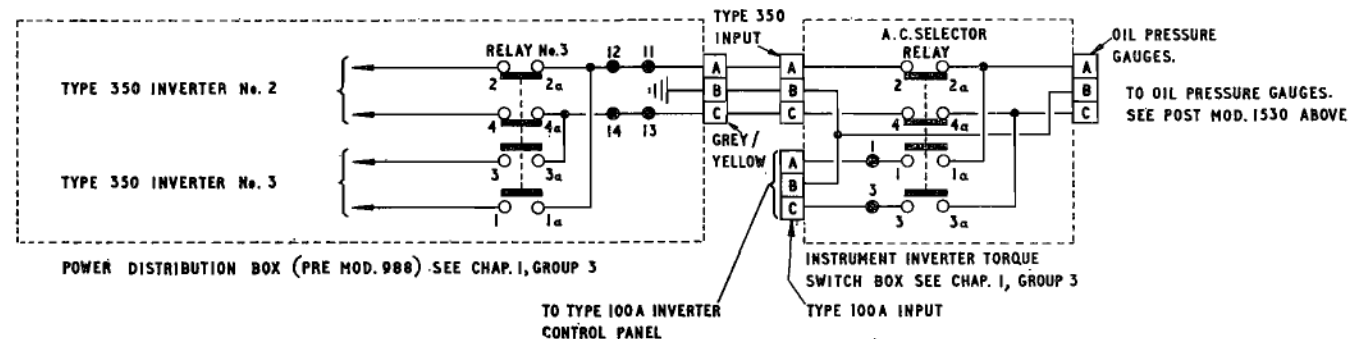
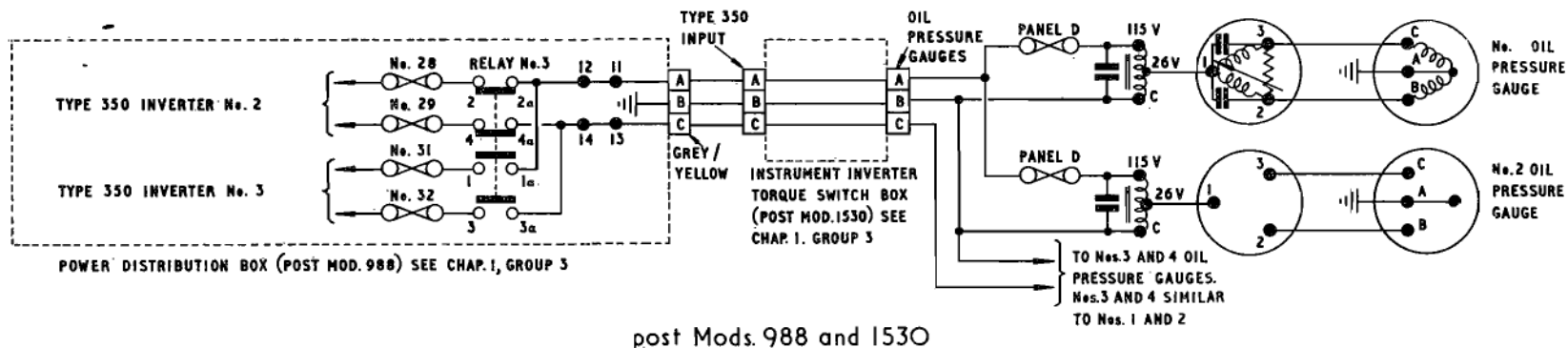


Fig. 2. Oil pressure gauges

underwing tank has three tank units in parallel feeding one indicator. Although only one indicator is provided for each fuselage tank, the three cells can be measured separately, or as a combined total, by means of a selector switch mounted on the fuel panel, and a relay rectifier unit mounted in the port and starboard service bays. When a selector has been made the relay solenoid R2 is energized. The relay which is of the rotary type, hunts until the correct position is obtained when the selected tank unit will be connected to the rectifier and the gauge. The wing, main fuselage and underwing tank indicators are mounted on the pilots' fuel panel.

7. In the event of failure of either the port
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or starboard wing tank oscillator units, the other may be used to measure fuel contents to port or starboard by means of a change-over relay, R1, operated by a switch on the starboard fuel panel. This relay is fitted into a junction box on the pacitor relay panel.

8. The transfer tank has one tank unit, in the starboard cell, and one rectifier unit; the fuselage reserve tanks to port and starboard each contain one tank unit and have an associated rectifier unit mounted in the port and starboard fuselage fuel service bays respectively. The three tank units obtain their supply from the No. 4 oscillator unit. The three indicators are mounted on the pilots fuel panel.

9. The five oscillator units and the port and starboard fuselage tank selector switch and relay are supplied from fuse panel F. The whole system becomes operative on closing the flight instruments master switch. The oscillator units are allocated as follows:-
- No. 1 Port wing tanks.
 - No. 2 Starboard wing tanks.
 - No. 3 Port and starboard fuselage tanks.
 - No. 4 Transfer and reserve tanks.
 - No. 5 Underwing tanks.

FUEL FLOWMETERS (fig. 7)

10. Flowmeter transmitters are fitted in the fuel line to each engine and are mounted

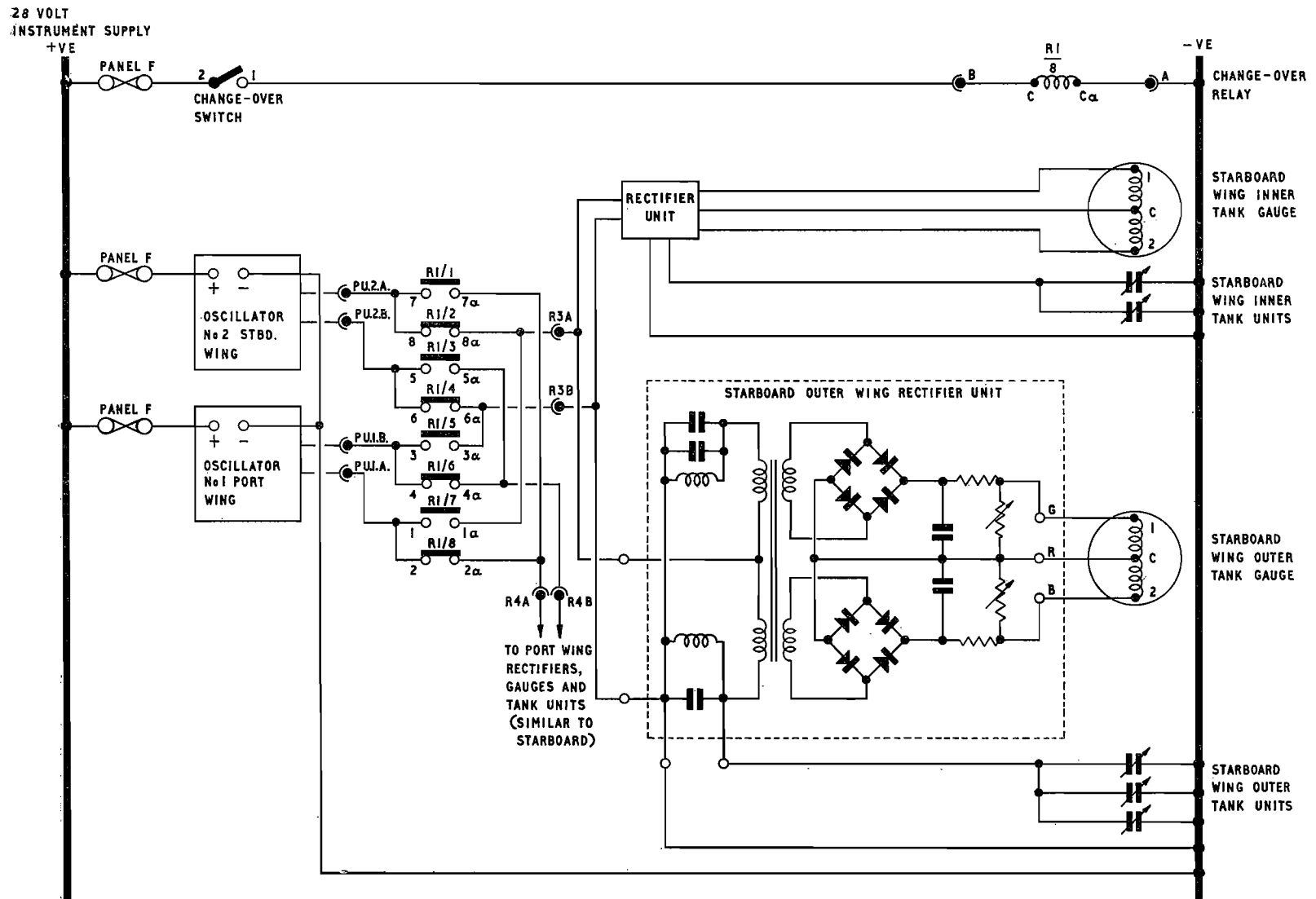


Fig. 4. Wing tanks fuel contents gauges

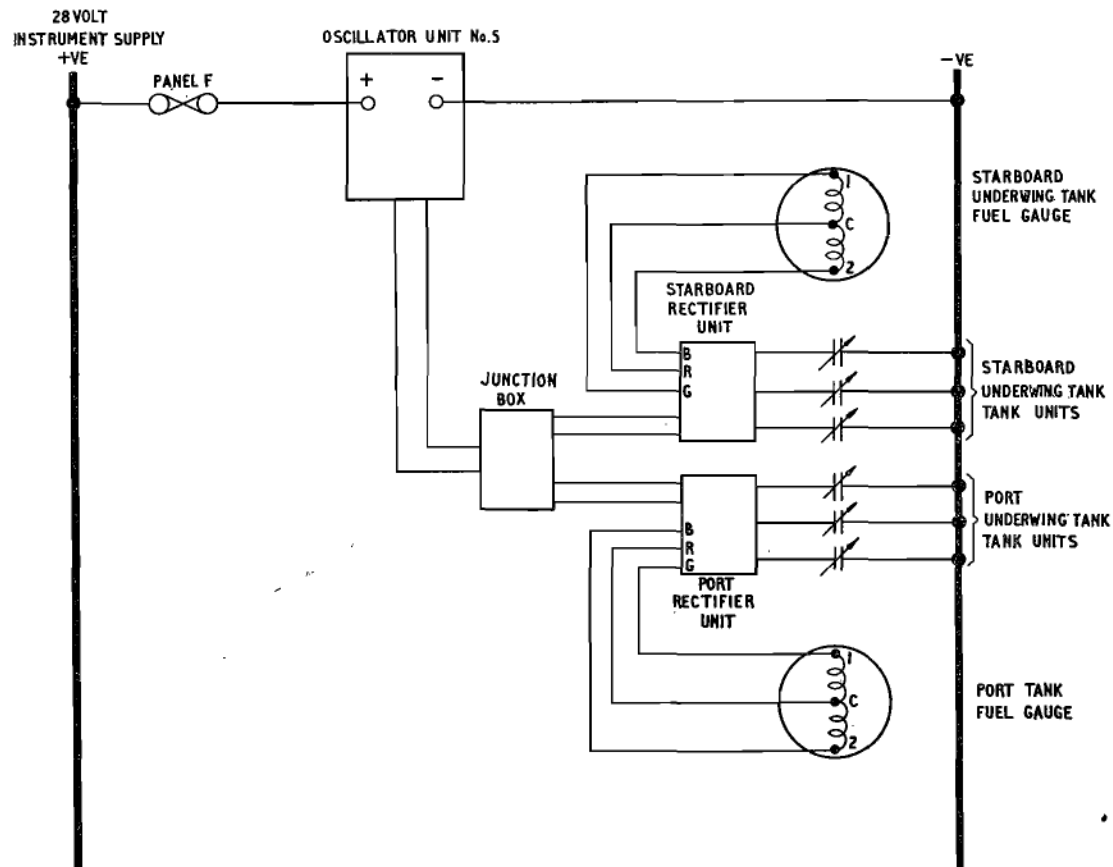


Fig. 5. Underwing tanks fuel contents gauges

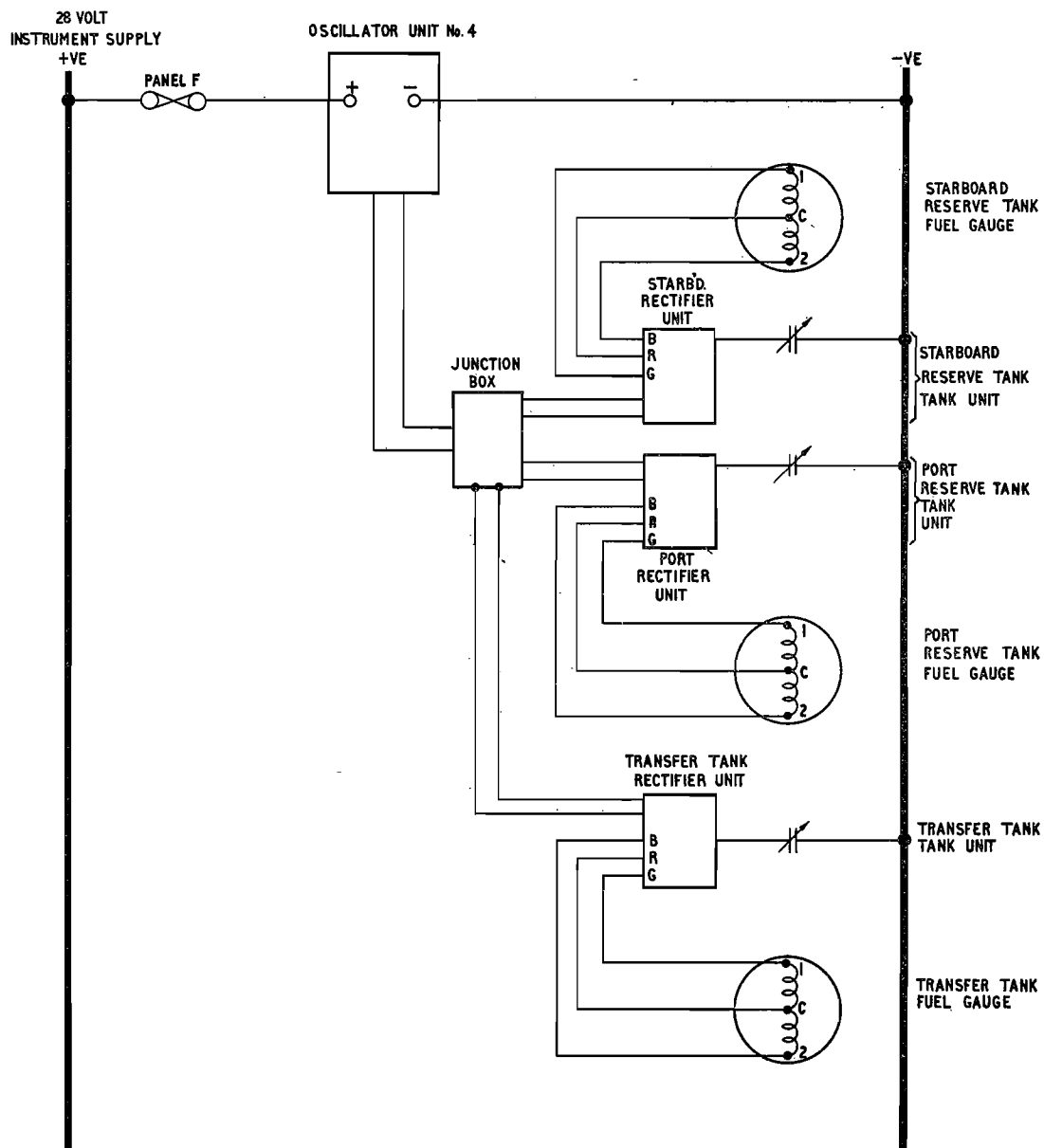


Fig. 6. Reserve and transfer tanks fuel contents gauges

Table 1
Fuel contents gauges—component capacities

Tank units (Pre. and Post Mod. 779)

Tank	Type	No. off	Capacity
Reserve	G.P. 384-023✓	2	473 ± 18 p.f.
Fuselage, Cell 1	G.P. 384-044✓	2	288 ± 12 p.f.
Fuselage, Cell 2	G.P. 384-043✓	2	546 + - 17 p.f.
Fuselage, Cell 3	G.P. 384-045✓	2	500 + - 10 p.f.
Wing tank No. 1, inner cell	G.P. 385-005✓	2	266 ± 11 p.f.
Wing tank No. 1, outer cell	G.P. 385-004✓	2	238 ± 9 p.f.
Wing tank No. 2, inner cell	G.P. 385-003✓	2	215 ± 8 p.f.
Wing tank No. 2, centre cell	G.P. 385-002✓	2	192 ± 8 p.f.
Wing tank No. 2, outer cell	G.P. 385-001✓	2	116 ± 8 p.f.
Starboard transfer tank	G.P. 384-047✓	1	240 ± 9 p.f.
Port transfer tank	G.P. 384-046✓	1	246 ± 9 p.f.
Underwing tank, forward	G.P. 354-058✓	2	194 ± 8 p.f.
Underwing tank, centre	G.P. 354-059✓	2	185 ± 7 p.f.
Underwing tank, aft	G.P. 354-060✓	2	139 ± 6 p.f.

Cable assemblies

Position	Type	No. off	Capacity
Underwing tank aft cable	G.P. 742-159	2	140 ± 10 p.f.
Underwing tank forward cable	G.P. 742-158	2	198 ± 10 p.f.
From underwing tank to rectifier	G.P. 742-160	2	30 ± 3 p.f.
From wing tank No. 2 connector to rectifier	G.P. 742-059	2	292 ± 14 p.f.
From wing tank No. 1 connector to rectifier	G.P. 742-060	2	38 to 43 p.f.
From reserve tank cell connector to rectifier	G.P. 742-065	2	96 ± 10 p.f.
From fuselage cell 1 connector to relay rectifier	G.P. 742-059	2	292 ± 14 p.f.

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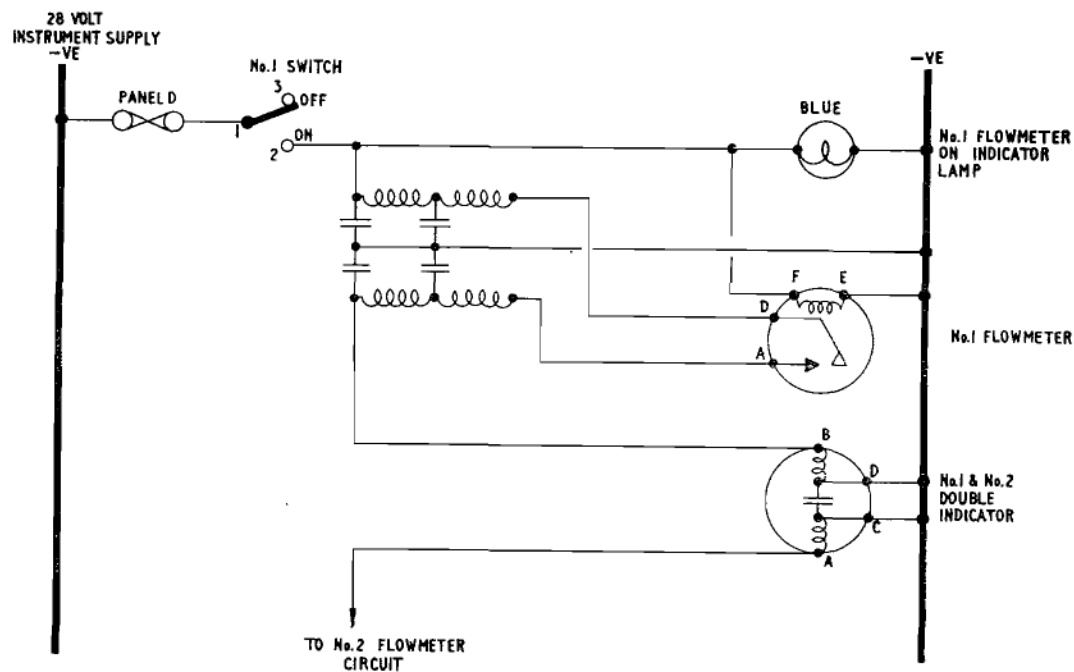
Table 1—continued

Position	Type	No. off	Capacity
From fuselage cell 2 connector to relay rectifier	G.P. 742-064	2	138 ± 7 p.f.
From fuselage cell 3 connector to relay rectifier	G.P. 742-063	2	148 ± 7 p.f.
◀ From transfer tank connector to rectifier	{ G.P. 742-161 (pre-Mod. 1830) G.P. 742-218 (post Mod. 1830)	{ 1 1	53 ± 4 p.f. ▶
From each reserve and fuselage cell 1, connectors to tank units	G.P. 743-026	4	23 ± 2 p.f.
Between transfer tank inter-cell connector and transfer tank units	G.P. 743-044	2	124 ± 10 p.f.
Between each fuselage cell 2 connector and tank unit	G.P. 743-027	2	50 ± 2 p.f.
From fuselage cell 3 connector to tank unit	G.P. 743-021	2	73 ± 4 p.f.
From transfer tank connector to starboard cell tank unit	G.P. 743-045	1	67 ± 4 p.f.
From wing tank No. 1 connector to inner cell tank unit	G.P. 743-018	2	104 ± 9 p.f.
From wing tank No. 1 inner cell tank unit to inter-cell connector	G.P. 743-019	2	161 to 174 p.f.
From wing tank No. 1 inter-cell connector to outer cell tank unit	G.P. 743-023	2	77 ± 6 p.f.
From wing tank No. 2 connector to inner cell tank unit	G.P. 743-020	2	163 ± 5 p.f.
From wing tank No. 2 inner cell tank unit to inner inter-cell connector	G.P. 743-024	2	209 ± 6 p.f.
From wing tank No. 2 inner inter-cell connector to centre cell tank unit	G.P. 743-021	2	73 ± 4 p.f.
From wing tank No. 2 centre cell tank unit to outer inter-cell connector	G.P. 743-025	2	90 ± 3 p.f.
From wing tank No. 2 outer inter-cell connector to outer cell tank unit	G.P. 743-022	2	121 ± 4 p.f.

Rectifier units (For additional items on B/K Mk. 1 and B/K/PR Mk. 1 aircraft see Chap. 9)

Tank	Type	No. off	Capacity	
			Pre-Mod. 779	Post Mod. 779
Underwing	G.P. 645-013/1	2	Empty 897 p.f.	897 p.f.
			Full 1375 p.f.	1375 p.f.
Wing No. 2	G.P. 645-013/3 (post Mod. 1512)	2	Empty 1508 p.f. Full 1981 p.f.	1508 p.f. 1968 p.f.
	G.P. 645-013/4 (post Mod. 2671)	2		
	G.P. 645-003	2		
Wing No. 1	G.P. 645-002	2	Empty 969 p.f. Full 1462 p.f.	923 p.f. 1399 p.f.
Reserve	G.P. 645-001	2	Empty 609 p.f. Full 1088 p.f.	609 p.f. 1070 p.f.
Transfer	G.P. 645-012	1	Empty 895 p.f.	895 p.f.
			Full 1400 p.f.	1400 p.f.
			G.P. 645-012/3 (post Mod. 1842)	1
	G.P. 645-022 (post Mod. 1830)	1		

Tank	Type	No. off	Capacity		
			Pre-Mod. 779	Post Mod. 779	
Relay rectifier for fuselage tanks	G.P. 654-001	2	Cell 1		
			Empty	590 ± 40 p.f.	590 p.f.
			Full	873 ± 12 p.f.	833 p.f.
			Cell 2		
			Empty	736 ± 40 p.f.	736 p.f.
			Full	1307 ± 25 p.f.	1269 p.f.
			Cell 3		
Empty	736 ± 40 p.f.	736 p.f.			
Full	1243 ± 21 p.f.	1184 p.f.			
Total			Empty	2062 ± 120 p.f.	2062 p.f.
			Full	3423 ± 95 p.f.	3286 p.f.



No. 3 AND 4 FLOWMETERS SIMILAR

Fig. 7. Fuel flowmeter

in the port and starboard fuselage fuel service bays. Each transmitter is connected to one half of two double indicators, mounted on the panel above the starboard console, the indicator measuring the fuel in terms of "gallons gone". The transmitter works on the displacement principle, measuring the quantity of fuel passing through the working chamber and transmitting an electrical pulse to the indicator for each $\frac{1}{10}$ gallon passed. A suppressor unit is included in the circuit to minimize any radio interference that may be set by the operation of the switch in the transmitter. The supplies to the circuits are obtained from the starboard fuse panel D and are controlled by switches mounted adjacent to the indicators. A blue warning lamp above each switch indicates that the flowmeters have been switched on.

Note . . .

Post Mod. 779, different transmitters and indicators are used to record the flow in terms of mass units in lieu of volumetric units. Post Mod. 1599, the indicators will be mounted on an angled bracket so that they are more readily seen by the 2nd pilot.

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EXHAUST GAS TEMPERATURE GAUGES

Pre-Mod. 1106 (fig. 8)

11. The systems of the four jet pipes are independent but identical. The following describes one system only. Around the jet pipe are four thermo-couples (these are separate from, but mounted adjacent to, the fuel control thermo-couples). These thermo-couples are connected in parallel in two pairs at terminal blocks on the wing ribs each side of the jet pipe and the two pairs are paralleled at connector blocks

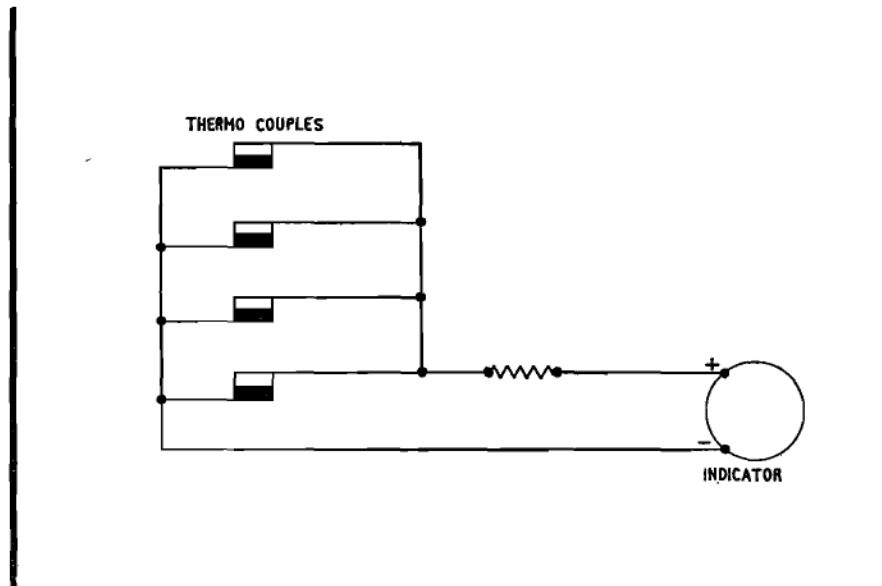


Fig. 8. Exhaust gas thermometers (pre-Mod. 1106)

mounted in the fuselage, just aft of the rear spar. The positive connection from the paralleled thermo-couples is taken through an adjusting spool, connected at the fuselage terminal blocks, to the indicator, mounted on the pilot's instrument centre panel. The negative line is taken from the indicator to the thermo-couples, via the fuselage blocks. The adjusting spool consists of a reel of resistance wire which is unwound and

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connected so as to give a total resistance from thermo-couple to indicator of $8 \pm .01$ ohms. The resistance of each thermo-couple complete with its cable is 0.82 ohms and the indicator range is $0-800$ deg. C.

Post Mod. 1106 (fig. 9)

Note . . .

Mod. 1106 introduces the thermometer exhaust gas system Type C; provides ground test facilities and wires the jet pipe and fuel control thermo-couple circuits in parallel.

12. The systems of the four jet pipes are identical but completely independent. The following description described one system only. Around the jet pipe are eight thermo-couples connected in parallel at two commoning terminal blocks, one positive, one negative. These terminal blocks are mounted on the top of the jet pipe shroud and are accessible through a panel in the upper wing surface. A connection is taken

from the positive terminal block through an adjusting spool, connected to the appropriate fuselage thermo-couple block, to the indicator mounted on the pilot's instrument centre panel. The negative line is taken from the indicator to the jet pipe shroud terminal block via the thermo-couple fuselage terminal block.

13. The adjusting spool consists of a reel of fine resistance wire the length of which can be varied so as to give a total resistance from thermo-couple to indicator of 8 ± 0.01 ohms. The resistance of each thermo-couple complete with cable is 2 ohms and the indicator range is 0 to 800 deg. C.

14. A test plug, mounted between the jet pipes, is directly connected to the jet pipe shroud terminal block. Two cables from the test plug are connected into the jet pipe temperature control circuit (*para. 20*).

JET PIPE TEMPERATURE FUEL CONTROL

Pre- and post Mod. 1106 (fig. 10 to 13)

Note . . .

Mod. 1106 provides for the wiring in parallel of the jet pipe temperature fuel control and thermometer exhaust gas system Type 'C' circuits.

15. This system automatically controls the fuel flow to each engine so that the exhaust gases in the jet pipe are kept below a predetermined temperature. Each engine is separately controlled by identical systems. Eight (four pre-Mod. 1106) thermo-couples mounted in the jet pipe feed a signal to a bridge circuit in the magnetic amplifier. (Pending further development the system will work for maximum throttle settings only, but will later take care of temperature for any throttle setting).

16. The amplifier bridge circuit, known as the cold junction compensator, corrects for changes of ambient temperature at the terminals of the amplifier to which the

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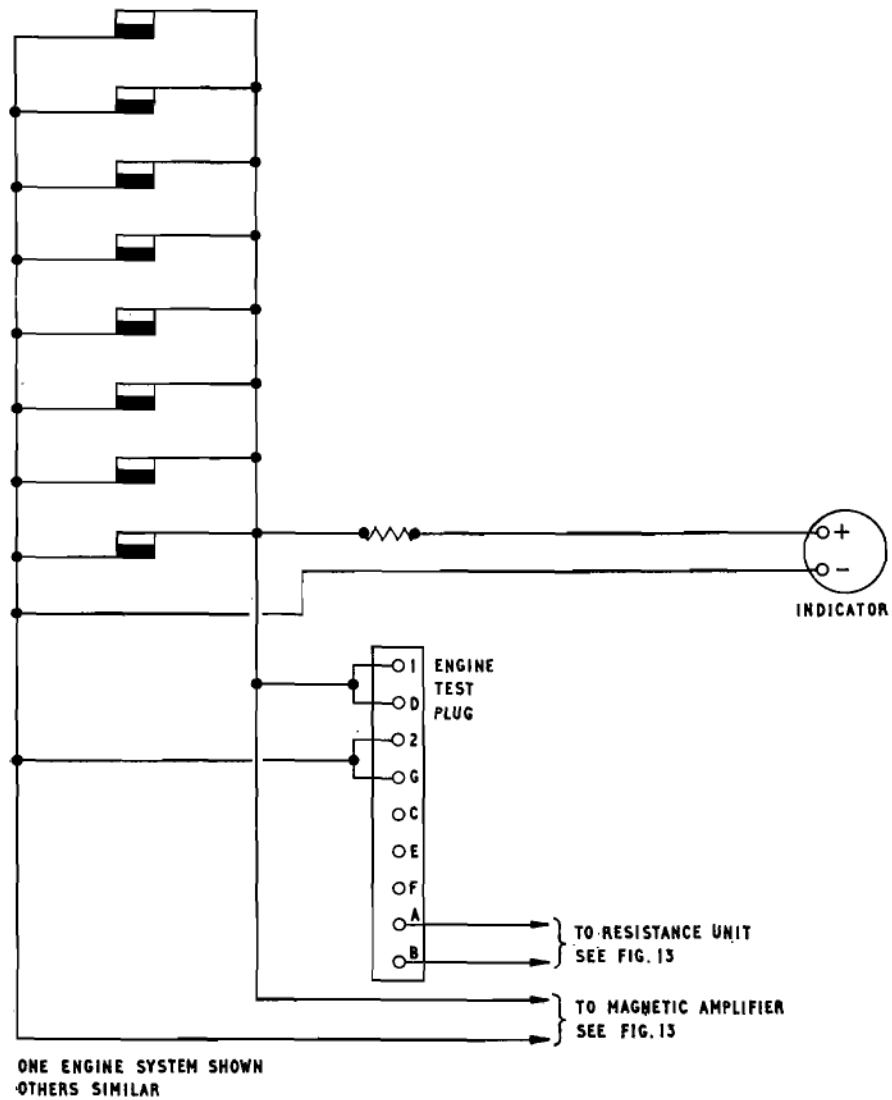
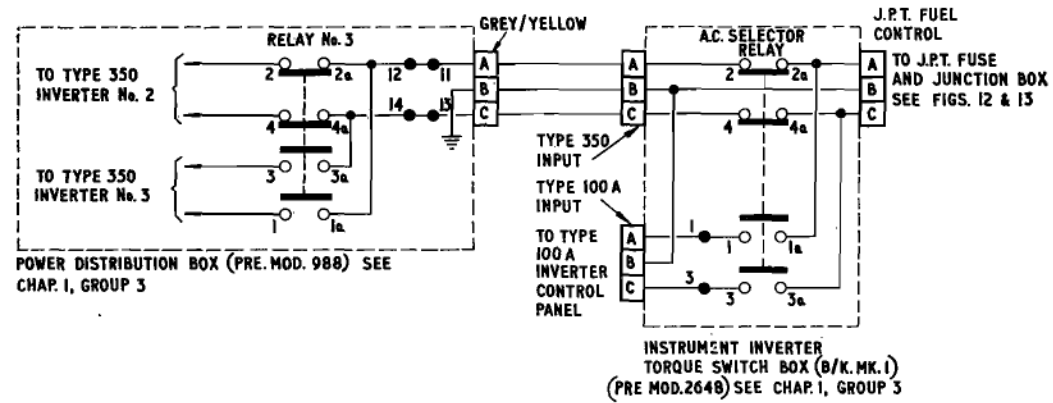
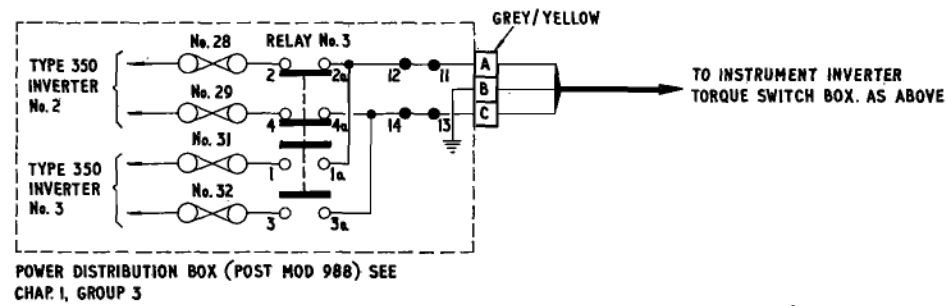


Fig. 9. Exhaust gas thermometers (post Mod. 1106)

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pre Mod. 988 and 2648



post Mod. 988, pre Mod. 2648

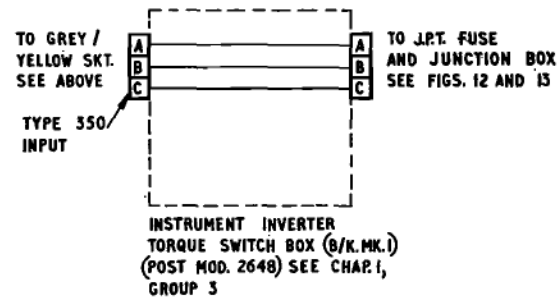


Fig. 10. Jet pipe temperature control power supplies (B/K Mk. 1)

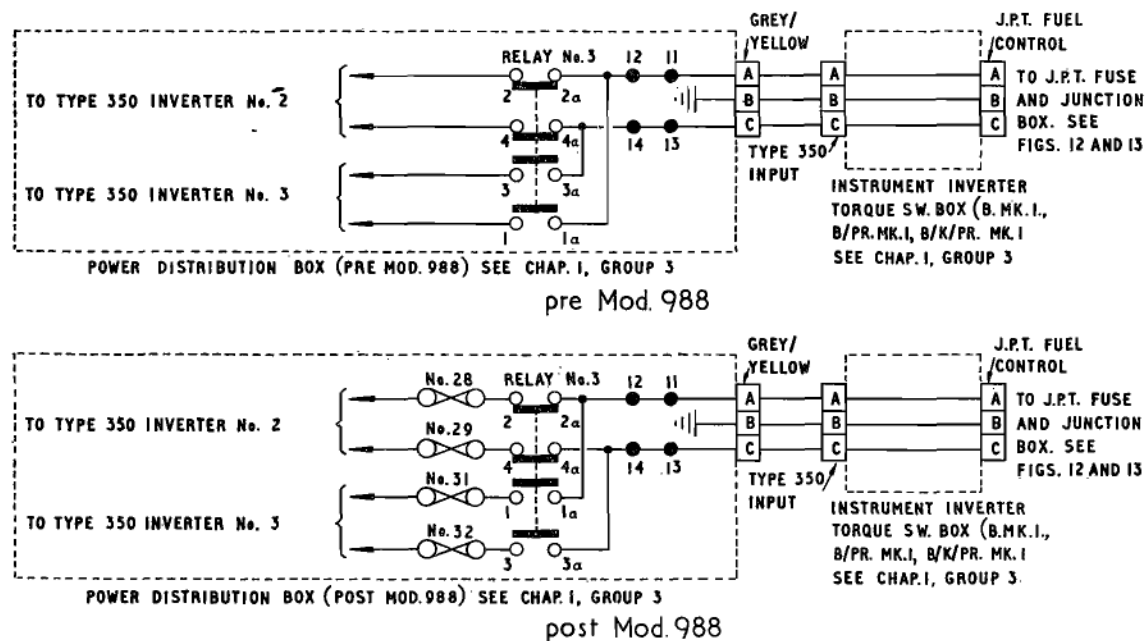


Fig. 11. Jet pipe temperature control power supplies (B. Mk. 1; B/K/PR Mk. 1; B/PR Mk. 1)

thermo-couples are connected. These terminals are the cold junction of the thermo-couples. The correction is effected by making one of the bridge arms temperature conscious so that it changes its resistance with the change in ambient temperature.

17. Another signal is fed to the compensator bridge from the jet pipe temperature selector, which is pre-set according to the value of controlled exhaust gas temperature required. The voltage difference between these two signals is obtained from the bridge and is fed into a three-stage magnetic amplifier, the output of which is fed to the J.P.T. solenoid fuel valve on the engine, thus controlling the fuel supply to the engine.

18. The system only operates when the exhaust gas temperature tends to rise above

the required level. For detailed information, see A.P.4343E, Vol. 1, Sect. 12. The supply for the system at 115 volts, 3-phase, is taken from the a.c. supplies power distribution box on the radio crate, through fuses in the junction box mounted near the starboard amplifiers. The four amplifiers are mounted in the fuselage roof forward of the front spar, lower limit and range trimmer units being mounted on each engine jet pipe temperature control selector.

19. Mod. 920 (WP.209 and onwards) introduces an isolating switch and relays to isolate the solenoid on the engine; thus the fuel control system can be brought out of use at will. On the pilot's instrument top panel is a guarded single-pole switch with two positions, NORMAL and ISOLATE. In the NORMAL position, the switch

connects a supply, from fuse panel D, to the coils of two isolating relays, Type S4, mounted adjacent to the magnetic amplifiers. These relays operate to connect the supplies from the magnetic amplifier to the J.P.T. solenoids. One relay is for No. 1 and No. 2 engines and the other is for No. 3 and No. 4 engines.

20. Mod. 1106 introduces a 30 ohm 6 watt resistance into each engine system. This resistance, connected across the secondary winding of the power transformer in the magnetic amplifier, provides a dummy load equivalent to the J.P.T. fuel control solenoid when the system is isolated by using the J.P.T. isolating switch. Mod. 1106 also introduces a 0.5 ohm resistance into each engine system. The resistance is connected in series with the J.P.T. solenoid and in parallel with the engine test plug. The 0.5 ohm resistor is provided for test purposes.

Note . . .

Pre-Mod 1106 this circuit is to be made inoperative by removing the a.c. supply fuses. These fuses are fitted in the fuselage junction box, mounted above panel Z.

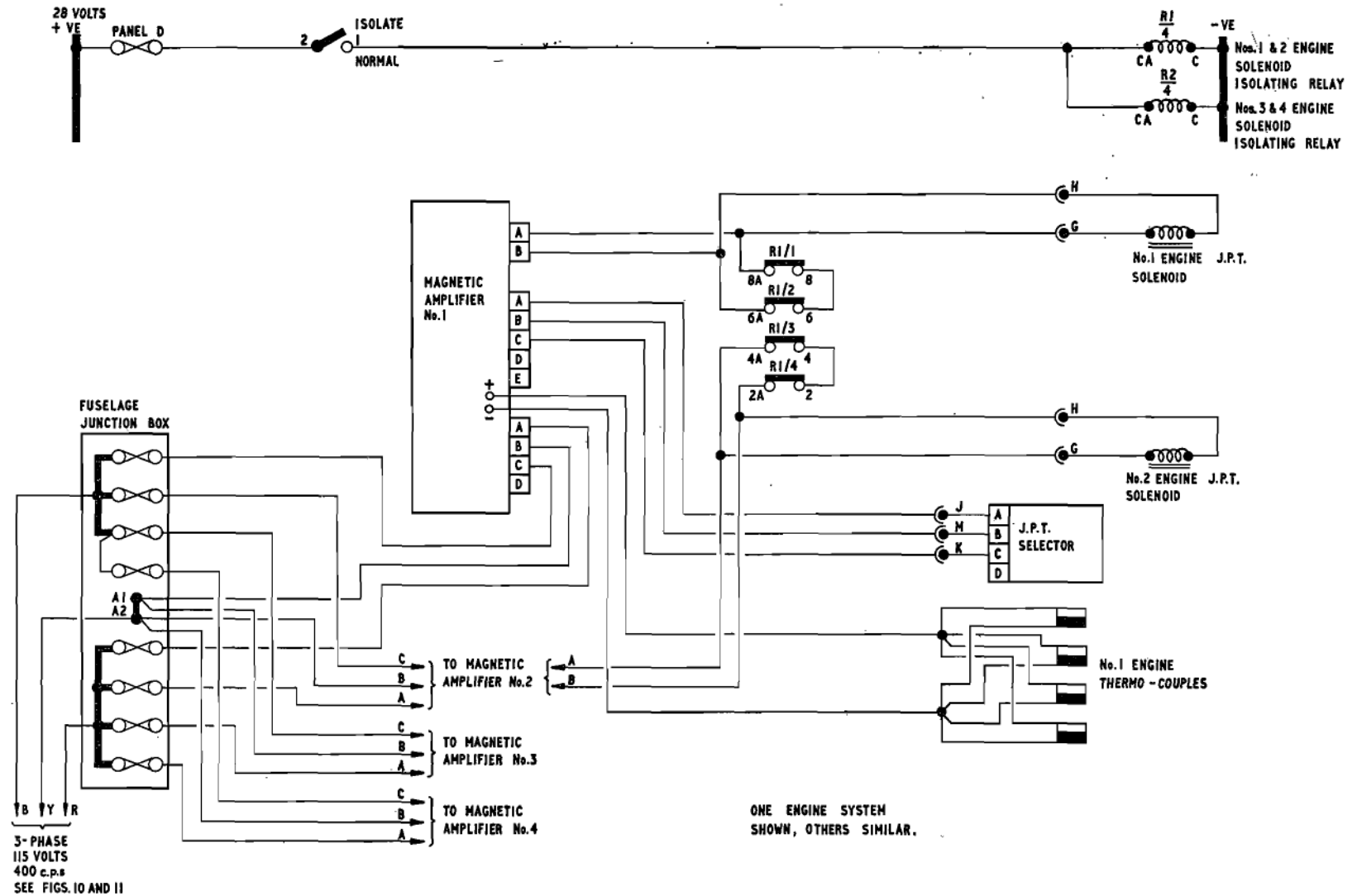


Fig. 12. Jet pipe temperature fuel control (pre. Mod. 1106)

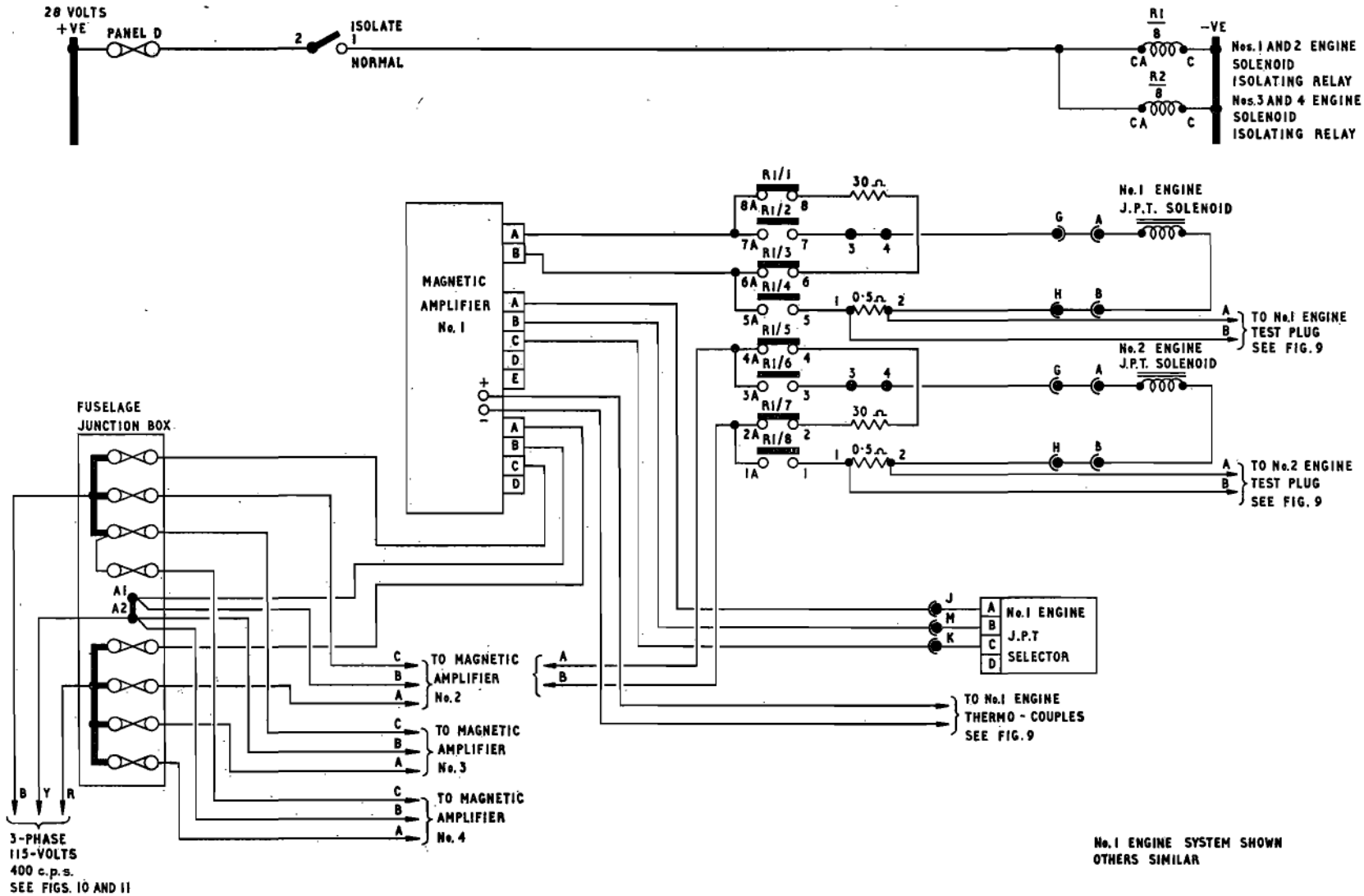


Fig. 13. Jet pipe temperature fuel control (post Mod. 1106)

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Table 2
List of equipment

Instrument	No. off	Type, Mk. or Ref. No.	Location	
Tachometer generator	4	Mk. 8	Near the oil filter on starboard side of each engine	
Tachometer indicator	4	Mk. 10A	Instrument centre panel	
Oil pressure indicator	4	Smiths 2-ACR	Instrument centre panel	
Oil pressure transmitter	4	—	On each engine	
Transformer for oil pressure gauge system	4	Smiths 213 MV	Starboard console	
Fuselage tanks selector switch	2	Type B, 5C/2910	Port and starboard fuel panels	
Change-over relay	1	5C/3944	Pacitor relay panel	
Pre-Mod. 779 Calibrated in galls. Post Mod. 779 Calibrated lbs.	Gauge, underwing tank	2	G.P. 280-050	Fuel panel
	Gauge, inner wing tanks	2	G.P. 280-022	Port and starboard fuel panels
	Gauge, outer wing tanks	2	G.P. 280-023	Port and starboard fuel panels
	Gauge, fuselage tanks	2	G.P. 280-021	Port and starboard fuel panels
	Gauge, reserve tanks	2	G.P. 280-020	Fuel panel
	Gauge, transfer tank	1	G.P. 280-051	Fuel panel
	Gauge, underwing tanks	2	G.P. 280-064 G.P. 280-064-2 (post Amend 2503)	Fuel panels
	Gauge, inner wing tanks	2	G.P. 280-062	Fuel panels
	Gauge, outer wing tanks	2	G.P. 280-063	Fuel panels
	Gauge, fuselage tanks	2	G.P. 280-061	Fuel panels
	Gauge, reserve tanks	2	G.P. 280-060	Fuel panels
	Gauge, transfer tank	1	G.P. 280-065	Fuel panel
	Rectifier unit inner wing	2	G.P. 645-002	Outer wing undercarriage bay
	Rectifier unit outer wing	2	G.P. 645-003	Outer wing undercarriage bay
◀ Relay rectifier unit fuselage ▶	2	G.P. 654-001	Port and starboard fuselage fuel service bay ▶	
Rectifier unit reserve	2	G.P. 645-001	Port and starboard fuselage fuel service bays	

Instrument	No. off	Type, Mk. or Ref. No.	Location		
◀ Rectifier unit, transfer	1	G.P. 645-012 (pre-Mod. 1830) G.P. 645-022 (post Mod. 1830)	Starboard fuel service bay (pre-Mod. 1830) Port side of starboard transfer tank cell (post Mod. 1830) ▶		
Rectifier unit, underwing	2	G.P. 645-013	Underwing tanks		
Oscillator unit	5	G.P. 512/002	Under navigator's table on radio crate		
Tank unit inner wing	2	G.P. 385/004 ✓	Port and starboard outer wing inner tank		
	2	G.P. 385/005 ✓			
Tank unit outer wing	2	G.P. 385/001 ✓	Port and starboard outer wing outer tanks		
	2	G.P. 385/002 ✓			
	2	G.P. 385/003 ✓			
Tank unit fuselage	2	G.P. 384/024 ✓	Port and starboard fuselage tanks		
	2	G.P. 384/025 ✓			
	2	G.P. 384/026 ✓			
Tank unit reserve	2	G.P. 384/023 ✓	Reserve tank, forward tanks in fuselage		
Tank unit—transfer	1	G.P. 384-047 ✓	Transfer tank starboard cell		
	1	G.P. 384-046 ✓	Transfer tank port cell		
Tank unit underwing	1	G.P. 354-058 ✓	Underwing tank forward		
	1	G.P. 354-059 ✓	Underwing tank centre		
	1	G.P. 354-060 ✓	Underwing tank aft		
Tank unit connector	4	G.P. 423-001	Various		
Inter-cell connector	2	G.P. 30861-2	Between wing No. 1 tank cells		
Inter-cell connector	4	G.P. 30861-1	Between wing No. 2 tank cells		
Inter-cell connector	1	G.P. 30861-3	Between transfer tank cells		
Junction box	3	Vickers 49936-Sht. 4	Outer wing undercarriage bays and under radio crate table		
Junction relay box	1	Vickers 66036-Sht. 51	Pacitor relay panel		
Junction box	1	Vickers 67436-Sht. 655	Starboard fuel service bay		
Pre-Mod. 779	}	Flowmeter double indicator	1	Kent type 105B/RH	Panel above starboard console
		Flowmeter double indicator	1	Kent type 105B/LH	Panel above starboard console
Post Mod. 779	}	Flowmeter transmitter	4	Mal. 4010	Port and starboard fuel service bays
		Flowmeter double indicator	1	Kent type 133/RH	Panel above starboard console
		Flowmeter double indicator	1	Kent type 133/LH	Panel above starboard console
		Flowmeter transmitter	4	Mal. 4010-P	Port and starboard fuel service bays
Switch	4	Rotax D.5404	Panel above starboard console		

RESTRICTED

Table 2—continued

Instrument	No. off	Type, Mk. or Ref. No.	Location
Suppressor	4	Type P	Adjacent to flowmeters
Warning lamp blue	4	—	Panel above starboard console
Pre-Mod. 1106 Exhaust gas thermo-couples	16	6A/1675 (pre-Mod. 269) 6A/3578 (post Mod. 269) 6A/5452 (post Mod. 2519)	On jet pipe
◀ Post Mod. 1106 Exhaust gas thermo-couples	16	6A/3578 (pre-Mod. 2497) 6A/5460 (post Mod. 2497)	On jet pipe ▶
Exhaust gas temperature indicator	4	Sangamo Weston S.64. Form 5C, Sub. 95 with 8 ohms external resistance	Instrument centre panel
Jet pipe temperature fuel control magnetic amplifier	4	EC1/2 (pre-Mod. 1467) EC1/3 (post Mod. 1467, pre-Mod. 2150) 5CZ/5040 or 5CZ/5541 (post Mod. 2150)	Centre fuselage just in front of front spar
Pre-Mod. 1106 jet pipe temperature fuel control thermo-couple	16	6A/1675 (pre-Mod. 269) 6A/3578 (post Mod. 269) (pre-Mod. 2159) 6A/5452 (post Mod. 2519)	In jet pipes
Post Mod. 1106 jet pipe temperature fuel control thermo-couple	16	6A/3578 (pre-Mod. 2497) H16/24 (post Mod. 2497)	In jet pipes
Jet pipe temperature solenoid	4	—	Starboard side of each engine
Jet pipe temperature selector	4	—	Starboard side of each engine
Jet pipe temperature trimmer	4	—	On each engine
Terminal blocks	8	5CZ/431	Between jet pipes and between jet pipes and fuselage
Terminal blocks	—	Vickers 67436-Sht. 363	Port and starboard of fuselage aft or rear spar

SERVICING

Introduction

21. For detailed information on the servicing of all items of equipment reference should be made to the relevant Air Publications.

22. A detailed description of all the general tests to be applied to all aircraft electrical circuits can be found in the General Information group, contained in Book 2, immediately after Section 5 marker card.

TACHOMETERS

23. The functioning of the tachometers should be checked in conjunction with the engine ground run check. Continuity and insulation tests, as described in the General Information group, should be carried out to determine the serviceability of the system's wiring.

OIL PRESSURE GAUGES

24. The functioning of the oil pressure gauges should be checked in conjunction with the engine ground run check.

- (1) Connect 28-volt and 112-volt d.c. supplies to the external connections.
- (2) Select on No. 2 inverter Type 350 and check that the gauge operates to read ZERO.

(3) Switch off No. 2 inverter and check that the gauge pointer moves away from ZERO.

FUEL FLOWMETERS

25.

- (1) Connect a 28-volt d.c. supply to the external connection.
- (2) Disconnect the plugs and sockets at the indicators and transmitters.
- (3) Select the flight instrument master switch to ON.
- (4) Select No. 1 flowmeter to ON and check that a 28-volt test lamp lights when connected across pins 'A'-'E', 'D'-'E', 'F'-'E', of the transmitter and pins 'B'-'D' of the indicator. Also check that the blue warning lamp lights when the switch is selected to ON.
- (5) Repeat item (4) for No. 3 flowmeter.
- (6) Repeat item (4) for Nos. 2 and 4 flowmeters but connect the test lamp across pins 'A' and 'C', in lieu of 'B'-'D', at the indicator.
- (7) Return all switches to OFF and reconnect the plugs and sockets. The functioning of the flowmeters should be checked whilst the engines are running.

FUEL CONTENTS GAUGES

Setting up the gauges

Note . . .

The procedure for setting-up the fuel contents gauges for the B/K/PR Mk. 1 aircraft in the tanker/receiver role, is contained in Book 3, Sect. 5, Chap. 9, Group 3.

26. The following drill should be carried out before any adjustments are made to the rectifiers for both pre and post Mod. 779 conditions:—

- (1) Ensure that the aircraft is level laterally and that the fuselage datum is 2 deg. nose down approximately.
- (2) Drain all fuel tanks (*Book 1*) by opening all fuel drains. It is not necessary to open the water drains.
- (3) Connect a 28-volt supply to the aircraft external supply point.

(4) Select the instrument master switch to ON.

(5) Using Pacitor test set 7C/1202 (if the test set is not available a thermo-couple voltmeter consuming not more than 5mA at 70 volts may be used), check the output of each oscillator unit as follows:—

Check that the output is 70 ± 5 volts a.c. (input voltage —26 volts d.c.) with a standard load of 8000 p.f. in series with a 500 ohm, 2 watt resistance across the output terminals.

(6) Run the system dry (tanks empty) for 10 minutes to allow the equipment to warm up.

Note . . .

(1) *It is not necessary, with the Mk. 5A contents gauge system, to wet the tank units before calibration.*

(2) *It is most important to measure the Specific Gravity of the fuel being used before refuelling when the gauges are calibrated in mass units (post Mod. 779).*

(3) *For absolute accuracy for setting gauges, all refuelling equipment should be checked (hydrometer and refueller flowmeter), the refueller can be checked against a standard tank and correction charts formulated.*

Pre-Mod. 779 (Volumetric units)

27. After carrying out the instructions given above, proceed as follows:—

No. 1 Wing tanks (553 \pm 10 gallons per side with unusable fuel).

- (1) Check that the change-over switch on the pilot's fuel panel is at NORMAL.
- (2) With 8 gallons unusable fuel in the tanks, adjust the rectifiers (adjustment E) so that the gauges read ZERO.
- (3) Fill the tanks to capacity, note contents, and adjust the rectifiers (adjustment F) so that the gauges read FULL.

28. *No. 2 Wing tanks (473 \pm 10 gallons per side with unusable fuel).*

- (1) Proceed as for No. 1 Wing Tanks.

29. *Reserve tanks (590 \pm 10 gallons port and starboard total).*

(1) With tanks empty, adjust the port and starboard rectifiers (adjustment E) so that both gauges read ZERO.

(2) Fill the tanks to capacity, note contents, and adjust the port and starboard rectifiers (adjustment F) so that the gauges read FULL.

30. *Fuselage tanks, cells 1, 2 and 3 (735 \pm 10 galls. port and starboard total for cell 1, 1370 \pm 10 galls. port and starboard total for cell 2, 1285 \pm 10 galls. port and starboard total for cell 3).*

(1) With all cells empty, adjust port and starboard relay rectifiers (adjustment E—1, 2, 3 and T with the selector switches on the pilot's fuel panels at the corresponding positions—Cell 1, Cell 2, Cell 3 and Total, so that the gauges read ZERO.

(2) Fill No. 1 cells to capacity, note contents, and adjust relay rectifiers (adjustment F-1) with selector switches at Cell 1 so that the gauges read on the RED SPOT.

(3) Fill No. 2 cells to capacity, note contents, and adjust the relay rectifiers (adjustment F-2) with the selector switches at Cell 2 so that the gauges read FULL.

(4) Fill No. 3 cells to capacity, note contents, and adjust the relay rectifiers (adjustment F-3) with the selector switches at Cell 3 so that the gauges read on the YELLOW SPOT.

(5) With all cells full and selector switches at TOTAL, adjust the relay rectifiers (adjustment F-T) so that the gauges read FULL.

31. *Transfer tank (710 \pm 10 gallons port and starboard total).*

(1) With the tank empty, adjust the rectifier (adjustment E) so that the gauge reads ZERO.

(2) Fill tank to capacity, note contents and adjust the rectifier (adjustment F) so that the gauge reads FULL.

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32. *Underwing tanks* (1645 ± 10 gallons per side with unusable fuel).

(1) With 15 gallons of unusable fuel in the tank adjust the rectifier (adjustment E) so that the gauge reads ZERO.

(2) Fill the tank to capacity and adjust the rectifier (adjustment F) so that the gauge reads FULL.

Post Mod. 779 (Mass units)

33. **IMPORTANT: MEASURE ACCURATELY THE SPECIFIC GRAVITY OF THE FUEL BEING USED.**

Note . . .

(1) *Specific Weight (S.Wt.)—Specific Gravity (S.G.)* × 10.

(2) *The Specific Gravity of fuels under various conditions should not fall outside the range 0.75 to 0.81.*

(3) *A specific quantity of fuel, in gallons, has been calculated to be pumped into each tank for setting up purposes whatever the S.G. conditions of the fuel may be, otherwise, the following conditions would arise with consequent indecision and error:—*

(a) *The variation of specific gravity of the fuel would in some cases result in the weight of fuel to fill a tank being greater than the maximum scale reading on the gauge, consequently setting-up must be carried out within the limits of the gauge scales.*

(b) *Under some conditions of S.G. and temperature the maximum scale reading (in lbs.) when converted to gallons would result in a quantity of fuel (in gallons) greater than the volumetric capacity of the tank, in which case it would be necessary to fill the tanks to capacity and to convert this number of gallons to lbs. for the gauge setting.*

◀ (4) *In order to ensure, when refuelling a specific tank or cell with a specified quantity of fuel, that none of this fuel leaks past the refuelling valves into other tanks or cells, the refuelling valve selector switches for all cells must be set to OFF with pressure in the refuelling*

pipes. This ensures that the refuelling valves are closed under pressure and are hydraulically locked shut. If this instruction is observed, no fuel should leak past the refuelling valves into other tanks or cells and all the fuel required for calibration purposes, as measured at the refueller, will pass into the tank concerned. ▶

34. After carrying out the instructions given in paras. 26 and 33, proceed as follows:

No. 1 Wing tanks (553 ± 10 gallons per side including unusable fuel).

(1) Select the pilot's change-over switch to NORMAL.

(2) With 8 gallons of unusable fuel in the tanks, adjust the rectifiers (adjustment E) so that the gauges read ZERO.

(3) Refuel each tank with 490 gallons measured at the refueller.

(4) Multiply the 490 gallons by the specific weight of the fuel to give the total weight of fuel.

(5) Adjust the rectifiers (adjustment F) so that the gauge reads the exact weight of fuel given by item 4.

35. *No. 2 Wing tanks* (473 ± 10 gallons per side with unusable fuel).

(1) Proceed as for No. 1 wing tanks, except that each tank should be refuelled with 420 gallons, see items (3) and (4).

36. *Reserve tanks* (590 ± 10 gallons port and starboard total).

(1) With tanks empty, adjust the port and starboard rectifiers (adjustment E) so that both gauges read ZERO.

(2) Refuel the tanks with 580 gallons measured at the refueller.

(3) Multiply the 580 gallons by the specific weight of the fuel to give the total weight of fuel.

(4) Adjust the rectifiers (adjustment F) so that each gauge reads $\frac{1}{2}$ the exact weight given by item 3.

37. *Fuselage tanks, cells 1, 2 and 3* (735 ± 10 gallons port and stbd. total for cell 1, 1370 ± 10 gallons port and stbd. total for cell 2, 1285 ± 10 gallons port and stbd. total for cell 3).

(1) With all cells empty, adjust the port and starboard relay rectifiers (adjustments E-1, 2, 3 and T), with the selector switches on the pilot's fuel panels at the corresponding positions:—Cell 1, Cell 2, Cell 3 and Total so that the gauges read ZERO.

(2) Refuel No. 1 cells with 670 gallons measured at the refueller.

(3) Multiply the 670 gallons by the specific weight of the fuel to give the total weight of fuel.

(4) Adjust the relay rectifiers (adjustment F-1) with the selector switches at Cell 1 so that the gauges read $\frac{1}{2}$ the exact weight of fuel given by item 3.

(5) Refuel No. 2 cells with 1300 gallons measured at the refueller.

(6) Multiply the 1300 gallons by the specific weight of the fuel to give the total weight of fuel.

(7) Adjust the relay rectifiers (adjustment F-2) with the selector switches at Cell 2 so that the gauges read $\frac{1}{2}$ the exact weight of fuel given by item 6.

(8) Refuel No. 3 cells with 1260 gallons measured at the refueller.

(9) Multiply the 1260 gallons by the specific weight of the fuel to give the total weight of fuel.

(10) Adjust the relay rectifiers (adjustment F-3) with the selector switches at Cell 3 so that the gauges read $\frac{1}{2}$ the exact weight of fuel given by item 9.

(11) With all cells refuelled to items 2, 5 and 8 and selector switches at TOTAL adjust the relay rectifiers (adjustment F-T)

so that the gauges read $\frac{1}{2}$ the total weight of fuel given by addition of items 3, 6 and 9.

Note . . .

The weights of fuel given by items 3, 6 and 9 are for the port and starboard cells combined, the weight per side will therefore be $\frac{1}{2}$ this weight.

38. *Transfer tank* (710 ± 10 gallons port and starboard total).

(1) With the tank empty, adjust the rectifier (adjustment E) so that the gauge reads ZERO.

(2) Refuel tank with 690 gallons measured at the refueller.

(3) Multiply the 690 gallons by the specific weight of the fuel to give the total weight of fuel.

(4) Adjust the rectifier (adjustment F) so that the gauge reads the exact weight of fuel given by item 3.

39. *Underwing tank* (1615 ± 10 gallons per side with unusable fuel).

(1) With 15 gallons of unusable fuel in the tank, adjust the rectifier (adjustment E) so that the gauge reads ZERO.

(2) Refuel the tank with 1550 gallons measured at the refueller.

(3) Multiply the 1550 gallons by the specific weight of the fuel to give the total weight of fuel.

(4) Adjust the rectifier (adjustment F) so that the gauge reads the exact weight of fuel given in item 3.

EXHAUST GAS TEMPERATURE INDICATORS

Pre-Mod. 1106

40. (1) Disconnect No. 1 engine indicator.

(2) Disconnect the compensating lead from the thermo-couple terminal block (on the frame at the rear of the flame tube) for No. 1 engine.

(3) Carry out a full normal continuity test on each compensating lead.

(4) Carry out a full insulation test (between poles and poles to earth) of the system using a 250-volt 'meggex'. MINIMUM permissible reading 2 megohms.

(5) When the above tests have been completed satisfactorily, connect together the leads at the indicator end and reconnect the compensating leads to the thermo-couple.

(6) Disconnect one side of the balance resistance unit FD.871 and connect a bridge 'megger' into the circuit.

(7) Unwind the wire of the resistance 'bobbin' until the resistance of the circuit is 8 ± 0.01 ohms.

(8) Repeat the above tests and operations for the other three engines.

Check the calibration of the indicator as follows:—

(1) Connect a Cambridge potentiometer in the circuit.

(2) Place a thermometer near the thermo-couples in the jet pipe to record the temperature at the cold junction.

(3) Inject the equivalent milli-volts, at the relative ambient temperature, into the circuit for 660 deg. C.

(4) Adjust the pilot's indicator to read 660 deg. C. using the zero adjustment.

(5) Inject the equivalent milli-volts for every 100 deg. C. between 100 deg. C. and 800 deg. C. Check that the pilot's indicator reads correct to ± 16 deg. C. at all readings except 660 deg. C. which must be exact.

Note . . .

(1) *Milli-volt and temperature equivalents can be obtained from the reference tables for "thermo-couples B.S.1872, 1952 (Gt. Britain) or National Bureau of Standards Circular No. 508 May 1st, 1951 (U.S.A.)".*

(2) *In item (4) above, after adjusting the pilot's indicator carefully, move the zero adjustment in the opposite direction without moving the indicator pointer from 660 deg. C. This is necessary to eliminate errors due to the indicator pointer resting on the zero adjuster.*

(3) *If the pilot's indicator is not accurate to within ± 16 deg. C. it is to be replaced by a new item.*

Post Mod. 1106

41. (1) Connect the test box Ref. QT.221 (Ultra) to the engine test socket.

(2) Place a thermometer near the cabin indicators to record the temperature at the cold junction.

(3) Add the reading to METER 1 using the zero adjustment.

(4) Select the test box selector switch to 'F'.

(5) Select INT. or EXT. supply on at the test box.

(6) Select METER 1 on the test box.

(7) Using the COARSE and FINE control knobs adjust METER 1 reading to 660 deg. C. Maintain this reading using the FINE control.

(8) Adjust the pilot's indicator to read 660 deg. C. No further adjustment is to be made to this indicator.

Note . . .

After adjusting the pilot's indicator, carefully move the adjusting screw in the opposite direction, making sure the indicator pointer has not moved from 660 deg. C. This operation is necessary to eliminate errors in the indicator due to the indicator pointer resting on the adjuster.

(9) Check the pilot's indicator reading against METER 1 reading for every 100 deg. C. to 800 deg. C. (Meter 1 reading is altered by using the COARSE and FINE controls).

(10) Repeat the above operations for all four engines.

Note . . .

MAXIMUM permissible error on pilot's indicator (in item 9 above) is ± 16 deg. C. at all readings except 660 deg. C. which must be exact. If the error is greater than ± 16 deg. C. the pilot's indicator is to be replaced by a new item.

JET PIPE TEMPERATURE FUEL CONTROL

Pre-Mod. 1106

42. Pre-Mod. 1106, this circuit is to be made inoperative by removing the fuses in the a.c. supply. These fuses are fitted in the fuselage junction box, mounted above panel Z.

Post Mod. 1106

43. Tests shall be carried out in accordance with A.P.4343S, Vol. 1, Sect. 23, Chap. 11. The following details will also be required in addition to the instructions given in the above mentioned Air Publication.

44. *Engines not running.*

- (1) Connect the test box Ref. QT.221 (Ultra) to the engine test socket.
- (2) Place a thermometer near the magnetic amplifier to record the temperature at the cold junction.
- (3) Add the thermometer reading to METER 1 using the zero adjustment.
- (4) Switch ON the inverters.

- (5) Select the test box selector switch to 'F'.
- (6) Select INT. or EXT. supply on at the test box.
- (7) Select METER 1 on the test box.
- (8) Using the COARSE and FINE control knobs adjust METER 1 reading to 660 deg. C.
- (9) Select to NORMAL the J.P.T. isolate switch on the pilot's instrument top panel.
- (10) Adjust METER 2 to read 200mA. Hold on 200mA using the COARSE and FINE controls.
- (11) Adjust the magnetic amplifier so that the pilot's indicator reads 660 deg. C.
- (12) Repeat the above operations for all four engines.

45. *Engines running*

- (1) Connect the test box Ref. QT.221 (Ultra) to the engine test socket.
- (2) Place a thermometer near the magnetic amplifier to record the temperature at the cold junction.

- (3) Add the thermometer reading to METER 1 using the zero adjustment.
- (4) Switch ON the inverters.
- (5) Select the test box selector switch to 'F'.
- (6) Select INT. or EXT. supply on at the test box.
- (7) Select METER 1 on the test box.
- (8) Select to ISOLATE the J.P.T. isolate switch on the pilot's instrument top panel
- (9) Run the engine so that 500 deg. C. is maintained on the pilot's indicator.
- (10) Adjust METER 1 to 700 deg. C. using the COARSE and FINE controls.
- (11) Select to NORMAL the J.P.T. isolate switch.
- (12) Increase and decrease engine speed and check that the pilot's indicator maintains a reading of 660 deg. C.
- (13) Repeat the above operations for all four engines.

If the pilot's indicator does not maintain a reading of 660 deg. C. adjust at the magnetic amplifier to suit and repeat the above test.

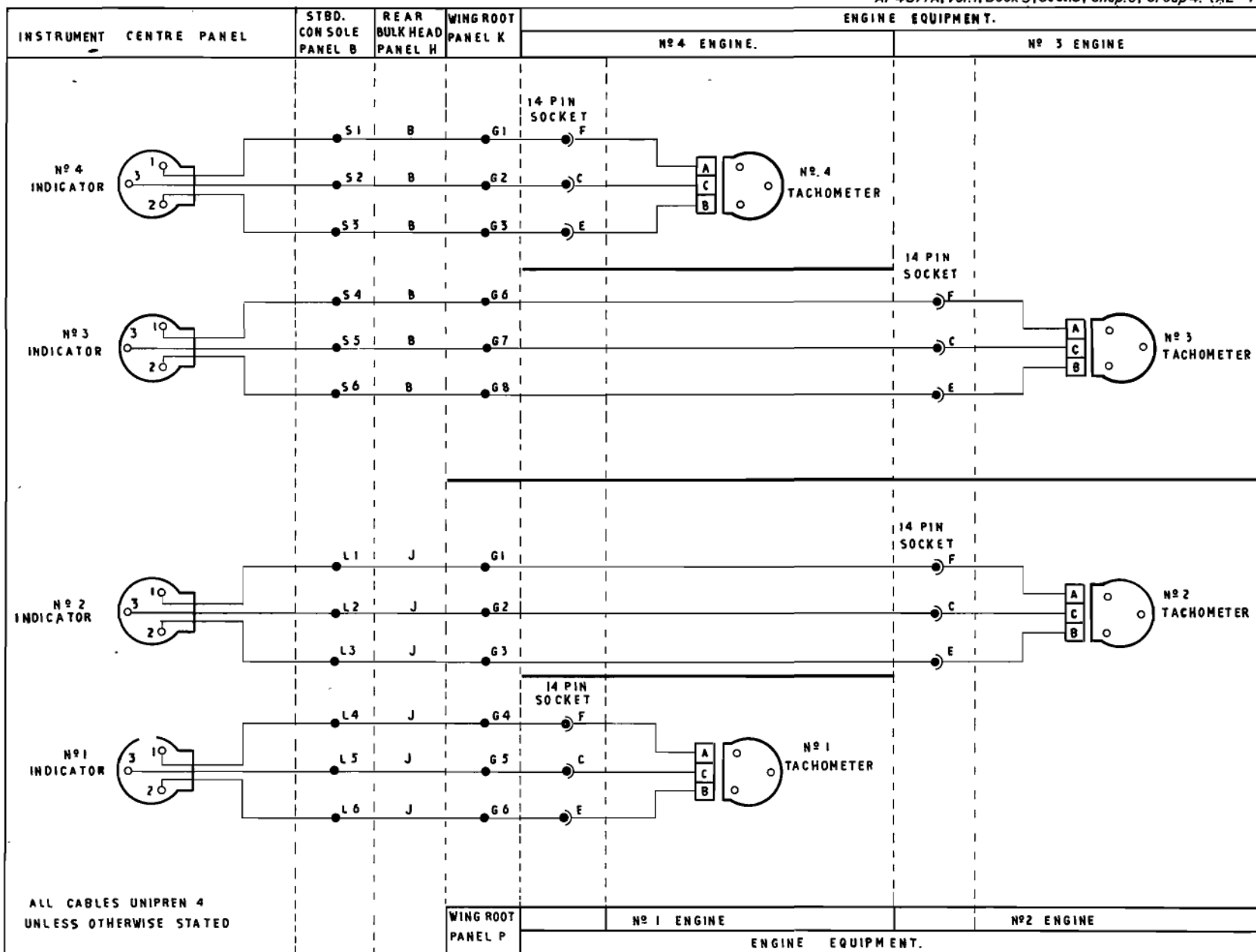


Fig. 14. Tachometers
R E S T R I C T E D

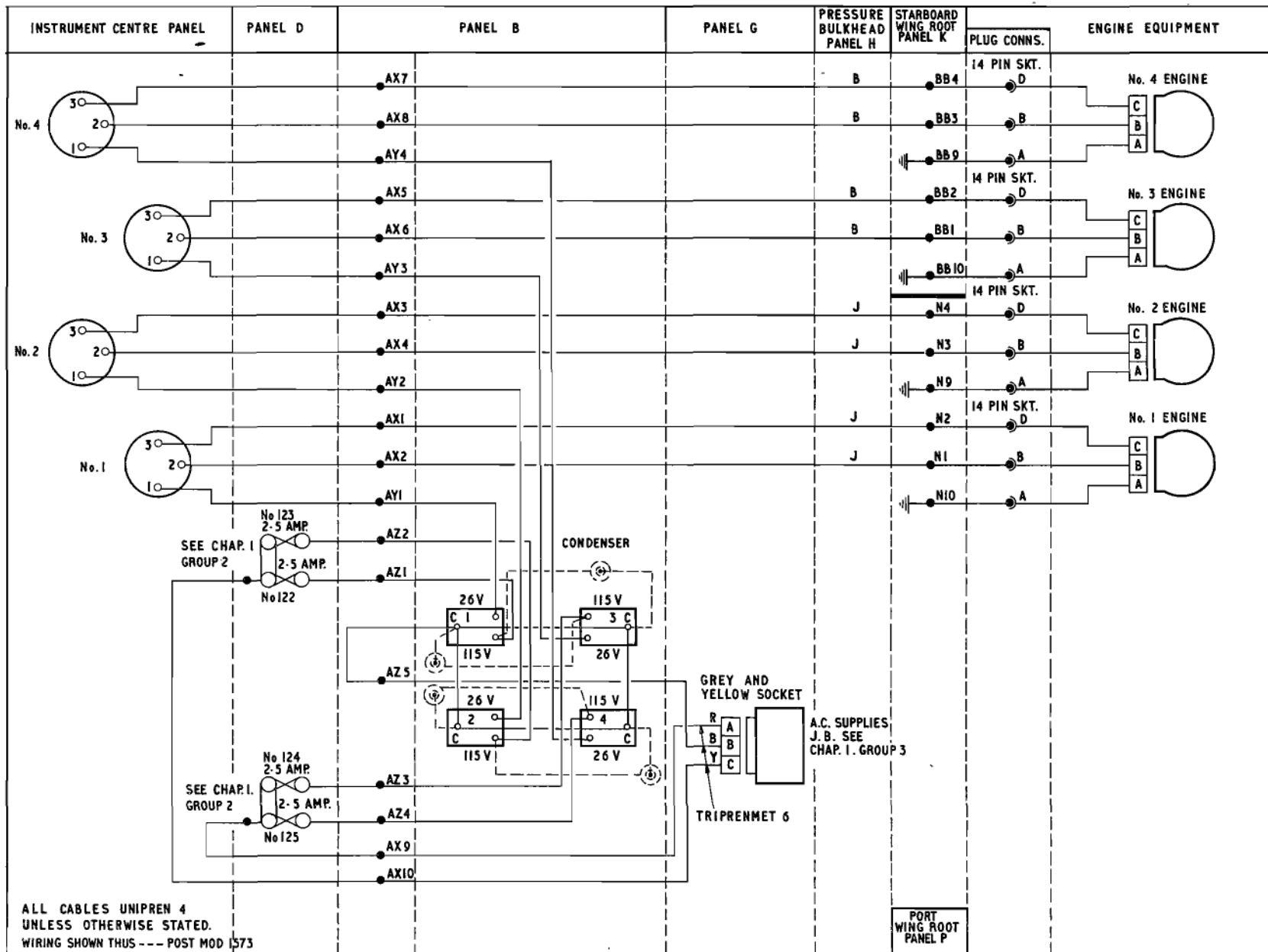


Fig. 15 Oil pressure gauges
RESTRICTED

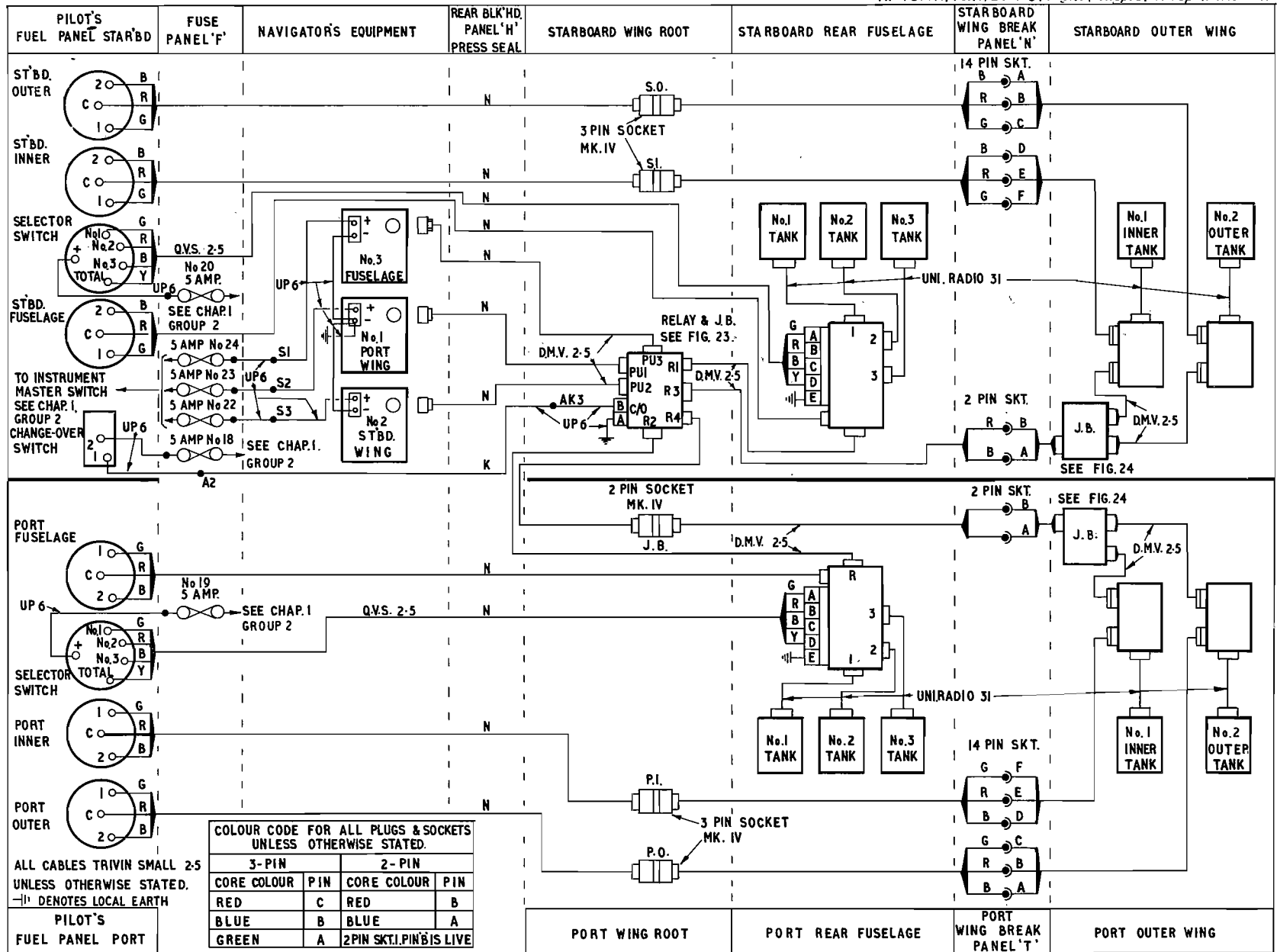


Fig. 16. Fuel contents gauges - main tanks (pre Mod 1835)
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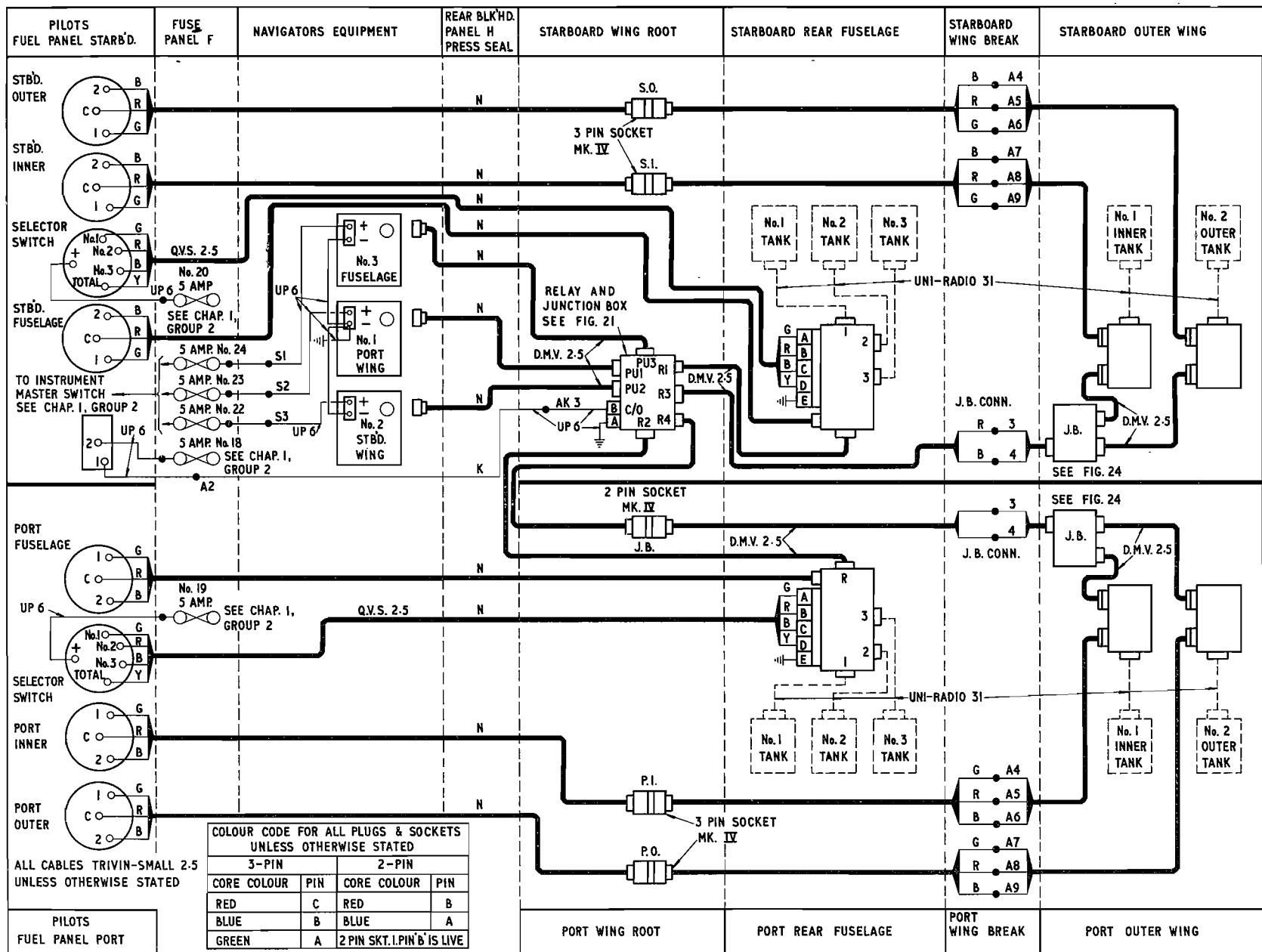


Fig. 17 Fuel contents gauges-main tanks (post Mod. 1835)

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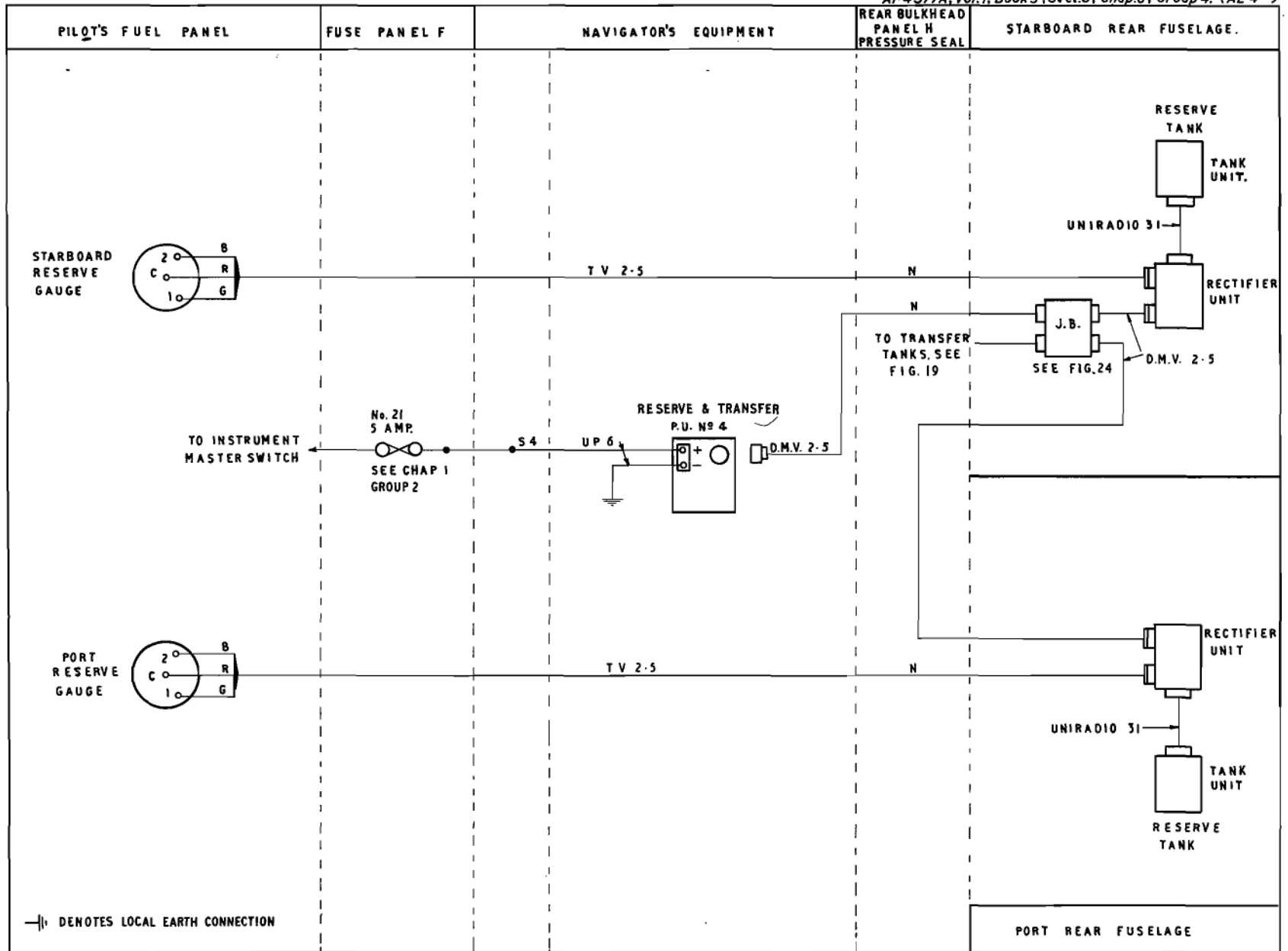


Fig. 18. Fuel contents gauges-reserve tanks

R E S T R I C T E D

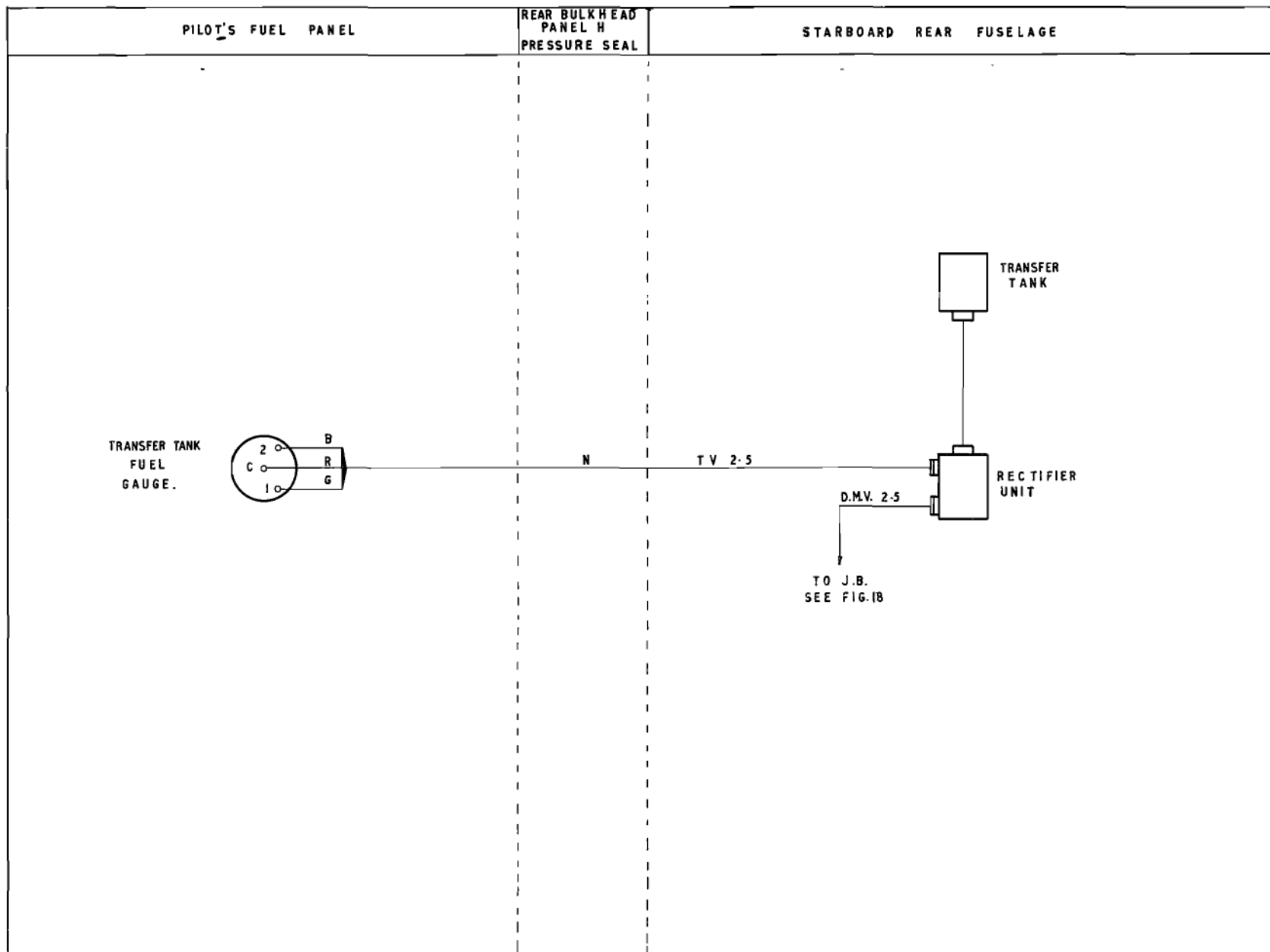


Fig. 19. Fuel contents gauges-transfer tank
R E S T R I C T E D

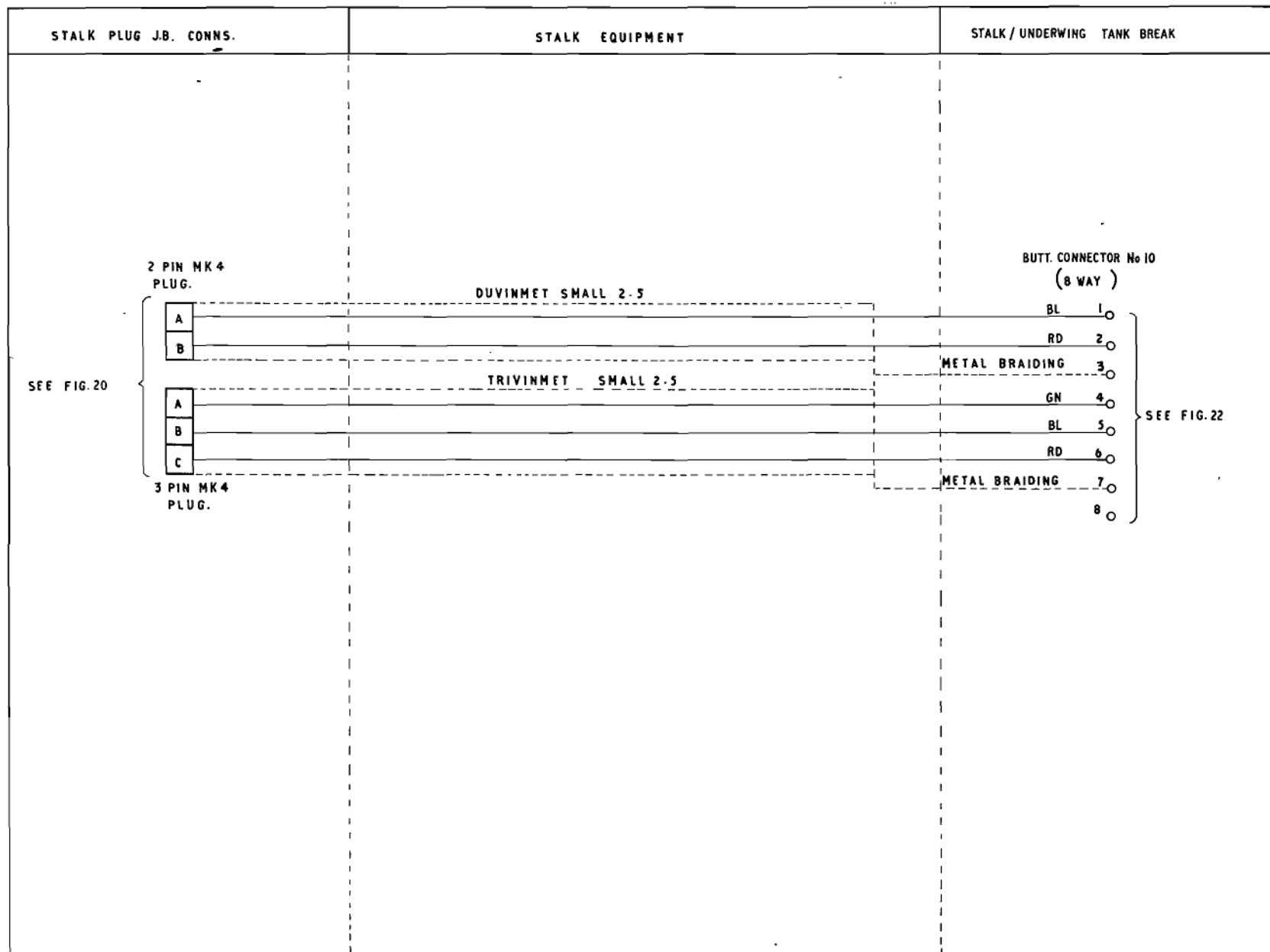


Fig. 21. Wiring in wing stalk - under wing tank contents gauges
 R E S T R I C T E D

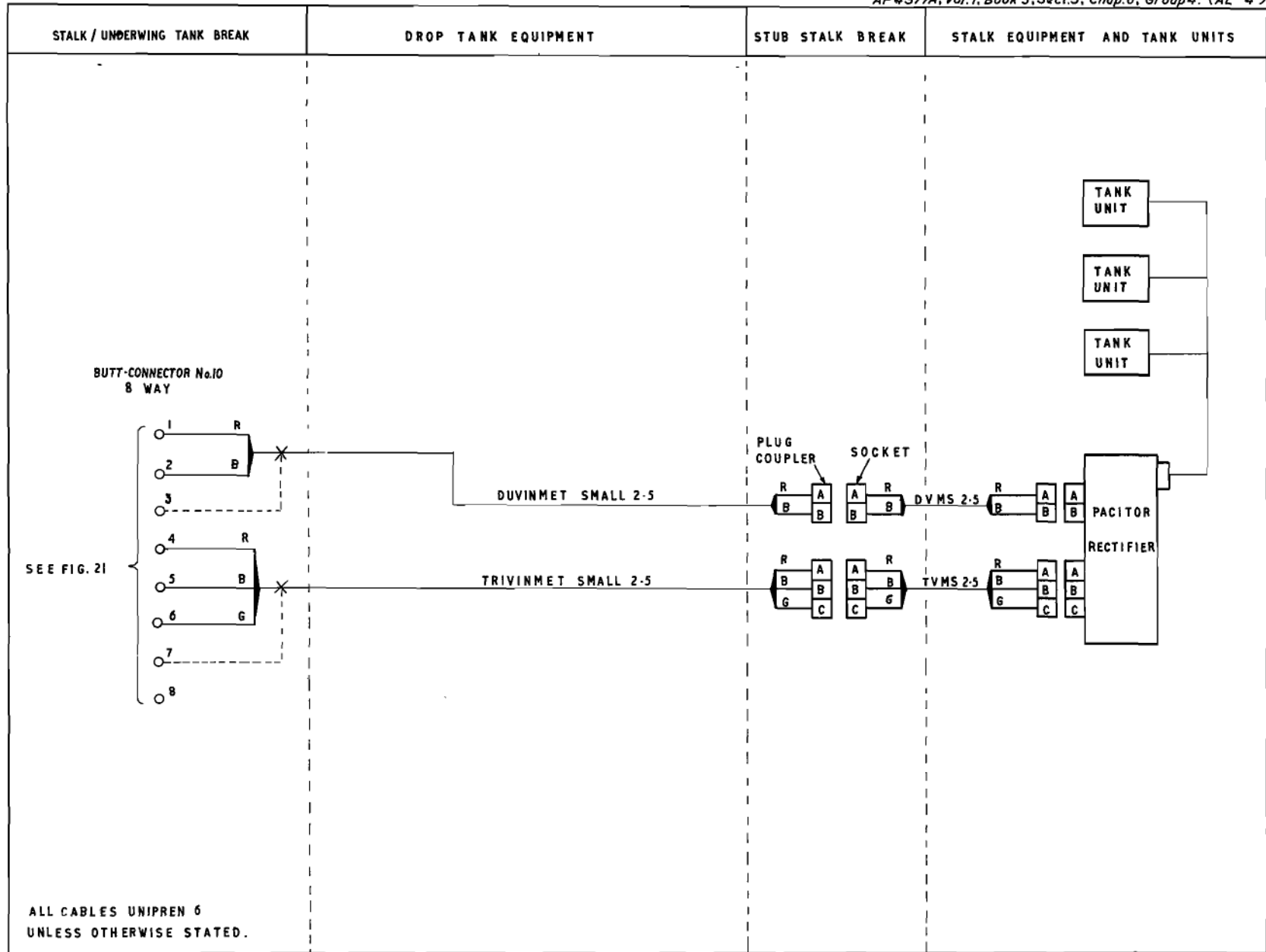
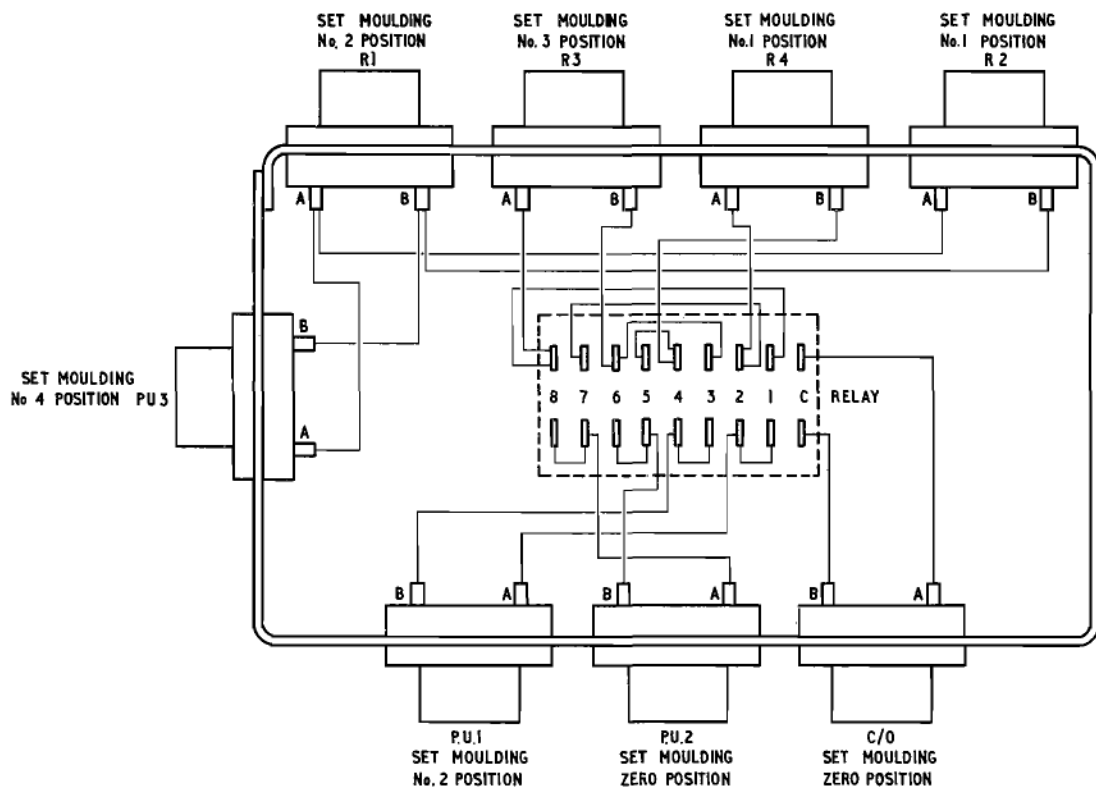


Fig. 22. Wiring in tank-underwing tank fuel contents gauges

R E S T R I C T E D

(AL 4, May '58)



RELAY BOX INTERNAL
WIRING TO BE UNIPREN 6

Fig. 23. Relay and junction box - fuel contents gauges
R E S T R I C T E D

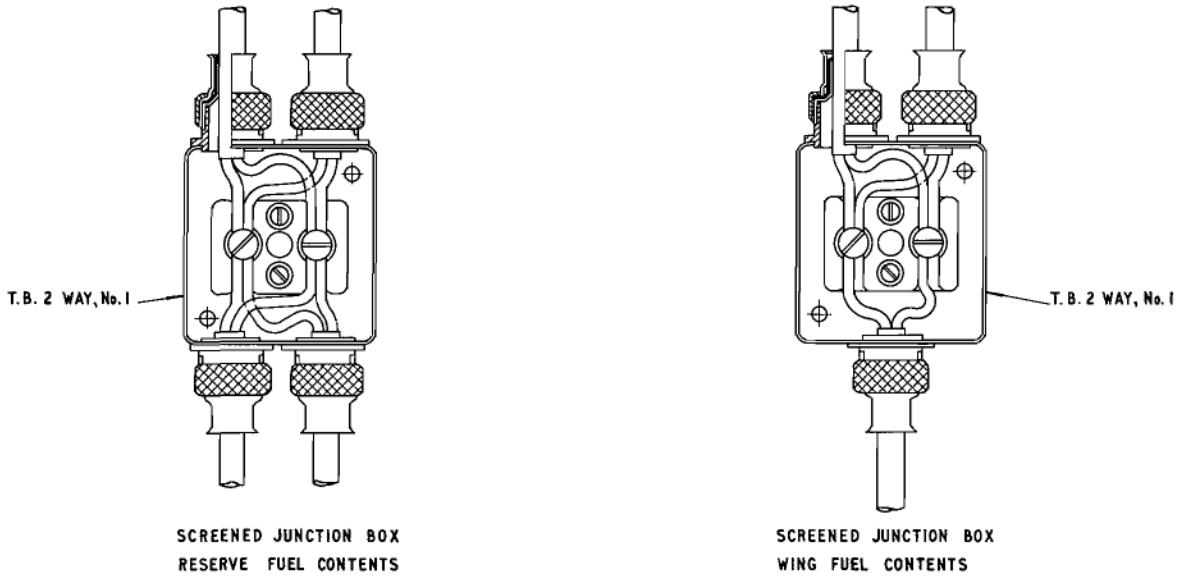


Fig. 24. Screened junction boxes - fuel contents gauges (AL 4, May '58)
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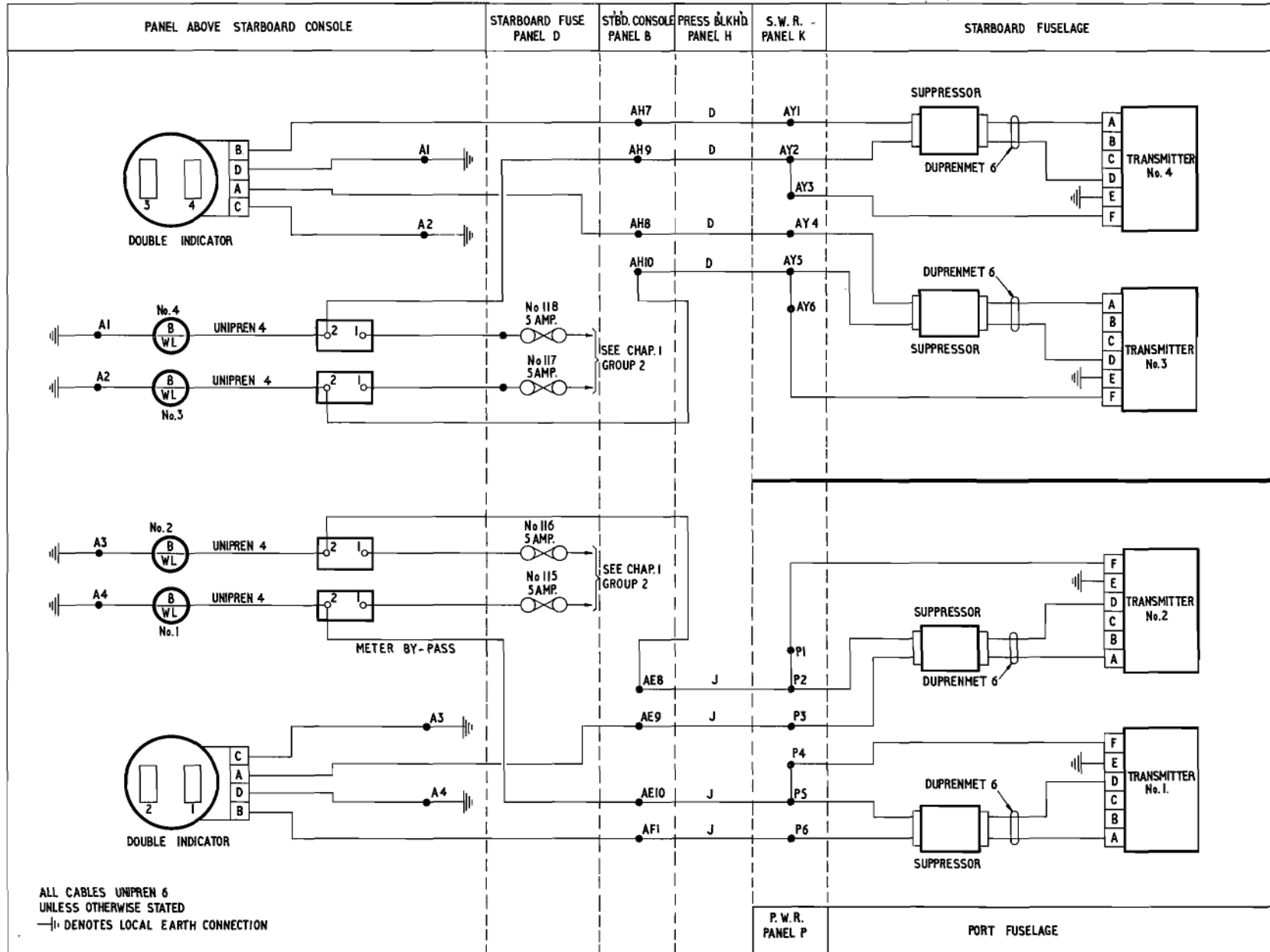


Fig. 25. Fuel flowmeters
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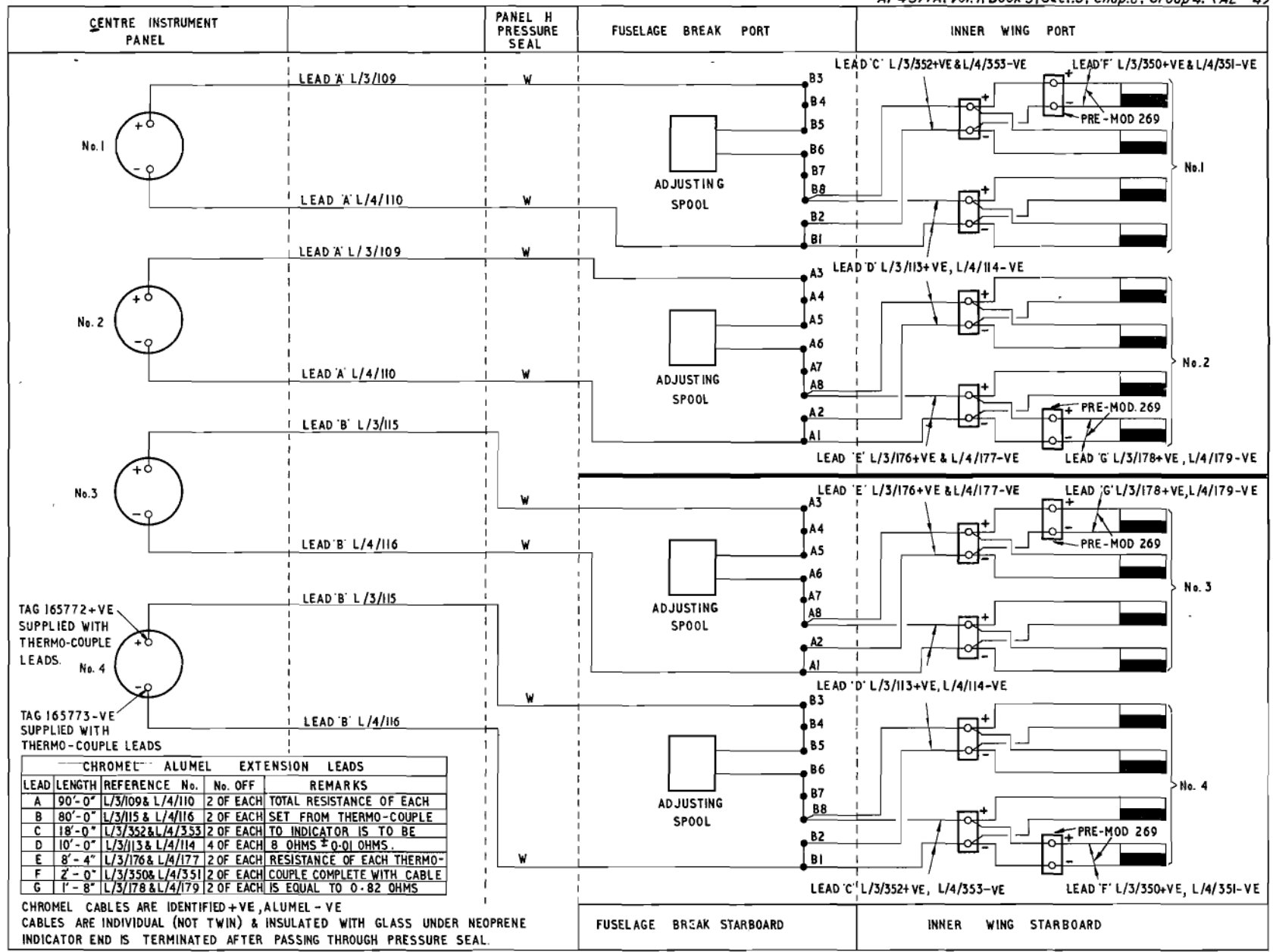


Fig. 26. Exhaust gas thermometers (pre Mod 1106)
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(AL 4, May '58)

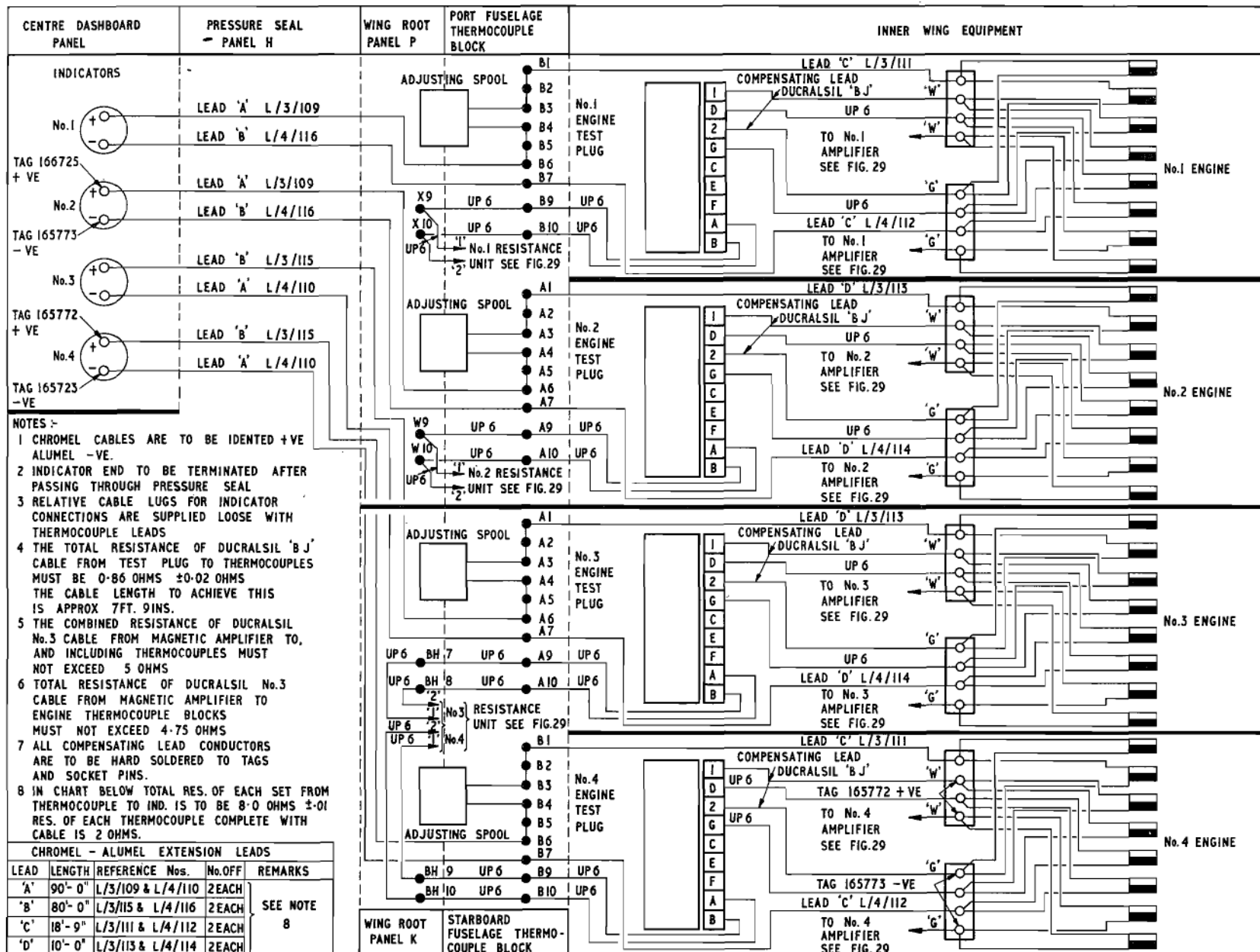


Fig 27 Exhaust gas thermometers (post Mod. 1106)
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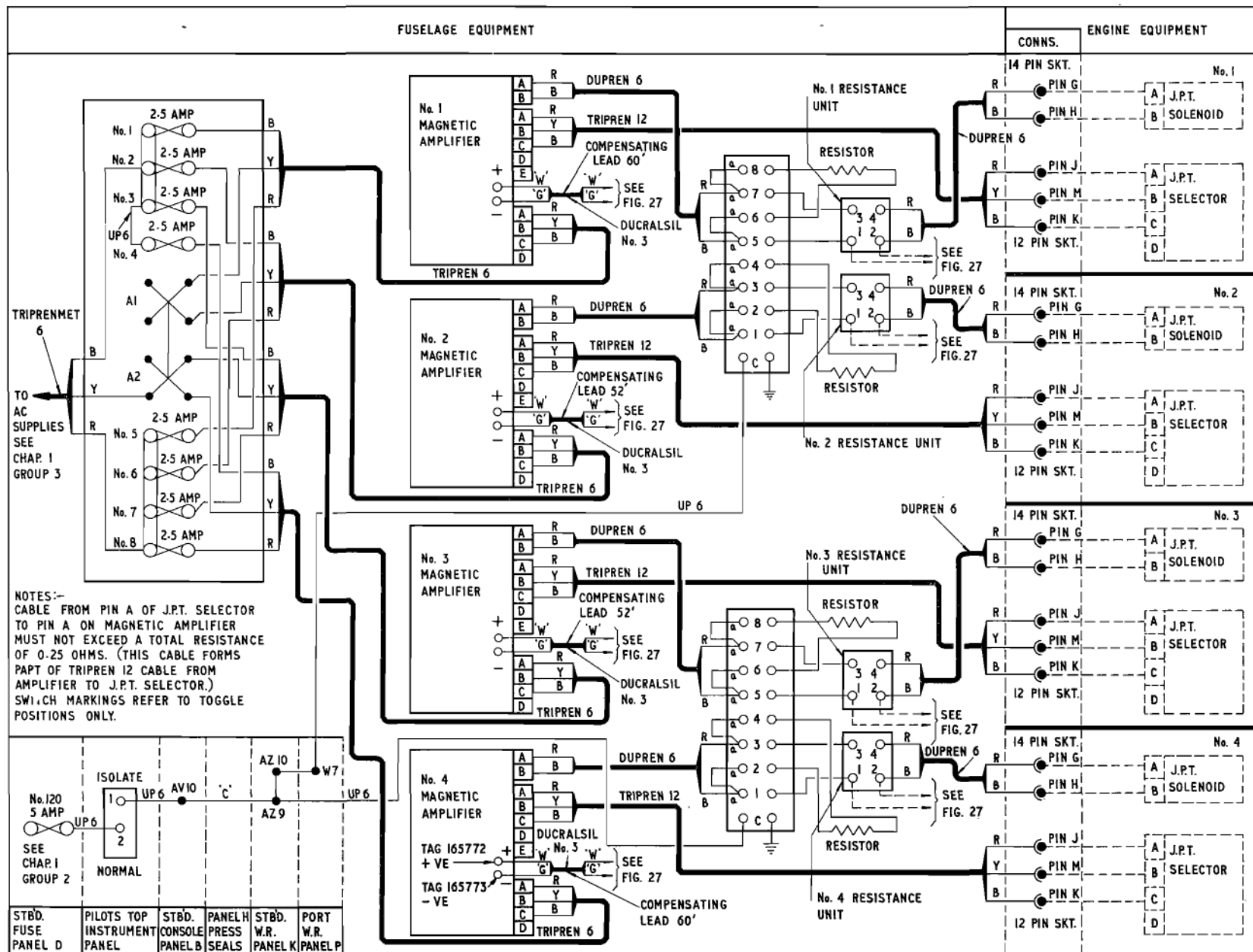


Fig. 29 Jet pipe temperature fuel control (post Mod 1106)

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