GROUP 2

ENGINE INSTRUMENTS

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Introduction

1. This group contains a description, including the method of operation of the engine instruments installed in this aircraft, together with the necessary servicing information required to maintain the equipment in an efficient condition. Routing and theoretical diagrams of the installations are also included. For a general description of the aircraft's instrument installation as a whole, reference should be made to Group 1 of this chapter. Detailed information on the standard components used, will be found in the relevant Air Publications, which are quoted in the appropriate paragraphs of this group.

DESCRIPTION

Fuel contents gauges and cock control (Code FC)

2. This is a 28 volt electronic installation. The two Smiths-Waymouth AO-26 or AO-26 Mod.01 gauges, one for the port and another for the starboard tanks, are located on the cabin starboard shelf. They give a continuous summated indication of the contents of the fuel tanks being used, irrespective of the aircraft's attitude. The port and starboard tank systems are entirely independent except for the common d.c. supply and differ only in the internal arrangements of the cable boxes due to differing coaxial cable lengths. The gauges, which are engraved in pounds (mass), are supplied from strap capacitor gauge units fitted within each tank, via two Smiths-Waymouth BW13 and 14 relay boxes and FAB or FAB/18 amplifier units mounted in the radio bay. The relay boxes are energized by four Type Q, No.1 relays, located adjacent to the supply panel, which in turn are energized by four Speed Development TP.1200 or 5252/1 pressure switches positioned one in each of the rear and wing fuel tank supply lines at frame 29 and in each stub wing. Two Dowty Mk.7 transfer pressure magnetic indicators, together with two Plessey CZ.74109/2 fuel cock position magnetic indicators, are located on the cabin starboard shelf adjacent to the fuel gauges. The transfer pressure indicators are operated from the Type Q relays, while the fuel cock position indicators are energized by Type S cock control relays located on the supply panel. The Type S relays also supply two fuel cock actuators, mounted between frames 26 and 27, and are energized by the Rotax D.5406 tank selector switches, positioned on the cabin starboard shelf and by the Flight Refuelling C.3504100/38 low level float switches mounted in the rear fuel tanks. Routing and theoretical diagrams of the circuits are given in fig.1 and 2 of this group, while the fuel system as a whole, is covered in Sect.4, Chap.2 of this volume. For a detailed description of the gauges and the operation of the system, reference should be made to A.P.1275A, Vol.1. The switches and relays are fully described in A.P.4343 Vol.1 series.

Operation

3. As the port and starboard fuel contents gauge and cock control systems are separately fused and provided with independent control equipment, it is only necessary to follow the operation of the port system to fully understand both installations. The theoretical diagram shows the state of the circuit when the aircraft is at rest on its alighting gear, with the engine and electrical supply switched off, but with the fuel tanks full. In this condition all the relays will be de-energized, while the pressure switches and the float switch will be open. The fuel cock actuator will be holding the fuel cock in the position which allows fuel to flow from the rear tank to the forward tank, and the fuel cock position indicator will show this state. The transfer pressure indicator will indicate no flow and neither the wing nor the rear fuel tank capacitor gauge strap units will be connected to the amplifier.

4. When the battery master switch is closed, prior to starting the engine, the amplifier and gauge will commence operation, indicating the contents of the forward tank, since the capacitor unit in this tank is always connected to the amplifier. If the tank selector switch is in the REAR or AUTO position, the control cock relay will remain de-energized, causing the fuel cock and fuel cock indicator to remain in the rear tank to forward tank position. If, however, the tank selector switch is placed in the WING position, the cock control relay will be energized, causing the fuel cock actuator to move the fuel cock, thus enabling fuel to be transferred from the wing tank to the forward tank. The fuel cock position indicator will also be energized to indicate the changed position of the fuel cock. When the engine is started it will be supplied with fuel from the forward tank, the contents of either the rear or wing tanks being transferred to the forward tank, as fuel is burnt, by transfer air pressure. The transfer of fuel will operate either the rear or the wing tank pressure switch thus energizing one of the Type Q relays. With the relay energized the appropriate capacitor gauge strap unit is connected to the amplifier, via the relay box causing the gauge to indicate the contents of the forward and either the rear or wing tanks. When a capacitor strap is not in circuit, a fixed capacitor having the same value as the strap when the tank is empty, is substituted. When either of the Type Q relays are energized, one pair of their contacts will supply the transfer pressure indicator, causing it to show that fuel is flowing. The float switch in the rear tank will close when there are a few gallons of fuel left in the tank. If the tank selector switch is in the AUTO position, the closing of this switch will energize the cock control relay, stopping the flow from the rear tank and bringing the wing tank into use as previously described.

Fuel pressure warning (Code FP)

5. The operation of the fuel pressure warning circuit is such that when the engine pump delivery pressure falls below 3 - $3\frac{1}{2}$ lb. per sq.in., the engine fuel pressure switch contacts close and make the supply to energize the indicator lamp, mounted on the starboard instrument panel which will show to give warning of this condition. The circuit is shown in fig.1.

Oil pressure indicator (Code OP)

6. This indicator is a Type 2 a.c. ratiometer instrument mounted on the leg panel in the cabin and actuated by a, Type 480AG/SB Mod.01, inductor transmitter mounted on the engine sump. The supply is obtained from the a.c. supplies circuit, via an auto transformer, as described in Sect.5, Chap.1, Group E.1 of this volume. A routing and theoretical diagram of the installation is given in fig.3 of this group.

Operation

7. For the principle of operation and a full description of the equipment, reference should be made to A.P.1275A, Vol.1.

Tachometer (Code RA)

8. This indicator is a Mk.10A electrically-operated instrument situated on the centre instrument panel and supplied with current from an engine-driven Mk.8C tachometer generator located on the engine wheelcase. The indicator and generator form a closed circuit as shown in the routing and theoretical diagram given in fig.3 of this group.

Operation

9. The principle of operation and a full description of the equipment will be found in A.P.1275A, Vol.1.

Exhaust gas thermometer and top temperature control (Code ET)

10. The exhaust gas thermometer and top temperature control installation is provided to indicate and control the temperature of the engine jet exhaust gases, in order that the engine top temperature limits are not exceeded. The Type C exhaust gas thermometer is located on the centre instrument panel and gives a continuous indication of the jet exhaust temperature from 0 to 800 deg. C. The instrument is a moving coil millivoltmeter, which is actuated by eight Type B.6 thermocouples located in the jet pipe and the circuit incorporates a Samgamo Weston FD.871 adjustable series resistor mounted on the supply panel. The indicator, adjustable resistor and thermocouples form a self-energized closed circuit linked, via the thermocouples to the top temperature control equipment. The top temperature control installation is provided to restrict the fuel flow to compensate for a rise in exhaust gas temperature above the permissible maximum. The installation incorporates a Smiths EC.1/3 or Ultra A.133/1 magnetic amplifier and a temperature trimmer resistor, which are both located at the top of the radio bay on the starboard side. The amplifier is fed with three phase a.c. taken from the a.c. supplies circuit and the unit amplifies the output of the eight thermocouples located in the jet pipe. The output from the amplifier is used to operate a solenoid-operated valve, which is incorporated in the engine fuel system. The installation is only operative when the aircraft is airborne, being overriden by a Type C.1831/Y Mk.2 micro-switch, which controls a Type F.H.M./A/57 time switch. The micro-switch and time switch are located on the aft face of frame 3, the micro-switch being operated by the nose wheel fairing door. An on/off cut-out switch is provided on the cabin port shelf to enable the installation to be rendered inoperative, in flight, if an emergency should make this necessary. A test plug, located adjacent to the access door for the jet-pipe rear mounting on the starboard side of the rear fuselage is provided to ground test the installation and provision has also been made for the incorporation of a test switch for the pilot's use in checking the installation before flight.

Operation

11. When the aircraft is airborne and the undercarriage retracted, the nose wheel fairing door micro-switch is operated and energizes the time switch, via the emergency cut-out switch when in the ON position. After the required time sequence, the time switch contacts change over to switch out the amplifier's 30 ohm. loading resistor and connect the solenoid valve into circuit to render the installation operative. If the exhaust gas temperature, as measured by the thermocouples and fed to the magnetic amplifier, rises above the permissible maximum, the amplifier will feed the solenoid-operated valve in the engine fuel system, which will open to reduce the main fuel flow and throttle back the engine to lower the temperature of the exhaust gas. When the exhaust gas temperature falls, the output of the thermocouples will decrease and the amplifier will cease to supply the solenoid valve, which will close and return the engine fuel system to the condition found before the exhaust gas temperature reached the permissible maximum. For a full description of the engine top temperature control equipment, together with the principle of operation, reference should be made to A.P.4343E, Vol.1, Sect.12. A full description of the exhaust gas thermometer, together with its principle of operation will be found in A.P.1275A, Vol.1, Sect.4.

Fuel low level warning

12. A pair of Type B warning lamps, mounted on a small bracket located above the R.P. selector panel in the cabin, are provided to indicate when the fuel in the port and starboard forward tanks drops to 650 lbs. These lamps are operated by the lower switch

of the Flight Refuelling Type D.3504147 or Hawker Pt. No. D.215808 double fuel level float switch unit installed in each front tank. The upper switch of this unit is employed in the pressure refuelling circuit as described in Group C.3 of Sect.5, Chap.1 of this volume. A routing and theoretical diagram of the low level warning circuit is given in fig.6 of this group.

SERVICING

General

13. Apart from the servicing information given in the following paragraphs, all other servicing to maintain the engine instruments in an efficient condition and the standard serviceability tests, which should be applied, together with the equipment to be used and the method of conducting the tests are contained in the appropriate sections of A.P.1275A and T, Vol.1. Before servicing or removing any of the electrically-operated instruments the aircraft must be rendered electrically safe, as described in Sect.5, Chap.1, Group A.1 of this volume.

Fuel content gauges

Data and tolerances on units

14. These figures are given in order that the units may be checked individually. The following equipment should be used for carrying out the tests and must be of at least the accuracy stated:-

(1) Variable capacitor - Range 100 to 2300 pF.
Accuracy ± 1 pF. at any point on its range.

(2) Milliammeter * - Range 0 to 7.5 mA, 0 to 15 mA., 0 to 30 mA.
Accuracy to BS.89 precision grade.

(3) Voltmeter - Range 0 to 40 volts. Accuracy to BS.89 first grade.

(4) FAB/18 amplifier - Tested using the above instruments for conformation to the limits given in para.21.

(5) 250 volt d.c. insulation resistance meter.

* Alternatively, a d.c. potentiometer and standard resistance may be used.

Tank units

15. The initial capacitance quoted in table 1 is measured with the tank unit moist, but thoroughly drained of all fuel. The range of a unit is the increase in capacitance when totally immersed, at a temperature between + 15 deg. and + 25 deg.C, in a kerosine fuel having a permittivity of 2.10 at the temperature of test. Measurements must be carried out with the unit well clear of all metal objects, and

with the leads a minimum of six inches apart. A resistance of at least 20 megohms should be obtained for a new or replacement unit before installation and at least 3 megohms if measured in-situ.

TABLE 1 - TANK UNITS

Code	Initial capacitance (pF.)	Range (pF.)	Tank
TC.94	227 ± 3	243 ± 3	Front
TC.95	287 ± 3	304 ± 3	Front
TC.127	124 ± 10	117 ± 10	Rear
TC.180	50 ± 3	53 ± 3	Wing
TC.181	74 ± 3	77 ± 3	Wing
TC.182	74 ± 3	77 ± 3	Wing
TC.183	118 ± 3	120 ± 3	Wing

Tank terminals

16. The capacitance of the tank terminals is as follows. The terminals should have a resistance of at least 20 megohms.

Code - JM14 Capacitance 23 ± 3 pF.
JU6 " 23 ± 3 pF.

Complete tank with tank terminal

17. The capacitance values for the tanks complete with terminals is given in tables 2 and 3. The insulation resistance of a complete tank installation, measured at the tank terminal coaxial socket should not be less than 1 megohm. Tanks should be completely drained of all fuel before carrying out the above check.

TABLE 2 - FUSELAGE TANKS
(Port and Starboard)

Tank	Empty, out of aircraft	Installed, wet and pressurized
Front	593 ± 20 pF.	638 ± 25 pF.
Rear	200 ± 15 pF.	220 ± 20 pF.

TABLE 3 - WING TANKS
(Port and Starboard)

Tank	Empty, out of aircraft	Installed dry	Installed, wet and pressurized
No.1	158 ± 15 pF.	172 ± 15 pF.	190 ± 15 pF.
No.2	116 ± 15 pF.	133 ± 15 pF.	152 ± 15 pF.
No.3	149 ± 20 pF.	173 ± 20 pF.	207 ± 20 pF.
No.4	88 ± 15 pF.	102 ± 15 pF.	110 ± 15 pF.

Coaxial cables

18. Coaxial cables should have a resistance of at least 20 megohms whether new or installed. Cable details are given in table 4 below:-

TABLE 4 - COAXIAL CABLES

Code	Length (ins.)	Capacitance (pF.)
CJ.136	136	217 ± 21
CJC.65	65	104 ± 10
CJC.166	166	265 ± 26
CR.30	30	54 ± 3
CR.65	65	117 ± 3
CR.154	154	277 ± 5
CR.192	192	346 ± 5
CR.228	228	411 ± 5
CRC.146	146	262 ± 5
CRC.54	54	97 ± 3
CS.21	21	38 ± 3

Cable boxes, code BW.13 and BW.14

19. All the capacitance figures given in tables 5, 6 and 7 should be measured at the front socket. Before checking the range values of a box, the trimmers must be adjusted to their nominal value. The range into, and out of, the box is the increase in capacitance above 2 mA, while the capacitance out of the box figure is the "tanks empty" capacitance of the amplifier less the capacitance of the connecting cable. When checking the box input minimum or maximum values, it is useless to check one trimmer in a group as they are complementary to each other in that group. To check the box input capacitance, **ALL** the trimmers in that group must be adjusted to their minimum or maximum value.

20. As each cable box contains a coil connected to earth, it is useless to subject them to an insulation resistance test. These units may be considered serviceable if they conform to the capacitance figures given in the tables.

TABLE 5 - CABLE BOXES - SUMMATION
(both relays energized)

Code	'Tanks empty' capacitance into box at front input socket			'Tanks empty' capacitance out of box	Range out of box	Range into box
	Trimmer at min. not less than	Box input nominal value	Trimmer at max. not more than			
BW.13	2985 pF.	2821 pF.	2657 pF.	712 pF.	500 pF.	1047 pF.
BW.14	2914 pF.	2755 pF.	2596 pF.	712 pF.	500 pF.	1047 pF.

TABLE 6 - CABLE BOXES - FRONT AND REAR TANKS
(unenergized relay connected to pin A)

Code	'Tanks empty' capacitance into box at front input socket		
	Trimmer at min. not less than	Box input nominal value	Trimmer at max. not more than
BW.13	1623 pF.	1543 pF.	1463 pF.
BW.14	1622 pF.	1542 pF.	1462 pF.

TABLE 7 - CABLE BOXES - FRONT AND WING TANKS
(unenergized relay connected to pin C)

Code	'Tanks empty' capacitance into box at front input socket		
	Trimmer at min. not less than	Box input nominal value	Trimmer at max. not more than
BW.13	2026 pF.	1970 pF.	1914 pF.
BW.14	2019 pF.	1968 pF.	1917 pF.

Amplifiers, code FAB/18

21. The relationship between the indicator current and capacitance with a power supply of 28 volts is given in table 8. The amplifiers contain a 150 volt working condenser, which would be damaged by the higher Megger voltage, thus an insulation resistance test must not be carried out on these units. They may be considered serviceable if they conform to the capacitance/indicator current test figures given in the table using the accurate test equipment referred to in para. 14.

Power supply - Nominal voltage 28 volts.
Current at 28 volts 0.7 amps. (approx.)

Capacitance - Initial (or tanks empty) ... 750 pF.
Tanks full . ... 1250 pF.
Range .. .. 500 pF.

TABLE 8

AMPLIFIER CAPACITANCE/INDICATOR CURRENT

Capacitance (pF.)	Indicator current (mA.)
750	2.0 ± .03
823	3.0 ± .05
908	4.0 ± .05
1005	5.0 ± .05
1120	6.0 ± .05
1250	7.0 ± .05

Coaxial harness, code CG1

22. The capacitance of the coaxial harness is 136 ± 5 pF. and it should have an insulation resistance of at least 20 megohms.

Indicators

23. Early aircraft are fitted with AO-26 indicators, while later aircraft have AO-26 Mod.01 indicators installed. It is essential that both port and starboard indicators should be of the same code, if they differ, the pilot will have a false indication of his fuel balance state. An insulated resistance test should not be carried out on the indicators. These may be considered serviceable if they conform to the figures given in table 9.

TABLE 9 - INDICATORS

Code AO-26 Mod.01

Indication (pounds x 100)	Indicator Current (mA.)
0	2.00
1	2.38
2	2.81
3	3.25
4	3.66
5	4.03
6	4.33
7	4.66
8	4.94
9	5.25
10	5.59
11	5.91
12	6.20
13	6.48
14	6.73
15.10(F)	7.00

Code AO-26

Indication (pounds x 100)	Indicator Current (mA.)
0	2.00
1	2.38
2	2.82
3	3.25
4	3.64
5	4.00
6	4.30
7	4.62
8	4.90
9	5.19
10	5.51
11	5.80
12	6.06
13	6.33
14	6.56
15.10(F)	6.82

Accuracy of the fuel gauge installation

24. It will be realised from the nature of the system that its accuracy depends, amongst other things, on the supply voltage being maintained at the required figure and the physical properties of the fuel conforming to specification. The calibration of this gauge is based on a kerosine fuel having a permittivity of 2.10 and a specific gravity 0.779 at a temperature of 20 deg.C.

Errors of the fuel gauge in normal flight

25. The following tables will enable an operator to obtain an approximate error from true reading caused by system inaccuracies and by various conditions of temperature, supply voltage, fuel permittivity and density. All errors are expressed as a percentage of the total indication, with the exception of fuel temperature errors, which are expressed as a percentage of indicated fuel contents per degree Centigrade.

TABLE 10 - TEMPERATURE

Temperature	-35°C	-10°C	+15°C	+40°C
Tank empty	+0.8	+0.4	0	-0.4
1/10	+1.0	+0.5	0	-0.5
1/3	+1.4	+0.7	0	-0.7
2/3	+2.0	+1.0	0	-1.0
Full	+2.6	+1.3	0	-1.3

TABLE 11 - SUPPLY VOLTAGE

Supply voltage	24V.	28V.	29V.
All fuel levels	-1.5	0	+0.8

Note...
The fuel contents gauge is calibrated for a supply voltage of 28 volts d.c. To obtain maximum accuracy, the voltage must be adjusted to this figure.

Setting-up fuel content gauges

26. Before commencing to set-up the fuel gauges, ensure that the power supply to the amplifier is switched on for at least 15 minutes, by placing the battery master switch to the ON position or by connecting an external supply to the aircraft's electrical system, before carrying out any adjustments. The recommended setting-up instructions are as following:-

(1) The supply voltage is to be 28 ± 0.5 volts.

(2) Fill and then drain the complete fuel system to the residual fuel level.

(3) Pressurize the complete fuel system to the normal working pressure. The transfer pressure indicator will be as shown in Fig.7, (detail A) with the wing tank selected.

(4) Trim summation circuit to zero, using the four trimmers marked SUM in the BW cable boxes.

(5) Release the pressure from the front and wing tanks by allowing it to dissipate through the vapour release valves in the front tanks. With the tank selector switch still in the WING position, the transfer pressure indicator and tank selector indicator should be as shown in Fig.7, (detail B). Trim the wing matching circuit to zero, using the two trimmers marked wing c/o.

(6) Release all the pressure from the system by setting the tank selector switch to REAR. The transfer pressure indicator and tank selector indicator should be as shown in Fig.7 (detail C). Trim the rear tank matching circuit to zero, using the two trimmers marked rear c/o.

Checking the fuel gauge installation

27. Apart from the normal inspection for physical damage, the installation on this aircraft requires no maintenance during service other than the functional (or tanks drained) check. The fault location checks should be carried out, using the code QAA test set, which is described in A.P.1275T, Vol.1. The figures quoted for these checks should only be employed as a guide when using the QAA test set, the necessary standard of accuracy not being obtainable with this instrument. If, however, a unit appears to deviate greatly from the figures quoted, it should be removed from the aircraft

and checked, using the accurate test equipment referred to in para. 14, or alternatively, replaced by a new unit and the fault location test repeated. On no account should a unit be rejected solely on the evidence of the test set.

28. It is permissible to change a valve in an amplifier, but this must be replaced only by a Code ZAA valve supplied by Smiths Aircraft Instruments Ltd. After a valve replacement has been carried out the amplifier must pass a capacitance/indicator current test (para. 21), again using the accurate equipment referred to previously.

Functional check

29. This check should be carried out at the times quoted in the aircraft's Servicing Schedule or after any major unit of the installation is changed. The check ensures a correct reading on the indicators when the tanks are drained of all normally usable fuel, and thus acts as a guide to the correct operation of the gauge. Each side of the system must be checked separately and therefore the following procedure must be carried out on each in turn.

30. Before commencing this test, the system must be pressurized to the normal working pressure, the tanks must also have been recently filled and then drained of all normally usable fuel. It is important to note that 15 minutes should be allowed to elapse to enable the tank units to completely drain, otherwise the tank units will have a higher capacitance than that quoted. In addition, the power supply to the amplifier must be switched on at least 15 minutes before the check is carried out.

31. If these conditions obtain, the indicator should read zero contents. If not, the trimmers marked SUM in the cable box must be revolved until the indicator gives a satisfactory reading.

32. The front and wing tanks should now be depressurized and the tank selector switch set to WING. The indicator should still show zero contents, but if not, the trimmers marked wing c/o in the cable box should be used to obtain the desired reading.

33. Release all the pressure from the system by setting the tank selector switch to REAR. The indicator should still show zero contents, but if not the trimmers marked rear c/o in the cable box should be used to obtain the desired reading. It must be realised that this check in no way guarantees the accuracy of the system throughout the range and that if this is suspect the units should be individually tested with the equipment listed in para. 14.

TABLE 12 - FUEL VARIATIONS

	(1) Fuel	(2) Permittivity	(3) Density gm/ml d	(4) % Errors				
				Tank empty	1/10	1/3	2/3	Tank full
BRITISH	AVTAG/DERD2486 (J.P.48 or F-40)	2.035 2.180	0.739 0.825	0 0	-0.08 +0.1	-0.3 +0.4	-0.6 +0.8	-0.8 +1.3
BRITISH	AVTUR/DERD2482 (J.P.1B or F-33)	2.035 2.165	0.780 0.810	0 0	-0.6 +0.2	-2.0 +0.6	-4.0 +1.2	-6.0 +1.8
BRITISH	AVCAT/DERD2488 (J.P.5B or F-42)	2.156 2.161	0.817 0.817	0 0	0 +0.05	0 +0.17	0 +0.33	0 +0.5
AMERICAN	J.P.1 (MIL-F-5616 or F-33)	2.093 2.186	0.8030 0.8479	0 0	-0.4 -0.09	-1.2 -0.3	-2.4 -0.6	-3.7 -0.9
AMERICAN	J.P.3 (MIL-F-5624C)	1.997 2.270	0.7434 0.8300	0 0	-0.5 +0.8	-1.6 +2.8	-3.2 +5.6	-5.0 +8.3
AMERICAN	J.P.4 (MIL-F-5624C or F-40)	2.020 2.106	0.7467 0.8251	0 0	-0.3 -0.5	-1.1 -1.7	-2.1 -3.4	-3.2 -5.1

Note...

The figures given in table 12 will enable an operator to calculate errors when using fuels differing in permittivity and density to those for which the gauge is calibrated. It should be borne in mind that the errors given in column (4) of table 12 are not extreme errors to be expected when using the fuels defined in column (1). The errors given are those which may be present when using fuels conforming to the permittivities and densities quoted in columns (2) and (3). The errors given have been calculated from the "highest" and "lowest" values obtained by laboratory measurement of fuel samples.

Since fuel permittivty does not always vary exactly in relation to density, an error may exceed that quoted or the sign of an error may reverse. Should a fuel be employed which differs to that defined in columns (2) and (3), the mass indication for that fuel will be in error by a factor equal to $\frac{k-1}{d} \cdot \frac{do}{ko-1}$; that is to say, the capacitance index of the fuel divided by that of the standard.

TABLE 13 - TEMPERATURE VARIATIONS ACTING ON THE FUEL

Condition	% Error
Temperatures above + 20 deg.C	-0.028/°C
Temperatures below + 20 deg.C	+0.028/°C
For 50 deg.C. fall in temperature	+1.40
For 50 deg.C. rise in temperature	-1.40

Note...

The correction to be made to the indicator reading, to indicate true contents, is equal in magnitude but opposite in sign to the error given.

TABLE 14 - SYSTEM ERROR

Tanks empty	±0.3*
1/10	±0.9*
1/3	±2.3*
2/3	±4.3*
Full	±6.5*

* Includes 0.3 per cent readability error.

Note...

Each unit of the fuel gauge is manufactured to a desired capacitance with an associated tolerance. It is, therefore, possible, although unlikely, for all these to be either high or low on tolerance. For this reason table 14 quoting the maximum system errors is given.

Insulation resistance check

34. An insulation resistance check should be carried out periodically with at least the same frequency as this check is made on the remainder of the aircraft's electrical system. Using a 250 volt insulation resistance meter, the individual units should conform to the tolerances laid down in para.14 to 23. It is important to note that insulation resistance checks should not be carried out on amplifiers, cable boxes and indicators for the reasons stated previously, and that it is preferable that the tanks are completely drained of all fuel before the checks are commenced.

WARNING

A 250 volt insulation resistance meter only should be used as the application of voltages above 300 may cause a tank explosion, if there is a distorted, or otherwise damaged tank unit present.

Fault location checks

35. Apart from a failure in the 28 volt supply, a fault in the installation will only affect one indicator and therefore in the great majority of cases it will only be necessary to carry out a check on the one side of the system. The method of testing each side is identical, but the test values are naturally a little different owing to certain cable dissimilarities. These necessitate the two tables 15 and 16 found in this chapter.

Check on amplifier and indicator

36. The first part of a fault location check is carried out by connecting the test set between an amplifier and its power supply as described in A.P.1275T, Vol.1. Move the test set's selector switch first to position 1 and then to position 2, thereby checking the power supply and current respectively into the amplifier by noting the test set meter reading; this procedure is explained in greater detail in the above Air Publication. If an unsatisfactory result is obtained, check back to the source of the power supply.

37. To test the circuit between an amplifier and indicator, turn the test set's selector switch to position 3. As the output of the FAB/18 amplifier varies between approximately 2 and 7 mA. over the range of 'tanks empty' to 'tanks full', it follows that the test set meter reading should lie between these two limits, depending on the amount of fuel on board. If a satisfactory reading is not obtained, the fault could lie either with the amplifier and associated tank circuit or with the indicator and its circuit. To check which of these two is at fault, move the selector switch to position 4. This cuts out the circuit to the indicator, and if a satisfactory result

is still not obtained, the fault must lie in the amplifier or in the tank circuit. If a satisfactory reading is obtained, the fault lies in the indicator circuit. The foregoing procedure is explained at greater length in A.P.1275T, Vol.1 and a table that summarises it appears in that publication as well as on the lid of the test set itself.

38. Now disconnect the tank circuit coaxial cable from the amplifier and substitute the coaxial cable supplied with the test set, connecting the other end of the cable to either of the test set's two coaxial sockets. This arrangement is also shown in A.P.1275T, Vol.1. As the test set's cable has a capacitance of 150 pF., if the variable capacitor on the set is adjusted to 600 pF., a capacitance of 750 pF. will be fed into the amplifier. Thus, if the selector switch is placed at position 3 or 4 the test set meter should read about 2 mA. This procedure should be repeated for each of the settings given in table 8 and the amplifier checked for approximate accordance with the values given.

Check on tank circuits

39. It will be seen in fig.7 that every connection or test point is numbered, starting at the cable box and working to the tanks. These numbers will be found in tables 15 and 16, together with the capacitance that must be connected at each point to give an indication of approximately 2 mA. on the test set meter and therefore a reading of zero contents on the indicator.

40. When testing at beyond points 3, 7 and 10 it is essential that the tank be drained of all normally usable fuel and the system pressurized. If the amplifier has proved serviceable, reconnect the aircraft's coaxial cable to the amplifier and disconnect it at point 1 of the associated system. The test set's coaxial cable must now be connected to the aircraft's cable, employing the double socket clipped to the inside of the test set's lid.

41. The variable capacitor should now be set to 750 pF., less the capacitance of the aircraft's CS.21 cables (port and starboard), test set cable and the socket; the resultant value is the figure given in the table. The indicator should now read approximately zero contents and the test set's meter about 2 mA. This process is repeated at each of the remaining points throughout the system, the variable capacitor value being set to the figures given in the appropriate table as each unit is connected back into the installation until a complete check has been made.

42. The capacitance values given have the total tolerance at each particular point quoted alongside. The desired meter reading of 2 mA. should, therefore, be obtainable with the variable capacitor setting within these limits, provided that the

system's trimmers are correctly adjusted. On no account should the cable box trimmer settings be altered; these settings should only be adjusted during a functional check.

43. The method of checking the units installed in the port and starboard wing tanks is a little different to that described in the preceeding paragraphs, and is therefore described below.

44. Disconnect the coaxial harness CG1 at points A, B, C and D (fig.7) and connect the QAA test set to the amplifier as described in A.P.1275T, Vol.1. Using a suitable length of coaxial cable and a Pye Waymouth adaptor, join the spare coaxial socket to any point of the harness. The variable capacitor should now be set to give a milliammeter reading of, say, 5 mA, and the harness disconnected, leaving the coaxial cable and adaptor all connected to the test set socket. Having noted the variable capacitor reading, it should be readjusted until the same milliammeter reading is again recorded. The capacitance of the CG1 harness is obtained by subtracting the first variable capacitor reading from the second, and should be within the limits quoted in para.22, plus ten per cent allowance for test set inaccuracies. This method is described in greater detail in A.P.1275T, Vol.1.

45. Assuming that the harness is serviceable, leave it disconnected and also disconnect the coaxial cable CRC.54 from the JM.14 tank terminal. Employing the method detailed for the CG1 harness, now check each tank at points A, B, C and D for accordance with the capacitance values given in table 17.

TABLE 15 TEST POINTS (PORT SYSTEM)

Test point	A Test capacitance (pF.)	B Test capacitance (pF.)	Adaptors and cables used	Approximate reading on Aircrafts indicator	Test set meter
1	712 ± 3	562 ± 6	CE1	zero contents	2 mA.
2	692 ± 28	542 ± 31	CE1	"	"
3	638 ± 25	480 ± 30	CC1, CE1	"	"
4	866 ± 61	716 ± 64	CE1	"	"
5	589 ± 56	431 ± 61	CC1, CE1	"	"
6	324 ± 30	166 ± 35	CC1, CE1	"	"
7	220 ± 20	62 ± 25	CC1, CE1	"	"
8	1278 ± 80	1128 ± 59	CE1	"	"
9	867 ± 75	709 ± 80	CC1, CE1	"	"
10	770 ± 72	612 ± 77	CC1, CE1	"	"

TABLE 16 TEST POINTS (STARBOARD SYSTEM)

Test point	A Test capacitance (pF.)	B Test capacitance (pF.)	Adaptors and cables used	Approximate reading on Aircrafts indicator	Approximate reading on Test set meter
1	712 ± 3	562 ± 6	CE1	zero contents	2 mA.
2	755 ± 28	605 ± 31	CE1	"	"
3	638 ± 25	480 ± 30	CC1, CE1	"	"
4	803 ± 56	653 ± 59	CE1	"	"
5	541 ± 51	383 ± 56	CC1, CE1	"	"
6	324 ± 30	166 ± 35	CC1, CE1	"	"
7	220 ± 20	62 ± 25	CC1, CE1	"	"
8	1213 ± 80	1063 ± 83	CE1	"	"
9	867 ± 75	709 ± 80	CC1, CE1	"	"
10	770 ± 72	612 ± 77	CC1, CE1	"	"

46. The values quoted in column A of tables 15 and 16 are the true capacitances to be connected at each point, whilst those in column B are the true capacitances less the capacitance of the connecting cables and/or sockets. In other words, the values in column B are the actual test set variable capacitor settings, and the values in column A are the theoretical values. Both are given so that an operator may make allowances accordingly should be use a different method of connection.

TABLE 17
TEST POINTS (WING SYSTEM)

Point into which test capacitance is connected	Value of tank unit, plus internal wiring, measured at tank terminal
A	183 ± 15
B	144 ± 15
C	182 ± 20
D	110 ± 15

Additional equipment required for checking wing tank system

47. The equipment issued with the standard QAA Mod.02 test set is insufficient when checking aircraft and/or components fitted with Pye coaxial plugs and sockets. On this particular aircraft, the wing tank system is so equipped. To meet these requirements, the following additional items with their capacitance values are given below and may be obtained through the usual channels:-

(1) Pye Waymouth adaptor, Code CC.1, Capacitance 8 ± 2 pF.

Exhaust gas thermometer and top temperature control tests

48. For detailed testing procedure of the exhaust gas thermometer and top temperature control installation, using the Ultra QT.221 test set, reference should be made to A.P.4343S, Vol.1, Sect.23, Chap.11.

REMOVAL AND ASSEMBLY

General

49. The removal of the instrument panels and cabin shelves carrying the engine instruments are fully described in Group 1 of this chapter, together with an illustration showing the location of all the components. Once access has been obtained, the removal of the remaining items of equipment should present no unusual difficulties.

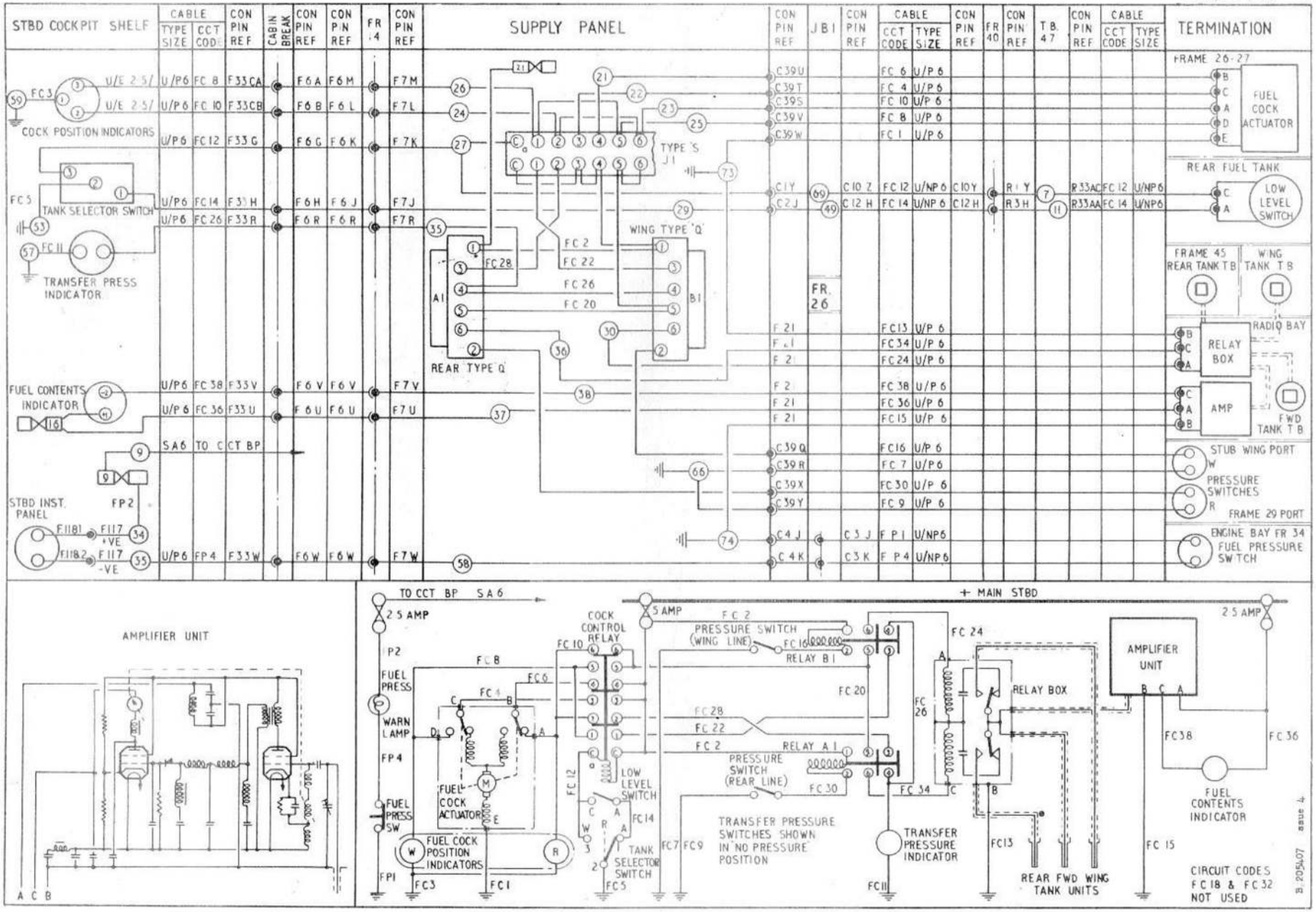

FIG. 1 FUEL CONTENT GAUGE, PRESSURE WARNING AND COCK CONTROL (PORT)

RESTRICTED

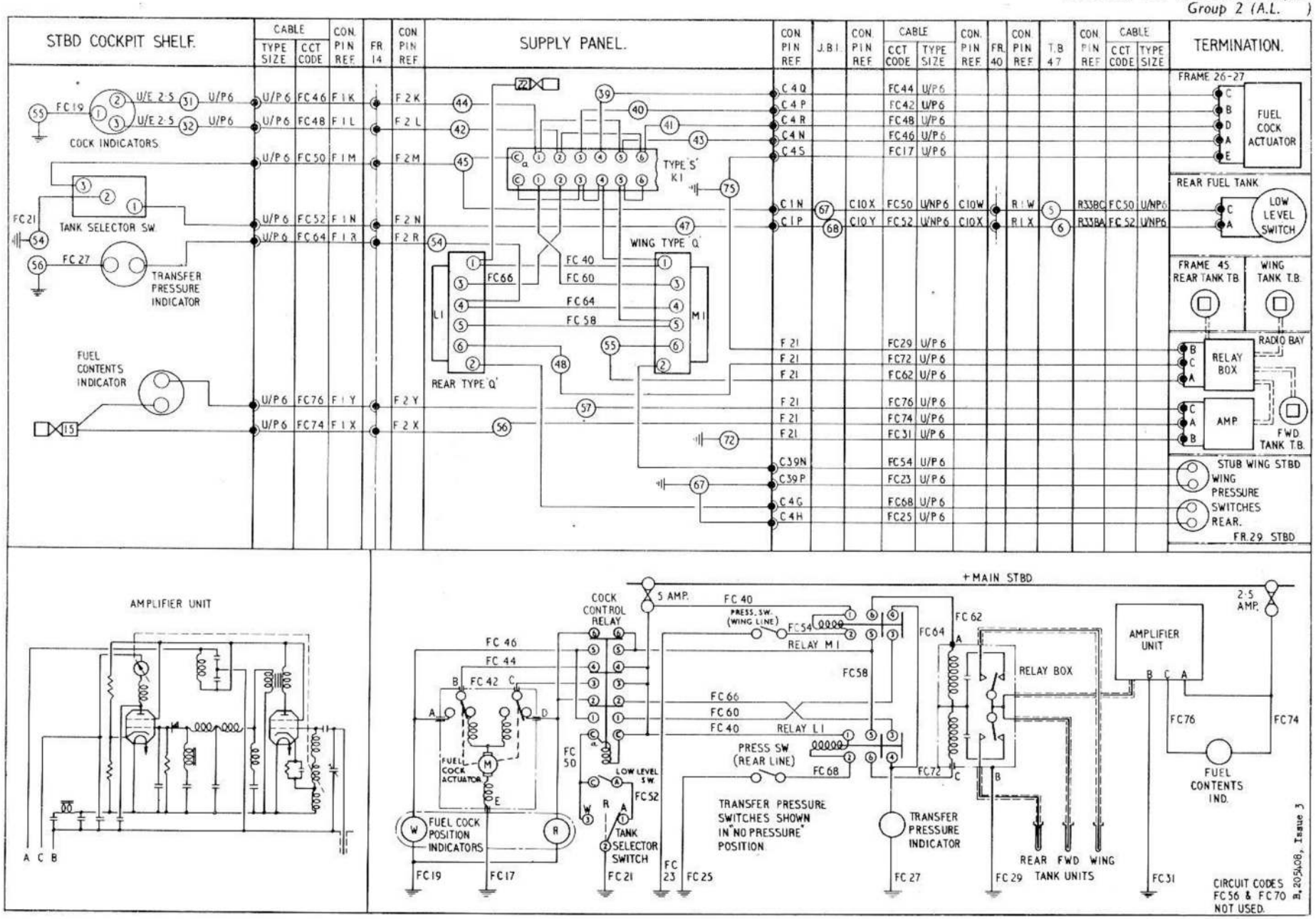

FIG. 2 FUEL CONTENT GAUGE AND COCK CONTROL (STARBOARD)

RESTRICTED

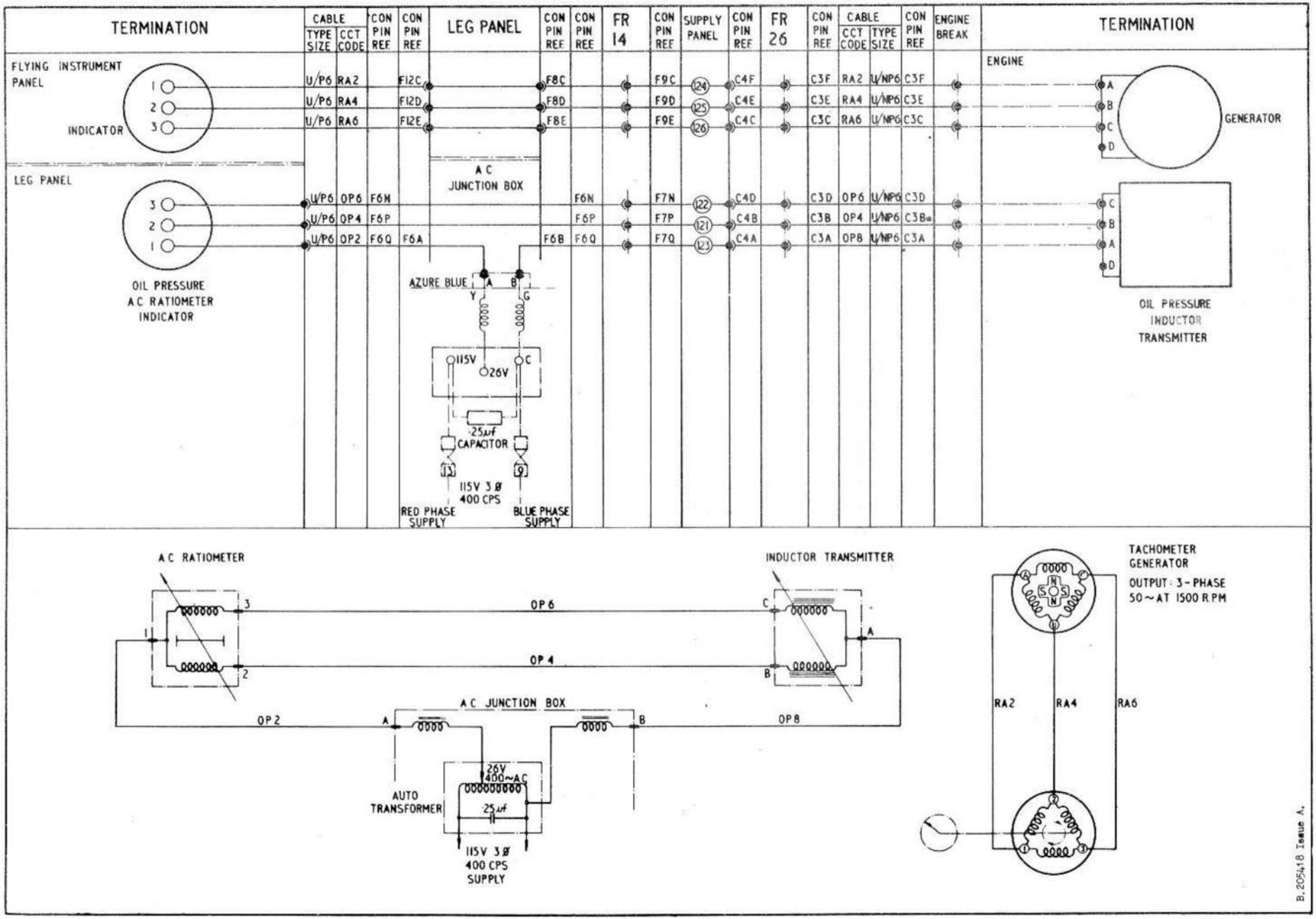

FIG. 3 OIL PRESSURE INDICATOR AND TACHOMETER

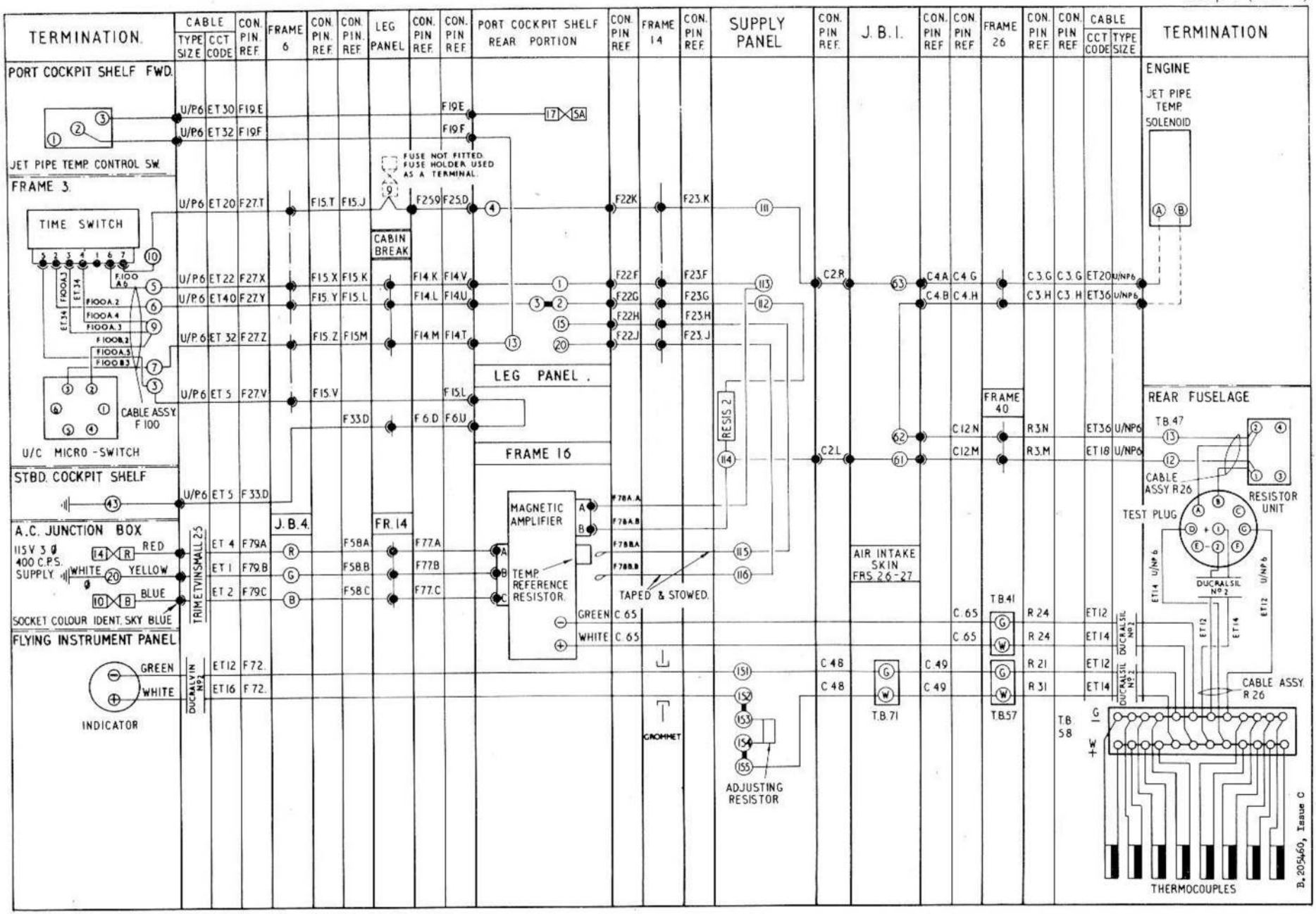

FIG. 4 EXHAUST GAS THERMOMETER AND TOP TEMPERATURE CONTROL (ROUTING)

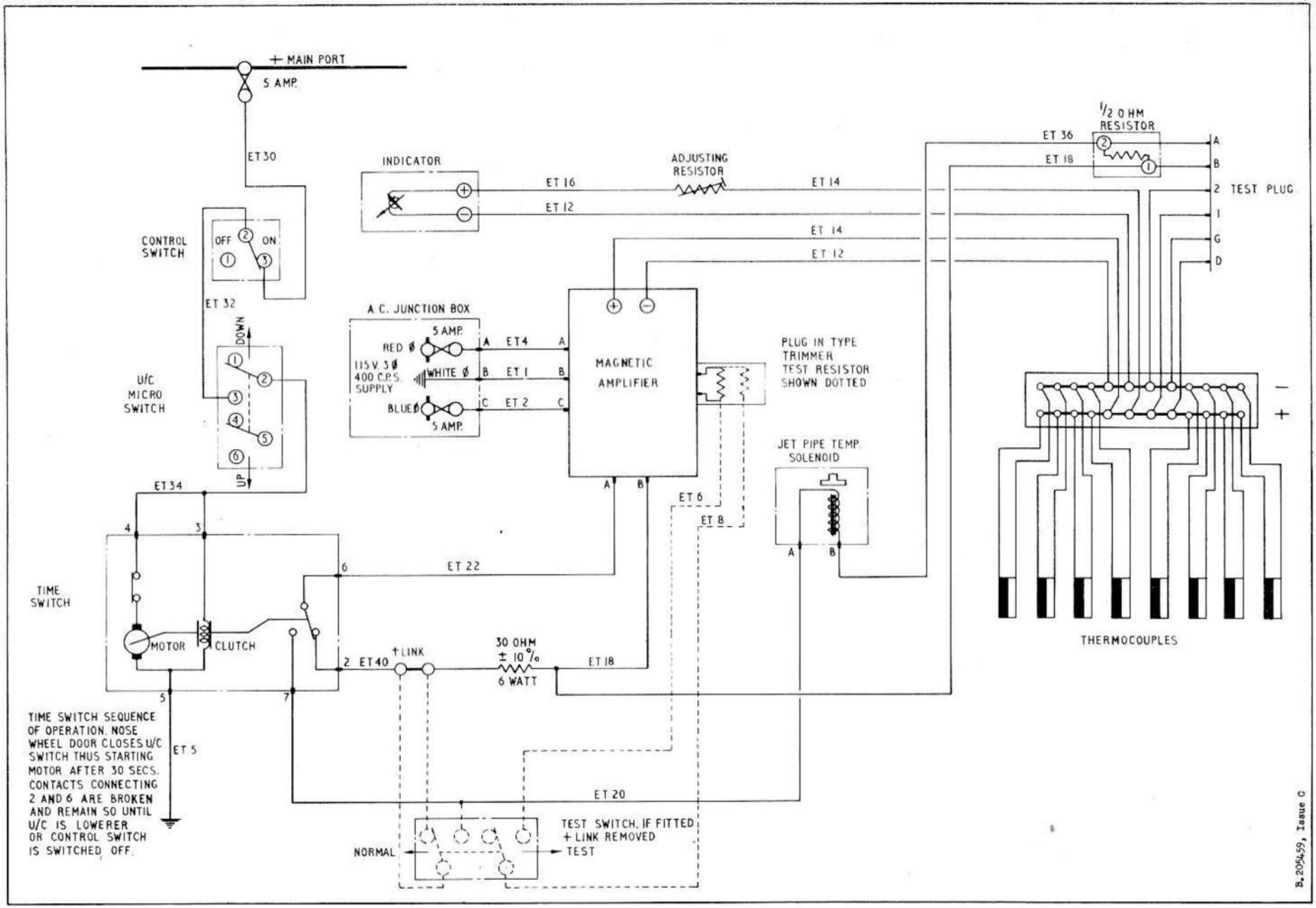

FIG. 5 EXHAUST GAS THERMOMETER AND TOP TEMPERATURE CONTROL (THEORETICAL)

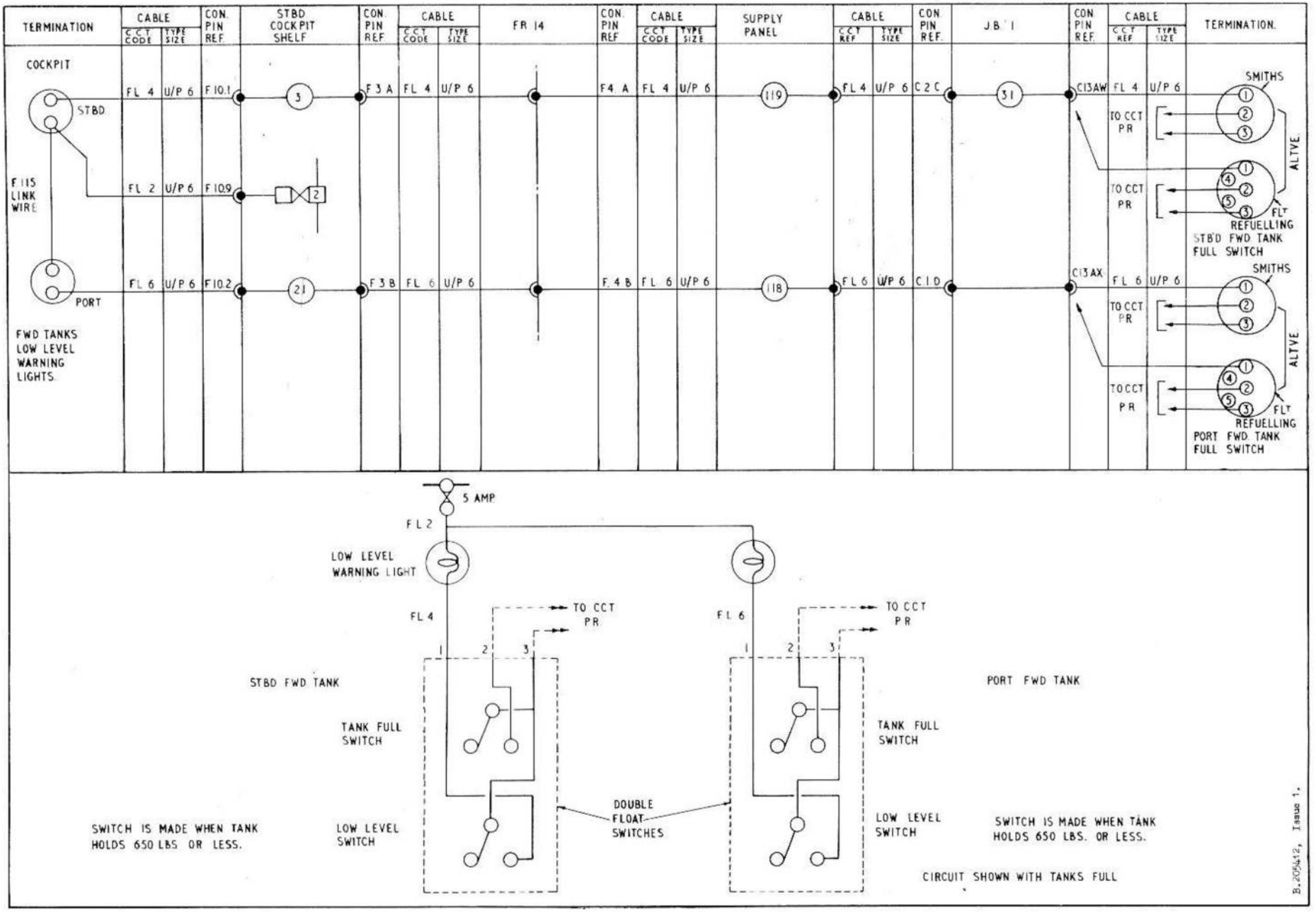

FIG. 6 FUEL LOW LEVEL WARNING

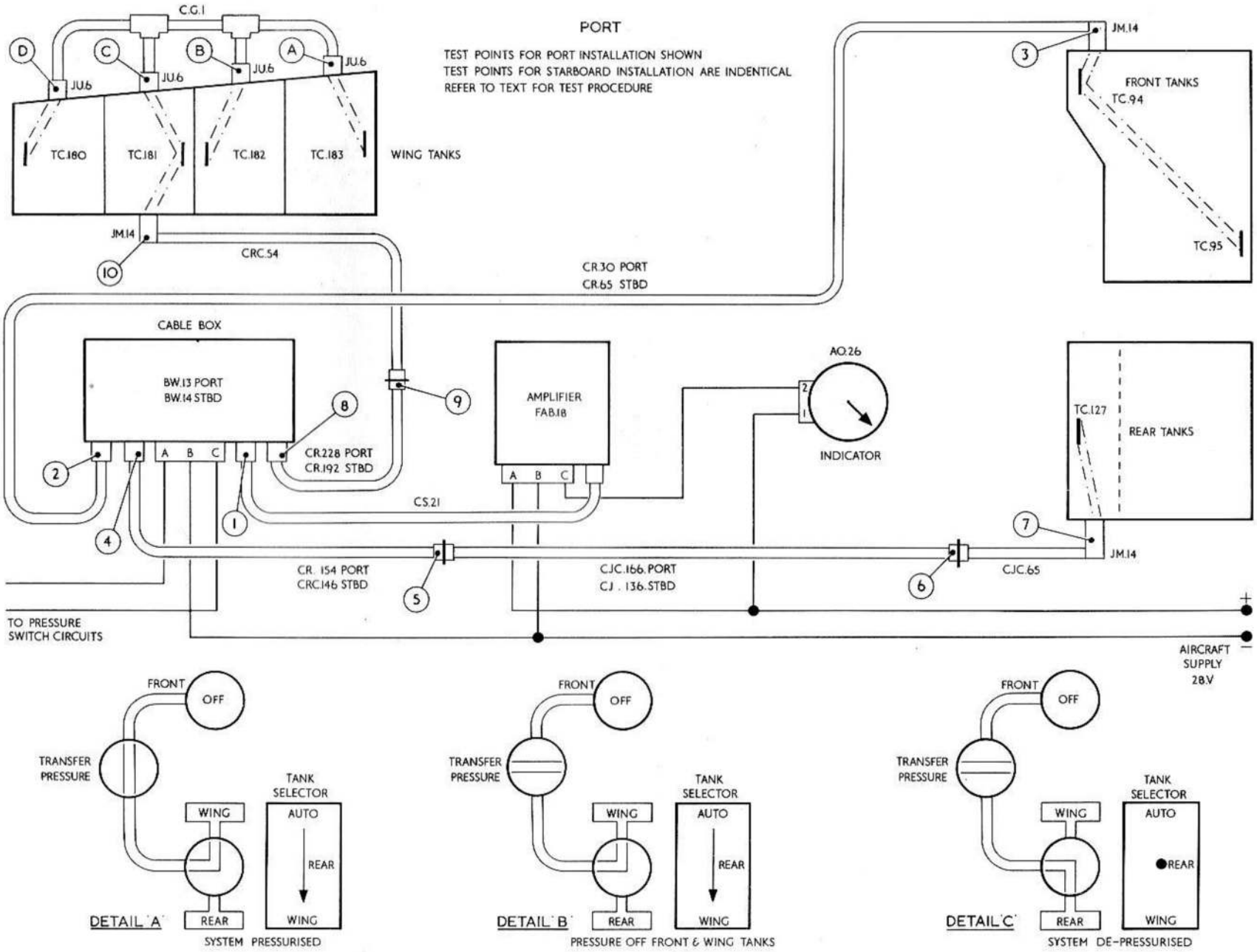

FIG. 7 FUEL CONTENT GAUGE TANK TEST POINTS

RESTRICTED