

Chapter 4 ENGINE INSTRUMENTS

LIST OF CONTENTS

DESCRIPTION		Para.			Para.			Para.
◀General	...	1	Jet pipe nozzle position			Test procedure...	...	19
Fuel contents gauges			indicators...	...	12	Fault location tests...	...	20
General	...	2	Tachometers			Insulation resistance tests	...	21
Tank units	...	3	Indicators	...	13	Jet pipe temperature system	...	22
Cable boxes	...	4	Generators	...	14	Tachometers	...	23
Amplifiers	...	5	Warning circuits					
Indicators	...	6	Fuel pressure warning	...	15			
Jet pipe temperature system			Oil pressure warning...	...	16			
General	...	7						
Thermocouples	...	8						
Servo-potentiometers	...	9						
Indicators	...	10						
Test plugs	...	11						

REMOVAL AND ASSEMBLY

Fuel contents gauges					
Tank units	...	...	...	...	24
Amplifiers	...	...	...	...	25
Jet pipe temperature system					
Thermocouples	...	...	...	...	26
Servo-potentiometers	...	...	...	...	27

SERVICING

Fuel contents gauges					
General	...	...	...	...	17
Functional tests	...	...	...	...	18

LIST OF TABLES

	Table		Table
Fuel gauging equipment...	1	Coaxial cables...	6
Capacitance values		Coaxial cable harness	7
Tank units	2	Amplifier, FAB 18	8
Tank terminals...	3	Cable box, JX 109	9A/B
Rigid connectors	4	Cable box, BT20-26	10
Complete tanks with tank terminals	5	Test points	11
		Test set equipment	12

LIST OF ILLUSTRATIONS

	Fig.
Engine instrument details	1
Fuel contents gauge installations	2 ▶

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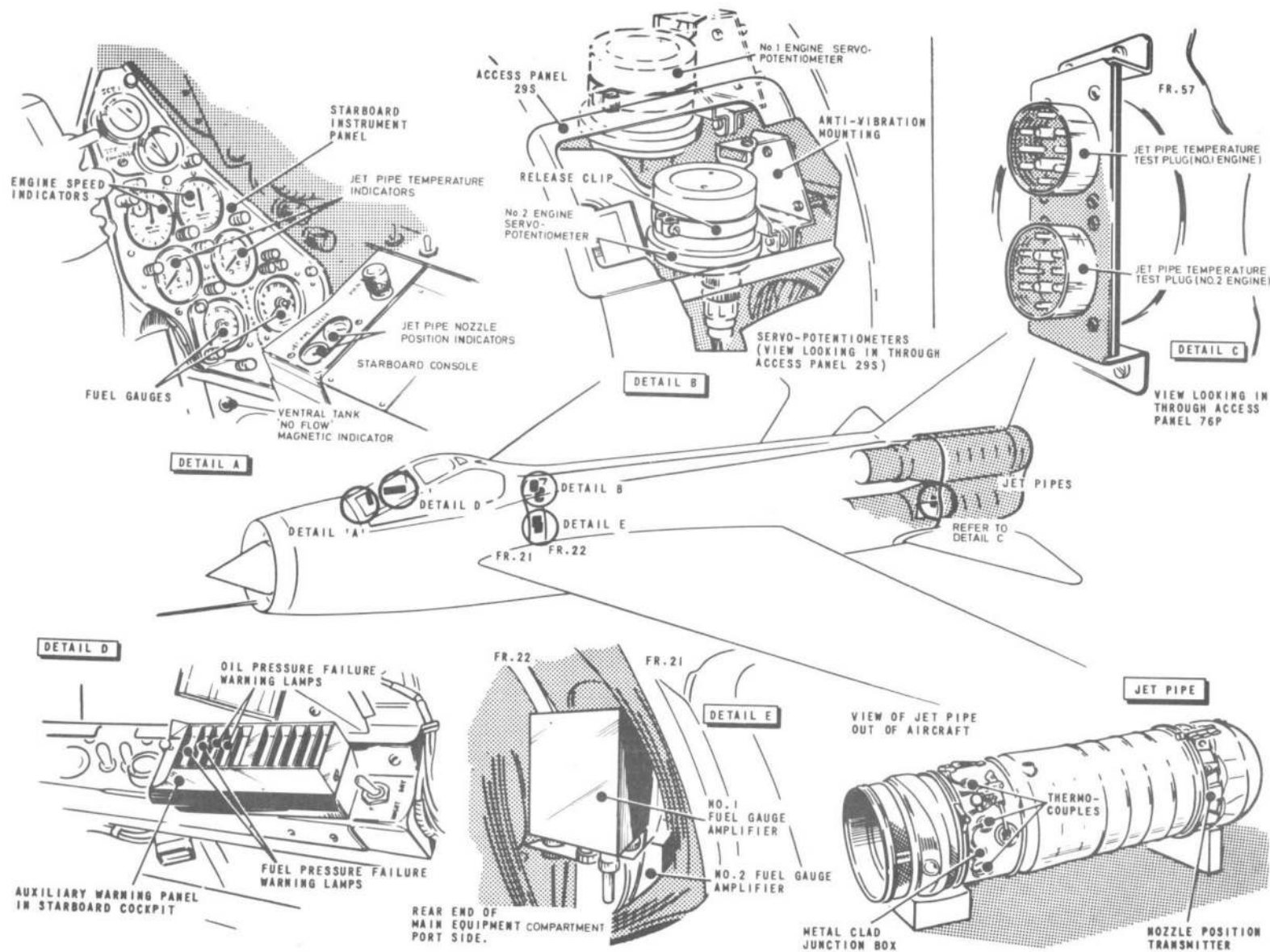


FIG. I. ENGINE INSTRUMENT DETAILS

◀ MINOR AMENDMENTS ▶

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## DESCRIPTION

## General

1. This chapter contains descriptions of all instruments and systems associated with the engine services. These include the fuel contents gauges, jet pipe temperature system, jet pipe nozzle position indicators, tachometers, and both fuel and oil pressure warning systems. The associated routing diagrams will be found in the appropriate chapter of Sect.6. The following modification is included in the text.

Mod.2162 To provide a light indication of 'tanks filled' mounted under the pilots attack sight in lieu of the existing indicator group on the port console.

## Fuel contents gauges

## General

2. The amount of fuel carried by the aircraft is indicated by two similar Smith Waymouth gauge installations, one serving the port, and the other the starboard tanks. Each installation, consisting of tank units, co-axial cables, cable boxes, an amplifier, and an indicator, operates from the d.c. system. The fuel contents readings cover the amount of fuel in the main leading edge, and flap tanks, but should a failure occur in the transfer of fuel from a flap to a main tank, the flap tank contents are automatically deducted from the total shown on the gauge. Contents of the ventral tank are not gauged but an indication of 'no flow'

from the tank is provided by a magnetic indicator located below the starboard instrument panel (Sect.6, Chap.10). During refuelling of the aircraft, 'tank full' conditions of the port, starboard and ventral tank systems, are given by indicator lamps positioned below pilot's attack sight and other lamps visible through a window at access panel 61P. Further information regarding the fuel system is contained in Sect.6, Chap.10, and A.P.101B-1001-1A, Sect.4, Chap.2. A description of the Smith Waymouth system is given in A.P. 112G-0725-1.

## Tank units

3. Channel-type (capacitor) units are employed throughout the system and are mounted inside the tanks, bolted to the tank ribs and spars. They are connected within the tank by rigid connectors to terminal boxes at the tank edges. From these boxes, the tank units are connected to the amplifier by coaxial cables. Provision is made to withdraw a faulty unit through panels in the tank edges (A.P.101B-1001-1A, Sect.4, Chap.2). In each installation, six units are fitted in the main tank, two in the flap tank, and one in the leading edge tank, all being connected in parallel.

## Cable boxes

4. The coaxial cables which connect the tank units in each wing to the associated amplifier are routed via a cable box, Code JX 109, located on the end of the ammunition collector box in the wing root. In addition to serving

as a connection point, the cable box contains a tapped choke, a fixed capacitor, and two trimming capacitors. Another cable box, Code BT20-26, installed between ribs 6 and 7 in the trailing edge of the wing, is associated with the flap tank circuit. It contains a relay, a test switch, a fixed capacitor, and a trimming capacitor. The relay operates in conjunction with a flow-sensing valve, fitted between ribs 16 and 17, to add or deduct the contents of the flap tanks (Sect.6, Chap.10). When the relay is de-energized, the fixed capacitor and trimming capacitor are switched into the circuit to simulate the 'empty' capacitance of the flap tank system. During servicing, the relay may be energized by depressing the test switch.

## Amplifiers

5. Two Type FAB 18 amplifiers are located between frames 21 and 22 in the port side of the main equipment compartment and are accessible after removal of panel 21P. The upper amplifier serves the starboard gauge system and the lower amplifier the port system.

## Indicators

6. Two fuel contents indicators, one labelled PORT TANK and the other STBD. TANK, are mounted on the starboard instrument panel. They are of the Type A.C. series and are basically milliammeters calibrated in pounds.

## Jet pipe temperature system

## General

7. Identical jet pipe temperature ►

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systems are provided for the engines, each system consisting of a number of thermocouples, a servo-potentiometer, and an indicator. The low millivolt output generated in the thermocouples is applied to the servo-potentiometer, which provides a high output for the operation of the indicator. The jet pipe temperature system is described in detail in A.P.112G-0607-1 and the associated power supply circuits are described and illustrated in Sect.6, Chap.7.

### *Thermocouples*

8. Eight KLG F 1065 thermocouples are connected in parallel, and spaced at regular intervals around each jet pipe to protrude into the exhaust gas stream. The thermocouples are connected, via a metal-clad terminal box mounted on the jet pipe and a short compensating lead, to terminals on the aft face of frame 56. From this point the circuit is continued by compensating leads to the associated servo-potentiometer. The thermocouples are also used for the jet pipe top temperature control system (Sect.6, Chap.7).

### *Servo-potentiometers*

9. The two a.c.-operated Type S144-4-38 servo-potentiometers are fitted on the aft face of frame 22. A full description of the units is contained in A.P.112G-0607-1. The power supply circuit is described in Sect.6, Chap.7, of this Volume.

### *Indicators*

10. The jet pipe temperature indicators,

Type S149-2-17, labelled ENG.No.1 and ENG.No.2 respectively, are mounted on the starboard instrument panel. Their circular scales are graduated over a temperature range extending from zero to 800 deg C.

### *Test plugs*

11. Two test plugs, one for each jet pipe temperature system, are positioned on the forward face of frame 57 port side, above the No.2 engine reheat ignition unit. The plugs are accessible via panel 76P. The top plug serves the No.1 engine system, and the bottom plug the No.2 engine system.

### *Jet pipe nozzle position indicators*

12. The jet pipe nozzle positions are shown by a Type PW884FL dual dial indicator, located at the forward end of the starboard console top. Position signals are supplied by Desynn transmitter units mounted on each reheat jet pipe and actuated by movement of the nozzle rams. A description of the indicator and transmitters will be found in A.P.112G series.

### *Tachometers*

#### *Indicators*

13. Engine speeds are shown by two Mk.11 indicators fitted in securing clamps and attached to the starboard instrument panel. Each indicator which consists of a 3-phase synchronous motor driving a pointer mechanism through a magnetic drag assembly, shows engine revs in terms of a percentage of maximum. Indication is shown on two scales; the main scale

is graduated in divisions of 10 per cent, and the subsidiary scale in divisions of 1 per cent.

### *Generators*

14. The generators which supply 3-phase a.c. to drive the indicator motors are located one on each engine external wheelcase at the starboard side, and are driven by a small square drive shaft which protrudes from the main casting and fits directly into the output drive provided on the engine. The shaft is designed to shear in the event of a generator seizure. A full description of the Tachometer Mk.11 system is given in A.P.112G series. ▶

### *Warning circuits*

#### *Fuel pressure warning*

15. Two Type 1278 pressure switches, located on the port side of the fuselage at frames 29 and 46 respectively, are connected in the low-pressure fuel delivery lines to the engines. When the pressure falls to  $3 \pm \frac{1}{4}$  lb/in<sup>2</sup>, the switches close and connect energizing supplies to the relevant circuits in the auxiliary warnings system (Sect.6, Chap.12).

#### *Oil pressure warning*

16. A Type 771/PJ/KP pressure switch, fitted in the oil pipeline of each engine, controls the oil pressure warning lamps on the auxiliary warnings panel (Sect.6, Chap.12). The switches are set to close when the oil pressure falls below 20 lb/in<sup>2</sup>.

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## SERVICING

## ◀ WARNING

The relevant safety precautions detailed on the LETHAL WARNING marker card must always be observed before entering the cockpit or performing any operations upon the aircraft.

## Fuel contents gauges

## General

17. The indicators, amplifiers, junction boxes, and connectors should be examined periodically for signs of damage and insecurity. When making continuity checks or fault-location tests on the power supply circuits, reference should be made to the routing diagram in Sect.6, Chap.4.

## Functional tests

18. In addition to the normal operational and continuity checks, the following tests should be made at the intervals specified in A.P.101B-1001-4, or whenever any major component in the system has been repaired or renewed. The object of the tests is to ensure that the indicators give correct readings when the tanks are drained of fuel. It should be noted that the tests do not guarantee the accuracy of the system over the entire range. The port and starboard sections of the system should be checked separately, the test procedures being identical.

## Test procedure

## 19.

## Port tanks

(1) With the ventral tank removed,

rig the aircraft with all datums level (A.P.101B-1001-1A, Sect.2, Chap.4).

(2) Switch on the d.c. ground supply.

(3) Refuel the aircraft via the refuelling adapter, and check that the lamps on the refuelling panel indicate the 'tanks full' condition (A.P.101B-1001-1A, Sect.2, Chap.2).

(4) Fit a pressure gauge (0-30 lb/in<sup>2</sup>) to the test connection on No.1 low pressure cock (access panel 122P).

(5) Connect the hose of the ground refueller to the refuelling adapter (access panel 63P), and set the refuelling cocks to allow defuelling flow.

(6) Set the starboard wing defuelling cock to ISOLATE WING TANKS.

(7) Disconnect the d.c. ground supply.

(8) Connect an air supply (30-120 lb/in<sup>2</sup>) to the auxiliary air system ground supply connection (access panel 63P), and apply air pressure to defuel the port flap tank (time:- approx. 5 min). Shut off the air supply.

(9) Set the port wing defuelling cock to DEFUEL MAIN TANKS, and ensure that the engine control is set to H.P. COCKS CLOSED.

(10) Set the port fuel pumps switch to No.1 engine.

(11) Switch on the d.c. and a.c. ground supplies. Adjust the d.c. voltage to 28±0.5 volts.

(12) Defuel at a rate not exceeding 15 gal per min and when the fuel pressure

at the valve outlet test connection drops to 6.5 lb/in<sup>2</sup>, stop defuelling.

(13) With the PRESS TO TRIM push-switch in the BT 20-26 cable box depressed, adjust the trimmer in the JX 109 cable box until the indicator registers zero.

(14) Release the PRESS TO TRIM push-switch, and adjust the trimmer in the BT 20-26 cable box until the indicator again registers zero.

## Note...

*Owing to fuel settling, the trimming operations should be completed as rapidly as possible. The time limit for these operations is 1½ minutes.*

(15) Switch off the d.c. and a.c. ground supplies.

## Starboard tanks

(1) Repeat operations (1) to (15) of the port tanks test schedule, substituting 'starboard' for 'port' and vice versa, in the test instructions.

(2) Disconnect and remove all test equipment.

## Fault location tests

20. Faults on the d.c. supply system will affect the readings of both indicators, but a fault on an individual supply circuit, or on any component of the gauging system, will affect one indicator only. In the latter event, it is necessary to check the relevant section only of the system, i.e. port or starboard. The fault location procedure is described in A.P.112G-0725-1. When using the Type QAA test set, reference should be made to fig.2 which shows the ▶

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locations of the test points. A group of tables following these instructions gives details of all components of the system, their reference numbers and capacitance values, and the test set readings for the various point-to-point checks. As the test set will not record capacitance values below 50 pF the following method must be employed when checking at test points 3, 8, and 9.

(1) Disconnect the cable harness at the relevant test point.

(2) Connect a CR51 cable between the tank terminal and the socket on the test set.

(3) Connect the test set cable CE1 to the free end of the cable harness by means of the CC1 adapter.

(4) Connect the free end of cable CE1 to the test set.

(5) Rotate the test set variable capacitor until a value of, say 5 mA, is registered on the test set meter. Note the variable capacitor setting.

(6) Disconnect the cable CR51 from the test set and adjust the variable capacitor until the test set meter again registers the predetermined figure (5 mA). Note the variable capacitor

setting. The difference between the two variable capacitor settings is the theoretical capacitance at the test point given in Table 11.

*Insulation resistance tests*

**21.** Insulation resistance tests should be made at the intervals laid down in Vol.4 of this publication, or whenever the necessity arises. Units containing earthed components or capacitors which have a voltage rating lower than the megger test voltage must not be subjected to these tests, and may be regarded as serviceable if their test capacitances are within the specified tolerances.

**TABLE 1**  
**Fuel gauging equipment**

CODE	DESCRIPTION	NO. PER A/C	CODE	DESCRIPTION	NO. PER A/C	CODE	DESCRIPTION	NO. PER A/C
TB 217	Tank unit	2	CO 218	Rigid connector	1	CO 237	Rigid connector	1
TB 218	Tank unit	2	CO 219	Rigid connector	2	CO 238	Rigid connector	2
TB 219	Tank unit	2	CO 222	Rigid connector	1	CY	Corundite terminal	4
TB 220	Tank unit	2	CO 223	Rigid connector	1	CC4	Sealed coaxial connector	10
TB 221	Tank unit	2	CO 227	Rigid connector	4	JX 109	Cable box	2
TB 222	Tank unit	2	CO 228	Rigid connector	1	BT 20-26	Cable box	2
TB 223	Tank unit	2	CO 229	Rigid connector	1	FAB 18	Amplifier	2
TB 224	Tank unit	2	CO 230	Rigid connector	1	XA	Attachment bracket	2
TB 225	Tank unit	2	CO 231	Rigid connector	1	AG 127	Indicator	2
CO 152	Rigid connector	1	CO 232	Rigid connector	1	CG 6	Cable harness	2
CO 153	Rigid connector	1	CO 233	Rigid connector	1	CG 8	Cable harness	2
CO 157	Rigid connector	2	CO 234	Rigid connector	1	CS 134	Coaxial cable	2
CO 216	Rigid connector	2	CO 235	Rigid connector	1	CR 51	Coaxial cable	2
CO 217	Rigid connector	1	CO 236	Rigid connector	1			

**TABLE 2**  
Tank units

CODE	INITIAL CAPACITANCE (pF)	RANGE (pF)
TB 217	113 ± 3	114 ± 3
TB 218	56 ± 3	54 ± 3
TB 219	60 ± 3	59 ± 3
TB 220	190 ± 3	190 ± 3
TB 221	159 ± 3	153 ± 3
TB 222	146 ± 3	142 ± 3
TB 223	153 ± 3	149 ± 3
TB 224	160 ± 3	157 ± 3
TB 225	73 ± 3	74 ± 3

**TABLE 3**  
Tank terminals

CODE	CAPACITANCE
CY	9 ± 3 pF
CC4	5 ± 2 pF

**TABLE 4**  
Rigid connectors

CODE	CAPACITANCE (pF)
CO 152	62 ± 3
CO 153	62 ± 3
CO 157	48 ± 3
CO 216	26 ± 3
CO 217	49 ± 3
CO 218	49 ± 3
CO 219	114 ± 3
CO 222	59 ± 3
CO 223	59 ± 3
CO 227	-
CO 228	50 ± 3
CO 229	50 ± 3
CO 230	82 ± 3
CO 231	82 ± 3
CO 232	73 ± 3
CO 233	73 ± 3
CO 234	63 ± 3
CO 235	63 ± 3
CO 236	24 ± 3
CO 237	24 ± 3
CO 238	43 ± 3

**TABLE 5**  
Complete tanks with tank terminals

TANK	DRY, INSTALLED.	WET WITH UNUSABLE FUEL
Main tank (port or starboard)	1615 ± 62 pF	1649 ± 62 pF
Leading edge tank (port or starboard)	118 ± 5 pF	124 ± 5 pF
Outboard flap tank (port or starboard)	65 ± 5 pF	70 ± 5 pF
Inboard flap tank (port or starboard)	61 ± 5 pF	66 ± 5 pF

**Note...**

CO 227 connectors fitted in the flap tanks are in effect sections of straight wire, and therefore have no capacitance values.

**TABLE 6**  
Co-axial cables

CODE	LENGTH (IN)	CAPACITANCE (pF)
CR 51	51	$92 \pm 3$ pF
CS 134	134	$241 \pm 5$ pF

**TABLE 7**  
Co-axial cable harness

CODE	CAPACITANCE
CG6	$120 \pm 3$ pF
CG8	$207 \pm 5$ pF

**TABLE 8**  
Amplifier, FAB 18

CAPACITANCE		RANGE
TANKS EMPTY	TANKS FULL	500 pF
750 pF	1250 pF	

**TABLE 9A**  
Cable box, JX 109  
Tanks empty capacitance

INTO BOX AT INPUT SOCKET			OUT OF BOX
TRIMMER AT MIN.	NOMINAL VALUE	TRIMMER AT MAX.	509 pF
NOT LESS THAN 2424 pF	2322 pF	NOT MORE THAN 2220 pF	

**TABLE 9B**  
Cable box, JX 109

RANGE OUT OF BOX	RANGE INTO BOX
500 pF	$1143 \pm 11$ pF

**TABLE 10**  
Cable box, BT20-26

CAPACITANCE OF BOX WITH RELAY DE-ENERGIZED, MEASURED AT THE MAIN TANK SOCKET			CAPACITANCE OF BOX WITH RELAY ENERGIZED
TRIMMER AT MIN.	BOX INPUT NOMINAL VALUE	TRIMMER AT MAX.	$10 \pm 2$ pF
NOT MORE THAN 331 pF	346 pF	NOT LESS THAN 361 pF	

**Note...**

Before checking a JX 109 cable box, the trimmers must be adjusted to their nominal value (mid setting).

Range into, and out of, the box is the increase in capacitance above 2mA. It will be seen in Table 9A that the 'capacitance out of the box' value is the 'tanks empty' capacitance of the amplifier less the capacitance of the connecting cables.

**TABLE 11**  
**Test points**

TEST POINT	TEST CAPACITANCE (pF) (THEORETICAL)	TEST CAPACITANCE (pF) (ACTUAL)	ADAPTERS AND CABLES USED	APPROX READING ON	
				AIRCRAFT INDICATOR	TEST SET METER
1	509 ± 5	351 ± 10	CE1, CC1	Zero contents	2 mA
2	2322 ± 102	2172 ± 105	CE1	Zero contents	2 mA
3	124 ± 5		Refer to note (2)		
4	2194 ± 82	2036 ± 87	CE1, CC1	Zero contents	2 mA
5	448 ± 20	298 ± 23	CE1	Zero contents	2 mA
6	356 ± 17	198 ± 22	CE1, CC1	Zero contents	2 mA
7	346 ± 15	196 ± 18	CE1	Zero contents	2 mA
8	66 ± 5		Refer to note (2)		
9	70 ± 5		Refer to note (2)		

**Note...**

- (1) The theoretical capacitance values in Table 11 are those to be expected at the test points, whilst the actual values represent the settings of the variable capacitor of the test set.
- (2) Instructions for testing at points 3, 8, and 9, are given in para. 20. At the retaining test points, checks should be made in accordance with procedure described in A.P. 112G-0725-1. ▶

**TABLE 12**  
**Test set equipment**

ITEM	CODE	CAPACITANCE
Coaxial cable with connector fittings	CE1	150 ± 3 pF
Adapter	CC1	8 ± 2 pF

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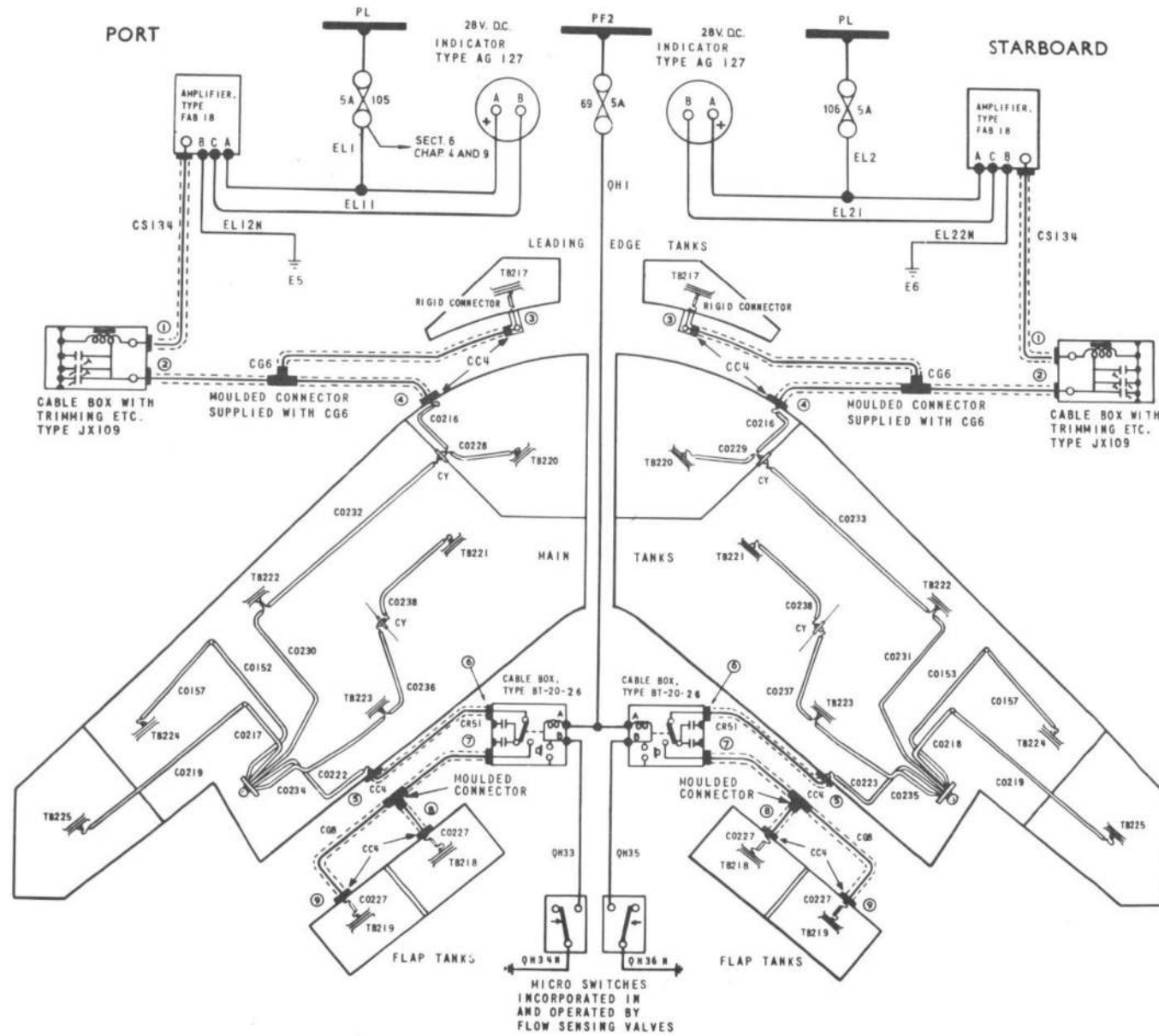


FIG. 2. FUEL CONTENTS GAUGE INSTALLATIONS

◀ MINOR AMENDMENTS ▶

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◀ **Jet pipe temperature system**

22. Servicing of the jet pipe temperature system is confined to periodic testing and calibration checking. Test equipment is available and should be used in accordance with the instructions laid down in A.P.112T series.

**Tachometers**

23. The components should be inspected periodically for signs of damage and insecurity. The interior surface of the indicator glass should be checked for signs of mist; this appears if the indicator sealing becomes defective.

**Note...**

*As the indicator is hermetically sealed and filled with inert gas, no attempt should be made to dismantle this component.*

**REMOVAL AND ASSEMBLY****Fuel contents gauges***Tank units*

24. Access to the tank units is via yellow-painted panels in the tank edges. The removal procedure is described in A.P.101B-1001-1A, Sect.4, Chap.2.

*Amplifiers*

25. These components are mounted on a metal chassis equipped with anti-vibration mountings, the whole being located on a back plate which is fastened to the fuselage wall. Removal is effected by operating the quick release device at the top of the amplifier and lifting it clear of the slot in the base of the back plate.

**Jet pipe temperature system***Thermocouples*

26. To renew a defective thermocouple,

remove the jet pipe (A.P.101B-1001-1A Sect.4, Chap.1) and disconnect the faulty thermocouple at the metal-clad junction box. Unlock the retaining nut at the top of the coupling housing, and withdraw the thermocouple.

**Note...**

*When installing a new thermocouple, the leads should never be shortened. Any spare cable length should be coiled and stowed safely.*

*Servo-potentiometers*

27. Remove panel 29S and release the retaining band on the body of the unit. Disconnect the plug and socket connections and withdraw the unit through the panel aperture.

**Note...**

*Servo-potentiometers are very delicate units and easily damaged. They should be handled with extreme care.*



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