GROUP 2.B

EXHAUST GAS THERMOMETER AND TOP TEMPERATURE CONTROL

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LIST OF ILLUSTRATIONS

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Introduction

1. This group contains a description of the engine exhaust gas thermometer and top temperature control installation of this aircraft, together with routeing and theoretical diagrams of the electrical circuits. A general description of the aircraft's instrument installation, will be found in Group 1.A, the removal of the instrument panels is covered in Group 1.B and the location of the instruments and their associated equipment is given in Group 1.C. Detailed information on the standard components used, together with their method of operation will be found in the relevant Air Publications quoted in Table 1.

Equipment employed

2. The principle components of the exhaust gas thermometer and top temperature control equipment employed in this aircraft are listed in Table 1, together with the appropriate Air Publications to which reference should be made for a description and the necessary servicing required to maintain them in an efficient condition.

DESCRIPTION

Exhaust gas thermometer and top temperature control (Code ET)

General

3. 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.

Exhaust gas thermometer

4. The exhaust gas thermometer is located on the centre instrument panel and gives a continuous indication of the

TABLE 1

Equipment Type and Air Publication reference

Equipment Type	Air Publication
Torque switch, Smiths EAP.2340	A.P.113D-1384-1
Exhaust gas thermometer, Type C Thermocouples Type B.9 Adjustable series resistor, Type FD.871	A.P.1275A, Vol.1, Sect.17
Top temperature magnetic amplifier, Type EC.1/3, EC.1/6 or A.133/1	A.P.4343E, Vol.1, Sect.12
Top temperature time switch, Type FHM/A/57	A.P.113D-1404-16
Override micro switch, Type C.1831Y, Mk.2	A.P.4343C, Vol.1, Book 1, Sect.2
Top temperature control switch, Single-pole, without centre-off Type No.3 (Ref.No.5CW/6429)	A.P.4343C, Vol.1, Book 1, Sect.1
Control relay, Type SM-5A-N25	A.P.4343C, Vol.1, Book 2, Sect.3
Test set, Ultra Type QE2230	A.P.120F-0202-1

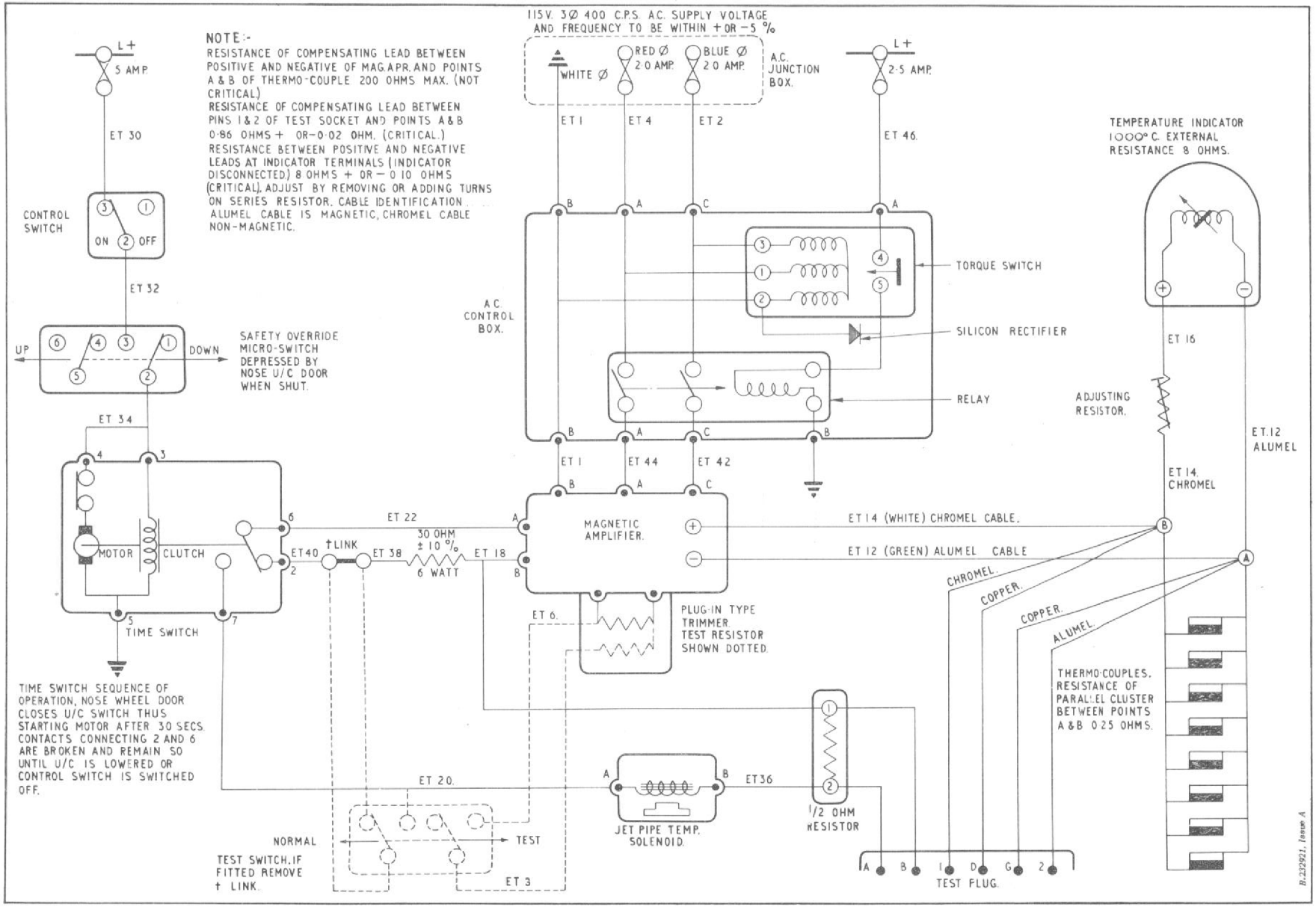

Fig.1 Exhaust gas thermometer and top temperature control (theoretical)

jet exhaust temperature from 0 to 1000 deg.C. The instrument is a moving coil millivoltmeter, which is actuated by eight thermocouples situated in the jet pipe, and the circuit incorporates a Sangamo Westor adjustable 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.

Top temperature control

5. 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 magnetic amplifier and a temperature trimmer resistor, both units being located at the top of the radio bay on the starboard side. The magnetic amplifier is used to amplify the output of the eight thermocouples located in the jet pipe. The a.c. supply to the amplifier is taken from the bus-bars of the a.c. supplies circuit *(Group E.1)*. The output from the amplifier is used to operate a solenoid operated valve which is incorporated in the engine fuel system.

6. On Pre Mod.417 aircraft the a.c. supply passes to an A.C. control box, via an A.C. junction box. On Post Mod.417 aircraft, however, the supply is fed to the A.C. control box via an A.C. junction box and an A.C. distribution box. The junction box is mounted aft of the cabin starboard shelf and the A.C. control box is mounted on the port side of the front fuselage at frame 17A in the radio bay above the radio sets, and contains a torque switch and relay, which control the a.c. supply to the magnetic amplifier. The A,C. distribution box is situated on the starboard side of the cabin aft of the pilot's seat being mounted on the upper surface of the longeron tie member at frame 13.

7. The installation is only operative when the aircraft is airborne, being overridden by a micro-switch, which controls a 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.

8. An ON-OFF cut-out switch is provided on the cabin port shelf to enable the installation to be rendered inoperative in flight should an emergency make this necessary.

9. 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

Power supply

10. The top temperature control installation employs both a.c. and d.c. The a.c. supply is fed to the magnetic amplifier from the phase bus-bars in the a.c. supplies circuit. This supply passes through fuses in the A.C. junction box, to a torque switch and relay in the A.C. control box.

11. When the output from the inverter supplying the a.c. supplies circuit builds up to 100 volts at the phase bus-bars, the torque switch in the control box will close its contacts 4 and 5 thus allowing a d.c. supply to energize the relay. With the relay energized the Red and Blue phase a.c. supply will pass through its made contacts to the magnetic amplifier, the White phase being the earth return. In this condition the amplifier is ready to commence operation when the time switch, which is controlled by the micro switch, completes its cycle.

Control of fuel flow

12. When the aircraft is airborne and the undercarriage is retracted, the nose wheel fairing door operates the micro switch breaking its contacts 1-2 and 4-5 and making contacts 3-2 and 6-5. A d.c. supply is now fed to energize the time switch via a fuse, contacts 3-2 of the jet pipe temperature control switch and contacts 3-2 of the micro switch. After the correct time sequence, the time switch will break contacts 6-2 and make 6-7, switching out the 30 ohm loading resistor and connecting the solenoid valve into circuit to render the top temperature control installation operative.

13. If the exhaust gas temperature, as measured by the thermocouples and fed to

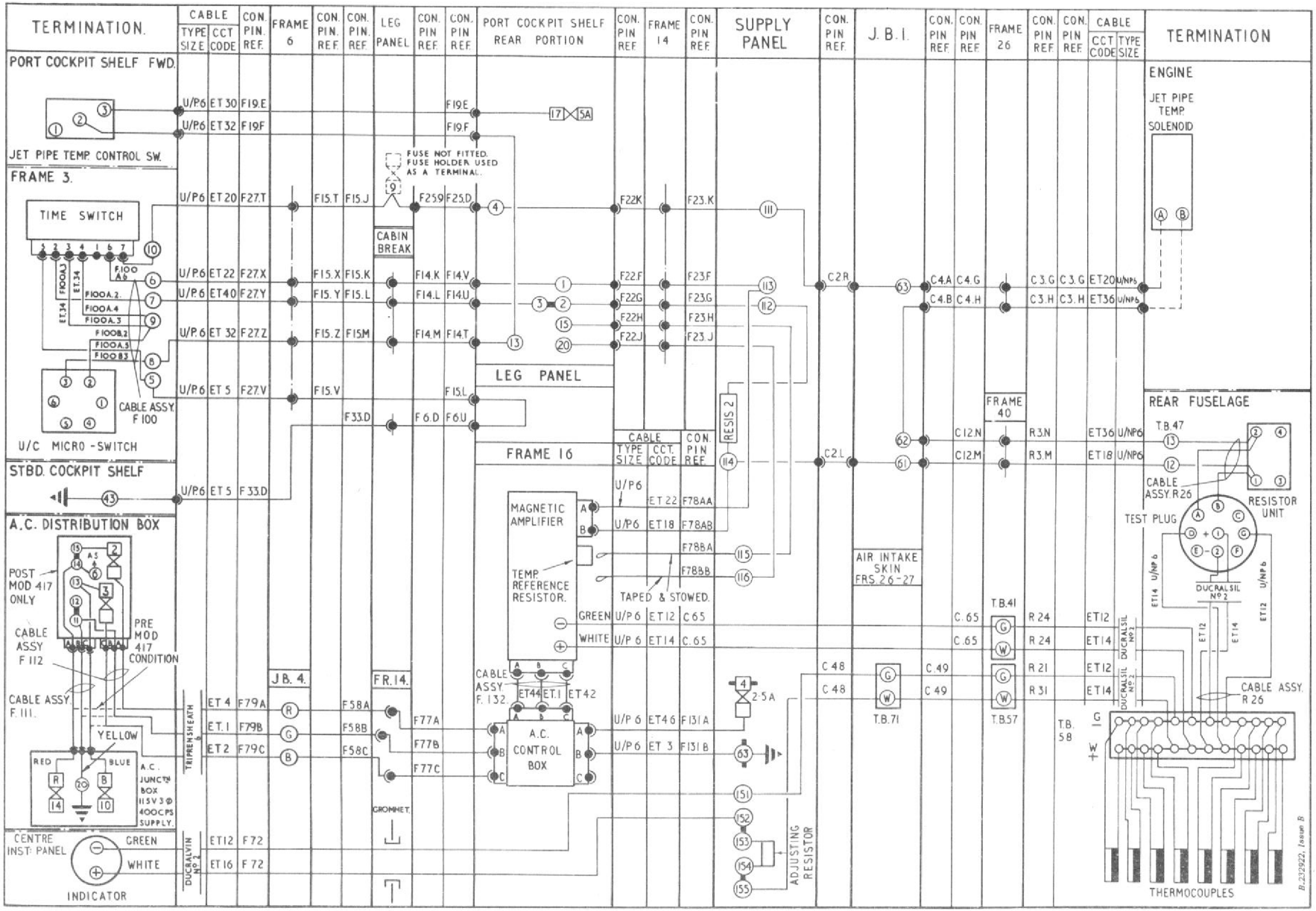

Fig.2 Exhaust gas thermometer and top temperature control (routeing)

RESTRICTED

the magnetic amplifier, rises above the permissible maximum, the amplifier will feed the solenoid-operated valve in the engine fuel system. The valve 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 from 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.

14. For a full description of the engine top temperature control equipment, together with the principle of operation, reference should be made to the Air Publications quoted in Table 1.

SERVICING

General

15. The servicing necessary to maintain the installation 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 is contained in the appropriate Air Publications quoted in para. 2. Before servicing or removing any components of the installation, the aircraft, must be rendered electrically safe, as described in Section 5, Chapter 1, Group A.1.

◀ Exhaust gas thermometer and top temperature control tests

16. These tests must only be carried out when the thermocouples are at normal ambient temperature, thus after an engine run, time must be given to allow them to cool, otherwise considerable error will occur in the readings. When carrying out the resistance tests (para.17) ensure that circuit or lead under test is isolated from associated circuitry which would influence the readings obtained.

17. Check that the resistance of the compensating lead between positive and negative of magnetic amplifier and points B and A respectively (fig.1) does not exceed 20 ohms. Check that the resistance of compensating lead between pins 1 and 2 of test socket and points B and A respectively is 0.86 ± 0.02 ohms. Disconnect the positive and negative terminals on the exhaust gas indicator and check the resistance of the external circuit (extension leads and thermocouples) which should be 8 ohms ± 0.10 ohms; if necessary adjust the series ballast resistor, connected into the positive (chromel) wire, by removing or adding turns of wire to the resistor spool. The resistance of the thermocouple cluster as measured between points A and B is 0.25 ohms.

18. The top temperature control system may be tested with the aircraft engine stationary by using test equipment, Type QE 2230. The thermocouple e.m.f. normally, dependent on the jet-pipe temperature, is simulated by the injection of a variable voltage, derived from test set QT 223, at the thermocouple commoning points. To prevent possible damage to the test set, the following precautions must be observed:-

(1) Before switching on the supply to the test set, the REHEAT/SPEED DATUM switch must be in the OFF (centre) position.

(2) When adjusting the DATUM TEMPERATURE scale, during temperature signal measurements, avoid running the associated potentiometer hard on to its limit stops.

(3) On completion of the tests, the galvanometer locking device should be returned to the CLAMP position, the relevant switches returned to their OFF positions, the TEMP. SIGNAL (COARSE and FINE) controls turned fully anticlockwise, and all cables disconnected and placed behind the hinged flap in the test set lid.

19. Prior to commencing tests on an aircraft installation the following tests should be applied to the test set to ensure that the internal batteries are serviceable:-

(1) To test the 23V reference source battery, set the TEMP. DATUM/OFF/TEMPERATURE DATUM & SIGNAL switch to the TEMPERATURE DATUM & SIGNAL position. Turn the TEST SELECTOR switch to the BATTERY position. Note the reading of METER 11 which should be in the green zone.

(2) To test the 5.4V temperature signal source battery, set the TEMP. DATUM OFF/TEMPERATURE DATUM & ▶

◀ SIGNAL switch to the TEMPERATURE DATUM & SIGNAL position. Turn the TEST SELECTOR switch to T/C RES. Turn the T/C HARNESS SELECTOR switch to position H. Depress the T/C RESIST. TEST key switch to the T/C RESIST. TEST position. Rotate the TEMP. SIGNAL, COARSE control slowly clockwise; with the COARSE control turned through approximately ¾ full travel, METER 11 should indicate full scale deflection.

20. Connect the test set QT 223 (plug labelled A/C TEST) to the aircraft test plug using test cable QY 2212. Remove the socket from the a.c. supply plug of the control system amplifier and substitute the socket, located on one of the two short leads from the Y-shaped junction of test cable QY 2216. Mate the remaining short lead from the Y-shaped junction with the socket previously connected to the amplifier a.c. supply plug. Connect the remaining socket of the test cable QY 2216 to the 4-hole plug (labelled PHASING) of the test set. Switch on the aircraft 115V, 400 Hz, 3 phase supply.

21. The following voltage, frequency and phasing tests provide an indication that the power supply to the temperature control system amplifier is correct. Allow 5 mins. to elapse, after switching on the supplies, before proceeding with the tests.

(1) Turn the TEST SELECTOR switch to C.P.S.

(2) Frequency is indicated on METER 1 The scale range is 380 to 420 Hz in steps of 10 Hz. The centre scale reading represents 400 Hz.

(3) The PHASING indicator lamp should be extinguished.

(4) Turn the TEST SELECTOR switch to VOLTS.

(5) Note the reading of METER 11. If the voltage is within the specified limits the meter reading should be within the BLUE ZONE.

(6) The PHASING indicator lamp should illuminate.

22. Disconnect and remove the test cable QY 2216 from the test circuit. Connect the aircraft supply lead to the a.c. supply plug of the control system amplifier.

23. If the resistance of the thermocouple harness has not been established (para.17) it may be done now by using the test set as follows:-

(1) Set the TEMP. SIGNAL, COARSE and FINE controls fully anti-clockwise.

(2) Rotate the T/C HARNESS SELECTOR switch to position G (inserts a standard resistance of 0.25 ohms).

(3) Rotate the TEST SELECTOR switch to T/C RES.

(4) Set the TEMP.DATUM/OFF/TEMPERATURE DATUM & SIGNAL switch to the TEMPERATURE DATUM & SIGNAL position. Ensure that the REHEAT/SPEED DATUM switch is in the centre position.

(5) Turn the TEMP.SIGNAL, COARSE control until the pointer of METER 11 coincides with the RED line.

(6) Depress the T/C RESIST TEST switch to the T/C RESIST TEST position.

(7) If the thermocouple harness resistance is correct, the position of the METER 11 pointer should still coincide with the RED line. With one open-circuit thermocouple, the fault is indicated by an increase in resistance of 0.0357 ohms which would result in a deviation of approximately 7.5 divisions from the RED line. Therefore readings of METER 11 in this region would indicate an unserviceable thermocouple. A meter reading in excess of this tolerance indicates a possible fault on the thermocouple cluster. It should be noted that as the meter readings indicate a voltage drop, firstly across the thermocouple harness and secondly across the standard resistor, a high reading of METER 11 indicates a probable short-circuited thermocouple, and conversely a low reading indicates a probable open-circuited thermocouple.

24. To carry out standing current, datum temperature and aircraft exhaust gas temperature indicator tests, proceed as follows:-

(1) Set the TEMP. SIGNAL, COARSE con- ▶

trol fully anti-clockwise and the FINE control to its mid-position (five complete turns from either limit stop).

(2) Adjust the side control knob to set the DATUM TEMPERATURE scale to the approximate datum temperature of the exhaust gas temperature control system (685 deg. C).

(3) Set the T/C HARNESS SELECTOR switch to position G.

(4) Rotate the TEST SELECTOR switch to the D.C. SOL. position.

(5) Set the METER 11 D.C. SOLENOID/A.C. ACTUATOR range switch to the ÷ 2 (0–400mA) range.

(6) With the nose wheel door microswitch made and retained in this position, and the aircraft jet pipe temperature control switch ON, the STANDING CURRENT, as indicated on METER 11 at this point, should not exceed 50mA.

(7) Set the galvanometer clamp to the FREE position and zero the pointer if necessary, using the adjusting knob.

(8) Set the TEMP.DATUM/OFF/TEMPERATURE DATUM & SIGNAL switch to the TEMPERATURE DATUM & SIGNAL position.

(9) Turn the TEMP. SIGNAL, COARSE control clockwise until METER 11 reads approximately the datum temperature output current (200mA).

Note . . .

When adjusting the COARSE control to obtain the datum temperature output current, an allowance must be made for the time lag. If allowance is not made, by careful setting of the COARSE control, 'overshoot' of output current will be experienced.

(10) Final adjustment of datum current may now be effected by the use of the TEMP. SIGNAL, FINE control.

(11) Depress the GALVO IN/SET UP key switch, momentarily, to the SET UP position and observe the deflection of the galvanometer needle. Adjust the DATUM TEMPERATURE scale to reduce the galvanometer reading, depressing the galvanometer key switch at frequent intervals to observe the effect on the galvanometer. When the galvanometer reading is within the eight divisions on either side of zero, the galvanometer key switch can be placed in the GALVO IN position.

Note . . .

For a galvanometer reading to the LEFT of the centre zero, the DATUM TEMPERATURE scale reading must be increased and when reading to the RIGHT the DATUM TEMPERATURE scale reading must be decreased.

(12) If the reading of METER 11 has fallen from the datum current set in sub-paras. (9) and (10), the correct datum current must be reset by adjustment of the TEMP. SIGNAL, FINE control.

(13) Make final adjustment to the DATUM TEMPERATURE scale to bring the galvanometer pointer to zero.

(14) Read off the datum temperature of the system from the DATUM TEMPERATURE scale; this reading should be 685 deg. C.

(15) If the DATUM TEMPERATURE scale is not within the specified limits, re-adjust the datum temperature trimming control on the amplifier until an acceptable figure is obtained. If this is not possible, the amplifier unit, selector unit, or the associated cables are at fault.

(16) Without altering any settings of the test set controls, check the reading of the aircraft exhaust gas temperature indicator. The reading on the indicator should agree (to within the limits given for the system) with the DATUM TEMPERATURE scale reading obtained in sub. para. (14) or (15).

(17) On completion of tests return the GALVO IN/SET UP key switch to the centre (OFF) position. Release nose undercarriage door micro-switch; carry out procedure detailed in para. 18 (3) and remove test set from aircraft.

REMOVAL AND ASSEMBLY

General

25. The removal of the instrument panel, which carries the exhaust gas thermometer is described in Group 1.B. Once access has been obtained, the removal of the remaining components should present no difficulties.