Cancelled, now AP 113F-0503-1

TRANSMITTER, ULTRA, TYPE T401/1

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LEADING PARTICULARS

Transmitter, Ultra, Type T401/1	*Ref. No. 5CZ/5722*
Overall dimensions	13 *in.* × $4\frac{1}{16}$ *in.* × $7\frac{3}{16}$ *in.*
Weight	$10\frac{1}{2}$ *lb.*

Introduction

1. Transmitter unit, Ultra, Type T401/1 (*fig.* 1.) forms part of the Throttle Control System, Ultra, Type B.A.P.3, described in A.P.4343K, Vol. 1, Sect. 1, Chap. 1. The transmitter unit comprises the following parts of the system :—

(1) Transmit synchro
(2) Governor amplifier
(3) Governor trim motor and potentiometer
(4) Positioner safety system
(5) Intermittent supply safety system (T401/2 only)

2. The transmitter synchro forms part of the basic throttle positioning system, and is connected mechanically to the pilot's control

lever. The governor amplifier, trim motor and potentiometer form part of an engine speed trim system, which, when governing is selected, applies a close-throttle signal to the positioner discriminator in the amplifier, Type A401/3, when the compressor speed exceeds preset datum

3. The transmitter unit also contains two safety circuits which prevent the throttle from moving in the event of a fault in the synchro stator system or a momentary interruption of the power supply. The positioner safety circuit isolates the throttle motor and causes a warning lamp to light if a short circuit or an open circuit occurs in the synchro stator system. The intermittent supply safety circuit, fitted to transmitters, Type T401/2 only, isolates the throttle motor and causes a warning lamp to light if the power supply to the positioner system is intemittent.

DESCRIPTION

4. The component parts of the transmitter unit are mounted on a light alloy chassis casting. On the front of the chassis are mounted three connectors two plugs and a socket. The two plugs connect the transmitter unit into the B.A.P.3 system. The remaining socket provides a number of test points. On the underside of the chassis are mounted two canisters, containing the governor amplifier, and the positioner and intermittent supply safety circuits. Also mounted on the underside of the chassis are the positioner safety relay and the intermittent supply safety relay (T401/2 only). The transmit synchro the governor trim motor and potentiometer and four preset potentiometers are mounted on the top of the chassis. Fig. 2 and 3 show the left-hand and right-hand views of the unit with the covers removed, and identify the above components.

5. The plugs of the transmitter unit are connected into the B.A.P.3 system as follows:—

T1 (16-pin) to amplifier unit
T2 (10-pin) to c.r.p.m. datum selector unit, trim indicator unit and safety relay unit.

In the circuit diagram of the transmitter unit (fig. 5) each external connection is prefixed with the plug number (e.g. 2.9, 1.13, 3.2 etc).

OPERATION

6. The principles of operation of the B.A.P.3 system are described in A.P.4343K, Vol. 1, Sect 1, Chap. 1.

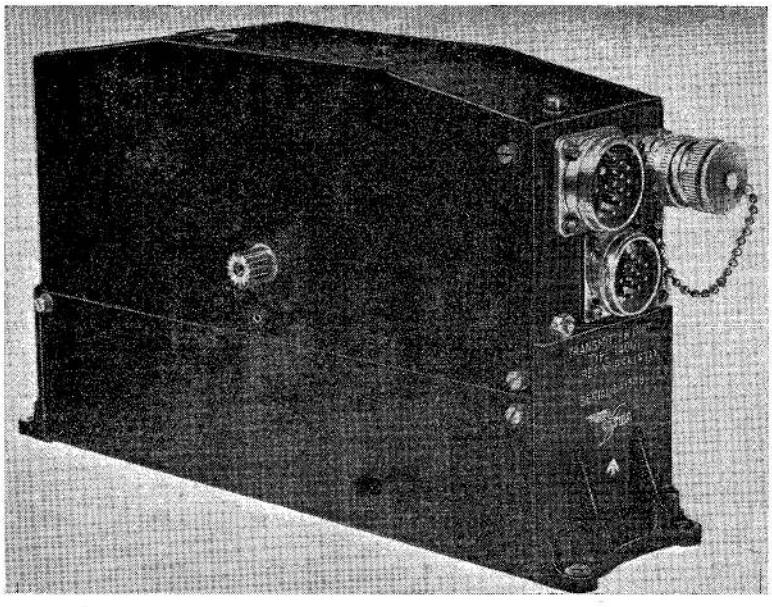

Fig. 1 Transmitter unit, Ultra, Type T401/1

CIRCUIT DESCRIPTION

7. The circuit diagram of the transmitter, Type T401/1 is illustrated in fig. 5. It will be seen that, apart from the transmit synchro, there are two main circuits in the transmitter namely, the governor channel and the positioner and intermittent supply safety circuits.

Transmitter synchro

8. The rotor of the transmitter synchro is fed with a 400 c/s supply derived from the power unit transformer in the amplifier, Type A401/3. The three stator windings of the synchro are connected to the corresponding windings of the throttle motor reset synchro stator as follows :—

(1) Blue phase	—	via pole 4 of plug 1
(2) Red phase	—	via C3 and pole 2 of plug 1
(3) Yellow phase	—	via C6 and pole 1 of plug 1

Governor channel

9. There are two signal inputs to the governor channel, both of which originate in the datum selector unit, Ultra, Type D401, described in A.P.4343K, Vol. 1, Sect. 6, Chap. 2. In the datum selector unit the tachogenerator signal is fed to two circuits, one resistive the other capacitive. As the output voltage and frequency of the tachogenerator vary linearly according to engine speed, the output of the resitive circuit will also vary linearly with engine speed. The level of the resitive output is set by preset potentiometers. The impedance of the capacitive circuit varies with the signal frequency, the attentuation of the input signal is, therefore, non-linear. Both output voltages are rectified to provide two d.c. voltages of a form illustrated in fig. 4.

10. The two voltages are applied, in opposition, to the input windings of transductor TD1 via poles 5, 6, 7 and 8 of plug 2. Thus at the datum speed, as selected at the datum selector unit, the two inputs are equal so no output appears from TD1. Any departure from the selected speed datum results in a d.c. error signal output, from TD1.

11. The output of TD2 is an a.c. signal the

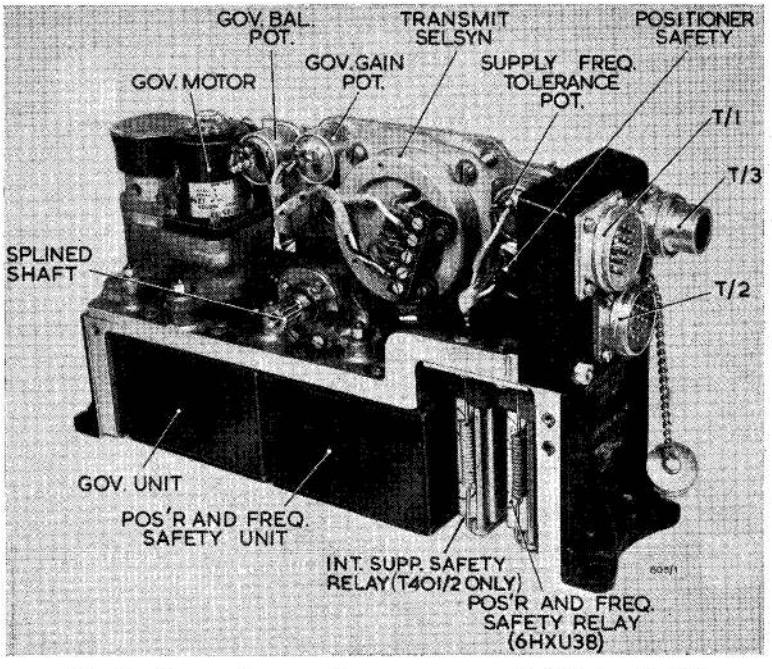

Fig. 2 Transmitter unit, cover removed (left-hand side)

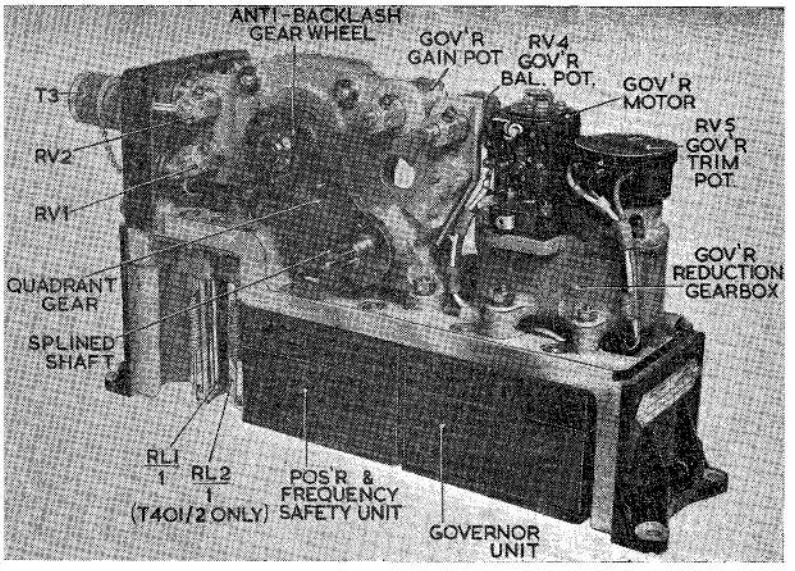

Fig. 3 Transmitter unit, cover removed (right-hand side)

magnitude and phase of which is proportional to the level and polarity of the output of TD1. This a.c. signal drives the governor trim motor IM1 in the appropriate direction. The motor shaft is connected, via a reduction gearbox, to the slider of potentiometer RV5. The potentiometer RV5 is fed from the power transformer in the amplifier, Type A401/3. When the engine speed exceeds the preselected datum, the trim motor turns thus moving the slider of RV5. The slider and one end of RV5 are connected to one input winding of the positioner discriminator transformer in the amplifier, Type A401/3 and the phase of the voltage on RV5 slider is such as to cause a shut signal to be applied to the positioner system. As a result, the throttle motor closes slightly, thus reducing the engine speed. At the same time, the movement of the throttle motor misaligns the synchro system, thus the synchro system is feeding an open throttle signal into the positioner; this signal being equal to the closing signal from RV5. In operation, the pilot adjusts his throttle lever, so that, when the engine is running at datum speed, a deflection of about one third full scale is shown on the trim indicator.

12. Potentiometer RV4 is connected across a balancing winding of TD1 and its slider is connected to the centre-tapped secondary of power transformer T1 in the positioner and frequency safety canister. RV4 is adjusted so that equal and opposite inputs to TD1 produce minimum output from TD2. The control winding of TD2 is connected, via RV3, to the output winding of TD1. The amplitude of the input applied to TD2 is controlled by RV3, which constitutes a gain control. A signal, derived from the output of TD1 is fed, via R11, R12 and C9 ,to a control winding of TD1 to provide transient negative feedback.

13. Transductor TD1 obtains its power supply from the secondary winding of power transformer T1 in the positioner and frequency safety canister. Transductor TD2 and the reference winding in the governor trim motor obtain their supplies from the power supply unit in amplifier, Type A401/3. This supply is fed into the transmitter on poles 6, 7 and 8 (centre-tap) of plug 1.

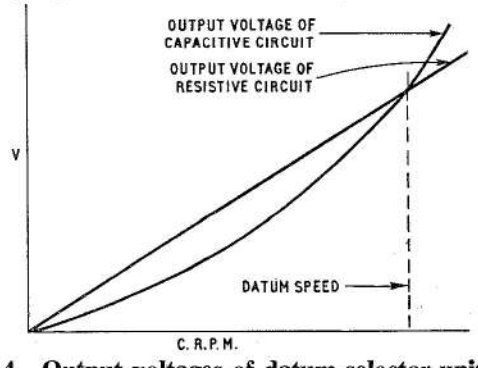

Fig. 4 Output voltages of datum selector unit

Positioner safety circuit

14. The a.c. supply which enters the transmitter on poles 6 and 7 of plug 1 is fed, via capacitor C1, to the bridge rectifier comprising MR12 and MR21. The resulting d.c. output is developed across RV2 and R4. R4 is in series with one of the lines between the transmitter synchro stator and the throttle motor reset synchro stator. C3 is connected in parallel with R4 and forms a low impedance path for the a.c. positioner signals. The two synchro stators are star connected thus a d.c. current flows in each of the stator lines. Resistor R5 is in series with a further stator line and therefore has a voltage developed in it, the d.c. component of which is proportional to the net d.c. current flowing in the synchro system. The network comprising R6, C6 and C7 shunts the a.c. component, i.e., the positioner signals, and the d.c. component is developed across the input winding of the positioner safety amplifier, **TD3.**

15. The effect of the positioner safety signal is offset, in TD3, by a balancing signal, derived from RV1, applied to a second input winding. RV1 is fed from the secondary winding of power transformer T1, via the full-wave rectifier MR11. RV1 is adjusted so that, under normal conditions, the output of TD3 is zero. A short or open circuit in the synchro stator system will result in a change in the d.c. current flowing through R5. The consequent unbalance of the two input signals to TD3 will result in an output from TD3, energising relay RL1. The contacts of RL1 are in series with the 150V 400 c/s supply, to the normal motor in the throttle motor, Type M174/1. This supply passes through the transmitter to the relay unit (pole 11 of plug 1 and pole 2 of plug 2) and back through the transmitter to the amplifier (pole 1 of plug 2 and pole 12 of plug 1). Occurrence of a fault in the synchro stator system, therefore, results in isolation of the normal control system. In addition, the failure warning relay in the relay unit, is de-energised and the failure warning lamp lights. The pilot then selects override operation of the throttle control system and thus maintains control of the engine.

Intermittent supply circuit

16. This circuit is not used in transmitters, Type T401/1. The intermittent supply safety relay, RL2, has been removed from transmitters of this type, although the remainder of the circuit components, C5 and MR13, are left in place. Transmitters Type T401/2 however, use this circuit. It will be seen, from fig. 5, that capacitor C5 and diode MR13 are connected in series across the d.c. supply derived from transformer T1 and the full wave rectifier MR11. When the 400 c/s supply is switched on C5 charges up, via MR13 and remains charged as long as the supply is maintained. When an intermittent supply fault occurs, C5 discharges through RL2 which is thereby energised. The normally open contacts of RL2 are connected across R71 in amplifier, Type A401/3. When RL2 is energised, R71 is short circuited and this unbalances the temperature safety amplifier. The temperature relay is thereby energised thus breaking the supply to the normal motor in a similar manner as previously described for the positioner safety system. A more complete description of the safety systems will be found in A.P.4343K, Vol. 1, Sect. 4, Chap. 1.

Tacho signal links

17. As described in para. 9, the output of the compressor driven tacho-generator is fed to the datum selector unit. The signal reaches this unit from the amplifier, Type A401/3, via links in the transmitter between poles 9 and 10 of plug 2 and poles 13 and 14 of plug 1.

SERVICING

Bench testing

18. The procedure for bench testing the transmitter, using the test set, Type QT4066 and ancillary equipment, is described in Appendix A.

Aircraft testing

19. Since it is not practicable to make accurate shaft angle measurements on an installed unit, comprehensive performance tests can only be done with the unit on a bench, using the bench test rig (see Appendix A).

20. Aircraft tests are performed with test equipment, Ultra, Type QE406. A description of this equipment, together with detailed test instructions, will be found in A.P.4343K, Vol. 1, Sect. 10, Chap. 3. Although the transmitter forms only a part of the B.A.P.3 system, the complete range of aircraft tests listed in Table3 of the above mentioned Chapter should be carried out after installation of the transmitter.

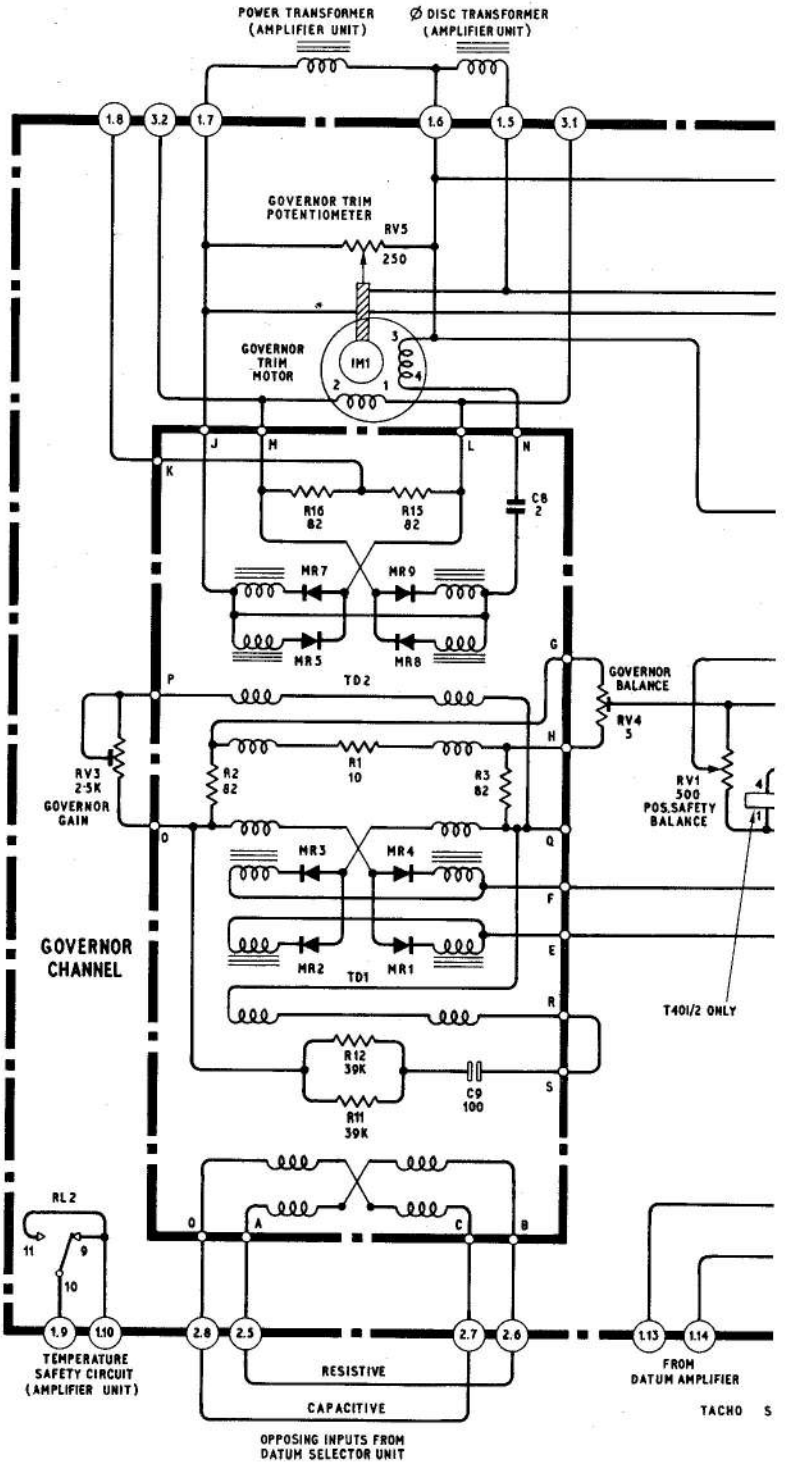

Fig.5 Transmitter Unit, l

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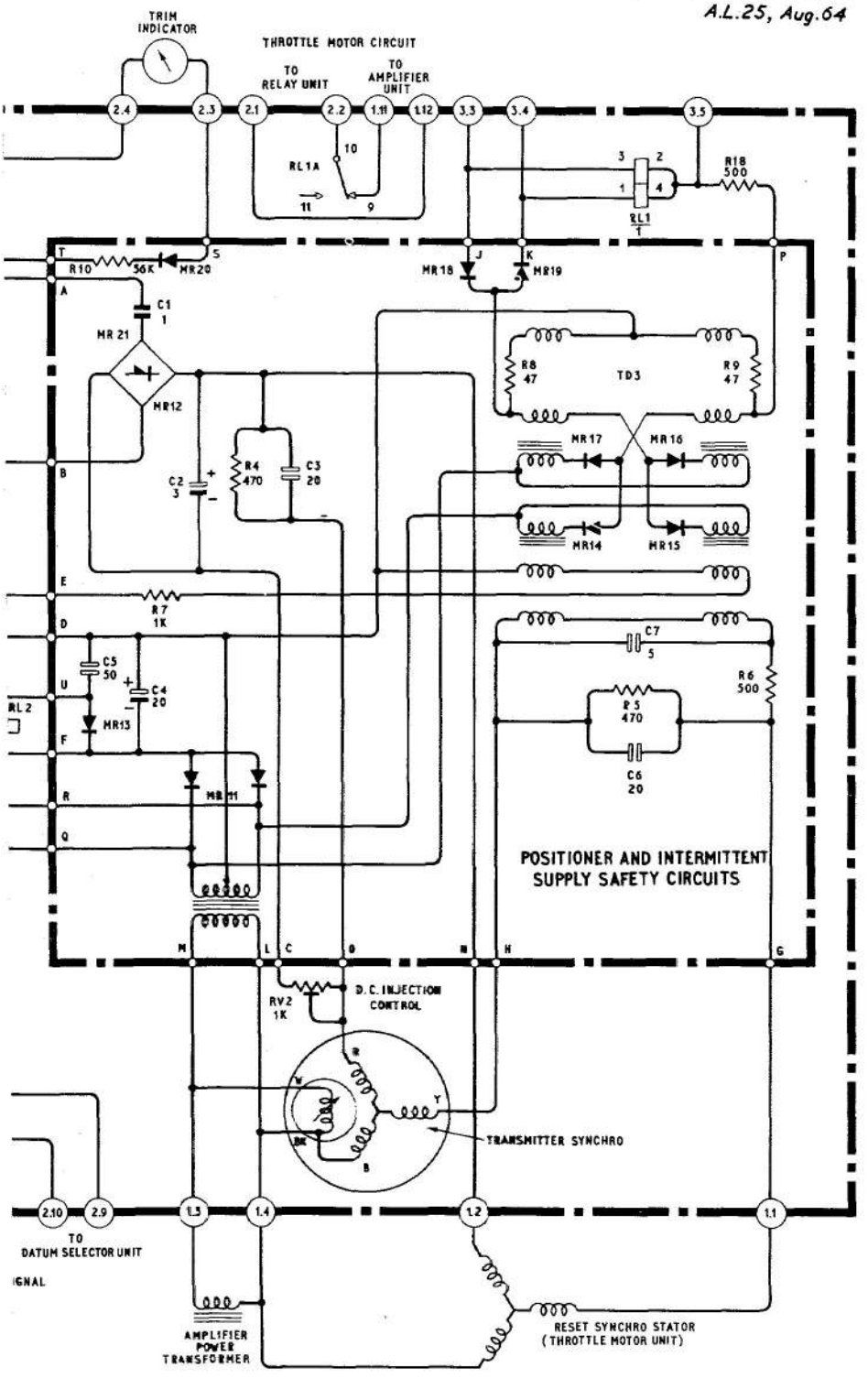
RES



Jltra, Type T401/1 – circuit

Fig. 5

TRICTED

Appendix A

STANDARD SERVICEABILITY TEST

FOR

TRANSMITTER, ULTRA, TYPE T401/1

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Introduction

1. The tests detailed in this Appendix may be applied to the unit before it is put into service, or at any time to determine its serviceability.

TEST EQUIPMENT

2. The following test equipment is required:—

(1) Test set, Ultra, Type QT4066

(2) Power amplifier, Ultra, Type QT4063

(3) Slave amplifier, Ultra, Type A401/3

(4) Slave throttle motor, Ultra, Type M174/1

(5) Mounting jig for throttle motor

(6) Mounting jig for transmitter

(7) Multimeter, Type 12889 (2-off)

(8) Insulation resistance tester (250V d.c.)

(9) Speed source, Ultra, Type Q2A8

(10) Engine speed indicator and starting switch

(11) Display unit, Ultra, Type D400

POWER SUPPLIES

3. The following power supplies are required:—

(1) 250V, 50 c/s capable of supplying a current of up to 5A.

(2) 28V, d.c. capable of supplying a current of up to 3A.

TEST PROCEDURE

Insulation resistance

4. Measure the insulation resistance between all plug pins (including plug 3) and the case of the transmitter using a multimeter, Type 12889 on the $\Omega \times 100$ range. The insulation resistance must be not less than 5MΩ. Repeat the test using a 250V d.c. insulation resistance tester; again, the insulation resistance must be not less than 5 MΩ.

Test connections

5. Secure the throttle motor and transmitter into their respective mounting jigs. Connect the transmitter, slave units and test equipment as shown in fig. 1. Switch on the power supplies as follows :—

(1) Set the AMLPIFIER RACK switch to STANDBY, and 2 minutes later, set the H.T. switch to ON.

(2) Adjust the voltage and frequency of the supply to 115V, 400 c/s.

(3) Ensure that the reading on METER 5 does not exceed 0·85A, that the warning lamp is not illuminated and that the trim indicator reads zero.

(4) Allow a 15 minute warming-up period.

Positioning

Zero alignment

6. (1) Using a torque of 6 lb. in., hold the transmitter shaft against the closed stop.

(2) After the throttle motor has come to rest, remove the DISCRIMINATOR I/P CURRENT link and connect the Multimeter, on the 2·5V a.c. range, between monitor points M.1.6. and M.1.7. The Multimeter reading must not exceed 0·15V. Replace the DISCRIMINATOR I/P CURRENT link.

(3) Depress the shorting switch between lines T.1.2 and T.1.4 and connect a shorting link between poles 3 and 4 of the transmitter test socket.

(4) Using the OVERRIDE control, set the throttle motor angle to approximately 15° then revert to NORMAL control. The angle taken up by the throttle motor is the zero angle and the protractor and pointer should be adjusted accordingly.

(5) Repeat the test in sub-para. (4) several times to ensure that the zero setting is accurate.

(6) Remove the short circuits made in sub-para.(3) set the transmitter angle so that the throttle motor angle is zero when the test in sub-para.(4) is repeated.

(7) Set the transmitter protractor and pointer to read zero at this angle, which should be obtained when the shaft is held against the closed stop by a torque of 6 lb. in.

Note . . .

It is not satisfactory to rely solely on the 6 lb. in. torque to set the transmitter zero.

Positioner sense

7. (1) Move the transmitter shaft smoothly from 0° to 70° and check that the throttle motor follows smoothly from 0° to 90°. Check that with the transmitter shaft held against the open stop, the transmitter angle is $70° \; -0° \; + \frac{1}{2}°$.

Linearity

8. (1) Connect the Multimeter, on the 10V a.c. range, between monitor points M.1.5 and M.1.6.

(2) Rotate the transmitter shaft to obtain a minimum reading on the Multimeter.

(3) When the throttle motor comes to rest, remove the DISCRIMINATOR I/P CURRENT link and switch the Multimeter to the 2·5V a.c. range.

(4) Set the transmitter shaft to obtain a final minimum reading on the Multimeter.

(5) The transmitter angle should be $29{\cdot}5° \pm 1°$.

(6) Repeat sub-para.(2) to (4) with the Multimeter connected between monitor points M.1.5 and M.1.7. The transmitter angle, at minimum Multimeter reading should be $57° \pm 1°$.

(7) Replace the DISCRIMINATOR I/P CURRENT link.

Governing

9. Unless otherwise stated, the transmitter angle should be set at 55° for the following test.

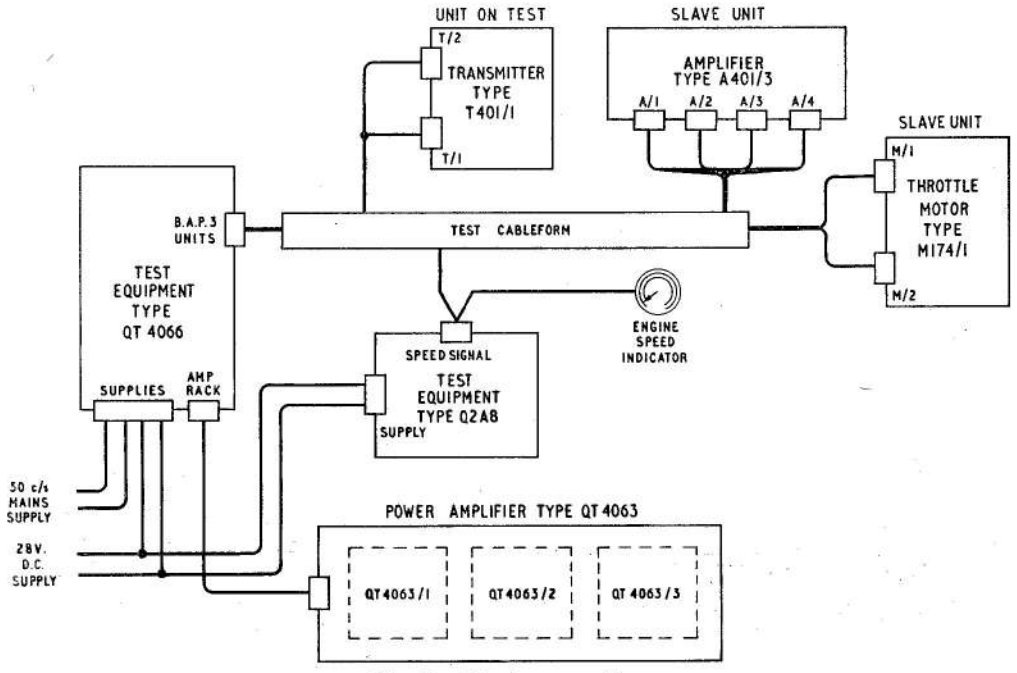

Fig. 1. Test connections

Governor balance—zero input

10. (1) Remove the GOVERNOR I/P link.

(2) Connect the Multimeter, on the 2·5V a.c. range, between poles 1 and 2 of the transmitter test socket. The reading must not exceed 0·2V.

Governor balance—balanced input

11. (1) Connect a Multimeter, on the 50μA d.c. range, between the GOVERNOR I/P sockets.

(2) Connect a further Multimeter, on the 2·5V a.c. range, between poles 1 and 2 of the transmitter test socket.

(3) Set the SELECT GOVERNING SIGNAL switch to SIMULATED and adjust the SET GOVERNOR I/P control to obtain a minimum reading on the Multimeter connected to the transmitter test socket.

(4) The reading on the other Multimeter should be within the limits -10μA to $+10\mu$A. Note the reading for future reference.

Note . . .

The GOVERNOR I/P Multimeter should be connected so that it gives a positive indication when the trim signal (indicated on D400) is increasing.

Governor sensitivity

12. (1) Reset the Multimeter, connected to the transmitter test socket, to the 10V a.c. range.

(2) Adjust the SET GOVERNOR I/P control to obtain a reading, on the GOVERNOR I/P CURRENT Multimeter, $+20\mu$A with respect to the reading obtained in sub-para. 11(4).

(3) The reading on the Multimeter connected to the transmitter test socket should be 1·1V $\pm$ 0·3V.

Governor sense, range and rate

13. (1) Adjust the SET GOVERNOR I/P control to obtain a reading on the GOVERNOR I/P CURRENT Multimeter, -20μA with respect to the reading obtained in sub-para. 11(4).

(2) When the trim indicator, on the Display Unit, Type D400, reads zero, open the throttle motor fully and note the throttle motor angle.

(3) Readjust the SET GOVERNOR I/P control to obtain a positive reading,

on the GOVERNOR I/P CURRENT Multimeter such that the Multimeter connected to the transmitter test socket reads 2V.

(4) Check that the trim indicator reading increases from zero to half full scale deflection (full trim) in a time of 80 sec. ± 20 sec.

(5) Check that the final throttle motor angle is 18·5° ± 2° less than that noted in sub-para.(2).

Governor signal

14. With full trim applied as described in sub-para. 13(3) and 13(4), check that the reading on a Multimeter, on the 100V a.c. range, connected between monitor points A. 2.E and A.2.F is 29V ± 3V.

Governor sense

15. (1) Set the SELECT GOVERNING SIGNAL switch to NORMAL and the R.P.M. GOV. switch, on the display unit, Type D400, to ON.

(2) Check that the governor trim motor is not rotating (an aperture in the transmitter case enables the trim motor shaft to be observed).

(3) Connect a Multimeter, on the 2·5V a.c. range, between poles 1 and 2 of the transmitter test socket. Check that the reading does not exceed 0·2V.

(4) Connect the speed signal cable, on the test cableform, to the speed signal socket on the left-hand equipment panel.

(5) Set the SUPPLY switch, on the control unit, Type QC2A80 to ON ; set the TACHO GENERATOR LOAD switch to NO LOAD ; set the SELECT METER TEST switch to ∅ 1 ; set the SPEED SIGNAL, COARSE control 45° from the fully counterclockwise position ; set the SPEED SIGNAL, FINE control fully counterclockwise.

(6) Depress the engine speed indicator START switch.

(7) Rotate the SPEED SIGNAL COARSE and FINE controls slowly clockwise to obtain an indicated speed of 12,000 c.r.p.m.

(8) Check that the governor motor runs in a clockwise direction, that the trim indicator reading increases and that the throttle motor angle decreases.

(9) Reduce the indicated speed to 10,000 c.r.p.m. and check that the governor motor reverses in direction, that the trim indicator reading decreases and that the throttle motor angle increases.

Safety circuits

Positioner safety balance

16. (1) Connect the Multimeter, on the 2·5V d.c. range, between poles 3 (–ve) and 4 of the transmitter test socket.

(2) Check that, with METERS 3 and 4 reading 400 c/s and 115V ± 1V respectively, the reading on the Multimeter is less than 0·05V.

Positioner safety

17. (1) Connect the Multimeter, on the 2·5V d.c. range, between poles 3 (–ve) and 4 of the transmitter test socket.

(2) Check that the warning lamp is illuminated when any one of the following shorting switches is depressed and check that, under these fault conditions, the Multimeter reading is not less than 0·45V.

(a) T.1.1.—T.1.2
(b) T.1.1—T.1.4
(c) T.1.2—T.1.4

(3) Remove the short circuits and lift the open-circuiting switches in lines T.1.1, T.1.2 and T.1.4. Check that the warning lamp is illuminated and that the reading on the Multimeter is not less than 0.45V.

Intermittent supply safety (T401/2 only)

18. (1) Using the NORMAL — OFF — OVERRIDE switch, interrupt the 115V, 400 c/s supply for a period of 0·1 sec.

(2) Check that the warning lamp is alight, and remains alight after reconnection of the supply.

(3) Unlatch the safety circuit by switching the 400 c/s supply off for a period of 2 to 3 sec. and then switching on again. Check that the warning lamp does not light.

Final check

19. Repeat the insulation tests detailed in para. 4. Switch off the supplies, disconnect the test equipment and replace the cap on the transmitter test plug.

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