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Chapter 10

AUTO-THROTTLE FIRST LINE TEST SET (SEA VIXEN)

LIST OF CONTENTS

	Para.
Introduction	1
Description	4
Principles of Operation	
Air speed tests	
Datum and gearing simulated signal	8
Air speed sensing tests	14
Pitch attitude tests	
Pitch attitude datum and gearing ...	17
Artificial horizon gyro signal sense	20
Servicing	
Introduction	23
Test equipment	24
Components	25
Power supplies	26
Preparation	27
Insulation resistance	
Test set	28
Cable harness	30
Functional tests	
Air speed control	31
TEST/CAPSULE switching ...	35
Air speed control phasing ...	37
Meter calibration (d.c. ranges)	
100-0-100 μA	39
500-0-500 μA	42
Reverse reading	43
Meter calibration (a.c. ranges)	
4*V r.m.s. range (throttle actuator)*	44
4*V r.m.s. range (Mag. Amp.)* ...	46
70*V r.m.s. range*	47
Pitch signal potentiometer	48
Final examination	50

LIST OF TABLES

	Table
Switch functions	1

LIST OF ILLUSTRATIONS

	Fig.
1st line test set complete with case and connectors	1
1st line test set (front view)	2
1st line test set (rear view cover removed)	3
Circuit diagram	4
Airspeed control phasing test circuit	5
Meter calibration test circuit ...	6

Introduction

1. The Sea-Vixen auto-throttle 1st line test set (fig. 1) Ref. No. 26FY/95399 is a portable unit which provides facilities for first line servicing of the units comprising the auto-throttle system.

2. The test set is connected into the auto-throttle system to simulate the output signals from the airspeed capsule and the pitch gyro and also embodies the facility to measure these signals. In addition, the test set may be used for checking the throttle servo amplifier output and the position feedback voltage.

3. For detailed information on the Sea-Vixen auto-throttle system reference

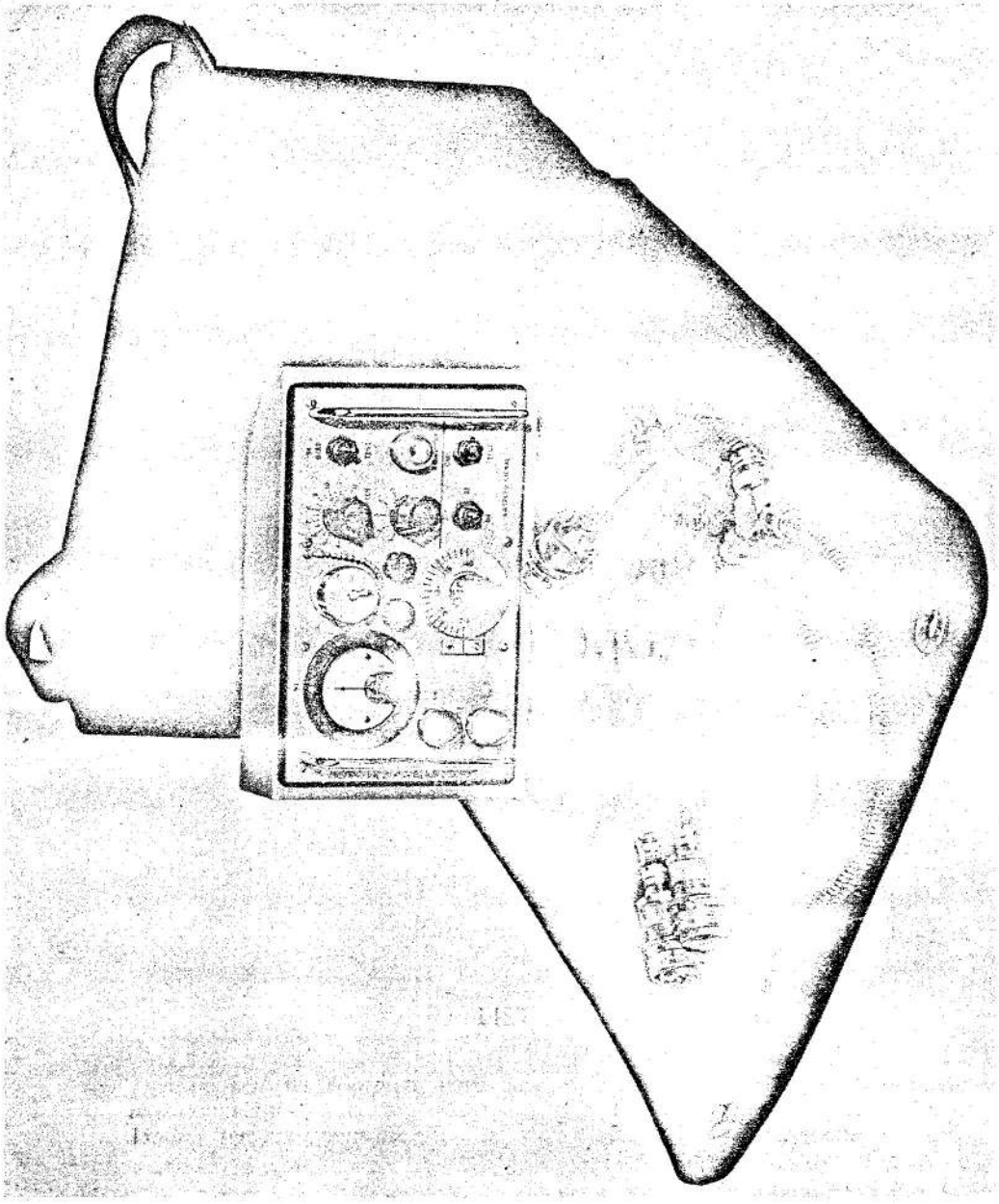

Fig. 1. 1st line test set complete with case and connectors

should be made to A.P.4343K, Vol. 1, Sect. 1.

DESCRIPTION

4. The test set comprises a front panel and two side chassis contained in an instrument case. The complete test set is housed in a canvas carrying case. A test lead is supplied with the test set and is housed in the upper compartment of the canvas case. The front panel and the two chassis embodies all the circuit components and is readily removable from the instrument case by withdrawing the eight securing screws from the periphery of the front panel.

5. The front panel carries one 100-0-100 micro-ammeter, three indicating lamps, two fuses, three toggle switches, one rotary switch, an air speed signal simulator and a pitch potentiometer. One

connector is mounted on the front panel and two handles are provided on each side of the front panel.

6. The overall dimensions of the unit including the carrying case are 18·75 in. × 11·25 in. × 6·5 in. and the total weight is 10·5 lb.

7. The power supplies for the test set is a nominal 28V d.c. and 115V 400 c/s, these being normally obtained from the aircraft supplies. The operating controls are all fitted to the front panel and their functions are summarized in Table 1.

ally with the output of the air speed datum pick-off contained in the actuator amplifier. Thus with the air speed control dial set at 130 knots, i.e. the Sea-Vixen datum air speed, the signal output from both pick-offs should be identical, so that no signal will be present at coil OP of magnetic amplifier 1 contained in the actuator amplifier. Consequently, since the amplifier output is at zero, the actuator will remain stationary and the position feedback signal derived from the actuator pick-off will also be at zero.

TABLE 1
Switch functions

Control	Type	Function
M1 RANGE (S1)	8-pole 5 way	Selects and attenuates the demand signal input to be measured by the meter.
ON-OFF (S2)	1-pole 2 way (toggle)	Switches the air speed pick-off and air speed datum signals through the test set.
CAPSULE/TEST (S3)	2-pole 2 way (toggle)	Selects either the test set air speed pick-off or the air speed datum signal.
GYRO/OFF/TEST (S4)	1-pole 3 way (toggle)	Selects either the external pitch signal source or the internal pitch signal potentiometer.

PRINCIPLES OF OPERATION

Air speed tests

Datum and gearing simulated signal (fig. 4)

8. The setting of the test set air speed control dial moves, via a mechanical gear train, the rotor of an a.c. pick-off to produce an electrical signal corresponding to the air speed figure selected on the control dial (120 knots—140 knots).

9. As shown in fig. 4, with S2 set in the ON position and switch S3 set in the TEST position, the test set air speed pick-off output is applied via pins B and C of PL1 to pins B and C of PL2 of the actuator amplifier and compared electric-

10. When the air speed control dial is set at a figure either above or below the datum (130 knots) however, a signal corresponding to a speed error from datum is applied to the actuator amplifier. The amplifier operates the actuator which, moving in a direction discriminated by the servo amplifier output, shifts the throttle linkage until both the positional and rate feedback signals back-off the speed error signal.

11. The positional feedback signal is applied to the test set via plug PL1, pins N and P and, with the M1 range switch set in position 1, is transformed by T2, via S1a and S1b, and rectified by the diode bridge X1, via S1c and S1d. The bridge output is applied to meter M1 via S1f and

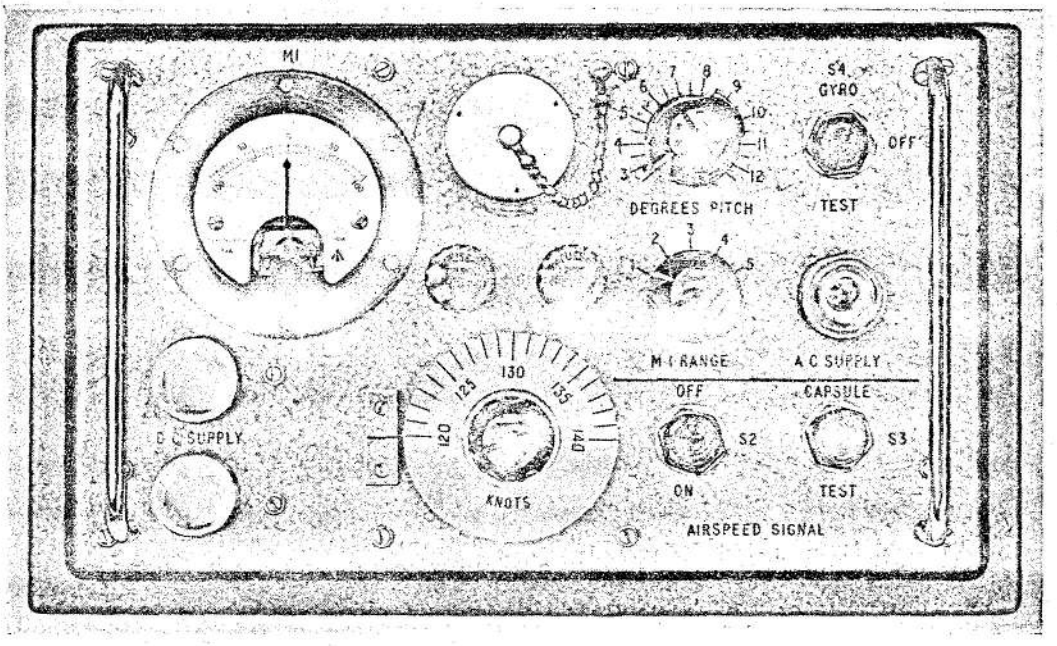

Fig. 2. 1st line test set (front view)

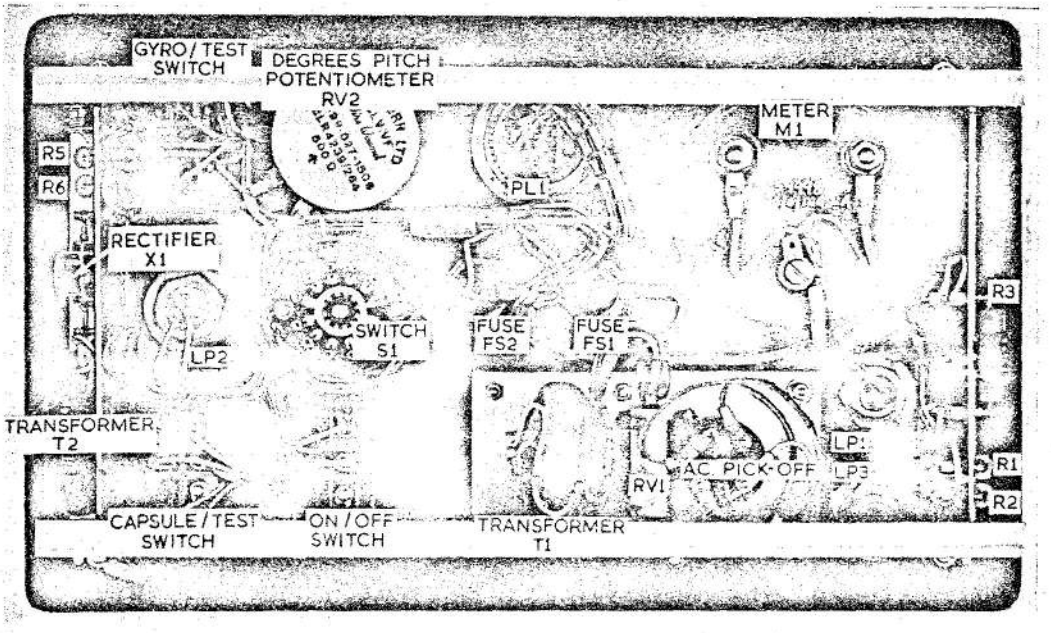

Fig. 3. 1st line test set (rear view, cover removed)

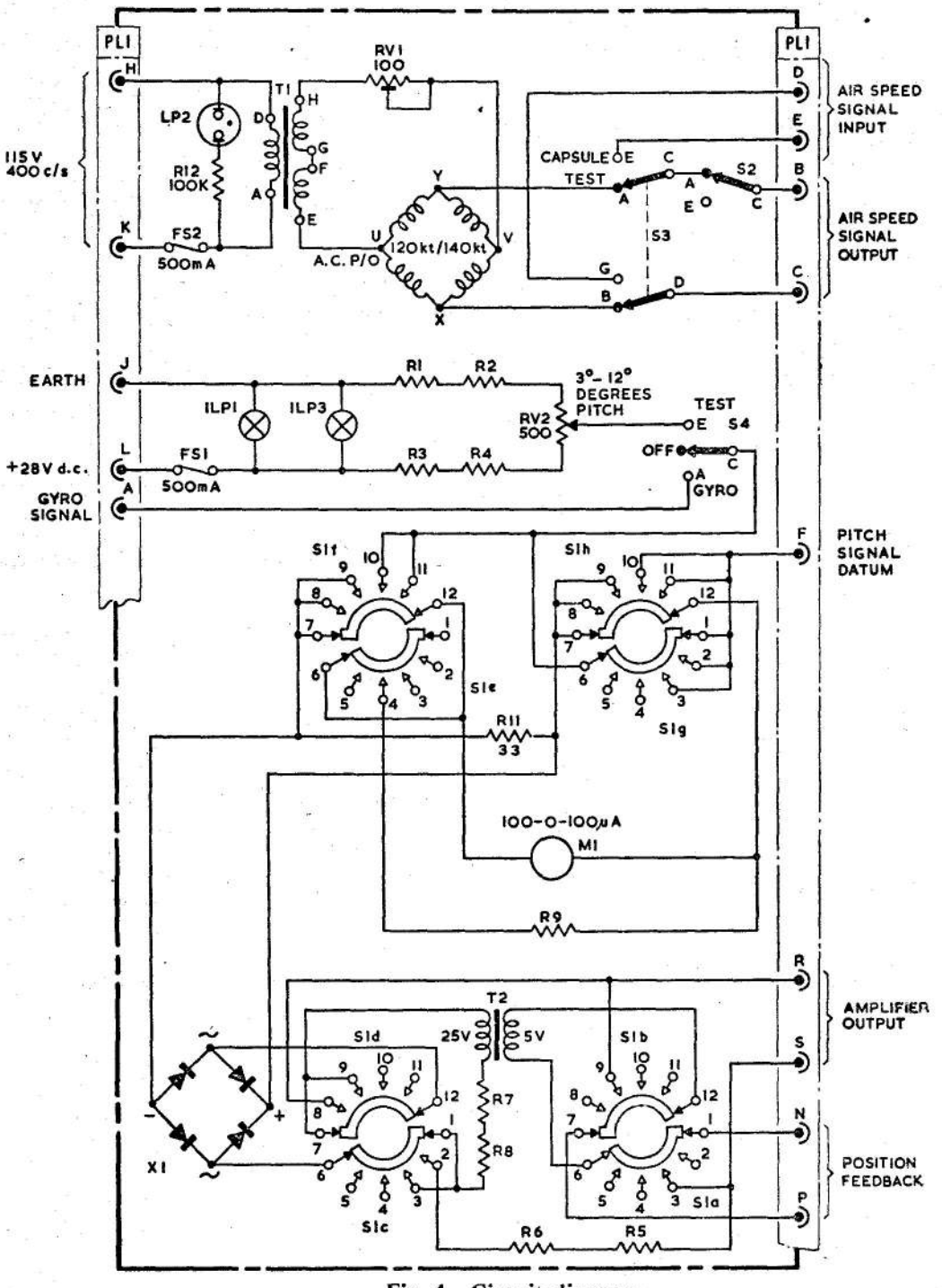

Fig. 4. Circuit diagram

S1h, which indicates the position feedback voltage being fed into Pins A and B of SK1(2) of the amplifier.

12. Thus with the following initial switch selections on the test set :—

(1) S1 to position 1.
(2) S2 to ON.
(3) S3 to TEST.
(4) S4 to OFF.
(5) 'Knots' dial to 130.

Note . . .

The Port throttle lever should be approximately mid-travel.

13. With the engage button in the cockpit pressed, the reading on meter M1 should not exceed 4 divisions. Adjusting the 'knots' dial to read 135, the meter M1 should read 15-25 divisions and the port throttle lever should move aft. Adjusting the 'knots' dial to read 125, the meter M1 should read 15-25 divisions and the Port throttle lever should move forward through the datum position. On resetting the knots dial to 130 the meter must not be greater than 4 divisions and the Port throttle lever should return to the datum position.

Air speed sensing

14. Any output from the a.c. pick-off of the air speed sensing unit is applied to the actuator amplifier via pins B and C of PL2 and compared electrically with the actuator amplifier air speed datum pick-off. Consequently, in a similar manner as described for the datum and gearing tests, variations of pitot pressure applied to capsule contained in the air speed datum and relay box will cause the actuator to move the throttle linkage and vary the positional and rate feedback signals.

15. When the test is in circuit the air-speed signal is applied via pins D and E of PL1 (test set) through switch S3 set in the CAPSULE position and on to the actuator amplifier via pins B and C of PL1. The test set meter M1 will indicate the speed error from datum in the terms of position feedback voltage. Thus, with the following initial switch selection on the test set : —

(1) S1 to position 1.
(2) S2 to ON.
(3) S3 to CAPSULE.
(4) S4 to OFF.
(5) 'Knots' dial to 130.

Connect a convenient source of pitot pressure to the starboard system pitot test point in the airbrake bay. Remove the blanking cap from the starboard system static point.

Note . . .

The port throttle lever should be approximately mid-travel.

16. Applying 130 knots, the reading on meter M1 must not exceed 6 divisions. Increasing the pitot pressure to 135 knots the meter M1 should read 15-25 divisions and the port throttle should move aft. Decreasing the applied pitot pressure to 125 knots, the meter M1 should read 15-25 divisions and the throttle lever moves forward through the datum position. Return applied pitot pressure to 130 knots and the port throttle lever should return to the datum position. Reduce the applied pitot pressure to zero and remove pitot tester.

Pitch attitude tests

Pitch attitude datum and gearing (fig. 4)

17. Normally, the pitch signal from the artificial horizon, Gyro Mk. 5 is applied to the actuator amplifier via pin A of PL2 (3) to coil AB of magnetic amplifier MA1 and compared electrically with the pitch datum signal derived from the speed trim switch. When the test set is connected into the system an additional pitch signal may be simulated by the test set potentiometer (RV2), this signal taken via switch 4 (TEST position) meter M1, and switch S1 (position 4 or 5) to pin F of PL1 and applied to the actuator amplifier at pin A of PL2 (3).

18. The wiper of RV2 may be adjusted by the 'DEGREES PITCH' knob (fig. 2) and it is arranged that with the setting at $7\frac{1}{2}$ degrees for the Mk. 1 and $5\frac{3}{4}$ degrees for the Mk. 2, i.e. the Sea-Vixen approach attitude, the applied signal will be identical to the attitude datum signal. Consequently, the actuator will remain stationary and the test set meter M1 will read approximately zero. Movement of

the DEGREES PITCH knob in either direction from the datum however, will cause the actuator to run in a direction such as to adjust the port throttle setting and will, in a similar manner as described in para. 16, result in a corresponding meter indication of the test set meter M1. Thus with the following initial switch selection on the test set :—

(1) S1 to position 1.
(2) S2 to OFF.
(3) S4 to TEST.
(4) DEGREES PITCH dial 7½ degrees.

Note . . .

The Port throttle lever should be approximately mid-travel.

19. With the engaged button in the cockpit pressed, the reading on meter M1 must not exceed 5 divisions. Adjusting the DEGREES PITCH dial to 12·5 degrees the meter M1 should read 20-30 divisions and the port throttle lever should move forward. On adjusting the DEGREES PITCH dial to 2·5 degrees the meter M1 should read 20-30 divisions and the port throttle lever should move aft through the datum position. On resetting the DEGREES PITCH dial to 7·5 degrees the meter M1 reading should not exceed 5 divisions and the port throttle lever should return to the datum position.

Artificial horizon gyro signal sense

20. An additional facility is incorporated in the test set to provide a means of monitoring the pitch signals while the aircrafts on test is in a static position either on land or at sea on an aircraft carrier. Thus with the following initial switch selection on the test set :—

(1) S1 to position 4.
(2) S2 to OFF.
(3) S4 to GYRO.
(4) 'DEGREES PITCH' dial to 9½.

Note . . .

The Port throttle should be approximately mid-travel.

21. On land, note that the port throttle lever should move aft. Set switch S4 to TEST and note that the port throttle lever returns to datum.

22. On the aircraft carrier, with the switch selections as above note that the port throttle movement is relative to the aircraft's pitching movement i.e., if the aircraft nose pitches up the throttle will move forward and if the aircraft nose moves down the throttle lever will move aft. Meter M1 will monitor the pitch signal output from the artificial horizon gyro potentiometer.

SERVICING

Introduction

23. The following test procedure should be carried out at regular intervals or whenever the serviceability of the test set is suspect.

Test equipment

24. The following test equipment is required :—

(1) A.C. valve voltmeter—accuracy of within one per cent of F.S.D. on the following ranges :—30mV, 0·3V, 10V and 100V r.m.s.

(2) D.C. valve voltmeter 0·25V, accuracy of within one per cent of F.S.D.

(3) Insulation resistance tester 500V Type A (5G/1621).

Components

25. The following components are required :—

(1) Capacitor 3μF ± 5 per cent reversible 15V working.

(2) Capacitor electrolytic 4μF 70V working—2 off.

(3) Resistor 470 ohm ± 1 per cent 0·5W.

(4) Resistor 100 kilohms ± 5 per cent 0·25W.

(5) Resistor 270 ohms ± 2 per cent 1·5W—2off.

(6) Resistor 68 ohms ± 5 per cent 1·5W—4 off.

(7) Resistor 25 kilohms ± 5 per cent 3W.

(8) Potentiometer 1 kilohm 1W.

(9) Potentiometer 100 kilohms 0·25W.

(10) Potentiometer 10 ohms 10W.

(11) Diodes silicon junction (Ferranti ZS30A)—4 off.

(12) Transformer 115V 400 c/s single phase input with a centre-tapped 11V output winding.

(13) Ammeter sub-standard 0-250 μA.

(14) Ammeter sub-standard 0-1mA.

(15) Ammeter 100-0-100 μA.

Power supplies

26. The following power supplies are required :—

(1) 115V 400 c/s single phase.

(2) 0-5V r.m.s. 400 c/s single phase variable supply.

(3) 0-5V d.c. supply.

(4) 0-75V r.m.s. 400 c/s single phase variable supply.

(5) 28V d.c. supply.

Preparation

27. Remove the lid from the unit and ensure that the sealing ring is serviceable. Examine the test set externally and internally for obvious signs of damage.

Insulation resistance

Test set

28. Connect a shorting link across the terminals of meter M1. Set switch S1 (meter M1 range switch) to position 2, set switch S2 to ON, set switch S3 to TEST and switch S4 to GYRO. Measure the resistance between each of the following isolated circuits and the chassis :—

Note . . .

PL1/J is connected to the front panel. PL1-A, B, D, E, H, N, P and R.

29. Check that in each case the insulation resistance as greater than 5 megohms when measured at 500V d.c. Remove the shorting link from meter M1.

Cable harness

30. The insulation resistance shall be measured between each of the following pins on the cable harness and between each of these pins and the metal casing of the connectors. In each case the insulation resistance should be not less than 5 megohms when measured at 500V d.c.

SK2—A, B, C, D, E, F, H, J, K, L, N, P, R and S.
PL1—D and F.

Functional tests

Air speed control

31. Set switch S2 to ON and switch S3 to TEST. Connect the 115V 400 c/s a.c. supply across pin H and K of PL1 on the test set and check that the A.C. SUPPLY lamp should light.

32. Connect the 3μF capacitor and the 470 ohms resistor in parallel across pins B and C of PL1 and connect the a.c. valve voltmeter across pins B and C of PL1.

33. Set the KNOTS dial to 130 and check that the valve voltmeter reading is not greater than 25mV r.m.s.

34. Set the KNOTS dial to 135 and then to 125 and check the valve voltmeter reading in each case reads 24·5 ± 2·5mV r.m.s.

TEST/CAPSULE switching

35. Connect a 0-5V r.m.s. a.c. variable supply across pins D and E in parallel with an a.c. valve voltmeter.

36. Adjust the a.c. supply until the a.c. valve voltmeter reads 1V r.m.s. Transfer the a.c. valve voltmeter from pins D and E to pins B and C. Set switch S2 to ON and switch S3 to CAPSULE. Check that the a.c. valve voltmeter reads 1V ± 0·1V r.m.s.

Air speed control phasing

37. Set the 'KNOTS' dial to 130, set switch S2 to ON and S3 to TEST. Connect the test circuit as shown in fig. 5 and connect the 115V supply across pins PL1/K and H.

38. Adjust the test circuit potentiometer RV1 until the test circuit meter M1 indicates zero. Increase the 'KNOTS' dial to 140 and note that the test circuit meter M1 indicates in a counter-clockwise direction. Disconnect the test circuit (fig. 5) from the test set.

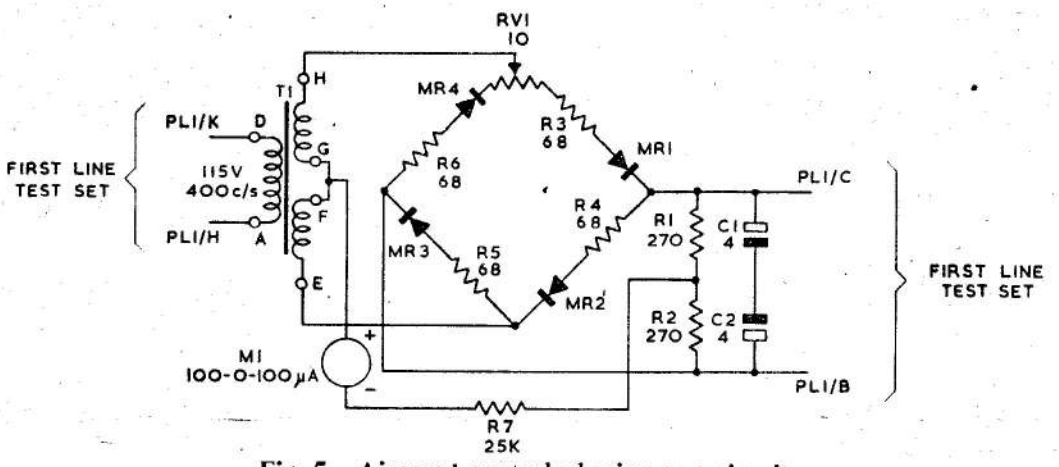

Fig. 5. Airspeed control phasing test circuit

Meter calibration (d.c. ranges)

100-0-100 *μA*

39. Set meter M1 range switch (S1) to position 5 and set switch S4 to GYRO and mechanically zero meter M1.

40. Connect the test circuit as shown in fig. 6 ensuring that the test circuit potentiometers RV1 and RV2 are adjusted to give minimum output on the test circuit meter.

41. The test circuit potentiometers should be adjusted to give in turn, each of the readings of meter M1 indicated below. For each setting, the test circuit meter should read within the limits indicated on the right hand column.

M1 (100-0-100)	Test circuit meter
0	0 ± 1 μA
50 clockwise	50 ± 4 μA
100 clockwise	100 ± 4 μA

The test circuit potentiometer RV2 should be adjusted until the test circuit meter indicates zero.

500-0-500 *μA*

42. Connect the test circuit as shown in fig. 6 using a 0-1mA meter in place of the 0·250 μA meter. Set M1 range switch (S1) to position 4 and switch S4 to the GYRO. Adjust potentiometer RV1 and RV2 of the test circuit to give, in turn, each of the readings of meter M1 indicated below. For each setting, the test circuit meter should read within the limits indicated in the right hand column.

M1 (100-0-100)	Test circuit meter
0	0 ± 1 μA
50 clockwise	250 ± 10 μA
100 clockwise	500 ± 10 μA

Adjust test circuit potentiometer RV2 until test circuit meter indicates zero.

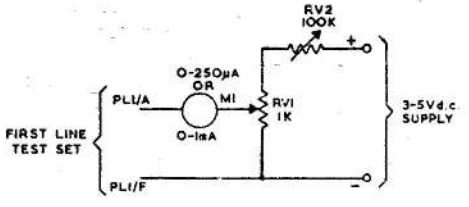

Fig. 6. Meter calibration test circuit

Reverse reading check

43. Reverse the terminals of the test circuit fig. 6 and still using the 0-1mA meter adjust potentiometer RV2 until the test set meter M1 reads, in turn, each of the readings indicated below. For each reading the test circuit meter should read within the limits indicated in the right hand column.

M1 (100-0-100)	Test circuit meter
0	0 ± 1 μA
50 counter-clockwise	250 ± 10 μA
100 counter-clockwise	500 ± 10 μA

Adjust test set potentiometer RV2 until test circuit reads zero and then disconnect test circuit from the test set.

Meter calibration (a.c. ranges)

4V r.m.s. range (throttle actuator)

44. Set the meter M1 range switch to position 1 and connect the 0-5V r.m.s. supply across PL1/N and P. Connect the a.c. valve voltmeter across PL1/N and P.

45. The a.c. supply should be adjusted to give, in turn, each of the readings of meter M1 indicated below. For each setting, the a.c. valve voltmeter should read within the limits indicated in the right hand column.

M1 (100-0-100)	Valve voltmeter reading
0	0 ± 0·04V r.m.s.
50 clockwise	2 ± 0·2V r.m.s.
100 clockwise	4 ± 0·2V r.m.s.

The a.c. supply should be adjusted until the valve voltmeter should read zero and then the a.c. supply and the valve voltmeter should be disconnected.

4V r.m.s. range (magnetic amplifier)

46 Connect the 0-5V r.m.s. a.c. supply and the a.c. valve voltmeter across PL1/R and PL1/S. Set the meter M1 range switch to position 3 and the a.c. supply should be adjusted until meter M1 reads 50 clockwise. The a.c. valve voltmeter should read 2 ± 0·2V r.m.s. Remove the valve-voltmeter and the a.c. supply from the test set.

70V r.m.s. range

47. Set the meter M1 range switch to position 2 and connect a 0-75V a.c. supply and an a.c. valve voltmeter across PL1/R and S. The 75V a.c. supply should be adjusted to give, in turn, each of the readings of meter M1 indicated below. For each setting, the a.c. valve voltmeter should read within the limits indicated in the right hand column.

M1 (100-0-100)	Valve voltmeter reading
0	0 ± 0·7V r.m.s.
50	35 ± 2V r.m.s.
100	70 ± 2V r.m.s.

The a.c. supply should be adjusted until the valve voltmeter reads zero and then the supply and the valve voltmeter should be removed from the test set.

Pitch signal potentiometer

48. Meter M1 range switch should be set to position 1 and switch S4 should be set to TEST. A 28V d.c. supply should be connected across PL1/J and PL1/L with PL1/L positive. Both d.c. supply indicator lamps should light.

49. A d.c. valve voltmeter should be connected across PL1/F and PL1/J with PL1/F positive. The 'DEGREES PITCH' control should be set, in turn, to the settings indicated below and the reading on the d.c. valve voltmeter should be within the limits stated below.

Setting of DEGREES PITCH control	Reading of valve voltmeter
2·5 degrees	14·0 ± 0·8V d.c.
7·5 degrees	17·5 ± 0·4V d.c.
12·5 degrees	21·0 ± 0·8V d.c.

Remove d.c. valve voltmeter and 28V d.c. supply.

Final examination

50. After completion of the functional testing, a visual check should be carried out to ensure that no external or internal damage has occurred.

Printed for H.M. Stationery Office by G F Wilson, Southampton No. 572342 930 91998 2/66 GFW8070