Chapter 2

SECONDARY LOW PRESSURE GOVERNOR, TYPE SLPG SERIES

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Introduction

1. The secondary low-pressure governor controls the maximum speed of the engine low-speed turbine. The unit houses a rocker-lever type amplifier valve which controls a half-ball valve. The rocker lever is balanced by a spring assembly and diaphragm housed in a governor chamber cover.

2. A typical type number (e.g. SLPG 1/1A) comprises the basic type designation (SLPG 1), followed by a stroke number (/1) which indicates the particular installation requirements, whilst the final letter (A) refers to the calibration schedule to which the unit must be adjusted and tested.

3. Scrupulous cleanliness is essential during the reconditioning operations and particularly when assembling the unit.

4. It is recommended that slave nuts, washers, connections and other such details are used where components are to be assembled temporarily.

5. All paper joint washers, gaskets, tab-washers and locking wire must be renewed.

6. Special tools

Tool No.	*Description*
G.63006	Jig, electrolimit comparator, orifice face.
G.76052	Setting gauge, governor tappet clearance
G.76053	Gauge holder, rocker lever tail lift
G.76054	Setting gauge, rocker lever pre-load
T.194287	Gauge stand, solenoid air gap
T.194289	Plug, electrical test indicator
T.196104	Base adapter, for gauge stand T.194287, solenoid air-gap
T.200725	Base adapter, servo valve leakage check
T.210194	Adapter, pressure drop test orifice strainer
T.265791	Adapter for hydraulic fixture, dismantling and assembling

DISMANTLING

General

7. In these instructions, the removal of the sub-assemblies is first described and is then followed in each case by the method of reducing the sub-assembly to its separate details.

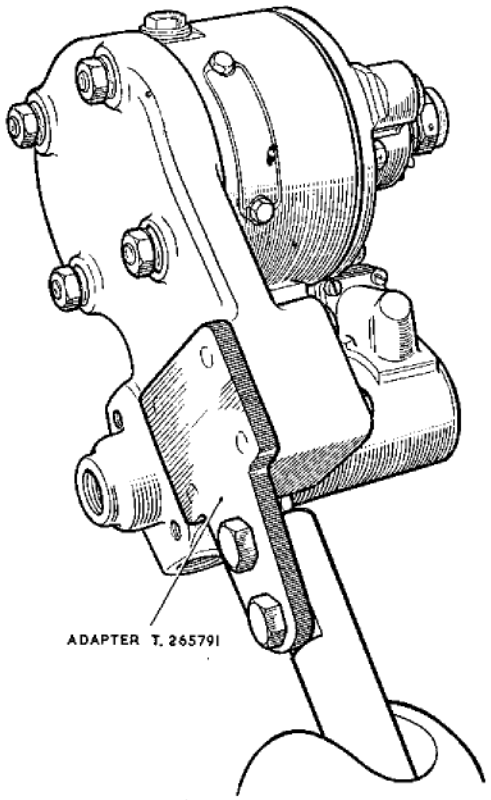

Fig. 1. Dismantling and assembling fixture

8. Mount the unit on the standard hydraulic fixture T.265791/H and the adapter T.265791 (*fig.* 1).

9. Remove and discard all locking wire from the unit with the exception f that on the electrical plug. Remove the dust cap from the centrifugal pressure connection on one side of the governor chamber cover and the seal drain plug and sealing washer from the other side. At the base of the governor chamber, ren ove dust caps from the return to pump inlet connection, the centrifugal make-up and pump servo connections, the plug and washer from the seal drain and the plug and washer from the alternative pump servo connection. On the solenoid valve housing remove dust caps from the servo inlet and servo outlet connections.

Servo valve

10. Remove the two nuts and washers and withdraw the solenoid valve assembly from its housing.

11. Remove the two setscrews from the base of the solenoid assembly whilst holding the orifice housing against the spring pressure. Lift off the orifice and housing and remove the half-ball valve.

12. Remove three sealing rings from the orifice housing one from each side of the seating flange and one from the groove round the base of the housing.

13. Unlock and unscrew the orifice from the housing and lift it out together with the tabwasher and shim.

14. Draw the armature and spring out of the solenoid then remove the spring from the armature. Remove the solenoid base and the sealing ring out from the bottom of the bore in the solenoid case. The electrical connection on the top of the solenoid case must not be disturbed.

Overspeed control

15. Remove the six nuts and plain washers from the studs and lift off the overspeed assembly. Remove the gasket and spacer plate from the joint face.

16. Remove the cap nut and the adjusting

screw; this will free the diaphragm and spring assembly which can then be lifted out.

17. Unlock and remove the large nut and then tap the spring anchor sleeve out of the housing with a hide hammer. Do not disturb the locating dowel. Remove the sealing rings from the adjusting screw and from the shoulder on the sleeve.

18. Remove the split pins and withdraw the clevis pins from the upper spring-anchor and the lower spring-anchor. On the other side of the diaphragm, bend down the tabs of the tabwasher, screw the tappet screw out of the spring anchor and remove the locknut from the screw. Press the spring anchor out of the diaphragm centre and remove the sealing ring. The diaphragm is a riveted assembly and must not be dismantled.

Amplifier valve

19. Bend down the tabs of the tabwashers, remove the two nuts and lift the rocker lever assembly out of the housing.

20. Unlock and remove the two nuts and bolts and lift the rocker lever off the torsion hinge. The half-ball valve will fall out when the lever is lifted away.

21. Bend down the tabs of the tab-washers, remove the two set screws and lift off the outer hinge plate, torsion hinge and inner hinge plate from the rocker lever and orifice mounting plate.

22. Bend down the tabs of the large tabwashers, release the locknut and screw the orifice assembly out of the mounting plate. Remove the sealing ring from the orifice body, then tap out the retaining pin and allow the strainer to fall out.

23. Remove the four nuts and washers from the studs securing the governor chamber to the base plate and detach the plate.

24. Turn the governor chamber over, bend down the tabwasher and remove the rocker lever tail stop and locknut from its housing. Remove the locknut and tabwasher from the tail stop. The housing is an interference fit in the body of the unit and must not be removed.

Cleaning

25. The components should now be thoroughly washed in kerosine; this does not apply to the solenoid and electrical connecting plug which must not be brought into contact with kerosine. Hard brushes, cloths and abrasives must not be used for cleaning.

26. After cleaning, the components should be dried thoroughly with compressed air and placed in clean dry containers.

INSPECTION

General

27. Parts which are subject to wear must be checked dimensionally and must be within the limits stated in Vol. 2, Part 2.

28. It is usual during inspection to reject any parts rendered redundant by modifications and therefore, complete information covering modifications must be at hand.

29. New consumable parts should be available for inspection with the main components.

30. In a case of suspected cracks or wherever there is the slightest doubt concerning the soundness of ferrous components they must be tested by means of approved magnetic crack detection equipment.

31. Inspect the drain plugs, adapters and unions for cleanliness and good general condition. Ensure that threads, joint faces and hexagon flats are not damaged.

Servo valve

32. Examine the solenoid case for dents which might indicate damage to the internal components. See that the cylinder in which the armature operates is free from corrosion and slide the armature up and down in the bore to check for freedom of movement. See that the armature is free from burrs and corrosion particularly in the seating recess for the half-ball.

33. Examine the spring for surface cracks and corrosion. The ends of the spring must be square and flat and the coils must be free from distortion.

34. Check the thread in the orifice housing for serviceability and see that all traces of the sealing rings have been removed.

35. Ensure that the solenoid base is not distorted and that the spring seating is unworn.

36. The half-ball valve must be polished with a chamois leather and the spherical and flat surfaces inspected for corrosion and pit marks. Also look for scratches on the face of the valves which have been caused by contact with the lands on the orifice.

37. The seating face of the half-ball valve must be checked with an optical flat glass gauge for flatness. Hold the glass gauge with the half-ball pressed lightly against it, preferably under a mercury fluorescent light. Slide it slowly across the glass whilst taking the reading. Not more than two colour bands must be seen, but first contact with the glass gauge will show many colour bands even with a good surface. Slight pressure, however, will give a true reading. The colour will be seen as two slightly curved bands across the surface, but when an unusually good surface is being checked the bands will be seen as a complete circle

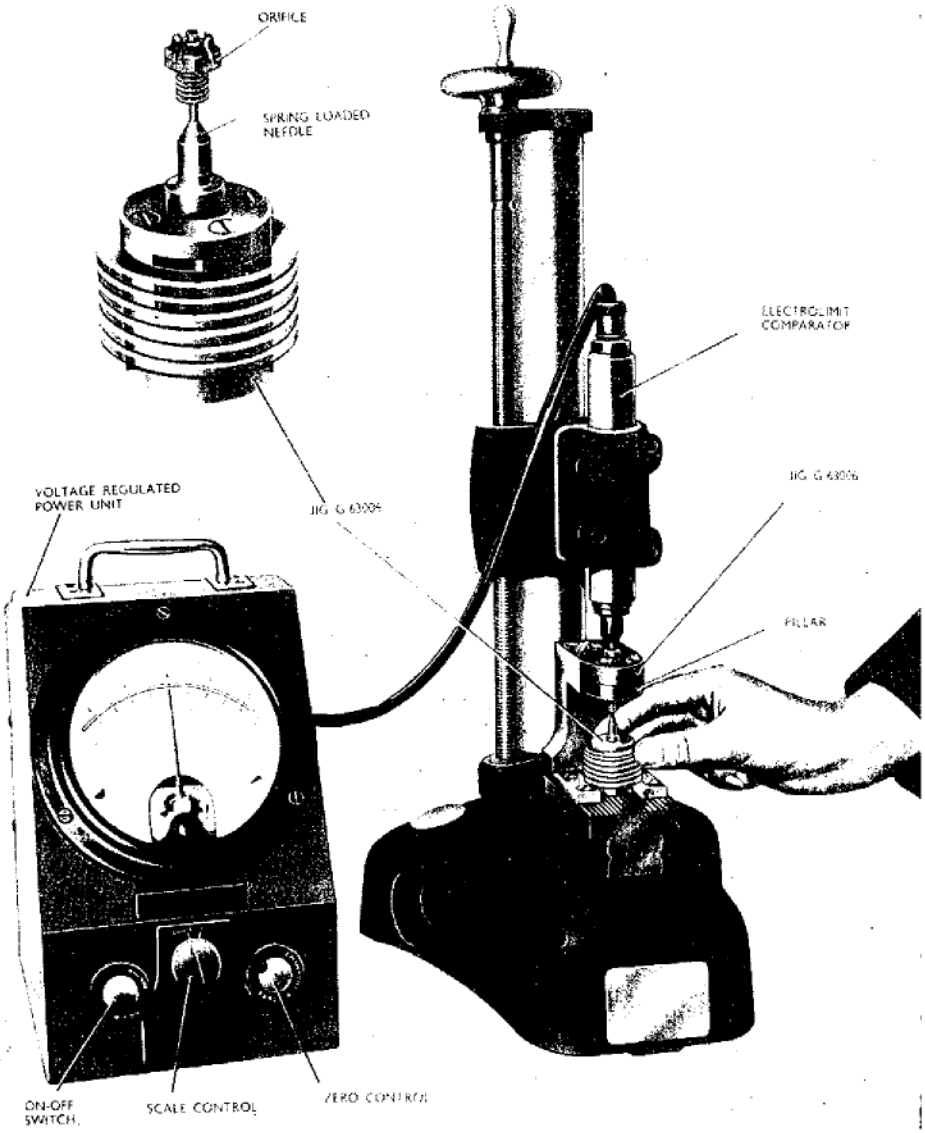

Fig. 2. Checking the orifice face

round the half-ball face. One colour band consists of four colours, i.e., red, yellow, green and blue.

38. Using a magnifying glass (X 25) examine the orifice faces for corrosion, pitting or scratches, and the edges of the lands for irregularity or crumbling. The bore of the orifice need not be centrally placed but its edges must be smooth and even.

39. Check the orifice face for flatness of the lands in relationship to each other by using an electrolimit comparator (*fig.* 2) or some similar instrument. To make the test, move the orifice in four directions at right angles to each other for two or three times. The maximum permissible error is $\pm$ 0·000002 in.

Overspeed control

40. Examine the cover and spacer plate for damage and see that the joint faces are in good condition.

41. Inspect the diaphragm for buckling or cracking and for indentations of the surface adjacent to the edge. Check the rivets for security.

42. Inspect the spring anchors for wear in the clevis-pin holes and for cracks around the fork lugs. Check the clevis pins for wear or corrosion.

43. Examine the tappet screw for wear and pitting on the head where it contacts the lever. Ensure that the threads of the screw and locknut are serviceable.

44. Inspect the governor spring for surface cracks and corrosion particularly round the attachment loops and see that the loops and coils are square and undistorted.

45. Examine the adjusting screw for scores and other surface damage on the underside of the flange. See that the thread is in good condition and that the square adjusting end is undamaged.

Amplifier valve

46. Examine the rocker lever for damage and corrosion, especially in the half-ball valve recess. Inspect the upper surface of the lever tail for wear by the tappet screw, and the spring seating in the lower surface for scores. Examine the torsion hinge and plates for cracks and distortion, also the setscrews and nuts and bolts for serviceability.

47. Inspect the mounting plate for corrosion and damage and check the large tapped hole which receives the orifice and the tapped holes which receive the torsion hinge securing setscrews for good condition of the threads.

48. Check the half-ball valve and the orifice as detailed in para. 36 to 39. Examine the orifice strainer for serviceability and see that the end-pieces are secure.

49. Ensure that the rocker lever tail stop is not worn and that the thread is serviceable. The return spring must be free from corrosion, cracks and distortion

Body

50. Inspect the housing for damage to the seating faces and studs. See that the joint faces are in good condition and that all sealing ring grooves are clean. See that the rocker lever tail stop housing is in good condition and is not loose in the body.

REPLACEMENTS

Servo valve

51. All parts of the servo valve assembly are interchangeable. The renewal of any part will, however, necessitate re-setting the solenoid air gap.

52. The solenoid case and electrical connecting plug cannot be dismantled and it must be replaced complete. If the winding or electrical connecting plug show an electrical fault, the assembly must be renewed.

Overspeed control

53. The overspeed control assembly can be supplied as a built-up assembly, but all the parts are separately interchangeable. The diaphragm assembly is riveted together and must not be separated.

Amplifier valve

54. This is supplied as a built-up assembly but all the parts are separately interchangeable. It is recommended that the torsion hinge is renewed if it has been disturbed.

Body

55. The rocker-lever tail stop housing is an interference fit in the body and must not be removed. If it is damaged the casting must be renewed.

56. Loose or damaged studs must not be renewed, and the body must be considered unserviceable.

Remaining items

57. All parts not mentioned are separately interchangeable but a check must be made on the fit of any new parts to ensure that they conform to the tolerances allowed.

ASSEMBLING

58. Assembling should be carried out with the unit mounted on the assembling fixture T.265791/H (*fig.* 1).

Amplifier valve

59. Before rebuilding the rocker lever and orifice assembly the strainer must be subjected to a pressure drop test. Fit the strainer to the adapter T.210194 (*fig.* 3) and connect to the adapter a fuel supply line and a pressure gauge. Apply a flow of 50 gallons per hour. The indicated pressure drop must not exceed 8 lb. per sq. in. If this is exceeded the strainer must be renewed and again tested before being fitted.

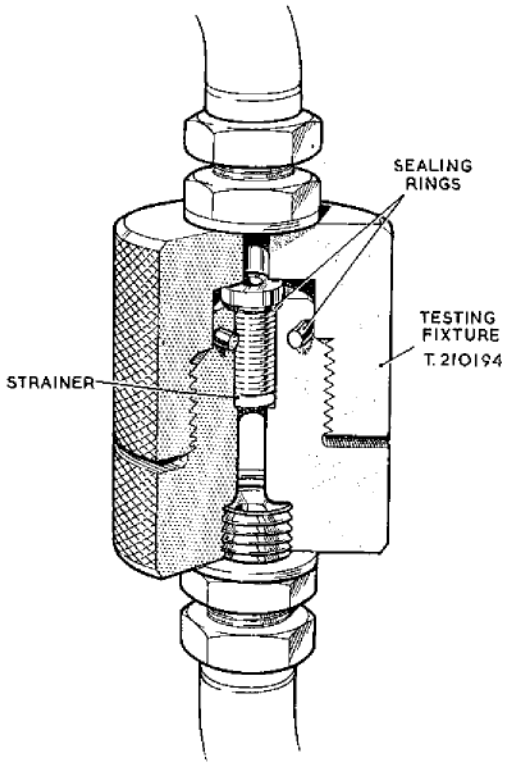

Fig. 3. Testing the strainer

60. Insert the strainer in the orifice body and secure it with the retaining pin then assemble the sealing ring to the groove round the orifice body. Screw the assembly into the mounting plate and fit a tabwasher and locknut but do not lock it at this stage.

61. Secure the torsion hinge to the rocker lever with two nuts and bolts with tabwashers beneath the bolt heads. Fit the lever and torsion hinge assembly on to the rocker lever and orifice mounting plate, with a hinge plate on either side of the hinge. Secure the components with two setscrews and tabwashers. Turn the assembly over, insert the half-ball valve in the rocker lever recess, screw the orifice up so that the half-ball just makes contact with the orifice face and then screw down the locknut on the orifice body finger-tight only.

Setting the rocker lever pre-load

62. Locate the rocker lever assembly on the setting gauge G.76054 (*fig.* 4) and tighten the two knurled screws. Move the dial test indicator until the needle rests on the rocker lever immediately above the orifice then lock it in this position. With the lever in free suspension set the dial test indicator to zero. By means of the key provided on the fixture, screw the orifice in to make contact with the half-ball valve and then screw in further until the gauge reads 0·001 in. Tighten the locknut on the orifice body, making sure that the setting is not disturbed, lock the tab-washer and check the setting. Remove the assembly from the gauge and record the setting.

Fitting the amplifier valve to the unit

63. Fit the adjusting screw, locknut and tabwasher to the rocker lever tail stop housing but do not lock it at this stage. Turn the housing upright and place the helical spring over the centre of the rocker lever tail stop housing. Lower the rocker lever assembly over the studs in the housing and secure with two tabwashers and nuts; do not lock the tabwashers.

Checking the rocker lever tail lift

64. Assemble the dial test indicator and holder G.76053 (*fig.* 5) to the housing and face with the foot of the indicator resting on the rocker lever tail. Set the indicator to zero then press the tail end of the rocker

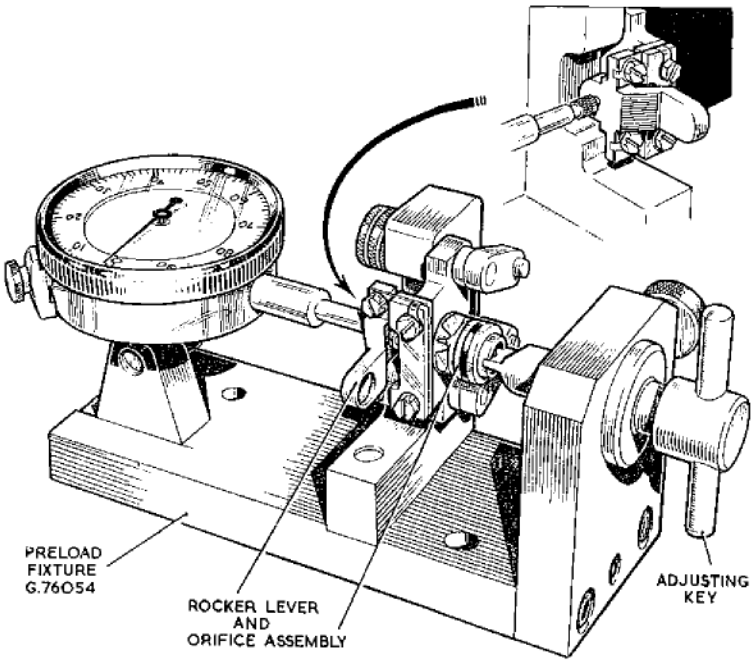

Fig. 4. Pre-loading the rocker lever

lever down fully and note the reading on the dial test indicator. Adjust the stop screw in the rocker lever tail stop housing to obtain a movement of 0·025 to 0·040 in. When satisfactory, tighten the stop screw locknut, check the setting and bend up the tabwasher.

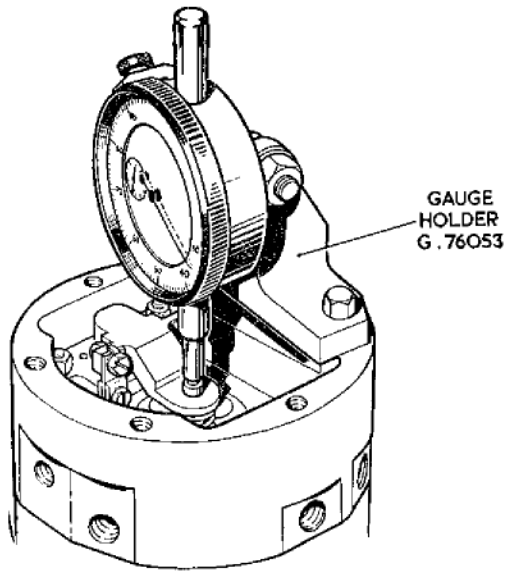

Fig. 5. Checking the rocker lever tail lift

Overspeed control

65. Insert the spring anchor sleeve and sealing ring in to the overspeed assembly housing taking care to locate it on the dowel in the housing and to see that it seats correctly. Place a sealing ring in the groove behind the flange of the diaphragm anchor and fit the tappet screw, tabwasher and locknut to the anchor. Insert the anchor into the diaphragm centre plate and fit the spring loop and link pin to the anchor fork. Place a plain washer over the end of the pin and insert a split pin. Secure the opposite end of the spring to the other anchor in a similar manner. Ease a sealing ring into the groove round the top of the spring anchor sleeve and lower the diaphragm and spring assembly into the cover, locating the upper square spring anchor in the square bore of the anchor sleeve. Screw the adjusting screw into the spring anchor from outside the housing and fit a tabwasher, locknut and cap nut to the threaded end of the spring anchor sleeve which protrudes through the top of the housing.

Setting the governor tappet clearance

66. Assemble the gasket and spacer plate to the overspeed housing and diaphragm and secure them to the top face of the gauge

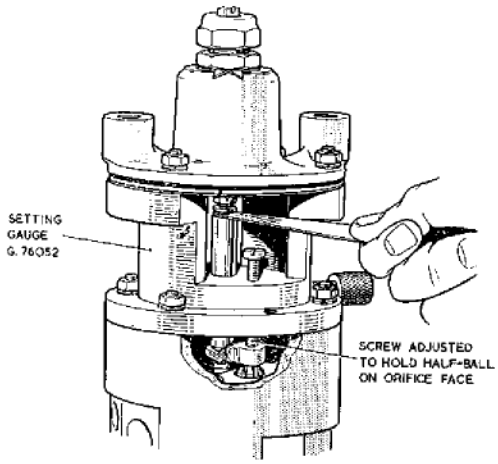

Fig. 6. Setting the governor tappet clearance

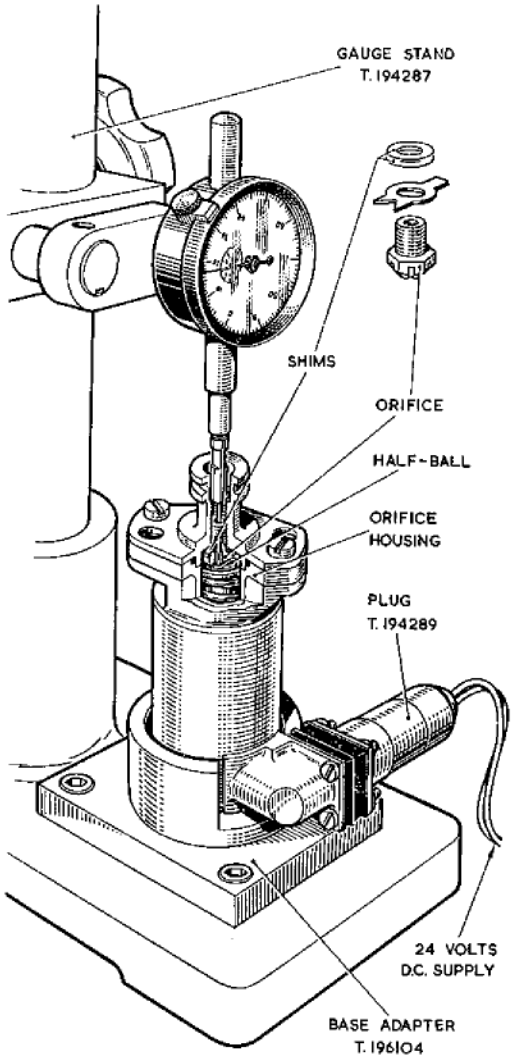

Fig. 7. Setting the solenoid air-gap

with four nuts and washers on each side of the plug bosses. Place the setting gauge G.76052 (*fig.* 6) over the studs on the housing and secure with nuts and washers. Adjust the plunger to the tool so that it just contacts the lever tail and lock it in this position with the knurled screw. At the same time tighten the small slotted screw to make contact with the opposite end of the lever to ensure that it is not depressed by the plunger on the other end. Mount the assembled diaphragm and housing, spacer plate and gasket on top of the setting gauge and secure with slave nuts and bolts. Turn the governor adjusting screw to fully tension the spring and, using feeler gauges, measure the clearance between the diaphragm tappet screw and the upper face of the gauge plunger. The clearance should be 0·017 to 0·019 in. Adjust the tappet if necessary, tighten the locknut and check the setting before removing the gauge and diaphragm housing. Bend up the tabs of the tabwasher to lock the tappet screw, tighten down the locknut and cap nut on top of the housing and lock the tabwasher.

67. Remove all slave nuts and bolts, lock all tabwashers and secure the overspeed assembly and diaphragm, spacer plate and gasket to the governor chamber with six plain and grover washers and nuts. Lower the assembly on to the base plate on the assembling fixture, interposing the gasket, and secure it with four plain washers, grover washers and nuts.

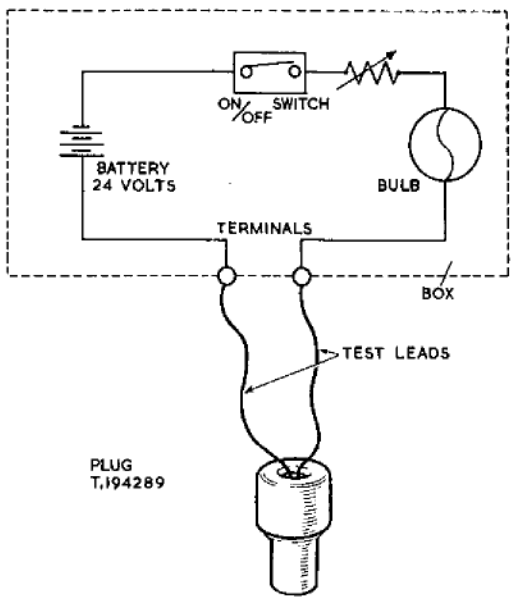

Fig. 8. Electrical indicating unit

Servo valve

68. The gauge stand T.194287 and the base adapter T.196104, for mounting the solenoid on the stand, are required for setting the solenoid air-gap (*fig.* 7). If the same shims are assembled as were removed when dismantling, the gap will be approximately correct and any discrepancy will be due to the fitting of a new tabwasher under the orifice.

69. Fit the orifice, shim washer and tabwasher to the orifice housing but do not lock the tabwasher. Fit the solenoid base, armature and spring to the solenoid and insert the half-ball valve in the recess in the end of the armature. Fit together the assembled orifice housing and the solenoid using suitable bolts. Invert the assembly and place it on the adapter on the base of the gauge stand. Lower the needle of the gauge through the orifice bore so that it rests on the flat face of the half-ball and set the gauge to zero.

70. Electrical equipment capable of energising the solenoid and fitted with an ON/OFF switch is necessary and can be made up with a 24-volt battery as shown in fig. 8. The special plug T.194289 is required to connect the equipment to the solenoid.

71. Energise the solenoid and check the reading on the gauge; this should be 0·015 to 0·020 in. Adjust the shims under the orifice if necessary and check again.

72. Remove the solenoid from the gauge stand, separate the orifice housing from the solenoid and lock the tabwasher under the orifice.

Valve leakage check

73. Assemble the three sealing rings to the orifice housing and lower it over the two studs and into the slave base T.200725 (*fig.* 9). Fit the solenoid assembly over the two studs and secure it with nuts and washers. Connect a fuel line and pressure gauge and apply a fuel pressure of 3,000 lb. per sq. in., with the solenoid de-energised. Leakage will be accompanied by a fall of pressure indicated on the gauge; if this occurs, fit a new orifice and half-ball valve.

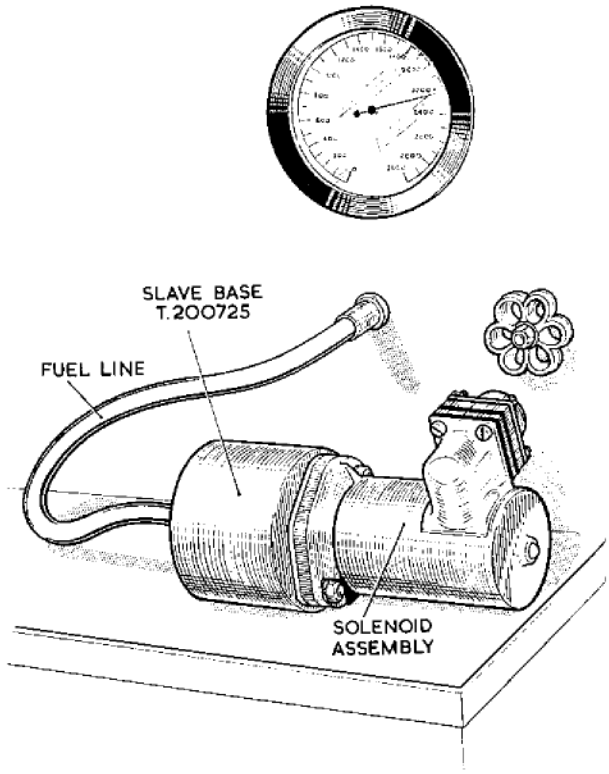

Fig. 9. Servo valve leakage check

Fitting the servo valve to the unit

74. Remove the assembly from the slave base and assemble it to the unit by pressing it down into its seating and securing it with plain washers, grover washers and nuts.

TESTING

General

75. Test-rig layout and equipment is illustrated in fig. 10. The pump to be used is either type GC or GD and must run at a constant speed of 2,900 to 3,100 r.p.m. The servo flow must be 9·0 to 10·0 gal. per hr. at 1,000 lb. per sq. in. pump delivery pressure and 150 gal. per hr. main flow. The pump inlet pressure is to be 10 to 15 lb. per sq. in.

76. The driven (slave) governor is to be of type 2/2A fully calibrated. The C.F. make-up connection must have the banjo assembly shown in the illustration.

77. The servo valve solenoid armature air gap must be checked. Energise and de-energise the solenoid at 16 and 24 volts a number of times and note

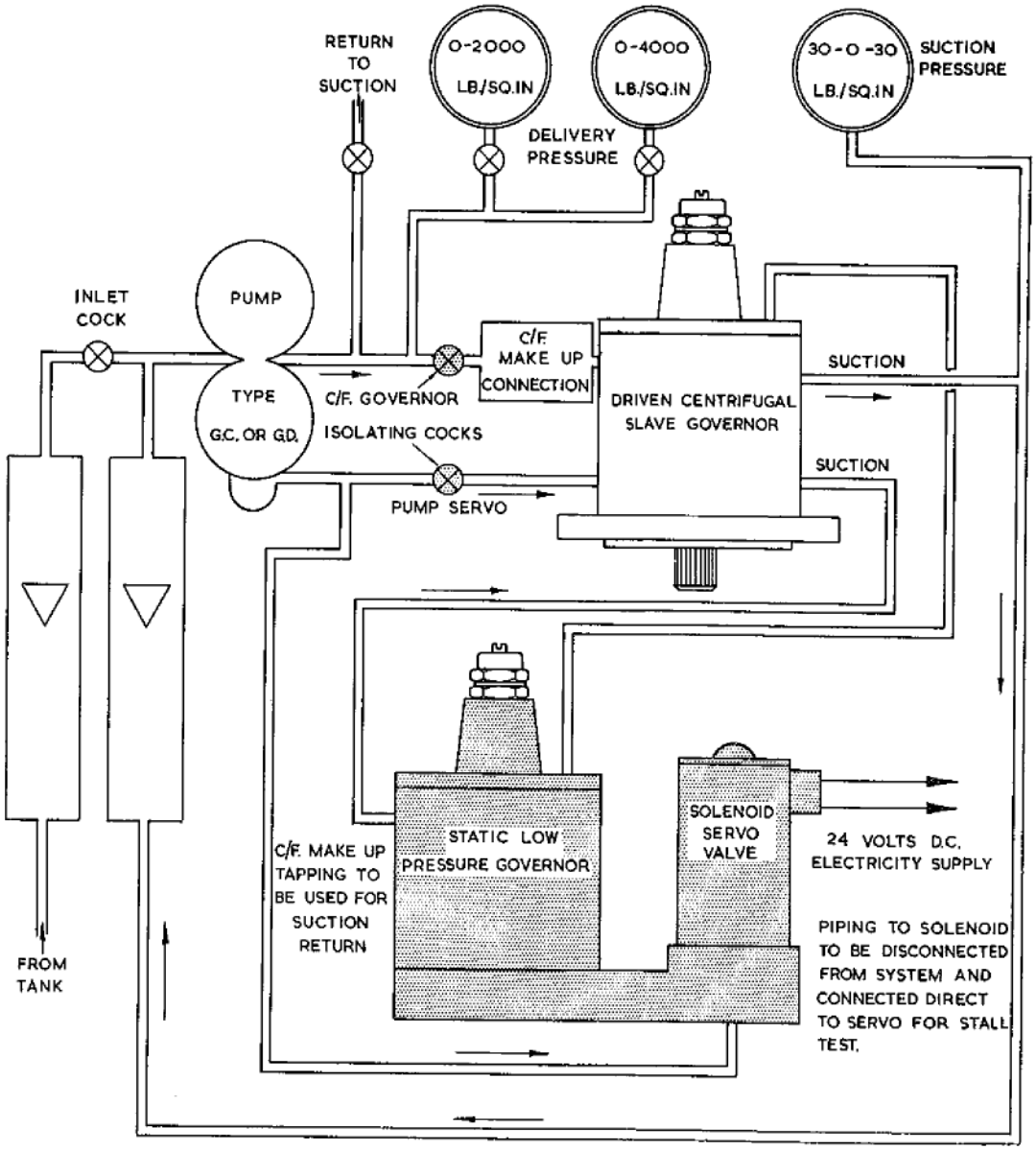

Fig. 10. Diagrammatic layout of test-rig

the reading on the gauge. The valve must then be subjected to a static fuel pressure test; at 3,000 lb. per sq. in. fuel pressure there must be no leakage (*para.* 73). The assembly must also be subjected to a shock test of 120 cycles at 0 to 2,500 lb. per sq. in. fuel pressure.

Preliminary calibration

78. The pump stall pressure must be adjusted above that of the governor. The driven centrifugal slave governor must be isolated by closing the stop cocks in the pump inlet and servo supply lines. The solenoid servo valve is also to be isolated by disconnecting the pipe from the system and connecting it direct to pump servo. This ensures that these two units are not subjected to excessive pressure.

79. The stall pressure is then checked by subjecting the static governor to the conditions given in the appendix. These conditions are to include the stall pressure limits

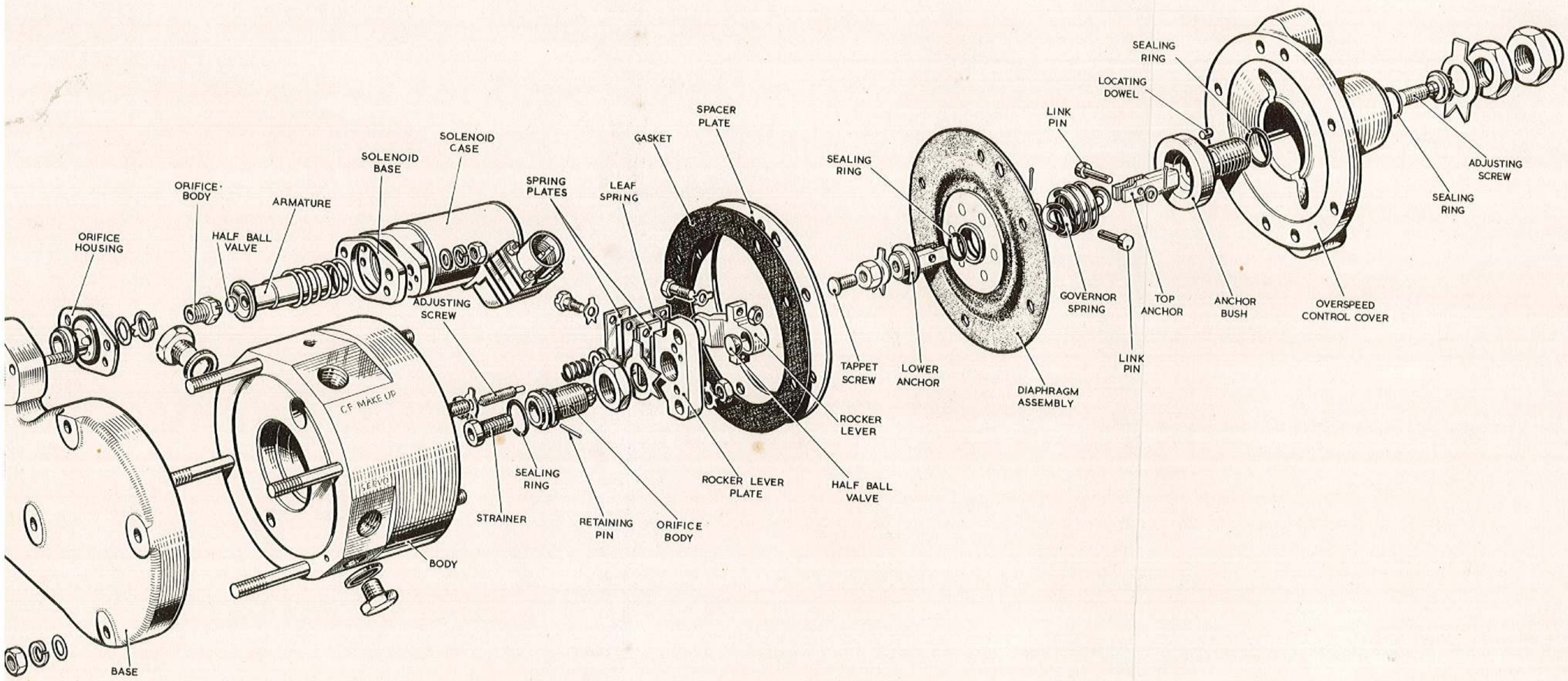

Fig. 11 Secondary low pressure governor

10/57 1500 C. B.&S. LTD GP55

and amplifier valve sealing requirements. The stall pressure is denoted by the maximum pump pressure achieved when restricting the pump outlet to zero flow.

80. The overspeed adjusting screw of the slave driven centrifugal governor must be set above the operating range of the static governor.

81. The static governor range is to be checked by operating the rig at the conditions stated in the appendix and increasing the speed until the pump governs. This will be denoted by a rapid decrease in delivery pressure. By varying the static governor adjusting screw it must be possible to obtain speed governing over the required range.

82. The governor over-run is to be checked at the following points as shown in the table in the appendix. The governor speeds must be within the required limits.

Point A—obtained by increasing the governor speed until the delivery pressure commences to fall.

Point B—obtained by further increasing the governor speed to reduce the delivery pressure to the required value as stated in the appendix.

Point C—obtained by further increasing the speed to reduce the delivery pressure below the lowest Point B pressure and then reducing the rig pump speed until the correct Point B delivery pressure is re-established.

Point D—obtained by further decreasing the rig pump speed until the delivery pressure has recovered to the Point A pressure.

83. The governor depression is to be checked at Point A by operating the governor at the inlet depression conditions given in the appendix. Speeds must be within the required limits.

84. The unit must now be pressure tested under the running conditions stated in the appendix. It is to be free from external leakage.

85. The solenoid is to be checked to ensure a complete shut-off by operating it at the conditions stated in the appendix.

Endurance test

86. The governor is to be cycled over the complete operating range. After the endurance test the unit is to be stripped, inspected and re-assembled.

Final calibration

87. For final calibration, all the tests in the preliminary calibration are to be repeated.

Leakage test

88. The governor is to be disconnected from the rig and connected to a compressed air supply, with all other connections sealed off. The unit is then submerged in fuel and the required air pressure applied. For this test the solenoid electrical connecting plug must be sealed. No leakage is permissible.

Inhibiting

89. The governor is to be thoroughly flushed with oil to the specification stated. All open connections are to be fitted with dust caps and the wire-locking completed.

APPENDIX 1

CALIBRATION CODE A

Fuel

1. The fuel to be used is AVTUR at a temperature of 20 to 30 deg. C. The pump inlet pressure to be maintained at 10 to 15 lb. per sq. in.

Preliminary calibration (*para. 78*)

2. (1) Set the stall to give no leakage from the amplifier valve at 1,700 lb. per sq. in. Stall to be within 2,500 to 3,600 lb. per sq. in.

(2) Overspeed adjusting screw of slave driven governor is to be screwed down fully to set the governor clear of the operating range of the static governor.

(3) Solenoid energised. Driven centrifugal slave governor to be restored to operation by opening isolating stop cocks. The static governor must be capable of adjustment over a range of 5,400 to 6,600 r.p.m. and 1,500 lb. per sq. in. pump pressure.

(4) Pump inlet pressure 10 to 15 lb. per sq. in. Solenoid energised at 24 volts. Centrifugal governor isolating stop cocks open. Check governor to table given below.

(5) Solenoid energised at 24 volts. Centrifugal governor isolating stop cocks open. Obtain 12 in. Hg. depression inlet. Governing Point A should not increase by more than 30 r.p.m.

(6) Solenoid energised at 24 volts. Centrifugal governor isolating cocks closed. Governor speed 6,050 r.p.m. Pump delivery pressure 2,500 lb. per sq. in. Pump inlet pressure 40 lb. per sq. in. No external leakage after 2 min.

(7) Solenoid energised at 24 volts. Centrifugal governor isolating cocks open. Set static governor to Point A conditions. Increase speed to Point B5 conditions. De-energise solenoid. Check for a completely shut-off condition by ensuring that the pump pressure rises to 1,500 lb. per sq. in.

Endurance test (*para. 86*)

3. The static governor is to be cycled 240 times over the complete operating range as detailed in the table by varying the speed of the slave driven centrifugal governor.

Strip, inspection and final assembly

4. The overspeed and the amplifier valve assembly are to be removed, examined and re-assembled.

Final calibration (*para. 78*)

5. Repeat the preliminary calibration, record the results.

Leakage test (*para. 88*)

6. Connect an air pressure line to the return to pump inlet connection and seal off all other connections. Immerse unit in kerosine and apply 40 lb. per sq. in. air pressure. No leakage permitted.

Point	Pump pressure lb. per sq. in.	Governor speed range r.p.m.
A	1,500	6,200
B1	1,300	Speed increase 20-45 above point A
B2	1,100	Speed increase 20-45 above point B1
B3	900	Speed increase 20-45 above point B2
B4	600	Speed increase 30-60 above point B3
B5	400	Speed increase 20-60 above point B4
C	400	Not more than 40 below point B5
D	1,500	6,180-6,200

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