Chapter 1

CENTRIFUGAL GOVERNOR

Type CFG 2 series

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

General

1. These instructions apply to types CFG 2/2A, 2/3A, 2/4A and 2/5A which are all basically identical with the exception of installation details, etc.

2. During the reconditioning of the unit, and particularly when assembling, a high standard of cleanliness must be maintained.

3. Joint washers, gaskets, sealing rings, split pins, tabwashers and locking wire must all be renewed irrespective of their condition.

4. Before commencing dismantling operations, consider any complaints reported with the unit then carefully examine the exterior for damage, giving particular attention to the locking wire on the adjustment screws.

5. Drain off the inhibiting fluid and, if the unit appears to be in good condition, check the concentricity of the drive shaft by using the gauge G.79762 (*fig.* 1). If this is satisfactory, flush out the unit with kerosine and then calibrate it as described in para. 78 to 82. The calibration check will give a good indication of the condition of the governor and of the parts requiring attention.

Special tools

6.

Tool No.	*Description*	*Application*
T.160988	Spanner	Diaphragm adjusting screw
T.177125	Box spanner	General
T.210194	Pressure drop-test fixture	Strainer
T.230220	Combination spanner	Rocker lever adjusting screw
T.233075	Assembly tool	Rotor drive circlip
T.233076	Adapter plate	Hydraclamp
T.233077	Extractor	Carbon bearings
G.76052	Setting gauge	Tappet screw
G.76053	Gauge	Rocker-lever tail lift
G.76054	Pre-load fixture	Rocker-lever
G.79762	Receiver gauge	Rotor shaft splines

DISMANTLING

General

7. Units should be dealt with according to their reported defects as complete stripping may not be essential in every instance, i.e., where units have completed only short running times, the stripping of sub-assemblies may be discretionary.

8. The bench upon which the work is to be effected must be clean and should be covered with zinc sheeting, linoleum or bakelized fabric. Containers in which to place the diamantled parts should be at hand.

9. Remove and discard all external locking wire. Unscrew and remove the installation connections and also the bleed plugs on the diaphragm housing.

10. To dismantle the make-up valve, carefully tap out the retaining peg and withdraw the strainer assembly comprising the orifice collar, sealing ring, orifice collar, sealing ring, orifice plate, strainer and sealing ring.

Removing the body

11. Mount the unit on the hydraclamp adapter T.233076 (*fig.* 2), remove the tabwashers and nuts at the driving end and withdraw the body and gasket from the rotor housing.

Diaphragm assembly

12. Remove the retaining nuts, grover washers and plain washers and carefully withdraw the control cover, diaphragm housing and if it is tight it should be lightly

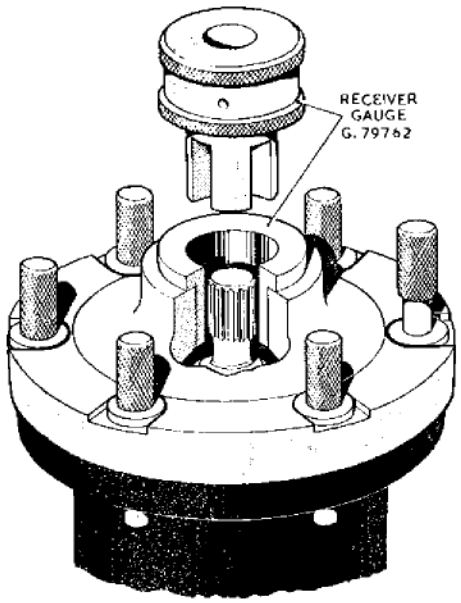

Fig. 1. Checking the rotor-shaft splines

assembly, spacer plate and gasket from the unit body.

13. Unlock and remove the adjusting screw locknut from the top of the housing and, using the spanner T.160988, unscrew and remove the adjusting screw and sealing ring from the top anchor. Withdraw the diaphragm and spring assembly from the housing.

14. Remove the locknut retaining the anchor bush and withdraw the bush. The bush is flanged and dowelled inside the

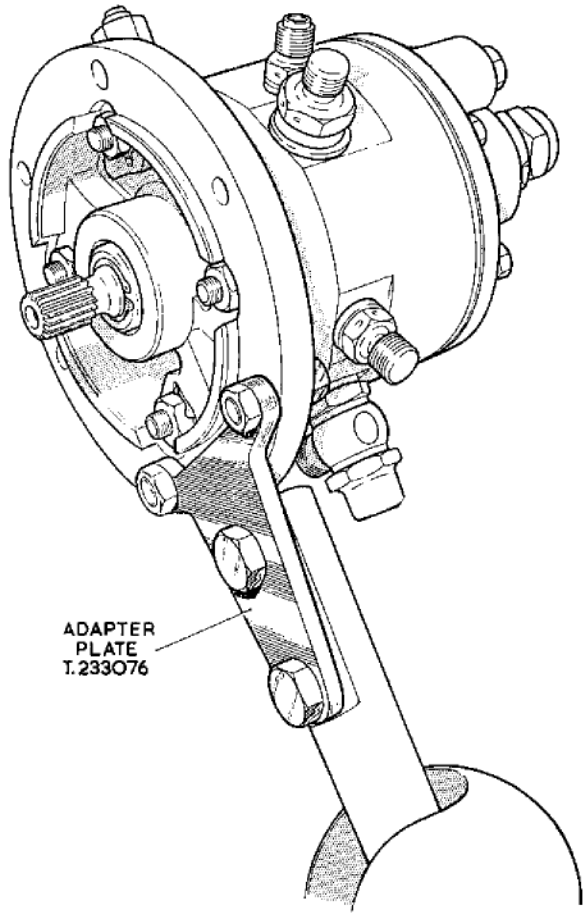

Fig. 2. Dismantling and assembling fixture

housing and if it is tight it should be lightly tapped out with a hide hammer. The dowel peg should not be disturbed unless it is damaged.

15. Extract the split pins and then the link pins to release the anchors from the ends of the governor spring. Withdraw the lower anchor from the diaphragm centre. If required, remove the tabwasher and nut from the tappet screw and withdraw the screw from the anchor face. The diaphragm is a riveted assembly and must not be dismantled.

Checking the rocker-lever tail lift

16. The amplifier valve is exposed when the diaphragm housing has been removed and it may be desirable to check the rocker-lever tail lift before further dismantling takes place, as this will indicate if an incorrect setting has caused the unit to be defective. To do this, carry out the test referred to in para. 68 and 69, omitting the blue spot procedure, and note the dimension obtained. If incorrect, the tail lift will be adjusted when assembling.

Rocker lever and orifice assembly

17. Remove the tabwashers and nuts securing the lever plate to the body housing and lift out the assembly. Resistance may be felt due to the sealing ring on the orifice strainer body, but a steady pull will release the seal. Withdraw the spring from the centre lever stop.

18. Remove the tabwasher and locknut on the orifice body, screw out the body from the rocker-lever plate and remove the retaining pin to allow the strainer to be withdrawn. Ease the sealing ring from the groove around the orifice body.

19. Remove the tabwashers, nuts and set-screws to separate the rocker lever, rocker-lever plate, clamping plates and leaf spring, at the same time taking care not to damage the orifice and the sealing face of the half-ball valve.

Body

20. Remove the tabwasher and nut from the adjusting screw in the centre lever stop, remove the screw and withdraw the centre lever stop from the body bore.

21. The plain carbon bearing is removed in a similar manner to the bearing in the rotor housing by using the extractor T.233077, fig. 3.

22. Do not withdraw the locating dowel in the bore unless there is evidence of damage or loose fitting.

Rotor housing

23. Fit the housing to the hydraclamp fixture T.233076 and remove the circlip retaining the rotor shaft.

24. Push the splined end to ease the rotor from the shaft seal then withdraw it from the housing. Remove the rotor collar, sealing rings, carbon-faced seals and spring from the end bore of the housing.

25. Remove the rotor bearing by using

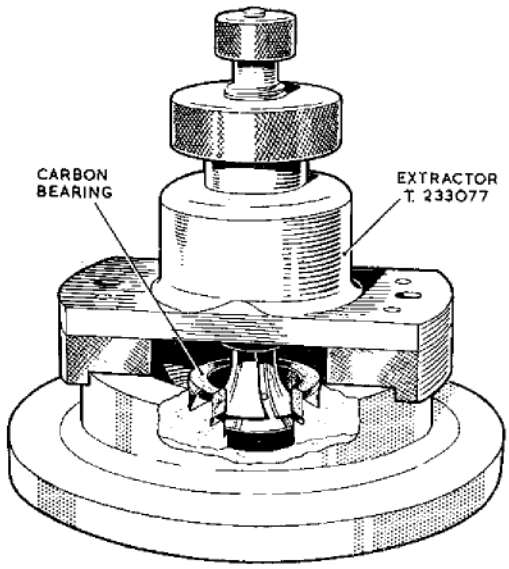

Fig. 3. Extracting the carbon bearings

the extractor T.233077 (*fig.* 3). Do not withdraw the locating dowel unless it is damaged or loose.

Cleaning

26. If any defect in the pump is suspected to be due to the presence of foreign matter, the parts suspected should be examined before cleaning, otherwise the cause of the defect may be washed away.

27. Clean the parts in kerosine using a pressure wash with adequate filtering facilities. Hard brushes, cloths and abrasives must not be used. Dry the components with compressed air and place them in clean, dry containers.

INSPECTION

General

28. Where dimensional checks of certain components are necessary, reference must be made to the Schedule of Fits, Clearances and Repair Tolerances (Vol. 2, Part 2).

29. Each component should be inspected closely for signs of damage, corrosion and wear and if considered necessary, with due regard to the function of the component and nature of the defects, the part should be renewed.

30. Unless otherwise stated, it is usual to discard any parts rendered redundant by modification action. Complete information regarding applicable modifications must therefore be available.

31. Tabwashers, split pins, locking wire, joint washers and sealing rings are to be discarded irrespective of condition and the new replacements made available for inspection with the main components.

32. In general, scores or surface damage on moving parts and joint faces will impair the operational efficiency of the unit, hence any part so affected should be renewed. Depending, however, upon the hours run, the purpose and region of operation and the availability of spares, certain defects which do not impair the efficiency and safety of the unit may be acceptable at the discretion of the Inspection Authority.

33. In the case of suspected cracks or wherever there is doubt concerning the soundness of parts such as the rotor, rocker lever and governor spring, they must be tested by means of an approved magnetic crack detection equipment.

34. Inspect all installation adapters and unions for cleanliness and general condition and ensure that the threads and joint faces are undamaged. If the make-up valve has been dismantled, check the strainer for cleanliness and the orifice collar and orifice plate for general condition. See that the sealing ring faces in the union are undamaged.

Diaphragm and rocker-lever assembly

35. If the assembly has been completely dismantled, examine the diaphragm for distortion and for signs of cracking or splitting. Check for indentation of the surface, particularly adjacent to the edge. Inspect the riveting for looseness and the centre plates for damage.

36. Check the spring anchors for damage, condition of threads and also their fit in the anchor bush and diaphragm centre. Inspect the clevis pins and the edges of the clevis-pin holes for undue wear and sign of radial cracks.

37. Examine the tappet screw for wear and pitting on the head. See that the threads of the screw and locknut are in good condition.

38. Inspect the governor spring for surface cracks and corrosion particularly around

the attachment loops and see that the loops and coils are free from distortion.

39. Examine the adjusting screw for surface damage on the underside of the flange as this is a sealing face and may cause leakage. Inspect the adjusting screw locknut and also the anchor bush and locknut for general condition, ensuring that the bush sealing-ring flange and dowel hole are serviceable.

40. Ensure that the overspeed control cover is in good condition, and that the joint face is free from scores or other damage. Check the threads in the bleed connections.

41. Ensure that all traces of the gasket have been removed from the face of the spacer plate and that no damage exists which may prove a source of leakage.

42. Examine the rocker lever for serviceability. Check that the half-ball valve recess is clean and that the half-ball swivels freely in it. Inspect the upper and lower surfaces of the rocker-lever tail for wear caused by the diaphragm tappet and centre-lever-stop adjusting screw.

43. Examine the rocker lever plate for damage and see that the holes and threads are in good condition.

44. Examine the half-ball valve for wear, particularly on the seating face. Check the face with an approved surface meter, and the colour registration with an optical flat. Reject the half-ball if more than two colour bands are apparent.

45. Inspect the orifice assembly for damage to the lands and for wear by the half-ball (*fig.* 4). Test the orifice face with an electrolimit comparator, if available (*fig.* 5) and an optical flat. Reject the orifice if more than two colour bands are apparent.

46. Check the sealing ring groove on the orifice body for serviceability and see that the locknut is serviceable.

47. Inspect the clamping plates, leaf spring and their attachment setscrews, nuts and bolts for good condition.

48. Examine the strainer assembly for cleanliness, particularly between the coils and see that the retaining pin is undamaged.

Body

49. Examine the joint faces of the body for damage and ensure good condition of the threads, studs and drillings. Examine the plain carbon-bearing for chipping, scores and burrs and ensure the dowel is a good fit.

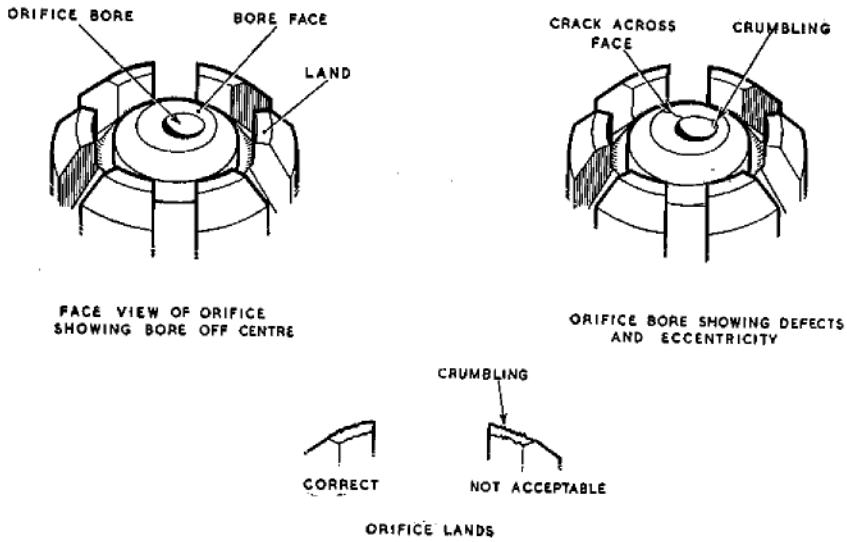

Fig. 4. Orifice defects (highly magnified)

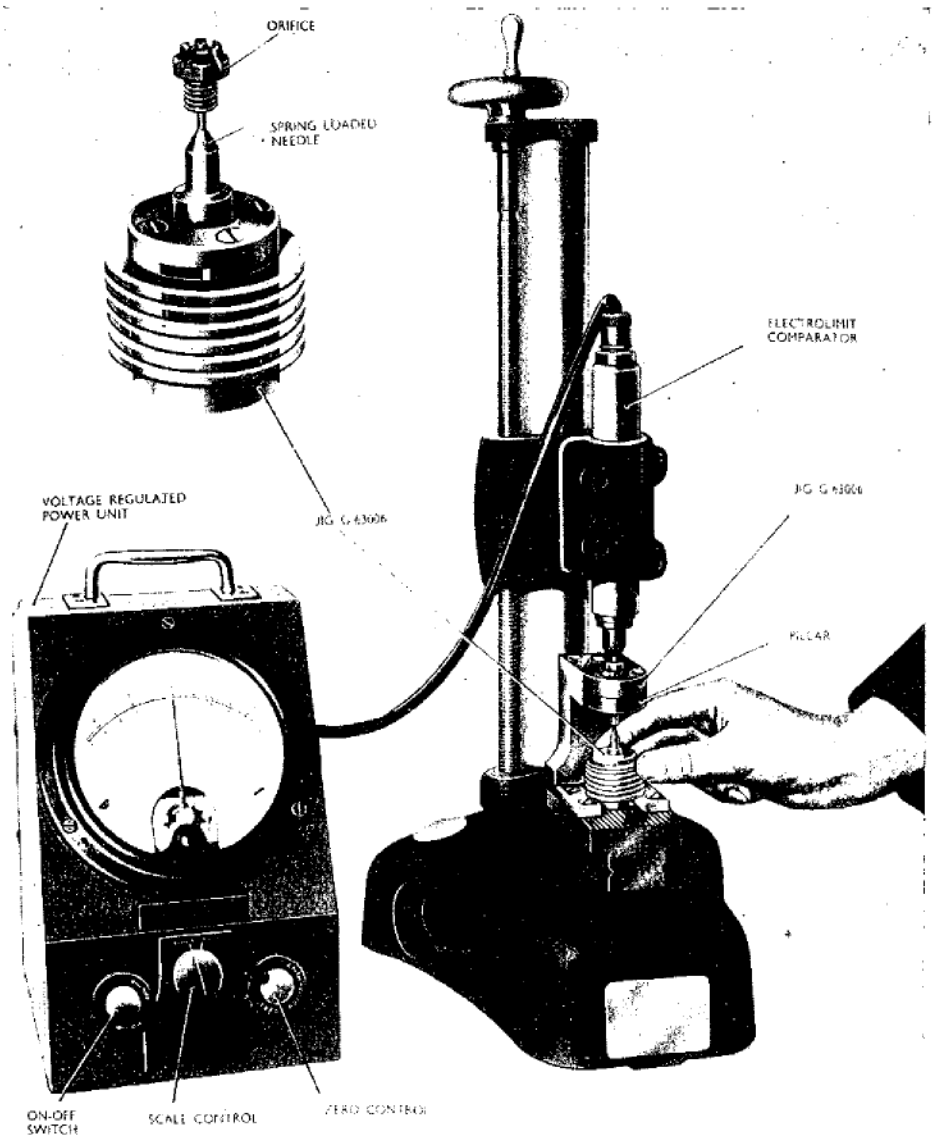

Fig. 5. Checking the orifice with an electro-limit comparator

50. Check the centre lever stop, adjusting screw, nut and spring for serviceability.

Rotor and rotor housing

51. Inspect the rotor for corrosion or distortion and for signs of picking-up or overheating on the bearing surfaces. Ensure that the splines have no fretting or undue wear.

52. Check that the carbon bearing is free from cracks and chipping and that it aligns with the dowel peg in the housing.

53. Examine the carbon faced seal, spring and rotor collar for wear and good general condition.

54. Inspect the housing for corrosion, distortion and damage to the joint face. See that the internal drillings are unobstructed and that the sealing ring shoulders in the shaft bore are in good condition. Examine the mounting face for distortion and the mounting holes for signs of damage and radial cracks.

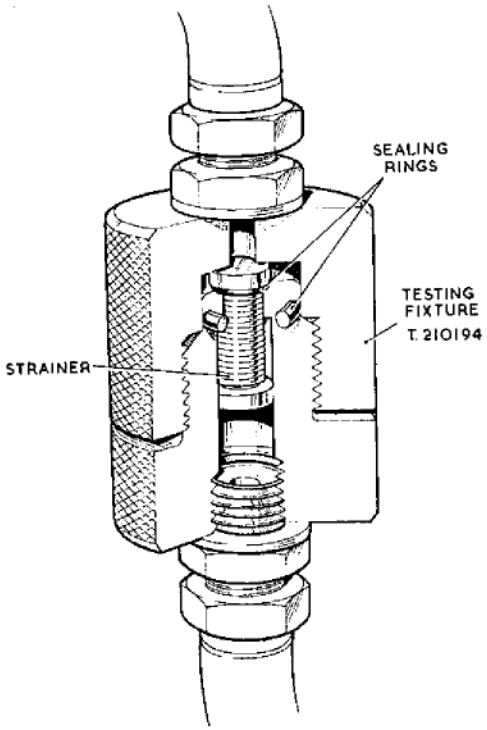

Fig. 6. Testing the strainer

REBUILDING

Assembling the rotor housing

55. Attach the rotor housing to the hydra-clamp adapter plate T.233076.

56. If previously removed, insert the peg in the carbon-bearing recess and ensure that it is a firm fit.

57. Place the carbon-faced seal with sealing ring into the inner end of the rotor housing bore, fit the carbon bearing into the larger bore and then insert the rotor.

58. Fit the spring and the second carbon-faced seal with sealing ring over the rotor shaft. Fit the seal to the collar, place this on the shaft and then secure the assembly with the circlip by using the tool T.233075.

Checking the rotor end-float

59. Place the rotor housing on a flat surface with the quill shaft uppermost. Lay two support blocks of equal height on the housing end face, place a micrometer depth gauge across them and measure the distance to the drive-shaft end. Fit the rotor housing to the body, press the rotor against the

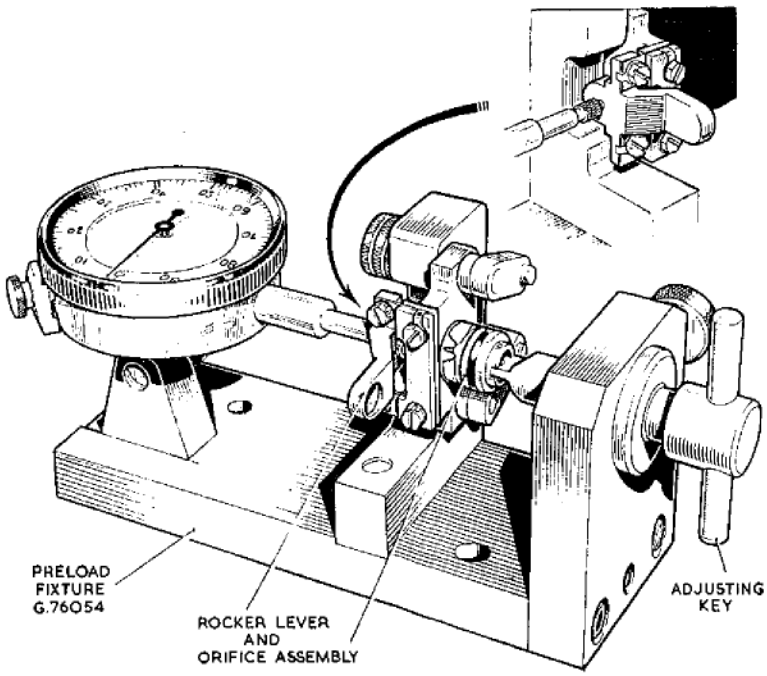

Fig. 7. Pre-loading the rocker lever

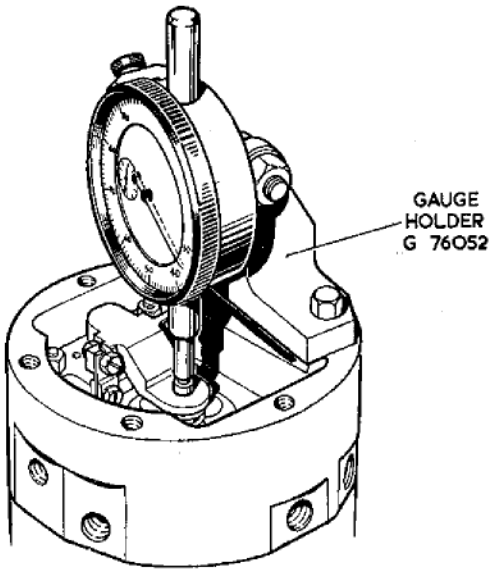

Fig. 8. Checking the rocker lever tail lift

carbon seal and measure likewise. The difference obtained between the two readings should be 0·006 in. to 0·013 in. Adjust by lapping the carbon face or renewing the carbon seal.

Rocker lever and orifice assembly

60. Before rebuilding the rocker lever and orifice assembly the strainer must be subjected to the following pressure-drop test.

(1) Fit the strainer to the fixture T.210194 (*fig.* 6) connect the fixture and apply a flow of 50 gallons per hour. The indicated pressure drop must not exceed 8 lb. per sq. in. If this is exceeded, fit a new strainer and repeat the test.

61. Insert the strainer with seal into the orifice body and secure it with the retaining pin. Secure the leaf spring to the rocker lever with a tabwasher beneath the heads of the retaining bolts. Align the holes in the assembled clamping plate and leaf spring with those in the rocker-lever plate and secure the plate with tabwashers and setscrews. Fit the locknut and tabwasher over the orifice body, place the half-ball valve in the rocker lever recess, then screw the orifice body into the lever plate until the orifice just contacts the half-ball. Tighten the locknut finger-tight but do not lock it at this stage.

Pre-loading the rocker lever and orifice assembly (*fig.* 7)

62. Position the assembly on the fixture G.76054 and tighten the two knurled screws. Move the D.T.I. gauge until the thimble rests on the rocker lever above the orifice body and lock it in this position. Depress the rocker lever to seat the half-ball firmly on the orifice plate and set the dial to read zero. Screw the orifice body in or out of the rocker lever plate by means of the key provided on the fixture until the dial registers +0·001 in. then lock the key with the knurled screw. Tighten the locknut on the orifice body, lock the tabwasher and then re-check the dial reading. Remove the assembly from the fixture and place in a safe position pending fitting it to the unit body. Record the figure obtained on the test record sheet.

Assembling the body

63. Insert the centre lever stop into the body, with the radiused edge away from the rocker lever chamber.

64. If previously removed, fit a dowel peg to the carbon-bearing housing, ensuring a good, firm fit, then locate the plain carbon bearing on the dowel and ease it into position. Fit the adjusting screw to the centre lever stop, place on a tabwasher and screw on the locknut by using the spanner T.230220.

65. Fit the sealing ring to the groove in the orifice body, smear a little vaseline into the recess on the underside of the rocker lever to hold the spring in position and lower the complete assembly over the studs in the body. Place a tabwasher and nut on each of the studs and tighten them evenly. Do not bend up the tabwashers at this stage.

66. 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, fit the spring loop and link-pin to the anchor fork, place a splain washer over the end of the pin and insert a split pin. If previously removed, insert the dowel into the shoulder of the adjusting screw bush. Attach the opposite end of the spring to the upper anchor fork with a link pin, washer and split pin. Ease a sealing ring into the groove of the bush, slide the top anchor into the bush and place the diaphragm housing over the assembly, at the same time locating the dowel. Fit a tabwasher and the locknut over the bush threads and make it

finger-tight only. Place a sealing ring beneath the head of the adjusting screw, turn the screw into the top anchor and loosely fit the cap nut over the screw end. Before fitting the assembly to the body, mark the tappet face with engineers blue to indicate its contact position on the rocker lever.

67. Gently ease the assembly over the studs on the end face of the body housing until the tappet contacts and marks the rocker lever, then withdraw the cover from the body.

Checking the rocker-lever tail lift

68. Fit the gauge and holder G.76053 (*fig.* 8) to the end face of the body. Position the button of the D.T.I. on the blued spot on the rocker lever.

69. Set the gauge to zero to give the neutral plane then press down the tail end of the lever and note the dial reading. Adjust the screw in the centre lever stop to obtain a movement of 0·025 in. to 0·040 in. When satisfactory, tighten the locknut using the spanner T.230220 and then re-check. Do not lock the tabwasher at this stage. Record the dimension obtained.

Setting the governor tappet clearance (*fig.* 9)

70. Assemble the gasket and spacer plate to the diaphragm housing and secure them with four slave bolts and nuts on either side of the plug bosses.

71. Place the gauge G.76052 over the studs on the end face of the body and fit slave nuts and washers. Ensure that the gauge plunger aligns with the blued spot on the rocker lever tail then tighten the nuts. Adjust the plunger so that it just contacts the lever and lock it in this position with the knurled screw, at the same time tightening the small slotted screw on to the opposite end of the lever to ensure the lever is not depressed by the plunger.

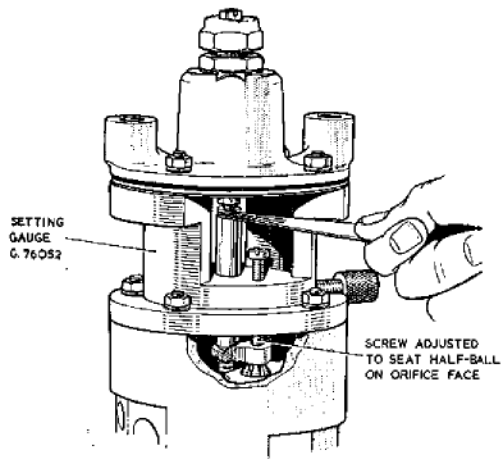

Fig. 9. Setting the governor tappet clearance

72. Mount the diaphragm housing, spacer plate and gasket to the gauge and secure them in position. Turn the governor adjusting screw to fully tension the spring then tighten the locknut. Using feeler gauges, measure the clearance between the diaphragm tappet screw and the upper face of the gauge plunger. The correct clearance is 0·017 in. to 0·019 in. Adjust the tappet if necessary then tighten the locknut and re-check the setting before removing the gauge and diaphragm housing. Finally, bend up the tabs on the tappet tabwasher and record the dimension on the test record sheet.

Fitting the body and rotor housing

73. Mount the body on the rotor housing, interposing a gasket, and secure it with a tabwasher and nut on each of the studs. Tighten evenly with a box spanner and bend over the tabwashers. Place a gasket and the spacer plate over the studs at the opposite end of the body and lower the diaphragm housing on to the spacer plate, ensuring that the transfer holes and locating dowel correspond. Secure the assembly with plain washers, grover washers and nuts.

Checking the rotor-shaft splines

74. Place the gauge G.79762 (*fig.* 2) on the rotor housing, locating the mounting holes with the six knurled pins. Check the concentricity of the splined shaft by lowering the centre piece into the bore of the gauge bush. Any mal-alignment will necessitate the removal of the impeller for investigation.

RIG TESTS

General

75. All governor performance tests are to be made with a 'C' or 'D' size pump running at constant speed of 2,900 to 3,100 r.p.m., and giving a servo flow of 9 to 10 gallons per hour at a pump delivery pressure of 1,000 lb. per sq. in. and a main flow of 150 gallons per hour.

76. The fuel used is AVTUR at a temperature limit of 20 to 30 deg. C.

77. Reference must be made to the calibration values listed in the appendix and to fig. 11.

Preliminary calibration

Stall setting

78. The stall pressure is denoted by the maximum pump pressure achieved when restricting the pump outlet to zero flow. Where the required stall pressures are higher than normal pump stall pressures, the rig pump stall is to be set clear, i.e., for this test, cock number 1 is to be closed to isolate the governor from excessive pressure. The stall pressure is then checked by subjecting the governor to the conditions stated in the appendix.

Make-up valve flow

79. With the servo flow blanked off, the governor make-up flow is to be checked at the conditions stated.

Governor range

80. The governor range is to be checked by running the governor at the conditions stated and increasing the speed until the pump governs which is denoted by a rapid increase in delivery pressure. By variation of the governor adjusting screw it must be possible to obtain speed governing over the required range.

Governor setting

81. The governor is to be set at point A and the governor overrun checked at the points specified in the appendix. The

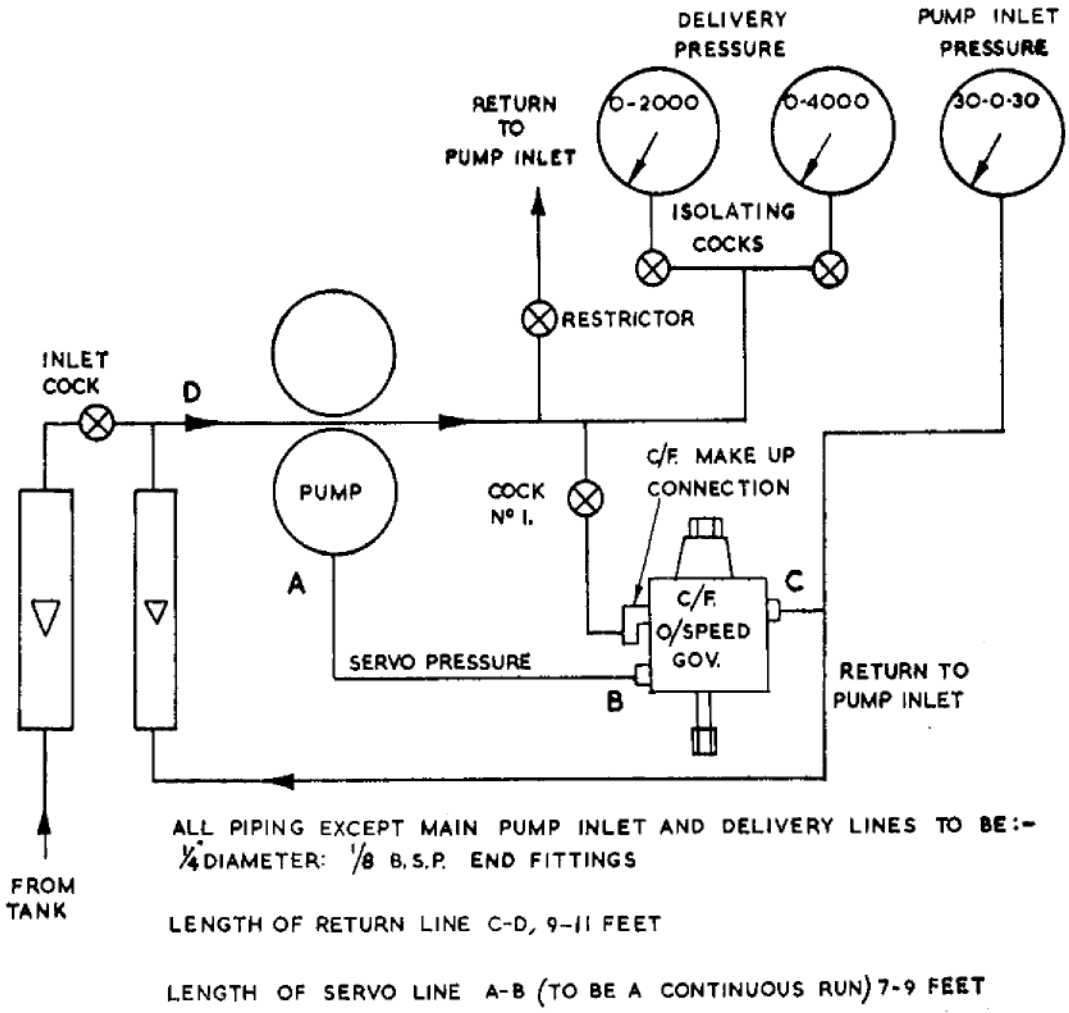

Fig. 10. Diagrammatic layout of test rig

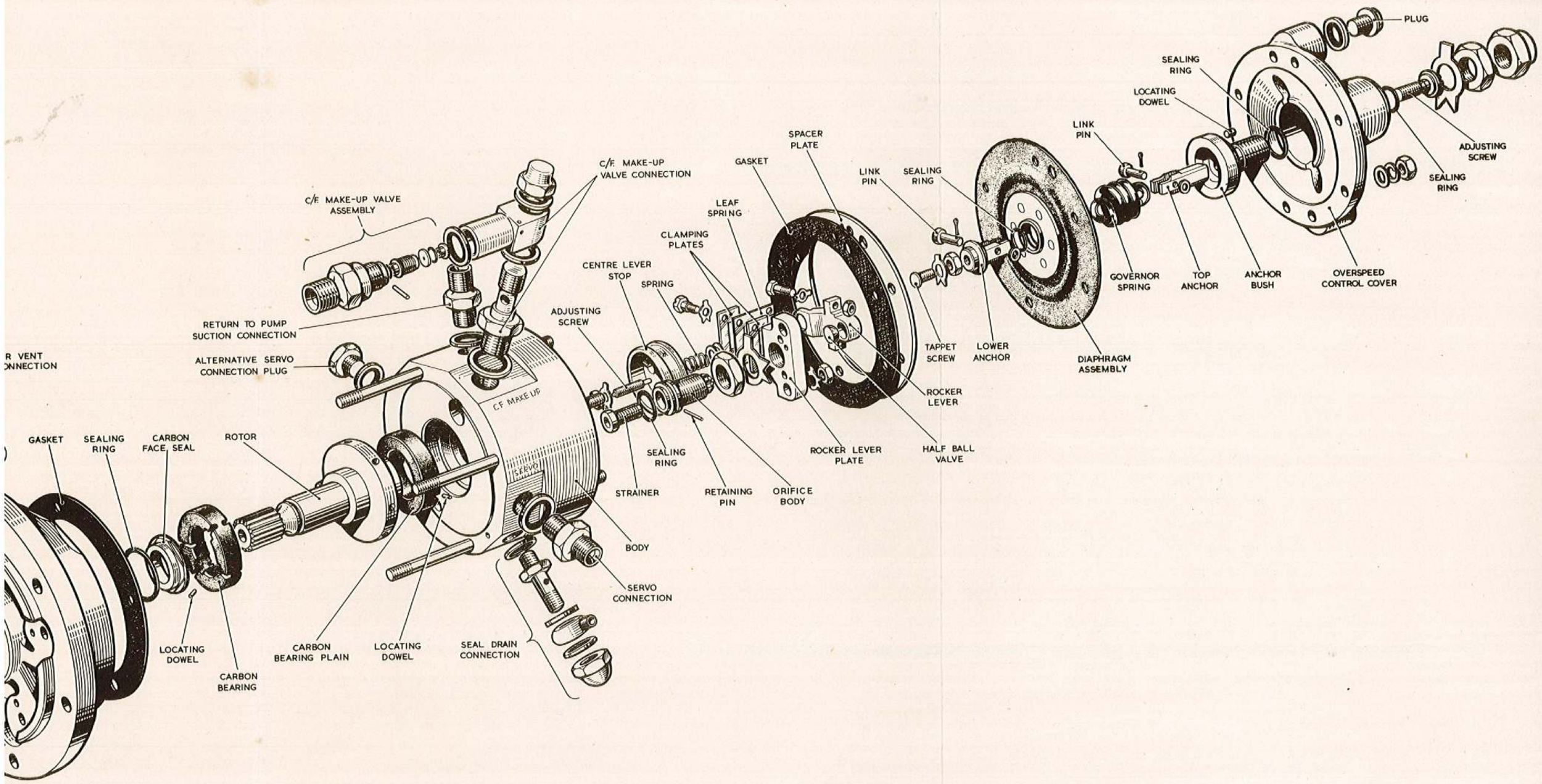

Fig. 11 Dismantled view of unit

RESTRICTED

governor speeds must be within the required limits.

Point A is obtained by increasing the governor speed until the delivery pressure commences to fall.
Point B is obtained by increasing the speed to reduce the delivery pressure to the required value.
Point C is obtained by further increasing the speed to reduce the delivery pressure below the lowest point B pressure and then reducing the governor speed until the correct point B delivery pressure is re-established.
Point D is obtained by further decreasing the governor speed until the delivery pressure has recovered to the point A pressure.

Governor depression

82. The governor is to be checked at point A by running the governor at the inlet depression conditions given in the appendix. Speeds must be within the required limits.

Pressure test

83. Pressure test the unit under running conditions and in the range of inlet pressures stated. It must be free from external leakage except for the limited loss at the carbon faced seal.

Endurance test

84. The governor is to be endurance tested by running at the stated conditions and cycled as specified.

Strip inspection

85. The unit must now be partially or wholly dismantled for inspection, the extent of this being determined by the general condition of the unit and the amount of reconditioning carried out. Before final re-assembly, all components must then be cleaned thoroughly as detailed in para. 26 before being re-assembled.

86. Re-building must be carried out in accordance with the previous instructions. In addition all internal locking must be completed at this stage and installation connections fitted.

Final calibration

87. Mount the governor on the test rig, re-calibrate it as detailed in para. 78 to 84 and enter the results on the test record sheet. Remove the unit from the test rig.

Air pressure test

88. Blank off all connections except the return to pump inlet. To this connection apply the required air pressure and then submerge the unit in fuel; there must be no leakage.

89. The governor must now be fitted with a drive protection cover and gasket suitably modified to take an air supply. Air at the specified pressure is then supplied to the fixture and the unit immersed in fuel. There must be no leakage from the oil-seal drain.

90. When satisfactory, complete all external connections and wirelocking. Inject oil (OM-11) into the unit and then fit the dust caps. Fit a protection cover and gasket to the mounting flange and secure it with six bolts, nuts and washers.

APPENDIX 1

CALIBRATION CODE A

1. The unit should be installed to the test rig as shown in the diagrammatic layout, fig. 10. Reference must be made to applicable paragraph in the chapter.

Stall setting (*para. 78*)

2. The pump stall is to be set clear for this test only, i.e., cock No. 1 to C.F. make-up valve closed. Set the stall to give nil leakage from amplifier valve at 1,700 lb. per sq. in. Stall to be within 2,500 to 3,600 lb. per sq. in.

Make-up valve (*para. 79*)

3. Open cock No. 1. Servo flow blanked off. Overspeed govern 5,500 r.p.m., pump delivery pressure 1,500 lb. per sq. in., flow from overspeed governor to pump inlet 13·5 to 16 gallons per hour.

Governor range (*para. 80*)

4. The overspeed governor must be capable of adjustment over a range of 5,700 to 6,900 r.p.m. at 1,500 lb. per sq. in.

Governor setting (*para. 81*)

5. Pump inlet pressure 10 to 15 lb. per sq. in.

	Speed (r.p.m.)	*Pump delivery pressure (lb. per sq. in.)*
Point A	6,500	1,500
Point B1	20 to 25 above Point A	1,300
Point B2	20 to 45 above B1	1,100
Point B3	20 to 45 above B2	900
Point B4	30 to 60 above B3	600
Point B5	20 to 60 above B4	400
Point C	Not more than 20 below B5	400
Point D	6,480 to 6,500	1,500

Governor depression (*para. 82*)

6. 12 in. Hg. depression by restricting pump inlet. The speed at which the overspeed governor governs the pump must not be in excess of 30 r.p.m. of the speed at Point A.

Pressure test (*para. 83*)

7. Speed 6,150 r.p.m. Delivery pressure 2,000 lb. per sq. in. Inlet pressure 20 lb. per sq. in. and 40 lb. per sq. in. There must be no external leakage other than from the carbon faced seal. This must be not more than 5 cc./hr. at 20 lb. per sq. in and 20 cc./hr. at 40 lb. per sq. in.

Endurance test (*para. 84*)

8. Run for two hours at 6,400 r.p.m. and 400 lb. per sq. in. pump delivery pressure. Make 240 overpeed governor cycles with governor set at Point A. Strip inspection (*para.* 90-91).

Final calibration (*para. 87*)

9. As in para. 2 to 7 of this appendix, all results to be recorded.

Air pressure test (*para. 88 and 89*)

10. With delivery connection and oil-seal drain blanked off, the overspeed governor is to be immersed in kerosine and 40 lb. per sq. in. pressure applied to the return to pump inlet connection. No external leakage is permitted.

11. With 5 lb. per sq. in. back air pressure applied to the carbon faced seal, there must be no leakage from the oil-seal drain.

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