Chapter 2

HIGH PRESSURE FUEL PUMPS, TYPE G.C.200 SERIES

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LIST OF ILLUSTRATIONS

LIST OF APPENDICES

GENERAL

1. The following instructions apply to type G.C.200 slipper type fuel pumps generally. Additional information on pumps fitted with solenoid operated isolating valves and non-return valves, as used with the dual pump installations, is given in para. 287 onwards.

2. The importance attached to cleanliness cannot be over-emphasised and care must be taken in every instance to ensure that all detail parts are thoroughly clean.

3. It is recommended that box or ring spanners be used for nuts and bolts whenever possible to ensure that damage is not caused by rounding off the flats and corners.

4. All paper joints or gaskets, metal joint washers, etc., must be renewed whenever the seal is disturbed, and new split pins and locking wire must always be used. Details of those parts which are not interchangeable are given under 'renewals' (para. 202).

SPECIAL TOOLS

5. Special tools and test rigs are required for the repair of these pumps, many of which are identical with those used for ball type pumps. To avoid duplication, the complete set of service tools which is listed in the accompanying table, has existing tools marked with an asterisk.

SPECIAL TOOLS

Tool No.	Nomenclature
*G.38745	Gauge, setting for adjusting tappet clearance
*G.46439	Gauge, concentricity for quill shaft in pump body
G.48552	Gauge, checking, for measuring auxiliary camplate lift
G.50185	Gauge, checking for carbon bearing clearance
*G.51239	Gauge, checking, for measuring squareness of port insert face and pump housing flange
G.51821	Gauge, setting for piston stop screw
G.52326	Fixture, oil seal testing
G.54218	Gauge, for inclining camplate for measuring auxiliary camplate lift
G.55010	Gauge, concentricity for quill shaft in rotor body
G.55011	Gauge, height for quill shaft
T.127645	Extractor, for removal of carbon bearing
*T.128561	Extractor, for removal of control cylinder liner
*T.128563	Box, stud, 2 B.A.
*T.129660	Box, stud for amplifier valve studs
*T.129661	Fixture, for assembling and stripping pump
*T.142854	Tool, for assembling orifice retainer to body
*T.142856	Holder, clock, for checking rocker lever lift
†T.146460	Fixture, for assembling and removing control cylinder end cover
*T.147031	Tool, assembly for fitting piston rod assembly to piston bore
*T.157037	Stand, for rotor pistons
*T.157038	Plug, blanking for pump body
*T.157039	Extractor, for removing and fitting rotor circlip
T.157872	Plug, expanding, blanking plate and seal
*T.157873	Tool, assembly for spring guides
*T.160988	Spanner, for dismantling diaphragm adjusting screw
*T.162242	Plates, for porosity test between piston rod and body
T.170761	Tool, for assembling torsion hinges to rocker lever

Tool No.	Nomenclature
T.171114	Extractor, for removing trunnion pins
*T.171267	Spanner, for tightening outlet union in body
*T.172608	Tool, for assembling bronze insert for amplifier valve to body
*T.173567	Tool, for assembling jet tube to restricting orifice
*T.174335	Spanner, for control piston screw
*T.174337	Tool, for assembling control cylinder liner into pump body
*T.174338	Tool, for fitting and dismantling slave cover and control cylinder end cover
T.174670	Tool, for assembling oil seal housing
T.174671	Base, for assembling piston rod
T.174672	Tool, riveting for assembling piston rod link
T.174673	Spanner, for assembling valve plunger, spring and peg to pump body
T.174674	Mandrel, for assembling rocker lever torsion hinges to rocker lever plate
T.174675	Spanner, for tightening assembled orifice to rocker lever plate
T.174677	Tool, for assembling and removing trunnion pins
T.174678	Key, for assembling delivery adjusting screw to body
T.174680	Adapter, test rig, for assembling to pump inlet before calibrating on rig
T.174681	Screwdriver, for adjusting slotted screw under amplifier valve
T.174683	Spanner, for locking control piston stop in end cover
T.178981	Stand, for rotor
T.182198	Extractor, for dismantling oil seal housing
T.185243	Tools, for inserting quill shaft in rotor
T.185244	Tools, for removal of spring ring, shim washer and rubber seal from quill shaft
T.188751	Guide, for assembling camplate housing assembly over quill shaft
T.188752	Guide, for removing camplate housing assembly over quill shaft
	Rig, calibration Rig, endurance

*Tools also used with ball type pumps.

†This is normally supplied with the calibration test rig.

6. Slave nuts, washers, etc., should be used in those instances where components are assembled temporarily to enable sound parts to be fitted on final assembly.

CHECKS AND PRECAUTIONS BEFORE DISMANTLING

7. Study any compaints reported with the fuel pump and carefully examine the exterior of the unit for any visible signs of damage, e.g. broken locking wire, and check that all parts have been securely covered to prevent the entry of any foreign matter into the interior of the pump.

8. Examine all exposed threads to ensure that no damage has been caused in transit.

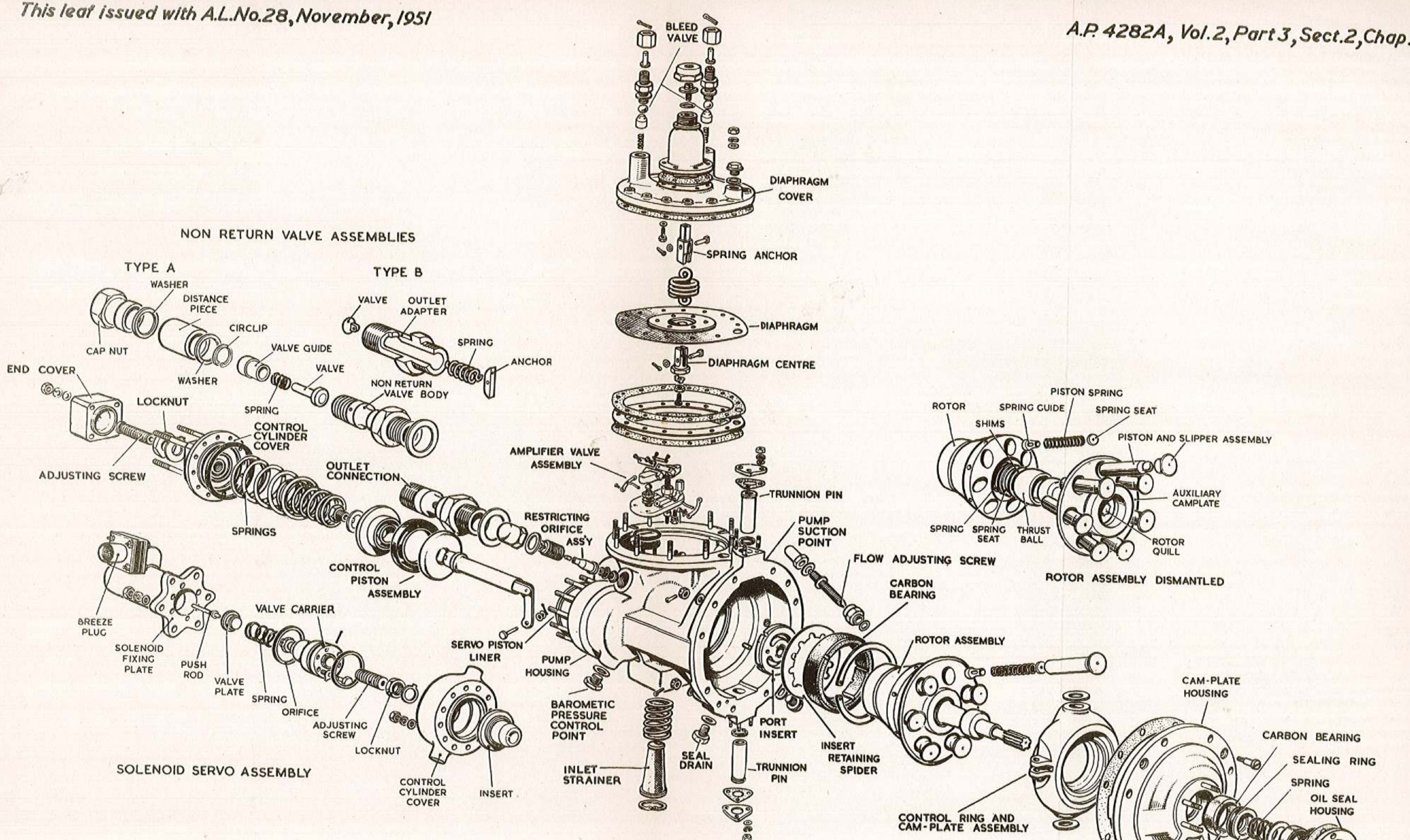


Fig.1 Dismantled view of pump

9. Carefully examine the interior of any dust caps removed, for the presence of foreign matter may seriously damage the pump. (If it is suspected that foreign matter is present, it is advisable to continue with the strip of the pump omitting the preliminary calibration tests.) The unit will contain inhibiting oil which should be spilled into a container before running on the test rig.

10. Remove the installation fittings from the pump and if the pump is in good running condition it should be mounted on the test rig as for final calibration (para. 270).

11. Proceed to calibrate the pump as described in para. 222.

12. Should any peculiar noises be heard during initial calibration, indicating a damaged condition, the motor on the rig must be stopped and the pump completely dismantled as described in para. 15 to 76.

13. If the pump is functioning correctly, the calibration test should be completed. The performance is a good guide to the condition of the unit and will indicate parts requiring attention.

14. The pump must then be completely dismantled.

DISMANTLING THE PUMP

15. It is advisable to have small receptacles or boxes in which all parts of separate units such as nuts, washers, bolts, springs, screws, etc., may be stored until required again.

16. Cut and remove all locking wire.

Removing the installation connections

17. Remove the pump inlet and outlet connections except for the pump outlet body and washer ; this is left in position to enable the unit to be mounted on the dismantling fixture.

18. Insert the end of a pair of small-nosed pliers into the holes of the circlip securing the spring-loaded strainer in the pump inlet connection and withdraw the circlip, conical strainer and spring. (These parts may not always be fitted).

19. Mount the pump on the stripping fixture T.129661, as shown in Chap. 1, fig. 3, the pump outlet connection body in the outlet port being lowered vertically downwards into the locating boss of the fixture, and the knurled wheel turned to locate its plunger with the inlet port in the pump housing. The quill shaft of the pump is vertically uppermost, the fixture being locked by the upper locking lever.

20. Remove the bleed connections. One or two may be fitted on the diaphragm cover, and in some units may be in the form of a tapping off the trunnion housing. Some bleed points have a flexible extension fitted to facilitate accessibility.

21. Extract the four split pins securing the nuts to the camplate housing securing bolts. Using a narrow shanked screw driver, to avoid damaging the counterbored holes, unscrew the four 2 B.A. screws securing the camplate housing to the pump housing and remove, together with the castellated nuts and plain washers. Note the difference in length and the location of the two pairs of screws.

22. Remove the camplate cover. Lower the stripping guide, T.188752, similar to that shown in Chap. 1, fig. 25, over the rotor quill shaft to protect the oil seals during withdrawal of the camplate housing. On no account must any tool be inserted between the contact faces of the cover and the pump housing in an effort to lever this cover free, as serious damage may be caused to the sealing face. A series of gentle taps with a hide hammer on the side of the camplate cover in a direction away from the pump housing will be sufficient to free the cover from the pump housing.

23. Lift off the gasket interposed between the camplate housing and pump housing flange.

Dismantling the camplate housing

24. Cut the locking wire passing through the six 4 B.A. nuts which secure the oil seal housing to the camplate housing, and remove the six nuts together with plain washers.

25. Lift off the seal housing, complete with carbon faced seal, sealing ring, spring and rotor oil seal, and remove the gasket interposed between the oil seal and camplate housings.

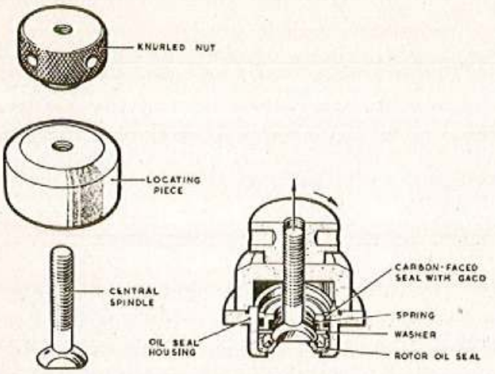


Fig. 2. Dismantling the oil seal housing, using tool T.182198

26. Carefully remove the carbon bearing from the camplate housing.

27. If necessary carefully remove the carbon faced seal with the sealing ring, spring, and rotor oil seal from the oil seal housing using the extractor T.182198 illustrated in fig. 2.

Removal of the control ring and camplate assembly

28. Remove the ¼ in. B.S.F. cap-nut from the flow adjusting screw. This screw is inclined into the pump housing on the opposite side of the pump to the nameplate and forms a stop for the control ring, thereby limiting the maximum fuel flow.

29. Slacken the ¼ in. B.S.F. lock-nut and the flow adjusting screw by the box key T.174678, until it is no longer in contact with the control ring.

30. Extract the split pin from the link pin, which secures the piston rod to the control ring lugs. A protective plate should be placed on the pump body flange adjacent to the link pin, to enable the necessary leverage to be obtained without damaging the machined facing for the camplate housing.

31. Carefully drive the link pin clear of the lugs on the control ring and the link by a drift slightly smaller in diameter than the link pin, taking care to retain the shim washer inserted on the drilled end of the link pin. Examine the shim washer and link pin for damage.

Note . . .

On types embodying Lucas Mod. CP.223 the link pin is shimmed to ensure that a 0·0015 in. feeler does not pass between head of link pin and control ring lug. Record the number of shims fitted to ensure correct replacement.

32. Remove the three 4 B.A. nuts securing the cover plate of each trunnion pin to the pump housing, together with the three grover washers and plain washers, and remove the cover plate and gasket. Screw the extractor T.174677 into each trunnion pin in turn (*fig.* 3), and withdraw the trunnion pins from the pump housing taking care to retain the shims on the trunnion pin interposed between pump body and control ring. If difficulty is experienced in removing the trunnion pins, it is advisable to use the extractor T.171114 as illustrated in fig. 3.

33. Carefully lift the slipper camplate assembly out of the pump body.

Removing and dismantling the rotor

34. Lift out the rotor assembly complete from the pump housing and immediately

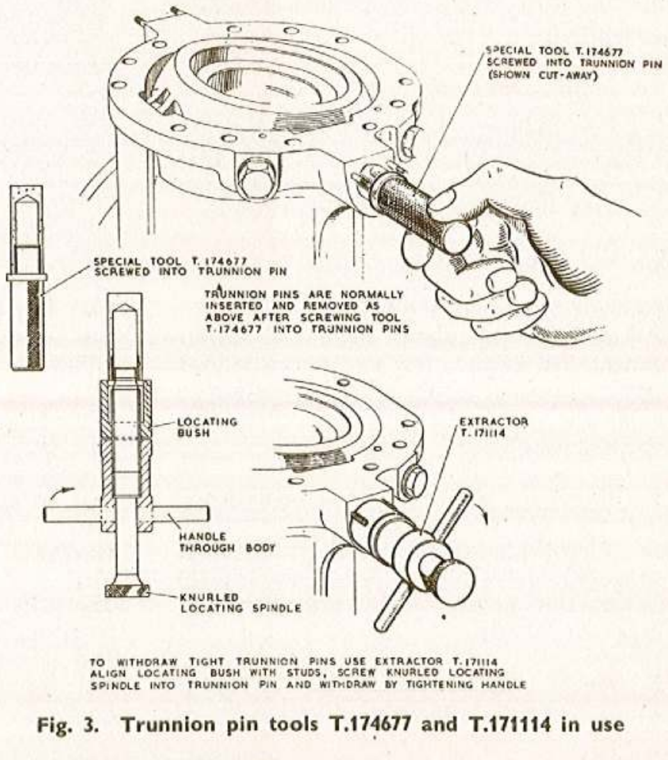


Fig. 3. Trunnion pin tools T.174677 and T.171114 in use

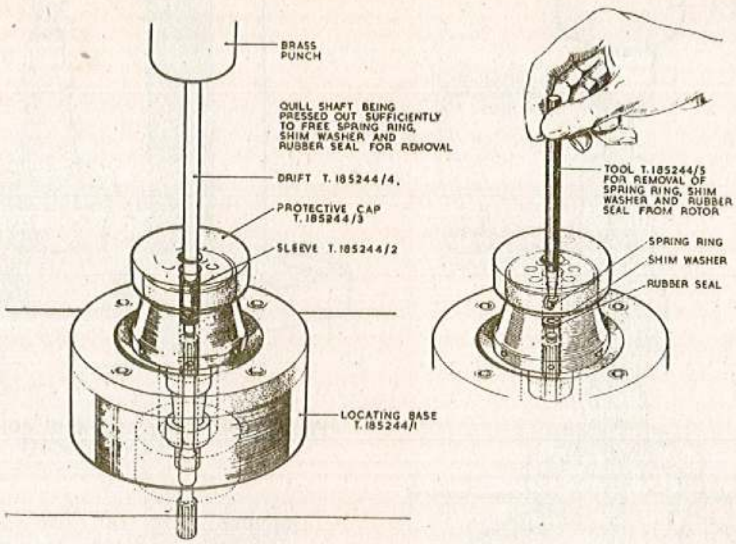


Fig. 4. Removal of spring ring, shim washer and rubber seal from rotor quill shaft, using tool T.185244

place the rotor assembly on the stand T.178981.

35. Remove the piston and slipper assemblies, spring seats and piston springs from the rotor assembly. Note the respective bore of the rotor from which each piston is removed and place each piston on the stand T.157037. Lift off the auxiliary camplate, thrust ball, shims, spring and spring seat. Remove the spring guides from the rotor piston bores by gently tapping with a drift inserted in the small end of the rotor bore.

36. Refit each rotor piston in its respective bore to ascertain that it reciprocates freely without side play or binding. Place the pistons on the stand as mentioned in previous paragraph.

37. If the quill shaft is damaged or shows sign of corrosion, it is to be removed from the rotor (*fig.* 4) and a replacement fitted in the following manner :—

(1) Position the locating base with the tufnol locating ring T.185244/1 on the bed plate of the press, and lower the rotor, quill shaft downwards, on to the base. Place the protective cap T.185244/3 over the rotor port insert face.

(2) Lower the drift T.185244/4 with sleeve T.185244/2 into the axial hole in the rotor. Insert a brass punch in the hand press and lower on to the drift in the rotor, applying sufficient pressure to start movement of the quill shaft and to free the rubber seal, shim washer and spring ring.

(3) Lift the press, withdraw the drift and use tool T.185244/5 to extract the spring ring, shim washer and rubber seal.

(4) Reposition the rotor on the press, as in (1), and again lower the drift with sleeve into the axial hole in the rotor. Carefully press the quill shaft fully out of rotor.

(5) Position the base with the pilot T.185243/1 on to the bed plate of the press and lower the rotor, port insert face downwards, in position fig. 5.

(6) Place the locating sleeve T.185243/3 over the rotor extension, select a new quill shaft and lower the shaft through the sleeve into the rotor.

(7) Insert the punch, T.185243/4, (with brass pad) in hand press and lower on to quill shaft firmly and press fully home to the pilot stop.

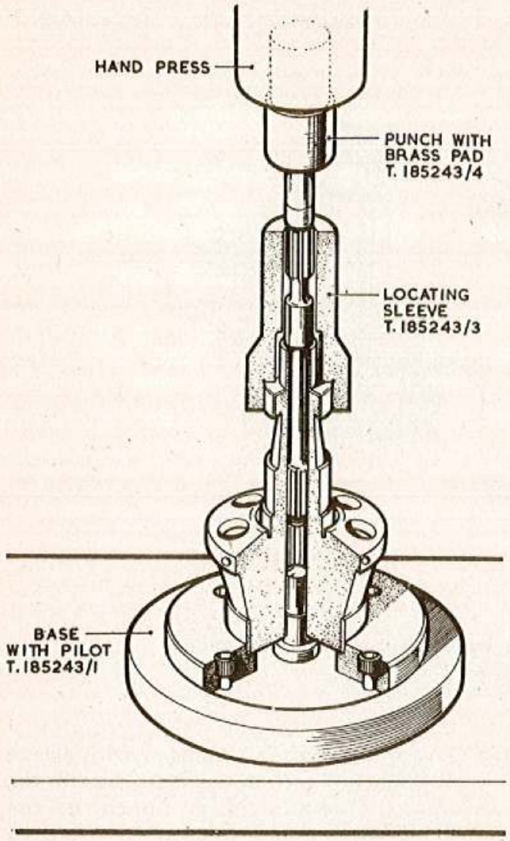


Fig. 5. Inserting quill shaft in rotor, using tool T.185243

(8) Remove the rotor complete with quill shaft from the press, place the protective base on port insert face and check the height of the rotor quill on height gauge G.55011 (*fig.* 6).

(9) Check the quill shaft in the rotor for concentricity using gauge No. 55010 (*fig.* 7), with a standard dial indicator and stand. If not concentric, remove the quill shaft from the rotor as described above, ignoring all reference to the rubber seal, shim washer and spring ring, which are not yet in position. Turn the quill shaft through 180 degrees (with regard to spline engagement in the axial bore of the rotor) and refit as in (5), (6) and (7), and again check the height and concentricity. If unsatisfactory fit a new quill shaft and recheck.

(10) When satisfactory, lower the rotor on to press as detailed in (1). Lower the rubber seal and shim washer into the axial bore of the rotor, and place the spring ring on the centre spindle T.185243/5 of the two-piece assembly tool, as shown in fig. 8, lower into the axial bore of the rotor and lock the spring ring over the quill shaft with the hollow drift T.185243/6. Withdraw the two-piece tool.

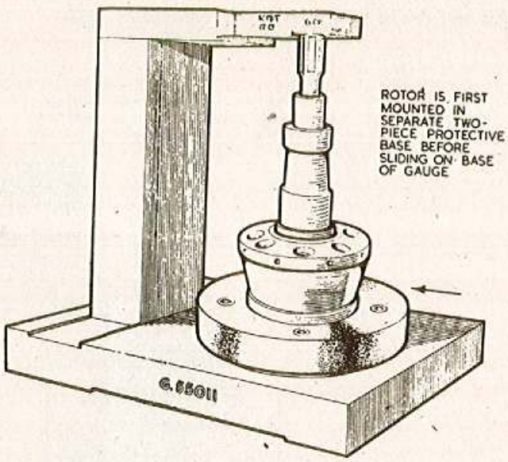


Fig. 6. Checking height of quill shaft, using gauge G.55011

(11) Lift the rotor off the press and again check the concentricity of the quill shaft.

(12) Subject the quill shaft to an end load of about 100 lb. per sq. in. and again check the height of the quill shaft. If the quill shaft has moved, remove and fit a replacement and effect the checks already described.

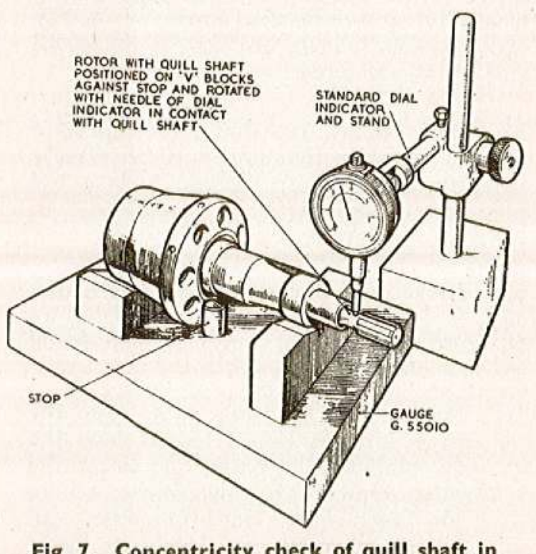


Fig. 7. Concentricity check of quill shaft in rotor, using gauge G.55010

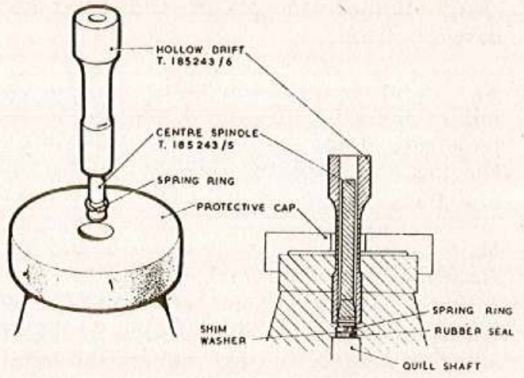


Fig. 8. Assembling spring ring into recess in quill shaft

Rotor piston bore, check for wear

38. Check the rotor piston bores with a standard clock gauge, as shown in Chap. 1, fig. 14, each bore having four readings taken.

39. Disengage the circlip securing the carbon bearing, spider and port insert inside the pump housing with the tool T.157039. The insertion of the pointed end in the hole in the circlip will enable it to be freed from its groove and withdrawn from the pump housing.

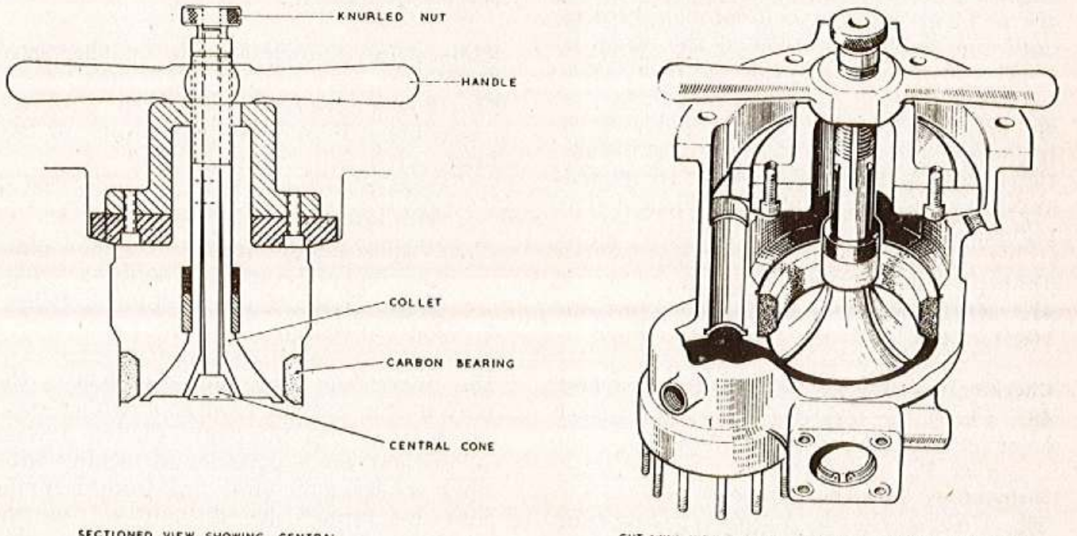
Checking the carbon bearing clearances

40. The clearance between the carbon bearing and the body should be between 0·0005 in. and 0·0015 in. The carbon bearing is a selective fit in the pump body and in the event of damage, the replacement must be a good push fit.

41. Firmly place the fingers of each hand on the inner diameter of the carbon bearing, press outwards and at the same time lift to remove the bearing from the pump housing. If difficulty is experienced in removing the carbon bearing use the extractor T.127645 illustrated in fig. 9.

42. Fit the carbon bearing on to the end of the rotor, place on the gauge G.50185, as shown in fig. 10, and check that the diametral clearance is between 0·007 in. and 0·008 in. For this check the rotor is located with its axial bore over the tapered plunger and split sleeve, with the lock-nut slackened off. With the rotor in position the lock nut is tightened by means of the screwed-in tommy bar. This will tend to pull tapered plunger out and cause the split sleeve to grip the walls of the rotor bore. Check the clearance in various positions with dial indicator by turning rotor assembly with the tommy bar in the lock-nut.

43. The other end of the tool mentioned in para. 39 may now be used to lift out the spider situated beneath the carbon bearing in the pump body.



SECTIONED VIEW SHOWING CENTRAL CONE EXTENDED TO ALLOW COLLET TO CLOSE FOR INSERTION THROUGH CARBON BEARING IN PUMP BODY

CUT AWAY VIEW SHOWING EXTRACTOR LOWERED INTO PUMP BODY WITH KNURLED NUT TIGHTENED TO ENGAGE COLLET WITH UNDERSIDE OF CARBON BEARING, WHICH MAY THEN BE WITHDRAWN BY TIGHTENING HANDLE

Fig. 9 Withdrawing carbon bearing, using tool T.127645

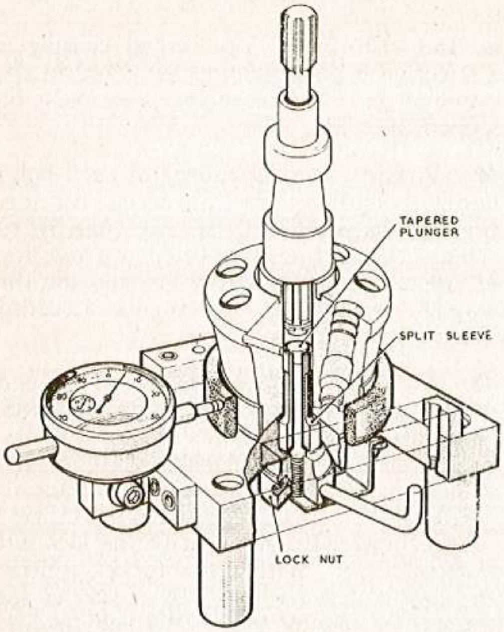


Fig. 10. Checking clearance between carbon bearing and rotor journal, using gauge G.50185

44. Remove the port insert and stabilising tube. Two locating dowels remain in the pump body ; these may or may not be free to drop out ; in the former instance they are to be removed and retained.

Removal of the diaphragm cover

45. Slacken the upper lock lever of the stripping fixture and allow the vertical centre pillar to be moved through 90 deg. until the diaphragm cover of the pump is uppermost. Again tighten the lock lever.

46. Remove the ½ in. B.S.F. lock nut on the top of the spring housing, unscrew the twelve 2 B.A. nuts, and remove the grover and plain washers and lift off the diaphragm cover.

Testing the tappet clearance

47. Effect this check as described in para. 106 to 110.

Checking the total tail lift of the rocker lever

48. Check the total tail lift of the rocker lever as described in para. 155A (8).

Dismantling the diaphragm cover

49. Unscrew the 2 B.A. governor adjusting screw from the spring anchor, using the spanner T.160988, and remove the screw together with the rubber sealing washer. The diaphragm assembly is thus detached from the cover itself and may be lowered clear. Remove the gasket joint interposed between them.

50. Bend back the tab-washer locking the nut to the adjusting screw inserted in the underside of the diaphragm centre, slacken the lock-nut, unscrew the adjusting screw and remove together with the tab-washer.

51. Extract the split-pin from the link pin securing the upper end of the governor spring to the spring anchor. Remove the washer and tap out the link pin to detach the spring from its upper anchorage point.

52. Ensure that the diaphragm centre is free in the diaphragm.

53. Extract the split pin from the remaining link pin to detach the spring from its lower anchorage point, and free the diaphragm centre from the diaphragm.

54. Cut the wire locking the six 4 B.A. screws which secure the spring housing to the diaphragm cover and remove the screws, together with the aluminium joint washers.

55. Separate the spring housing from the diaphragm cover, and examine the jointing gasket for damage.

56. Lift off the gaskets and diaphragm outer ring interposed between them, from the diaphragm cover mounting studs in the pump housing.

Removing and dismantling the amplifier valve assembly

57. The amplifier valve, which is of the cross torsional hinge design, is one of two basic types :—

(1) With steel base plate and rocker lever with integral bridge piece.

(2) With either bronze or steel base plate and rocker lever with built on bridge piece. Each is described in the following paragraphs :—

58. Insert the fibre plug T.157038 in the port in the amplifier valve chamber communicating with the pump suction passage to prevent small particles of locking wire, nuts, screws, split pins, etc., from dropping into it during the dismantling of the amplifier valve assembly. A typical assembly is shown dismantled in fig. 11. Cut all locking wire and knock back the lips of all tab-washers locking the nuts which secure the amplifier valve base plate to the pump housing, unscrew and remove the nuts and tab-washers. Lift out the complete amplifier valve assembly.

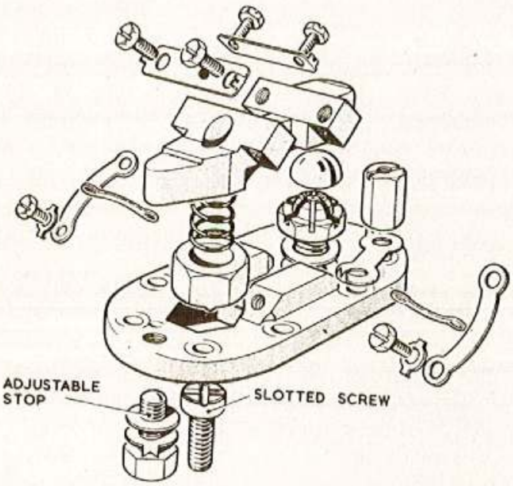


Fig. 11. Dismantled view of amplifier valve assembly showing adjustable stop and slotted screw

59. If complete dismantling of the amplifier valve is necessary proceed in accordance with the operations given in either para. 59A or 59B.

Steel base plate with integral bridge piece

59A. (1) Turn back the tab-washer on the underside of the amplifier valve base which locks the adjustment screw forming the stop at the tail end of the rocker lever. Unscrew this adjustment screw and remove, together with the tab-washer and shim washers. Record the thickness of the shims fitted for guidance when reassembling.

(2) Position the amplifier valve in the fixture T.170761 (*fig.* 12), but do not secure with the Vee block. Open the lips of the two tab-washers locking the 6 B.A. screws securing the hinges to the bridge piece, and remove the screws and tab-washers. Remove the rocker lever, taking care to retain the half ball.

(3) Turn back the lips of the four tab-washers locking the four 6 B.A. screws which secure the hinges to the base

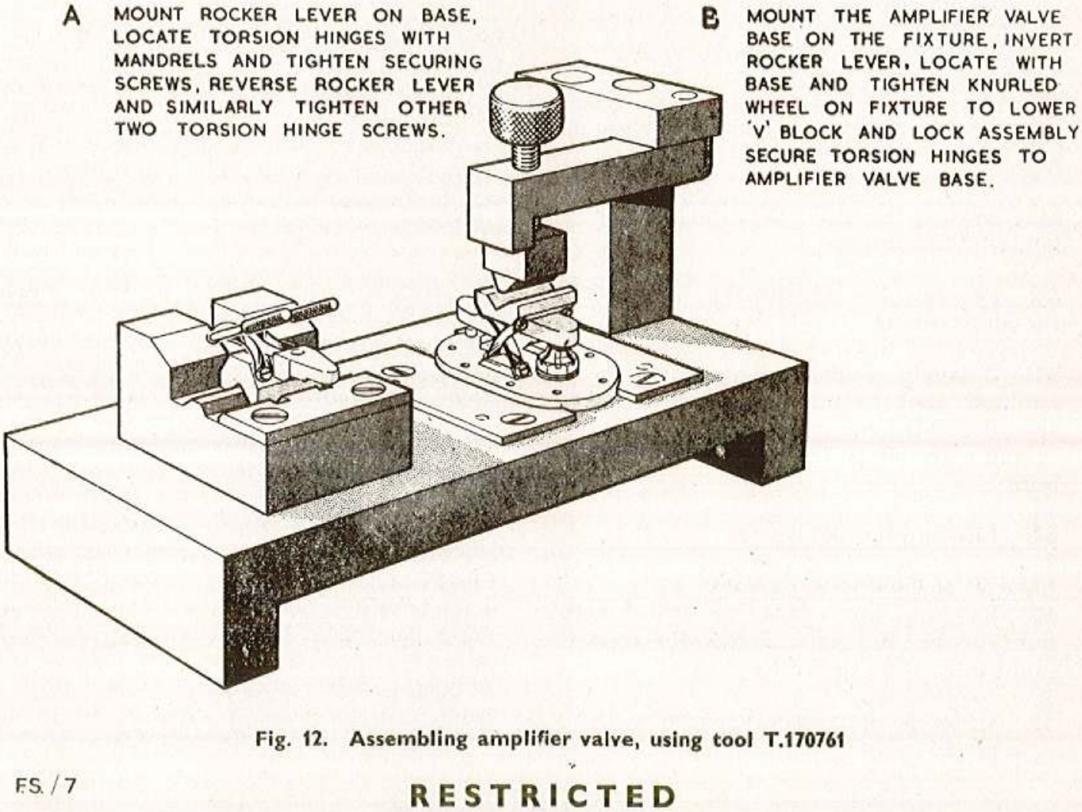


Fig. 12. Assembling amplifier valve, using tool T.170761

plate, and remove the screws, tab-washers and hinges.

(4) Turn back the lip of the tab-washer securing the orifice to the base plate and unscrew the orifice using spanner T.174675 and remove together with shim washers and tab-washer. Record the thickness of shims for guidance in reassembly.

Bronze or steel base plate and rocker lever with built-on bridge piece

59B. (1) If an adjustable stop is fitted, remove as in para. 59A(1).

(2) Position the amplifier valve in the fixture T.170761 as in fig. 12, and secure in position with Vee blocks. Turn back the lips of the tab-washers locking the four 6 B.A. screws which secure the hinges to the base and remove the screws, tab-washers and hinges. Remove the rocker lever, taking care to retain the half ball.

(3) Locate the rocker lever in the fixture as in fig. 12, turn back the lips of the tab-washers locking the 6 B.A. screws which secure the hinges to the bridge piece, and remove the screws, tab-washers and hinges.

(4) Turn back the lip of the tab-washer locking the orifice, unscrew the orifice and remove together with the tab-washer and shims. Record the thickness of shims for guidance in reassembly.

60. Lift out the spring, upon which the rocker lever normally rests, from the pump housing.

61. Remove the spring cup which normally houses the spring.

62. Unscrew the adjustment screw from the brass insert.

63. Carefully remove the rubber seal, situated above the flat strainer, by the special pointed tool mentioned in para. 39, taking care not to damage the strainer or bore.

64. Lift out the flat strainer.

Removal of the restricting orifice

65. Unscrew the restricting orifice cap-nut (½ in. B.S.P.), and withdraw the aluminium washer from the orifice sleeve.

66. Unscrew the restricting orifice sleeve or retainer by inserting the box key driver T.142854 in the groove of the sleeve. Extract the orifice together with the jet tube.

67. Remove the wire-wound strainer from the restriction orifice port by tilting the pump off the stand to allow the strainer to drop into the open hand. Some pumps have a synthetic rubber ring interposed between the head of the strainer and the jet tube. Ensure that this ring is undamaged. Do not attempt to include a rubber ring in the earlier pumps as these are not chamfered to take it.

Removal of the barometric pressure control connection

68. Remove the ⅛ in. B.S.P. plug together with washers.

69. Remove all the remaining cap-nuts, unions, etc., while the pump housing is still mounted on the stand.

70. Remove the pump housing from the stripping fixture and place on the bench with the flange of the pump body to which the camplate housing is normally fitted, facing downwards. Remove the pump outlet connection body if necessary.

Removal of the control piston assembly

71. Some types have a control cylinder cover with studs upon which is secured an additional end cover. This control cylinder cover incorporates an adjustable piston stop secured with lock-nut and tab-washer. A seal is interposed between pump body and control cylinder cover.

72. Remove the twelve 2 B.A. nuts, grover washers and plain washers securing the control piston end cover to the pump housing. These should be slackened off evenly all round, a few threads at a time, otherwise the pressure of the two springs between the end cover and the control piston will tend to tilt the end cover and cause it to foul the securing studs. Tool T.174338 (*fig.* 13) must be used for this operation. Remove the cylinder end cover. Finally remove all nuts except two in diametrically opposite positions on the cover; these can then be removed while hand pressure is applied to take the load of the springs, and to centralise the cover on the studs until the cover is clear of the pump housing, when it may be removed.

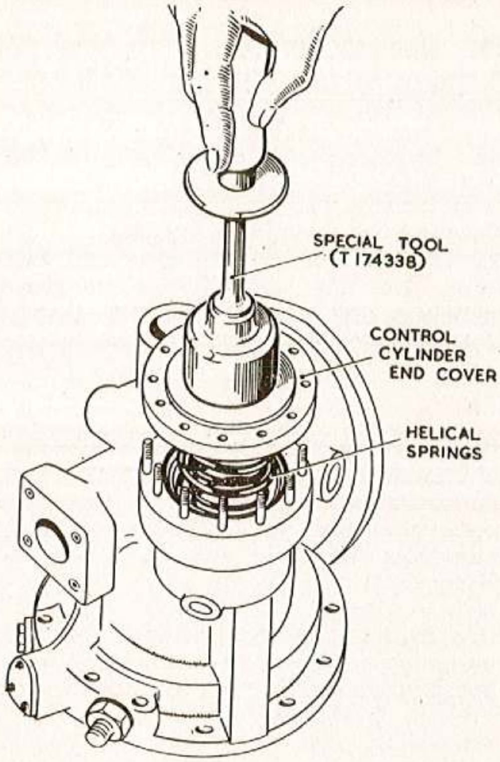


Fig. 13. Fitting and removing control cylinder end cover, using tool T.174338

73. Remove the rubber joint ring interposed between the end cover and the mating face of the control cylinder housing of the pump.

74. Lift out the two helical springs from the control piston cylinder.

75. Invert the pump to allow any surplus fuel to drain from the control piston cylinder.

76. Ensure that the link riveted to the piston rod is straightened to form a continuous line with the latter and, by inserting the hand in the rotor chamber of the pump housing, carefully ease the control piston out of its cylinder by applying pressure upon the piston rod, taking care the link does not foul the control piston rod bore during removal of the piston and rod assembly. This assembly is not normally dismantled (para. 137), but if necessary a special spanner T.174335 and base T.174671 (*fig.* 14) must be used when removing or fitting the securing screw.

Note . . .

On some types a minimum flow stop is fitted in the head of the control piston; for this type a supplementary tool passing inside the box spanner is provided to facilitate adjustment.

CLEANING

77. It is important that the work bench used should be kept scrupulously cleaned and free from all dirt, swarf, etc. It is recommended that the bench be covered with zinc sheeting or linoleum to facilitate cleaning, and that several clean containers be available in which to keep the various parts removed.

78. All parts must be thoroughly cleaned and washed before reassembly, using a parawash machine having a kerosine bath and spray gun. *Hard brushes, cleaning cloths, or abrasives of any kind must not be used.*

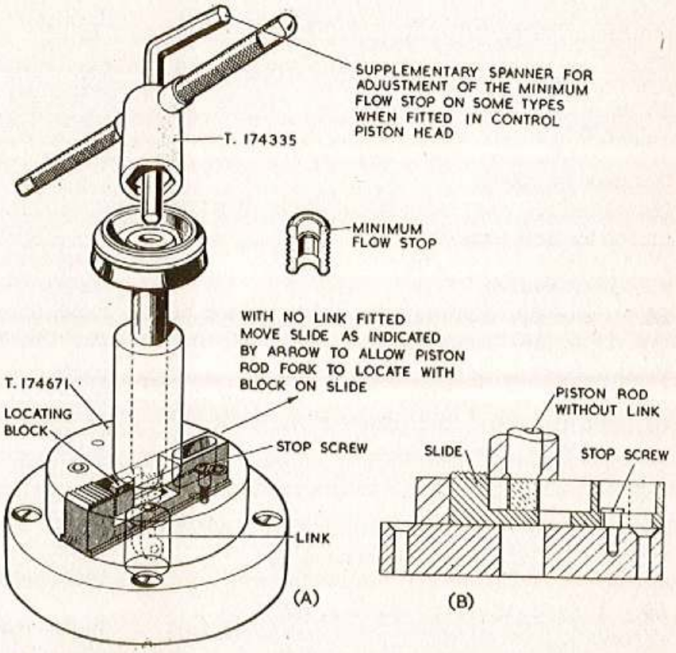


Fig. 14. Piston rod located in base T.174671, while tightening piston screw with spanner T.174335 (A) with link, (B) without link

INSPECTION

General

79. Dimensional detail checks are not included in this section, but must be carried out by reference to the Schedule of Fits and Clearances, Vol. 2, Part 2, of this Air Publication.

80. The detail components are grouped as nearly as possible into sub-assemblies.

81. Separate details which do not form part of a sub-assembly are dealt with nearest to their associated group, and the viewing and inspection checks are listed to correspond with the normal dismantling sequence of operations.

Redundant and consumable parts

82. It is usual during inspection to reject all parts rendered redundant by the embodiment of essential modifications, and the inspector must thus have complete information concerning modifications so that redundant parts can be rejected.

83. Tab washers, split pins, gaskets and other consumable parts will be rejected during dismantling.

Scores and surface damage

84. The standard of acceptance when dealing with scores and other forms of surface damage may vary according to the number of hours the pump is to run, the purpose and region of operation, accessibility of spares and the issue of up-to-date instructions.

Installation fittings

85. Ensure that all installation fittings are clean and sound.

Camplate housing

86. Carefully examine the sealing face of the camplate housing for scratches and marks likely to affect the seal.

87. Ensure that the six 4 B.A. nuts are sound, that the washers are not cracked and the threads of the studs are undamaged.

88. Examine the rotor oil seal and renew if swollen, distorted, or damaged.

89. Ensure that the sealing rings in the carbon faced seal, and those between the seal housing and camplate housing, are free from damage.

90. Ascertain that the flange of the oil seal housing is flat, and free from damage.

91. Ascertain that the carbon faced seal is sound, also that the helical spring is free from damage.

92. Examine the carbon bearing for freedom from cracks and chips.

Camplate and control ring assembly

93. Examine the control ring and camplate assembly visually for condition. Ascertain that there is no visible damage due to pick-up from the piston slippers, or excessive discolouration through over-heat ing.

94. Examine the trunnion pins for signs of fretting, wear, or damage of any kind. If replacements are fitted, it should be noted that these are a selective assembly and those selected should be a good fit. Note that a slight amount of stain is always present on the trunnion pins after running, but this can usually be removed by polishing lightly with rouge or metal polish, ensuring that all surplus cleaning medium is thoroughly cleaned off before assembling.

95. Ascertain that the trunnion pin cover plates bed down evenly, and examine the oil seals for freedom from distortion and damage.

96. Carefully examine the trunnion pin shims for damage, wear and cracks, and if these pins are to be replaced proceed as follows. Align the control ring and camplate in its normal fitted position in the pump housing, namely in alignment with the trunnion pin bores, and insert the trunnion pins into both pump housing and control ring, using the tool T.174677 (*fig.* 3). Push the camplate over to one side of body and measure with a feeler gauge the clearance between the control ring and the inside of the pump housing. Select shims to give a diametral clearance of between 0·005 in. to 0·010 in. Remove each trunnion pin, place the selected shims evenly on each side of the control ring and again insert the trunnion pins into both pump body and control ring and check that the specified clearances still obtain.

Rotor assembly

97. Carefully examine the plated port face or underside of the rotor which normally bears against the port insert in the pump housing, (cadmium plating on earlier pumps, silver plating on later pumps). This face must be quite flat and clean. Some wear of the plating may occur after service, but no evidence of bronze showing through the plating is permissible on this type of pump. Carefully examine both the large and small journal bearing surfaces on the rotor for evidence of pick-up, cracks, or excessive heat discolouration. Ensure that the thrust ball is sound, its faces clean and the spherical surface smooth. Ensure that the spring seat is sound and clean, and the spring free from sharp edges and fractures.

98. Examine the piston bores for freedom from scores and for any foreign matter in the oil relief grooves, and check the diameter of the piston bores in four positions with a clock gauge, as shown in Chap. 1, fig. 14. The maximum worn clearance allowed between any one piston and bore is specified in the Schedule of Fits and Clearances.

99. Examine the pistons for ease of reciprocation in the bores and note any tightness; also examine for discolouration on the piston skirts and slippers. Inspect the plating in the piston bores in the rotor for scoring or evidence of pick-up; damaged bores should be marked with a pencil on the upper face of the rotor for subsequent detailed check.

100. Remove each piston in turn and wipe with clean muslin, noting from which bore each is removed. By placing these pistons on white paper, any tendency to surface corrosion or heavy scoring can be more readily discerned. Examine the spherical face of the piston slipper which makes contact with the camplate and ensure that the plating is intact and is not severely scored. Ascertain that the slipper pad swivels freely on the piston crown without binding. Ensure that the pressure feed hole in the centre of the slipper pad is free from obstruction. Check the float of the slipper on the piston to the Schedule of Fits and Clearances.

101. Examine the helical springs of the rotor pistons for sharp edges and fractures. Also ensure that the spring seat is sound and the pressure feed hole unobstructed.

102. Ensure that all radial drillings from the axial bore of the rotor are clean and free from any foreign matter.

103. Examine the piston spring guides for freedom from wear and fractures, and for burrs or sharp edges likely to cause damage to the springs.

104. Ensure that the carbon bearing is free from cracks, is not chipped, and that no foreign matter has accumulated on its underside.

105. Check the carbon bearing clearances as described in para. 40 and 42.

Diaphragm and cover assembly

Tappet clearance check

106. This check is normally effected with the amplifier valve assembly fitted to the pump housing and with the diaphragm and cover assembly complete. Mount the tappet clearance gauge G.38745 across the studs in the pump housing to which the diaphragm cover is normally fitted and secure, as shown in Chap. 1, fig. 27, ensuring that the three gaskets and diaphragm outer ring are fitted on the flange of the pump.

107. Slacken the knurled locking screw in the side of the gauge to free the central plunger. Press the latter down until it just makes contact with the rocker lever in its seated position, and then tighten the knurled screw to lock the plunger.

108. Invert the detached diaphragm cover and place it on the other half of the setting gauge G.38745. Remove the tappet clearance gauge from the pump housing studs and place it in the inverted position on the diaphragm cover. Ensure that the dowel pins in the tappet clearance gauge are in correct alignment with the holes in the diaphragm cover.

109. Pull up the swing bolts and pull the two halves of the gauge together by tightening the knurled locking nuts, to clamp the diaphragm cover. Measure the clearance between the plunger of the gauge and the button of the diaphragm cover by means of a feeler gauge. The clearance should be 0·017 in. to 0·019 in.

110. This gap will be found to have reduced somewhat after service, and the tappet should be readjusted to give the correct clearance.

Diaphragm cover

111. If the diaphragm cover is dismantled proceed as follows :—Scrap and renew the rubber sealing washer beneath the head of the governor adjusting screw.

112. Ensure that the threads of both governor adjusting screw and control spring housing are undamaged.

113. Examine the contact faces of both control spring housing and diaphragm cover to ensure that these are not scored or damaged, otherwise some leakage of fuel may result.

114. Examine the bleed valve assemblies for cleanliness and freedom from damage ; the pressure test described in para. 164 is the method for ensuring that each assembly is satisfactory.

115. Examine the threads of the overspeed control plug for damage and the washer for cracks and damage.

116. Inspect the diaphragm centre and spring anchor, together with the spring anchor pins and washers, for general soundness. Scrap and renew the split pins.

117. If the tappet screw is disturbed, scrap and renew the tab-washer.

118. Carefully examine the spring for sharp edges and fractures.

119. Examine the diaphragm for damage or cracks.

120. Ensure that the diaphragm centre is free in the diaphragm.

121. Inspect the diaphragm outer ring for scores and scratches likely to affect the seal.

122. Scrap and renew all gaskets.

123. Examine the twelve 2 B.A. nuts, grover washers and plain washers, also the six 4 B.A. screws and the aluminium washers for freedom from cracks and damage.

Amplifier valve assembly

124. Discard all tab-washers. Ensure that the nuts securing the base plate to the body are sound.

125. Ensure that the adjustable stop screw (if fitted) is sound and clean, also that the shims are sound and free from fracture.

126. Examine the 6 B.A. screws securing the hinges to the base plate and bridge piece and ensure that these are sound and clean.

127. Ensure that the orifice is clean and sound, that its seat is optically flat and its lands and threads undamaged.

128. Ensure that the half ball is free from damage, and that it swivels freely in the socket in the rocker lever.

129. Examine the rocker lever spring for freedom from sharp edges and fractures.

Restricting orifice

130. Examine the orifice together with jet tube for cleanliness and freedom from damage.

131. Inspect the strainer for freedom from damage and corrosion or displacement of the wire.

132. Examine the $\frac{1}{4}$ in. B.S.P. cap-nut and ensure that the washer is free from cracks and damage.

133. Ascertain that the threads and slot of the orifice retainer or sleeve are free from damage and that no burr or rough edges exist.

Control piston assembly

134. Examine the piston-rod for damage, corrosion and frettage marks. Some fretting occurs after service and this can usually be removed by polishing lightly with rouge or metal polish.

135. Examine the servo piston oil seal for distortion, swelling or other damage.

136. Inspect the seal retaining ring and the control piston itself for any sharp edges, burr or other damage, and the presence of foreign matter.

137. This assembly is not normally dismantled, but if the securing nut has for any reason been removed, the spanner T.174335 and base T.174671 will be required (*fig.* 14, para. 161). Scrap and renew the tab-washer and examine the threads of the nut for damage.

138. Carefully inspect the rivet securing the link to the piston rod end to ensure that it is secure and that no burr or damage exists. Operate the link to and fro to ensure that there is complete freedom of movement without perceptible end play or fouling. Ensure also that the link is clean and free from burrs.

Remaining details

139. Examine the two helical springs for fracture, sharp edges, or signs of rust.

140. Inspect the control cylinder end cover for cleanliness and freedom from damage. Ensure that the no-flow adjusting screw is sound, that its threads are clean and undamaged, and that its axial hole is unobstructed. If the screw is removed discard the tab-washer, ensure that the lock-nut threads are clean and undamaged, and the flats sound.

141. The seal between the control cylinder cover and the main body should be discarded. Ensure that the control cylinder cover is sound, its axial hole clean and unobstructed, and its threads undamaged. Examine the four nuts securing the end cover to the control cylinder cover ; ensure that their threads are undamaged and their flats sound. Inspect the shims for freedom from cracks and distortion, and ensure that the grover washers are sound.

Pump housing

142. Make a close examination of the pump housing generally, ensuring that all machined faces are smooth and unscored. Ensure that all studs are tight and the exposed threads are sound.

143. Examine all internal tappings for cleanliness and condition.

144. Carefully examine the servo piston bore or sleeve for scores and other damage likely to affect the seal of the servo piston.

145. Examine the bore of the control rod and ensure that the felt washer at the piston end of the control rod bore is sound and not distorted.

146. Carefully examine the port insert. Test for parallelism of the port insert with the pump housing flange by using the test bar and clock gauge G.51239, as shown in Chap. 1, fig. 17. Ensure that the parallelism reading (quoted in para. 179) is maintained.

147. When the insert is removed, examine for cracks, pitting, etc., and the presence of foreign matter.

148. Ensure that the conical strainer is unbroken and is clean and undamaged.

149. Examine the strainer spring for freedom from sharp edges and fractures.

150. Inspect the securing circlip for freedom from distortion and damage, also its groove in the pump housing inlet port for burrs.

151. Examine the insert retaining spider for freedom from cracks and fractures, and the carbon bearing retaining circlip for distortion and burrs.

152. Ensure that the circlip groove in the rotor chamber of the pump housing is undamaged and free from burrs.

Magnetic crack detection

153. If any doubt exists as to the soundness of any of the following parts they should be subjected to a magnetic crack detection test. Control ring assembly, quill shaft, rotor (steel journals only), spring guides, port insert, trunnion pins, control piston rod assembly, link pin, orifice and jet-tube.

REASSEMBLING THE SUB-ASSEMBLIES

154. Before reassembly of the pump is commenced, various sub-assemblies must be completed, and these are dealt with first so that the final assembling of the pump may be treated in an unbroken sequence of operations.

Assembling the amplifier valve

155. The design of this valve varies slightly (para. 57) but the assembling instructions are similar, the type with the steel base plate and rocker lever with integral bridge piece is dealt with first, and then the type with the bronze or steel base plate with built-on bridge piece.

Steel base plate and rocker lever with integral bridge piece

155A. (1) Partly bend up the lips on the tab-washers under the 6 B.A. screws securing the torsion hinges to the base plate and rocker lever, two for the four upper screws, and four for the four lower screws.

(2) Fit to the tail end of the bridge piece two hinges, with their curved portions towards the lever, one tab-washer (to lock both screws) and make secure, finger tight, with two 6 B.A. screws.

(3) Fit to the orifice end of the bridge piece two hinges, with their curved portions lying outside the other two, one tab-washer (to lock both screws) and make secure, finger tight, with two 6 B.A. screws.

(4) Assemble to the amplifier valve base plate, shims, tab-washer and assembled orifice, using the spanner T.174675, but do not lock the tab-washer until later (sub-para. (8)).

(5) Assemble the half ball to the rocker lever, smearing a thin coating of white petroleum jelly on the spherical face of the half ball and in the socket of the rocker lever to enable the half ball to be retained in the rocker lever.

(6) Fit the base plate to the fixture. Assemble the rocker lever complete with half ball to the amplifier valve base plate, using the four assembly mandrels T.174674. Lock down the mandrels tightly, using a standard spanner. Use a feeler gauge to check the clearance between the half ball and the orifice ; this must be between 0·001 in. to 0·004 in. with the rocker lever level.

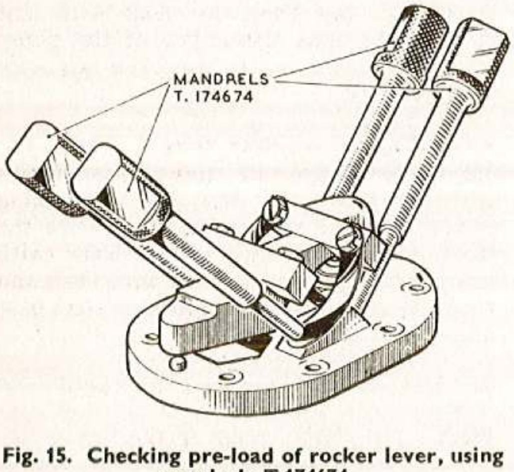


Fig. 15. Checking pre-load of rocker lever, using mandrels T.174674

(7) If this reading is not obtained, remove the four assembly mandrels and lift off the rocker lever from the amplifier valve base plate. Remove the orifice, using the spanner T.174675, remove the existing shims and re-shim as necessary to give the desired clearance. Again fit the rocker lever to the amplifier valve base plate and recheck the clearance. Repeat until satisfactory, then remove the mandrels one at a time, replacing each with a 6 B.A. screw and tab-washer. It is best to employ a fairly long narrow shanked screwdriver to fit these screws, the blade of which should be a good fit in the slot. By smearing a little petroleum jelly on the screwdriver blade, the screw can be positioned on the driver and located in its hole in the base with little dificulty. When turning up the lips of these small tab-washers, great care must be taken not to damage the hinges.

(8) Fit the adjustable tail stop with tab-washers and shims to give a gap of 0·025 in. to 0·040 in. between the tail of the rocker lever and the stop. When satisfactory lock the tab-washers on the tail stop and the orifice.

Bronze or steel base plate, with built-on bridge piece

155B. (1) Fit the rocker lever in the fixture T.170761 as in fig. 12, and locate the two hinges on the tail end of the bridge, curved portions towards the rocker lever, with two mandrels as shown.

(2) Secure the hinges to the bridge with two 6 B.A. screws and tab-washers. Tighten down the screws with the mandrels in position.

(3) Remove the mandrels and reverse the rocker lever in the fixture.

(4) Locate the two hinges on the orifice end of the bridge, curved portions outside the other two hinges, with mandrels as before. Secure the hinges to the bridge piece with two 6 B.A. screws and tab-washers. Tighten the screws with the mandrels in position.

(5) Assemble the orifice to the base plate with tab-washer and shims, but do not lock the tab-washer at this stage.

(6) Assemble the half ball in its socket in the rocker lever, as in para. 155A, sub-para. (5).

(7) Fit the base plate to the fixture as in fig. 12 and locate the bridge, with hinges in position on the base plate by the mandrels.

(8) Check the gap between the orifice face and the half ball ; this should be 0·001 in. to 0·004 in. and may be obtained by shimming below the orifice. If the base plate is fitted with an adjustable stop, the orifice may be locked by the tab-washer at this stage.

(9) Remove the mandrels one at a time, and replace each with a tab-washer and 6 B.A. screw, steadying the bridge in position by the Vee block on the fixture. Tighten the screws and remove the assembly from the fixture. Lock the screws with the tab-washers.

(10) If the adjustable tail stop is fitted, fit the stop screw with tab-washer and shims to give 0·025 in. to 0·040 in. gap between the stop and the tail of the lever. Lock the tail stop with the tab-washer.

(11) With the riveted type of stop, adjust by filing the stop pin to the required gap. When satisfactory, lock the orifice by the tab-washer.

Oil seal housing and camplate housing

156. Assemble to the camplate housing, the rotor carbon bearing, ensuring that the recess is in correct alignment with the bearing locating peg on the oil seal housing face. If the oil seal housing has been dismantled, first fit the rubber sealing washer to the carbon face seal. Lower these on to the spindle of the tool T.174670, with spring washer and rotor oil seal and press fully home by tightening the knurled nut (*fig.* 16). Insert the bearing locating peg and assemble the oil seal housing to the

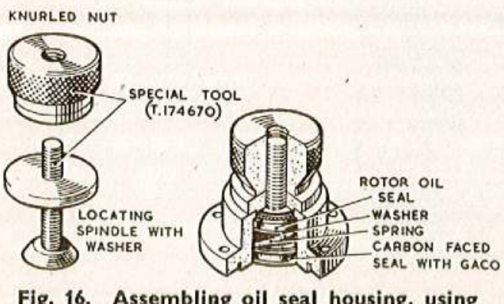


Fig. 16. Assembling oil seal housing, using tool T.174670

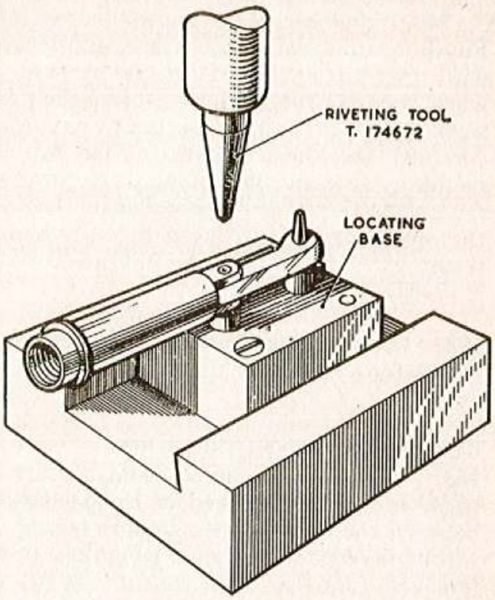


Fig. 17. Securing piston rod and link, using tool T.174672

camplate housing. Secure with the six 4 B.A. nuts and plain washers, then remove the tool.

Assembling the piston-rod and control piston

157. The piston-rod and control piston assembly will normally be available from the stores already built up, but these assembling instructions are given for guidance in instances of extreme urgency, when stocks of the assembly are exhausted, in which case this assembly may be built up if stocks of details are available.

158. Clean the inner bore of the piston-rod with a stiff spiral hair brush, and the para-wash machine.

159. Locate the link between the forked ends of the piston-rod, insert the bush and rivet, and roll over the latter to secure the link to the piston-rod end, (*fig.* 17).

Note . . .

This link may be changed if necessary without dismantling the piston details from its rod.

160. With the link facing downwards, slide the seal retaining ring on to the other end of the piston-rod against the flange with its cup uppermost and press fully home.

161. If the control piston has been dismantled, lower the piston-rod into the base T.174671 and secure as shown in fig. 14. Fit the piston seal to the piston and locate with the piston-rod. If necessary use a wheel press for this purpose. Obtain the tab-washer for the piston securing nut and carefully bend over the tip of the tab to facilitate subsequent locking and prevent damage to the control piston flange. Locate the washer and nut with the piston-rod, and secure with the spanner T.174335 and base T.174671 (*fig.* 14).

162. If the felt ring has been removed from the piston-rod bore a replacement must be fitted.

Renewing the control cylinder liner

163. In instances where a control liner is badly scored or damaged or leakage exists between the liner and the pump housing, it will be necessary for the existing liner to be removed and a replacement fitted as follows :—

(1) Withdraw the existing liner with the extractor T.128561.

(2) Inspect the edges of the replacement liner for burrs due to impact damage, and where necessary remove with a smooth file.

(3) Thoroughly clean the liner with the parawash.

(4) Insert the liner in the pump housing and gently tap in evenly all round, using a hide hammer, sufficiently to give the liner a square start into the pump housing.

(5) Use the tool T.174337 (*fig.* 18) in conjunction with a handpress until the liner is pressed firmly home to the base of the control or servo piston chamber in the pump housing.

Note . . .

Pressure tests for liner and seal must now be effected as described in the following paragraphs:—

(6) Ensure that the felt ring is correctly positioned in the recess in the control rod bore of the pump housing.

(7) Use the assembly bush T.147031 shown in Chap. 1, fig. 17, to protect the control piston seal and enable the control piston assembly (complete with piston-rod and link) to be lowered into position.

(8) Blank off the passage connecting the servo chamber with the orifice chamber using the plug T.162242.

(9) Mount the clamp on to the studs in the pump body around the control piston cylinder and tighten to ensure that the control piston is held at the bottom of its stroke while the test is being effected. Both plug and clamp are listed under T.162242, and illustrated in Chap. 1, fig. 31.

(10) Mount the pump on the hand pump and subject it to a fuel pressure of 200 lb. per sq. in., the fuel being supplied through the normal barometric pressure control connection in the pump housing. This pressure must be maintained for 15 minutes. If a leak is indicated, the fault in either the liner or piston seal must be traced and rectified, and the unit re-tested.

(11) Remove the fuel pump from the hand-pump and remove both the clamp and plug.

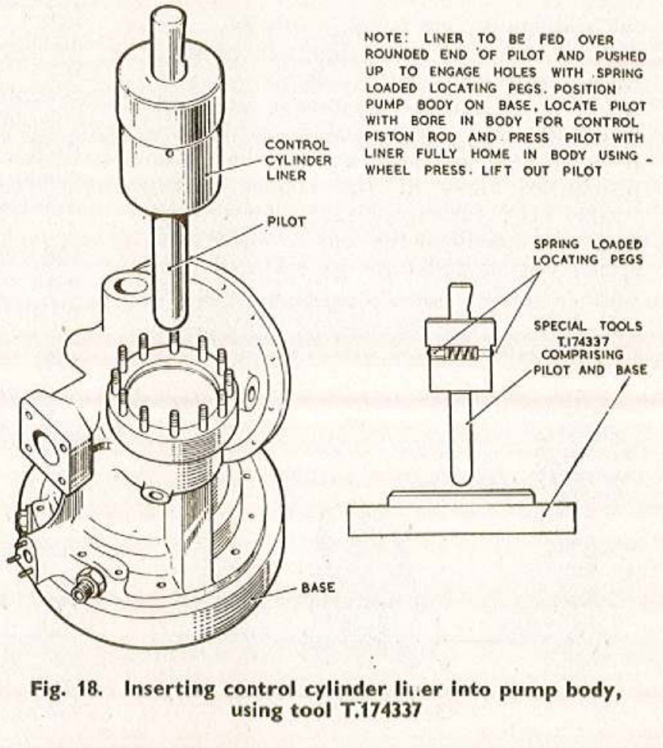


Fig. 18. Inserting control cylinder liner into pump body, using tool T.174337

(12) Press the piston-rod, complete with control piston, out of the pump housing.

Air bleed assemblies

164. A bleed valve assembly may be fitted to the diaphragm cover of the pump, though some units have a bleed valve tapped off the trunnion pin housing extension. In certain cases a flexible extension is connected to facilitate access. There are three types of valve available, two are of the ball type, and the third is of the peg type. A typical bleed valve unit of the peg type is assembled as follows :—

(1) Assemble to the valve body the valve plunger, spring and peg, using the assembly spanner T.174673, illustrated in fig. 19. Subject this assembly to a kerosine pressure of 20 lb. per sq. in. and ascertain that any resultant leakage through the valve does not exceed 5 c.c. per minute.

(2) When this test is satisfactorily passed, fit the cap nut to the valve assembly, then subject the unit to a kerosine pressure of 50 lb. per sq. in. and ensure that no external leakage exists.

Note . . .
One ball valve type comprises body, ball and spring, screwed-in stop and cap-nut with seal in the form of an assembly; the other type consists of an assembled blanking nipple, nut and split pin, with loose parts comprising the valve body, ball, piston and spring. The same tests apply, but a separate holder is required to test the last mentioned type.

Diaphragm cover and overspeed control

165. Assemble the adjustment screw, tab-washer and lock-nut to the underside of the diaphragm centre, but do not lock the tab-washer (this is subsequently locked as in para. 217.

Note . . .
The diaphragm is supplied as a built-up unit having the larger steel diaphragm ring above, the smaller aluminium diaphragm ring below, and the diaphragm itself in between, these three parts being secured by six aluminium rivets.

166. Locate with the diaphragm assembly and secure the lower end of the overspeed spring to the diaphragm centre with the link pin, washer and split pin.

167. Align the spring anchor with the upper end of the overspeed spring, and similarly secure with the link pin, washer and split pin. Ensure that each link pin is fitted with its head on the same side of the overspeed spring.

168. Assemble to the diaphragm cover the gasket and control spring housing, and secure with six 4 B.A. screws and washers, which must be immediately wirelocked.

169. Fit the assembled air bleed valve (para. 164) with washers to the diaphragm cover.

170. Assemble to the control spring housing the gasket and rubber sealing washer for the adjusting screw; feed the adjusting screw into the spring anchor and tighten, using the spanner T.160988.

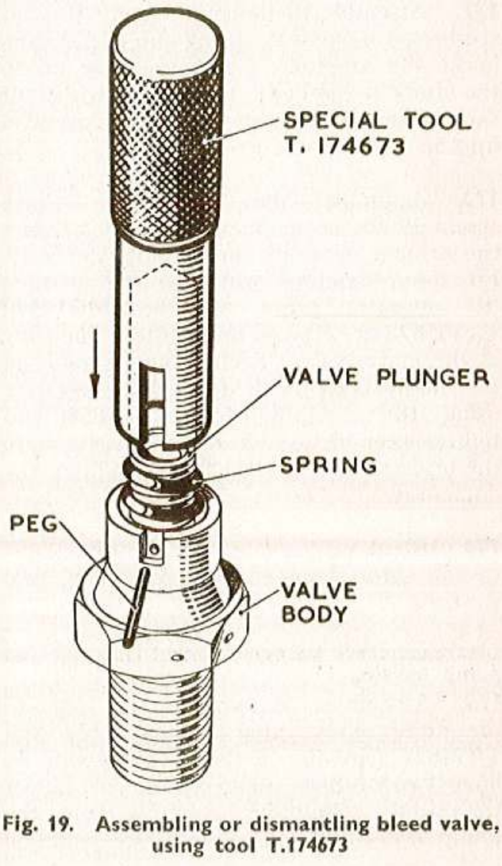


Fig. 19. Assembling or dismantling bleed valve, using tool T.174673

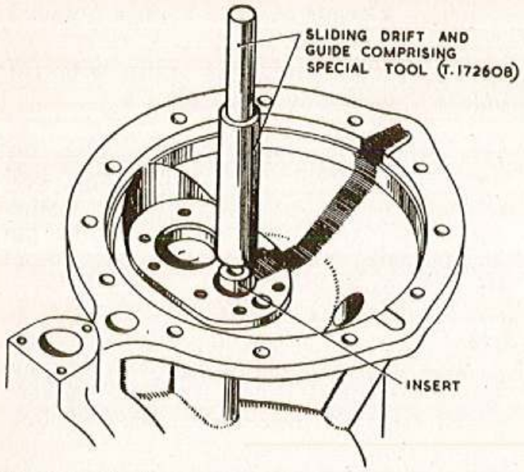


Fig. 20. Fitting stall valve adjustment screw insert into main pump body, using tool T.172608

171. Ensure that the bronze insert is fitted to take the stall adjustment screw. This insert is fitted to the main body with tool T.172608 (*fig.* 20). Studs may be replaced, using standard stud boxes T.129660 and T.128563.

172. Assemble to the pump body the flat strainer, rubber seal, spring cup and spring, lower the amplifier valve assembly on to the studs in the body, and secure with four tab-washers and eight nuts ; do not bend up the tab-washers at this stage.

173. Assemble the restricting orifice assembly to the main pump body. Lower the strainer assembly and seal into the body. Fit the restricting orifice to the jet-tube (if separate) using the assembly tool T.173567 (*fig.* 21) and lower into its housing in the main body. Secure the assembly in the main body with the orifice retainer using the assembly tool T.142854 and tighten securely. Lower the washer on to the orifice retainer, then fit and tighten the dome-nut.

174. Blank off the $\frac{1}{8}$ in. B.S.P. tapped hole to the servo bore with a slave plug and washer.

Clearance check between control ring face and pump housing

175. Assemble the two trunnion pins to the pump body using the assembly tool T.174677 (*fig.* 3); it is advantageous to have two of these tools available. Lower the slipper camplate assembly into the pump body and locate with the trunnion pins. Move the control ring and camplate assembly laterally against one side of the pump housing, and measure with a feeler gauge the gap between control ring face and pump housing on the other side.

176. Remove each trunnion pin in turn and place equal shims on each between pump body and control ring to reduce the gap to between 0·005 in. and 0·010 in. (i.e., 0·0025 to 0·005 in. each side).

177. When satisfactory again remove the trunnion pins and camplate, but retain selected shims in position on the trunnion pins.

Main body

178. If the port insert and the dowel pins have been removed from the port insert face of the main body, ensure that the dowel pins are refitted. Ensure that the port insert seating is free from bruising of any kind.

179. Lower the port insert (with stabilising tube) into the main body. Ensure that the port insert is parallel to the face of the body to within 0·0000 to 0·00012 in. when new. Parallelism of the port inserts after service must not exceed 0·0005 in. Also check the thickness of the port insert ; this should be as specified in the Schedule of Fits and Clearances. To effect this check the gauge

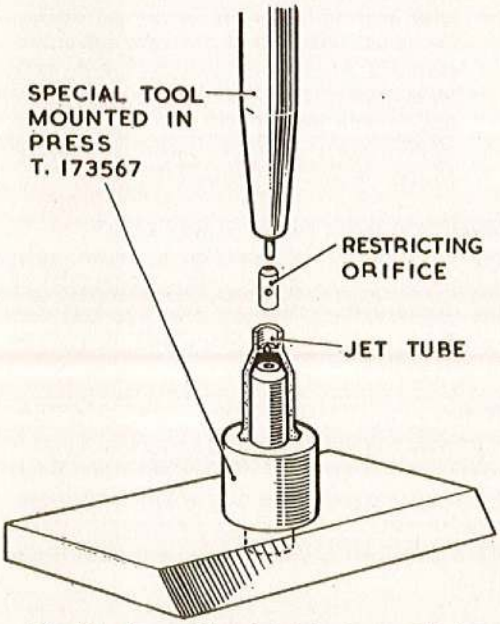


Fig. 21. Assembling jet tube to restricting orifice, using tool T.173567

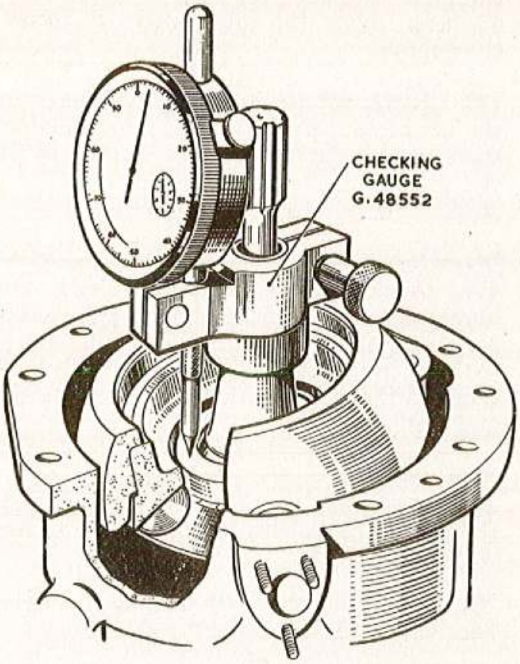


Fig. 22. Measuring lift of auxiliary camplate, using gauge G.48552

G.51239 must be used, as shown in Chap. 1, fig. 17. If the reading is outside these limits, remove the port insert and ensure that no rough edges exist on the kidney shaped slots. If still unsatisfactory, a replacement port insert should be selected and the check repeated until a suitable unit is found.

180. With the port insert correctly fitted to the main body, lower the insert retaining spider and carbon rotor bearing into the main body and secure with the circlip, taking care that the chamfered edge of the circlip is uppermost.

181. Assemble to the rotor assembly the spring, spring seat, shims, thrust ball, auxiliary camplate, piston and slipper assemblies.

182. Fit the assembled rotor to the main pump body. Lower the slipper camplate over the rotor into the body and insert the two trunnion pins (with shims, para. 176) through both pump body and control ring.

183. Fit the gauge G.48552 to the upper rotor journal as in fig. 22, and secure in position, ensuring that the needle point of the gauge is resting on the auxiliary camplate. Using gauge G.54218, set the camplate angle to 15 deg. 30 min. as shown in fig. 23, by the flow adjusting screw. Depress with the finger the auxiliary camplate axially against the thrust ball, and spring, then release and note the lift reading ; this should be 0·002 in. to 0·004 in. With the camplate in the neutral position, depress and release the auxiliary camplate, ensuring that the lift is less than 0·016 in. The lift may be adjusted by increasing or decreasing the thickness of shims between the thrust ball and spring seat.

184. Remove the trunnion pins with shims, slipper camplate assembly, assembled rotor, rotor bearing circlip, carbon rotor bearing and insert retaining spider. Dismantle the rotor.

185. Visually inspect all parts of the pump, together with all other parts about to be assembled, and thoroughly clean in the parawash machine.

ASSEMBLING THE PUMP

186. Assemble to the body the piston-rod assembly, rubber seal, inner spring, outer spring and slave cover, secure with slave plain washers, grover washers and nuts.

187. Fit the washer and union to the main outlet connection of the pump body, using the spanner T.171267.

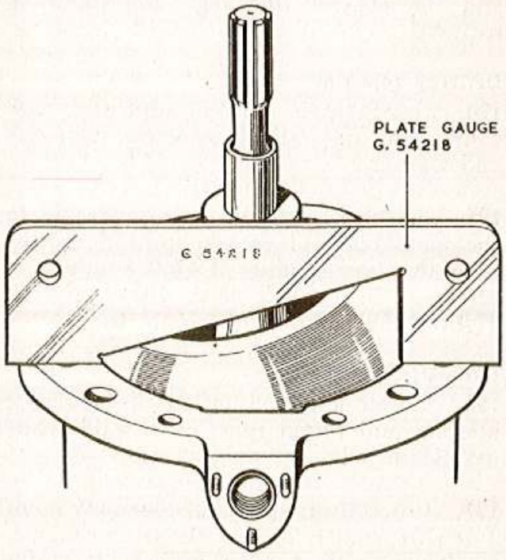


Fig. 23. Setting camplate inclination and control ring, using gauge G.54218

188. Fit the partially assembled body of the pump on to the stripping and assembling fixture T.129661.

189. Assemble the retaining spider, carbon rotor bearing and rotor bearing circlip to the main body of the pump, ensuring that the chamfer on the circlip is uppermost.

190. Assemble to the rotor the spring, spring seat, shims, thrust ball, auxiliary camplate, and spring guides, using assembly tool T.157873, then the piston springs, spring seats, and the piston and slipper assemblies.

Note . . .

On initial assembly the piston and slipper assemblies are specially selected to suit their respective bores in the rotor, and both the piston and bore are numbered to correspond.

191. With the main body of the pump still mounted on the special fixture, lower the rotor assembly into position in the pump body.

192. Assemble the trunnion pins to the main body, with tools T.174677, and the slipper camplate to the trunnion pins.

193. Secure the link of the control piston-rod assembly to the control ring lug with link pin, shim washer and split pin. Check on the later types that a 0·0015 in. feeler does not pass between head of the link pin and the control ring lug. Fit shims as required.

Delivery adjusting screw

194. Assemble the delivery adjusting screw comprising the adjusting screw, stop-nut and washer.

195. Fit this assembly with its washer to the main body of the pump, and tighten with the box spanner T.174678 until the screw is in contact with the camplate. Tighten the screw another two turns.

Camplate housing

196. Lower a gasket on to the camplate housing and retain in position with white petroleum jelly.

197. Correctly position the assembly guide T.188751, similar to that shown in Chap. 1, fig. 25, over the splined quill shaft of the rotor and carefully lower the assembled camplate housing onto the pump body. Blank off the two oil seal drain holes in the camplate housing with screws and tab-washers. Lock the tab-washers to secure the screws.

198. Blank off the trunnion pin bores in the main pump body with trunnion plates, slave washers and slave nuts. Do not fit the gaskets until the final assembly (para. 264).

Diaphragm cover

199. Assemble to the pump body the diaphragm cover gasket, diaphragm outer ring, diaphragm cover gasket and cover, with control spring housing (para. 168), and temporarily secure with four slave washers and nuts.

Inlet strainer

200. Assemble to the main pump body the inlet strainer with its spring, and secure with the circlip.

201. Blank off the inlet hole in the servo bore with a slave plug and washer.

RENEWALS

202. All paper joints or gaskets, rubber seals, other than the servo piston seal and metal joint washers, must be replaced by new ones whenever the seal is disturbed. New split pins, lock plates and locking wire must always be used.

Camplate housing

203. The camplate housing is normally supplied as a built up assembly complete with the oil seal housing sub-assembly which is screwed and wire-locked to it. This sub-assembly comprises a sealing ring, bearing locating peg, rotor oil seal, washer, spring and carbon faced seal accommodated in the housing.

Control ring and camplate assembly

204. The control ring and camplate are supplied as a built up unit, and in the event of damage to either part the complete assembly must be renewed.

Rotor assembly and associated details

205. In instances of a damaged quill shaft or rotor, a new assembly comprising rotor, quill shaft, spring guides, spring, spring seats, piston (complete with slipper pads), auxiliary camplate, thrust ball, washer and spring and carbon bearing (in the pump body) must be fitted. Auxiliary camplates and thrust balls must not be replaced separately as these are supplied as matched sets. Pistons and slipper pads are always supplied together as an assembly.

206. As carbon bearings are a selected fit with the body, these are normally supplied with the body, but damaged bearings may be replaced separately provided they are selected to come within the specified limits (para. 40 and 42).

207. Individual pistons can be renewed provided they are of the correct size. There are five nominal sizes of pistons, and the rotor is etched with its corresponding nominal size. The nominal diameter of a size 2 piston is 0·5515 in. and the corresponding nominal size of the piston bore in the rotor is 0·5519 in. The range of nominal piston bore sizes in the rotor in inches is as follows :—

Size 1	0·5510
Size 2	0·5519
Size 3	0·5529
Size 4	0·5539
Size 5	0·5549

Port insert

208. A replacement port insert may be fitted separately but must be subjected to the test described in para. 179.

Diaphragm cover

209. The diaphragm cover is normally supplied as a built-up assembly, together with the spring housing which is screwed and wire-locked to it, but all parts are separately interchangeable.

Diaphragm assembly

210. The diaphragm is supplied as a built-up assembly comprising metal rings or plates, between which is interposed the diaphragm, the whole being secured with rivets.

Trunnion pins

211. The trunnion pins are a selective assembly.

Amplifier valve assembly

212. The amplifier valve is normally supplied as a built-up assembly but all parts are separately interchangeable. The tests described during the assembling operations of the amplifier valve (para. 155), together with functional tests, are the best guide as to whether any parts need renewing.

Control piston assembly

213. The control piston assembly is normally supplied as a built-up unit complete with riveted link, but all parts are interchangeable.

Control piston liner

214. In the event of a badly scored or leaking liner, this may be removed and renewed, as described in para. 163.

Orifice and jet tube

215. This is normally supplied as a built-up assembly.

Remaining details

216. Other parts are separately interchangeable, but if a new pump body is required, care must be taken to check the fit of parts by referring to the previous paragraphs, and to the Schecule of Fits and Clearances.

RIG TESTING (PRELIMINARY)

General

217. The general procedure for testing slipper type fuel pumps is similar, but the calibration settings vary for different types. In view of this a basic test procedure is outlined on the following pages, the particular calibration values, comprising the respective calibration codes, being listed in the form of Appendices at the end of this section, to which reference must be made for specific types. During calibration tests, and after governor tests and stall checks, remove the four slave nuts and washers and lift off the diaphragm cover, diaphragm and overspeed control, and check both rocker lever tail lift, using clock holder T.142856, and the tappet clearance, using gauge G.38745, and check that clearances are as specified in para. 155 A and B and 109 respectively. Lock the tab-washer for the diaphragm centre adjustment screw when satisfactory. The special test rig adapter T.174680, must be fitted to the inlet boss in the main pump body, and the unit is then ready for rig testing.

218. After all cases of major repair the pump must be subjected to a running in test. Carefully record all calibrations and test results for subsequent entry in to the pump log book.

219. Before effecting any running tests always ensure that the pump is thoroughly bled by means of the bleed valves provided. Fuel should be allowed to spill until all signs of air have disappeared.

220. The fuel for these tests must be as specified in the appendix, viz.—

(1) For gasoline tests ; use aviation gasoline Specification D.ENG.R.D.2485 grade 73, the limits of its temperature to be between 20 and 30 degree C.

(2) For kerosine tests ; use aviation kerosine Specification D.ENG.R.D.2482, the limits of its temperature to be between 20 and 26 degrees C.

The test fuel must be checked at regular intervals to ensure that it complies with the appropriate specification.

Running in

221. Fit the adapter T.174680 to the inlet adapter of the pump, mount the unit on the calibration rig, and subject it in turn to the speeds and delivery pressures for the periods specified.

First preliminary calibration

222. Effect a preliminary calibration. This comprises a volumetric efficiency check, a governor cycling check, and a recovery test. Each is described separately as follows :—

Volumetric efficiency check

(1) Check the volumetric efficiency of the pump by running it first at the high, and then at the low delivery pressure specified, and confirm that the flow difference is within the specified limits.

Governor cycling check

(2) Set the governor at point 'A' and check the governor cycle at points 'A', 'C' and 'D' at the specified conditions. Ensure that the pump speeds are within the required limits. Point 'A' is obtained by increasing the pump speed until the delivery pressure commences to fall. Point 'C' is obtained by further increasing the pump speed to reduce the delivery pressure below the required value at 'C' and then reducing the pump speed until the specified delivery pressure is re-established. Point 'D' is obtained by further decreasing the pump speed until the delivery pressure has re-recovered to the specified value.

Recovery test

(3) A stop watch is required for this test. Adjust the rig controls until the conditions are as at point 'C' (refer to governor cycling check). Decrease the speed of the pump to that as specified for final condition 'D' and observe the time taken for the delivery to recover from the initial to the final condition. The period must be as specified. If the recovery time is much greater than that specified, the governor must be examined for stiffness or sluggishness in the mechanism. If less than that specified, a leakage in the servo mechanism either past the control piston, or past the parts comprising the restrictor assembly, is indicated and must be rectified.

Endurance tests

223. Mount the unit on the endurance rig and effect a straight endurance test to the conditions specified.

Major repairs

(1) Instances of major overhaul, which involve the renewal of one or more of the following assemblies, namely the rotor assembly, the control ring and camplate assembly, or the port insert, necessitate the straight endurance test, as specified in the relevant Appendix.

Minor repairs

(2) Minor overhauls, such as the replacement of quill shaft seals, or control piston parts, necessitate two hours endurance running, and one hour governing only.

224. Subject the pump unit to a cycling endurance test, as specified.

225. Endurance test the governor of the pump, the governor being mounted in its lowest position for preference, at the specified condition, the speed being varied to give the required number of cycles.

226. Subject the pump unit to a series of starts from rest to idling, as specified.

Second preliminary calibration

227. The second preliminary calibration comprises a stall pressure check, followed by those tests already described in para. 222. The stall pressure check is effected as follows.

Note . . .

The stall pressure is the maximum delivery pressure the pump is allowed to build up before the servo valve opens to reduce the flow by causing the control piston to move to restrict the delivery.

Adjustment to the stall is effected with the diaphragm cover and diaphragm assembly removed, by inserting the screwdriver T.174681, through the hole in the rocker lever, and adjusting the slotted screw as desired. One quarter of a turn of this screw represents approximately 50 lb. per sq. in. difference in the stall pressure reading. The screw must be turned in a clockwise direction to reduce the stall pressure. The adjustment may be made on the rig with the diaphragm cover and diaphragm assembly removed provided the expanding blanking plug, plate and seal T.157872, are used. Set the stall pressure by running the pump at the conditions specified, and increase the delivery pressure by restricting the outlet until the pump stalls ; this will be denoted by a rapid decrease in flow. The specified delivery pressure must be obtained in every stall test. After these tests the pump must be dismantled, inspected and reassembled.

DISMANTLING THE PUMP (FOR FINAL INSPECTION)

228. Mount the pump unit on the fixture T.129661 and remove the four slave nuts, washers and bolts securing the camplate housing to the pump body. Lift off the camplate housing using the guide T.174682 ; then lift off the gasket.

229. Extract the split pin securing the link pin of the control ring and piston-rod link, and remove the shim washer(s) and link pin ; note and record the number of shims for correct replacement.

230. Unscrew the six slave nuts securing the trunnion pin covers to the main pump body, and remove together with the slave washers. Withdraw the trunnion pin covers, then extract the trunnion pins with the tool T.174677, taking care to retain the shims interposed between the pump housing and the control ring.

231. Lift off the control ring and camplate assembly from the pump rotor.

232. Withdraw the rotor assembly complete from the pump body, and dismantle as follows :—

(1) Lift off the seven piston and slipper assemblies, taking care to retain the spring seats, and store the pistons on the stand T.157037. Remove the piston springs.

(2) Remove the auxiliary camplate, thrust ball shim(s), spring seat and spring.

233. Remove the rotor bearing circlip from the pump body, using the tool T.157039.

234. Withdraw the carbon rotor bearing from the pump body, using the extractor T.127645 (*fig.* 9).

235. Lift out the insert retaining spider, using the tool T.157039, and remove the port insert.

236. Unscrew the cap-nut (if fitted) from the overspeed control spring housing, unscrew the diaphragm adjusting screw, and remove with the rubber sealing ring.

237. Unscrew the four slave nuts securing the diaphragm cover to the main pump body and remove, together with the slave washers. Lift off the diaphragm cover and gasket, the diaphragm assembly together with overspeed spring, and then the two remaining gaskets with the interposed diaphragm outer ring.

238. Unscrew the eight nuts securing the amplifier valve assembly to the studs in the main body and remove, together with tab-washers. Lift off the amplifier valve assembly, and remove the helical spring, spring cup, rubber seal and flat strainer.

239. Remove the twelve slave nuts, grover washers and plain washers, and carefully withdraw the slave cover, using the tool T.174338. Remove the inner and outer servo springs, rubber seal and piston-rod assembly.

240. Unscrew the dome-nut securing the orifice retainer to the pump body and remove together with the washer. Remove the orifice retainer from the pump body using the box driver T.142854. Withdraw the jet-tube together with restricting orifice, then the seal and strainer.

241. Remove the assembled air bleed valve assemblies and washers from the pump (refer to para. 164).

INSPECTION (FINAL)

242. Thoroughly inspect all parts visually and ensure that these are free from any particles of swarf.

243. Finally subject the rotor assembly with quill, the assembled piston-rod, and the port insert with tube to a crack detection test.

Note . . .
Should it be found necessary to renew any parts, reference must be made to the renewals section, and all necessary tests carried out according to the particular renewal, and at the discretion of the Inspector-in-Charge.

CLEANING (FINAL)

244. Thoroughly clean all parts before finally assembling the pump, using a kerosine bath and spray gun with adequate filtering facilities.

ASSEMBLING THE PUMP (FINAL)

245. Refit the restricting orifice parts to the pump by reversing the procedure described in para. 240.

Setting the minimum flow stop

Note . . .
For this setting the parts mentioned in para. 247 *are only assembled temporarily.*

246. Assemble the piston-rod assembly and associated parts to the body by reversing the sequence of operations outlined in para. 239, and using the tool T.147031.

247. Assemble the adjusting screw, lock-nut and tab-washer to the control cylinder cover, and secure to the main body of the pump with two slave nuts.

248. Mount the partially assembled pump on the fixture T.129661 and lower the control ring and camplate assembly into alignment with the trunnion pin holes in the body; then insert the trunnion pins through their bores in the pump body into the control ring, using the tool T.174677.

249. Align the link riveted to the piston-rod with the lug in the control ring and secure with link pin.

Setting the flow stops (on the bench)

250. Set the control ring and camplate in approximately the horizontal position by the flow adjusting screw, with its stop-nut temporarily removed.

Note . . .
At no other time should the flow adjusting screw be fitted to the body without its stop-nut, otherwise serious damage to the slipper pads may result when the pump is run.

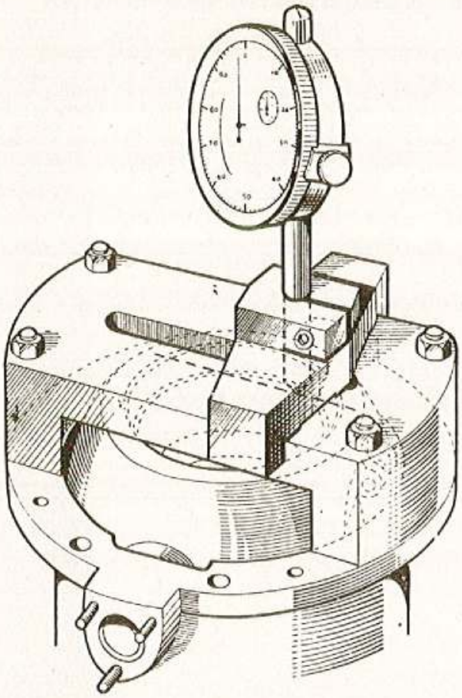


Fig. 24. Setting control piston adjusting screw, using gauge G.51821

Assemble the gauge G.51821 to the pump body as in fig. 24, and adjust the camplate by the flow adjusting screw until it is 0·002 in. to 0·004 in. high on the side adjacent to the control ring lug to which the control piston link is fitted. Using tool T.174683 as in fig. 25, set the minimum flow adjusting screw in the control cylinder cover to make contact with the head of the control piston. Again check the inclination of the camplate, and lock the lock-nut when satisfactory. There should be no movement of the camplate between the two adjusting screws when correctly set. Some types of pump have a minimum flow adjusting screw fitted in the head of the control piston and bearing against a fixed stop in the control cylinder cover. These types are set in a similar manner to that previously described, except that tool T.174335 (*fig.* 14) is used. The control cylinder cover must be removed each time the setting of the adjusting screw is altered, and then refitted to check the setting. When correctly set, there should be no movement of the camplate between the two adjusting screws, and the camplate inclination should be as specified. The cover should then be removed, the lock-nut locked, and the setting re-checked.

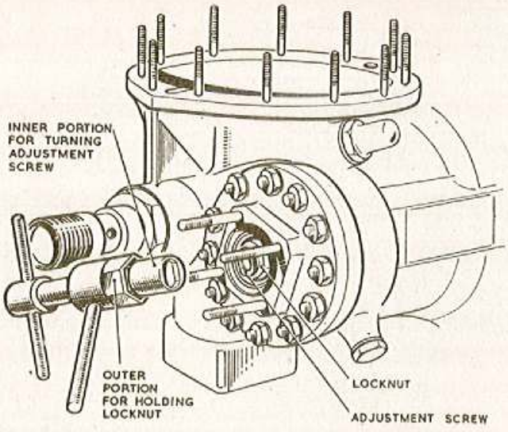


Fig. 25. Adjustment of minimum flow stop for control piston, using tool T.174683

251. Lock the tab-washer on the minimum flow adjusting screw. Remove the flow adjusting screw from the body and replace it with the stop nut fitted.

Note . . .
On pumps having ' F ' calibration, the tab-washer should not be locked at this stage (see instructions in the relevant appendix).

252. Extract the link pin from the control ring lug, and detach the link to free the control ring from the control piston-rod.

253. Withdraw the trunnion pins, using the extractor T.174677, and remove the control ring and camplate assembly, taking care to retain the shims.

254. Withdraw the control piston and rod assembly from its bore in the main body.

255. Again thoroughly wash all parts using a kerosine bath and spray gun.

256. Lower the flat strainer normally fitted beneath the amplifier valve orifice on to the pump body, then the rubber seal, spring cup and spring, then lower the amplifier valve assembly correctly on to the studs. Secure with the eight nuts and tab-washers.

257. Lower the diaphragm cover gasket, outer ring, gasket, diaphragm assembly with overspeed spring and gasket on to the pump body. Locate the diaphragm cover with its studs on the pump body and secure with four slave nuts and washers.

258. Assemble the sealing ring adjusting screw and lock-nut to the overspeed control, using the spanner T.160988. Remove the remaining slave blanking plugs and washer from the diaphragm cover.

259. Fit to the main pump body the control piston assembly, using the tool T.147031, the rubber seal, outer spring and inner spring. Locate the cover correctly with the control cylinder liner studs, using the tool T.174338, and secure with the twelve plain washers, grover washers and nuts.

260. Assemble the end cover to the four studs in the control cylinder cover with the sealing ring, plain washers, grover washers and nuts. Fit a slave plug and washer to the end cover.

261. Mount the partially assembled pump into the fixture T.129661, and lower into it the port insert, insert retaining spider, and the carbon rotor bearing, and secure with the circlip.

262. Assemble to the rotor (with spring guides already in position) the spring, spring seat, shims, thrust ball, auxiliary camplate, piston springs, and piston and slipper assemblies (with spring seats already in position).

263. Lower the assembled rotor into the pump housing.

264. Locate the gaskets for the trunnion pins with the three securing studs on the pump body. Assemble a seal to each trunnion pin, then lower the control ring and camplate assembly over the rotor quill into the pump body in alignment with the trunnion pin holes. Insert the trunnion pins (taking care to interpose the shims, para. 253, between the pump body and control ring) through the pump body into the control ring using the tools T.174677. Position the trunnion pin cover plates over their studs, and secure with the six plain washers, grover washers and nuts.

265. Attach the piston-rod link to the control ring lug by inserting the link pin, washer and split pin. Re-check the auxiliary camplate lift, as described in para. 183.

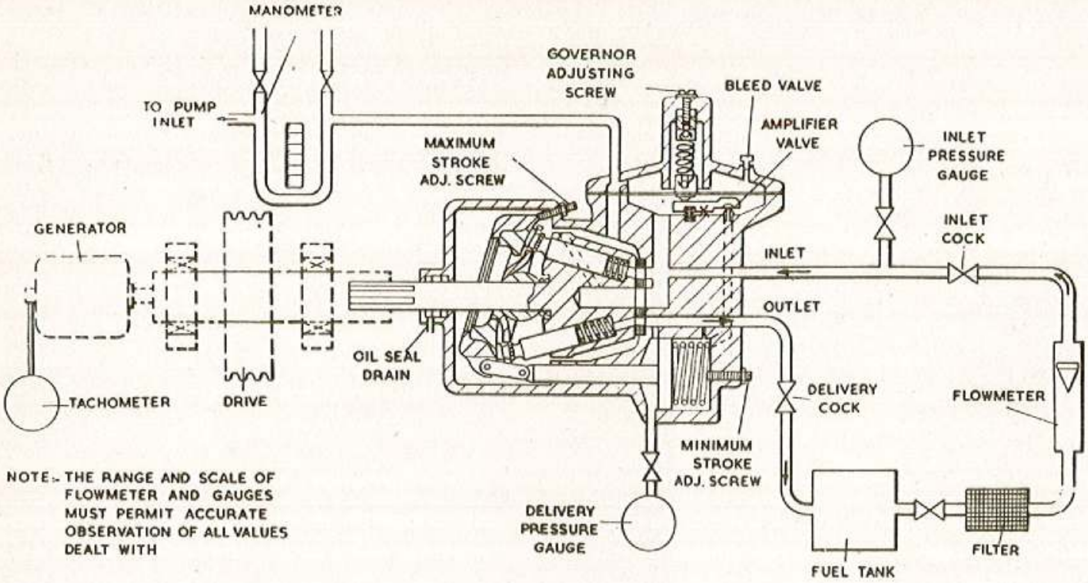


Fig. 26. Diagrammatic layout of test rig (calibration)

266. Lower the camplate housing gasket on to the pump body over the control ring and camplate assembly; position the assembly sheath T.188751 over the rotor quill shaft, and lower the camplate housing on to the pump body. Secure with the two long and two short bolts, plain washers, castellated nuts and split pins.

267. Ensure that the air bleed valves with washers are assembled either to the diaphragm cover, or to the trunnion pin housing extension, as required.

268. Fit the spring and conical strainer in the inlet housing of the pump and secure with the circlip.

RIG TESTING (FINAL)

Final endurance test

269. Mount the pump on the governor endurance rig (preferably with the governor mounted in the lowest position) and note that the rig is to contain aviation kerosine, Specification D.Eng.R.D.2482. Subject the unit to the governing test as specified in the relevant appendix. Remove the unit from the endurance rig.

Final calibration

270. Mount the pump on the calibration rig, illustrated in fig. 26, and effect the following tests.

Note . . .

During calibration tests and after governor tests remove the four slave nuts and washers, and the assembled overspeed control, to check the rocker lever tail lift and tappet clearance (para. 155 and 106 respectively).

Setting the maximum flow

271. Adjust the rig to the conditions specified, and set the maximum flow adjusting screw, using the tool T.174678, to obtain the required flow, then lock the adjusting screw.

Centrifugal pressure rise test

272. (1) This test is effected with the unit mounted as shown in fig. 26, with the manometer connected across the governor diaphragm. Adjust the inlet pressure to the value specified, and bleed the pump and manometer of all air.

(2) Adjust the speed of the pump to the specified value which must remain constant throughout the test.

(3) Stall the pump down to half of its maximum flow to expel any residual air and to check the stability of the amplifier valve.

(4) With the delivery restriction wound right out (namely, at zero delivery pressure) and the pump running at the specified speed, set the manometer datum on the mercury

level. Close the restriction until the delivery pressure reaches the higher of the two figures quoted in the relevant Appendix, and observe whether the mercury level rises or remains constant. Run for three minutes under these conditions to check stability. Govern the pump down, by the governor adjusting screw, to the lower of the two pressures specified in the relevant Appendix, and ensure that the mercury level does not fall below the datum. Disconnect the manometer from the pump and blank off the connections. *During this test, the greatest care must be taken to ensure that no mercury is allowed to enter the pump, since mercury contamination of non-ferrous parts can cause rapid mechanical failure.*

Stall pressure check

273. Check the stall pressure as described in para. 227.

Volumetric efficiency check

274. Check the volumetric efficiency as described in para. 222.

Governor range check

275. Check the governor range by running the pump at the conditions given in the Appendix, and increasing the speed until the pump governs (denoted by a rapid decrease in delivery pressure). Vary the position of the governor adjusting screw and ensure the pump governs over the specified speed range.

Governor cycling check

276. Effect the governor cycling check as described in para. 222.

Recovery test

277. Effect the recovery test as described in para. 222.

Governor setting check (point 'A')

278. Set the rig to the conditions as specified for point 'A' (para. 222). Ensure that the pump speeds are within the specified limits.

Pressure test (first running)

279. Wipe the fuel pump dry and run at the conditions specified. No external leakage is permissible except from the oil seal drain.

Self priming test

280. The fuel pump must be capable of producing the required inlet pressure when it is running with a closed inlet at the conditions specified.

Note . . .

The duration of this test should not exceed one minute.

If this value is not obtained, a leakage either through the oil seals, or through the various joints or flanges is indicated, and must be traced and rectified. The pump must now be removed from the rig and thoroughly drained of all fuel before undergoing leakage tests.

LEAKAGE TESTS

281. The pump unit must now be subjected to three leakage tests as described below, the third test is effected after the wire-locking of the unit has been completed.

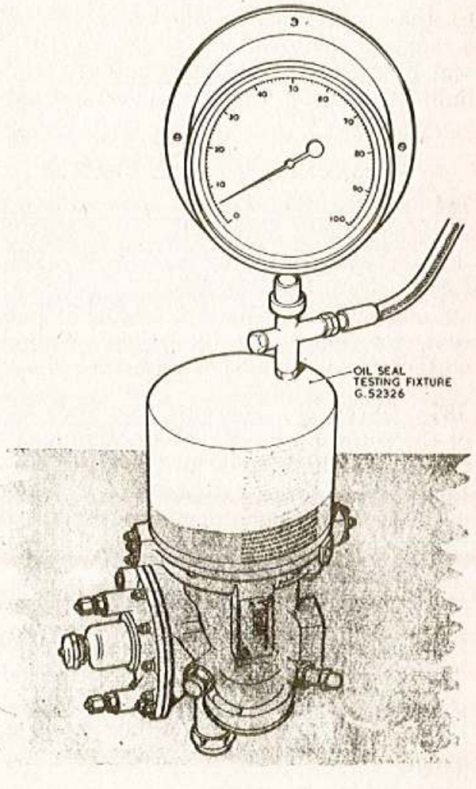


Fig. 27. Pump, with oil seal testing fixture G.52326 fitted, submerged in kerosine for leak test

Air pressure test (static)

(1) Blank off all connections, including the oil seal drains, and inject compressed air into the unit to the pressure specified; then submerge the unit in a tank of kerosine and ascertain that no leakage exists (refer to Chap. 1, fig. 36).

Air pressure test (oil seal drains)

(2) Fit the gauge G.52326 to the camplate housing of the pump (*fig.* 27) and connect the compressed air line to the unit. Remove the blanking caps from the seal drains or the seal drains complete. Apply the air pressure specified, submerge in a tank of kerosine and ensure that no leakage occurs from the oil seal drains.

WIRE LOCKING

282. Complete all external connections with dust caps and wire-lock, except for the inlet and outlet connections, and repeat the air pressure test (static) as in para. 281(1).

PRESSURE TEST (FINAL RUNNING)

283. Mount the fuel pump on the rig and remove the inlet and outlet connections. Wipe the pump thoroughly dry and run to the conditions specified. No external leakage is permissible except for the oil seal drain, and that must not exceed the limits specified. Refit the inlet and outlet connections.

PREPARATION FOR DESPATCH

284. Mount the unit on the flushing rig and thoroughly flush with oil to specification DTD.587 and then stall the pump. Ensure that the wire-locking of the inlet and outlet connections is completed, and that the nameplate is affixed with the correct serial number as in log book.

285. Check the concentricity and height of the rotor quill. Mount the pump in the fixture as illustrated in Chap. 1, fig. 3. Lower the gauge G.46439 (*fig.* 28) into position on the camplate housing. Align the pins with the holes in both camplate housing and pump body. Locate the attachment with the quill shaft splines and press into full engagement. Lower the central plunger until in contact with the top of the quill shaft, when the top of its shoulder should be between the limits of the thickness of the step in the attachment gauge.

286. Fit the protection cap (7083/841X) with gasket (7083/853) over the quill shaft and secure to the flange of the camplate housing with four bolts, washers and nuts, and pack in a suitable container with the completed and approved log book and test sheet.

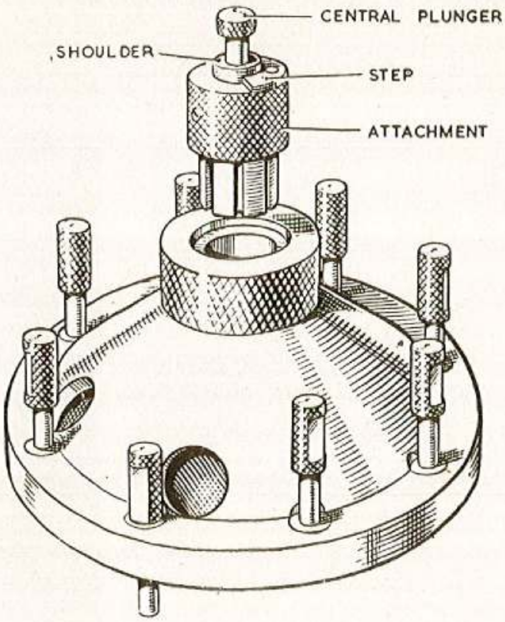


Fig. 28. Concentricity gauge - G.46439, with attachment, for pump housing and quill shaft

SOLENOID SERVO ISOLATING VALVES

General

287. With installations employing dual pumps it is common practice for one or both pumps to be fitted with a solenoid operated servo isolating valve, and for a non-return valve to be provided in the outlet connection of each pump. The solenoid valve is fitted on the end of the pump control cylinder housing. A typical solenoid valve and non-return valve are shown dismantled in fig. 1. There are three basic types of solenoid valve in use and while certain differences do occur in construction, each functions in a similar manner, and is described in the following paragraphs :—

Rotax types 1142 and 1191

(1) The solenoid is secured by four bolts and nuts, with plain washers and grover washers, to an extension of the control cylinder cover casting; this in turn is secured to the body of the control cylinder by twelve nuts with plain washers and grover washers. These solenoids are fitted in pairs on a dual pump installation, the cover castings being such that solenoid type 1142 is fitted at right angles to the control

cylinder axis of one pump, and type 1191 lies parallel to the control axis of the other pump. Electrical connections are made to a two-pin Breeze plug built into the solenoid case, and the pump servo connection to the altitude control unit is made from an $\frac{1}{8}$ in. B.S.P. tapped hole in the casting, adjacent to the domed-nut securing the orifice strainer assembly in position.

Lucas types 7083/802 and 7083/817

(2) On a pump fitted with either of these types of solenoid, the latter is secured by twelve studs (which are alternately long and short) in the control cylinder body. The control cylinder cover fits over all twelve studs and is secured in position by six nuts, plain washers and grover washers, to the six short studs projecting through the control cylinder cover. The solenoid is fitted directly to the control cylinder cover, and is secured by six nuts, with plain and grover washers, to the six long studs. Electrical connections are made to a two-pin Breeze plug on the solenoid case, and the pump servo connection to the altitude control unit is made from an $\frac{1}{8}$ in. B.S.P. tapped hole in the boss projecting from the control cylinder cover.

Lucas type 7083/804

(3) The type is fitted in a similar manner to (2) above, and also has a similar servo connection point. Electrical connections are made to two terminals in a bakelite plug mounted on that end of the solenoid case remote from the mounting flange.

Special tool

288. Only one special tool is required for use when removing or fitting the solenoid valve (complete with control cylinder end cover) from the fuel pump when the unit is mounted on the rig.

289. This tool T.146460 is normally fitted to the calibration rig (type R.) and holds the control piston springs under compression while the plain washers, grover washers and nuts are assembled or removed.

Preliminary checks and precautions

290. Examine the solenoid valve externally for any signs of damage, and if it appears to be in good condition, test as follows :—

(1) Mount the pump (complete with solenoid valve) on the test rig as shown in fig. 26. Remove the blanking plug (or dust-cap) from the altitude control unit connection point of the solenoid valve, connect the terminals (or Breeze plug) to a 16 volt D.C. supply. With the solenoid energized, start the rig and run the pump up to the speed specified in the relevant Appendix, and restrict the pump delivery pressure to the stall value. With stall pressures as specified in the Appendix, open and close the valve by energizing and de-energizing the solenoid valve several times as specified. There must be no leakage of fuel from the connection point to the altitude control unit when the solenoid is energized.

(2) In the event of leakage, examine for foreign matter between the valve plate and orifice (para. 291). If this is not the cause of leakage, discard the whole valve unit and fit a complete replacement.

(3) Similarly, if the solenoid fails to operate, discard and fit a complete new unit.

Examination for foreign matter on seating faces of valve plate and orifice

291. To obtain access to the orifice and valve plate to inspect for the presence of foreign matter on the seating faces, proceed as follows, according to the type of solenoid valve being dealt with :—

Rotax types 1142 and 1191

(1) Remove the four nuts and bolts, with plain washers and grover washers, securing the solenoid to the control cylinder cover casting, and remove the solenoid, taking care to retain the valve plate and spring. The orifice is located in the end cover casting, and the spring and valve plate are assembled between it and the solenoid push rod. These types of solenoid must not be dismantled beyond this stage, but if unsatisfactory, should be returned to Stores and a new unit fitted. To assemble these types of solenoid, reverse the dismantling instructions above.

Lucas types 7083/802, 7083/817 and 7083/804

(2) Remove the six nuts with plain washers and grover washers securing the solenoid to the control cylinder cover, and remove the solenoid. Bend back the tabs on the tab-washers locking the six 4 B.A. screws which secure the valve carrier to the solenoid case, remove the screws and tab-washers, then withdraw the valve carrier, taking care to retain the spring and valve plate. Withdraw the push rod from the valve guide and if the valve carrier seals are damaged, discard and fit new seals.

Cleaning

292. For cleaning purposes a kerosine bath and spray gun with adequate filtering facilities must be used.

293. Thoroughly clean the seating faces of both orifice and valve plate, the ports of the control cylinder end cover or cover casting, the helical spring and the push rod.

Inspection

294. Examine the push rod for freedom of movement in its guide and ensure that it is free from damage and corrosion.

295. Ensure that no sharp edges exist on the end which makes contact with the valve.

296. Inspect the valve and ensure that its sealing face is clean and optically flat. Ensure that on initial assembly an air gap between the push rod and face of valve guide of 0·010 to 0·015 in. is set while the solenoid is energized ; this must always be maintained.

Note . . .

The air gap in Rotax solenoids types 1142 *and* 1191 *is set after the solenoid has been secured to the control cylinder cover casting, and in the event of failure the solenoid and cover casting should be removed from the pump, as on assembly, and a complete renewal effected.*

297. Ensure that the seating face of the orifice is clean and optically flat.

298. Ensure that the helical spring is free from damage, fracture or sharp edges.

299. Ensure that the sealing rings located in the recesses in the control cylinder end cover are not distorted or damaged.

300. Examine all securing screws, nuts, plain washers and grover washers, for cleanliness and freedom from damage.

Renewals

301. In view of the necessity for maintaining this air gap as set, the component parts of one solenoid are not interchangeable with those of another with the exception of seals, washers nuts and screws. If unsatisfactory the complete solenoid must be returned to Stores and a new unit fitted.

Assembling the unit and refitting to the pump

302. Mount the pump on the rig.

303. Again clean all parts as described in para. 292.

304. Assemble the solenoid by reversing the sequence of operations described in para. 281.

Rig testing

305. Test as described in para. 290.

Insulation test

306. Plug in from the Breeze plug terminal to a megger testing apparatus, and when generating a potential difference of 500 volts, ensure that the minimum resistance measured is 1 megohm.

Preparation for despatch

307. Blank off the connections in the control cylinder end cover.

NON-RETURN VALVES

General

308. There are two types of non-return valve in use :—

(1) The non-return valve illustrated in fig. 1(a) comprising a valve, compression spring, valve guide, and circlip housed in the valve body, over which fit the sealing washers, distance piece and cap-nut.

(2) The other type shown in fig. 1 (b) comprises valve, tension spring and spring anchor housed in the valve body, over which fit the sealing washers, distance piece and cap-nut.

The instructions below are subdivided into (1) compression type, and (2) tension type, unless applicable generally to both types.

Dismantling the non-return valve

309. Unscrew the cap-nut from the non-return valve body or adapter situated in the pump outlet, and remove together with washers and distance piece.

310. (1) Remove the valve body from the pump, extract the circlip from the outer end of the valve body and withdraw the valve guide, compression spring and valve.

(2) Remove the valve body from the pump, unseat the spring anchor from its locating slots in the inner end of the body, and allow it to enter the body lengthwise, under the spring tension, when the valve spring and anchor assembly can be withdrawn from the outer end of the body.

Cleaning

311. All parts must be thoroughly cleaned and washed using a kerosine bath and spray gun with adequate filtering facilities.

Inspection

312. Examine the valve generally for condition, especially its seating face.

313. Ensure that the spring is free from damage, fractures and sharp edges.

314. (1) Ensure that the valve guide, circlip, distance piece and washers are free from damage.

(2) Ensure that the spring anchor, distance piece and washers are free from damage.

Assembling the non-return valve

Note . . .

This unit is normally fitted to the pump immediately before the final leak test (para. 283) *provided the sub-assembly tests stated below have been effected satisfactorily.*

315. There are two tests which are common to each valve. In the first, the pressure drop through the valve must be 10 to 25 lb. per sq. in. at a flow of 500 g.p.h. In the second the leakage past the valve must not exceed 20 c.c. per min. with a pressure of 2,000 lb. per sq. in. applied downstream of the valve.

Note . . .

The correct banjo fitting must be used for these tests to obviate damage to the valve. The tests referred to above must always be effected in the sequence stated, as the seating characteristics of the valve may be influenced by the second test to give a false indication.

Renewals

316. All parts are separately interchangeable, but when new parts are fitted the unit must again pass the sub-assembly tests.

APPENDIX 1

CALIBRATION CODE 'E'

Note . . .
The values below must be rigidly adhered to when calibrating fuel pumps to code 'E' and reference must be made to the particular paragraph quoted.

RUNNING-IN PROCEDURE
(refer to para. 221)

1.

Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)	Time (Minutes)
250	50	2·5
500	50	2·5
500	100	2·5
500	200	2·5
1,000	200	2·5
1,000	350	2·5
1,500	350	2·5
1,500	500	2·5
2,000	500	5·0
2,000	750	5·0
2,500	750	5·0
3,000	750	5·0
3,500	750	5·0
3,500	1,000	45·0

Note . . .
Before 45 minutes run set the maximum stroke to 890 g.p.h. at 100 lb. per sq. in. and 3,500 r.p.m.

FIRST PRELIMINARY CALIBRATION
(refer to para 222)

2. (1) **Volumetric efficiency check**

At a constant speed of 3,500 r.p.m.
High delivery pressure .... 1,000 lb. per sq. in.
Low delivery pressure .... 100 lb. per sq. in.

The flow difference must not exceed 28 g.p.h. when using aviation kerosine (Specification D.ENG.R.D.2482) or 60 g.p.h. when using aviation gasoline (Specification D.ENG.R.D.2485 Grade 73).

(2) **Governor cycling check**

Point	Inlet Pressure (lb. per sq. in.)	Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)
'A'	3 to 5	3,500	1,250
'B'	NOT APPLICABLE		
'C'	3 to 5	3,580 to 3,620	150
'D'	3 to 5	3,460 to 3,500	1,250 to 1,200

Note . . .
The governor overrun during endurance on gasoline to be recorded only.

(3) Recovery time ; point ' C ' to point ' D ': 2 to 3 seconds.

ENDURANCE TEST

(refer to para. 223)

3. $1\frac{3}{4}$ hours at a delivery pressure of 1,600 lb. per sq. in. (this reading being obtained by setting the stall valve), a speed of 3,500 r.p.m. and a flow of 750 g.p.h. During this test the temperature of the fuel should be allowed to rise to between 36 deg. and 38 deg. C. for a period of 15 minutes, then reduced again. The pump should then be run for 15 minutes at a delivery pressure of 2,000 lb. per sq. in. and a speed of 3,700 r.p.m. at full stroke.

CYCLING ENDURANCE TEST

4. The pump must complete 12 cycles consisting of 5 minutes at a speed of 3,500 r.p.m., a flow of 750 g.p.h., and a stall pressure of 1,800 to 2,000 lb. per sq. in., followed by 10 minutes at a speed of 700 r.p.m., a flow of 60 g.p.h., and a delivery pressure of 1,250 lb. per sq. in.

GOVERNOR CYCLING TEST

5. The pump must complete 240 full governor cycles during which the speed is varied with the governor set at Point ' A ' as in para. 222 (2).

6. Set the pump to give idling conditions, then stop the rig. The pump must now complete 25 starts from rest to idling. No further adjustment should be made to the pump during this test.

SECOND PRELIMINARY CALIBRATION

(refer to para. 227)

7. Pump to run at inlet pressure of 3 to 5 lb. per sq. in., a speed of 3,500 r.p.m. and zero flow at which the stall pressure is to be set to 1,800 to 2,100 lb. per sq. in. The volumetric efficiency, governor cycling and recovery time checks, as in para. 222, to be repeated.

FINAL ENDURANCE TEST

8. Repeat the governor cycling test, as detailed in para. 5 and 6 above.

FINAL CALIBRATION

9. Setting maximum flow (refer to para 271). Inlet pressure to be 3 to 5 lb. per sq. in. speed 3,500 r.p.m. delivery pressure 1,500 lb. per sq. in. and flow 600 to 610 g.p.h.

10. Centrifugal pressure rise test (refer to para. 272). (1) Inlet pressure to be 10 to 15 lb. per sq. in.

(2) Speed to be 3,500 to 3,600 r.p.m.

(3) Bleed pump and check amplifier valve.

(4) Delivery pressure of 1,300 lb. per sq. in. then govern down to delivery pressure of 1,000 lb. per sq. in.

11. Stall pressure check (refer to para. 227). Speed 3,300 to 3,700 r.p.m. at delivery pressure of 1,250 lb. per sq. in.

12. Governor setting check (refer to para. 278). Pump speeds to be within limits of 3,500 and 3,520 r.p.m. at a delivery pressure of 1,250 lb. per sq. in. and an inlet depression of 12 in Hg.

13. Pressure test (refer to para. 279). Pump speed to be 3,400 r.p.m. delivery pressure 1,500 lb. per sq. in. and inlet pressure of 20 lb. per sq. in. for 5 minutes.

14. Self priming test (refer to para. 280). Pump speed to be 500 r.p.m. With inlet closed a reading of 24 in. Hg. depression or more must be obtained on the boost gauge.

15. Leakage tests (refer to para. 281). (1) Air pressure of 40 lb. per sq. in. for 5 minutes.

(2) Air pressure of 5 lb. per sq. in. for 5 minutes. Seal drain leakage must not exceed 5 c.c. per hour.

16. Pressure test final. Repeat para. 13 above.

SOLENOID ISOLATING VALVE (if fitted)

(refer to para. 290)

17. Speed 3,400 r.p.m. Solenoid to be operated ten times at 16 volts with the pump running at half stall and full stall (i.e., half flow and zero flow).

APPENDIX 2

CALIBRATION CODE 'F'

Note . . .
The values below must be rigidly adhered to when calibrating fuel pumps to code ' F ', and reference must be made to the particular paragraph quoted.

RUNNING-IN PROCEDURE
(refer to para. 221)

1.

Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)	Time (Minutes)
250	50	2·5
500	50	2·5
500	100	2·5
500	200	2·5
1,000	200	2·5
1,000	350	2·5
1,500	350	2·5
1,500	500	2·5
2,000	500	5·0
2,000	750	5·0
2,500	750	5·0
3,000	750	5·0
3,500	750	5·0
3,500	1,000	45·0

Note . . .
Before 45 *minutes run set maximum stroke to* 890 *g.p.h. at* 100 *lb. sq. in. and* 3,500 *r.p.m.*

FIRST PRELIMINARY CALIBRATION
(refer to para. 222)

2. (1) **Volumetric efficiency check**

At a constant speed of 2,900 r.p.m.
High delivery pressure .... 1,000 lb. per sq. in.
Low delivery pressure .... 100 lb. per sq. in.

The flow difference must not exceed 28 g.p.h. when using aviation kerosine (Specification D.ENG.R.D.2482) or 60 g.p.h. when using aviation gasoline (Specification E.ENG.R.D.2485 Grade 73).

(2) **Governor cycling check**

Point	Inlet Pressure (lb. per sq. in.)	Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)
'A'	3 to 5	3,200	1,250
'B'	NOT APPLICABLE		
'C'	3 to 5	3,280 to 3,320	150
'D'	3 to 5	3,160 to 3,200	1,250 to 1,200

Note . . .
The governor overrun during endurance on gasoline to be recorded only.

(3) Recovery time, point 'C' to point 'D': 2 to 3 seconds.

ENDURANCE TEST
(refer to par. 223)

3. $1\frac{3}{4}$ hours at a delivery pressure of 1,600 lb. per sq. in. (this reading being obtained by setting the stall valve), a speed of 3,500 r.p.m. and a flow of 750 g.p.h. During this test the temperature of the fuel should be allowed to rise to between 36 deg. and 38 deg. C. for a period of 15 minutes, then reduced again. The pump should then be run for 15 minutes at a delivery pressure of 2,000 lb. per sq. in. and a speed of 3,700 r.p.m. at full stroke.

CYCLING ENDURANCE TEST

4. The pump must complete 12 cycles consisting of 5 minutes at 3,500 r.p.m. and 750 g.p.h. at a stall pressure of 1,800 to 2,000 lb. per sq. in., followed by 10 minutes at a speed of 700 r.p.m., a flow of 60 g.p.h., and a delivery pressure of 1,250 lb. per sq. in.

GOVERNOR CYCLING TEST

5. The pump must complete 240 full governor cycles during which the speed is varied with the governor set at point 'A', as in para. 222 (2).

6. Set the pump to give idling conditions, then stop the rig. The pump must now complete 25 starts from rest to idling. No further adjustment should be made to the pump during this test.

SECOND PRELIMINARY CALIBRATION
(refer to para. 227)

7. Pump to run at inlet pressure of 3 to 5 lb. per sq. in., a speed of 2,900 r.p.m., and zero flow at which stall pressure is to be set to 1,800 to 2,100 lb. per sq. in. Volumetric efficiency, governor cycling and recovery time checks, as in para. 222, to be repeated.

FINAL ENDURANCE TEST

8. Repeat governor cycling test as detailed in para. 5 and 6 above.

FINAL CALIBRATION

9. Setting maximum flow (refer to para. 271). Inlet pressure to be 3 to 5 lb. per sq. in. speed 2,900 r.p.m. delivery pressure 1,250 lb. per sq. in. and the flow 500 to 510 g.p.h. The minimum flow stop, which has been approximately set on assembly, should now be set finally as follows. With the pump running at 3,000 r.p.m. and inlet pressure 3 to 5 lb. per sq. in. close the restriction to give zero flow and allow pump servo pressure to spill to atmosphere through the bore of the minimum flow stop screw. Using the tool T.174683, adjust the stop screw to give 1,200 to 1,300 lb. per sq. in. delivery pressure. It will be found advantageous to reduce the pump speed to 500 r.p.m. while adjusting the stop screw. When satisfactory, tighten the lock-nut and bend up the lip of the tab-washer.

Note . . .

On some units the minimum flow stop screw is located in the head of the control piston, and bears against a fixed stop in the control cylinder cover. The setting figures are the same as those above, but the rig must be stopped and the control cylinder cover removed, using tool T.146460, each time the stop screw is adjusted. Adjustments are made with tool T.174335 (fig. 14) the supplementary spanner being used to adjust the screw, and the box spanner to secure the lock-nut. When satisfactory, tighten the lock-nut and turn up the lip of the tab-washer.

10. Centrifugal pressure rise test (refer to para. 272). (1) Inlet pressure to be 10 to 15 lb. per sq. in.

(2) Speed to be 3,500 to 3,600 r.p.m.

(3) Bleed pump and check amplifier valve.

(4) Delivery pressure of 1,300 lb. per sq. in., then govern down to delivery pressure of 1,000 lb. per sq. in.

APPENDIX 2

11. Governor range check (refer to para. 275). Speed 3,000 to 3,400 r.p.m. at delivery pressure of 1,250 lb. per sq. in.

12. Governor setting check (refer to para. 278). Pump speeds to be within limits of 3,200 and 3,220 r.p.m. at a delivery pressure of 1,250 lb. per sq. in. and an inlet depression of 12 in. Hg.

13. Pressure test (refer to para. 279). Pump speed to be 3,100 r.p.m. delivery pressure 1,500 lb. per sq. in. and inlet pressure of 20 lb. per sq. in. for 5 minutes.

14. Self priming test (refer to para. 280). Pump speed to be 500 r.p.m. With inlet closed a reading of 24 in Hg. depression, or more must be obtained on the boost gauge.

15. Leakage tests (refer to para. 281). (1) Air pressure of 40 lb. per sq. in. for 5 minutes.

(2) Air pressure of 5 lb. per sq. in. for 5 minutes. Seal drain leakage must not exceed 5 c.c. per hour.

16. Pressure test final. Repeat para. 13 above.

SOLENOID ISOLATING VALVE (if fitted)
(refer to para. 290)

17. Speed 3,100 r.p.m. Solenoid to be operated ten times at 16 volts with the pump running at half stall and full stall (i.e., half flow and zero flow).

APPENDIX 3

CALIBRATION CODE 'J'

Note . . .
The values below must be rigidly adhered to when calibrating fuel pumps to code 'J' and reference must be made to the particular paragraph quoted.

RUNNING-IN PROCEDURE
(refer to para. 221)

1.

Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)	Time (Minutes)
250	50	2·5
500	50	2·5
500	100	2·5
500	200	2·5
1,000	200	2·5
1,000	350	2·5
1,500	350	2·5
1,500	500	2·5
2,000	500	5·0
2,000	750	5·0
2,500	750	5·0
3,000	750	5·0
3,500	750	5·0
3,500	1,000	45·0

Note . . .
Before 45 minutes run, set maximum stroke to 890 g.p.h. at 100 lb. per sq. in. and 3,500 r.p.m.

FIRST PRELIMINARY CALIBRATION
(refer to para 222)

2. (1) **Volumetric efficiency check**

At a constant speed of 3,500 r.p.m.
High delivery pressure .... 1,000 lb. per sq. in.
Low delivery pressure .... 100 lb. per sq. in.

The flow difference must not exceed 28 g.p.h. when using aviation kerosine (Specification D.ENG.RD.2482) or 60 g.p.h. when using aviation gasoline (Specification D.ENG.RD.2485, Grade 73).

(2) **Governor cycling check**

Point	Inlet Pressure (lb. per sq. in.)	Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)
'A'	3 to 5	3,580	1,000
'B'	NOT	APPLICABLE	
'C'	3 to 5	3,610 to 3,680	70
'D'	3 to 5	3,550 to 3,580	1,000 to 950

Note . . .
The governor over-run during endurance on gasoline to be recorded only.

(3) Recovery time, point ' C ' to point ' D ': 2 to 3 seconds.

ENDURANCE TEST
(refer to para. 223)

3. 1¾ hours at a delivery pressure of 1,600 lb. per sq. in. (this reading being obtained by setting the stall valve), a speed of 3,500 r.p.m. and a flow of 750 g.p.h. During this test the temperature of the fuel should be allowed to rise to between 36 deg. and 38 deg. C. for a period of 15 minutes, then reduced again. The pump should then be run for 15 minutes at a delivery pressure of 2,000 lb. per sq. in. and a speed of 3,700 r.p.m. at full stroke.

CYCLING ENDURANCE TEST

4. The pump must complete 12 cycles consisting of 5 minutes at a speed of 3,500 r.p.m., a flow of 750 g.p.h., and a stall pressure of 1,800 to 2,000 lb. per sq. in., followed by 10 minutes at a speed of 700 r.p.m. a flow of 60 g.p.h. and a delivery pressure of 1,250 lb. per sq. in.

GOVERNOR CYCLING TEST

5. The pump must complete 240 full governor cycles during which the speed is varied with the governor set at Point ' A ' as in para. 222 (2).

6. Set the pump to give idling conditions, then stop the rig. The pump must now complete 25 starts from rest to idling. No futher adjustment should be made to the pump during this test.

SECOND PRELIMINARY CALIBRATION
(refer to para. 227)

7. Pump to run at inlet pressure of 3 to 5 lb. per sq. in. speed of 3,500 r.p.m. and zero flow at which stall pressure is to be set to 1,800 to 2,100 lb. per sq. in. Volumetric efficiency, governor cycling and recovery time checks, as in para. 222, to be repeated.

FINAL ENDURANCE TEST

8. Repeat governor cycling text, as detailed in para. 5 and 6 above.

FINAL CALIBRATION

9. Setting maximum flow (refer to para 271). Inlet pressure to a 3 to 5 lb. per sq. in. speed 3,500 r.p.m. delivery pressure 1,000 lb. per sq. in. and flow 560 to 570 g.p.h.

10. Centrifugal pressure rise test (refer to para. 272). (1) Inlet pressure to be 10 to 15 lb. per sq. in.

(2) Speed to be 3,500 to 3,600 r.p.m.

(3) Bleed pump and check amplifier valve.

(4) Delivery pressure of 1,300 lb. per sq. in. then govern down to delivery pressure of 1,000 lb. per sq. in.

11. Governor range check (refer to para. 275). Speed 3,300 to 3,700 r.p.m. at delivery pressure of 1,000 lb. per sq. in.

12. Governor setting check (refer to para. 278). Pump speeds to be within limits of 3,580 and 3,590 at a delivery pressure of 1,000 lb. per sq. in. and an inlet depression of 12 in. Hg.

13. Pressure test (refer to para. 279). Pump speed to be 3,500 r.p.m. delivery pressure 1,500 lb. per sq. in. and inlet pressure of 20 lb. per sq. in. for 5 minutes.

14. Self priming test (refer to para. 280). Pump speed to be 500 r.p.m. With inlet closed a reading of 24 in. Hg. depression or more must be obtained on the boost gauge.

15. Leakage test (refer to para. 281). (1) Air pressure of 40 lb. per sq. in. for 5 minutes.

(2) Air pressure of 5 lb. per sq. in. for 5 minutes. Seal drain leakage must not exceed 5 c.c. per hour.

16. Pressure test final. Repeat para. 13 above.

SOLENOID ISOLATING VALVE (if fitted)
(refer to para. 290)

17. Speed 3,100 r.p.m. Solenoid to be operated ten times at 16 volts with the pump running at half stall and full stall (i.e., half flow and zero flow).

APPENDIX 4

CALIBRATION CODE 'M'

Note . . .
The values below must be rigidly adhered to when calibrating fuel pumps to code 'M' and reference must be made to the particular paragraph quoted.

RUNNING-IN PROCEDURE
(refer to para. 221)

1.

Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)	Time (Minutes)
250	50	2·5
500	50	2·5
500	100	2·5
500	200	2·5
1,000	200	2·5
1,000	350	2·5
1,500	350	2·5
1,500	500	2·5
2,000	500	5·0
2,000	750	5·0
2,500	750	5·0
3,000	750	5·0
3,500	750	5·0
3,500	1,000	45·0

Note . . .
Before 45 minutes run set maximum stroke to 890 g.p.h. at 100 lb. per sq. in. and 3,500 r.p.m.

FIRST PRELIMINARY CALIBRATION
(refer to para. 222)

2. (1) **Volumetric efficiency check**

At a constant speed of 2,900 r.p.m.

High delivery pressure .... 500 lb. per sq. in.

Low delivery pressure .... 70 lb. per sq. in.

The flow difference must not exceed 18 g.p.h. when using aviation kerosine (Specification D.ENG.2482) or 40 g.p.h. when using aviation gasoline (Specification D.ENG.2485 Grade 73).

(2) **Governor cycling check**

Point	Inlet Pressure (lb. per sq. in.)	Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)
'A'	3 to 5	2,880	500
'B'	NOT APPLICABLE		
'C'	3 to 5	2,930 to 2,980	70
'D'	3 to 5	2,840 to 2,880	500

Note . . .
The governor overrun during endurance on gasoline to be recorded only.

(3) Recovery time, point ' C ' to point ' D ': 2 to 4·5 seconds.

ENDURANCE TEST
(refer to par. 223)

3. $1\frac{3}{4}$ hours at a delivery pressure of 1,000 lb. per sq. in. (this reading being obtained by setting the stall valve), a speed of 3,500 r.p.m. and a flow of 750 g.p.h. During this test the temperature of the fuel should be allowed to rise to between 36 deg. and 38 deg. C. for a period of 15 minutes, then reduced again. The pump should then be run for 15 minutes at a delivery pressure of 1,000 lb. per sq. in. and a speed of 3,700 r.p.m. at full stroke.

CYCLING ENDURANCE TEST

4. The pump must complete 12 cycles consisting of 5 minutes at a speed of 3,500 r.p.m., a flow of 750 g.p.h., and a stall pressure of 1,000 lb. per sq. in, followed by 10 minutes at a speed of 700 r.p.m., a flow of 60 g.p.h., and a delivery pressure of 1,000 lb. per sq. in.

GOVERNOR CYCLING TEST

5. The pump must complete 240 full governor cycles during which the speed is varied with the governor set at point ' A ', as in para. 222 (2).

6. Set the pump to give idling conditions, then stop the rig. The pump must now complete 25 starts from rest to idling. No further adjustment should be made to the pump during this test.

SECOND PRELIMINARY CALIBRATION
(refer to para. 227)

7. Pump to run at inlet pressure of 3 to 5 lb. per sq. in. a speed of 2,900 r.p.m. and zero flow, at which the stall pressure is to be set to 700 to 800 lb. per sq. in. Volumetric efficiency, governor cycling and recovery time checks, as in para. 222, to be repeated.

FINAL ENDURANCE TEST

8. Repeat governor cycling test, as detailed in para. 5 and 6 above.

FINAL CALIBRATION

9. Setting maximum flow (refer to para. 271). Inlet pressure to be 3 to 5 lb. per sq. in. speed 2,900 r.p.m., delivery pressure 500 lb. per sq. in. and flow 650 to 660 g.p.h.

10. Centrifugal pressure rise test (refer to para. 272). (1) Inlet pressure to be 10 to 15 lb. per sq. in.

(2) Speed to be 3,500 to 3,600 r.p.m.

(3) Bleed pump and check amplifier valve.

(4) Delivery pressure of 500 lb. per sq. in. then govern down to delivery pressure of 350 to 400 lb. per sq. in.

11. Governor range check (refer to para. 275). Speed 2,680 to 3,080 r.p.m. at delivery pressure of 500 lb. per sq. in.

12. Governor setting check (refer to para. 278). Pump speeds to be within limits of 2,880 and 2,900 r.p.m., at a delivery pressure of 500 lb. per sq. in., and an inlet depression of 12 in. Hg.

13. Pressure test (refer to para. 279). Pump speed to be 2,750 r.p.m., delivery pressure 500 lb. per sq. in., and inlet pressure of 20 lb. per sq. in. for 5 minutes.

14. Self priming test (refer to para. 280). Pump speed to be 500 r.p.m. With inlet closed a reading of 24 in. Hg. depression or more must be obtained on the boost gauge.

15. Leakage test (refer to para. 281). (1) Air pressure of 40 lb. per sq. in. for 5 minutes.

(2) Air pressure of 5 lb. per sq. in. for 5 minutes. Seal drain leakage must not exceed 5 c.c. per hour.

16. Pressure test final. Repeat para. 13 above.

SOLENOID ISOLATING VALVE (if fitted)
(refer to para. 290)

17. Speed 2,750 r.p.m. Solenoid to be operated ten times at 16 volts with the pump running at half stall and full stall (i.e., half flow and zero flow).

APPENDIX 5

CALIBRATION CODE 'N'

Note . . .
The values below must be rigidly adhered to when calibrating fuel pumps to code 'N', and reference must be made to the particular paragraph quoted.

RUNNING-IN PROCEDURE
(refer to para. 221)

1.

Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)	Time (Minutes)
250	50	2·5
500	50	2·5
500	100	2·5
500	200	2·5
1,000	200	2·5
1,000	350	2·5
1,500	350	2·5
1,500	500	2·5
2,000	500	5·0
2,000	750	5·0
2,500	750	5·0
3,000	750	5·0
3,500	750	5·0
3,500	1,000	45·0

Note . . .
Before 45 minutes run set maximum stroke at 890 g.p.h. at 100 lb. per sq. in. and 3,500 r.p.m.

FIRST PRELIMINARY CALIBRATION
(refer to para 222)

2. (1) **Volumetric efficiency check**

At a constant speed of 3,500 r.p.m.
High delivery pressure .... 1,000 lb. per sq. in.
Low delivery pressure .... 100 lb. per sq. in.

The flow difference must not exceed 28 g.p.h. when using aviation kerosine (Specification D.ENG.RD.2482), or 60 g.p.h. when using aviation gasoline (Specification D.ENG.RD.2485 Grade 73).

(2) **Governor cycling check**

Point	Inlet Pressure (lb. per sq. in.)	Speed (R.P.M.)	Delivery Pressure (lb. per sq. in.)
'A'	3 to 5	3,510	1,000
'B'	NOT APPLICABLE		
'C'	3 to 5	3,590 to 3,630	100
'D'	3 to 5	3,470 to 3,510	1,000 to 950

Note . . .
The governor overrun during endurance on gasoline to be recorded only.

(3) Recovery time, point 'C' to point 'D': 2 to 3 seconds.

ENDURANCE TEST
(refer to para. 223)

3. $1\frac{3}{4}$ hours at a delivery pressure of 1,600 lb. per sq. in. (this reading being obtained by setting the stall valve), a speed of 3,500 r.p.m. and a flow of 750 g.p.h. During this test the temperature of the fuel should be allowed to rise to between 36 deg. and 38 deg. C. for a period of 15 minutes, then reduced again. The pump should then be run for 15 minutes at a delivery pressure of 2,000 lb. per sq. in., and a speed of 3,700 r.p.m. at full stroke.

CYCLING ENDURANCE TEST

4. The pump must complete 12 cycles consisting of 5 minutes at a speed of 3,500 r.p.m., a flow of 750 g.p.h., and a stall pressure of 1,800 to 2,000 lb. per sq. in., followed by 10 minutes at a speed of 700 r.p.m., a flow of 60 g.p.h., and a delivery pressure of 1,250 lb. per sq. in.

GOVERNOR CYCLING TEST

5. The pump must complete 240 full governor cycles during which the speed is varied with the governor set at point 'A' as in para. 222 (2).

6. Set the pump to give idling conditions, then stop the rig. The pump must now complete 25 starts from rest to idling. No further adjustment should be made to the pump during this test.

SECOND PRELIMINARY CALIBRATION
(refer to para. 227)

7. Pump to run at inlet pressure of 3 to 5 lb. per sq. in., a speed of 3,500 r.p.m., and zero flow at which the stall pressure is to be set to 1,800 to 2,100 lb. per sq. in. Volumetric efficiency, governor cycling and recovery time checks, as in para. 222, to be repeated.

FINAL ENDURANCE TEST

8. Repeat governor cycling test, as detailed in para. 5 and 6 above.

FINAL CALIBRATION

9. Setting maximum flow (refer to para 271). Inlet pressure to be 3 to 5 lb. per sq. in, speed 3,500 r.p.m. delivery pressure 1,000 lb. per sq. in. and flow 830 to 840 g.p.h.

10. Centrifugal pressure rise test (refer to para. 272). (1) Inlet pressure to be 10 to 15 lb. per sq. in.

(2) Speed to be 3,500 to 3,600 r.p.m.

(3) Bleed pump and check amplifier valve.

(4) Delivery pressure of 1,300 lb. per sq. in. then govern down to delivery pressure of 1,000 lb. per sq. in.

11. Governor range check (refer to para. 275). Speed 3,300 to 3,700 r.p.m. at delivery pressure of 1,000 lb. per sq. in.

12. Governor setting check (refer to para. 278). Pump speeds to be within limits of 3,510 and 3,530 r.p.m. at a delivery pressure of 1,000 lb. per sq. in. and an inlet depression of 12 in. Hg.

13. Pressure test (refer to para. 279). Pump speed to be 3,000 r.p.m., delivery pressure 1,500 lb. per sq. in. and inlet pressure of 20 lb. per sq. in. for 5 minutes.

14. Self priming test (refer to para. 280). Pump speed to be 500 r.p.m. With inlet closed a reading of 24 in. Hg. depression or more must be obtained on the boost gauge.

15. Leakage tests (refer to para. 281). (1) Air pressure of 40 lb. per sq. in. for 5 minutes.

(2) Air pressure of 5 lb. per sq. in. for 5 minutes. Seal drain leakage must not exceed 5 c.c. per hour.

16. Pressure test final. Repeat para. 13 above.

SOLENOID ISOLATION VALVE (if fitted)
(refer to para. 290)

17. Speed 3,000 r.p.m. Solenoid to be operated ten times at 16 volts with the pump running at half stall and full stall (i.e., half flow and zero flow).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