Chapter 7

HIGH PRESSURE FUEL PUMPS, TYPE G.B.B. SERIES

LIST OF CONTENTS

	Para.
General	1
Special tools	5
Checks and precautions before dismantling	6
Dismantling the pump	12
Removing the installation connections	14
Removing the overspeed control assembly	16
Dismantling the overspeed control assembly	17
Checking the rocker lever tail lift	22
Removing the amplifier valve assembly	23
Dismantling the amplifier valve assembly	24
Removing and dismantling the camplate housing	28
Removing the control ring and camplate assembly	36
Removing and dismantling the rotor	39
Removing the port insert	41
Removing the control piston assembly	43
Dismantling the control piston assembly	46
Removing the control cylinder liner	47
Removing the servo-pressure restricting orifice	49
Remaining details	50
Cleaning	52
Inspection	
General	54
Redundant and consumable parts	57
Scores and surface damage	59
Crack detection	60
Installation fittings	61
Overspeed control assembly	62
Amplifier valve assembly	71
Camplate housing assembly	78
Camplate	80
Rotor assembly	82
Checking the rotor bores	87
Checking the rotor pistons	89
Checking the piston slippers	91
Port insert	92
Checking the carbon bearing clearances	95
Control piston assembly	99
Servo pressure restricting orifice	102
Pump housing	103
Remaining details	104
Building the sub-assemblies	108
Control cylinder liner	109
Port insert and carbon bearing	110
Control piston assembly	115
Camplate housing assembly	116
Amplifier valve assembly	117
Overspeed control assembly	122
Rotor assembly	126
Building the pump	
Trunnion block clearance	129
Camplate end-float	134
Control piston assembly	136
Rotor assembly	139
Camplate assembly	140
Checking the rotor for rotation	144
Checking the camplate angle	145
Checking the auxiliary camplate lift	146
Fitting the camplate housing to the pump body	147
Amplifier valve assembly	149
Checking the governor tappet clearance	150
Control cylinder end cover	155
Overspeed control assembly	156
Servo pressure restricting orifice	157
Remaining details	158
Replacements	
Rotor quill shaft	161
Camplate housing	163
Rotor assembly	164
Carbon bearings	165
Pistons	166
Port insert	167
Governor housing	168
Diaphragm assembly	169
Trunnion block	170
Amplifier valve assembly	171
Control piston assembly	172
Control cylinder liner	173
Servo pressure restricting orifice	174
Remaining details	175
Rig testing	
General	176
Running in	184
Preliminary calibration	185
General endurance test	186
Pump cyclic endurance test	187
Governor cyclic endurance test	188
Starting test	189
Performance test	190
Strip inspection	191
Final assembly	192
Re-calibration	194
Second endurance test	195
Final calibration and performance test	196
Setting the maximum flow	196

LIST OF CONTENTS—*continued*

	Para.
Checking the governor pressure rise	197
Checking the stall pressure	198
Checking the volumetric efficiency	200
Checking the governor range	201
Checking the governor cycle	202
Checking the governor recovery time	203
Checking the governor cycle with pump inlet depression	204
Self priming test	205
Fuel leakage test	206
Air pressure test	207
Air pressure test outer seal	208
Final leakage test	209
Calibration code	Appendix 1

LIST OF ILLUSTRATIONS

	Fig.
Dismantled pump	1
Checking the quill shaft concentricity	2
Dismantling and assembling fixture	3
Removing the overspeed governor adjusting screw	4
Checking the rocker lever tail lift	5
Removing the amplifier valve reach nuts	6
Withdrawing the amplifier valve assembly	7
Removing the stall pressure adjustment	8
Amplifier valve assembling and dismantling fixture	9
Fitting and removing the camplate housing	10
Removing the maximum flow stop	11
Storage stand for rotor	12
Storage stand for rotor pistons	13
Removing the rotor piston spring guides	14
Removing the rotor carbon bearing circlip	15
Removing the control cylinder liner	16
Checking the rotor bores	17
Checking the rotor pistons	18
Checking the slipper piston clearance	19
Checking the parallelism of the port insert	20
Checking the carbon bearing clearances	21
Assembling the control cylinder liner	22
Fitting the control piston, seal retaining circlip	23
Adjusting the amplifier valve	24
Pressure testing the rotor quill shaft oil seal	25
Inserting the rotor spring guides	26
Measuring the trunnion block clearance	27
Checking the end-float on the camplate	28
Fitting the control piston assembly	29
Checking the camplate angle	30
Checking the auxiliary-camplate lift	31
Checking the overspeed governor tappet clearance	32
Removing the rotor quill shaft	33
Removing the rotor quill shaft locking and sealing rings	34
Fitting the rotor quill shaft	35
Locking the quill shaft on the rotor	36
Slave adapters for test rig	37
Diagrammatic layout of test rig	38
Bleed tool in position on valve	39
Checking the centrifugal pressure rise	40
Adjusting the stall pressure	41

General

1. These instructions cover the GBB series fuel pump, and the calibration settings, which vary with the requirements of different engines, are given in the Appendix.

2. The log book of the pump contains test and clearance figures, running times and details of servicing, repairs and modifications. It is important that all further details of this nature are recorded when the work is completed.

3. The necessity for cleanliness cannot be over-emphasised and precautions must be taken in every instance to ensure that all details are thoroughly clean.

4. Paper joints or gaskets, metal washers, etc., must be replaced by new ones whenever the seal is disturbed, and new split pins and locking wire must always be used. Slave nuts, washers, etc., should be used when components are being assembled temporarily. This will enable sound parts to be fitted on final assembly. Details of those parts which are not interchangeable are given in para. 161 to 175.

Special tools

5. The special tools required are given in the following list. In most instances an illustration of the tool to be used is also provided adjacent to the appropriate instructions.

Tool No.	*Description*	
G.54232	Gauge, parallelism check, port insert	
G.54619	Setting piece, (grade 1)	rotor piston measurement
G.54620	Setting piece, (grade 2)	
G.54621	Setting piece, (grade 3)	
G.54622	Setting piece, (grade 4)	
G.54623	Setting piece, (grade 5)	
G.56550	Gauge, checking, piston slipper clearance	

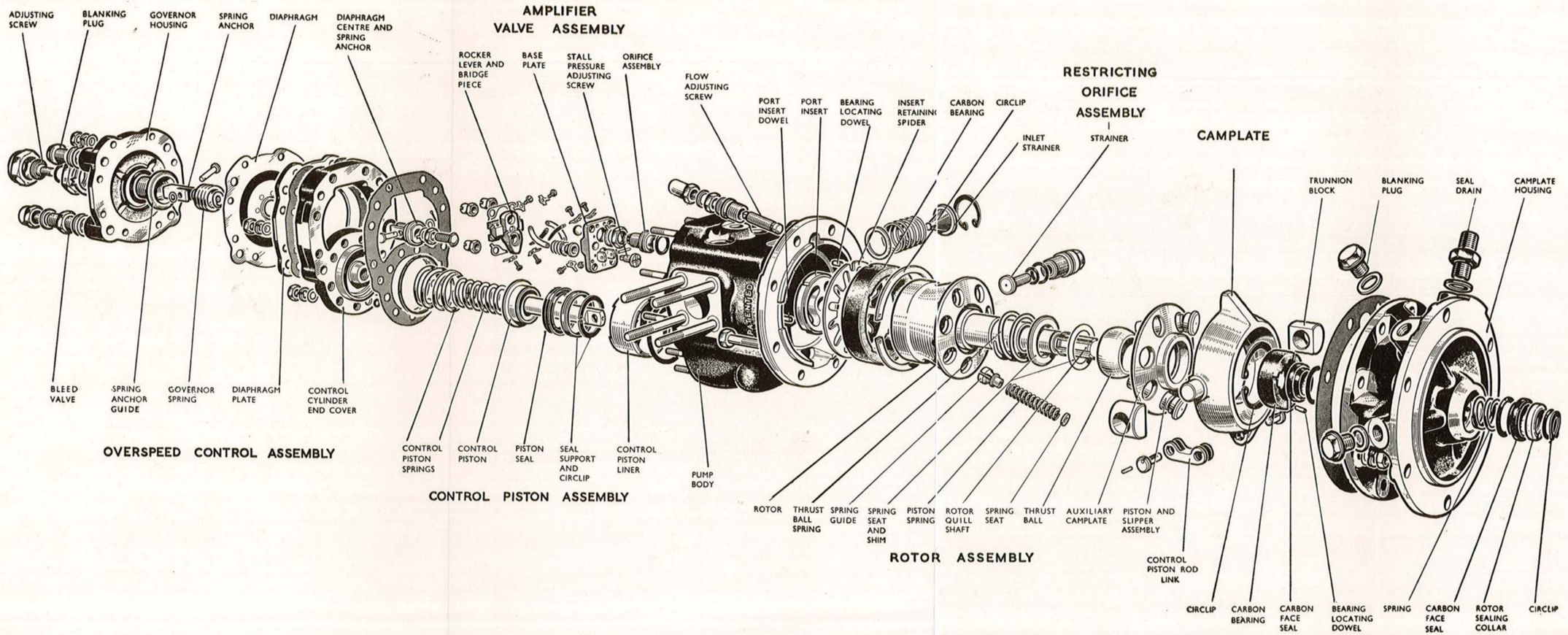


Fig. 1. Dismantled pump

Tool No.	*Description*	
G.59529	Setting ring (grade 1)	rotor bore measurement
G.59530	Setting ring, (grade 2)	
G.59531	Setting ring, (grade 3)	
G.59532	Setting ring, (grade 4)	
G.59533	Setting ring, (grade 5)	
G.61113	Plate gauge, camplate angle	
G.61324	Adapter ring and locating pegs for use with G.68363	
G.61436	Gauge, clearance check, rotor main bearing	
G.61437	Concentricity gauge, quill shaft	
G.62105	Gauge, checking camplate end-float	
G.62106	Gauge, clearance check rotor top bearing	
G.64208	Gauge, checking, governor tappet clearance	
G.68363	Gauge, checking, auxiliary camplate lift	
T.157039	Assembly tool, carbon bearing circlip	
T.160988	Spanner, adjusting screw, overspeed governor	
T.166109	Assembling and dismantling fixture, amplifier valve	
T.175555	Assembly tool, control piston seal	
T.175562	Spanner, bleed valve	
T.175565	Driver amplifier valve reach nuts	
T.175567	Assembly tool, rotor spring guides	
T.175579	Bleed tool, priming, rig test	
T.178981	Storage stand, rotor	
T.192035	Adapter, rig test, overspeed governor	
T.193935	Spanner, maximum flow stop adjusting screw	
T.193936	Drift, removal of rotor spring guides	
T.193937	Storage stand, rotor pistons	
T.193938	Spanners, locknut amplifier valve orifice assembly	
T.193939	Spanner, stall pressure adjusting screw	
T.198170	Extractor amplifier valve assembly	
T.199561	Splined spanner, rotating rotor	
T.201711	Adapter, assembling and dismantling fixture	
T.201712	Gauge, checking, rocker lever tail lift	
T.202263	Fixture, pressure test, rotor quill shaft oil seal	
T.203055	Assembly tool, rotor quill shaft	
T.203382	Tool, removing rotor circlip	
T.203383	Assembly sheath, camplate housing	
T.203384	Test rig adapters ($\frac{1}{2}$ and $\frac{3}{8}$ in. B.S.P. to suit 2 B.A. inserts)	
T.203385	Test rig adapters ($\frac{1}{2}$ and $\frac{3}{8}$ in. B.S.P. to suit $\frac{1}{4}$ B.S.F. studs)	
T.203522	Assembly tool, control cylinder liner	
T.204980	Guide, piston rod to pump	
T.204988	Extractor, control cylinder liner	
T.206237	Adjusting fixture, amplifier valve	
T.249079	Base and drift, removal of rotor quill shaft.	

Checks and precautions before dismantling

6. A pump must not be dismantled unless complete calibration testing equipment and service tools are available.

7. Consider any complaints reported with the fuel pump and examine the exterior of the unit for any visible signs of damage or broken locking wire. Check that all parts have been securely covered to prevent the entry of foreign matter into the pump. Examine exposed threads to ensure that no damage has been caused in transit.

8. When removing dust caps examine the interior of each for signs of foreign matter. If it is suspected that this is present, it is advisable to continue with the dismantling of the pump, omitting the preliminary calibration tests. The unit will contain inhibiting oil which should be drained into a container.

9. Check the concentricity of the quill shaft by using the gauge G.61437 as shown in fig. 2 ; if the quill shaft will not accept the gauge the pump must not be run on the test rig. Remove the installation fittings from the pump and if the pump appears to be in running condition it should be mounted on the test rig as for final calibration.

10. Calibrate the pump as described in para. 185 to 190. The calibration setting or code is denoted by the suffix letter in the type number viz. GBB 6/1Y means that

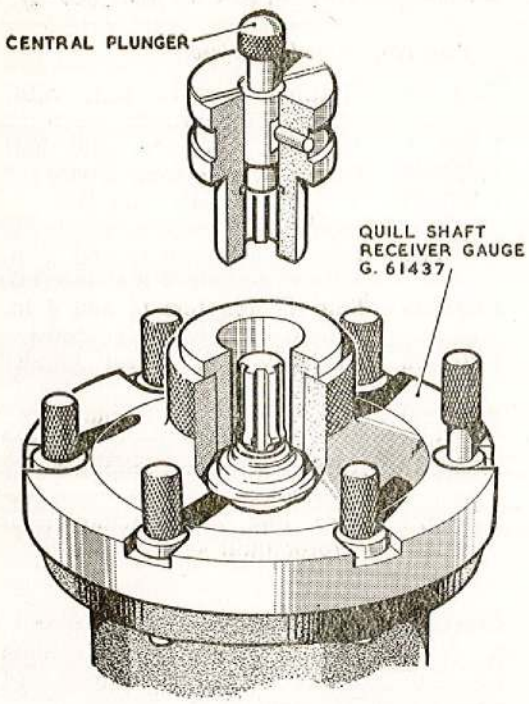


Fig. 2. Checking the quill shaft concentricity

the calibration is code Y. The calibration codes are listed in the Appendix.

11. When the rig is started, should there be any noise which indicates a damaged condition, the rig must be stopped and the pump completely dismantled. If the pump runs smoothly the calibration test should be completed. The performance is a good guide to the condition of the unit and will indicate parts requiring attention.

DISMANTLING THE PUMP

12. The following instructions for dismantling the pump are listed in the recommended sequence and where the stripping of a sub-assembly is not considered advisable it must be replaced by a new one. Defective pumps must be dealt with according to their reported complaints, complete stripping not being essential in every instance, i.e., where units have completed short running times, the stripping of sub-assemblies may be discretionary.

13. It is advisable to have at hand small boxes in which nuts, washers, bolts, springs, screws, etc., of separate units may be stored until required for re-build.

Removing the installation connections

14. Remove the pump inlet and outlet connections by unscrewing the retaining nuts and bolts and removing together with plain washers and grover washers. Lift off the connections and joint washers, extract the strainer retaining circlip from the pump inlet connection and remove the strainer spring and washer.

15. Remove the bleed connections; one or two may be fitted on the governor housing of the pump and in some units may be in the form of a tapping off the camplate housing. Some bleed points have a flexible extension.

Removing the overspeed control assembly

16. Mount the pump on the stripping fixture adapter T.201711 as shown in fig. 3. Remove the nuts grover and plain washers and lift off the overspeed control governor assembly. Remove the gasket.

Dismantling the overspeed control assembly

17. It is not necessary to dismantle this assembly unless the cover or diaphragm is defective.

18. Unlock and remove the adjusting

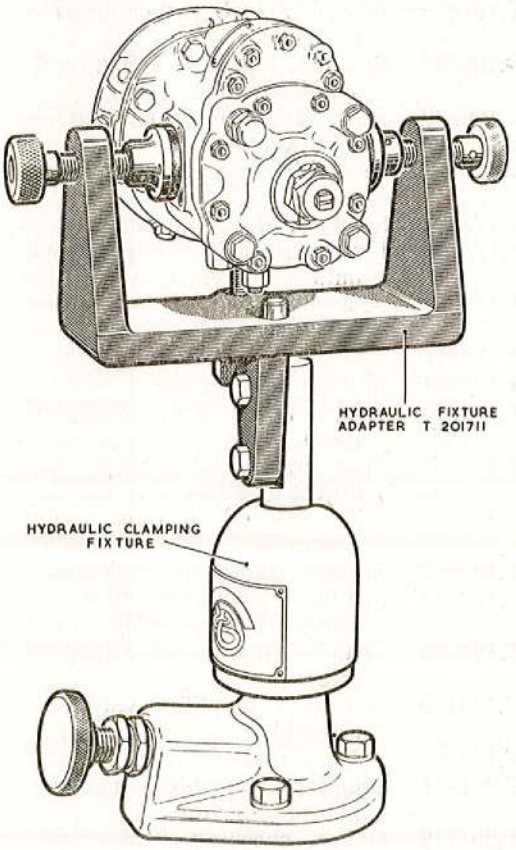


Fig. 3. Dismantling and assembling fixture

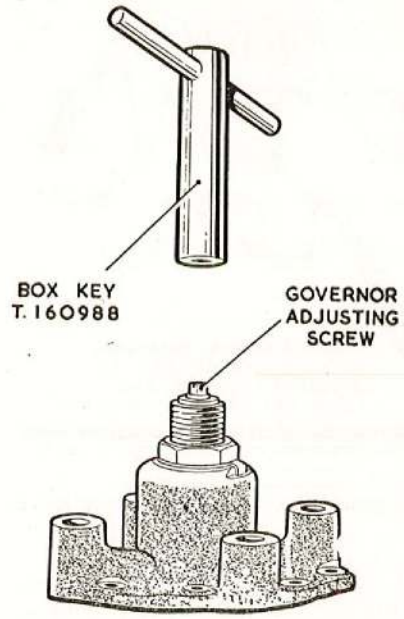


Fig. 4. Removing the overspeed governor adjusting screw

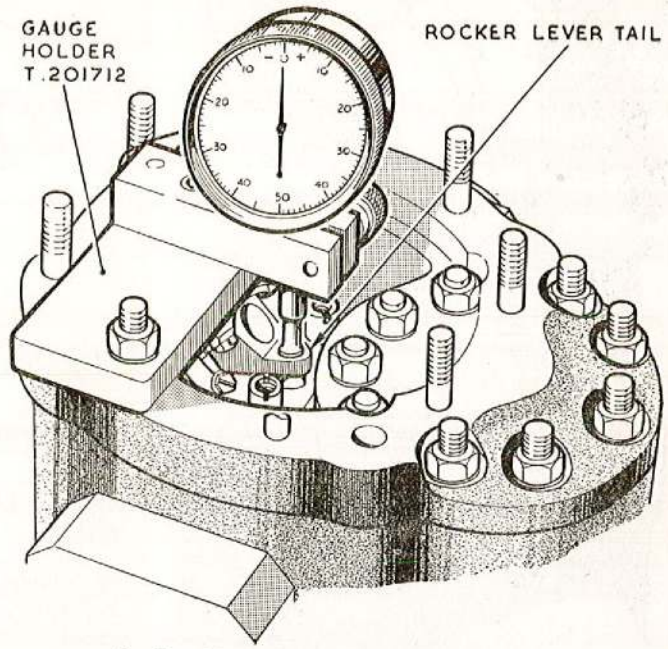


Fig. 5. Checking the rocker lever tail lift

screw locknut from the top of the spring housing, unscrew the adjustment screw from the spring anchor by using spanner T.160988 as shown in fig. 4. Withdraw the diaphragm and spring assembly from the housing.

19. Unlock the large nut retaining the spring anchor guide, remove the nut and the anchor guide ; the guide is flanged and dowelled inside the spring housing and if tight it should be driven out by tapping the outer end lightly with a hide faced hammer. The dowel should not be disturbed unless it is damaged.

20. Extract the split pin from the link pin securing the upper end of the governor spring to the spring anchor. Remove the washer and withdraw the link pin to separate the spring anchor.

21. Extract the remaining link pin likewise to detach the spring from the diaphragm centre piece then remove the centre piece and sealing ring from the diaphragm plate and the gasket from the diaphragm cover mounting studs in the pump housing. The diaphragm is a riveted assembly and must not be dismantled.

Checking the rocker lever tail lift

22. The amplifier valve is exposed when the governor housing has been removed and before any further dismantling takes place the rocker-lever tail lift should be checked as follows :—

(1) Place the holder T.201712 in position on the pump housing and secure with a washer and nut on two opposite studs.

(2) Set up the dial test indicator and check the lever tail lift as shown in fig. 5.

(3) Record the dimension.

Removing the amplifier valve assembly

23. Unlock the tab-washers securing the nuts which retain the amplifier valve base plate to the pump housing then, using the special tool T.175565, as shown in fig. 6, unscrew and remove the four reach nuts. Screw in two extractors T.198170 as shown in fig. 7, and lift the assembly out of the pump body. The assembly may feel slightly tight at first due to the rubber sealing ring on the orifice strainer housing but a steady pull on the extractors will release the seal.

Dismantling the amplifier valve assembly *(fig. 8 and 9)*

24. Reduce the spring load on the rocker lever by rotating the stall pressure adjusting screw anti-clockwise as far as possible, then

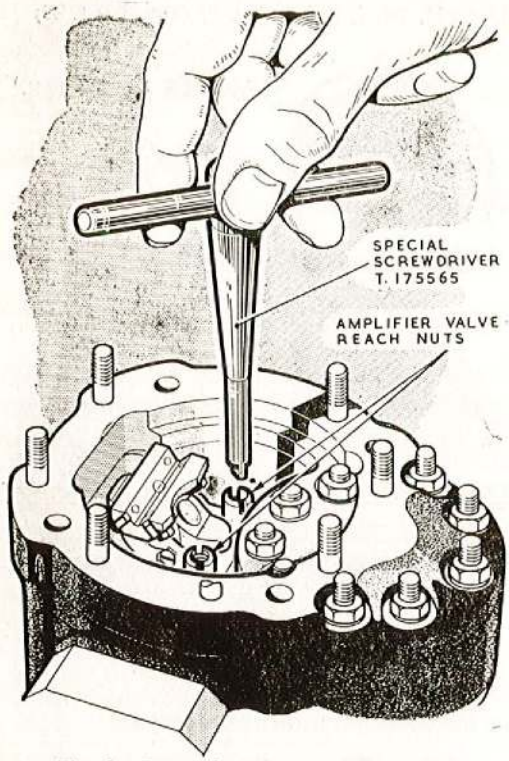


Fig. 6. Removing the amplifier valve reach nuts

compress the spring slightly as shown in *fig. 8* and remove the retaining pin, adjusting screw, spring seating and spring.

25. Unlock the tab-washer securing the orifice locknut, release the nut by using spanner T.193938 and then remove the orifice and strainer. Take care to avoid losing the half-ball which will fall out as soon as the orifice is clear of the valve base plate.

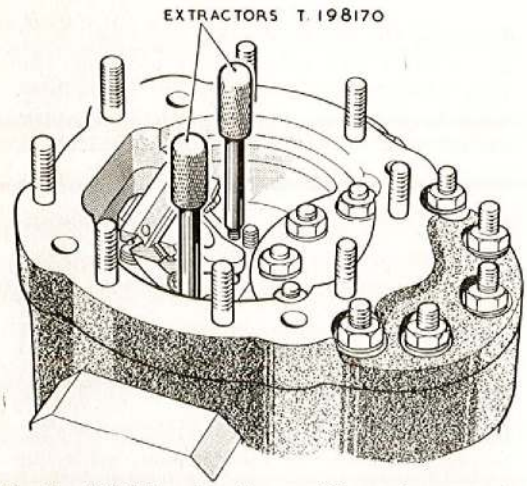


Fig. 7. Withdrawing the amplifier valve assembly

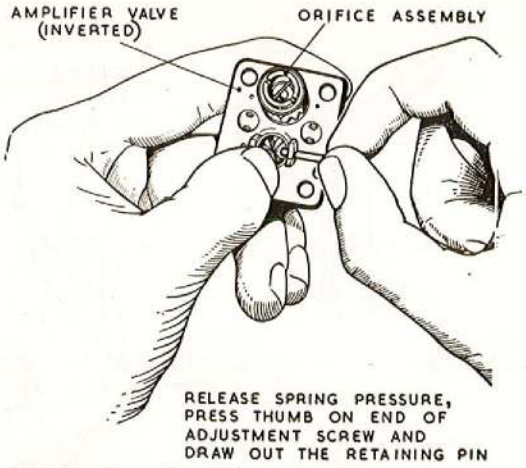


Fig. 8. Removing the stall pressure adjustment

26. Mount the assembly on fixture T.166109, unlock the tab-washer, remove the set-screws and detach the rocker lever and bridge piece from the baseplate.

27. Transfer it to the other side of the fixture and insert the mandrels to hold the free ends of the hinge blades. Unlock and remove the set-screws securing the blades to the lever piece then reverse the lever in the fixture and remove the remaining two blades likewise.

Removing and dismantling the camplate housing

28. Mount the pump in the stripping fixture T.201711 as shown in fig. 3 and remove the circlip from the rotor shaft by using circlip pliers and also the tool T.203382 for compressing the rotor sealing collar.

29. Place the sheath T.203383 (*fig.* 10) over the rotor quill shaft and withdraw the rotor sealing collar complete with sealing ring. Remove the sheath and then lift off the carbon face seal, sealing ring and spring.

30. Remove the eight nuts and bolts, grover washers and plain washers holding the camplate housing to the pump body. When the nuts are freed the camplate housing may rise from the pump body under pressure of the rotor piston springs acting through the camplate trunnion blocks; in this event, hold the housing down until the nuts and bolts have been removed.

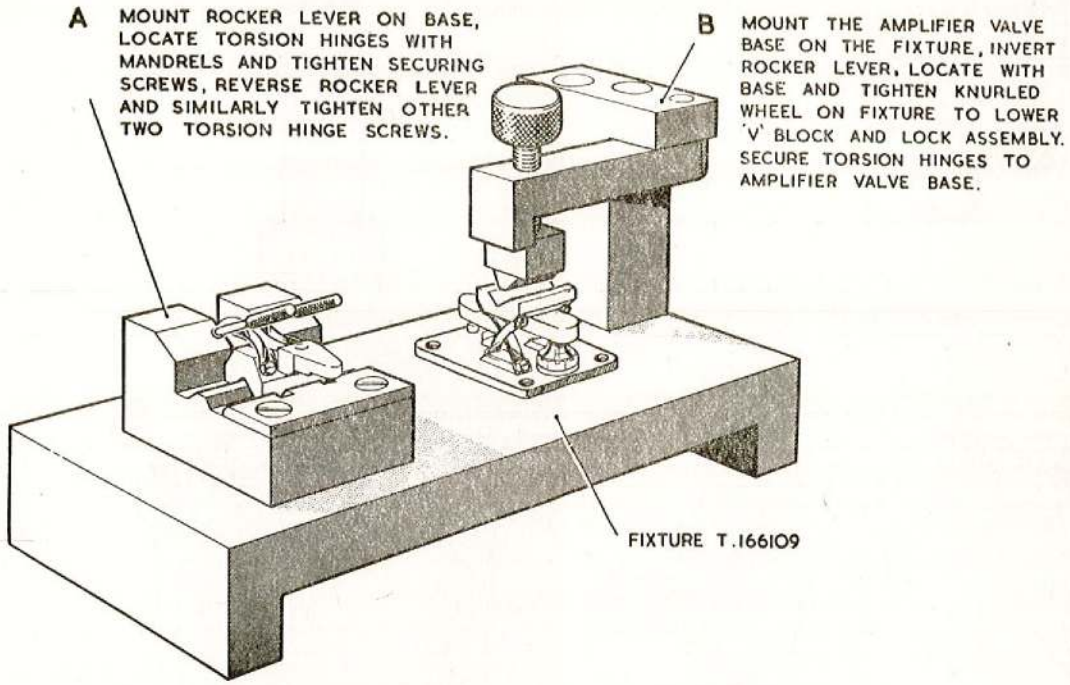


Fig. 9. Amplifier valve assembling and dismantling fixture

31. If the housing does not free itself from the body as the nuts and bolts are removed tap it lightly with a hide faced hammer around the housing rim to release the joint. As soon as this is free take care to hold the housing centrally as the pump rotor is now supported only by the carbon main bearing at the opposite end and any side movement of the housing may cause damage to the carbon bearing.

32. When the housing is free lift it carefully from the pump body keeping it central until it is clear of the rotor quill shaft. Also avoid allowing the carbon bearing bore to foul the quill shaft splines when lifting the camplate housing off the pump.

33. Remove the trunnion blocks from the control ring trunnions and lift the camplate housing joint washer from the pump body joint face.

34. Extract the circlip from the inner end of the camplate housing bore and withdraw the carbon bearing, carbon face seal and sealing ring. It is not advisable to remove the locating dowel, unless this is damaged.

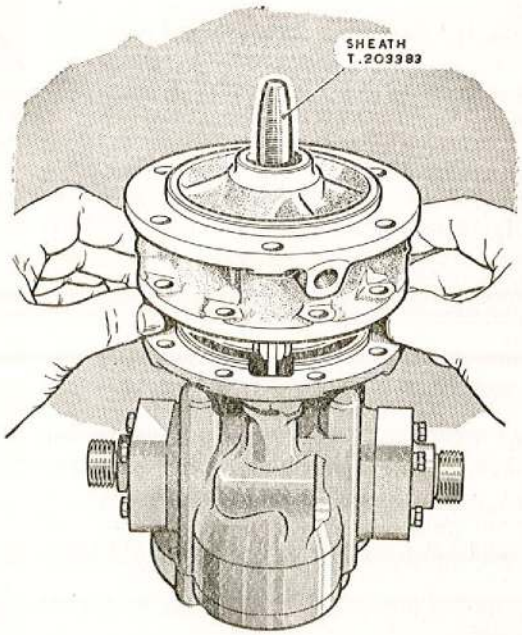


Fig. 10. Fitting and removing the camplate housing

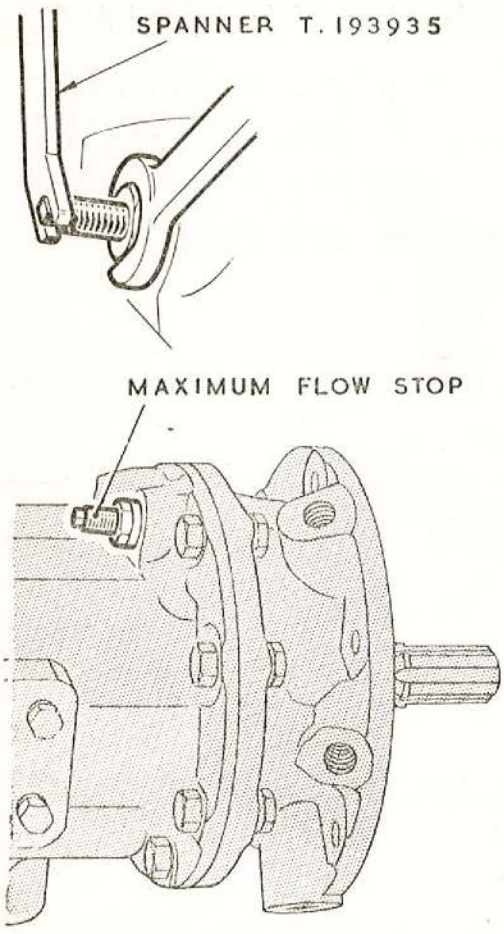


Fig. 11. Removing the maximum flow stop

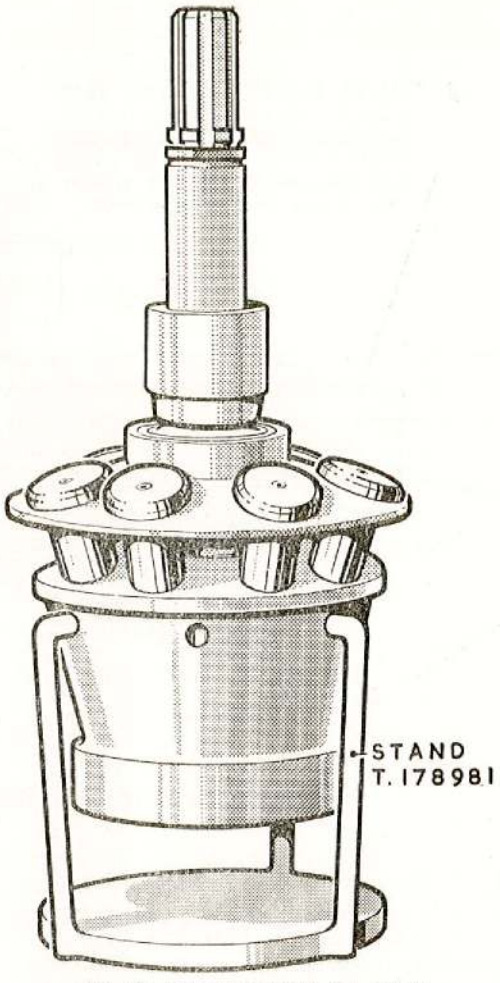


Fig. 12. Storage stand for rotor

35. Remove the bleed valves and blanking plugs.

Removing the control ring and camplate assembly

36. Remove the cap nut from the maximum flow adjusting screw. This screw is slightly inclined into the pump housing and forms a stop for the camplate, thereby limiting the maximum fuel flow. Slacken the maximum flow screw locknut and remove the screw by means of the spanner T.193935 (*fig.* 11).

37. Using thin nosed pliers extract the split pin from the link pin which secures the piston rod to the camplate lug. 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.

38. Remove the link pin, taking care to retain the shim from the drilled end of the pin, then remove the control ring and lift the camplate assembly out of the pump body. Later type pumps are fitted with the self-locking type of link pin. On these types raise the camplate as far as possible and with a fine drift tap out the retaining peg and withdraw the link pin. Turn over the link and disconnect the other end in a similar manner.

Removing and dismantling the rotor

39. Lift out the rotor assembly from the pump housing and place it on the stand T.178981 as shown in fig. 12. Remove the piston and slipper assemblies, spring seats and piston springs from the rotor assembly. The rotor bores are numbered, therefore note the respective bore of the rotor from which each piston is removed and place each piston on the appropriate peg on stand

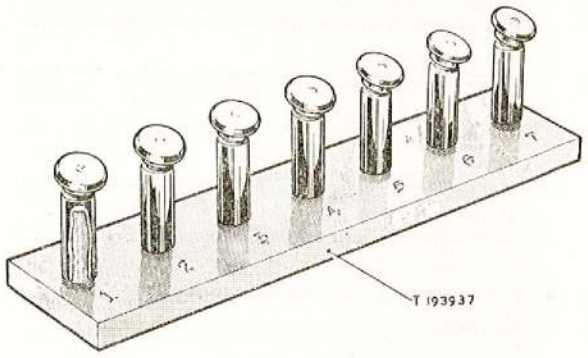


Fig. 13. Storage stand for rotor pistons

T.193937 (*fig.* 13). Lift off the auxiliary camplate, thrust ball, shims, spring and spring seat. Remove the spring guides from the rotor bores by gently tapping each with a soft-nosed drift T.193936 inserted through the small end of the rotor bore (*fig.* 14).

40. If the quill shaft is damaged or shows sign of corrosion, it is to be removed from the rotor and a new shaft fitted as described in para. 161.

Removing the port insert

41. With the rotor assembly removed the carbon bearing and port insert is exposed. To remove these components disengage the circlip securing the carbon bearing, spider and port insert by means of the tool T.157039 as shown in fig. 15. Place the fingers of each hand inside the main bearing, press firmly onto the walls of the bore and lift at the same time to draw the bearing from the pump housing.

42. Lift out the retaining spider and the port insert. The insert locating dowel and the carbon bearing locating dowel are tightly fitted and to avoid destroying their interference fit neither of them should be withdrawn unless damaged.

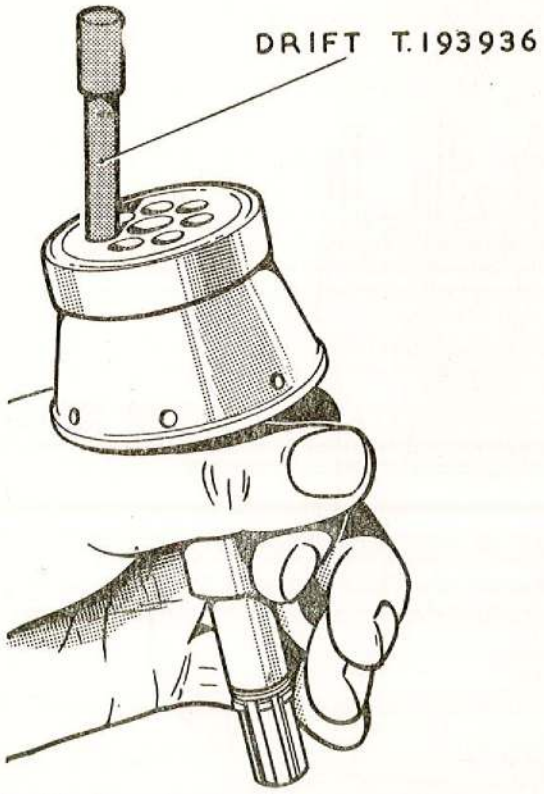


Fig. 14. Removing the rotor piston spring guides

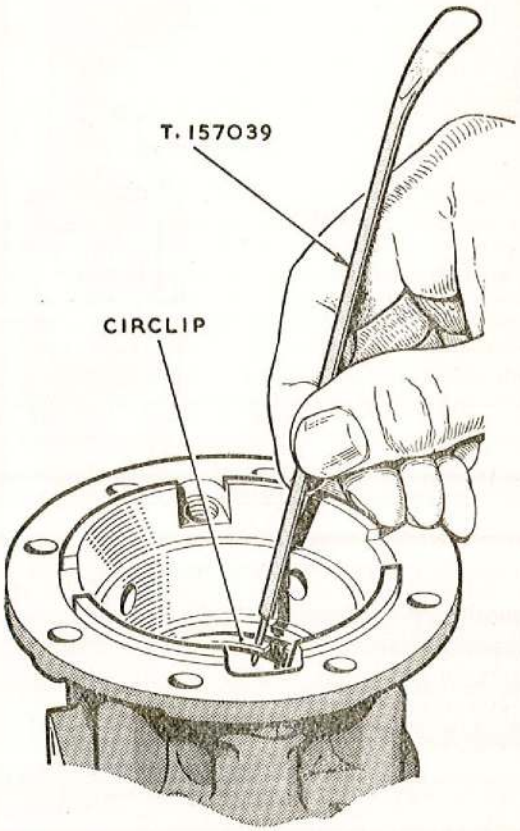


Fig. 15. Removing the rotor carbon bearing circlip

Removing the control piston assembly

43. Remove the 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.

44. Remove all nuts except two in diametrically opposite positions on the cover; these two 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 it is clear of the pump housing. Remove the sealing ring from the joint face and lift out the two helical springs from the control piston cylinder.

45. Using a pair of small-nosed pliers, extract the split pin from the link pin attached to the piston rod. 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. Carefully drive the link pin out by means of 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. For removal of the self-locking type of link pin see para. 38. Push down on the piston rod in order to force the piston head out of the cylinder whence the assembly can be withdrawn.

Dismantling the control piston assembly

46. Using tool T.175555, remove the seal retaining circlip from behind the piston head and remove the seal support ring by drawing it off the head. If it should be necessary to prise the seal away, use a tool from which

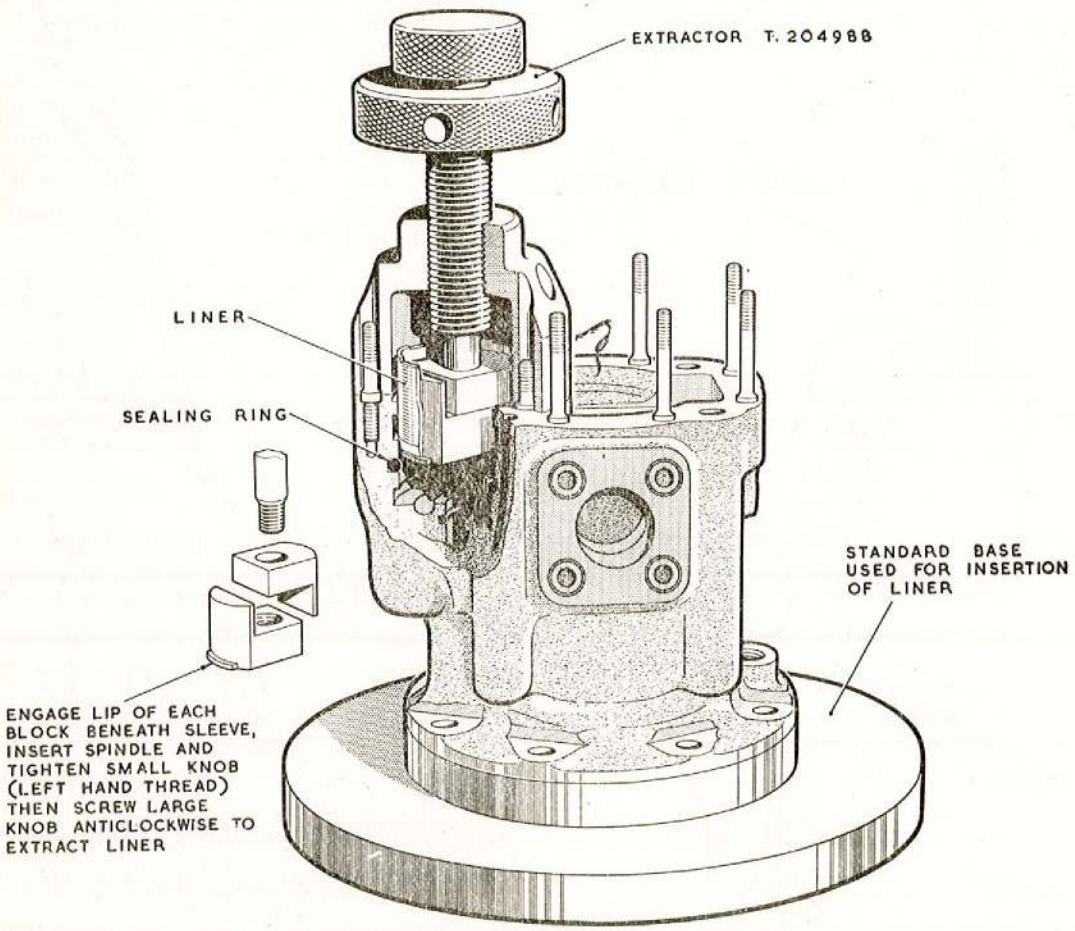


Fig. 16. Removing the control cylinder liner

all sharp edges have been removed. Take care to avoid damaging the piston.

Removing the control cylinder liner

47. The control cylinder liner is removed with extractor tool T.204988, having two lipped blocks which can be expanded to engage the lips under the inner end of the liner as shown in fig. 16. The tool is used as follows :—

(1) Lower the two lipped blocks into the cylinder bore and engage the lips of each block beneath the liner, at the same time ensuring that the drillings in the two blocks are in alignment.

(2) Lower the extractor on to the housing, and screw back the larger of the two knurled nuts.

(3) Screw the spindle down by means of the small knurled nut (left-hand thread) until it engages in the threaded bore in the lipped block and screw down fully.

(4) Rotate the large knob anti-clockwise to extract the liner.

48. Remove the sealing ring from the groove in the piston rod bore and remove the large sealing ring from the control cylinder bore.

Removing the servo-pressure restricting orifice

49. The restricting orifice assembly is housed on the pump body adjacent to the control cylinder. Remove the complete assembly by using a standard box spanner, draw out the strainer and remove the seal and sealing ring from the assembly.

Remaining details

50. When a pump is dismantled completely the remaining details in the pump body consists of the retaining studs, dowel pins and blanking plugs. The latter can be removed with standard spanners. Should any studs be loose or damaged, however, they must only be renewed under an approved repair scheme.

51. Dowel pins are a tight push fit and can be withdrawn with pliers but they should not be removed unless damaged or loose.

CLEANING

52. If any defect in the pump is believed to be due to the presence of foreign matter the parts suspected should be inspected before cleaning, otherwise the cause of the defect may be removed.

53. The components must be cleaned by washing in kerosine. It is recommended that they should be pressure-washed using an appropriate bath and spray gun supplied by a pump with adequate filtering facilities. Hard brushes, cloths and abrasives must not be used. The parts should then be dried with compressed air, which must be free from water, and placed in clean dry containers ready for inspection.

INSPECTION

General

54. Where dimensional checks of certain components are necessary, the method only is described in this section, the appropriate dimensions being given in the Schedule of Fits, Clearances and Repair Tolerances (Vol. 2, Part 2).

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

56. Scrupulous cleanliness is essential with regard to the inspection and assembly bench and to all containers and tools in use. It is advisable that the surface of the bench be covered with zinc, linoleum or bakelized fabric to assist in maintaining the high standard of cleanliness required. Following inspection the details should be placed in containers holding a quantity of light oil for safe storage pending re-build.

Redundant and consumable parts

57. As it is usual during inspection to reject any parts rendered redundant by essential modifications, complete information covering modifications must be at hand.

58. Tab-washers, split pins, locking wire, joint washers and other consumable parts are discarded during dismantling and their new replacements, should be available for inspection with the main components.

Scores and surface damage

59. In general, scores or surface damage on moving parts and joint faces will impair the operational efficiency of the unit, hence any part so affected should be renewed.

In certain circumstances, depending upon the number of hours the pump may be required to run, the purpose and region of operation and the accessibility of spares, certain defects which do not seriously impair the efficiency and safety of the unit may be acceptable at the discretion of the inspection authority.

Crack detection

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

Rotor (for cracks on steel journals)
Quill shaft
Camplate
Camplate—control piston link
Auxiliary camplate
Control piston assembly
Port insert
Overspeed governor spring
Amplifier valve rocker lever
Control piston springs
Flow adjusting screw
Stall pressure adjusting screw
Piston spring guides.

Installation fittings

61. Inspect all installation adapters and unions for cleanliness and general conditions and ensure that threads and joint faces are undamaged.

Overspeed control assembly

62. If the assembly has been completely dismantled examine the diaphragm for buckling and for any signs of cracking or splitting. Check that there is no indentation of the surface particularly adjacent to the edge as this may be a source of leakage. Inspect the riveting for signs of looseness and the diaphragm centre boss and support plate for damage.

63. Check the diaphragm spring attachment centre generally for damage, ensure that it is a free fit in the diaphragm centre boss and see that the internal threads are in good condition. Inspect the clevis pin holes in the fork for undue wear and for any signs of radial cracks around the holes.

64. Examine the tappet screw for undue wear and pitting on the head ; see that the threads of the screw and locknut are clean and in good condition.

65. Inspect the governor spring for surface cracks and corrosion particularly around the attachment loops and see that the loops and coils are square and free from distortion.

66. Check the clevis pins for undue wear and corrosion and see that they are an easy push fit in the spring attachment fork and spring anchorage fork.

67. Inspect the spring anchorage for wear in the clevis pin holes and for cracking around the fork lugs. See that the stem is smooth and free from damage and that the threads are clean.

68. Examine the adjusting screw for scoring and other surface damage on the underside of the flange as this is a sealing face and damage may cause leakage. See that the threads are in good condition and that the spannering square and screwdriver slots are undamaged. Inspect the adjusting screw locknut for damage to the threads and hexagon and also for cracks on its top face.

69. Examine the cover generally for damage and see that the joint face is free from scoring and other damage which may cause leakage. Ensure that all traces of the joint washer have been removed from the facing.

70. Inspect the diaphragm mounting ring generally for damage and for scoring on the faces. Ensure that all traces of joint washers have been removed and that no sharp edges or burrs are present on the inner edge of each face.

Amplifier valve assembly

71. Examine the rocker lever generally for damage and ensure that the bridge piece is tight. Check that the half-ball valve recess in the lever is clean and free from damage at the edges. Inspect the upper and lower surfaces of the lever tail for undue wear by the lever stop and diaphragm tappet. See that the threads of the tapped holes in the bridge piece are serviceable.

72. Inspect the base plate generally for damage and check that the rocker lever stop rivet is secure and not worn unduly. Ensure that the threads of the large tapped hole which receives the orifice assembly

and also the tapped holes which receive the torsion hinge anchoring setscrews are serviceable. Examine the slot which houses the stall pressure adjustment and ensure that it is free from sharp edges or burrs and that the sides are not scored.

73. Examine the half-ball valve for undue wear on the face and on the back and check the face for colour registration against an optical flat. Reject the half-ball if more than two colour bands are apparent. Check that the half-ball is a free fit in its recess.

74. Inspect the orifice assembly generally for cleanliness, check that the threads are in good condition, and examine the orifice and surrounding lands for damage, burrs and corrosion, also check for wear by the half-ball. Test the orifice face for flatness, using an optical flat. A colour registration must be obtained on the orifice face and on each land.

75. Check that the sealing ring has been removed from the orifice body flange and that the groove is clean. See that the locknut is serviceable.

76. Inspect the stall pressure adjusting screw, spring, spring seating, and retaining pin generally for cleanliness, damage and corrosion ; see that the screw threads are clean and serviceable.

77. Examine the torsion hinges and their retaining setscrews for serviceability. See that the hinge springs are not distorted and inspect them closely for surface cracks.

Camplate housing assembly

78. Examine the joint face of the camplate housing flange for damage and scoring which may affect the seal and examine the housing generally for signs of damage and corrosion. Inspect the trunnion block locating pockets for the presence of foreign matter, burrs, and scores and see that the housing bore and circlip groove is clean and undamaged.

79. Examine the carbon bearing and the two carbon face-seals for chipping, scores and other damage, also see that the helical spring and circlip are free from damage and distortion.

Camplate

80. Ensure that there is no visible damage due to pick-up from the piston slippers or discolouration through overheating. See that the control rod link-pin hole is not worn and that the opposite lug is not damaged through contact with the maximum flow screw. Check that the trunnions are not worn or damaged and test the trunnion blocks and camplate for end float using C.62105 as shown in fig. 28.

81. Examine the trunnion blocks for fretting, wear and damage. These are a selective assembly and should have a clearance of 0·002 in. between the trunnion block and the joint face of the pump body (para. 131).

Rotor assembly

82. Carefully examine the plated port face on the underside of the rotor which normally bears against the port insert in the pump housing. This face must be quite flat and clean. Some wear of the plating may occur after service, but any traces of bronze showing through the plating is not permissible. Carefully examine both the large and small bearing surfaces on the rotor for evidence of pick-up, cracks, or heat discolouration. Check that the radial drillings are clean.

83. Ensure that the thrust ball is sound, its faces clean and its spherical surface smooth and free from scores. Ensure that the spring is undistorted and that the spring, spring seat, and any shims that are fitted are free from sharp edges, cracks and other damage.

84. Examine the rotor piston springs for sharp edges, fractures and distortion. Also ensure that the spring seats are sound and that their pressure feed holes are unobstructed.

85. Examine the piston spring guides for wear and fractures and any burrs or sharp edges likely to cause damage to the springs.

86. Inspect the auxiliary camplate for burrs and general damage. See that there are no cracks between the holes and particularly between each hole and the rim. Check that the bore is clean and smooth.

Checking the rotor bores

87. Examine the rotor bores for scores or worn plating. Check the diameter of the bores in four positions with a small bore gauge and setting rings G.59529 to G.59533 as shown in fig. 17. The maximum worn clearances allowed between any one piston and bore is specified in Vol. 2, Part 2.

88. The bores of the setting rings are identical in diameter to those of a new rotor, five sizes being available for the five different sizes of rotor bore as indicated in the illustration. The gauge is set to zero in the bore of the setting ring and is then inserted in the rotor bore. The reading on the gauge indicates the amount of wear which has taken place in the rotor bore.

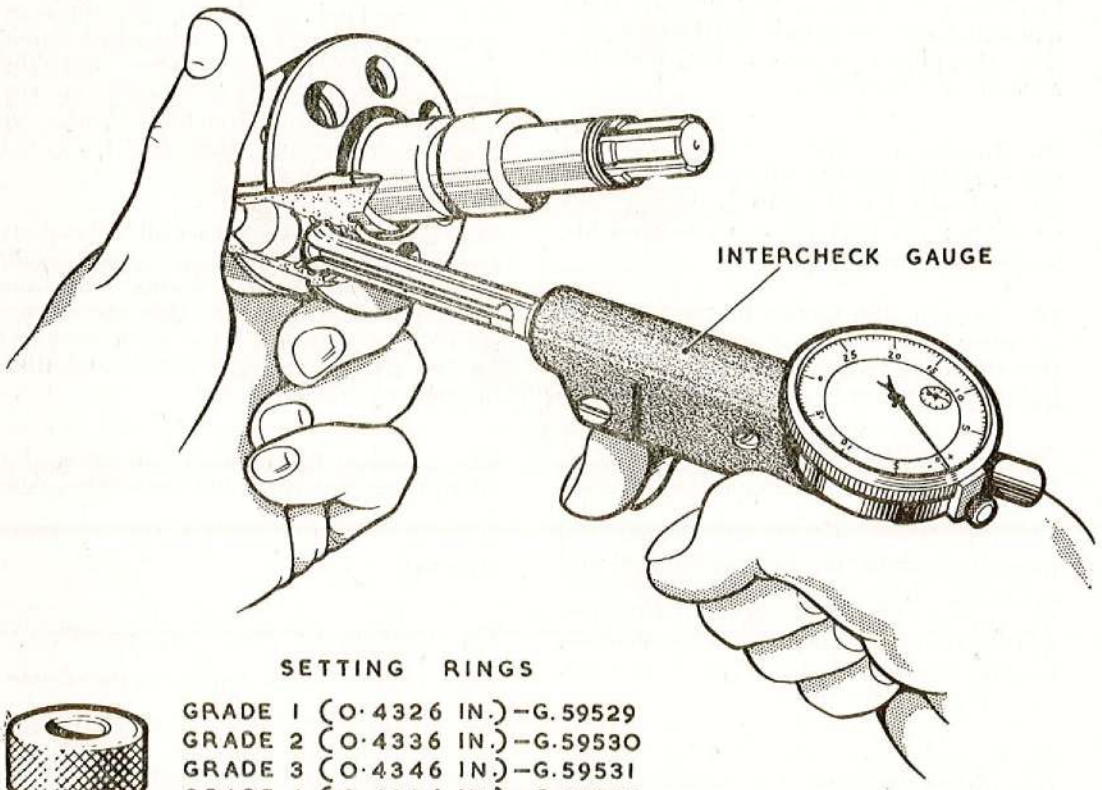
Checking the rotor pistons

89. Examine the pistons for ease of reciprocation in the bores and note any tightness ; also examine for discolouration on the piston skirts and slippers.

90. Check the pistons for wear by using a dial comparator and the setting pieces G.54619 to G.54623 as shown in fig. 18. The diameter of a setting piece is identical to that of a new piston. Five sizes are available for the five different sizes of piston. The setting piece is placed under the comparator and the gauge adjusted to zero reading. Each piston is passed in turn under the comparator ; the reading on the gauge indicates the amount by which the piston has worn.

Checking the piston slippers

91. Wipe the pistons with clean muslin and place each one in turn on a sheet of clean white paper when any tendency to surface corrosion or heavy discolouration will 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 scored. Ascertain that the slipper pad swivels and rotates freely on the piston crown. Ensure that the pressure feed hole in the centre of the slipper pad is free from



SETTING RINGS

GRADE 1 (0·4326 IN.)—G.59529
GRADE 2 (0·4336 IN.)—G.59530
GRADE 3 (0·4346 IN.)—G.59531
GRADE 4 (0·4356 IN.)—G.59532
GRADE 5 (0·4366 IN.)—G.59533

Fig. 17. Checking the rotor bores

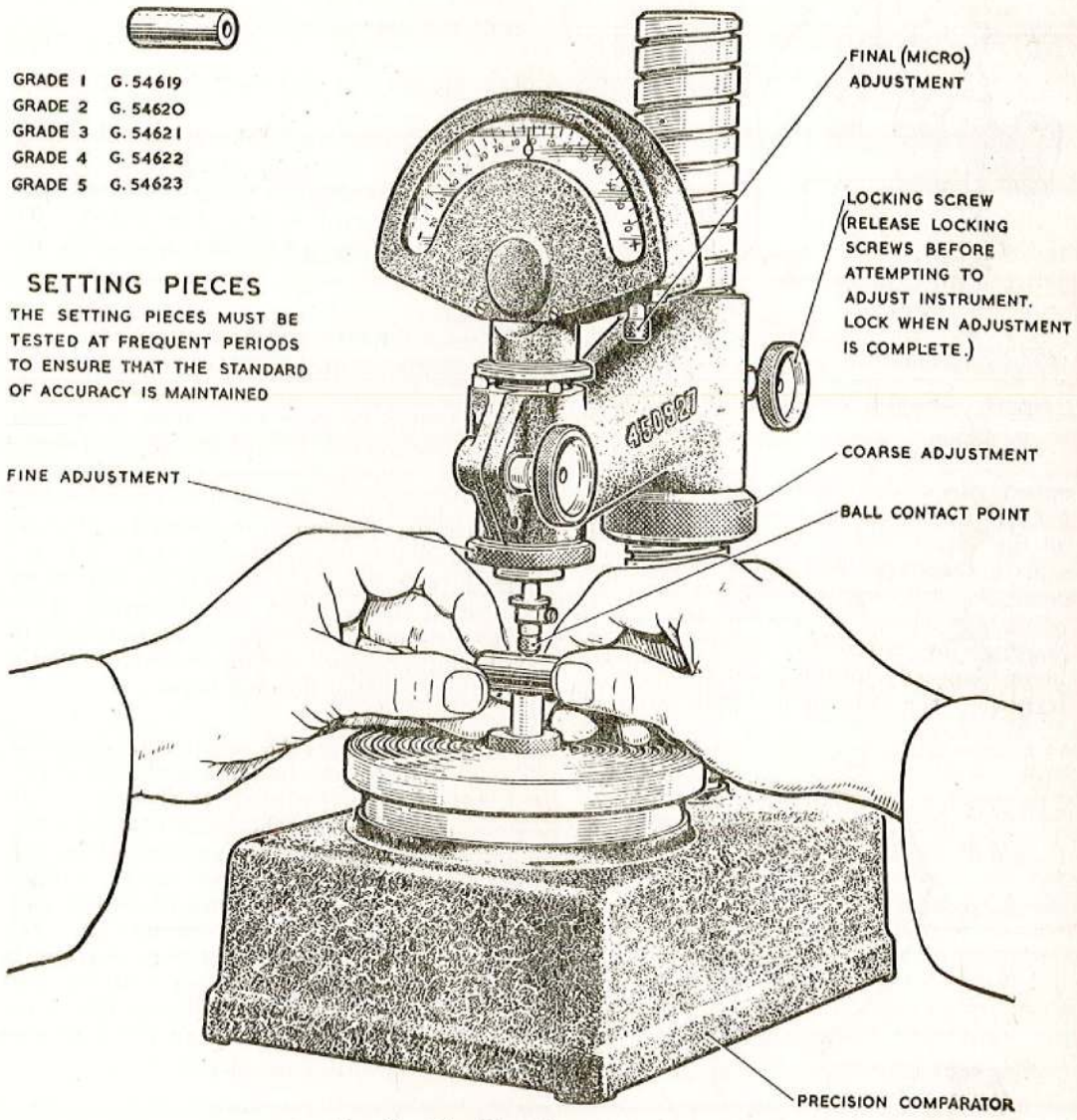


Fig. 18. Checking the rotor pistons

obstruction. Check the fit of the slipper on the piston with that given in Vol. 2, Part 2 and using gauge fixture G.56550 as illustrated in fig. 19.

Port insert

92. Examine the insert closely for signs of surface cracks, and for chipping at the edges of the ports and around the pheriphery. Ensure that the working face is unworn and that there is no evidence of rotor face plating adhering to the insert face. The thickness of the insert and the parallelism of the faces relative to each other must be measured in accordance with the dimensions stated in Vol. 2, Part 2.

93. To check the parallelism of the insert, place it in the pump body and ensure that it is located correctly on the dowels, then place the test bar and indicator G.64243 on the pump housing face as shown in fig. 20. Check at several points across the face of the insert. If the reading obtained is

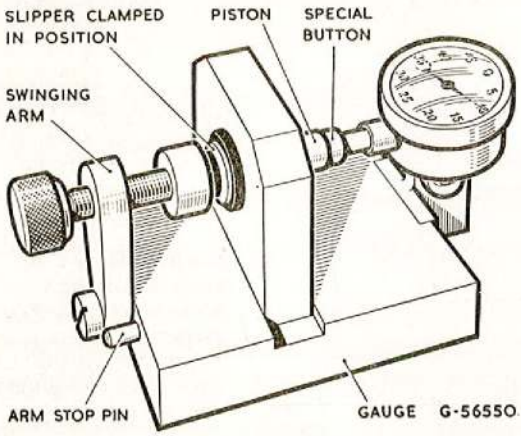


Fig. 19. Checking the slipper piston clearance

outside the stated figure, remove the test bar and the insert, see that the seating face of the insert and body are clean, then replace the insert and test again. If the result is still unsatisfactory remove the insert and check the seating face in the housing for parallelism relative to the pump flange by lowering the gauge in the test-bar. The same limits apply as for the check on the insert. In the case of a new insert the parallelism must be within 0·0000 to 0·00012 in. and after service must not exceed 0·0005 in.

94. Should this last test prove the pump housing to be unsatisfactory a new housing must be fitted and the rejected housing returned for reconditioning, but if the housing is serviceable the port insert must be rejected and a new one fitted. In either case, the parallelism test must be repeated.

Checking the carbon bearing clearances

95. Inspect both carbon bearings for cracks and for chipping at the edges and around the dowel slots in their faces then insert the main bearing into the pump body and check the fit. The bearing must be a good sliding fit in the body bore and where a new bearing is to be fitted this must be selected to give the required fit. There should be no attempt made to ease a tight bearing by the use of a file or emery paper ; other bearings must be tried until the required fit is obtained. Check the small carbon bearing similarly in the camplate housing bore.

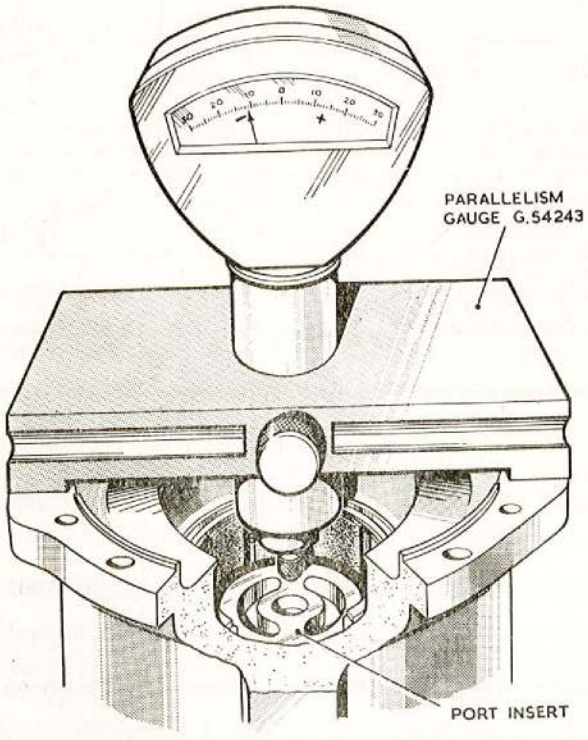


Fig. 20. Checking the parallelism of the port insert

96. Check the diametral clearance between the bearings and their corresponding journals on the rotor. In this instance the large bearing clearance is checked on gauge G.61436 and the small bearing on gauge G.62106 both being used together for convenience as shown in fig. 21. The rotor and main carbon bearing is placed first on gauge G.61431 and secured by moving the locking lever which expands a small collet to grip the centre bore of the rotor.

97. To check the clearances, place a finger on the bearing adjacent to the dial test indicator button and press that side of the bearing against the journal to take up all clearance. Set the dial test indicator to zero and then transfer the finger pressure to the opposite side of the bearing when the dial test indicator will indicate the diametral clearance. Repeat the check at one-sixth of a turn intervals until the bearing has been rotated completely, thereby checking for any distortion. The clearance required is 0·005 to 0·006 in. and should distor-

tion be present, provided that this is not excessive, the mean of six readings is acceptable. If the required clearance cannot be obtained another bearing must be selected but the new bearing must first be checked for fit in the pump body as described in para. 95.

98. Fit the gauge G.62106 over the rotor tail bearing and place the small carbon bearing on the rotor journal. Check the clearance by the same method as that for the main bearing; the required clearance in this instance is 0·002 to 0·003 in. If the bearing has to be changed, the new bearing must first be checked for its fit in the camplate housing bore as described in para. 95.

Control piston assembly

99. Inspect the control piston rod and piston head generally for severe wear, scoring and other damage. Ensure that there are no cracks developing around the piston, inspect the circlip groove for wear aud see that the seal seating is quite clean. Check that the piston seal support and retaining circlip are serviceable.

100. Examine the link and link-pins, which have been detached from the piston rod, for damage or cracks. Also see that the slot along the shank on the self locking type is in good condition. Examine any shim washers, if fitted, for cracks or damage.

101. Examine the cylinder liner for wear

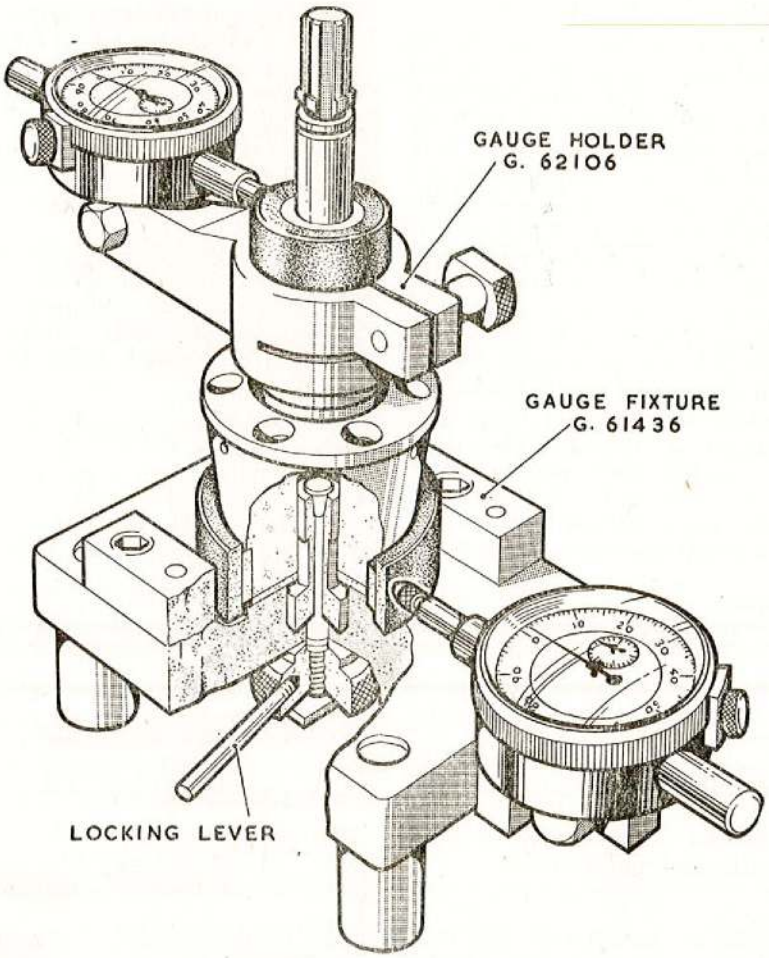


Fig. 21. Checking the carbon bearing clearances

and scores and if necessary, remove it for closer inspection as described in para. 47. Inspect the servo piston inner and outer springs for distortion and surface defects. See that the control cylinder cover is free from cracking and corrosion and that the joint faces are undamaged. Ensure that the facing which locates the outer spring in the bottom of the counterbore is clean.

Servo pressure restricting orifice

102. The details comprise a retaining plug and orifice, seal, strainer assembly and sealing ring. Inspect the retaining plug and orifice for damage and general condition and ensure that the orifice bore is quite clean and unrestricted. See that the threads are clean and undamaged. Examine the strainer element for damage and distortion ensure that the end pieces are secure.

Pump housing

103. Inspect the housing generally for damage to the casting and studs, see that the joint faces are in good condition and that all traces of joint washers have been removed. Check that all sealing rings have been removed and that their grooves are clean. Examine the spot-faces, around the blanking plug holes and see that they are free from scoring or damage which may cause leakage. Check all drillings for cleanliness and freedom from obstruction. If the dowels have been removed see that the dowel holes in the port insert seating face and also those which locate the dowels for the carbon bearings are free from any obstruction or damage that may prevent the dowels from entering fully. See that the threads for the flow adjusting screw are in good condition and that all tab-washer locating holes are undamaged.

Remaining details

104. Inspect the flow adjusting screw and locknut for good general condition and examine the dome end of the screw for damage or pitting from contact with the camplate lug.

105. Examine the inlet strainer gauze for damage, and for defects of the seam and joints at each end. See that the circlip is free from cracks and undistorted.

106. Ensure that all blanking plugs are in good condition, particularly the faces under the heads. See that their threads are serviceable and that the lockwire holes are free from sharp edges.

107. Examine all dowel pins for fretting, wear and signs of corrosion. Inspect nuts, bolts, setscrews, washers and shims for serviceability.

BUILDING THE SUB-ASSEMBLIES

108. Mount the pump on the assembly adapter T.201711. Fit the maximum flow adjusting screw, inserting it domed-end first from outside the pump housing. Fit a new washer and the locknut to the squared end but do not lock at this stage. The washer and cap nut are to be fitted later.

Control cylinder liner

109. Before fitting the control cylinder liner, fit the piston rod felt sealing ring and also a new sealing ring to the groove midway down the bore, insert the liner, chamfered end first, with tool T.203522 as shown in fig. 22 and press the liner in as far as possible.

Port insert and carbon bearing

110. If the dowels which locate the insert and the carbon bearing have been removed new ones must be fitted. If a new insert is being fitted, remove any sharp edges around the ports and central hole by using a small polishing stone, taking care to avoid chamfering the edges.

111. Place the insert in the pump housing, locate it on the dowel in accordance with the location marking and press in firmly by finger pressure only. When seated, the face of the insert must be checked for

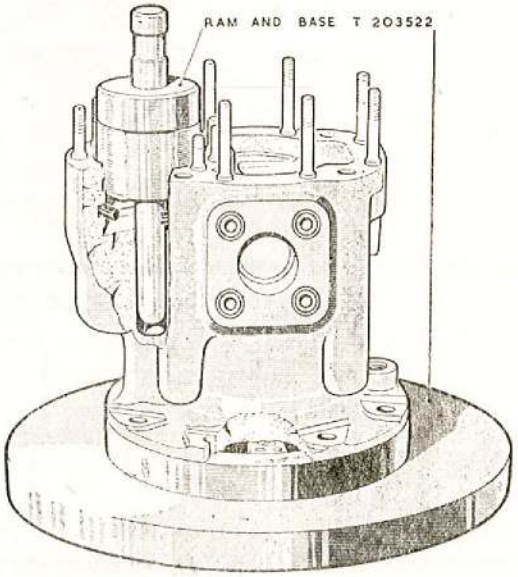


Fig. 22. Assembling the control cylinder liner

parallelism with the pump housing flange as described in para. 92.

112. When the insert is satisfactory, fit the retaining spider and locate it on the carbon bush retaining dowel in the face surrounding the insert. Ensure that the bore of the spider engages correctly on the land on the periphery of the insert.

113. Insert the bearing into the housing, locate the slots in the end face over the dowel in the housing and push down fully. Check the bearing clearance in the housing as described in para. 97.

114. Fit the bearing retaining circlip, chamfered side uppermost, and ensure that it seats correctly in the groove.

Control piston assembly

115. Fit the piston seal, flat side towards the piston face, passing it over the piston rod and pressing it gently with the fingers on to the piston. Follow this with the seal retaining plate, large diameter towards the seal, then secure the assembly by fitting the circlip into the retaining groove using tool T.175555 as shown in fig. 23.

Camplate housing assembly

116. Fit a new sealing ring to the carbon face seal, then assemble the seal and sealing ring, location peg and carbon bearing into the housing; the carbon bearing should be a push-in fit in the housing using finger pressure only. Fit the bearing retaining circlip.

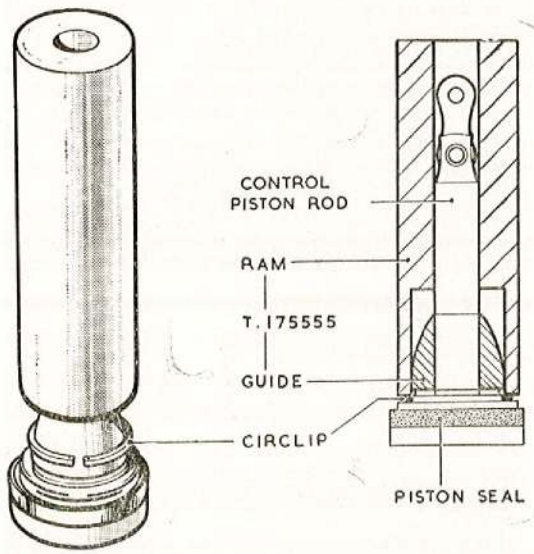


Fig. 23. Fitting the control piston, seal retaining circlip

Amplifier valve assembly

117. Place the amplifier valve rocker lever on the assembly fixture T.166109 as shown in fig. 9. Assemble the two inner hinge blades to the lever bridge piece, retain them with the setscrews and new tab-washers. Before tightening the setscrews locate the free end of each blade with the mandrel then tighten and lock the screws. Reverse the lever assembly in the fixture and fit the two outer blades likewise.

118. Place the amplifier valve base plate on the other side of the fixture as shown and transfer the rocker lever to it, reverting the lever to the correct position with the bridge piece at the top. Align the holes in the spring blades with the tapped holes in the base plate and rotate the knurled screw on the fixture to lower the vee-block on to the bridge piece. Tighten just sufficiently to locate the lever and align the spring holes correctly. Insert the retaining setscrews complete with new tab-washers and tighten and lock them. Remove the assembly from the fixture.

119. Fit the locknut and a new tab-washer to the orifice assembly, invert the lever assembly so that the base plate is uppermost and place the half-ball valve in the lever recess, then screw the orifice assembly into the base plate until the orifice just contacts the half-ball. Screw the locknut finger tight but do not lock it at this stage.

120. Assemble the spring seating to the stall pressure adjusting screw and fit these, together with the spring and retaining pin, to the valve base plate.

121. The amplifier valve is adjusted before assembly into the pump by means of the fixture T.206237 as shown in fig. 24. Position the amplifier valve on the locating dowels with the rocker lever horizontal inside the upright support and clamp down tightly by means of the two knurled screws. Move the dial test indicator until the thimble rests on the tail of the rocker lever, lock in position and set the indicator to zero. The gap between the tail of the rocker lever and the stop pin should be between 0·025 in.

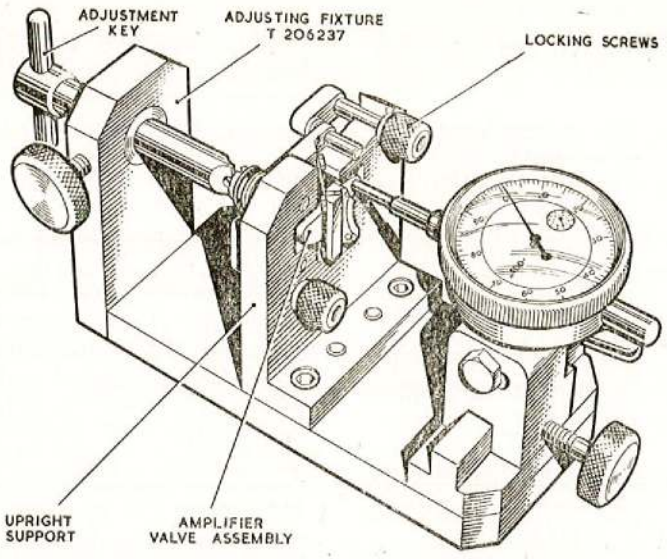


Fig. 24. Adjusting the amplifier valve

and 0·040 in. with the head of the lever depressed to seat the half-ball firmly on the orifice face. It is recommended that a lift of 0·028 in. will provide the most desirable pre-load. If the gap is incorrect, release the orifice locknut using the spanner T.193938, adjust the orifice assembly with the key provided on the fixture and lock the fixture key by means of the knurled screw. Check the adjustment on the D.T.I. and when correct tighten the locknut with the spanner T.193938 and lock the tab-washer. Remove the amplifier valve assembly from the fixture.

Overspeed control assembly

122. Fit a sealing ring to the groove behind the flange of the diaphragm centre and fit the tappet screw complete with locknut and tab-washer. Insert the centre assembly into the diaphragm centre plate, attach the spring loop of the governor spring to the diaphragm centre fork, fit a clevis pin, place a plain washer over the end and insert a split pin. Turn the legs around the end of the clevis pin to secure it. Assemble the spring anchor likewise to the opposite end of the spring. Stretch the spring until the ends of the upper and lower spring anchors rest upon each other and are held in this position by the tension of the spring. Lower the adjusting screw bush over the squared end of the upper spring anchor.

123. Fit a gasket on the governor housing and then lower the diaphragm and governor spring assembly into the housing. Rotate the adjusting screw bush until the locating peg engages with the socket provided for it.

124. Align the holes in the gasket and diaphragm with those in the cover by rotating the diaphragm about its centre. Fit the tab-washer and lock-nut, tighten

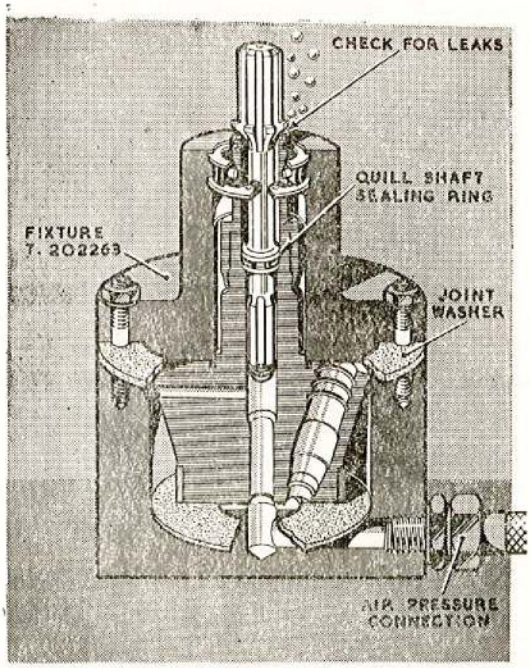


Fig. 25. Pressure testing the rotor quill shaft oil seal

the locknut lightly but do not lock it at this stage.

125. Place a rubber sealing washer on to the adjusting screw, fit the latter into the upper spring guide by passing it through the adjusting-screw bush and make it finger tight. Screw on cover nut also tighten finger tight. Assemble to the cover four sealing washers, four plain washers, three plugs and a bleed valve.

Rotor assembly

126. Where the rotor quill shaft has been removed, the method of fitting is identical with that for fitting a new shaft as described in para. 161.

Pressure test the sealing ring on the rotor quill shaft using the fixture T.202263 (*fig.* 25).

127. If the piston spring guides have been removed, insert them into the rotor piston bores by using the tool T.175567 as shown in fig. 26.

128. Assemble to the rotor the thrust ball spring, spring seating, piston springs, spring seats, spring, shim, thrust ball and auxiliary camplate mating assembly. Fit the piston springs, spring seatings and assembled pistons.

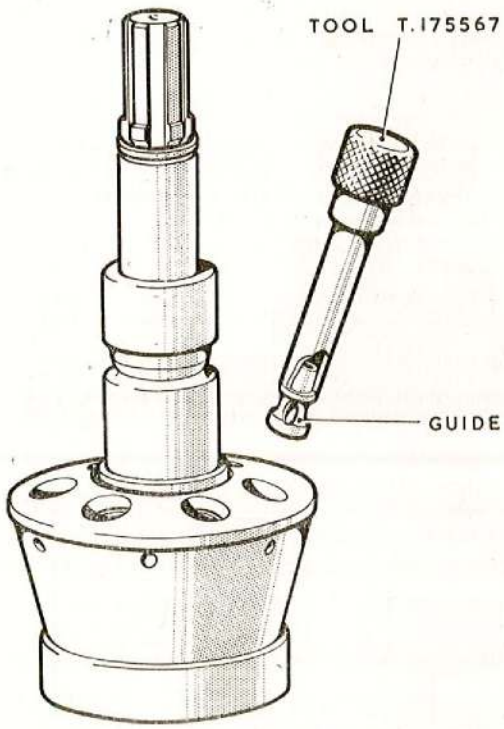


Fig. 26. Inserting the rotor spring guides

Note . . .

The piston and slipper assemblies are selected to suit their respective bores in the rotor and both piston and bore are numbered to correspond.

BUILDING THE PUMP

Trunnion block clearance

129. The following instructions (*para.* 130 *to* 135) apply particularly where new trunnion blocks or a new camplate housing is to be fitted. It is advisable, however, to carry out the check where existing components are being refitted, to ensure that the assembly is quite satisfactory.

130. Place each trunnion block in the camplate housing and check that it is a good sliding fit. If one block appears tighter than the other, change them about and if there is no improvement, provided that the easier of the two is a good fit, remove the tight block and rub the sides lightly on super-fine polishing paper to remove any surface flaws. Should either block be too free in the housing another block must be selected.

131. Following the check for tightness place one block into its appropriate pocket, check that it is seated on the bottom face of the pocket and then measure with a depth micrometer (*fig.* 27) that the upper face of the block is not less than 0·002 in. below the camplate housing joint face. This is to ensure that when assembled, the blocks do not prevent the housing being tightened down correctly on to the joint washer. Measure the remaining block likewise.

132. Should the clearance be less than 0·002 in. rub the bottom face of the trunnion block lightly on super-fine emery paper, checking the block frequently until the clearance is obtained. Avoid rubbing the block face off-square with the opposite face.

133. When the clearance is satisfactory, remove the blocks from the housing and assemble them to the camplate trunnions; the trunnion block which has been selected for the left side of the housing must be fitted

to the left-hand trunnion on the camplate.

Camplate end-float

134. Place the camplate into its housing, and using gauge G.62105 as shown in fig. 28, locate the contact point of the gauge on the camplate lug. Move the camplate along the trunnion axis to take up the play and then set the dial test indicator to zero. Move the camplate fully in the opposite direction and note the end float; this should be between 0·006 in. and 0·010 in. If the clearance stated is not obtainable remove the trunnion blocks and rub the flat face of each on fine polishing paper to remove any surface flaws. Check the clearance again. Continue to polish until the correct clearance is obtained, taking care to avoid rubbing the face off-square with the bore.

135. The trunnion blocks are a selective fit and if the clearance is too great then others should be tried until the correct clearance is obtained.

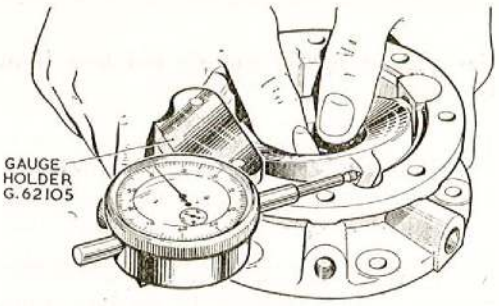


Fig. 28. Checking the end-float on the camplate

Control piston assembly

136. Insert the control piston assembly into the pump body, using tool T.204980 as shown in fig. 29. Guide the piston seal gently into the cylinder liner and push the piston in as far as possible using the tool T.204980 to guide the assembly.

137. Assemble the link to the top of the piston rod with the link pin, shim washer and split pin. The link pin is to be shimmed until end float is such that a 0·0015 feeler

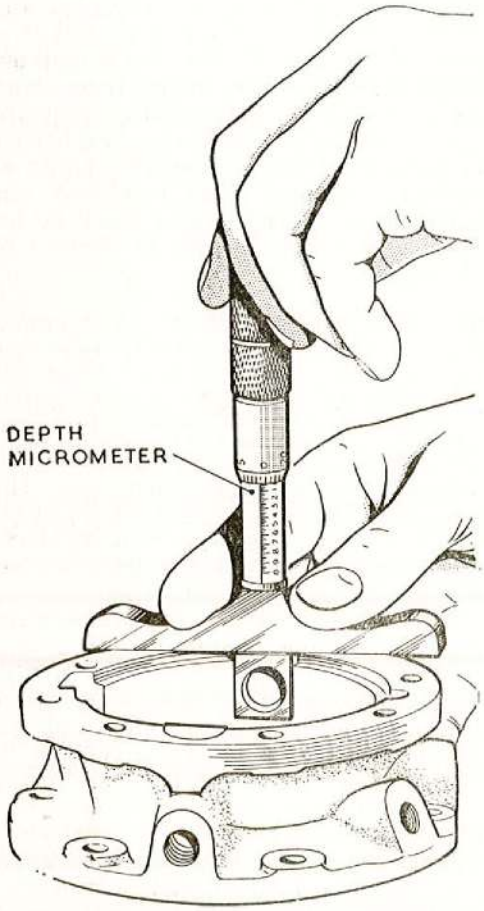


Fig. 27. Measuring the trunnion block clearance

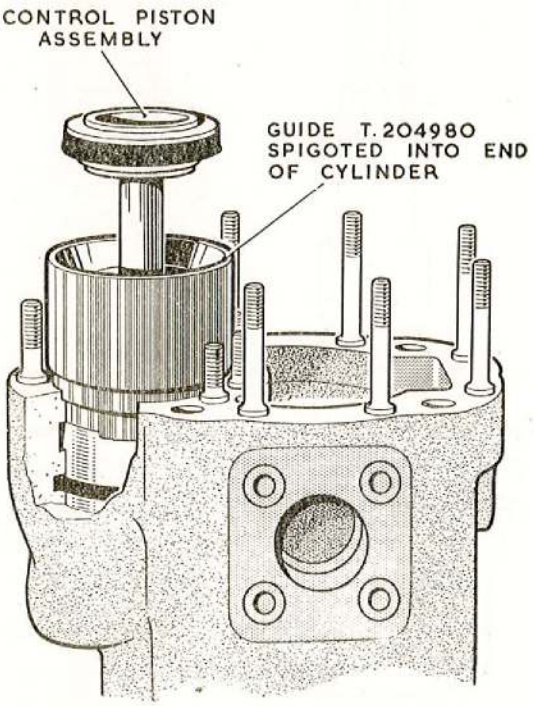


Fig. 29. Fitting the control piston assembly

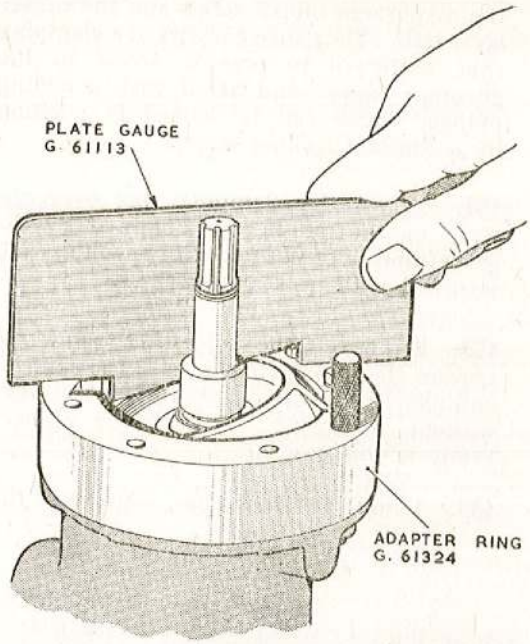


Fig. 30. Checking the camplate angle

gauge will not enter between the link and the head of the pin. Open the split pin and bend the legs around the link pin.

138. On later types insert the link pin and line up the hole in the link pin head and the slot on the shank with the slot in the link. Then press in the retaining peg, using a fine drift to push it through the hole in the head of the pin. Assemble the other end of the link to the piston rod in a similar manner.

Rotor assembly

139. Ensure that the faces of the port insert and rotor are clean then lower the rotor assembly gently into the pump housing taking care to hold it central as the journal enters the carbon bearing. Avoid forcing the rotor sideways at this and successive stages until the camplate housing is fitted to support the rotor assembly.

Camplate assembly

140. Remove the trunnion blocks from the camplate trunnions and place the camplate over the rotor, lowering the assembly until the camplate is resting on the piston slippers.

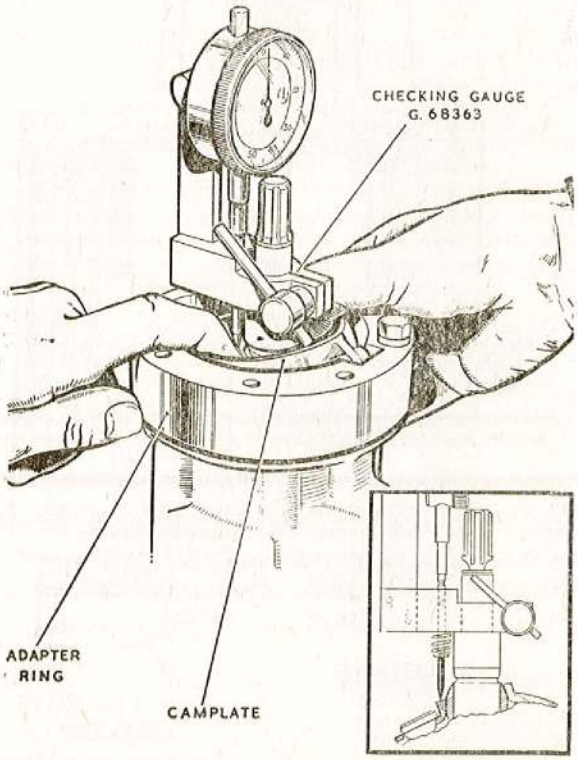


Fig. 31. Checking the auxiliary—camplate lift

141. Rotate the camplate to align the lug and the control piston link and connect them together with the link pin. Place a shim washer over the end of the link pin, insert a new split pin and turn its legs round the end of the link pin. For assembly of later types see para. 138.

142. Assemble the trunnion blocks to the camplate trunnions and locate the blocks over the pump facing.

143. Fit the adapter ring G.61324 to the pump body, ensuring that the pockets in the ring engage with the trunnion blocks. This ring replaces the camplate housing to enable the auxiliary camplate lift to be checked. Secure the ring with nuts and bolts. Fit the maximum flow screw and locknut by using the spanner T.193935 illustrated in fig. 11.

Checking the rotor for rotation

144. Before checking the auxiliary camplate, fit the turnkey T.199561 to the rotor quill shaft splines and check that the rotor can be turned evenly and without undue tightness throughout 360 degrees.

Checking the camplate angle

145. Using the plate gauge G.61113 (*fig.* 30) set the camplate angle at 15 degrees by adjusting the maximum flow adjusting screw. When satisfactory, tighten the adjusting screw locknut.

Checking the auxiliary camplate lift

146. Check the auxiliary camplate for lift at 15 degrees setting and also at the zero (minimum flow) setting by using the dial indicator gauge G.68363 (*fig.* 31). The lift must be between 0·002 in. and 0·007 in. at 15 degrees. Record the lift at the zero setting. Remove the adapter ring and locating pegs G.61324 from the pump body.

Fitting the camplate housing to the pump body

147. Before fitting the camplate housing, the sheath T.203383 (*fig.* 10) must be placed over the rotor quill shaft to protect the seals from damage when passing over the splines, and to assist them onto the rotor tail shaft. Position the sheath with its end face abutting the end of the rotor, fit the gasket on to the pump body flange and align the holes with those round the flange. Lower the camplate housing over the sheath, ensure that the trunnion pockets are located over the control ring trunnion blocks, then press the housing down on to the pump facing. Hold it down and insert a bolt adjacent to either trunnion, fit a plain washer, grover washer and nut, and tighten sufficiently to hold the housings together. Remove the assembly sheath, fit the remaining bolts, plain washers, grover washers and nuts and tighten all the nuts evenly.

148. To the centre boss in the camplate housing, fit the spring, sealing ring, carbon face seal and sealing ring, rotor sealing collar and circlip. Check the rotor again for rotation by using the turnkey T.199561.

Amplifier valve assembly

149. Assemble a rubber sealing ring to the groove on the orifice body and fit the complete assembly to the mounting face and retaining studs in the pump housing. It is advisable to smear the sealing ring lightly with white petroleum jelly or kerosine to facilitate its entry into the housing bore. Place two double tab-washers on the studs, fit and tighten but do not lock the four reach nuts.

Checking the governor tappet clearance

150. In addition to checking the governor tappet clearance, it is also advisable to recheck the rocker lever tail lift as shown in fig. 5 (*para.* 22).

151. A special gauge G.64208 (*fig.* 32) is provided for checking the clearance between the diaphragm tappet screw and the rocker lever tail. The gauge consists of a clamping ring, sectioned to provide access to the governor tappet and fitted with a sliding plunger which can be locked in position by a knurled locking screw.

152. Mount the clamping ring over the studs on the pump body followed by the gasket and overspeed control assembly and secure it with nuts and washers.

153. Screw in the adjusting screw to tension the spring then release the plunger and allow it to rest on the rocker lever tail without depressing it. Lock the plunger firmly in this position.

154. Using feeler gauges, measure the

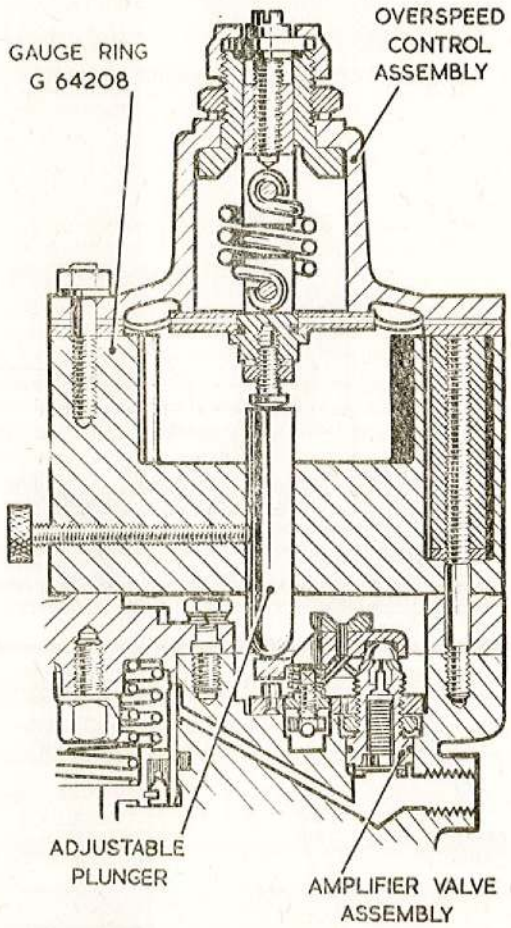


Fig. 32. Checking the overspeed governor tappet clearance

clearance between the diaphragm tappet screw and the end of the clamping ring plunger. The correct clearance is 0·017 in. to 0·019 in; adjust the tappet to this clearance and tighten the locknut but do not lock it at this stage.

Control cylinder end cover

155. Fit a rubber sealing ring to the recess in the mouth of the control cylinder and insert the two springs. Place the gasket on the control cylinder end face and place the end cover, spigoted end first, over the springs. Force the cover down by hand against the spring pressure until the retaining nuts can be fitted. Secure the amplifier platform with four nuts and tab-washers and the servo flange with four plain washers, grover washers and nuts.

Overspeed control assembly

156. Fit the gasket and diaphragm plate on to the studs in the pump housing face. Lower the cover, overspeed control assembly and diaphragm into position and secure it with eight plain washers, grover washers and nuts.

Servo pressure restricting orifice

157. Insert the strainer assembly into the retaining plug and orifice, fit the seal and sealing ring and screw the assembly into the threaded bore on the side of the control piston cylinder.

Remaining details

158. The remaining details consist of the air bleed valve, several sealing plugs and the inlet strainer assembly.

159. Fit a light alloy washer to the small sealing plugs and screw the plugs into the tapped holes in the pump body.

160. Into the inlet bore of the pump housing, insert the washer, the spring and then the strainer assembly. Compress the spring and fit the retaining circlip.

REPLACEMENTS

Rotor quill shaft

161. (1) To remove the quill shaft, position the rotor on the base guide T.249079 as shown in fig. 33 lower the drift into the central bore of the rotor and using a hand press force the quill shaft out of the rotor. The spring ring, rubber sealing ring and shim washers will remain in the rotor bore. To extract these use the hooked tool as shown in fig. 34.

(2) To fit a replacement quill shaft, place a rubber sealing ring in the seating on the quill shaft, position the rotor on the location base T.203055 (*fig.* 35) and place the assembly under a hand press. Locate the brass ram of the tool on the quill shaft and press the shaft in until it is felt to bottom in the rotor. Remove the rotor assembly from the press and place it on the location base T.249079 (*fig.* 33). Place the spring ring, shim washer, rubber sealing ring and shim washer over the plunger on the special drift supplied with T.203055 and lower into the rotor bore as shown in fig. 36. Using a hide hammer tap the drift until the spring ring engages in the recess on the end of the quill shaft.

(3) Check the quill shaft in the rotor for concentricity by using vee blocks and a standard dial test indicator (tolerance 0·008 in.). If not concentric remove the quill

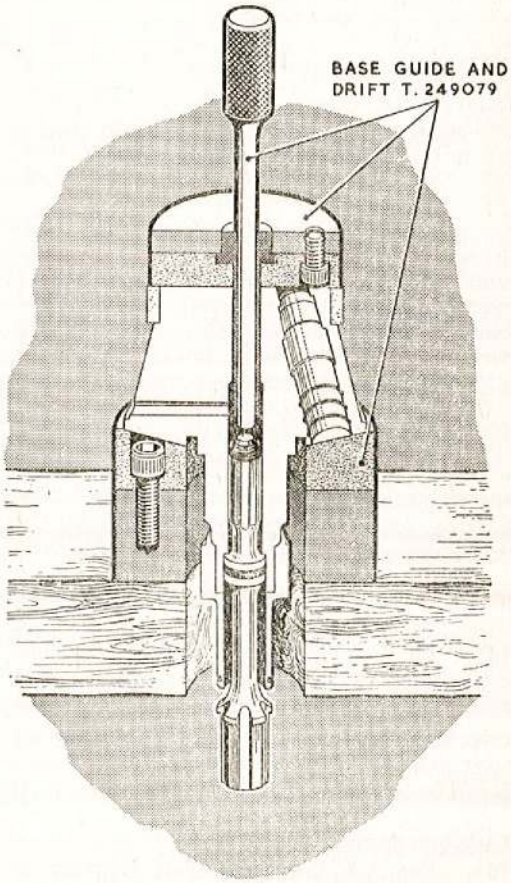
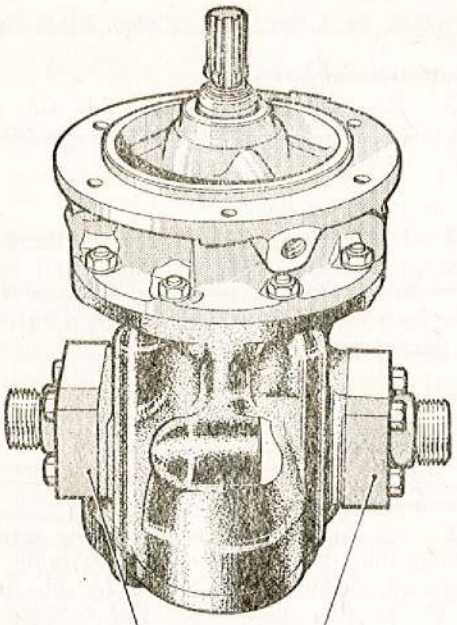


Fig. 33. Removing the rotor quill shaft



T. 203385 (1/2 AND 5/8 B.S.P. TO SUIT 4 STUD ADAPTER)
T. 203384 (1/2 AND 5/8 B.S.P. TO SUIT 3 SETSCREW ADAPTER)

Fig. 37. Slave adapters for test rig

form to the Specification stated in the Appendix.

182. The fuel temperature is to be maintained within the stated limits; where temperatures in excess of 30 deg. C are specified then the temperature limits are to be within ± 5 deg. C of the temperature at which the flowmeters have been calibrated.

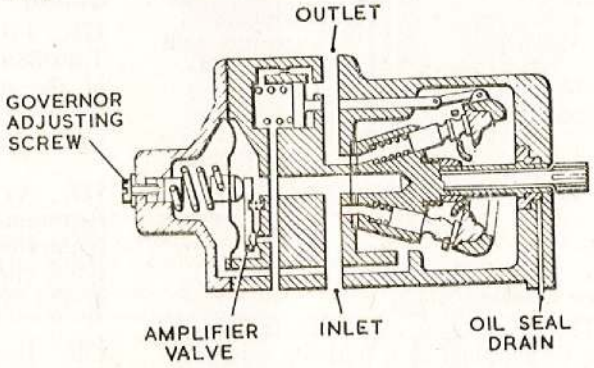
183. The fuel pressure at the pump inlet is to be maintained constant at the stated value throughout these tests except where stated otherwise for a specific condition.

Running in

184. It is recommended that for initial running-in and calibrating, the pump should be mounted on the combined rig. It must then be run at the conditions specified in the Appendix.

Preliminary calibration

185. Before commencing any testing, the pump must be calibrated provisionally as follows :—



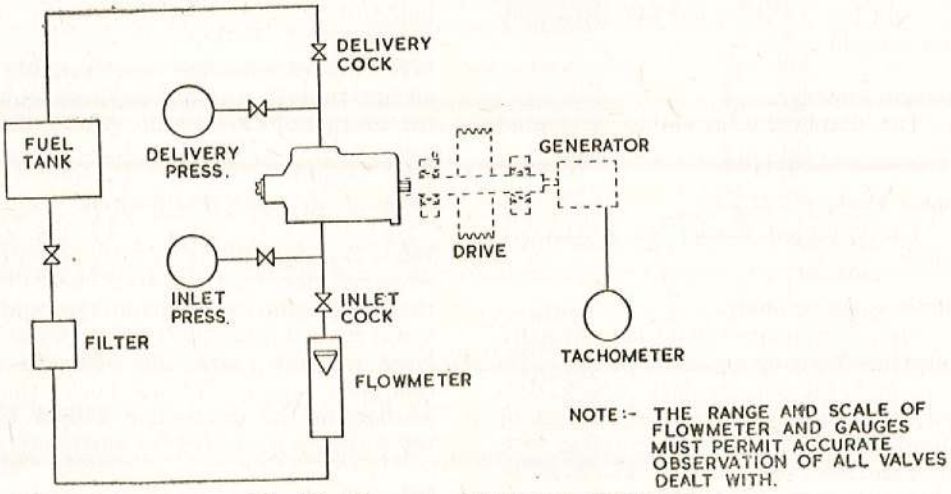


Fig. 38. Diagrammatic layout of test rig

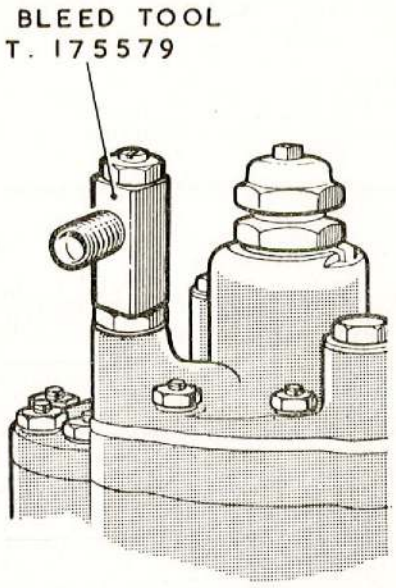


Fig. 39. Bleed tool in position on valve

Set the maximum flow (*para.* 196)

Set the stall pressure (*para.* 198)

Check the volumetric efficiency (*para.* 200).

Check the governor operating cycle (*para.* 202)

Check the governor recovery time (*para.* 203).

General endurance test

186. With the pump calibrated, adjust the rig to provide the conditions specified in the Appendix and run the pump for the stated periods. During the first period the temperature of the fuel is to be allowed to rise to the value stated then reduced again before the start of the second period.

Pump cyclic endurance test

187. Following the general endurance test the pump is to be cyclic tested, the number and frequency of the cycles to be regulated as specified.

Governor cyclic endurance test

188. The overspeed governor is to be adjusted to the speed stated for Point A in the Appendix then the pump speed is to be varied regularly to operate the governor in accordance with the cyclic frequency specified.

Starting test

189. The rig must be adjusted to the condition required at idling speed then the pump is to be stopped, started and run to idling speed and stopped again periodically. The number of starts is specified in the Appendix and after the initial setting at idling speed conditions no further adjustments are to be made during the test. At the end of the test there must be no change in either the flow or delivery pressures.

Performance test

190. Check that the pump has run-in and settled down satisfactorily by re-calibrating as follows :—

Check the stall pressure (*para.* 198)

Check the volumetric efficiency (*para.* 200)

Check the governor cycle (*para.* 202)

Check the governor recovery time (*para.* 203)

Check for leakage (*para.* 206 *to* 208).

Strip inspection

191. The pump is to be partially or wholly dismantled for inspection, the extent of this being at the discretion of the inspection authority and determined by the general condition of the pump, extent of servicing carried out and the behaviour of the unit during the preliminary testing. If new pistons, rotor, port insert, control piston camplate or auxiliary camplate have been fitted, such components must be crack-tested at this stage.

Final assembly

192. Before final reassembly all components must be cleaned as described in para. 52.

193. Re-building must be carried out in accordance with the instructions given in this chapter. In addition, all internal locking must be completed at this stage, except for those items which may require adjustment during final rig-testing. Installation connections are to be fitted and should not be disturbed after the final leakage test.

Re-calibration

194. The pump is to be re-installed on the test rig and re-calibrated as follows :—

Check the governor pressure rise (*para.* 197)

Check the stall pressure (*para.* 198)

Check the volumetric efficiency (*para.* 200)

Check the governor cycle (*para.* 202)

Check the governor recovery time (*para.* 203).

Second endurance test

195. It is essential that the flowmeters are calibrated at a temperature within ± 5 deg. C of the fuel temperature specified in the Appendix. The governor is then to be cyclic endurance tested at the conditions specified. This is a repetition of the cyclic test described in para. 202.

Final calibration and performance test

Setting the maximum flow

196. The governor should be adjusted by rotating the setting screw clockwise approximately one turn so as to raise the governing speed sufficiently to avoid interference whilst the maximum flow is being adjusted. The maximum flow must then be set by running the pump at the condition specified and adjusting the maximum flow stop screw to obtain the stated flow. The screw locknut is then to be tightened fully and locked.

Note . . .

Where the fuel temperature exceeds 30 *deg. C., i.e., when using gasoline (as in preliminary testing), the maximum flow setting is to be determined as follows :—*

(1) *The pump stroke is to be set initially to approximately* 20 *g.p.h. less than the flow setting stated, to avoid over-stroking.*

(2) *The volumetric efficiency from the maximum flow setting pressure of* 100 *lb. per sq. in is to be recorded.*

(3) *For every degree C. above* 20 *deg. C.,* 1·10 *per cent. of the figure recorded in sub-para.* (2) *must be subtracted from the maximum flow limits specified.*

(4) *The resulting flow limits together with the specified speed and delivery pressure will be the flow setting conditions at the fuel temperature prevailing.*

EXAMPLE :—

Stroke setting at normal temperature (20 to 26 deg. C) :—
830 to 840 g.p.h. at 1,250 lb. per sq. in. at 3,500 r.p.m.

Volumetric efficiency at flow setting pressure at 50 deg. C.—43 g.p.h.

Applying correction (sub para 3) 1·10 per cent. per deg. C. normal temperature (20 deg. C) :—

50-20=30 × 1·10 per cent. = 33 per cent. of 43 g.p.h. (vol. efficiency)= 14 g.p.h.

Stroke setting for temperature of 50 deg. C.:—

830 to 840 minus 14=816 to 826 g.p.h. Therefore at a fuel temperature of 50 deg. C. the stroke setting would be 816 to 826 g.p.h. at 1,250 lb. per sq. in. at 3,500 r.p.m.

Checking the governor pressure rise

197. The governor pressure rise is to be checked with a manometer on a constant speed rig as follows :—

(1) Remove the governor adjusting screw from the pump and fit in its place the adapter T.192035 as shown in fig. 40.

(2) Three plugs are fitted to the side of the pump body opposite to the servo cylinder ; remove the plug marked PUMP INLET and connect one side of the manometer to the exposed tapping then attach the other manometer connection to the adapter on the governor adjustment.

(3) Run the pump at the speed and inlet pressure stated with delivery unrestricted (zero pressure) then close the delivery cock gradually to increase the pressure to the maximum stated. The governor pressure rise must remain constant or increase throughout the range of increasing delivery pressure. There must be no decrease in governor pressure.

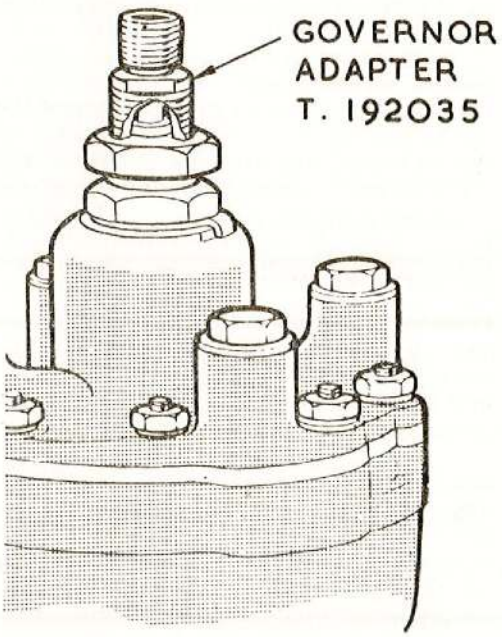


Fig. 40. Checking the centrifugal pressure rise

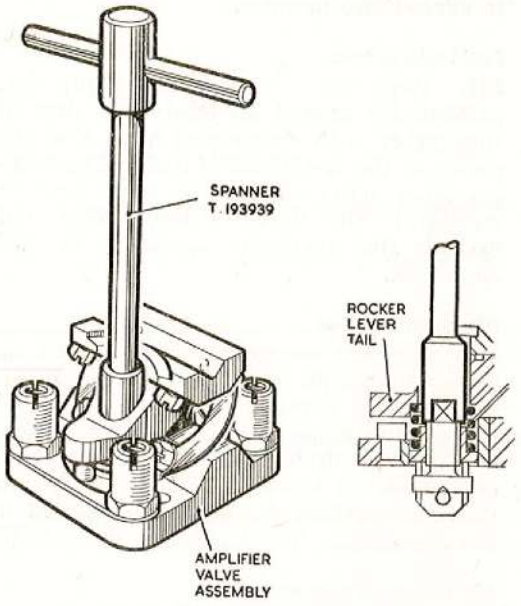


Fig. 41. Adjusting the stall pressure

(4) Run the pump for three minutes at maximum delivery pressure to check the stability of the governor pressure then govern the pump down to the lower pressure stated by adjustment of the manometer connection adapter on the governor control.

(5) Run the pump at this condition for three minutes and check that during this time the governor pressure does not fall below the datum recorded in sub para. (3). Should the pressure fall, re-check the datum setting and repeat the tests in sub para. (3) and (4).

Checking the stall pressure

198. Run the pump at the speed and inlet pressure stated in the Appendix then increase the delivery pressure, by closing the delivery restrictor cock, until the pump stalls, denoted by a rapid decrease in flow. The delivery pressure at which the stall occurs must be within the specified limits.

199. Should the stall pressure be above or below the value stated, insert the spanner T.193939 into the aperture in the tail of the amplifier valve rocker lever, as shown in fig. 41 and rotate the stall pressure adjusting screw. Clockwise rotation will increase the valve spring loading and consequently the pressure at which the stall occurs; conversely, anti-clockwise rotation will decrease the loading and enable the valve to lift at a lower pressure. The pressure is altered by approximately 50 lb. per sq. in. for each one-quarter turn of the screw, which can be felt by the detent grooves in the head of the pin passing over the locking pin. Stall the pump a number of times in accordance with the appendix; at the end of the stall test the pressure must not show any variation.

Checking the volumetric efficiency

200. To check the volumetric efficiency run the pump at the stated speed and high delivery pressure, record the flow, then reduce the delivery pressure to the low value stated and record the flow. Any variation between the two recorded flow values must not exceed the variation stated. Where the fuel temperature exceeds 30 deg. C. an addition of 2·20 per cent. g.p.h. per degree above 20 deg. C. is permissible.

Checking the governor range

201. To check the governor range, run the pump at the delivery pressure and lower of the speeds stated, then leaving the delivery restrictor cock as set, rotate the governor adjusting screw anti-clockwise until the governor operates, denoted by a rapid decrease in flow. Set the governor to operate at the stated speed and by reducing and then increasing speed several times check that the governor operates satisfactorily. Increase the speed to the higher value stated and rotate the governor adjusting screw clockwise until the flow recovers, then re-adjust the governor until the flow falls and check the operation several times at this point. The adjusting screw locknut should be tightened each time the governor is checked.

Checking the governor cycle

202. Run the pump at the speed and delivery pressure stated for Point A in the Appendix then adjust the governor until the pump governs at these conditions. Check several times that the governor operates satisfactorily at these conditions. With the governor adjusted satisfactorily, increase speed until the governor operates then immediately adjust the speed to the value stated for Point C in the appendix without altering the delivery restrictor cock setting. Check that the delivery pressure is steady at the Point C value specified then reduce speed to the value stated for Point D

and observe that the delivery pressure recovers to within the specified limits. Check the cycle several times.

Checking the governor recovery time

203. A stop watch is required for checking the recovery time. Run the pump at the conditions stated for Point A in the previous test then adjust the speed to obtain the Point C condition. When the speed and delivery pressure are steady, start the stop watch and simultaneously reduce speed as rapidly as possible to the Point C, condition. Stop the watch immediately the delivery pressure recovers to the value stated for Point D. The recovery time as recorded by the stop watch must not exceed the time stated in the Appendix. Check the recovery several times to ensure that it is satisfactory.

Checking the governor cycle with pump inlet depression

204. The duration of this test must not exceed two minutes. Run the pump at just below governed speed (Point A) at the delivery pressure stated in the Appendix, switch off the rig tank boost pressure, open the manometer cock then close the pump inlet cock steadily, until the specified pump inlet depression is indicated. Increase speed to the Point A value and check that the governor operates satisfactory at this condition.

Self priming test

205. Close the pump inlet cock and run the pump at the stated speed when the pump must produce the inlet depression specified. The duration of this test is not to exceed two minutes.

Fuel leakage test

206. Wipe the exterior of the pump dry, particularly around all joints and dry off thoroughly with compressed air. Run the pump at the conditions stated. Any leakage other than from the seal drains must be rectified; the drain leakage must not exceed the quantity specified in the Appendix.

Air pressure test

207. Remove the pump from the test rig and complete all locking. Connect an air line to the pump inlet connection and blank off all other connections except those of the seal drain. Submerge the pump completely in kerosine and apply the air pressure specified for the period stated in the Appendix. There must be no leakage.

Air pressure test outer seal

208. Bolt the pressure test adapter T. 202263 to the pump mounting face, with a joint washer interposed, connect the compressed air supply to the union on the test adapter and apply the air pressure specified for the period stated in the Appendix with the pump and adapter submerged in kerosine. There must be no leakage.

Final leakage test

209. Remove the pressure test adapter from the mounting face, complete all external locking then remount the pump on the test rig and repeat the test described in para. 206.

Appendix 1

CALIBRATION CODE Y

Fuel specification

1.1. 73 NLAVGAS is to be used for running-in and preliminary calibration (items 2.1 to 6.1).

1.2. Fuel temperature limits 20 deg. to 40 deg. C. Except where stated otherwise the temperature is to be maintained at between 20 deg. and 26 deg. C.

Running-in (*para. 184*)

2.1. The maximum cam angle (15 deg.) having been set during assembly, run-in under the conditions stated in the following table :—

Speed (r.p.m.)	Delivery Pressure (lb. per sq. in.)	Time (minutes)
500	100	2½
1,000	100	2½
1,500	200	2½
2,000	300	2½
2,000	400	2½
2,500	500	2½
3,000	600	5
3,000	700	5
3,500	800	10
Set max. flow to 420 g.p.h. at 3,500 r.p.m. and 100 lb. per sq. in. delivery pressure then :—		
3,500	900	15

Preliminary calibration (*para. 185*)

3.1. Check the volumetric efficiency (item 9.3). Check the governor cycle (item 9.6) The flow difference must not exceed 50 g.p.h. Check the governor recovery time (item 9·7).

First endurance test (*para. 186*)

4.1. Run the pump at 3,500 r.p.m. with a flow of 3,800 g.p.h. at a delivery pressure of 13,500 lb. per sq. in. for 1½ hours, the delivery pressure being set by an external stall valve. During this period allow the fuel temperature to rise from 25-30 deg. C to 36-38 deg. C.

4.2. Run the pump at 3,800 r.p.m. at full stroke at a delivery pressure of 1,500 lb. per sq. in. for 15 minutes.

4.3. Run the pump for 5 minutes at 3,500 r.p.m. with a flow of 340 to 380 g.p.h. at a delivery pressure of 1,800 to 2,100 lb. per sq. in. followed by 10 minutes at 1,220 r.p.m. (idling speed) with a flow of 20 to 25 g.p.h. at a delivery pressure of 1,350 lb. per sq. in. Repeat the cycle 12 times.

4.4. Set the governed speed to the value stated for Point A (item 9.6) then operate the governor control 240 times by varying the pump speed.

Starting test (*para 189*)

5.4. The pump is to be started, run to 1,220 r.p.m. with a flow of 20 to 25 g.p.h. at a delivery pressure of 1,350 lb. per sq. in., then stopped. This starting cycle is to be repeated 25 times, during which no adjust. ments are to be made to the rig controls.

Performance test (*para. 190*)

6.1. Check the stall pressure (item 9.3)

Check the volumetric efficiency (item 9.4)

Check the governor operating cycle (item 9.6)

Check the governor recovery time (item 9.7)

Check the pump for leakage (item 10.1 to 10.3)

Strip inspection

7.1. Dismantle the pump, clean, inspect and rebuild (*para.* 191).

Second endurance test (*para. 195*)

For this and all subsequent tests the fuel used is to be AVTUR and the temperature must be maintained at between 20 *deg. and* 26 *deg. C.*

8.1 The governor cycling endurance test (item 4.4) is to be repeated

Final calibration (*para. 196 to 205*)

9.1. Set the maximum flow to 365 to 375 g.p.h. at 3,480 r.p.m., 1 to 5 lb. per sq. in. inlet pressure and 1,000 lb. per sq. in. delivery pressure.

9.2. Check the centrifugal pressure rise by running the pump at 3,500 to 3,600 r.p.m. with an inlet pressure of 10 to 15 lb. per sq. in. then vary the delivery pressure from zero to 1,200 lb. per sq. in. and reduce to 1,000 lb. per sq. in. There must be no decrease in centrifugal pressure.

9.3. Set the stall pressure valve to operate at 1,800 to 2,100 lb. per sq. in. at a speed of 3,480 r.p.m., with an inlet pressure of 1 to 5 lb. per sq. in. Stall the pump 10 times to check the stability of the valve.

9.4. Check the volumetric efficiency by running the pump at 3,480 r.p.m. at a delivery pressure of 1,000 lb. per sq. in., then reducing the delivery pressure to 100 lb. per sq. in. The difference in flow must not exceed 22 g.p.h.

9.5. With an inlet pressure of 1 to 5 lb. per sq. in. and a delivery pressure of 1,200 lb. per sq. in. check that the governor will operate over the range 2,500 r.p.m. to 4,000 r.p.m.

9.6. Check the overspeed governor operating cycle. Set the governor adjustment to operate at 3,480 r.p.m. at 1,000 lb. per sq. in. delivery pressure and 1 to 5 lb. per sq. in. inlet pressure, then check the cycle in accordance with the following table :—

Check Point	Speed (r.p.m.)	Delivery pressure (lb. per sq. in.)
A	3,480	1,000
B	Not applicable	
C	3,560 to 3,630	100
D	3,460 to 3,480	950 to 1,000

9.7. Check the time taken by the pump to recover from the governed condition at Point C to the conditions at Point D in the previous check. The recovery time is to be within 0·80 to 3·00 seconds.

9.8. With an inlet depression of 12 in. Hg. Abs and a delivery pressure of 1,000 lb. per sq. in. check that the governor control will operate at between 3,480 and 3,500 r.p.m. This test is not to exceed two minutes.

9.9. Check that at a speed of 500 r.p.m. with the inlet cock closed, the pump will produce an inlet depression of 24 in. Hg. Abs. or more. This test must not exceed two minutes. *Ensure that the depression is not so excessive as to draw mercury from the manometer into the pump as mercury has a rapid deleterious action on the pump body material.*

Leakage tests (*para. 206 to 209*)

10.1. Run the pump at 3,200 r.p.m. with a delivery pressure of 1,500 lb. per sq. in. and an inlet pressure of 40 lb. per sq. in. for five minutes. then reduce the inlet pressure to 20 lb. per sq. in. and run for a further five minutes. Leakage is not permissible except from the seal drain ; this leakage must not exceed 20 c.c. per hour at 40 lb. per sq. in. and 5 c.c. per hour at 20 lb. per sq. in.

10.2. Apply air at a pressure of 40 lb. per sq. in. to the pump body for five minutes with the pump submerged in kerosine. There must be no leakage.

10.3. Apply air at a pressure of 5 lb. per sq. in. to the seal pressure test adapter for five minutes with the pump and adapter submerged in kerosine. There must be no leakage.

10.4. Complete all locking and repeat the test in item 10.1.

6496 590272 5/56 1,250 C.B.&S.Ltd. Gp.999