Chapter 5

HIGH PRESSURE FUEL PUMPS, TYPE GTD AND MGTD SERIES

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1. The GTD type of fuel pump is fitted with a centrifugal governor, whilst that on the MGTD pump is of the hydro-mechanical type. In other respects the two pumps are identical and therefore the following instructions deal first with the complete GTD pump and then in para. 316 onwards with the MGTD pump. Reference is made to earlier paragraphs if the information applies also to the MGTD type.

HIGH PRESSURE FUEL PUMP, TYPE GTD

2. The pump consists of twin pumping units operating together with inter-connected servo control but with only one governor. To avoid unnecessary repetition, only one of the twin units is described in detail, but where differences do occur additional notes are given.

3. The two pumping units are referred to as the upper and the lower pump, i.e., in the installed position; in fig. 34, the upper pump is shown in the foreground.

4. When the pump is being dismantled, the sub-assemblies are first removed but are not dismantled until after the pump body and camplate. The reverse applies when the pump is being assembled.

LIST OF TOOLS

G.51239	Gauge, parallelism check, port insert.
G.56521	Gauge, checking slipper piston clearance.
G.56528 G.56529 G.56530 G.56531 G.56532	Setting pieces piston measurement.
G.61521	Gauge, clearance check, small carbon bearings(s).
G.61522	Gauge, clearance check, large carbon bearing(s).
G.61523	Gauge, setting, camplate angle.
G.61524	Gauge, checking, auxiliary camplate lift.
G.61525	Gauge, setting, servo piston stop.
G.61526	Gauge, clearance check, governor tappet.

LIST OF TOOLS—*continued*

G.61531 G.61532 G.61533 G.61534 G.61535	Setting rings, rotor bore measurement.
G.61541	Gauge, checking, rocker lever(s) tail lift.
G.63686	Gauge, concentricity check, quill shaft(s).
G.65018	Gauge, checking, backlash of gears.
G.65019	Gauge, checking end float main gear bearing(s).
G.65020	Gauge, checking end float centrifugal shaft bearing.
G.100348	Gauge, concentricity.
T.160988	Spanner, governor adjusting screw
T.128563	Box, stud, body assembly.
T.177125	Spanner, box, $\frac{1}{4}$ in. BSF
T.190007	Extractor, sealing rings
T.190849	Tool, assembling quill shaft(s) to rotor(s).
T.190850	Extractor, quill shaft(s) from rotor(s).
T.193774	Fixture, pressure test, servo isolating valve.
T.193939	Spanner, adjusting screw(s), stall pressure(s).
T.199121	Extractor, large carbon bearing(s).
T.199125	Tool, assembling garter seal(s) to end cover(s).
T.199126	Spanner, maximum flow adjusting screw.
T.199127	Spanner, ring, camplate housing to pump body nut(s).
T.199140	Fixture, assembling governor control spring.
T.200618	Tool, extracting servo piston.
T.201735	Fixture, assembling and dismantling, bearing race(s) sleeve(s).
T.201736	Spanner, bearing lock ring(s).
T.201739	Tool assembling, bearing race, camplate housing.
T.201740	Tool assembling, servo control liner(s).
T.201741	Extractor servo control liner(s).
T.207142	Guide, servo control piston(s).
T.201745	Stand, retaining, rotor(s).
T.201746	Stand, retaining, pistons.
T.201748	Sheaths, assembly quill shafts—camplate housing.
T.201749	Spanner, centrifugal rotor shaft nut.
T.201754	Tool, assembling plugs to amplifier housing
T.201755	Turn key, rotor quill shaft(s).
T.201758	Adapters, test rigs, inlet and outlet fuel connections.

LIST OF TOOLS—*continued*

T.201770	Tool, assembling and dismantling, piston spring guides.
T.206866	Adapter, test rig, servo isolating valve.
T.206867	Locking screws, slave, camplate trunnion block(s).
T.208267	Extractor, bearing race camplate housing.
T.209310	Extractor, pressure supply orifice strainer(s).
T.209311	Key, box, centrifugal make-up valve.
T.209315	Fixture, pressure test, oil seals, rotor quill shaft(s).
T.210192	Fixture, pressure test, port insert(s) and rotor bore strainer.
T.210193	Fixture, pressure test, servo pressure supply orifice(s) strainer(s).
T.210194	Fixture, pressure test, amplifier orifice valve(s) and solenoid strainer.
T.210195	Fixture, pressure test, amplifier valve housing strainer(s).
T.212169	Ball race, slave, centralisation centrifugal rotor.
T.228558	Tool, closing, governor drive gear.
T.230694	Fixture, assembling, governor.
T.13493	Fixture, pressure drop test h.m. governor fuel strainer
T.241658	Tool, expanding, servo bore felt washer.
T.245434	Sheath, assembling, C.F. make up valve.
T.248418	Extractor, end cover assembly.
T.253858	Tool, compression, assembling and dismantling rotor piston spring.
T.260330	Key, test, body assembly.
T.266733	Lap, governor rotor.
T.268379	Punch, dowel, end cover.
T.268380	Extractor, carbon bearing.
T.268391	Sheath, assembling, seal.
T.271057	Lap, rotor extension.
T.271066	Punch, dowel to port insert.
T.271067	Tool, compression, assembling and dismantling, rotor carbon-faced seal.
T.299368	Fixture, porosity test.
T.271087	Plate, adapter, general assembly.
T.271093	Equipment, test, non-return valve.
T.277764	Fixture, leak test, diaphragm assembly.
T.280577	Extractor, camplate housing from body.
T.285717	Sheath, assembling, governor rotor.
T.285737	Tool, assembling, spring guides to rotor.
T.287355	Tool, riveting, diaphragm assembly.
T.290954	Adapter, torque spanner, end cover.
T.289653	Extractor, main gears.
T.289668	Tool, assembling and aligning, main gears.

DISMANTLING THE PUMP

5. As the size and weight of the unit make it difficult to handle on the normal workshop bench, a foot-operated hydroclamp, together with adapter T.271087, should be used.

6. Drain any fuel from the pump and remove all locking wire. Mount the pump on the hydroclamp, with the overspeed control housing upright, and remove external couplings and blanks.

Removing the servo piston end cover

7. Figures in brackets refer to parts illustrated in fig. 34—the exploded view of the pump.

8. Remove the eight nuts to release the

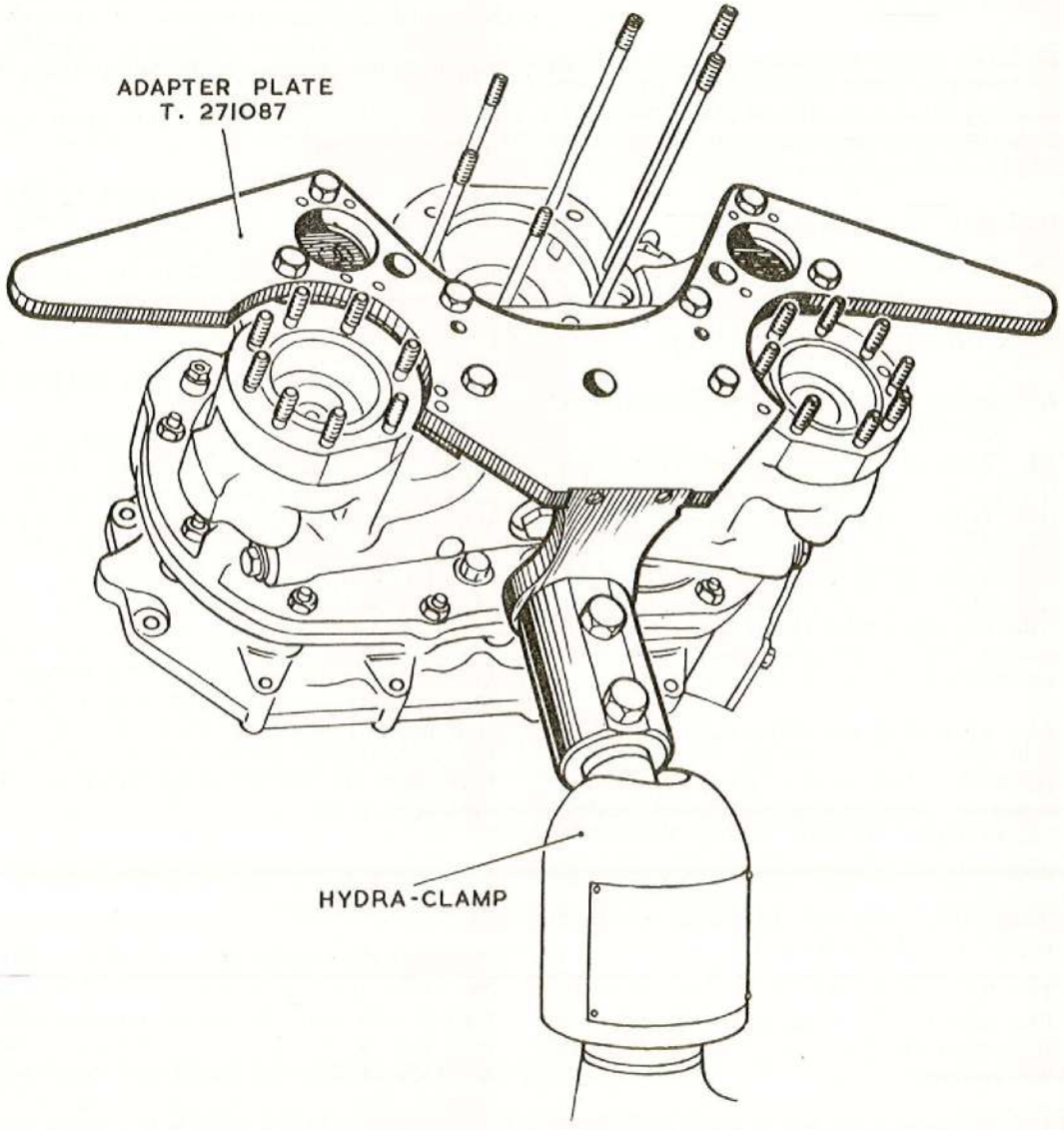

FIG. 1 ASSEMBLING AND DISMANTLING FIXTURE

servo piston cover (104). Whilst removing the last two nuts, place the free hand across the cover to resist the spring load created by the servo piston springs. Lift off the washers from each stud, allow the cover to become free from the studs and remove the two springs (101) from the servo piston housing.

Dismantling the servo piston end cover

9. Unlock the minimum flow stop-screw (106) and, unscrew the stop from the cover, taking care to retain the shim washers (107). Remove the casting cover sealing ring (108). (Lower pump only).

10. The control cylinder end cover casting of the upper pump forms part of the servo isolating valve, and removal of the minimum flow stop (106) and the cover sealing ring (108) is as described in the previous para.

Removing the diaphragm cover

11. Remove the six nuts securing the diaphragm housing cover to the pump body studs. To ease removal lightly tap the cover with a hide faced hammer.

Dismantling the governor diaphragm cover assembly

12. Remove the open cap nut (118) from the head of the governor spring housing (117) then remove the square headed governor adjusting screw (119) from the spring fork connection using spanner T.160988. This will allow the diaphragm (6) complete with the diaphragm centre (11), spring (4) anchor fork (116) and diaphragm outer spacing ring (5) to drop clear.

13. To remove the diaphragm extract the split pins from the diaphragm centre and the anchor fork, taking care to remove the washers. Tap the link pins (9) with a drift and push clear from the spring. Should any difficulty be encountered in removing the link pins, the governor spring may be temporarily stretched by using assembly fixture T.199140 ref. fig. 19.

14. To remove the air bleed valve (1), first take off the dome nut and seal ring, then remove the valve body, using a standard box spanner.

15. To remove the bell housing (117) from the diaphragm cover, remove the locking wire and unscrew the six set screws. Beneath the flange of the spring housing but within the diaphragm cover casting is located a rubber seal washer (2).

Removing and dismantling the amplifier housing

16. Lift off the amplifier housing (99), including the rocker lever plate and orifice assembly (14), carbon faced seal (17) and spring and the gasket (23).

17. At the amplifier housing face to the pump body are two connecting bobbins and seals (97), one for each pump unit, these relay the pump servo pressure to the half ball control valves. To remove, apply a light push load on the strainer unit from the opposite face. In some instances the bobbin and seals may remain in the pump body, if so remove the upper gaco seal, ease out the bobbin, then remove the strainer units and seal washers (100).

18. Unlock the tab-washer from the four nuts which secure the rocker lever plate and orifice assembly and remove the nuts. Insert two 2 B.A. screws into the holes in the baseplate to withdraw the rocker lever plate.

Dismantling the rocker lever plate and orifice assembly

19. To remove the strainer assembly, push the lockpin clear with a normal pin type drift and allow the assembly to drop clear. With early type pumps having the lockpin peened over, carefully file away one of the pin edges and push clear as described. The orifice locknut must not be disturbed.

20. To remove the stop screw, prise back the tab-washer and release with a standard box spanner. Apart from removing the stall pressure adjusting screws by releasing the spring loading and pushing the steel pins (13) clear, no further dismantling is permitted.

21. Remove the two plugs, one beneath each half-ball valve strainer, from the base of the amplifier housing.

Removing the centrifugal rotor and gear drive

22. Turn the pump body so that the gear train is vertical and facing the operator, prise back the cup locking washer (54) from the nut (55) holding the centrifugal rotor and remove the nut with spanner T.201749. Insert turning key T.201755, to engage with the driving splines of the lower pump and so resist rotation of the rotor gear, whilst removing the nut.

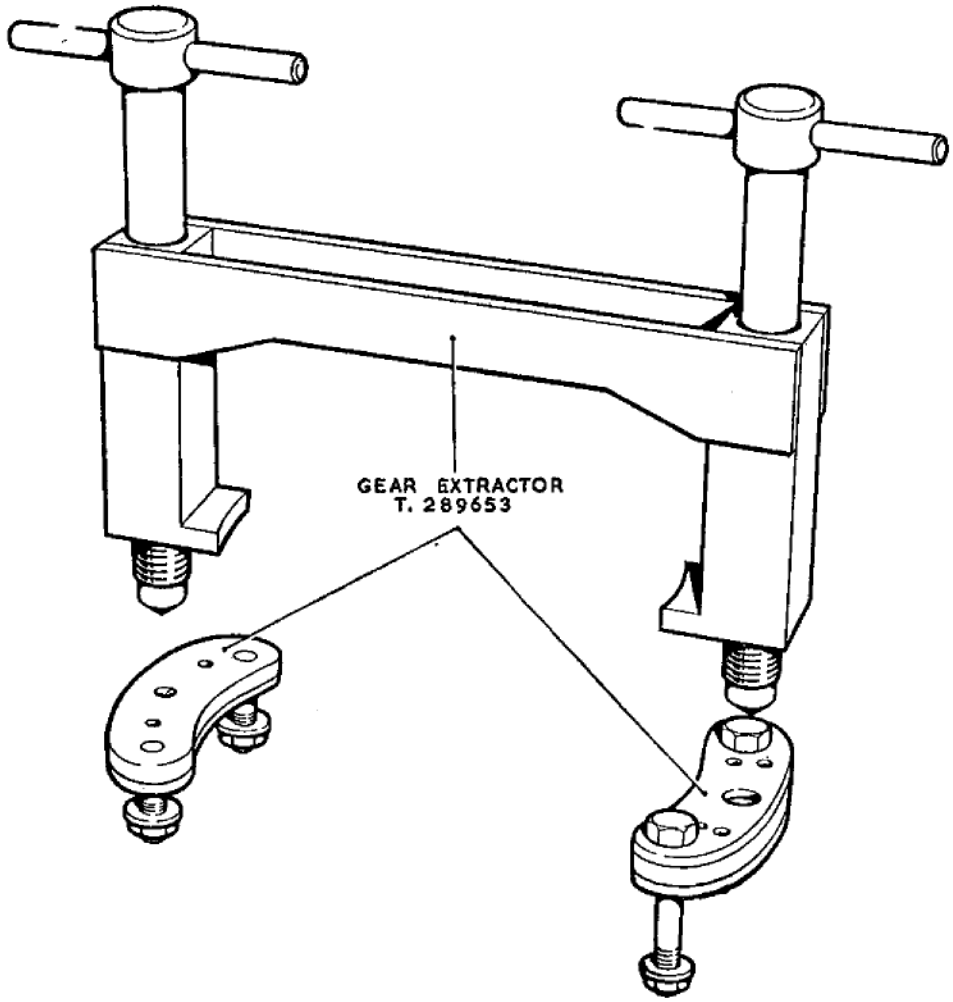

Fig. 2. Gear extractor

23. Remove the cup washer from the splined shaft. Lightly drift the shaft and remove it from the opposite end of the pump body, leaving the splined gear drive behind.

24. Lift out the combined bearing face seal (19) and spring from the centrifugal rotor bore of the pump body, amplifier housing end. Remove the similar components of smaller diameter, which are situated lower in the bore. To assist in the removal of the seals a smearing of light mineral lubricating oil will be advantageous.

Removing the gear train and bearing

25. Using the adapter plate T.271087 (*fig.* 1), mount the unit on the hydraclamp.

26. With the camplate in a vertical position, gears uppermost, unlock and remove the bolts (57). Use the extractor T.289653 (*fig.* 2) to remove the gears.

27. Clear the peened cup washer (60) and, using the spanner T.201736, remove the serrated nut (59). Remove the bearing ring (62) and the ballrace (61) of the upper pump, and also the combined bearing ring and governor gear drive of the lower pump by using the extractor T.248418 (*fig.* 3).

Removing and dismantling the end cover

28. Unlock and remove the eight nuts and detach the end cover (64) from the camplate housing (45).

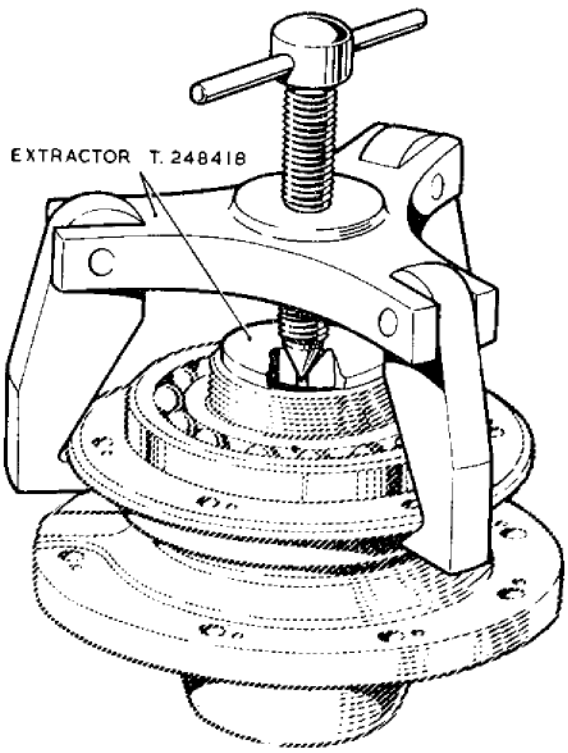

Fig. 3. Bearing-ring and ball-race extractor

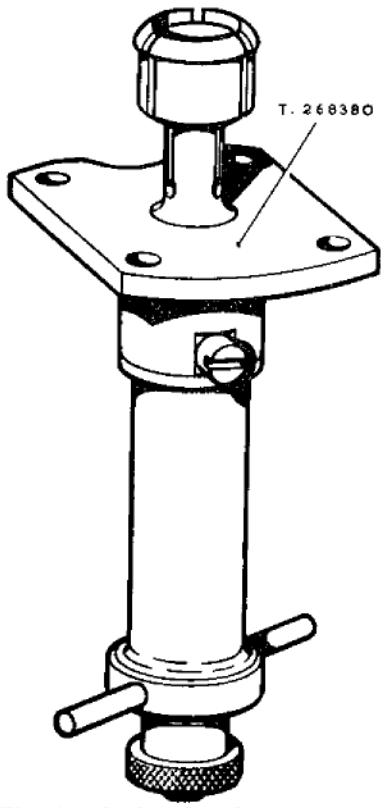

Fig. 4. Carbon-bearing extractor

29. Place the end cover on the bench with the carbon bearing (71) uppermost. Use the compressing tool T.271067 to ease the spring load, then remove the circlip and fit the extractor T.268380 (*fig.* 4) to withdraw the carbon bearing.

30. Take out the carbon-faced seal and sealing ring assembly (70) and also the spring and spring cups, garter seal (66) and washer.

31. To remove the bearing sleeve, mount the end cover on the two studs to the locating stand which is provided with the extractor T.201735 (*fig.* 5). Fit two slave washers and nuts.

32. Unlock and remove the six nuts which secure the sleeve to the end cover. Place the large knurled nut of the extractor over the spindle of the locating stand and screw it on to the threaded portion of the bearing sleeve. Screw on the extracting sleeve-nut and turn the T-shaped screw to withdraw the bearing sleeve.

Removing the rotor ball-bearing

33. Extract the circlip and, using the extractor T.208267, withdraw the bearing from the camplate housing (*fig.* 6). Take out the shim (49) and note its thickness, then remove the abutment ring, carbon-faced seal and spring.

Camplate housing removal

34. Remove the trunnion blanking plugs (22) and fit locking screws tool T.206867 so that the trunnion bearings are attached to the pump body face. Upper and lower pump.

35. Extract the split pins and remove the nuts, securing the pump body and camplate housing, using ring spanner T.199127.

36. Separate the pump body (24) and camplate housing (45), using extractor T.280577 as shown in fig. 7.

Rotor removal

37. Mount the pump body vertically on the stand so that the splined rotor shafts are uppermost. Detach the link connecting fork (76) from the servo control piston to camplate, by bending back the tab-washer locking from the nut holding the link bolt (75), and remove with box spanner T.199128. A light tap will clear the bolt from the link fork. On later types, remove the dowels, link-pins and links from the camplates and servo piston rods.

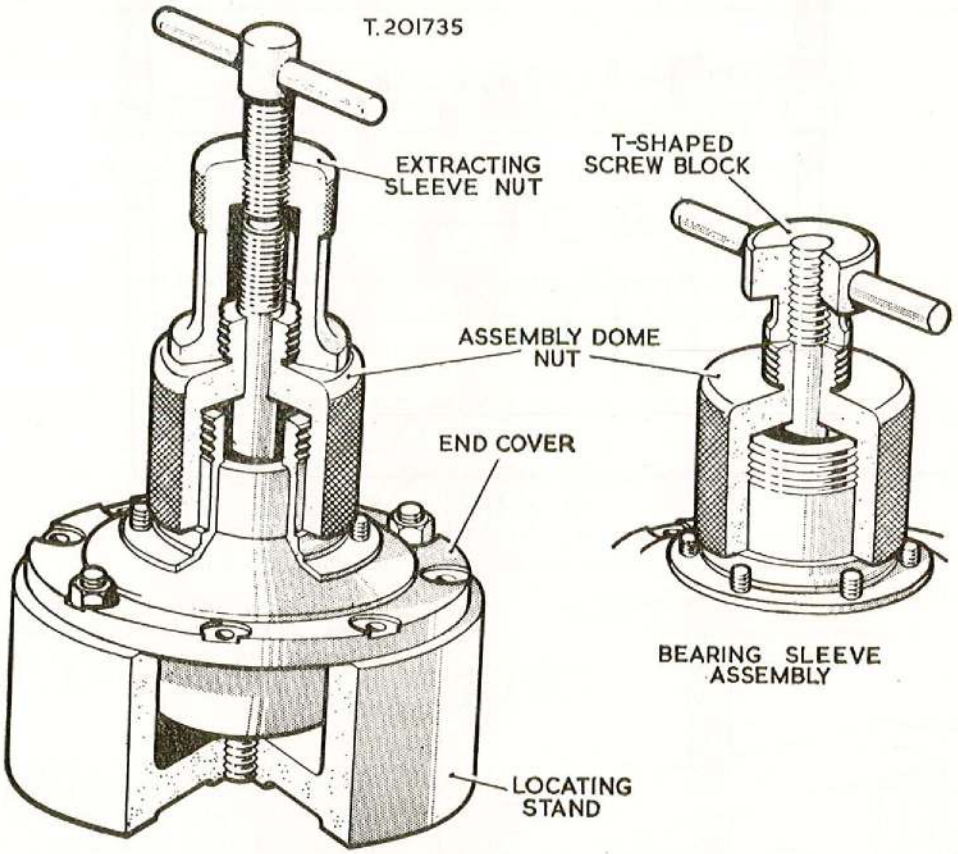

Fig. 5. Removing or fitting the bearing sleeve

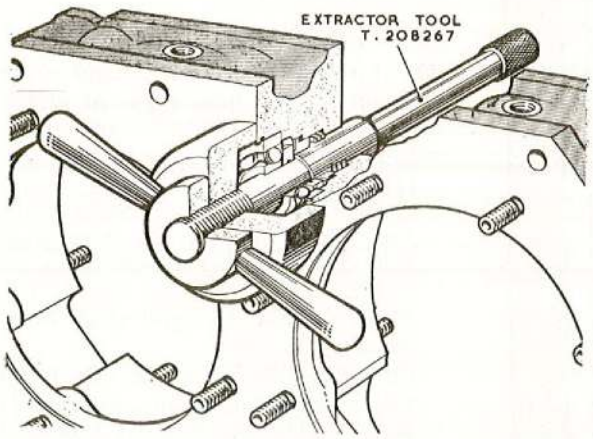

Fig. 6. Removing the governor rotor ball-bearing

38. Fit clamp tool T.253858 (*fig.* 8) over the splined rotor shaft and press down firmly to compress the piston springs and lock; remove the locking screws, tool T.206867. Remove the clamp tool.

39. The camplate assembly, with the rotor, can now be removed from the pump body as one unit. Remove both the trunnion blocks (42) and the camplate (44). Place the rotor (81) on retaining stand, T.201745 and remove the pistons (74), placing each in turn on stand T.201746.

40. Lift the auxiliary camplate (43), thrust ball (41), shims (77), spring

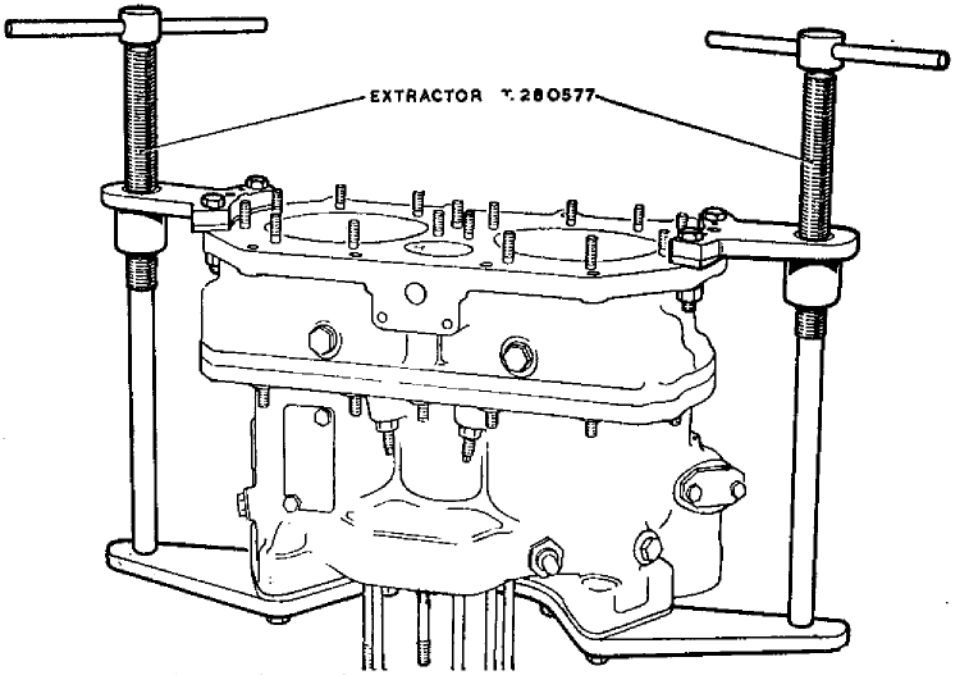

Fig. 7. Separating the pump body and camplate housing

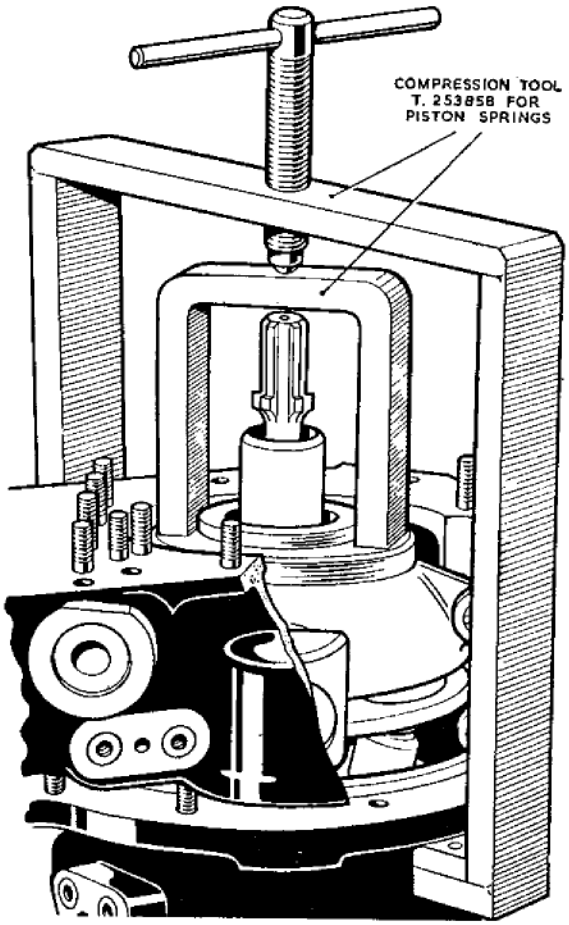

Fig. 8. Compressing the piston springs

seat (40) and spring (39) clear of the rotor. The auxiliary camplate and thrust ball are matched and must not be interchanged with similar components.

41. Remove the spring guides (80), situated in the base of the rotor piston bores, using tool T.201770 (*fig.* 25). A threaded plug, an accessory to the tool, is fitted through the base of the piston bores to engage with the tapping formed in the push rod. This will now locate the spring guide on to the assembly tool and withdrawal is completed by removing the tool from the respective bore.

Rotor quill shaft removal

42. For this operation a hand press is required, the base plate of which must have a hole of $1\frac{1}{4}$ in. dia. to ensure clearance for the component.

(1) Place the rotor locating stand consisting of tool T.190850/1/6/8 and /9 (*fig.* 9) on the handpress base plate and mount the rotor on to the tufnol supporting ring of the stand so that the quill shaft faces towards the base.

(2) Place the protective cap T.190 850/5 over the rotor port insert face so that the sleeve T.190850/7 locates in the axial bore of the rotor.

(3) Insert the drift T.190850/3

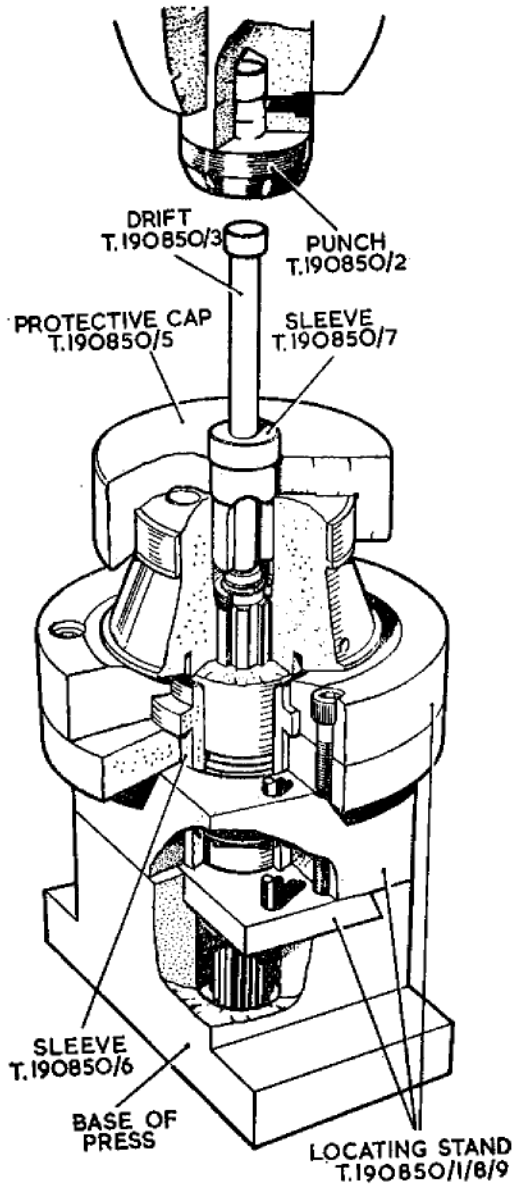

Fig. 9. Removing the rotor quill shaft

through the sleeve to contact the end section of the quill shaft; fit the punch T.190850/2 into the press ram block and lower the ram so that contact is made with the drift. Two or three sharp blows with the press will push the quill shaft down slightly and clear the jump ring from its groove. Lift the press ram and remove the drift.

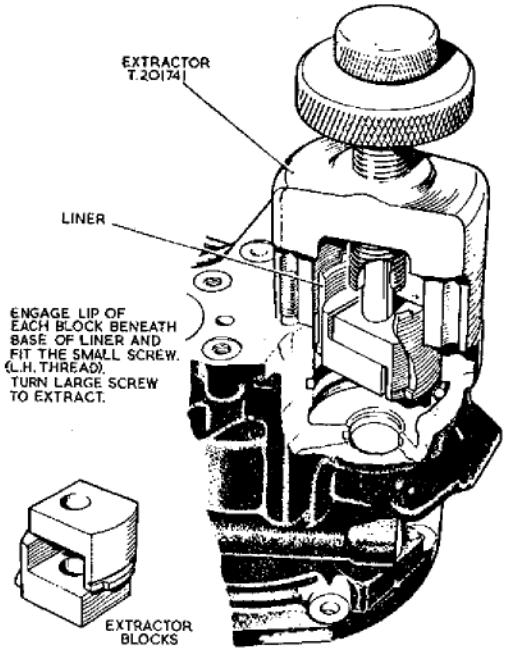

Fig. 10. Removing the servo cylinder liner

(4) With tool T.190850/4, remove the jump ring, washer, seal ring and washer from the rotor. Re-insert the drift into the rotor bore and again lower the press ram to press the quill shaft fully out of the rotor.

Removing the rotor bore interconnecting strainer unit

43. Remove the circlip retaining the strainer unit (37) and lift out the washer (38), strainer unit and rubber seal washer (36).

Removing the servo piston assembly

44. On early types, unlock and remove the nut, with box spanner T.199128. Remove the tabwasher, then push the link bolt (75) clear of the link connecting fork (76) and servo piston rod (98). On later types, remove the dowels and link pins to detach the servo piston rod.

45. Reverse the position of the pump body so that the machined faces for the control piston covers are upper-most; screw tool T.200618 into the tapping of the stop plug in the control piston head, pull on the tool

and bring the control piston assembly orward to clear the aperture.

Dismantling the servo piston assembly

46. Hold the control piston assembly on the bench with the piston rod uppermost. Extract the circlip from beneath the piston head, then remove the seal retaining plate and seal washer.

47. The plug stop insert is shrunk into the piston head and must not be removed.

Removing the servo cylinder liner

48. Extractor T.201741 (*fig.* 10) consists of two angled sections, each having a protruding lip. Place the sections within the liner bore, so that the lips of each section can be made to contact underneath the base of the liner. Mount the circular supporting piece over the cover plate studs; location is provided in this section for a large knurled setscrew (right hand thread) which is threaded through the block. This setscrew is drilled through the centre and forms a guide for a smaller, knurled setscrew (left hand thread) which passes through and engages with the two sections. With the extractor so positioned, tighten the large knurled setscrew and withdraw the liner.

49. Clear the rubber seal (90) from the control piston liner bore and the felt seal washer (89) from the piston rod bore.

Removing the servo connecting bobbins

50. In the pump body to the servo cover face are two bobbins, fitted with rubber seals. The smaller one is a blank and the inner one is a transfer connection to the servo isolating valve. Remove the inner bobbin by peeling off the rubber seal washer, grip lightly with the fingers and extract. The blank may be removed by carefully inserting a lever under the head.

Carbon bearing removal

51. Remove the carbon bearing (34) by extracting the circlip (35) and then lifting out the bearing by inserting both hands into the bore, gripping the sides of the bearing with the fingers and pulling evenly. If the carbon bearing is tight, use tool T.199121.

Port insert removal

52. Lift out the retaining spider (33) from above the kidney shaped port (83), then the kidney shaped port from the pump body locating dowel. Remove the strainer (84) and the spring and seating washer from the rotor bore by tilting the pump body.

Removing and dismantling the centrifugal make up valve

53. Mount the pump body horizontally on the bench so that the centrifugal make up valve (21) is uppermost. Remove the dome nut and the washer. Hold the tapered adjustment screw with box key T.209311, release the locknut and washer and extract the adjusting screw.

54. Remove the body, lift off the plain flat rubber washer and from the body itself, the rolled rubber seal washer.

Removing the servo pressure supply orifice

55. Remove the cover by releasing the two set screws. Remove the spring and plain washers and lift off the cover removing the rubber seal from the protruding section.

56. Extract the servo pressure supply orifice body (88) and remove the rolled rubber seal washer from around the base of the housing. Remove the wire wound strainer unit (86) using extractor T.209310 and lift off the rolled rubber seal washer.

Removing the fuel delivery non-return valve

57. Move the pump body round, still in the horizontal plane, for access to the fuel outlet ports. Extract the circlip and remove valve guide (94), valve (91) and valve spring.

Removing the remaining parts

58. Within the pump body are the two maximum fuel flow adjusting screws (30). Remove the cap nut and washer. Retain the delivery screw with spanner T.199126, release the lock nut and remove the delivery screw from the threaded insert. All dowel pins are a push fit and should not be withdrawn unless loose or damaged.

CLEANING

59. The components should not normally be very dirty and washing in a clean bath of kerosine is sufficient. The cleaning bath must have adequate filtering facilities and be fitted with a pressure type of feed to a flexible hose containing a spray delivery nozzle.

60. Abrasives, washing compounds, hard brushes or cloth must not be used.

61. The components should be dried thoroughly with a compressed air blast, which must be free from water, and placed in dry clean containers. If inspection is likely to be delayed the components should be lightly smeared with oil and placed in covered containers.

INSPECTION

62. All inspection should be directed to eliminate components in which defects have started to develop. Visual inspection of the parts, described in this section, have been divided into various assemblies to correspond as far as possible with the normal dismantling sequence.

63. Bolts, nuts, washers and circlips, etc., have not been individually mentioned in a detailed inspection, as these are subject to standard inspection practice.

64. Components which are discoloured such as blacking, even after a kerosine wash, do not necessarily mean rejection, for this may be caused through electrolytic action and any attempted removal by abrasive methods could prove harmful. This discolouration must be differentiated from that which may be caused through the pump over-heating.

65. Components which are subject to wear must be checked dimensionally in accordance with the Schedule of Fits, Clearances, and Repair Tolerances.

66. The inspector should be conversant with the current modification standard of the pump so that modified parts can be embodied.

67. Tabwashers split pins, locking wire, joint washers, rubber seals and other consumable parts must be discarded during dismantling. Replacements should be available for inspection with their associate components.

Scores and surface damage

68. Components having scores and surface damage must be examined with consideration of the function of the part concerned. Such damage on moving parts or joint faces will impair the efficiency of the unit and may lead to complete failure.

69. With piston slipper heads an initial bedding-down occurs, causing an irregular line pattern. Providing no breakdown of the plating is observed and other functions are satisfactory, the piston can be regarded as being serviceable.

Magnetic crack detection

70. The following components must be subjected to test, by an approved magnetic crack detector.

Rotors (for cracks on steel journals)	(2 off)
Fuel port inserts.	(2 off)
Camplates.	(2 off)
Auxiliary camplates.	(2 off)
Maximum flow screws,	(2 off)
Link bolts.	(4 off)
Connecting forks.	(2 off)
Governor rotor and pinion.	(1 off)
Servo control rods.	(2 off)
Gear assemblies (not including bearings)	(2 off)
Bearing sleeves.	(2 off)
Piston spring guides.	(14 off)
Piston spring seats	(14 off)
Stall adjustment screws.	(2 off)

STRAINER UNITS

71. Examine each strainer for serviceability. Check the head of the strainer for security, wire winding for completeness and ensure that no loose particles are present.

72. Strainers must be subjected to a pressure drop test and a separate test fixture must be used for each size of strainer. Any normal burner test rig can be arranged to cater for the test conditions. All test fixtures are of two piece construction and are connected into the rig delivery line by a threaded inlet port.

73. The following procedure should be adopted with the test rig illustrated in fig. 11.

(a) Record the pressure drop with the test fixture in the line without the strainer.

(b) Fit the strainer into the test fixture and again record the pressure drop. Subtracting (b) from (a) will give the actual drop, which must be as specified in the relevant appendix.

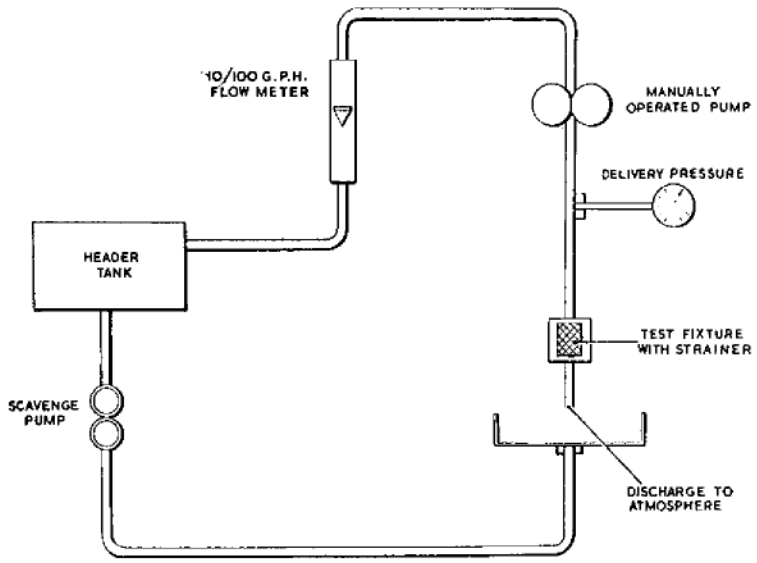

Fig. 11. Diagrammatic layout of pressure drop test rig

Port insert and interconnecting rotor bore strainer assemblies

(Test fixture T.210192)

74. Place the strainer assembly into the lower half of the fixture, with a rolled rubber seal washer located in the fixture beneath the strainer head. Fit a small rolled rubber seal washer into the upper half of the fixture, where it is recessed and internally threaded to accommodate the lower section. Screw the upper section into the lower and connect to the test rig. The inlet connection is on the upper half of the fixture and with a fuel supply of 50 gal/h the pressure drop must not exceed 2 lb/in².

Servo pressure supply orifice strainer

(Test fixture T.210193)

75. Fit a seal washer around the groove at the base of the strainer and mount the assembly into the larger half of the two piece test fixture. The other half of the fixture has a male thread and is screwed into the larger section, provision being made for the location of the small boss formed at the head of the strainer, a seal washer being fitted at the joint face. Connect to the test rig so that the fuel flow is to the centre of the strainer and then outwards, for a fuel supply of 50 gal/h the pressure drop must not exceed 5 lb/in².

Amplifier orifice valve and solenoid strainer assemblies

(Test fixture T.210194)

76. Locate the strainer assembly into the housing formed by the male threaded half of the testing fixture. The top of the housing is countersunk to accommodate a rolled rubber seal washer. A machined groove round the outside diameter of the housing, above the thread line, retains a seal washer; by screwing on the other half of the fixture, a seal between the two halves is made. The pressure drop must not exceed 8 lb/in² for a fuel supply of 50 gal/h.

Amplifier valve housing strainer

(Test fixture T.210195)

77. The larger half of this test fixture has a central drilling through the unit, above which is a larger threaded drilling. A further drilling is taken into the block to form a connecting passage, with the through drilling. On the joint face of the block is a circular groove for locating a rolled seal washer. Install a seal washer around the grooved head of the strainer and fit the assembly, head downwards, into the through drilling. The other piece of the fixture consists of an externally threaded inlet connection combined with a threaded plug for attachment to the other block. A circular seal washer is fitted into a recess at the end of the drilled plug so when the fixture is assembled a seal is formed around the end of the strainer. Attach the sections together and connect to the rig, supply fuel at 50 gal/h and note that the pressure drop does not exceed 5 lb/in².

INSTALLATION FITTINGS

78. Examine all installation components for cleanliness and general condition. Ensure that the joint faces, especially the fuel connections are free from any burrs and indentations, the thread inserts secure and free from damage. Check that the aluminium seal washers are free from score marks and regular in shape. Carefully view the blank plugs for damage and condition of the threads, check with the particular housing for fit and effective sealing. Ensure that the flats across hexagon heads are in good condition and that any wire locking holes are clear.

SERVO PISTON END COVER PLATE

79. Visually inspect the cover for signs of bruising and fracture, check the eight stud clearance holes for elongation and evidence of the studs fouling the cover. Examine the spigot fitting for security and check that the spring retaining grooves are clean and free from any obstruction. The internally threaded boss, for locating the servo piston stop set screw, must be complete with no fracture, the threads a good fit and check that there are no signs of elongation from the head of the thread bore by inserting the set screw.

OVERSPEED CONTROL UNIT

Bell housing, governor spring

80. Check the bell housing for external damage, the flange must be flat and free from burrs. Examine the six threaded holes for general condition, the spring anchor guide must be clean and free from scores, ensure that the spring anchor moves freely in its guide. The cap nut threads must be clean and free from damage. Leakage may be caused by damage to the seal washer recess formed in the top of the housing.

81. Inspect the underside of the adjusting screw flange for scoring and other surface damage. Make sure that the threads are in good condition, the spanner flats square and the screwdriver slot undamaged.

Diaphragm cover

82. The diaphragm cover casting must be free from bruising and distortion. Check the stud clearance holes for elongation and for signs of cracks. The joint face must be flat and free from indentations and the machined recess for the seal washer, between the cover and bell housing, must be sound.

Air bleed valve

83. Examine the body for signs of distortion and check that the external threads, for locating the unit in the diaphragm cover casting and securing cap nut, are in good condition. Manually operate the valve and ensure that the spring loading is effective. Should any corrosion be present inside the valve housing reject the unit.

84. The assembly must now be subjected to the following pressure tests. With the cap nut not fitted apply a fuel pressure of 5 lb/in^2 to the valve, leakage must not exceed 5 c.c./min. If satisfactory, raise the fuel pressure to 20 lb/in^2; the leakage must not exceed 5 c.c./min. Fit the cap nut and subject the valve to a pressure of 80 lb/in^2; no external leak is permitted.

Diaphragm assembly

85. Inspect the spring anchor and the combined spring anchor and diaphragm centre for corrosion and distortion. Check the link pin holes for undue wear and signs of radial cracks. Ensure that the stem of the spring anchor is smooth and the internal threads clean. The base of the combined spring anchor and diaphragm centre must be flat, the locating hole for the tabwasher undamaged and the threads for locating the tappet screw clean.

86. Examine the link pins for undue wear and corrosion, check that the split pin holes are clean. The link pins should be an easy push fit through the forks of the spring anchors.

87. Examine the governor spring for cracks and corrosion, particularly the eyelets. Check that the loops and coils are square and free from distortion, and ensure that the spring is free from magnetism.

88. Carefully examine the diaphragm for any signs of cracking or splitting. Lightly move the diaphragm and see that damage has not occurred around the stud clearance holes. Inspect the six rivets, securing the centre support plate, for any signs of looseness, and ensure that the plate is free from distortion.

89. Inspect the diaphragm inner and outer spacing rings for damage, in particular for score marks on the faces and sharp edges or burrs.

90. Examine the tappet screw for damage, see that the threads of the screw and locknut are in good condition and check the screw into the diaphragm centre. The tappet head should be square to the screw and free from wear and pitting.

Amplifier valve housing

91. Visually check the condition of the housing, particularly for bruising. The spigot mounting should be concentric and a good fit. All stud clearance holes should be free from elongation and burrs which might foul the joint faces. Both the locations for the strainer orifices including the angled drilled connecting passages must be clean and free from any restriction. Examine the interior of the housing for signs of damage and the four studs retaining the amplifier and rocker lever assembly for security, length and squareness to the base of the housing. Carefully mount the amplifier and rocker lever assembly over the studs and ensure that the plate seats correctly.

Rocker lever plate and orifice assembly

92. Inspect the assembly generally, for signs of damage and corrosion. Ensure that the base plate stud clearance holes are free from elongation and that the two threaded assembly holes are clean and serviceable.

93. Check that the eight torsion hinges are free from distortion and surface cracks. See that the securing set screws are firmly attached and locked with tabwashers. The two rocker levers should be square, with the operating tail tips in alignment; depress each rocker lever to ensure freedom of movement.

94. Check as far as possible, without dismantling, the serviceability of the half ball valves and housings, examine the locknuts securing the orifice pillars for security and locking.

95. Examine the stop screw for wear, carefully check the threads together with the corresponding tapped section of the rocker lever plate.

96. Inspect in turn, each of the stall pressure adjusting screws, springs, adjusting nuts and lock pins. Test the operation of the screws with spanner T.193939.

Checking the tail lift of the rocker lever

97. Temporarily fit and secure the rocker lever assembly into the amplifier housing, mount the bar block of gauge G.61541 (*fig.* 12) across the face of the housing and secure with two slave nuts and bolts. Locate the plunger of the dial indicator to contact the extreme point of a rocker lever tip; then depress the lever fully to the stop and allow the plunger to follow. Set the dial indicator face to a datum point and release the rocker lever, check that the reading is between 0·025 in. and 0·045 in.

98. Repeat this check with the other rocker lever. If the readings are outside the limits, re-adjust by shimming beneath the stop screw head. Tighten the screw and when satisfactory lock the tab-washer.

Note . . .

The rocker levers need not have the same amount of travel.

Rocker lever alignment

99. To check the rocker lever tips for alignment set a dial indicator, with divisions of 0·0001 in. from the bar-block to contact

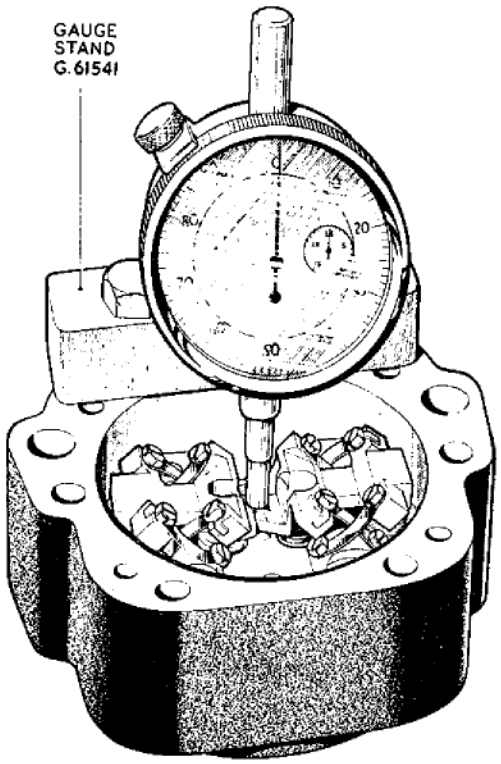

Fig. 12. Checking the lift of the rocker levers

both rocker lever tips. With the dial indicator set at zero reading, depress alternately each rocker lever; the tolerance allowed is 0·0005 in.

SERVO PISTON ASSEMBLY

Piston springs

100. Check that the plating is not flaking and no cracks exist, also, see that the coils are even and not distorted. Stand the springs upright on the bench, apply a light hand loading and observe that there is a ready response on releasing the load. Test for magnetism and if present, demagnetise before assembly.

Piston and control rod

101. Examine the piston and control rod, generally, for severe wear, scoring or other damage. Check that the locations for the springs are clean with no signs of fracture. Check the plug stop insert for fretting, indentations, cracks and security. Ensure that the seal seating, beneath the head of the piston is clean and free from damage; inspect the circlip groove for wear.

102. Check the diameter of the piston rod and its bore in the pump body, dimensionally to the figures in the Schedule of Fits, Clearances and Repair Tolerances, also, the end play of the link pin bolt in its hole in the end of the piston rod.

103. Check that the piston seal retaining plate and circlip are serviceable.

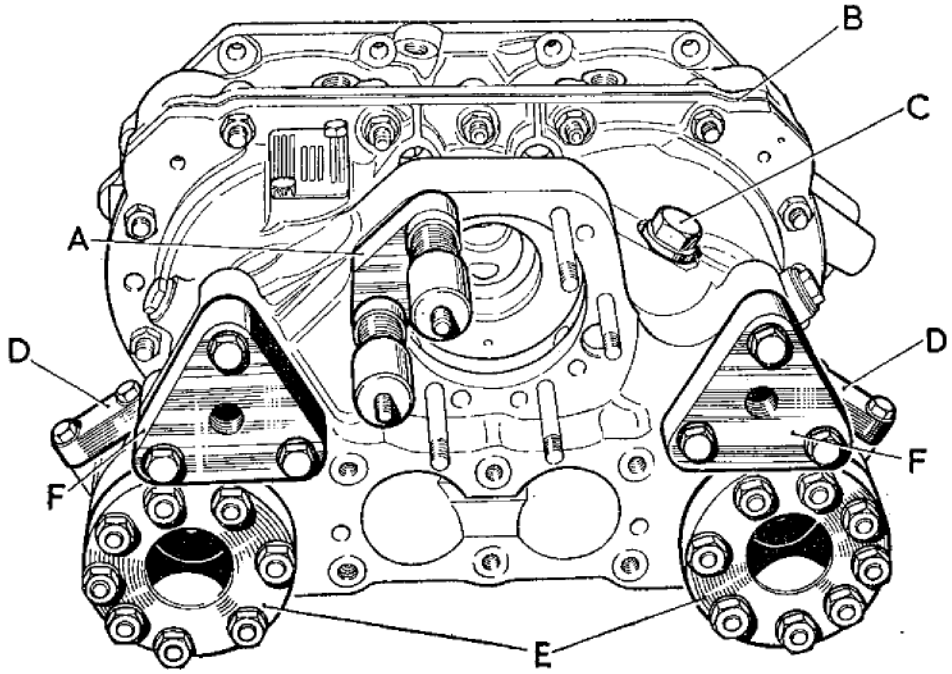

Fig. 13. Pressure test equipment T.271093 for non-return valves

A — MGTD pumps only. Blanking plate with sealing ring, threaded distance pieces (2 off), and cap nuts (2 off).

B — Normal gasket as in assembly.

C — Flanged blanking plug with sealing ring.

D — Servo blank orifices with sealing ring.

E — Servo cylinder blanking plates with sealing rings.

F — Pump delivery connections and sealing rings.

Piston liner

104. Examine the servo piston liner for wear. Observe that the protective finish is not flaking and that there is no evidence of cracks or distortion.

105. If the liner is removed, a closer inspection will be possible and an initial test for cracks can be made by ringing the component. Check that the lips are undamaged.

Non-return valve assembly

106. Inspect the valves for score marks, corrosion and indentations, especially the valve seat; the whole unit should have a smooth, polished finish.

107. Check the spring for freedom from flaking of the protective coating, and for surface cracks and coil distortion. Check the valve guide for damage and ensure that the valve will slide freely inside the bore.

108. Examine the circlip for cracks and distortion and temporarily fit the whole assembly together into the pump body location, with the circlip in position. Test that the assembly is free to rotate.

109. Pressure test each non-return valve by fitting the camplate housing and gasket to the pump body. Fit the valve assemblies and the equipment as shown in fig. 13 to the pump body. Apply fuel at a pressure of 2000 lb/in^2 to the triangular pump delivery connections and check that no leakage occurs. In the event of leakage some lapping of the valve seat may be necessary.

Centrifugal rotor

110. The finish of the rotor must be smooth and polished. Check that the disc face is not distorted and that the six radial drillings and the four drillings around the boss are not restricted and are free from scratches. Examine the splines for freedom from damage and sharp edges, check the engagement of the splines with the centrifugal pinion and bush assembly. Subject this component to a crack detection test.

111. Check the centrifugal rotor diameter and carbon bearing bore dimensionally, the limits and clearance to the figures in the Schedule of Fits, Clearances and Repair Tolerances.

Centrifugal make-up valve

112. Examine the body for external damage to the hexagon flats, wire locking holes, threads and washer retaining grooves. Check that the adjusting screw is not distorted, the threads clean and concentric with the internal body threads, the tapered section must be a smooth finish and the square shaped head undamaged.

Maximum flow adjusting screw

113. Inspect the adjusting screw and locknut for condition and cleanliness of the threads; examine the face contacting the camplate, for damage or pitting and see that the adjusting square at the opposite end is in good condition. Check the fit and security of the dome shaped cap nut and ensure that the wire locking holes are clear. Subject the component to the approved crack detection test.

Servo pressure supply orifice assembly

114. Inspection of the strainer assemblies is covered in paragraph 71 to 77, but check also the fit of the head of the strainer in the base of the pressure supply orifice body.

115. Examine the pressure supply orifice body for damage, check that the seal retaining groove is clean and that the orifice is free from obstruction; visually check the round head for distortion and the transfer holes for being clear.

116. Observe that the combined orifice retainer and cover plate is not damaged and locates satisfactorily with the pump body. Ensure that the seal retaining groove is clean.

Camplate assembly

117. Examine the camplate surface for damage, especially the areas around the trunnions, the connecting lug to the servo piston control rod and the point of contact where the adjusting screw abuts. Inspect the track of the piston slippers, for signs of overheating, scores, indentations and uneven wear. The detection of cracks is most important and this component should be subjected to an approved magnetic crack detection test. The clearance between the connecting lug bore and the link bolt must be checked dimensionally, in accordance with the Schedule of Fits and Clearances.

118. Inspect the trunnion blocks generally for signs of damage and the bore of the blocks for frettage. Check the camplate trunnion pins and the blocks dimensionally

to the Schedule of Fits and Clearances. Temporarily fit the trunnion blocks into the camplate housing casting and ensure that no interference is taking place. A check of the side play between camplate and trunnion blocks is effected during assembling.

Auxiliary camplate

119. The auxiliary camplate and thrust ball are lapped together and must not be interchanged. If either of the components is damaged both must be renewed.

120. Examine the auxiliary camplate generally, for condition. Inspect the seven piston holes for signs of frettage and subject the unit to a crack detection test.

121. The spherical thrust ball must be free from tracking, undue wear and indentations; the use of abrasives to remove tracking stains is prohibited. Check the bore for signs of picking up and measure the diameter to the Schedule of Fits and Clearances.

Rotor assembly

122. Examine the silver plating on the rotor face for flaking. Some wear generally occurs but provided that there is a good running track and the face is not badly scored or eroded, evidence of bronze showing slightly through the plating is not regarded as serious.

123. Check that the jump ring securing the quill shaft is undamaged and secure, also that the central bore and the seven radial drillings are clean and free from obstruction.

124. Examine the rotor bearing journals for security, particularly the large steel band; inspect for score marks, cracks and signs of overheating indicated by excessive discolouration. Subject the rotor to a magnetic crack detection test.

125. Check the diameters of the rotor carbon-bearing journals dimensionally in accordance with the Schedule of Fits, Clearances and Repair Tolerances, effect a clearance check with the bores of the carbon bearings. If it is necessary to lap the rotor extention, use tool T.271057.

126. Examine the location for the spherical thrust ball and spring seating for cleanliness and serviceability. Check the diameter of the rotor thrust ball journal and the clearance with the thrust ball bore.

127. Check the rotor piston bores for damage including flaking of the plating, severe score marks, and cleanliness of the relief grooves.

Note . . .

The seven piston bores in the rotor are manufactured to one of five sizes. The particular size is etched on the side of the rotor.

128. Check the rotor piston bores dimensionally for size and taper with a standard dial type intercheck small bore gauge; this is illustrated in fig. 15, Chap. 3, Sect. 2.

129. Ring type setting gauges are provided,

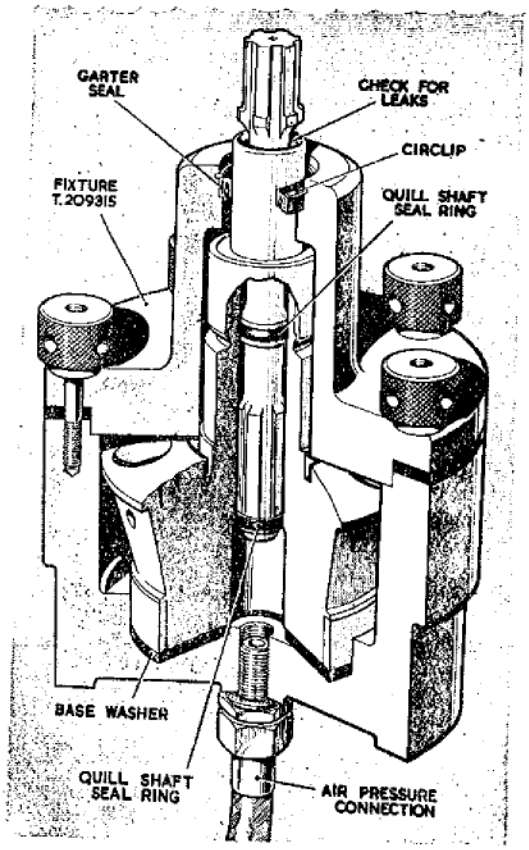

Fig. 14. Pressure testing quills shaft seal rings

for setting the intercheck gauge and are stepped in sizes, tabulated herewith, to cover the range of rotors.

ROTOR PISTON BORE SETTING RING GAUGES

Grade	Diameter (in.)	Tool No.
1	0·7194	G.61531
2	0·7204	G.61532
3	0·7214	G.61533
4	0·7224	G.61534
5	0·7234	G.61535

130. Select the appropriate setting ring, pass it over the tips of the gauge anvil and set the dial indicator to zero. Measure each bore in turn. Record all figures, the nominal size plus readings indicates wear, but for the actual clearance of the bore, the figures must be checked against the piston diameter.

Pressure testing the quill shaft seal rings

131. (1) Separate the test chamber T.209315 (*fig.* 14). Ensure that the base seal washer is in position in the lower chamber, and mount the rotor assembly, with the quill shaft vertical, into the chamber.

(2) Place sheath T.201748 over the quill shaft both during assembling, and when dismantling after testing.

(3) With the joint washer in position, lower the upper half of the test chamber over the assembly sheath and secure the halves of the chamber together by tightening the five knurled set screws.

(4) Connect an airline to the tapping in the base of the lower half of the test chamber using an appropriate union. Immerse the chamber in a bath of kerosine, apply air at a pressure of 4 lb/in² If satisfactory, raise the air pressure to 40 lb/in² and again check for leakage.

Quill shaft

132. View the quill shaft splines for burrs and other damage before checking the concentricity of the shaft to the rotor (para. 206). If the quill shaft has been removed from the rotor, check the locating splines for burrs and sharp edges, there may be slight frettage but wear should be negligible. Examine the shaft for corrosion and cracks, see that the sealing ring grooves and the jump ring grooves are clean and free from harp edges.

Pistons

133. Pistons and slippers are considered as an assembly and are numbered to fit into similarly numbered bores in the rotor. Examine the plating on the slipper heads for even surface, some cross line indentation is permissible and the components are serviceable provided that there is no lifting or peeling of the plating. Carefully ease off sharp edges and ensure that the small central hole is clear.

134. Check the skirt of the slipper heads for causing score marks and separation from the piston. Ensure that regular angular movement exists and check the skirt diameter dimensionally to the limits stated in the Schedule of Fits and Clearances.

135. Inspect the surface of the pistons for score marks and discolouration and inspect the bores for cleanliness. Ensure that the small central hole communicating with the slipper is clear.

136. Check each piston diameter, using a precision dial type comparator, to ensure that the clearance between the pistons and the corresponding rotor bores is within the limits stated in the Schedule of Fits and Clearances.

137. The pistons also conform to one of five grade sizes, a range of setting pieces being provided to enable the comparator gauge to be correctly set.

138. Select the appropriate setting piece for the size marked on the rotor, place on the plate of the comparator and adjust the instrument needle to zero. Pass each piston in turn under the contact point and read off on the indicator the amount by which the piston is less than nominal size.

PISTON DIAMETER SETTING PIECE GAUGES

Grade	Diameter (in.)	Tool No.
1	0·7192	G.56528
2	0·7202	G.56529
3	0·7212	G.56530
4	0·7222	G.56531
5	0·7232	G.56532

139. Subtract the indicated piston sizes from the corresponding bore sizes to obtain the clearance, this must be within the limits stated. If the clearance in any bore should exceed the specified worn limit the complete rotor and pistons must be rejected.

140. To ensure that the slipper lift is not excessive, check by inserting the assembly into gauge block G.56521. This tool is identical to that illustrated in fig. 2, Chap. 4, Sect. 2.

141. A swinging arm on the gauge block has an adjustable screw locating against the slipper head, whilst a centralizing button from the clock gauge positions the other end of the piston; secure by tightening the adjustable screw. Push the piston in the direction of the slipper head to take up the play, set the dial indicator to zero and pull the piston away to take up all movement in the opposite direction allowing the amount of lift to be read from the clock gauge, this must not exceed the specified clearance.

Piston springs, guides and seats

142. Inspect the piston springs for signs of damage, particularly distortion of the coils; check that the end coils lie flat and are free from fracture. Check each spring to ensure that it is not coil bound.

143. Examine the spring guides generally for damage such as cracks and distortion, see that the end section locates freely within the inner diameter of the piston spring and the axial bore is free from any obstruction.

144. The spring seats must be flat, circular with no sharp edges, and the small central hole must be free from foreign matter. The seats must all be carefully checked for cracks by an approved magnetic crack test, after which the central hole must again be checked.

Rotor carbon bearings

145. There are two rotor carbon bearings for each rotor, one large and one small. Examine both for fracture, cracks, chipping at the edges and elongation of the dowel slots. Score marks will cause crumbling and cannot be accepted. With the large bearing light line marks may be sometimes observed on the pressure side of the bearing; this is permissible at the discretion of the Inspection authority.

146. Insert both bearings into their respective locations, i.e., pump body and the end cover. The bearings must be a good sliding fit without any slackness.

147. Check the clearance between the inside diameter of the large carbon bearing and the diameter of rotor seal band dimensionally, also, check the clearance of the small carbon bearing and the rotor shaft extension.

148. With the two carbon bearings fitted to the bearing journals of the rotor, mount the assembly on to the stand of gauge G.61522. Set point of the dial indicator to contact the large bearing, push the bearing against the rotor and note the reading, this must not exceed 0·010 in. The clearance necessary, is obtained by selectively choosing the carbon bearing to match the rotor.

149. Check the small bearing using gauge G.61521, this forms a bracket arm mounted on the thrust ball journal of the rotor. Set the point of the dial indicator to contact the bearing, push the bearing against the rotor and note the reading, this must not exceed 0·005. This check should be undertaken whilst the rotor is on the stand of gauge G.61522, the stand is similar to that illustrated in fig. 3, Chap. 4, Sect. 2 of this Air Publication.

Port insert

150. Check that no damage has occurred to the surface finish of the port insert, inspect for cracks, score marks and other indentations, by visual inspection. Scores across the face of the insert are not permissible. Ensure that the dowel peg hole is clean and free from elongation, and that the small fuel transfer hole is clean and free from any foreign matter. Examine the sections of the shaped fuel ports and the axial bore for cleanliness and completeness of contour, carefully ease any sharp edges with a suitable oilstone. Subject the component to a magnetic crack detection test.

151. Check the thickness of the insert to the figures in the Schedule of Fits and Clearances. The faces of the insert must

be parallel to within 0·0001 in. and the following check must be effected.

(1) Check that the seating in the pump body is undamaged, clean and the dowel pin serviceable.

(2) Mount the pump body vertical with the rotor bores uppermost and ensure that the flange face is flat and clean. Locate the bar-block of gauge G.51239 across the flange face as shown in fig. 15 and lower the plunger of the direct reading gauge to contact the seating; from a datum reading move the block over several points to cover the area of the seating. Note that no readings must exceed the limits of the insert.

(3) If the pump body seating is satisfactory, ensure that the insert is clean and carefully lower it into position over the dowel peg, using no excess pressure. Again, mount the bar-block of gauge G.51239 across the pump body flange face and allow the plunger to contact the face of the insert, set the gauge to a datum point and check in several positions. The readings must be within the limits stated in the Schedule of Fits and Clearances.

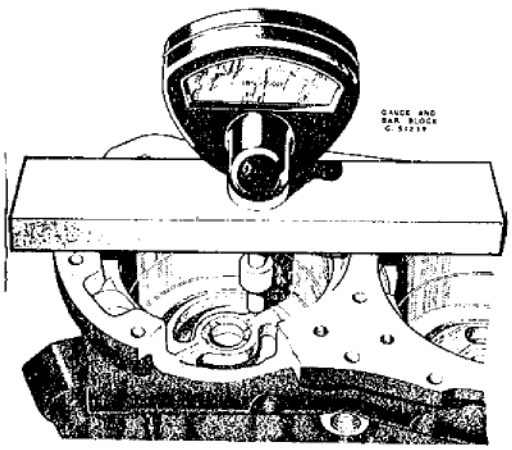

Fig. 15. Checking the parallelism of port inserts

Centrifugal make-up valve

152. The needle valve at the end of the screw must be free from corrosion and indentations. Examine the square shaped head of the adjusting screw for damage and ensure that spanner T.209311 is a good fit. Check the 2 B.A. threads for serviceability and freedom in the union body.

153. The hexagon flats of the union body must be regular and the wire locking holes clean and serviceable; ensure that the machined recesses for locating seal washers are clean. The axial bore and the two opposed holes must be free from any restriction, both internal and external threads must be checked for general condition and fit.

Pump body

154. Traces of joint gaskets and rubber seals must be removed to leave the casting clean. Examine carefully for bruising of the casting and if severe, effect a porosity test to ascertain serviceability.

155. Check all studs for security, height and freedom from damage. Observe that the threaded inserts are tight, not proud of the locating face and the threads sound. Spot faces, particularly around plug thread tappings must be examined for signs of damage, which could be a source of leakage.

156. Check the non-return valve bodies for security, and the areas around the valve seats for signs of cracks, scores, and other indentations.

157. The centrifugal make-up valve and the two servo orifice locations must be inspected for serviceability and general cleanliness, communicating ports must be clear.

158. Examine the rotor bores for condition, any signs of rotor fouling being investigated; the faces for the port inserts are diamond turned surfaces and must be free from indentations or erosion.

159. The centrifugal rotor bore should be free from score marks and signs of shaft interference, location points for seals should be carefully checked for sharp edges likely to cause damage. Check that the fuel inlet port to the bore is clear.

160. Inspect the servo piston liner bores for fretting and sharp edges around the machined grooves for the rubber type seal washers. If the liner is fitted check for cracks and flaking of the protective plating.

161. Inspect the servo control piston rod bores for scoring, check the clearances of the piston rod diameters and the pump bores with the limits stated in the Schedule of Fits and Clearances. Check the felt washer location for cleanliness.

Camplate housing

162. Carefully inspect for any bruising or outward signs of damage to the casting. Check all studs for security, correct height and condition of the threads; the threaded inserts of the end sections, must be flush with the face, secure, and the condition of threads serviceable.

163. Examine all joint faces for damage including burrs or indentations which could be a source of leakage, remove any sharp edges. Ensure that no seal drainage drillings are obstructed.

164. Inspect the bores of the two camplate locations, for fouling and other damage. Temporarily fit the camplates, with the trunnion bearing blocks, in the housing and check for free movement.

165. Observe that the centrifugal rotor bore is clean and free from score marks. Examine the three seating locations for condition and freedom from sharp edges; check the ball bearing housing dimensionally to the figures stated in the Schedule of Fits Clearances and Repair Tolerances.

End cover

166. Examine the joint face to the camplate housing for damage, see that the face is clean and smooth without adherence of the old joint gasket. Check that the seal drain drillings are free from obstruction and ensure that the plug seals to the drillings are secure.

167. Examine the spot faces, and around the stud clearance holes, for distortion and cracks. Check the studs for security, height, serviceability of the threads and squareness. The contour of the cone and boss, for locating the bearing sleeve, must be free from score marks.

168. The bore of the end cover must be clean and smooth; check that the seatings for the seals, bearing and circlip are free from damage and sharp edges.

Bearing sleeve

169. Check that the sleeve is square and that there is no distortion of the locating face to the end cover. Inspect the six spot faces for cleanliness and elongation of the clearance holes. The boss section is a smooth finish and should be carefully examined for score marks; the end section is threaded and must be free from damage. The bore must be clean and the cone seating smooth and regular. Test for cracks by subjecting to a magnetic crack detection test.

GEAR ASSEMBLY

Bearing ring (Upper pump)

170. The bearing ring and gear wheel of both assemblies are machined together and must not be interchanged.

171. Check the jointing face to the gear wheel, for distortion and the six holes for elongation. Inspect the race bore for a smooth finish and sharp edges.

Bearing ring and governor drive gear (Lower pump)

172. Inspect the bearing ring as described in the previous para. also the attached gear wheel for tooth damage such as chipping, ensure that the gear formation is regular and that no cracks exist at the roots of the teeth.

Main drive gear

173. Check the surface finish and gear formation for damage. All gears must be closely inspected for cracks, particularly at the root of the teeth by using a magnetic crack detector. Also, inspect the teeth for signs of heat discolouration, chipping, burrs, high spots and wear.

174. Check wear of the teeth for excessive backlash, refer to para. 252. The fitting of the gear to the bearing ring must be examined for alignment and assembly marks must correspond.

175. Examine the internal splines for damage, carefully stone any sharp edges and check the fit with the rotor quill shaft.

176. The bore for locating the ball bearing outer race should be viewed for any distortion and damage to the seat. A dimensional check must be made of this diameter to ensure satisfactory clearance with the bearing.

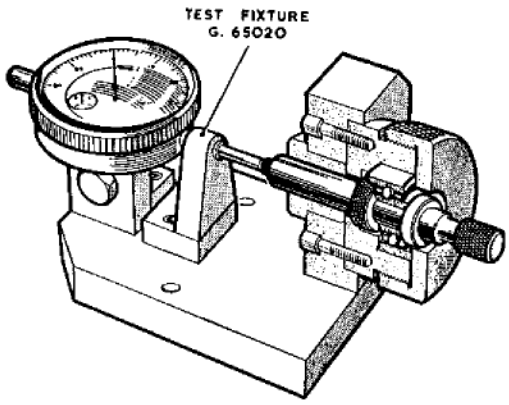

Fig. 16. Checking centrifugal rotor ball bearing end-float

BALL BEARINGS

177. There are two types of ball bearings used in this pump, a large double row bearing for the main drive gear wheels and a smaller single row being for the governor drive gear.

178. The races must be inspected on visible surfaces and the balls checked for corrosion, a defective race must be renewed. Examine internally and externally for wear and picking up, badly pitted rings must be rejected and replaced by a new race. Check dimensionally the outside diameters of the ball bearing races with the figures obtained from the bearing rings of the large bearings and the camplate housing for the small bearing.

Checking the bearing end-float

179. Both types are checked in a similar manner, the only difference being that gauge G.65019 is used for the large bearings and gauge G.65020 (*fig.* 16), for the small bearing.

(1) Mount the bearing on the two piece mandrel and tighten so that the two collars are firmly located either side of the inner race. Fit the mandrel to the gauge bracket arm and secure with a large knurled nut which contacts the bearing outer race but allows clearance to the mandrel.

(2) Set the plunger of the dial indicator at the other end of the gauge block to contact the protruding end of the mandrel. Push the knurled handle of the mandrel firmly forward, towards the dial indicator and set the clock to a datum. Pull the mandrel back and note the reading of the clock, this must not exceed 0·006 in.

Remaining details

180. Carbon-faced seals are used in several of the pump assemblies, it is most important that a good track exists, check for cracks and satisfactory adhesion of the carbon ring by applying a tension load by hand.

181. Before fitting any new rolled rubber type seals, carefully check and avoid the peeling away of small string-like edges. Check circlips for cracks and distortion; shim washers and abutment rings for cleanliness, freedom from indentations and sharp edges. Other small components must also be examined.

ASSEMBLING THE SUB-ASSEMBLIES

182. When fitting sealing rings to cylindrical strainers, use the sheath T.268371.

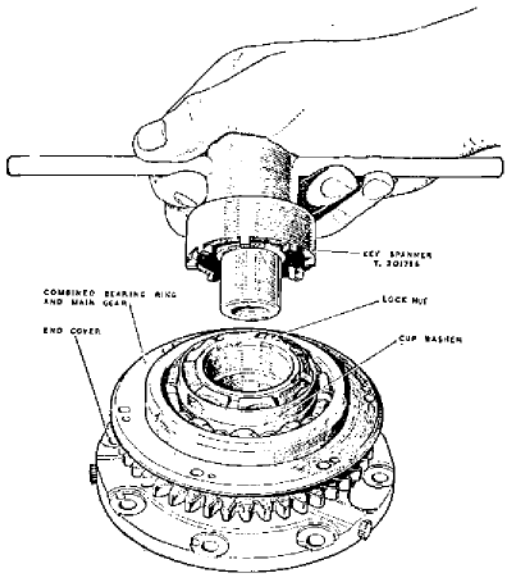

Fig. 17. Securing end-cover bearing race to bearing sleeve

END COVER

Bearing sleeve assembly

183. Mount the end cover (64) on fixture T.201735 (*fig.* 5), and secure with slave washers and nuts. Screw the large knurled nut, which is part of both assembly and

extractor tool, on to the threaded section of the bearing sleeve. Offer the bearing sleeve (63) squarely to the end cover casting and mount the spindle piece of the assembly tool to pass through the centre of the knurled nut, bearing sleeve and end cover to locate with the threaded section in the base of the fixture. The other end of the spindle has a T-shaped handle and the centre boss butts against the knurled nut. Ensure that the bearing sleeve is positioned to give clearance from the end cover studs when the sleeve is correctly located. Tighten the T-handle of the spindle to press the bearing sleeve home.

184. Place a new tabwasher over each of the six end cover to bearing sleeve locating studs. Secure with 2 B.A. nuts and lock with tab-washers. Remove the assembly tool.

Bearing ring assembly

185. Assemble the gear, ball bearing race (61) to the bearing ring (62) of the upper pump assembly. Also, assemble the gear ball bearing race to the combined governor drive gear and bearing ring (56) of the lower pump assembly. Locate both assemblies on to their respective bearing sleeves. Mount the large cup-washer (60) in position over the bearing and secure the assembly with the serrated lock nut (59), using spanner T.201736 (*fig.* 17) closing the cup washer with tool T.228558.

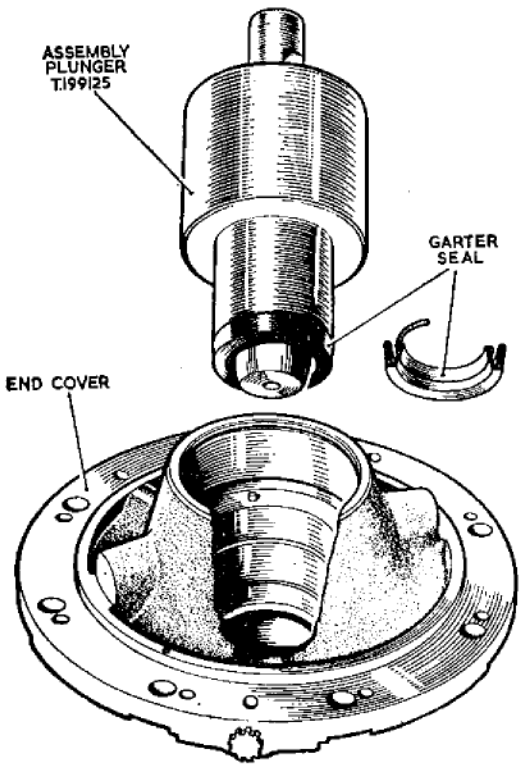

Fig. 18. Inserting garter seal in end cover

Fitting the end cover seals and carbon bearing

186. Remove the end cover from the fixture and position it with the rotor bearing bore location uppermost. If a locating dowel is to be fitted, insert by using punch T.268379 and a hammer. Ensure that no burrs exist on the dowel after this operation.

187. Place the washer (65) in the base of the end cover. Fit the garter seal (66) with the narrow section against the washer by placing the seal on the lip of the assembly plunger T.199125 (*fig.* 18). Mount the plunger into a hand press and correctly position the end cover on the press base plate. Lower the ram block with the assembly plunger, and the garter seal into the end cover bore and withdraw the plunger leaving the seal behind in the housing. Remove the end cover from the press base plate.

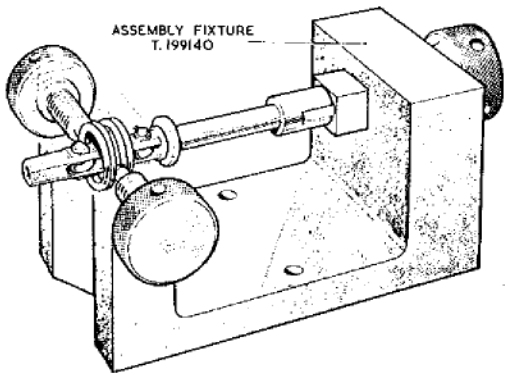

Fig. 19. Assembling the diaphragm spring anchor

188. Locate the spring cup (67), correct way up, against the garter seal. Complete the assembly by positioning the spring (68) and the other spring cup (69), (the latter being fitted in the reverse manner to the first spring seat, thereby forming a semi-spring cage). Assemble the carbon-faced seal assembly, with the rolled rubber seal

ring (70) around its outside diameter, by using the compressing tool T.271067.

189. Push the carbon bearing 'home', (this is only a push fit), and ensure that the locating groove of the bearing is positioned correctly over the dowel peg (50). Secure the circlip with standard circlip pliers.

OVERSPEED CONTROL UNIT

Bell housing governor spring

190. If the bell housing (117) has been removed, refit by placing the rubber seal (2) in the locating recess of the diaphragm cover casting and secure the housing in position with six 2 B.A. set screws from the inside of the casting, the spring housing being threaded to receive them. Fit a plain washer beneath each setscrew head, tighten all set screws and wire lock the hexagon heads with 24 s.w.g. stainless steel wire.

191. Screw the diaphragm air bleed valve (1) assemble into the casting, with a washer positioned beneath the hexagon. Tighten with a standard box-spanner.

Diaphragm assembly

192. Fit the rubber seal ring (7) on to the shoulder at the base of the combined spring anchor and diaphragm centre (11). Insert the spring anchor through the centre of the diaphragm so that the seal washer is interposed between the base of the spring anchor and the diaphragm. Fit the tappet adjusting screw (12), with a tabwasher into the threaded base and leave the tabwasher locking until the final adjustment on rig.

193. Position the control spring eyelet between the fork of the combined spring anchor and diaphragm centre and push the link pin (9) through, fit a washer on the protruding link pin and secure with a split pin.

194. Extend the free end of the spring, with tool T.199140 (*fig.* 19) and fit the spring anchor (116), this is secured in exactly the same manner as stated in the previous paragraph, then release the tool.

195. Place the joint gasket and the diaphragm spacing ring (5) against the diaphragm cover casting. Push the diaphragm assembly against the spacing ring with the overspeed control spring locating in the bell shaped housing. Ensure that the spring anchor stem slides freely in the cover guide.

196. Fit the seal in the recess on the top of the spring housing then fit the cap nut and insert the spring tension screw (119) through the spring housing cover to pick up the threaded section of the upper spring anchor, using tool T.160988.

Amplifier valve housing

Note . . .

Check the centralization of the centrifugal rotor before assembling the amplifier valve housing (*para.* 215).

197. Fit a rubber seal washer on each plug, and thread tool T.201754 into the tapped centre of the plug, then push each plug firmly into its recess. Unscrew and remove the tool.

198. Lower the rocker lever plate and orifice assembly (14) over the four protruding studs in the base of the housing. The torsion hinges must not be used as leverage points to force the plate over the studs. Two tappings are provided on the rocker plate and by inserting a 2 B.A. set screw into each of them the plate may be lowered carefully over the studs. Remove the set screws. Fit a tabwasher over each housing stud and secure with 2 B.A. nuts and lock with the tabwashers.

199. Fit a strainer assembly with a rubber seal washer (100) to the two servo pressure connecting points of the housing.

200. Turn the amplifier valve housing so that the face to the pump body is uppermost, locate a spring (16) and a carbon face seal (17) with rolled rubber seal washer fitted around the shoulder into the open bore.

Assembling the quill shaft to the rotor

201. Ensure that the inner seal ring groove is clean. Smear petroleum jelly round the inner rubber seal ring and carefully fit into position.

202. Place the rotor assembly block, (*fig.* 20), consisting of tools T.190849/7, T.190849/6, T.190849/5 and T.190849/4 in position on the hand press base plate. Mount the rotor on the assembly block with the port face downwards and locating in the machined recess. The rotor axial bore is centralised by the protruding pin of the assembly block.

203. Fit the centralizing sleeve T.190849/3 to locate over the rotor small end bearing surface and carefully lower the quill shaft through the sleeve and into the rotor body, ensuring that engagement is made with the receiving splines.

204. Fit punch T.190849/1 into the hand press ram block. Lower the ram so that the brass end of the punch contacts the quill shaft, apply a load and force the quill shaft into the rotor body (a limit stop is formed inside the axial bore of the rotor). Take off the centralizing sleeve and remove the rotor from the press.

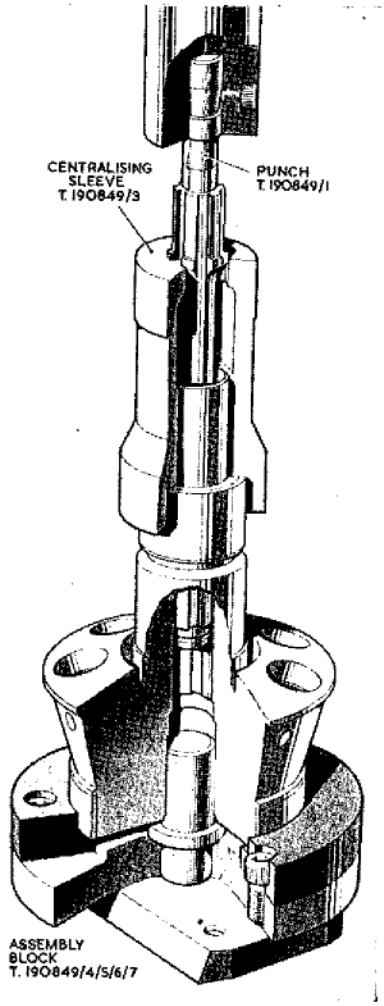

Fig. 20. Assembling the quill shaft

205. Mount the assembly on to a surface table and with a vernier height gauge, check the height from the base of the rotor to the top of the shoulder of the protruding splines, the limits are 6·3750 to 6·3825 in.

206. Mount the rotor horizontally on the gauge G.100348 and with a standard dial indicator check the concentricity of the quill shaft at its extremity. If the run-out is more than 0·008 in., the shaft should be removed as described in para. 42. Turn it through 180 deg. (in relation to the spline engagement in the axial bore of the rotor) and refit it. Again check the height and concentricity. If still unsatisfactory fit a new quill shaft and again check that the specified limit is obtained.

207. Check the inner rubber sealing rings for leakage as described in para. 131.

208. Place the rotor assembly on the locating stand T.190850 with the quill shaft facing downwards. To ensure sufficient clearance for the rotor it is recommended that the locating stand be placed on the base plate of the hand press. Lower a plain washer into the axial bore of the rotor and over the end of the quill shaft, a normal workshop scriber will assist in the positioning. Fit the outer rubber seal and plain washer.

209. Put the quill shaft retaining jump ring on to the small end of the tapered pin T.190849/9, locate the hollow drift T.190849/8 over the tapered pin thereby forming an outer sleeve. The combined tool, comprising tapered pin and hollow drift, is inserted into the axial bore of the rotor to contact the end of the quill shaft.

210. Place the whole assembly under a hand press, bring the ram block down to contact the drift and apply a sharp load, forcing the drift down the tapered pin and spreading the jump ring out into the machined groove of the quill shaft.

211. Lift the rotor off the press and again check the concentricity and height of the quill shaft. Re-check the quill shaft rubber ring seals with the pressure test (para. 131).

Servo piston

212. The servo piston and control rod (98) are integral. A drilling in the piston head

locates a shrunk plug-insert which forms a stop for arresting the piston movement. On earlier pumps the plug insert is an interference fit and is replaced by using a suitable drift and hand press.

213. Place the servo control rod uppermost and ease the piston seal (96) with the split section facing the operator on to the piston, but below the head. Fit the seal retaining ring (95) to spread the seal and secure with a circlip, ensuring that it is seated correctly within the retaining groove.

MAIN ASSEMBLY

Camplate housing

214. Fit the trunnion blocks (42) complete with camplate (44) into the housing. Check the clearance between the trunnion blocks and the pivoting shoulder of the camplate with a feeler gauge, the total clearance should be between 0·004 in. and 0·012 in. If this clearance is not obtainable recheck the fit of the trunnion blocks within the housing, if this is not satisfactory, light stoning on the trunnion block end faces should suffice. Dismantle when satisfactory.

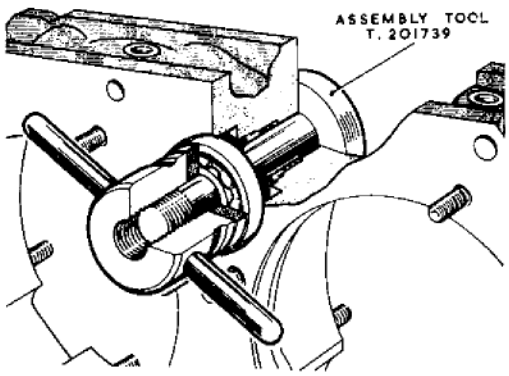

Fig. 21. Fitting the governor rotor bearing

Centralization of the governor rotor

215. Attach the camplate housing with joint gasket (32) to the pump body, and secure with slave washers and nuts. From the pump body end fit the rotor (18) into the bore so that the splined shaft protrudes from the camplate housing. Temporarily fit tool T.212169 into the centrifugal bore of the camplate housing.

216. Fit the amplifier housing gasket (23) in position over the pump body studs and install the housing (99), without the rocker lever and orifice assembly. To enable the stud threads to be effective use spacing washers.

217. Mount the whole assembly in the horizontal position. Locate a depth-gauge micrometer from the amplifier valve housing so that the spindle will contact the centre of the rotor. Push the rotor forward and take a reading from the micrometer, (position A). Reverse the load on the shaft by pushing rearwards so that the rotor is fully back, hold firmly in this position and take a further micrometer reading (position B).

218. Remove T.212169 and fit into the bore a spring, carbon-faced seal assembly with a rolled rubber seal beneath the head, abutment ring with a sealing ring fitted on the inside diameter, a shim washer and again tool T.212169. Secure with a circlip. A choice of three sizes of shim washer is available; select the correct thickness by trial as detailed in the following para.

219. Fit the pinion and bush assembly, slave cup washer and the lock nut and secure with spanner T.201749. Again, push the rotor forward and take a reading with the depth micrometer (position C). Reverse the load on the rotor, i.e., push the rotor in the opposite direction, and again take a micrometer reading (position D). Dimensions C and D must be between A and B but not within 0·010 in. of each other. Check, by taking C from A and B from D.

Example Figures (these must not be taken as a means of reference).	A = 1·944 in.
	B = 1·871 in.
	C = 1·920 in.
	D = 1·908 in.

A − C = 0·024 in; D − B = 0·037 in. which shows that the appropriate shim was used.

220. Remove the slave nuts and spacing washers from the amplifier housing then lift the housing clear from the studs, With spanner T.201749 remove the pinion nut and slave cup washer. Apply a light blow to the rotor shaft and remove the rotor from the pump body, leaving the centrifugal pinion and bush assembly behind. Remove the circlip holding tool T.212169 and lift the tool from the bore. Detach the camplate housing from the pump body.

Fitting the governor rotor bearing

221. Place the camplate housing vertical on the bench. Locate the bearing (51) into position with the bore of the housing. Mount the spindle piece of tool T.201739 (*fig.* 21) through the rotor bore from the body face end so that the base of the spindle contacts the housing. The end of the spindle is threaded and should protrude through the centre of the bearing race. Screw the T-shaped threaded boss on to the spindle to tighten so that the boss will contact the bearing and press into the housing bore. Secure with circlip.

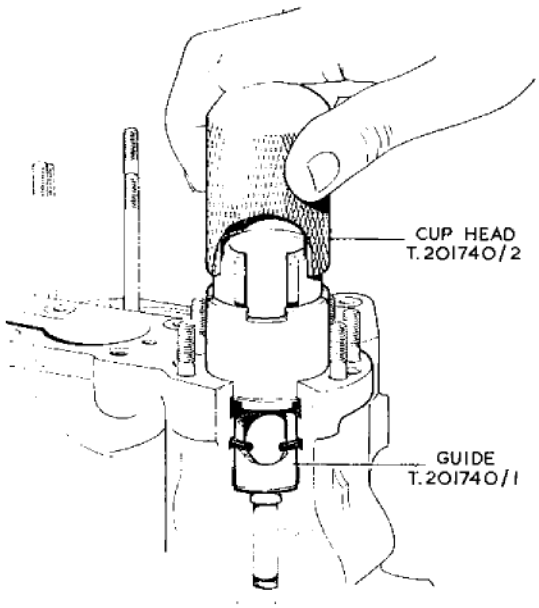

Fig. 22. Fitting servo liner inserts

Fitting the end cover

222. Each end cover is secured by eight studs to the camplate housing. Position the gasket (72) and fit the covers to the camplate housing. Fit tabwashers and nuts, tighten them with a box spanner, and finally with a torque spanner, fitted with the adapter T.290954, to 24 lb/in².

PUMP BODY

Fitting the servo liner insert

223. Place the pump body vertically on the bench with the servo liner bores facing upwards. Smear the liner sealing ring (90) with petroleum jelly and locate in the machined recess of the liner bore. Position the guide of assembly tool T.201740 (*fig.* 22) into the bore and centralise by positioning the smaller end section of the guide into the control rod housing. Place the liner (92) over the guide, locate the knurled cup head of the assembly tool over the guide but on to the top edge of the liner insert and press the liner firmly 'home'. Remove the assembly tool.

Fitting the servo piston sub-assembly

224. Locate assembly sleeve T.201742 over the servo liner bore with the end section entering the bore to form a continuation of the liner diameter. Place a felt washer in position in the piston rod bore of the pump body and expand it into its groove by using tool T.241658.

225. Lower the servo piston sub-assembly carefully through the sleeve into the liner.

Fitting the fuel delivery non-return valve

226. With the pump still in the vertical position, fit the non-return valve (91), spring (93) and guide (94) into the fuel delivery port, with the sleeve fixed; secure with circlip.

Fitting the inter-connecting rotor bore strainer unit

227. Reverse the position of the pump body so that the rotor bores are now uppermost. Place a rolled rubber seal washer into the countersunk bore of the drilling connecting the two bores and install the strainer unit (37), lock with circlip.

Fitting the fuel port insert

228. Fit into the recess in the centre of the rotor bore a washer, spring (85) and strainer unit (84). Check the dowels in the base of the rotor, for the port insert and rotor carbon bearing, for security. Carefully locate the kidney shaped fuel port insert (83) over the dowel, using no excess pressure and locate the copper retaining spider (33) over the insert.

Fitting the carbon bearing

229. Fit the carbon bearing (34) into the rotor bore, and press it into position over the dowel. Secure it with the circlip.

Checking the auxiliary camplate lift

230. Fit the rotor assembly into the pump body, assemble the thrust ball spring (39), spring seat (40) and suitable shims (77), also, the thrust ball (41) with auxiliary camplate (43) to the rotor (81) and locate on the top of the shims.

231. Install each piston and slipper assembly (74) through the auxiliary camplate into the correct rotor piston bore. Mount the camplate and trunnion blocks into position and secure the blocks to the pump body face with slave reach screws, T.206867.

232. Fit the fuel adjustment screw (30) into the pump body to contact the camplate. Set the camplate angle at 15 deg. and lock the adjustment screw, using plate gauge G.61523 (*fig.* 23) for this projection.

233. Check the lift of the auxiliary camplate using gauge G.61524 shown in fig. 24. Secure the gauge in position on the rotor shaft extension, with clamp screw. Lift the rods clear of all contact and mount the clock dial indicator to just touch the head of the depressed gauge block pins, and set the clock gauge to a datum point.

234. Depress the arm locating the rods and, forcing the auxiliary camplate down, take a reading from the clock gauge, this must be within 0·002 in. to 0·007 in. If adjustment is necessary, shim as required beneath the thrust ball.

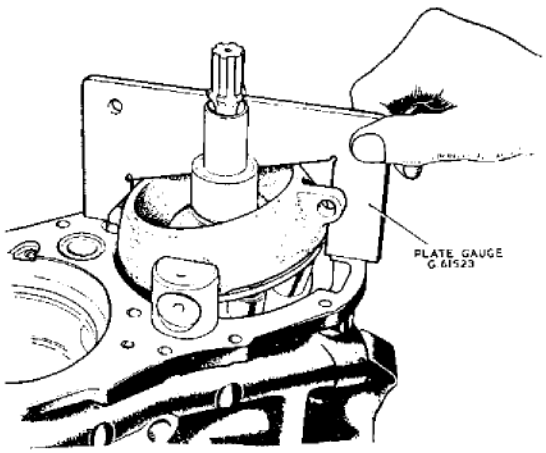

Fig. 23. Checking the camplate angle

235. Reset the camplate to the neutral position and check the amount of lift, in this position. Remove the camplate with trunnion blocks, (release slave reach screw) lift the complete rotor assembly from the pump body, and remove the pistons, springs and spring seats.

Fitting the rotor assembly

236. Fit a spring guide (80) using tool T.201770 or T.285737 (*fig.* 25), into the rotor piston bores, fit a spring bore and refit the pistons. Lower and upper pump assemblies are identical except for the piston springs, these are coiled in opposite directions. It is essential that the springs are not interchanged between the rotors. The upper pump is R.H. rotation and is fitted with the R.H. helix angle springs; the lower pump is L.H. rotation and is fitted with the L.H. helix angle springs.

237. Fit the camplate, trunnion blocks attached, over the rotor and install tool T.253858 on to the rotor quill shaft. Push down hard to compress the piston springs and lock the tool. Locate the assembly

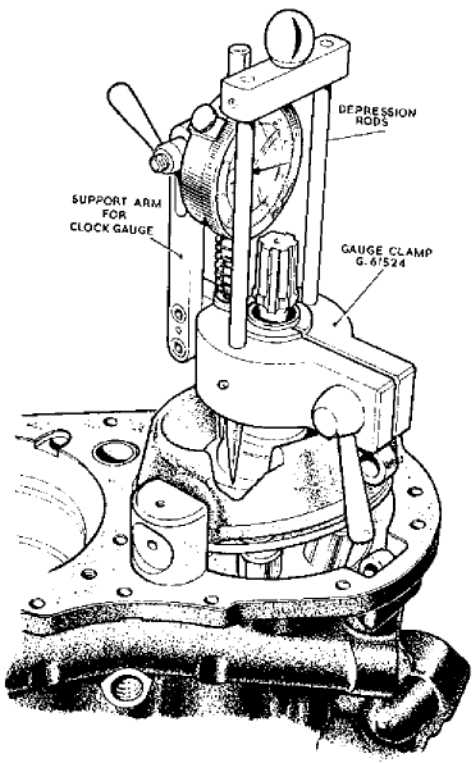

Fig. 24. Checking auxiliary-camplate lift

into the pump body and secure the trunnion blocks with reach screws T.206867. Remove the tool T.253858.

Connecting the servo piston control rod

238. Slide the link connecting fork (76) over the piston rod and align the drilled holes; note that one side of the fork is recessed to contact the shoulder of the link bolts (75) thus preventing rotation. Push the bolt through the fork and rod and fit the tabwasher and nut. Adjust the attached fork and piston control rod to align with the drilled lug of the camplate, push the link bolt through the two components ensuring that the head of the link bolt engages within the recess of the fork. Fit the tabwasher and nut, tighten both connections and lock the tabwashers.

239. On later types, slide the link over the piston rod and align the holes. Fit the dowel into the pin and push the pin through the link. Fit the other pin to the camplate in a similar manner. Use tool T.260330 to check that the link is locked.

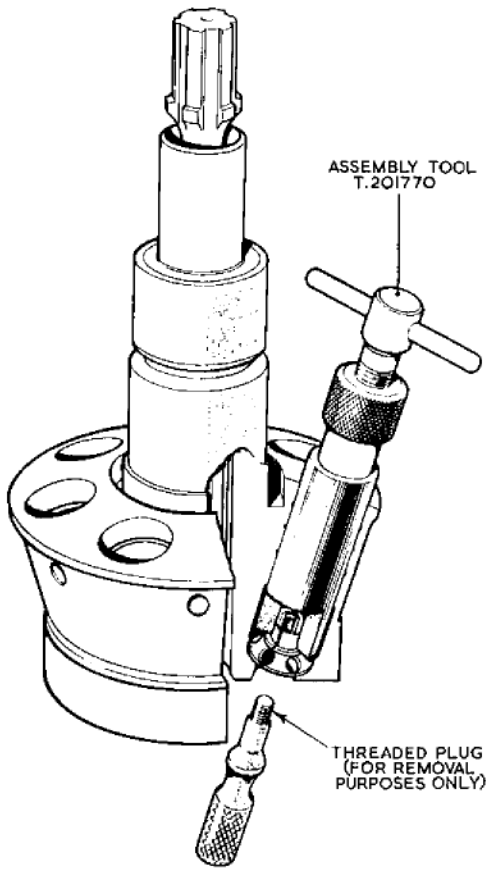

Fig. 25. Fitting or removing piston-spring guides

Setting the camplate minimum angle

240. Move the camplate to the neutral position, and check the clearance between the servo piston head and the stop screw in the cover with gauge G.61525 (*fig.* 26).

241. Using the gauge block as a transfer gauge, check the clearance with feeler gauges, the limit is 0·000 in. to 0·006 in. towards the working position, adjust by fitting shims beneath the head of the stop screw. When the clearance is satisfactory, tighten the stop screw and lock the tabwasher. Recheck after locking.

Fitting the servo piston cover plate

242. Reverse the position of the pump body so that the servo piston bores are uppermost. Place rubber seal washers on to the blank and transfer bobbins, then fit into the body face, and install the springs on to their piston head location. Fit a rolled rubber sealing washer (108) round the inner shoulder of the cover casting and position the cover (104 or 109) on to the protruding springs, push to compress and clear the studs. Secure the cover to the eight studs with plain and grover washers and nuts. Note that the solenoid servo valve assmbly (109) forms the cover for the upper pump unit.

Fitting the servo pressure supply orifice

243. Place the pump body horizontally on the bench. Install the strainer unit (86), with a small rolled seal washer round the base shoulder, into the bottom of the drilling for the pressure supply orifice. Fit the pressure supply orifice body (88) with a rolled rubber seal washer in the recess around the bottom shoulder, over the small pip of the strainer and locate the pressure supply orifice retainer into the top of the drilling to form the cover plate. Fit a plain and grover washer under the heads of two setscrews which secure the cover plate.

Fitting the centrifugal make-up valve

244. Using the sheath T.245434, place a plain rubber seal beneath the hexagon of the centrifugal make-up valve body and screw firmly into the body casting. The

inside diameter of the body is threaded to receive a tapered adjusting screw, this screw is locked and a dome nut fitted after calibration.

Fitting the camplate housing

245. Place the pump body vertically on the fixture with the quill shafts facing uppermost. Fit a rolled rubber seal (31) into the recess at the top face of the centrifugal rotor bore and place the tapered assembly sheaths, tool T.201748, over the quill shafts, smear with petroleum jelly. These sheaths are to prevent damage to the carbon bearing and garter seals when the camplate assembly is fitted.

246. Position the joint gasket over the camplate housing studs and dowel pins. Align the housing with the body and carefully lower so that the studs clear the drilled holes of the body. Fit a plain washer and slotted nut to the studs, tighten with ring spanner T.199127 and lock with split pins. Remove the assembly sheaths and the trunnion block reach screws tool T.206867, fit the $\frac{1}{8}$ in. B.S.P. plugs and wire-lock.

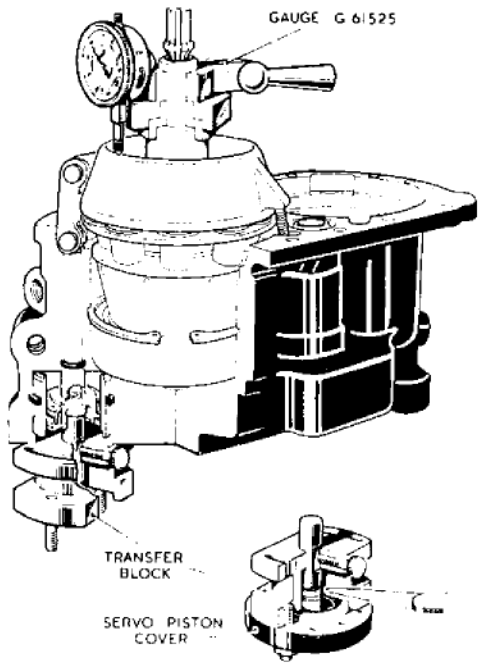

Fig. 26. Setting camplate minimum angle stop

Fitting the centrifugal rotor and pinion

247. Carefully enter the centrifugal rotor (18) into the bore from the pump body end so that the shaft is positioned through both the pump body and camplate housing.

248. Fit a shim washer (52) over the splines and slide the governor drive pinion and bush assembly (53) on to the shaft, at the same time meshing the gear with the drive gear (56) of the lower pump. Fit the cup washer (54) and serrated lock nut (55) and tighten with spanner T.201749.

249. Check the alignment of the governor gear face with the drive gear and if necessary, correct by changing the thickness of the shim washer beneath the pinion gear. Finally, close the cup washer with tool T.228558.

Fitting the gear assembly (lower pump)

250. Mount the pump vertically, with the end covers uppermost. Use tool T.289668 and assemble the governor drive gear to the main gear (58) drive, align both components with the assembly marks and secure with six nuts and bolts (57), the latter being numbered to match the holes.

Fitting the gear assembly (upper pump)

251. Assemble to the bearing ring (62), the main drive gear (58), and align both components with the assembly marks, mesh the gear with that of the lower pump and secure the gear and bearing ring with the selected nuts and bolts.

CHECKING THE BACKLASH OF THE GEARS

Lower pump gear and governor pinion

252. Check the backlash between the gear of the lower pump and the governor pinion, using gauge G.65018 secured to the engine mounting face of the camplate housing with two slave nuts and bolts (*fig.* 27). Screw in the lower of two knurled screws from the gauge block to contact between the gear teeth of the pinion and serve as a stop, lock in position with the knurled lock nut.

253. Attach the clamp arm of the gauge to the internally splined boss of the lower pump main gear drive; adjust the plunger of the dial indicator to contact the end section of the clamp arm at right angles.

254. Push the clamp arm attached to the gear wheel firmly in one direction until checked by the resistance of the tooth stop, and set the clock gauge to a datum. Reverse the direction of rotation of the

clamp arm until movement is again checked, note the clock gauge reading, this should not exceed 0·014 in. This check should be made over at least six positions.

Main drive gears

255. With gauge G.65018 attached to the engine mounting face of the camplate housing, screw in the upper knurled pin of the gauge block between the teeth of the upper pump gear drive to serve as a stop. Continue as described in para. 252 to 254.

FITTING THE AMPLIFIER HOUSING

256. Place the pump on the bench stand with the centrifugal rotor uppermost. Fit the two bobbins (97), with seals, into the respective drillings of the pump body face adjacent to the amplifier housing location. Fit the face joint gasket (23) and carefully lower the amplifier housing assembly over the studs.

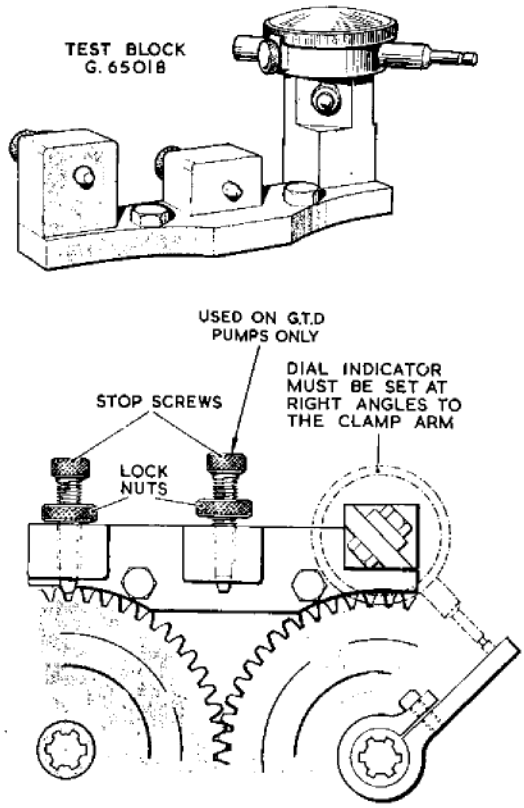

Fig. 27. Checking the backlash of the gears

Setting the tappet clearance, overspeed governor assembly

257. Before fitting the overspeed control housing, the tappet clearance must be set with transfer type gauge G.61526 which consists of two parts, a locating stand and a bridge-bar fitted with a sliding plunger.

258. Place the outer diaphragm spacing gasket (5) in position and mount the bridge-bar over the higher amplifier studs, secure with slave $\frac{1}{4}$ in. B.S.F. nuts. Release the knurled set screw and allow the plunger to contact the rocker lever tails. It is most important that the rocker levers are not depressed. Tighten the knurled set screw to lock the plunger, then remove the slave nuts and lift the bridge piece clear of the studs.

259. Mount the overspeed control assembly on one side of the locating stand and the bridge-bar on the other, location is by two knurled dowel pegs and set screws, these pass through and into the upright section of the locating stand (*fig.* 28). Check the clearance between the plunger of the bridge-bar and the tappet of the diaphragm by using feeler gauges; this should be 0·017 in. to 0·019 in.

Fitting the diaphragm cover

260. Lower the diaphragm cover assembly into position, fit a plain and grover washer over each of the six studs, fit and tighten the nuts.

Checking the height and concentricity of the gears and quill shafts

261. Fit the gauge G.63686 (*fig.* 29) on to the pump. Insert the correct dowels according to the type of pump as shown in the table, then make the following checks.

Fuel pump types GTD.3 and 16	Fuel pump types GTD. 4, 5, 8, 9, 11, 12, 14, 15, 17, 18 MGTD.19, 20, 21, 23
Dowel types 9A (9 off) 11A (4 off) 14 (1 off) 14A (1 off)	Dowel types 9B (9 off) 11B (4 off) 14B (1 off)

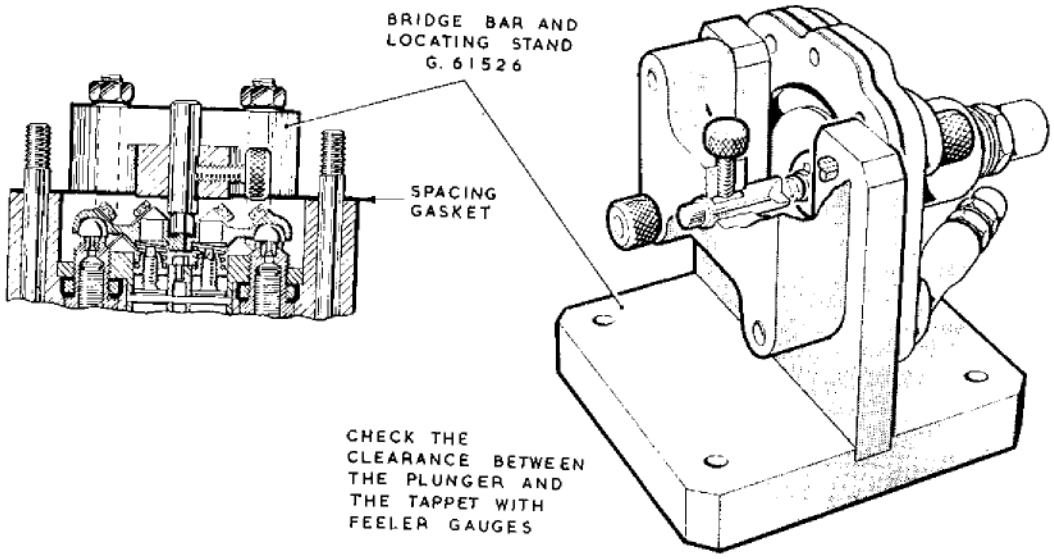

Fig. 28. Setting governor tappet clearance

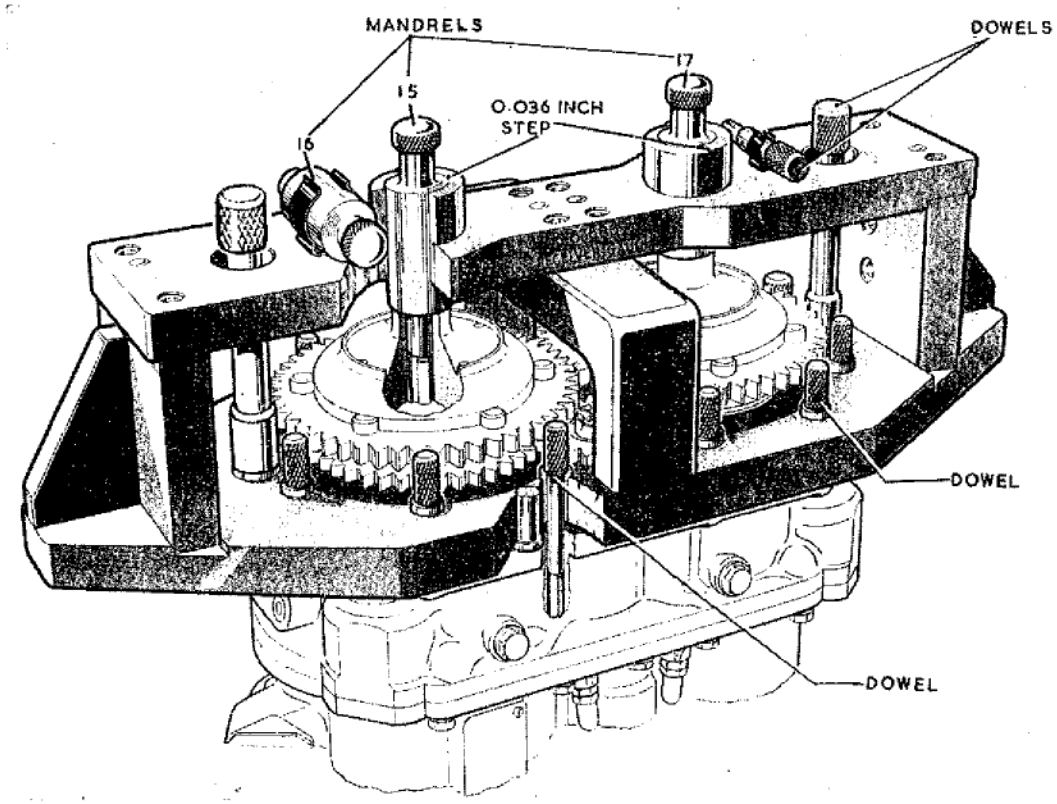

Fig. 29. Checking the height and concentricity of the quill shafts

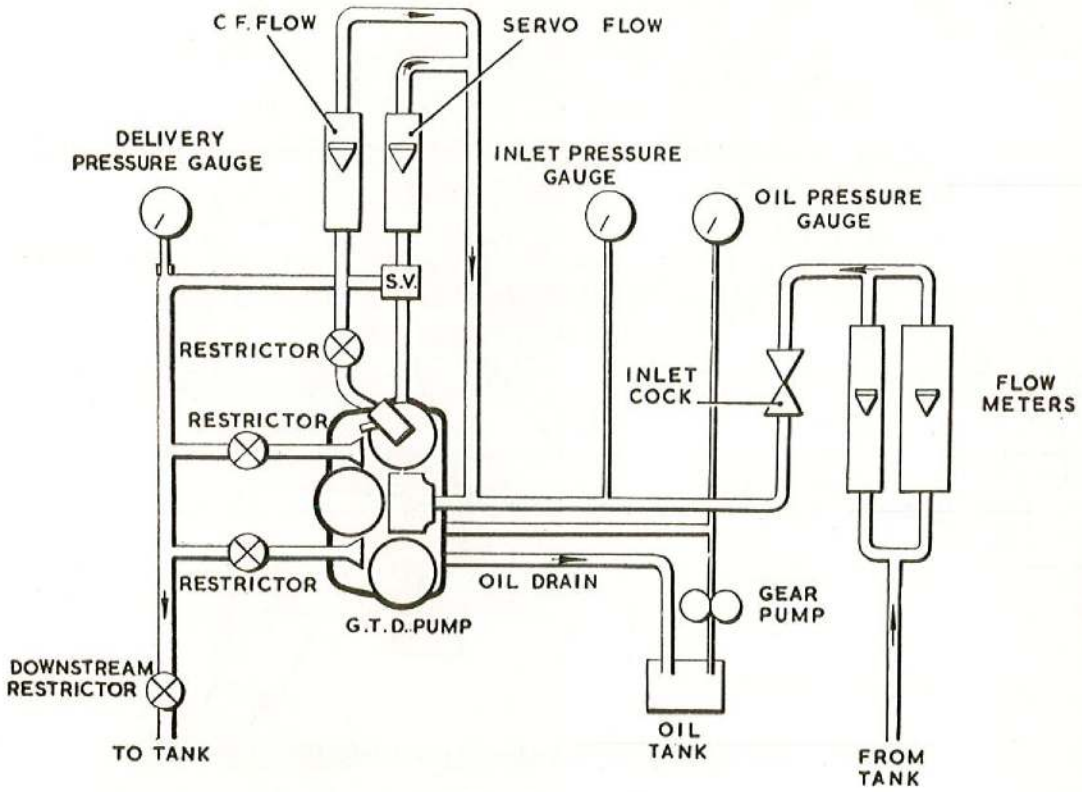

Fig. 30. Layout of test rig

(1) Concentricity.
Insert the mandrel (16) into the gears in various positions. Failure to locate the gear bores will prove malalignment.

(2) Quill shaft height.
Insert the mandrel (15) to rest on the end of the quill shaft and check that the top of the mandrel shoulder is either level with or between the steps in the gauge bush.

(3) Gear height.
Insert the mandrel (17) to rest on the end of the gear boss and check that the shoulder height is level with or is between the steps in the gauge.

Failure of the pump to meet the requirements will necessitate removal of the gears and rotor assemblies for detailed inspection.

RIG TESTING (PRELIMINARY)

262. The following test and calibration procedure is applicable to all derivations of the basic type of pump covered in this chapter. Specific test conditions and performance requirements vary with different calibration codes, details of which are provided in Appendices to this chapter. Before attempting to run a pump on the rig, the fuel inlet cock must be opened and all air must be released from the pump by means of the air bleed valve situated in the diaphragm cover casting, Item 1 of fig. 34. The valve should be allowed to spill fuel until all signs of air bubbles have disappeared.

Test rig adapters

263. The pump must be fitted to the test rig connections with adapters in place of the normal installation fittings. A dual inlet fuel adapter and two separate fuel outlet adapters are used. These adapters are listed under tool T.201758 (*fig.* 31). To isolate either pump, adapter T.206866 must be screwed into the appropriate servo pressure tapping.

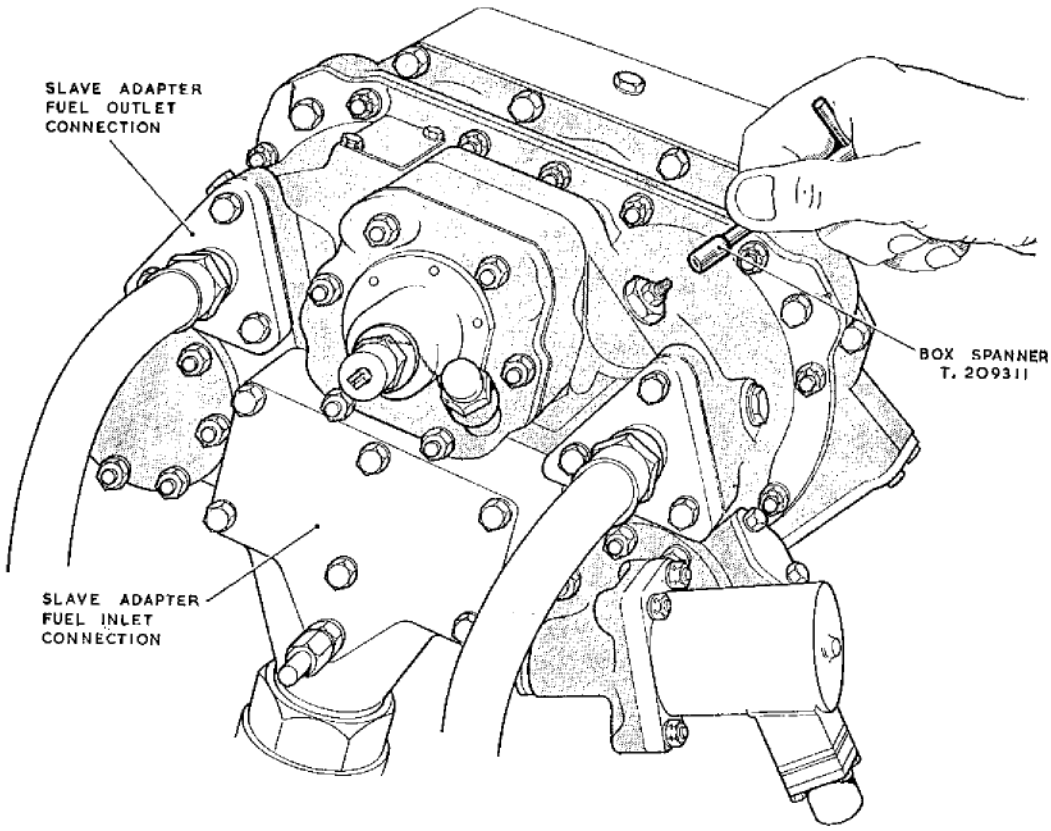

Fig. 31. Test rig adapters, and adjusting centrifugal make-up valve

Running in

264. The pump must be mounted on the test rig and operated at the conditions stated in the relevant appendix.

Preliminary calibration

265. Before proceeding with the initial endurance test, the pump must be calibrated sufficiently to ascertain satisfactory functioning. This entails setting the maximum stroke, checking the volumetric efficiency, setting the governing speed and checking the governor range.

Straight endurance test

266. Run the pump at the conditions stated in the appendix, this consists of two periods with the pump at full stroke, and constant speed but under different delivery pressures. A further period of running is effected with the fuel temperature raised.

Cyclic endurance test

267. Cyclic endurance test the pump under two different stall conditions, the number and period of the cycles being regulated as specified in the appendix.

Governor endurance test

268. Endurance test the pump governor by running to the conditions given in the appendix. Vary the pump speed to exercise the governor for the required number of cycles.

Starting test

269. Effect a number of starts from rest to idling according to the conditions in the appendix. If necessary adjust the pump to the correct idling conditions before commencing the test.

Performance check

270. Check the volumetric efficiency (para. 282), the governor operating cycle, recovery time, synchronization, servo flow and external fuel bleed.

Leakage tests

271. Check the pump as detailed in para. 293, 294 and 296.

Self priming test

272. The pump must produce the required inlet pressure when running with a closed fuel inlet at the conditions given in the appendix. All connections on the pump must be tight and the pipelines free from leakage when performing this test. The duration must not exceed 1 minute.

STRIP INSPECTION

273. Partially or fully dismantle the pump for inspection, the extent being at the discretion of the Inspection Authority according to the condition of the pump and the behaviour of the unit during the initial endurance test. Components referred to in para. 70 must be crack-tested if a defect is suspected.

CLEANING

274. Clean all components thoroughly in kerosine, preferably applied by a spray nozzle fed by a pump having adequate filtering facilities. After cleaning, the parts should be dried in a compressed air blast which must be free from water.

FINAL ASSEMBLY

275. All internal locking of the tab-washers, split pins, etc. must be completed at this stage except for those which may require adjustment during final testing.

RIG TESTING (FINAL) AND CALIBRATION

276. The first test comprises a second preliminary calibration, (para. 265), setting the stall pressure, solenoid isolating valve endurance test, second pressure test.

Governor endurance test

277. Repeat the governor endurance test described in para. 268.

Setting the stall pressure adjustment

278. Set the stall pressure and check at the conditions given in the appendix. Adjust to the values required by inserting spanner T.193939 into the aperture of the appropriate amplifier valve rocker lever and rotating the adjusting screw clockwise to increase or anti-clockwise to decrease the setting.

Setting the maximum flow adjustment

279. Adjust the rig to provide the speed and delivery pressure stated in the appendix. Open the centrifugal make-up valve with spanner T.209311, (*fig.* 31) to pass the required flow. Screw out the maximum flow adjusting screw of each pump in turn until the specified flow is obtained, tighten the locknut and reduce the pump speed to idling conditions and record the flow.

Setting the minimum flow

280. Isolate the servo pressure of one pump by screwing test rig adapter, T.206866 into the appropriate tapping of the pump, remove the servo restricting orifice and fit a blank. Run the pump to the speed stated and close each fuel outlet restrictor, ascertain that the delivery pressure is within the limits. Reduce the speed of the pump to idling speed and check that a positive delivery pressure is obtained.

281. Should adjustment be necessary, remove the servo end cover casting and adjust the shimming beneath the stop screw as required.

Testing the volumetric efficiency

282. Check the volumetric efficiency of the pump by closing the centrifugal make up valve and running the pump at the stated speed and the alternate low and high delivery pressures. The flow difference must be within the limits stated. Open the centrifugal make-up valve to the previous setting and record the efficiency.

Checking the governor range

283. Check the governor range by running the pump at the conditions given in the appendix and varying the setting of governor adjusting screw, using spanner T.160988.

284. Run the pump at the lower limit of the range and rotate the governor adjusting screw clockwise if the governor operates before the specific speed is obtained, or, anti-clockwise if the governor has not operated. Operation of the governor is denoted by a rapid decrease in delivery pressure.

285. Increase progressively the pump speed to the high limit of the range, altering the governor settings to cater for the conditions.

A t each point, check that the governor is operating satisfactorily by decreasing the speed and then returning to the set governor position. Repeat this check several times.

Checking the governor cycle

286. Check the governor cycle by running the pump at a given speed and delivery pressure, point A. Increase the speed of the pump until the governor operates and the delivery pressure falls to a stated value, point B. Increase the pump speed still further to reduce the delivery pressure below that of point B, then reduce the speed until the delivery pressure (point B) is again obtained, point C. Continue to decrease the speed of the pump until the original delivery pressure is re-established, point D.

287. When increasing the speed from point A care must be taken that the sudden reduction in load due to governor operation, does not create an excessive speed. Throughout the governing cycle the conditions obtained must conform to the values of points A, B, C and D specified in the appendix.

Checking the governor recovery time

288. In conjunction with the above test check the recovery time from point C to point D. Repeat several times to ensure that the time period does not exceed that stated in the appendix.

Governor synchronisation

289. Set the pump to run at point A conditions with each rotor, i.e., upper and lower pump, delivering through a separate rig restrictor. Increase the speed and note the governing speed from each pump, this must be within the limits stated.

Setting the governor servo supply orifice flow

290. The servo flow from each pump must be set to pass the required amount. Connect the servo flow to suction, run the pump at the speed and delivery pressure stated, and measure the flow. Adjust if necessary by fitting an alternative size of servo pressure supply orifice.

Checking the governor, with external fuel bleed

291. Connect the centrifugal flow from the camplate bleed point back to pump inlet and run the pump at the conditions stated for point A of the governor cycle. With the centrifugal flow passing the stated amount observe that the governed speed does not vary beyond the specified limits.

Solenoid endurance

292. Endurance test the solenoid operated servo isolating valve by stalling the pump as stated in the appendix. No leakage through the valve is permissible.

Fuel leakage test (pump assembly)

293. Wipe dry the exterior of the pump and subject the unit to a running and static test, at the conditions stated in the appendix. No external leakage is permitted other than from the seal drains.

Pressure test (oil seals)

294. Pressurize the seals of the end covers and the centrifugal rotor bore by applying a fuel boost pressure to the seal drain connection, the pump running at the specified conditions. No leakage is permitted.

Porosity test

295. Remove the pump from the test rig, drain it, then fit the components of the test fixture T.299368 (*fig.* 32). Connect an air supply at E, submerge the pump in a kerosine bath and apply the pressure given in the appendix.

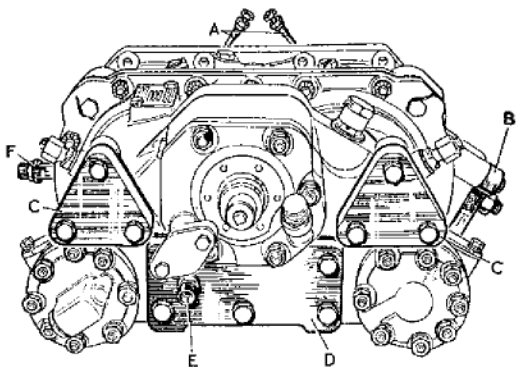

Fig. 32. Porosity test fixture T.299368

A — End cover, screwed plugs with sealing rings.

B — Drain connection blanking plate with sealing rings, union and blanking plug.

C — Blanking plates and sealing rings.

D — Inlet cover plate and gasket.

E — Union and sealing washer.

F — Pressure connection.

296. Remove the pump from the kerosine bath and change the air supply to the seal drain connection, immerse the pump and supply air at the pressure stated, check that any leakage from the garter seals and the carbon-faced seal does not exceed the specified limits.

Final leakage test

297. Complete all locking of adjustments, mount the pump on the test rig and repeat the leakage tests described in para. 293 and 294.

Insulation test (Solenoid valve)

298. Test the insulation of the solenoid valve by connecting the leads of an insulation resistance tester to the valve connections and applying a pressure of 500 volts; the resistance must not be less than 1 megohm.

Inhibiting

299. The pump is to be inhibited in accordance with the information contained in A.P.4471A.

Fitting the installation connections

300. Remove the special rig adapters and fit the installation fittings, these differ according to the particular engine installation, the method of fitting the connections however, is straightforward, no special instructions being required.

SOLENOID-OPERATED SERVO ISOLATING VALVE

301. The upper pump control end cover forms a bracket for the servo isolating valve; this valve has a fixed mounting position, but different locations for the electrical connection may exist.

Dismantling and inspection

302. Examine the complete unit, externally, for signs of damage and incompleteness.

303. Remove the two nuts holding the retaining plug and lift the cover clear of the studs to gain access to the strainer assembly. Remove the strainer from the housing and examine for signs of damage. Wash in kerosine, and test as described in para. 76.

304. Remove the strainer housing and orifice body assembly, do not disturb the shim. Examine the orifice for cleanliness and ensure that the bore is clear, wash thoroughly in kerosine and dry off by means of a compressed air blast. Check the face for any indentation.

305. Remove the four nuts securing the solenoid case. Lift the cover clear of the studs, taking care that the push rod does not fall and receive damage. Inspect the push-rod for damage and corrosion. Light polishing at the ends of the rod is permissible but no abrasives must be used, for the length of the rod is set on initial assembly and must not be altered or interchanged. Check that the rod is not bent and will move freely in its guide.

306. Remove the plate valve and spring from the bracket cover, wash and examine for serviceability. The valve should be free from pitted indentations, and the sealing face quite smooth and flat, if there is any doubt the face should be checked for colour registration against an optical flat.

307. Ensure that the valve spring is in good condition and is free from distortion, surface cracks and corrosion. Check that all set screws are secure, straight and square to the casting, and the threads clean and

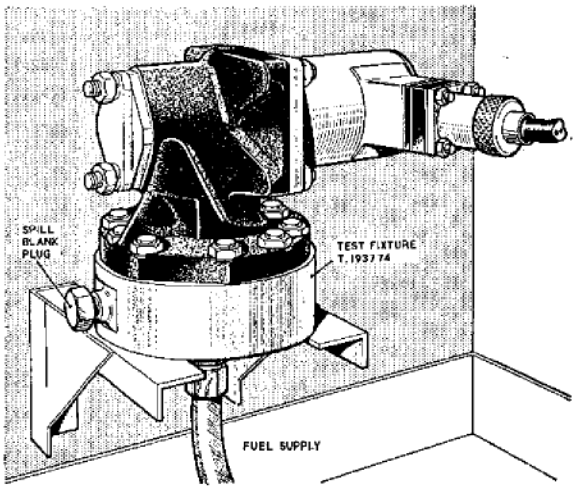

Fig. 33. Testing the solenoid-operated servo isolating valve

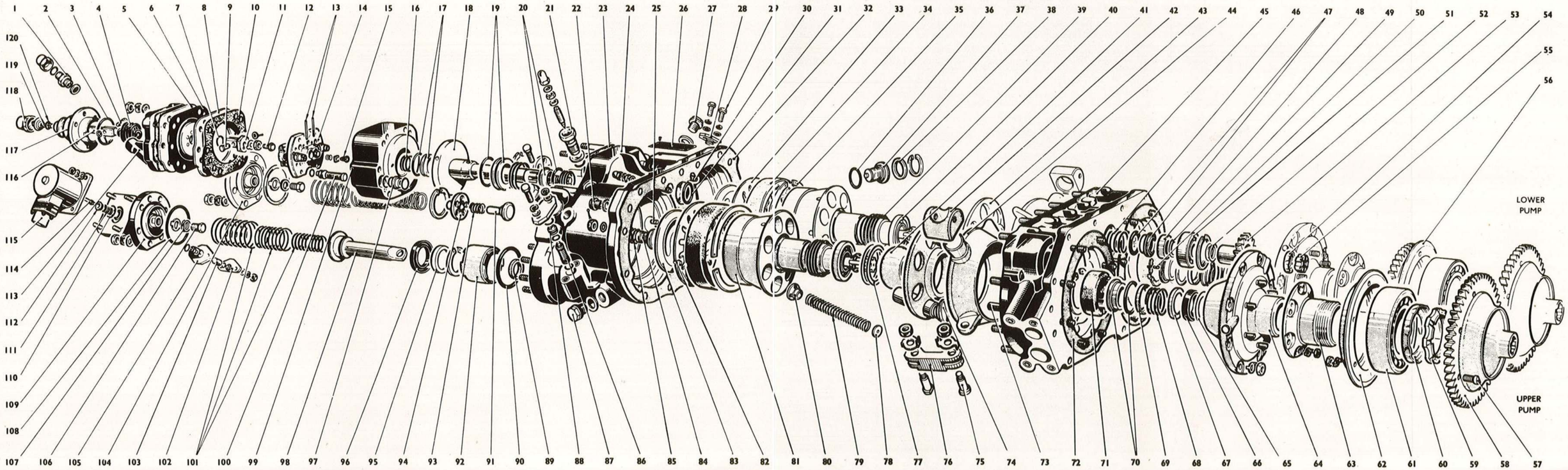

Fig. 34. High pressure fuel pump, type G.T.D.

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KEY TO FIG. 34

1 AIR BLEED VALVE ASSEMBLY
2 COVER SEAL, SPRING HOUSING
3 LINK PIN (OUTER)
4 GOVERNOR SPRING
5 DIAPHRAGM SPACING RING (OUTER)
6 DIAPHRAGM
7 ROLLED SEAL WASHER
8 DIAPHRAGM SPACING RING (INNER)
9 LINK PIN (INNER)
10 JOINT GASKET, DIAPHRAGM COVER
11 SPRING ANCHOR AND DIAPHRAGM CENTRE
12 TAPPET ADJUSTING SCREW
13 LOCK PIN (2 OFF)
14 ROCKER LEVER PLATE AND ORIFICE ASSEMBLY
15 STALL PRESSURE ADJUSTING SCREW (2 OFF)
16 SPRING
17 ROLLED SEAL WASHER AND CARBON FACE SEAL
18 CENTRIFUGAL ROTOR
19 ROLLED SEAL WASHER AND COMBINED BEARING FACE SEAL
20 CARBON FACED SEAL ASSEMBLY WITH ROLLER SEAL WASHER
21 CENTRIFUGAL MAKE-UP VALVE ASSEMBLY
22 PLUG, TRUNNION BLOCK (4 OFF)
23 JOINT GASKET
24 PUMP BODY
*25 LOCATING PEG, PORT INSERT
26 NAMEPLATE
*27 PLUG, FUEL PRESSURE TAPPING
*28 SERVO ORIFICE COVER PLATE
*29 COVER PLATE SET SCREWS
*30 CAMPLATE ANGLE ADJUSTING SCREW ASSEMBLY
31 ROLLED SEAL WASHER
32 JOINT GASKET
*33 SPIDER RETAINER, PORT INSERT
*34 CARBON BEARING, LARGE
*35 CIRCLIP, CARBON BEARING
36 ROLLED SEAL WASHER
37 STRAINER ASSEMBLY, INTERCONNECTING ROTOR BORE
38 WASHER
*39 SPRING, THRUST BALL
*40 SPRING SEAT
*41 SPHERICAL THRUST BALL
*42 TRUNNION BLOCK (2 OFF)
*43 AUXILIARY CAMPLATE
*44 CAMPLATE
45 CAMPLATE HOUSING
46 SPRING
47 ROLLED SEAL WASHER AND CARBON FACED SEAL ASSEMBLY
48 ABUTMENT RING
49 SHIM WASHER(S)
*50 DOWEL PEG, SMALL CARBON BEARING
51 BALL BEARING, CENTRIFUGAL ROTOR
52 SHIM(S)
53 CENTRIFUGAL PINION AND BUSH ASSEMBLY
54 CUP, LOCK WASHER
55 SERRATED LOCK NUT
56 GOVERNOR DRIVE GEAR AND BEARING RING
*57 FITTED BOLT (6 OFF)
*58 MAIN GEARS
*59 LOCK NUT
*60 CUP LOCK WASHER
*61 BALL BEARING, MAIN GEARS
62 BEARING RING
*63 BEARING SLEEVE
*64 END COVER
*65 WASHER
*66 GARTER SEAL ASSEMBLY
*67 SPRING CUP
*68 SPRING
*69 SPRING CUP
*70 ROLLED SEAL WASHER AND CARBON FACED SEAL ASSEMBLY
*71 CARBON BEARING, SMALL
*72 JOINT GASKET
73 DOWEL PEG, PUMP BODY FACE (2 OFF)
*74 PISTON AND SLIPPER ASSEMBLY (7 OFF)
*75 LINK BOLT (2 OFF)
*76 LINK CONNECTING FORK
*77 SHIM WASHERS
*78 CAP, PISTON SPRINGS (7 OFF)
*79 SPRING, PISTON (7 OFF)
*80 SPRING GUIDES (7 OFF)
*81 ROTOR
*82 LOCATING PEG, CARBON BEARING
*83 KIDNEY SHAPED, FUEL PORT INSERT
*84 STRAINER ASSEMBLY
*85 STRAINER SPRING
*86 STRAINER ASSEMBLY SERVO ORIFICE
*87 SERVO PRESSURE BLANKING PLUG
*88 SERVO SUPPLY ORIFICE BODY
*89 FELT WASHER
*90 ROLLED SEAL WASHER, LINER HOUSING
*91 NON-RETURN VALVE
*92 LINER, SERVO PISTON
*93 NON-RETURN VALVE SPRING
*94 NON-RETURN VALVE GUIDE
*95 SEAL RETAINING RING
*96 PISTON SEAL, WASHER
*97 CONNECTING BOBBIN AND SEAL WASHERS
*98 SERVO PISTON CONTROL ROD
99 AMPLIFIER VALVE HOUSING
100 STRAINER ASSEMBLY, AMPLIFIER HOUSING (2 OFF)
*101 SPRINGS, SERVO PISTON (3 OFF)
102 STRAINER COVER, ISOLATING VALVE
103 STRAINER ASSEMBLY ISOLATING VALVE
104 COVER PLATE, SERVO PISTON-ASSEMBLY
105 STRAINER HOUSING AND ORIFICE ASSEMBLY
*106 MINIMUM FLOW STOP SCREW
*107 SHIMWASHER(S)
*108 SEAL WASHER SERVO PISTON COVER PLATE
109 SOLENOID BRACKET AND COVER ASSEMBLY
110 ROLLED SEAL WASHER
111 SPRING
112 PLATE VALVE
113 DIAPHRAGM COVER
114 PLUNGER
115 SOLENOID ASSEMBLY
116 SPRING ANCHOR
117 BELL HOUSING, GOVERNOR SPRING
118 OPEN CAP NUT
119 ADJUSTING SCREW
120 ROLLED SEAL WASHER

* COMPONENTS APPLICABLE TO UPPER AND LOWER PUMP ASSEMBLIES

undamaged. Do not renew individual components, except seals, washers, nuts and screws. Defective units must be returned complete for investigation.

Assembling

308. Fit the strainer housing and its attached orifice body assembly to the casting, locating the strainer assembly to its housing and fit the retaining plug. Secure the whole assembly to the two studs with plain washers, grover washers and nuts.

309. Mount the bracket with the orifice vertical, and carefully position the spring and valve plate. Fit the push rod into its guide and lower the solenoid case on to the bracket joint face. Correctly locate the spigot mounting of the case; ensure that the seal washer is fitted. Secure to the studs with plain washers, grover washers and nuts.

Testing

310. Mount the solenoid servo valve assembly to the pressure test fixture T.193774 (*fig.* 33) and secure with eight bolts passing from the fixture through the stud clearance holes. Connect a fuel delivery line to the base of the fixture.

311. Ensure that the spill connection of the fixture is securely blanked and apply a fuel pressure of 3000 lb/in² to the orifice for 5 min. No external leakage or fall of pressure is permitted.

312. Connect the electrical pin plug, of the valve, to a 16-volt D.C. supply and energise the solenoid. Remove the blanking plug from the spill connection of the test fixture and again apply a fuel delivery pressure of 3000 lb/in². No leakage from the spill connection, or fall in pressure is permitted.

313. In the event of leakage remove and examine the plate valve and orifice for foreign matter which may have become trapped between the two components. If this is not the cause, or should the solenoid fail to operate reject the unit and fit a replacement.

314. The solenoid valve should be endurance tested under shock load conditions. De-energise the solenoid with the spill connection shut, applying a varying fuel delivery to simulate engine isolation conditions for at least eight hours, the rate of cycling being at least once every two minutes. No external leakage is permitted.

315. Make an insulation test; the resistance must be not less than 1 megohm for a pressure of 500 volts. On satisfactory completion of the above tests the solenoid valve must be subjected to the normal pump endurance test.

HIGH PRESSURE FUEL PUMP, TYPE MGTD SERIES

316. This type of pump is fitted with a hydro-mechanical governor (*fig.* 38), but as it is similar in other respects to the GTD pump, reference is made to previous parts of the chapter when the information is common to both types of pump. In the first instance, the instructions given in para. 2 to 21 are applicable to both types and are then continued as follows.

Removing the governor

317. Position the pump body, with the gears vertical. Release the cup lockingwasher (61) then insert the key T.201755 in the driving splines of the lower pump to prevent the gear turning whilst removing the nut (60) with spanner T.201749. Lightly drift out the rotor shaft from the opposite end of the pump body, leaving the splined drive behind.

318. Remove the circlip (19) and withdraw the carbon bearing (20), carbon-faced seal (21) and spring. Do not remove the dowel (22) unless it is damaged or loose.

319. Mount the governor assembly in the fixture T.230694 and remove the twelve outer bolts from the cover plate (108a). Fit two bolts into the extractor holes to release the cover plate and attached assembly (108i).

320. Remove the balance weight (108b) and the diaphragm mounting assembly (108g), with attached lever (108e and f) from the end cover.

321. Unlock and remove the centre nut and the two bolts on the top of the governor lever, then tap lightly on the bench to separate the lever and attached hinge from the diaphragm mounting assembly.

322. Remove the governor weight (108d) from the lever, and detach the large sealing ring (108h).

323. To dismantle the diaphragm unit, place it on a suitable anvil and drive out the rivets with a small pin punch. Discard the diaphragm.

Removing the rotor

324. Mount the pump on the stand, with the splined shafts uppermost. Remove the pin (82) and dowel (84) and detach the link. Continue as described in para. 38.

Governor strainer

325. Remove the cap nut and screw out the assembly (92). Continue as described in para. 55.

INSPECTION

326. The governor lever and hinge and the governor rotor must be magnetically crack-tested.

327. Carry out the checks detailed in para. 71 to 77 then proceed as follows. The governor strainer (92) should be pressure-drop tested using the fixture T.234013. For a fuel supply of 50 gal/h the pressure drop must not exceed 5 lb/in².

328. Examine the governor feed orifice for serviceability and subject it to a flow test (without the strainer), using a suitable union adapter to house the orifice body. Connect the inlet end to the delivery line of a burner test rig which has facilities for measuring the outlet flow from the orifice. Apply kerosine at a pressure of 1000 lb/in² and a temperature of 20 to 26° C. Check that the outlet flow is within 22 to 23 gal/h.

329. Examine the rotor shaft for fretting and corrosion. See that the shaft is free from scores which may have affected the bore of the carbon bearing.

330. Check the condition of the diaphragm mounting assembly and see that the riveting is sound and the orifice clean.

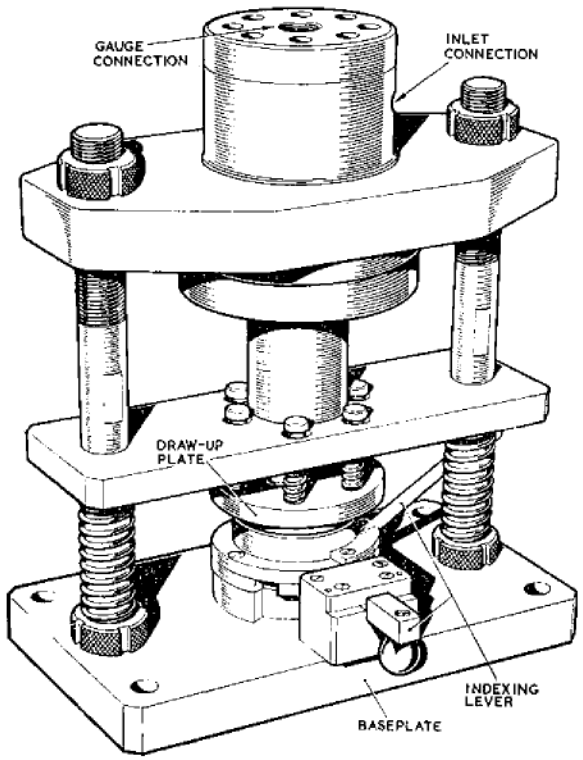

Fig. 35. Diaphragm riveting fixture T.287355

331. Examine the governor lever and hinge, balance weight and governor weight for serviceability.

Note . . .

Special equipment is required for removing and fitting the lever hinge and where any defect is apparent the riveted assembly should be returned for specialised repair.

332. Examine the carbon bearing and the carbon-faced seal for chipping or scoring. The bearing should be a good fit in the bore in the pump body and should rotate freely on the rotor shaft. Also check that the spring and circlip are in good condition.

ASSEMBLING

333. Continue as described in para. 78 to 109 then 113 to 189.

Fitting a new governor diaphragm

334. (1) Loosely assemble the diaphragm, shroud plate and rivets to the mounting plate.

(2) Measure and record the overall thickness of the shroud plate, diaphragm and mounting plate at six equidistant points on the pitch circle diameter of the rivets.

(3) Mount the assembly on the fixture T.287355 and align it on the dowels.

(4) Close the pressure release cock and operate the hand pump until the draw-up plate just contacts the lever assembly. Check that the draw-up plate is free to lift against its springs, then continue pumping until a pressure of 700 lb/in² is obtained.

(5) Release the pressure, rotate the base of the fixture to position the remaining rivets and again apply the pressure.

(6) Release the pressure and remove the assembly. Check the overall thickness; this must be 0·002 to 0·005 in. less than the figure obtained before riveting.

(7) If the decrease is less than 0·002 in., fit the assembly to the fixture and apply pressure in excess of 700 lb/in² but not more than 950 lb/in². At each stage the pressure must be equal on each set of rivets.

(8) After the riveting operation inspect the rivet heads. These must be well formed and not more than 0·005 in. proud of the component. Examine the diaphragm for distortion and ensure that the centre screw is square to the mounting plate.

(9) Wash the unit in gasoline, dry it and ensure that it is free from grease, then mount it on the pressure-test fixture T.277764.

(10) Adjust the clearance between the fixture screw and the diaphragm centre to 0·005 in. then apply a fuel pressure of 500 lb/in² for five minutes, during which time there must be no leakage.

Assembling the governor

335. Assemble the governor weight (108d) (with markings uppermost) to the governor lever and hinge assembly (108e and f). Fit the lever and hinge assembly over the centre bolt in the diaphragm mounting assembly (108g), ensuring that the pad on the lever aligns with the orifice beneath it.

336. Fit the balance weight (108b) to the cover plate (108a) followed by the previously mentioned governor components.

337. Check the gap between the orifice and the lever; the minimum dimension should be 0·025 in. If the gap is incorrect, other balance weights should be selected to suit. When satisfactory, lock all tabwashers and fit a new sealing ring around the diaphragm mounting assembly.

338. Mount the governor rotor in the fixture T.230694. Fit the built-up assembly into the rotor (108i), fit the cover plate, ensuring that the orifice is in line with the rotor feed hole. The cover plate tabwashers must not overhang the cover plate. Proceed as described in para. 190 to 196 and 214.

Amplifier valve housing

339. Fit a rubber seal washer on each plug, then push each plug firmly into its recess.

340. Fit the amplifier valve assembly (12) over the four studs in the base of the housing. Two tappings are provided on the rocker plate and by inserting a 2 B.A. set screw into each of them the plate may be lowered over the studs. Remove the set screws, fit and lock the nuts.

341. Fit a strainer and bobbin (109) with a rubber seal to the two servo pressure connecting points of the housing.

342. Turn the amplifier valve housing so that the face to the pump body is uppermost, fit the shim washers (14), spring seat (15), spring (16) and carbon face seal (17) with sealing ring into the housing bore. Proceed as described in para. 257-259.

Centralizing the governor rotor

343. Attach the camplate housing with joint gasket (34) to the pump body, and secure it with slave washers and nuts. From the pump body end fit the rotor (108) into the bore so that the splined shaft protrudes from the camplate housing. Temporarily fit the tool T.212169 into the bore of the camplate housing.

344. Fit the amplifier housing (18) without the rocker lever and orifice assembly. To enable the stud threads to be effective use spacing washers.

345. Mount the whole assembly in the horizontal position. Locate a depth-gauge micrometer from the amplifier valve housing so that the spindle will contact the centre of the rotor. Push the rotor forward and take a reading from the micrometer (position A). Reverse the load on the shaft by pushing

rearwards, then take a further micrometer reading (position B).

346. Remove the tool T.212169 and fit into the camplate housing bore the spring (50), carbon-faced seal assembly (52) with a rubber seal (51) beneath the head, abutment ring (53) with a sealing ring fitted on the inside diameter, and shim washer (54). Again fit the tool T.212169 and secure it with a circlip. Three sizes of shim washer are available; select the correct thickness by trial as detailed in the following paragraph.

347. Fit the pinion, slave cup-washer and the lock nut and secure it with the spanner T.201749. Again push the rotor forward and take a reading with the depth micrometer (position C). Reverse the load on the rotor, i.e., push the rotor in the opposite direction, and again take a micrometer reading (position D). Dimensions C and D must be between A and B but not within 0·010 in. of each other. Check, by taking C from A and B from D. The following is given as an example only:—

A=1·944 in.
B=1·871 in.
C=1·920 in.
D=1·908 in.

A−C=0·024 in.: D−E=0·037 in. which shows that the appropriate shim was used.

348. Remove the nuts and spacing washers and lift off the amplifier housing. With the spanner T.201749 remove the pinion nut and cup washer. Apply a light blow to the rotor shaft and remove the rotor from the pump body, leaving the pinion in position. Remove the circlip holding the tool T.212169 and lift the tool from the bore. Detach the camplate housing from the pump body.

Fitting the governor rotor ball-bearing

349. Place the camplate housing vertical on the bench. Locate the bearing (56) into position with the bore of the housing. Mount the spindle of tool T.201739 (*fig.* 21) through the rotor bore from the body face end so that the base of the spindle contacts the housing. The end of the spindle is threaded and should protrude through the centre of the bearing race. Screw the T-shaped boss on to the spindle to contact the bearing and press it into the housing bore. Secure with circlip. Continue as described in para. 222 to 237.

Connecting the servo piston control rod

350. Slide the link (83) over the piston rod and align the drilled holes. Fit the dowel (84) in the link pin (82) and push through link (83). Fit the other pin in the same manner to the camplate. Proceed as described in para. 240 to 243.

Fitting the governor strainer

351. Place a plain rubber sealing ring on the strainer, also one on the orifice body and screw the strainer into the body casting. The cap nut is to be fitted after testing.

352. Fit the camplate housing as detailed in para. 245 and 246.

Fitting the governor rotor and pinion

353. Fit the spring (23) and carbon-faced seal (21) with a new sealing ring into the pump body bore. Locate the carbon (20) bearing on the dowel and secure it with the circlip.

354. Fit the assembly sheath T.285717 over the rotor splines and insert the rotor assembly (108) so that the shaft is positioned through both the pump body and camplate housing (73), then remove the sheath.

355. Fit the shim washer (57), slide the pinion (59) over the shaft and mesh the pinion gear with the drive gear (55c).

356. Fit the cup washer (61) and locknut (60) and tighten with the spanner T.201749.

357. Check the alignment of the meshed gears and adjust if necessary by the shim washers (57). If it is necessary to lap the rotor shaft, use tool T.266733. Finally, close the cup washer with the tool T.228558. Continue as described in para. 250 to 255 and 260-261.

TESTING

358. Before proceeding with the initial endurance test, the pump must be calibrated sufficiently to ascertain satisfactory functioning. This entails the following:—

Setting the pump stall pressure
Setting the maximum stroke
Checking the volumetric efficiency
Governor pressure characteristics, i.e., the pressure generated by the governor to the overspeed governor diaphragm
Setting the governor speed
Checking the governor recovery time
Checking the governor range

Setting the pump stall pressure

359. Set the stall pressure to the value stated in the appendix. Insert the spanner T.193939 into the aperture of the amplifier valve rocker lever and turn the stall adjusting screw clockwise to increase.

Setting the maximum stroke

360. Adjust the rig to provide the speed and delivery pressure stated. Screw out the maximum flow screw on each pump in turn until the specified flow is obtained, then check the combined flow.

Checking the volumetric efficiency

361. Check the volumetric efficiency at the stated high and low delivery pressures.

Governor pressure characteristic

362. The value of the pressure signal generated by the governor is measured as the differential pressure across the overspeed diaphragm at the conditions stated in the appendix. If the governor differential pressure is above the limits stated, the governor weight is to be trimmed by drilling balancing holes. By using the jig T.268734 drilling can take place without the complete dismantling of the governor assembly. The lever must be lightly clamped against the orifice and the weight supported to avoid straining of the leaf hinge.

363. The size and number of holes must be determined in stages and the pump assembled and a governor pressure check made at each stage.

364. A range of drilling plates with various hole sizes is provided with the jig, and experience gained in matching technique will enable the operator to determine hole sizes and thus minimise repetitive testing. A final check of governor pressure characteristics must be made after final assembly and locking.

Setting the governor speed

365. Set the governor to point A and check the governor cycle at points A, B, C and D at the conditions specified. Obtain point A by increasing the pump speed until the delivery pressure commences to fall.

366. Obtain point B by further increasing

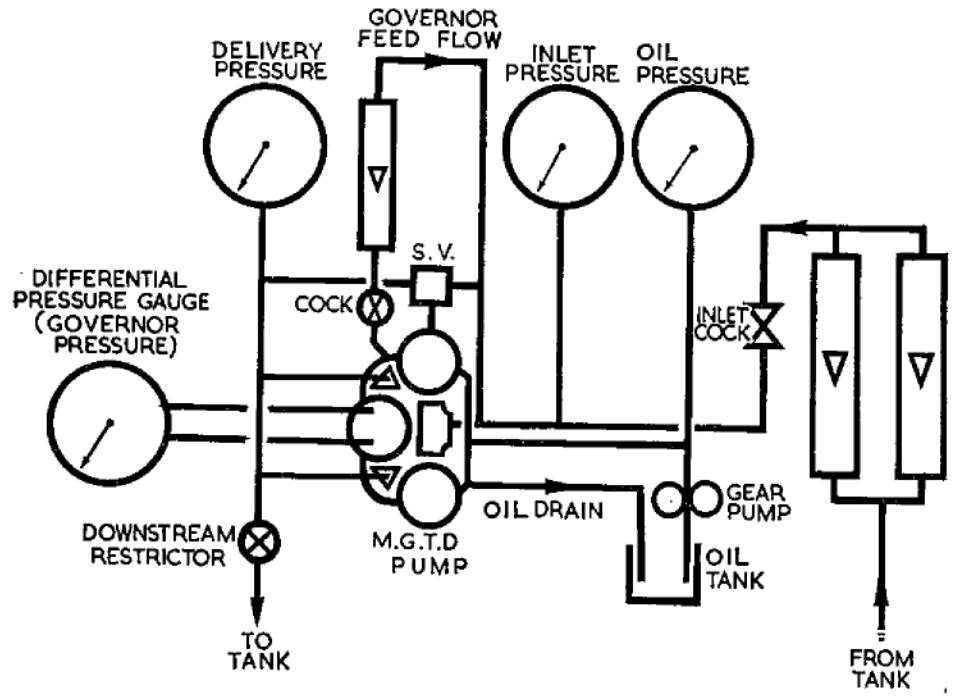

Fig. 36. Layout of test rig

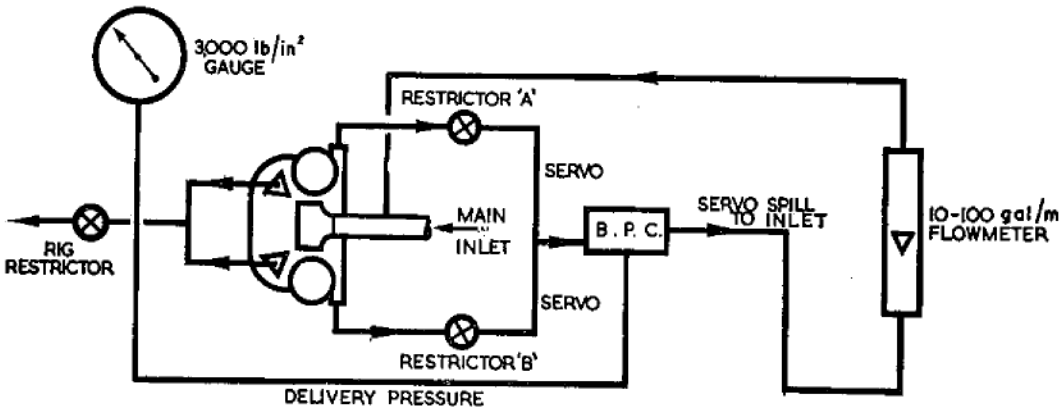

Fig. 37. Test rig for servo flow check

the pump speed to reduce the delivery pressure to the required value.

367. Obtain point C by further increasing the pump speed to reduce the pressure below point B and then reducing the speed until the correct pressure is re-established.

368. Obtain point D by decreasing the pump speed until the delivery pressure had recovered to the required value.

Checking the governor recovery time

369. Run the pump at point C condition then rapidly decrease the pump speed to point D condition and observe the time taken for the delivery pressure to recover from the initial to the final condition. Repeat several times.

Checking the governor range

370. Check the governor range by running the pump at the stated conditions then increasing the speed until the pump governs (denoted by a rapid decrease in delivery pressure). Adjust the governor adjusting screw to obtain speed governing over the stated range.

Straight endurance

371. Run the pump at the conditions stated in the appendix.

Cycling endurance

372. Set the pump stall and exercise the pump at the specified conditions then complete the required number of cycles as stated.

Governor endurance

373. Run the pump at the stated conditions then vary the speed for the required number of cycles.

Starting test

374. Set the pump to idling conditions then effect a number of starts as specified in the appendix.

Volumetric efficiency check

375. Check the volumetric efficiency as in para. 361.

Setting the governed speed

376. Check the governed speed at points A, B, C and D as in para. 365.

Checking the governor recovery time

377. Check the recovery time as in para. 369.

Governor synchronization

378. For this check the pumps are run as separate units. Isolate each servo system by a test plug and with each pump rotor delivery through separate restrictors, check the difference in each of the pump pressures as specified in the appendix.

Servo flow check

379. Connect the pump as shown in fig. 37 and measure the servo flow to pump inlet at the specified conditions.

Governor check (with external fuel bleed)

380. Connect the camplate housing bleed point back to pump inlet, run the pump at the stated conditions and check the governed speed.

Leakage tests
381. Dry the pump externally and check for leaks at each of the three tests specified.

Self-priming test
382. Run the pump with closed inlet at the stated condition and ensure that an inlet depression is achieved.

Strip inspection
383. Partially or wholly dismantle the pump for inspection, the extent of this being at the discretion of the inspection authority. If new, pistons, rotor, port insert, camplate, auxiliary camplate or governor components have been fitted, such parts should be crack-tested.

384. Cleaning, inspection and building should be carried out in accordance with the earlier instructions. All internal locking should be completed except for those items which may require adjustment during final testing.

TESTING (FINAL)

385. The fuel used, temperature limits and inlet pressures are specified in the appendix.

Governor endurance
386. Repeat the test as in para. 373.

Setting the pump stall pressure
387. Repeat the test as in para. 359.

Setting the maximum stroke
388. Repeat the test as in para. 360 then record the idling flow at the conditions specified in the appendix.

Setting the minimum stroke
389. Fit blank servo restrictors alternatively to each pump and set the minimum stroke as specified.

Checking the volumetric efficiency
390. Check the volumetric efficiency at the stated high and low pressures.

Checking the governor range
391. Repeat the test as in para. 370.

Governor pressure characteristic
392. Repeat the test as in para. 362.

Setting the governor speed
393. Repeat the test as in para. 365.

Checking the governor recovery time
394. Repeat the test as in para. 369.

Governor synchronization
395. Repeat the test as in para. 378.

Servo flow check
396. Repeat the test as in para. 379.

Governor check (with external fuel bleed)
397. Repeat the test as in para. 380.

Solenoid test (where applicable)
398. Endurance test the solenoid by energising the valve the required number of times with the pump running at the specified conditions. There must be no leakage through the valve.

Leakage test
399. Repeat the first leakage test as in para. 381.

Self-priming test
400. Repeat the test as in para. 382. Remove the pump from the rig fit all installation parts and complete all wirelocking.

Porosity tests
401. Drain the pump and, using the fixture T.299368 connect a compressed air supply to E (*fig.* 32). Immerse the pump in kerosine and apply the stated air pressures. No leakage is permissible, other than from the seal drain.

402. Change the air supply to the seal drain connection, immerse the pump and supply air at the pressure stated. Check that there is no leakage from the garter seals and that the carbon-faced seal (52) does not exceed the specified limits.

Final leakage tests
403. Repeat the three tests as in para. 381.

Solenoid insulation test (where applicable)
405. Test the insulation of the solenoid valve by connecting the leads of a Megger to the valve and applying the specified pressure.

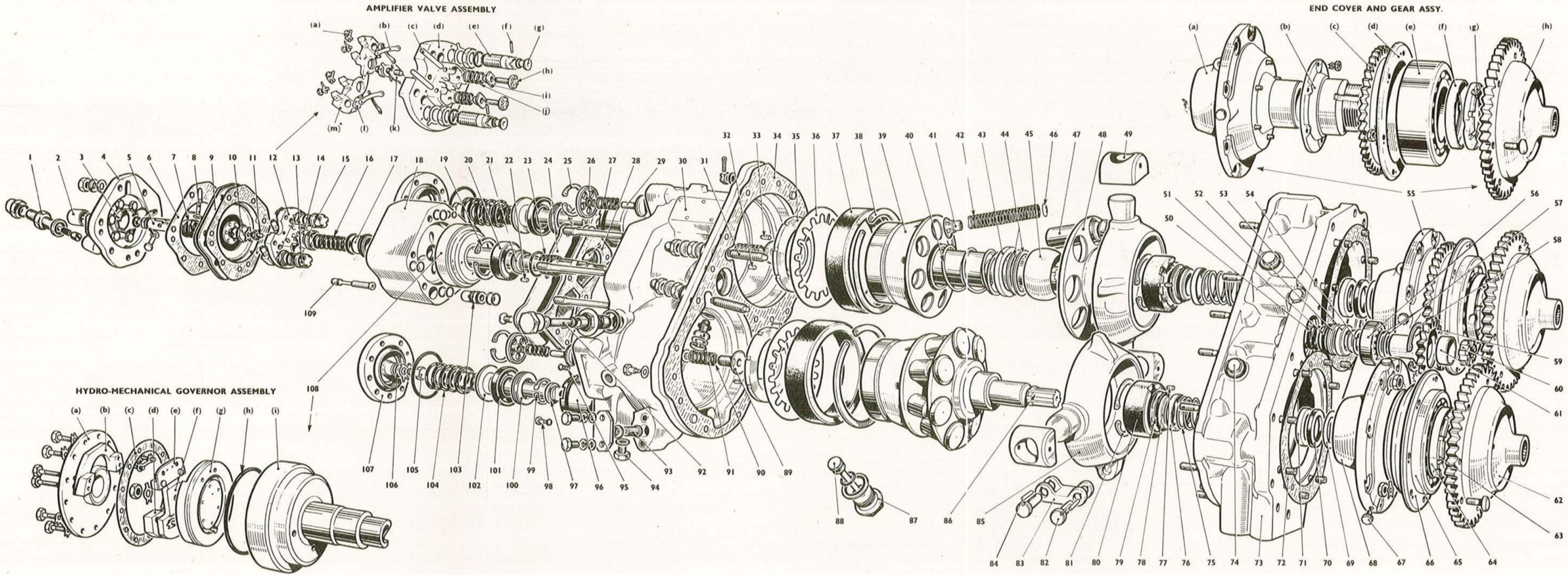

Fig. 38. H.P. fuel pump, type M.G.T.D.

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KEY TO FIG. 38

1 AIR BLEED VALVE ASSEMBLY
2 GOVERNOR ADJUSTMENT
3 SPRING HOUSING
4 DIAPHRAGM COVER
5 SPRING ANCHOR
6 GASKET (2 OFF)
7 GOVERNOR SPRING
8 ANCHOR PIN (2 OFF)
9 DIAPHRAGM & SPACER PLATES
10 SPRING ANCHOR
11 TAPPET ADJUSTING SCREW
12 AMPLIFIER VALVE ASSEMBLY
12(a) TORSION HINGE SCREWS (16 OFF)
12(b) TORSION HINGES (8 OFF)
12(c) LOCK PINS (2 OFF)
12(d) BASEPLATE
12(e) ORIFICE & STRAINER ASSY. (2 OFF)
12(f) STRAINER PINS (2 OFF)
12(g) END PIECES (2 OFF)
12(h) STALL ADJUSTING SCREWS (2 OFF)
12(i) COLLAR (2 OFF)
12(j) SPRINGS (2 OFF)
12(k) STOP PLATE
12(l) HALF BALL (2 OFF)
12(m) ROCKER LEVER (2 OFF)
13 PLUG (2 OFF)
14 SHIM WASHER/S
15 SPRING SEAT
16 SPRING
17 CARBON FACE SEAL
18 AMPLIFIER VALVE HOUSING
19 CIRCLIP
20 CARBON BEARING
21 CARBON FACE SEAL
22 LOCATING DOWEL
23 SPRING
24 COVER PLATE
25 CIRCLIP
*26 NON-RETURN VALVE GUIDE
*27 SPRING
28 GAUZE STRAINER & GASKET
*29 NON-RETURN VALVE
30 PUMP BODY
*31 MAXIMUM FLOW SCREW
*32 LOCATING DOWEL
*33 LOCATING DOWEL
*34 GASKET
*35 PORT INSERT
*36 RETAINING SPIDER
*37 CARBON BEARING
*38 CIRCLIP
*39 ROTOR
*40 SPRING
*41 SPRING GUIDES (7 OFF)
*42 PISTON SPRINGS (7 OFF)
*43 SPRING SEAT
*44 SHIM WASHERS
*45 THRUST BALL
*46 SPRING CAPS (7 OFF)
*47 PISTON ASSEMBLY (7 OFF)
*48 AUXILIARY CAMPLATE
*49 TRUNNION BLOCKS (2 OFF)
50 SPRING
51 SEALING RING
52 CARBON FACE SEAL
53 ABUTMENT RING
54 SHIM WASHER/S
55 END COVER & GEAR ASSY.
55(a) END COVER
55(b) BEARING SLEEVE
55(c) GOVERNOR DRIVE GEAR
55(d) BEARING RING
55(e) BALL BEARING
55(f) CUP WASHER
55(g) LOCK NUT
55(h) MAIN GEAR
56 BALL BEARING
57 SHIM WASHER/S
58 CIRCLIP
59 PINION
60 LOCK NUT
61 CUP WASHER
62 MAIN GEAR
63 LOCK NUT
64 CUP WASHER
65 BALL BEARING
66 BEARING RING
*67 BLANKING PLUGS (2 OFF)
68 END COVER
*69 WASHER
*70 GARTER SEAL
*71 SPRING SEAT
*72 GASKET
73 CAMPLATE HOUSING
74 BLANKING PLUGS (2 OFF)
*75 SPRING
*76 SPRING SEAT
*77 LOCATING DOWEL
*78 CARBON FACE SEAL
*79 SEALING RING
*80 CARBON BEARING
*81 CIRCLIP
*82 LINK PIN (2 OFF)
*83 LINK
*84 LINK DOWEL
*85 CAMPLATE
*86 QUILL SHAFT
87 PLUG
88 BLANK BOBBIN
*89 STRAINER
*90 SPRING & WASHER
91 INTERCONNECTING STRAINER
92 STRAINER/ORIFICE ASSY.
*93 SERVO ORIFICE ASSEMBLY
*94 SERVO BLANKING PLUG
*95 SERVO TUBE & SEAL
*96 SERVO LINER
*97 FELT SEAL
*98 BOBBIN & SEAL
*99 CIRCLIP
*100 SEAL RETAINER
*101 PISTON SEAL
*102 SERVO PISTON
103 BOBBIN
*104 SERVO SPRINGS (2 OFF)
*105 MINIMUM FLOW SCREW
*106 SHIM WASHERS/S
*107 SERVO END COVER
108 HYDRO-MECHANICAL GOVERNOR ASSY.
108(a) COVER PLATE
108(b) BALANCE WEIGHT
108(c) GASKET
108(d) GOVERNOR WEIGHT
108(e) GOVERNOR LEVER HINGE
108(f) GOVERNOR LEVER
108(g) DIAPHRAGM MOUNTING ASSY.
108(h) SEALING RING
108(i) ROTOR
109 STRAINER & BOBBIN

*APPLICABLE TO UPPER AND LOWER PUMPS

APPENDIX 1

CALIBRATION CODE A

Introduction

This appendix is to be used for G.T.D. type fuel pumps. Paragraph numbers refer to the appropriate information in the general test procedure.

Throughout the tests, the fuel used is to be 73 NLAVGAS and the temperature of the fuel, unless otherwise stated is to be maintained at 20 to 40 deg. C. The fuel inlet pressure, unless specifically quoted, must be within the range of 15 to 20 lb/in^2.

The gears must be lubricated with oil applied at a pressure of 20 to 25 lb/in^2, where the gears are out of mesh.

Running-in

1. Run the pump at 1000 rev/min with 250 lb/in^2 delivery pressure and open the centrifugal make-up valve to pass 10 gal/h, then run the pump at the following conditions:—

Speed (rev/min)	Delivery Pressure (lb/in^2)	Duration (minutes)
1000	250	10
1500	250	10
1500	500	10
2000	500	10
2000	750	10
2500	750	10
3000	1000	20

PRELIMINARY CALIBRATION

(*para.* 265)

Maximum stroke

2. Run the pump at a speed of 3000 rev/min and obtain a delivery flow of 3050-3150 gal/h (adjust camplate angles) at 150 lb/in^2.

Volumetric efficiency (*para.* 282)

3. Close the centrifugal make-up valve, run the pump at 3000 rev/min with a delivery pressure of 150 lb/in^2 and observe the delivery flow; raise the delivery pressure to 1000 lb/in^2 and check the difference in delivery flow which must be approximately 250 gal/h (gasoline) or 120 gal/h (kerosine). Open the centrifugal make-up valve to the previous setting and record the efficiency.

Governor setting and cycle (*para.* 286)

4. Run the test rig at a speed of 2900 rev/min and set the pump governor to operate at this speed with a delivery pressure of 1250 lb/in^2 (Point A). Increase the pump speed (test rig control) to reduce the delivery pressure until it falls to 400 lb/in^2, the speed must be within 2960-3040 rev/min (Point B). Further increase the pump speed so that the delivery pressure falls below that of point B; reduce the pump speed and allow the delivery pressure to regain 400 lb/in^2 when the rev/min must be within 30 rev/min below that at Point B. Continue to decrease the speed of the pump until the original delivery pressure of 1200 to 1250 lb/in^2 is obtained, for a speed of 2860 to 2900 rev/min (Point D).

Governor recovery time (*para.* 288)

5. Check the time taken for the pump to recover from the conditions at point C to the conditions at point D, in the previous paragraph. The recovery time is to be within 0·8 and 2 seconds.

Governor range (*para.* 283)

6. With the pump running at 2700 rev/min and a delivery pressure of 1250 lb/in^2 adjust the governor setting, by screwing in the governor adjusting screw until the governor operates. Progressively re-adjust the pump speed and governor setting by unscrewing the adjusting screw over a range terminating at 3100 rev/min. Correct governor operation must be obtained for any speed selected, within the range, repeat this check several times.

Straight endurance test (*para.* 266)

7. Run the pump for 30 min. at 3000 rev/min with the fuel delivery set at full stroke and 1000 lb/in^2 delivery pressure. Increase the delivery pressure to 1600 lb/in^2 for a further period of 90 min. Where necessary, allow the fuel temperature to rise to 36-40 deg. C. and run the pump for a final period of 15 min. at 2000 gal/h, 3000 rev/min and 1600 lb/in^2 (by external stall valve).

Cyclic endurance test (*para.* 267)

8. Let the pump run at 3000 rev/min, set the stall pressure of both pumps at 1900 to 2200 lb/in² and reduce the restrictor to give a delivery flow of 2000 gal/h, continue to run, at these conditions for 5 min. Decrease the pump speed to 1000 rev/min and by means of an external stall valve set the flow and delivery pressure to 120 gal/h and 1250 lb/in² for a period of 10 min. This sequence is to be repeated 12 times.

Governor endurance test (*para.* 268)

9. The overspeed governor is to be endurance tested by running the pump at 2900 rev/min with a delivery pressure of 1250 lb/in² increase the speed until the governor operates then reduce speed and allow the governor to recover. The cycle is to be repeated 240 times at regular intervals.

Starting test (*para.* 269)

10. From start, run the pump to idling conditions (1000 rev/min with a flow of 120 gal/h at 1250 lb/in²), stop and repeat 25 times.

Volumetric efficiency (*para.* 282)

11. Repeat the volumetric efficiency check as described in para. 3 of this appendix.

Governor setting and response time (*para.* 286 *to* 288)

12. Check the governor setting and response time under the conditions described in para. 4 and 5 of this appendix.

Governor synchonization (*para.* 289)

13. Arrange the fuel delivery from the upper and lower pumps to pass through separate restrictors. Run the pump at Point A conditions, i.e., 2900 rev/min at 1250 lb/in² delivery pressure, increase the speed and observe the governing rev/min of both pumps, which must be within 25 rev/min.

Servo flow (*para.* 290)

14. Connect the servo flow back to inlet and measure the flow from each pump, this must not exceed the limits with the pump running under the following conditions.

Speed (rev/min)	Total flow (gal/h)	Pressure (lb/in²)	Servo flow (gal/h) Kerosine	Gasoline
2880	150	400	15—17	15—19
2880	150	*1200	20—25	23—28
3000	1000	1400	not less than at 1200 lb/in²	

* At the 1200 lb/in² condition, close cocks A and B (*fig.* 37). Avoid closing both together.

15. To obtain the delivery pressure use an external stall valve and should the flow be outside the limits, fit an alternative size of pressure supply orifice to the appropriate pump.

16. At 1000 gal/h and with the external stall valve pressure increased to 1400 lb/in² vary the speed in stages of 100 rev/min from 3000 to 2000 and then back to 3000 rev/min. The change in servo flow must not exceed 5 gal/h when using gasoline or 2 gal/h when using kerosine. Repeat the test five times and record the result of the last cycle.

External fuel bleed (*para.* 291)

17. Connect the centrifugal delivery flow from the camplate housing back to suction. Run the pump at Point A conditions i.e., 2900 rev/min, 1250 lb/in² delivery pressure and with a bleed of 200 gal/h, under these conditions the speed must not vary more than 10 rev/min.

Leakage tests (*para.* 293)

Pump running

18. Wipe the exterior of the pump perfectly dry. Connect both carbon faced seal and centrifugal seal drains to a measuring glass, and run the pump for 15 min, at the following conditions.

Note . . .

During this test there must be no leakage other than from the seal drains.

Fuel Inlet Pressure (lb/in²)	Speed (rev/min)	Delivery Pressure (lb/in²)	Carbon Faced and Centrifugal Drain Seals Total Leakage (c.c./hr.)
40	2750	1900	30
20	2750	1900	15

19. Reduce the fuel inlet pressure to normal (15-20 lb/in²) and with the pump running under the conditions quoted in para. 17 apply a fuel pressure of 10-15 lb/in² to the seal drain connection. There must be no leakage.

Pump stationary

20. With all external fuel pressures released, gradually increase fuel inlet pressure from 0 to 20 lb/in². No external leakage is

permitted other than from the drain connection, this leakage must not exceed 5 c.c. per hour. Increase the fuel inlet pressure to 40 lb/in^2 when the drain leakage must not exceed 30 cc/h.

Self priming

21. With the pump running at 500 rev/min and the inlet closed, the pump must be capable of producing an inlet depression. Record the results obtained. (The duration must not exceed one min.)

Inspection and final assembly,

22. Dismantle, inspect and rebuild the pump. Measure the slipper lift; this must not exceed the lift at initial build by more than 0·003 in. for phosphor-bronze slippers or 0·004 in. for beryllium copper slippers. Also measure the overall length of the piston and slipper assemblies for wear. The reduction in area must not exceed 0·001 in. for phosphor-bronze slippers or 0·002 in. for beryllium copper slippers.

Final calibration

General

23. For final calibration, the temperature of the fuel must be maintained between 20 and 30° C.

Governor endurance test

24. Repeat the governor endurance test at the conditions stated in para. 9 of this appendix.

Stall pressure setting (*para.* 278)

25. Set the stall pressure so that with the pump running at 3000 rev/min and the restrictor cock providing a delivery pressure of 2050 to 2200 lb/in^2, the pump stalls within this range. Operate the fuel delivery cock to stall and allow the pump to recover, observe that the required delivery pressure is obtained over several tests.

Maximum flow setting (*para.* 279)

26. With the pump running at 1000 rev/min and 1000 lb/in^2 delivery pressure, open the centrifugal make-up valve to pass 20 to 50 gal/h. Increase the speed of the pump to 3000 rev/min and adjust the camplate angle of each pump to give 1525 to 1575 gal/h at 1250 lb/in^2 delivery pressure. Record total delivery (3050 to 315 gal/h) then lock the camplate adjusting screws.

27. Reduce the pump speed to idling conditions, i.e., 970 rev/min at 800 lb/in^2 delivery pressure, and record the delivery flow.

Minimum flow setting (*para.* 280)

28. Remove the servo pressure blanking plugs from both pumps and fit test rig adapters T.206866. Remove the servo pressure supply orifices and fit blanks. Connect the fuel delivery from each pump, to pass through a separate restrictor, run the pump at 3085 rev/min and close each outlet restrictor; observe the delivery pressures, these must be between 200 and 400 lb/in^2 Reduce the pump speed to 1000 rev/min and ensure that there is a positive delivery pressure.

Volumetric efficiency

29. Repeat the test given in para. 3 of this appendix. Open the c.f. bleed to pass 20 to 25 gal/h. Record the efficiency at 3000 rev/min and 150 to 1000 lb/in^2 delivery pressure.

Governor range

30. Check the governor range at the conditions stated in para. 6 of this appendix.

Governor setting and response time

31. Repeat the checks on the governor setting and response time at the conditions stated in para. 4 and 5 of this appendix.

Governor synchronization

32. Repeat the governor synchonization test, para. 13 of this appendix.

Servo flow

33. Check the servo flow as stated in para. 14 of this appendix.

External fuel bleed

34. Repeat the centrifugal fuel delivery bleed test as stated in para. 17 of this appendix.

Solenoid endurance

35. Endurance test the solenoid operated servo isolating valve, run the pump and stall it by energising the valve. Repeat the cycle 15 times at full stall and then 15 times at half stall.

Leakage test

Running test

36. Repeat the pressure test with the pump running at the conditions stated in para. 18 of this appendix.

Porosity test

37. Apply air pressure at 40 lb/in^2 for a period of 15 min. There must be no leakage other than from the seal drain, which must not exceed 10 c.c. per min.

38. Remove the pump from the kerosine bath and fit the air supply to the seal drain. Re-immerse the pump and apply air pressure at 40 lb/in^2 for a period of 15 min. Check that there is no leakage past the garter seals (item 66, *fig.* 34) in the respective end covers. Air leakage past the carbon faced seal of the centrifugal rotor must not exceed 10 c.c. per min.

Final leakage test.

39. Following satisfactory completion of all calibrations and tests, finally lock all adjustment points. Mount the pump on the test rig and repeat the pressure tests as detailed in para. 18 to 20 of this appendix.

Insulation test (Solenoid valve)

40. Test the insulation of the solenoid valve by connecting the leads of an insulation resistance tester across the Breeze plug pins and the casting. Apply a pressure of 500 volts; resistance must be not less than 1 megohm.

APPENDIX 2

CALIBRATION CODE M

Introduction

This appendix is to be used in conjunction with the testing procedure, para. 358 to 405.

Fuel specification 73 NLAVGAS
Temperature limits 20 to 40 deg. C.
Inlet pressure 15 to 20 lb/in²
Gear lubrication D.T.D.44D
Applied pressure 20 to 25 lb/in².

Running-in

1.

Speed (rev/min)	Delivery pressure (lb/in²)	Duration (minutes)
1000	250	10
1500	250	20
1500	500	10
2000	500	10
2000	750	10
2500	750	10
3000	1000	10
3000	1500	10

Note . . .
The governor feed orifice is to be calibrated to give a flow of 22 to 23 gal/h at 1000 lb/in².

PRELIMINARY CALIBRATION

Pump stall pressure

2. Set at 2050 to 2200 lb/in².

Maximum stroke

3. Each rotor delivering to a separate restrictor at 3000 rev/min and 150 lb/in² delivery pressure.

Flow per rotor 1525 to 1575 gal/h
Combined flow 3050 to 3150 gal/h

Volumetric efficiency

4. At 3000 rev/min with delivery pressure of 150 and 1000 lb/in² the change in flow is not to exceed 270 gal/h. Compare the figure obtained with that in the preliminary calibration. There should be no appreciable change.

Governor pressure characteristic

5. (1) Record the differential pressure across the overspeed governor diaphragm at 3200 rev/min with delivery pressures of 1250, 400 and 150 lb/in². The differential pressure at 400 and 150 lb/in² must be within 5 lb/in² below that recorded at 1250 lb/in² delivery pressure.

(2) Record the differential pressure across the governor diaphragm at the following conditions. This must be within the stated limits.

Pump speed (rev/min)	Pump pressure (lb/in²)	Differential pressure (lb/in²)
2490	700	44 to 48 (Point A)
2490	1200	Point A (+1 to 2)
2600	700	Record as Point B
2600	1200	Point B (+ 1 to 2)
2700	700	Record as Point C
2700	1200	Point C (+ 1 to 2)
2840	700	Point C (+ 13·5 to 15·5)
2840	1200	Point C (+ 1 to 2)

Governor speed setting

6.

Point	Delivery pressure (lb/in²)	Speed (rev/min)
A	1250	3085
B	400	3180 to 3230
C	400	Within 20 rev/min below B
D	1200 to 1250	3060 to 3085

Recovery time

7. From point C to point D 0·8 to 2·0 seconds.

Governor range

8. 2700 rev/min to 3300 rev/min at 1250 lb/in².

INITIAL ENDURANCE TESTS

Straight endurance

9.

Duration	Speed (rev/min)	Flow (gal/h)	Delivery pressure (lb/in²)	Temp. (deg. C)
2 hr	3085	2600	1900	—
	(using an external stall valve)			
15 min	3085	2600	1900	36 to 40
10 min	3250	—	2000	—
	(at full stroke)			

Cycling endurance

10. Pump stall set at 2050 to 2200 lb/in² on each rotor. With pump stalled to 400 gal/h and speed range from 3000 to 2000 rev/min and back, the stall pressure must be within 1900 to 2200 lb/in². No adjustment to the stall valve is to be made during the cycles.

5 min. at 3085 rev/min, 2600 gal/h and 1900 lb/in²

10 min. at 970 rev/min, 140 gal/h and 800 lb/in²

Governor endurance

11. Complete 240 full governor cycles at point A conditions.

Starting test (*para.* 374)

12. Set the pump to idling conditions, i.e., 970 rev/min, 140 gal/h 800 lb/in² then stop the rig. Complete 25 starts from rest to idling with no alteration to the rig setting.

Volumetric efficiency

13. Repeat the test as in para. 4 of this appendix.

Governor setting

14. Repeat the test as in para. 6 of this appendix.

Recovery time

15. Repeat the test as in para. 7 of this appendix.

Synchronization check

16. Separate the two servo systems, using the test plug T.206866. With each rotor delivering through a separate restrictor, set ach pump at point A conditions of speed and pressure. Increase speed until both pumps have commenced to govern (denoted by a fall in delivery pressure) then continue to increase speed until each pump has achieved or exceeded point B. The differences in the separate pump pressures during the cycle from point A to B is not to exceed 150 lb/in².

Note . . .

Pump pressures are to be tapped upstream of the delivery non-return valves.

Servo flow-check

17. (a) Connect the pump as in fig. 46 and measure the servo flow at the following conditions:—

Speed (rev/min)	Main flow (gal/h)	Pressure (lb/in²)	Servo flow (gal/h) Kerosine	Gasoline
2880	150	400	13 to 17	15 to 19
2880	150	*1200	20 to 25	23 to 28
3000	1000	1400	Not less than at 1200 lb/in²/	

*At the 1200 lb/in² condition, cocks A and B are to be closed in turn. The servo flow must remain within the limits stated. Avoid closing both cocks together. The correct pump delivery pressure for these tests is to be obtained by using an external stall valve.

(b) At 1000 gal/h main flow and the external stall valve pressure increased to 1400 lb/in², vary the speed from 3000 rev/min to 2000 rev/min in decrements of 100 rev/min and return. The change in servo flow must not exceed 5 gal/h (gasoline) or 2 gal/h (kerosine). Repeat the test 5 times and record the results on the last cycle.

Governor check with external bleed

18. With 200 gal/h the flow from the camplate housing back to pump inlet the governed speed must not vary more than 10 rev/min from that recorded at point A.

Leakage tests

19. Wipe exterior of the pump dry. Connect the seal drain on the camplate housing to a measuring glass and run the pump for 5 minutes at each of the following conditions; the leakage must not exceed the amount shown:—

(a)

Inlet pressures (lb/in²)	Speed (rev/min)	Delivery pressure (lb/in²)	Carbon-faced seal leakage (c.c./h)
40	2750	Stall pressure	30
20	2000	1000	15
20	2750	Stall pressure	15
40	2750	Stall pressure	30

(b) Run the pump for five minutes at stall pressure, 2750 rev/min, 15 to 20 lb/in² inlet pressure and with 10 to 15 lb/in² pressure applied to the seal drain connection. No leakage is permitted.

(c) Stop the pump and apply fuel at an inlet pressure gradually from 0 to 20 lb/in². Maximum leakage from the seal drain is 15 cc/h. Increase the pressure slowly to 40 lb/in². Maximum leakage is 30 cc/h.

Self-priming test

20. Run the pump at 500 rev/min with the inlet closed. The pump must be capable of producing an inlet depression. Ensure that there is no appreciable change from the figure obtained in the initial endurance test.

Inspection

21. Dismantle, inspect and rebuild the pump. Measure the slipper lift; this must not exceed the lift when measured at initial build by more than 0·003 in. for phosphor-bronze slippers or 0·004 in. for beryllium copper slippers. Also measure the overall length of the piston and slipper assemblies for wear. The reduction in area must not be more than 0·001 in. for phosphor-bronze slippers or 0·002 in. for beryllium copper slippers.

RIG TESTING (FINAL)

22. Fuel specification, Gasoline D.ENG. RD. 2485 grade 73 or Kerosine D.ENG. RD.2482.

Temperature limits 20 to 30 deg. C.
Inlet pressure 15 to 20 lb/in²

Governor endurance

23. Repeat the test as in para. 11 of this appendix.

Pump stall pressure

24. Repeat the test as in para. 2 of this appendix.

Maximum stroke

25. Repeat the test as in para. 3 of this appendix. Record the idling flow at 970 rev/min with 800 lb/in² delivery pressure.

Minimum stroke setting

26. With blank servo restrictors fitted and delivery through separate rig restrictors, run the pump at 3085 rev/min and open the servo line to atmosphere to reduce the stroke of both pumps to minimum then close both rig restrictors completely. The indicated delivery pressure should be between 200 and 400 lb/in². Adjust by shimming under the minimum flow screw (105) fig. 39. When satisfactory, reduce the speed to 1000 rev/min and ascertain that there is a positive delivery pressure.

Volumetric efficiency

27. At 3000 rev/min and a delivery pressure of 150 and 1000 lb/in² the change in flow must not exceed 275 gal/h (gasoline) or 190 gal/h (kerosine).

Governor range

28. Repeat the test as in para. 8 of this appendix.

Governor pressure characteristic

29. Repeat the test as in para. 5 of this appendix.

Governor speed setting

30. Repeat the test as in para. 6 of this appendix.

Recovery time

31. Repeat the test as in para. 7 of this appendix.

Synchronization check

32. Repeat the test as in para. 16 of this appendix.

Servo flow checks

33. Repeat the tests as in para. 17 of this appendix.

Governor check with external bleed

34. Repeat the test as in para. 18 of this appendix.

Solenoid tests

35. Complete 15 operations at:—

(1) Stall pressure and zero flow
(2) Stall pressure and 1525 to 1575 gal/h.

Leakage tests

36. Repeat the tests given in para. 19 of this appendix.

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CALIBRATION CODE R

APPENDIX 3

Introduction

This appendix is to be used in conjunction with the testing procedure, para. 358 to 405.

Fuel specification 73 NLAVGAS.

Temperature limits 20 to 40°C.

Inlet pressure 15 to 20 lb/in² except where otherwise stated.

Gear lubrication D.E.F.2001, at an applied pressure of 20 to 25 lb/in².

Running-in

1.

Speed (rev/min)	Delivery pressure (lb/in²)	Duration (minutes)
1000	250	5
1500	250	5
1500	500	5
2000	500	5
2000	750	5
2500	750	5
3000	1000	5
3000	1500	10

Note . . .

The governor feed orifice is to be calibrated to give a flow of 22 to 35 gal/h. This flow may be varied within the stated limits to adjust the governor over-run figures. An increase in flow will result in increased over-run figures.

PRELIMINARY CALIBRATION

Pump stall pressure

2. Set stall on each pump to 1900 to 2200 lb/in². Combined stall to be 1900 to 2200 lb/in².

Maximum stroke

3. Each rotor delivering through a separate restrictor at 3000 rev/min and 150 lb/in² delivery pressure.

Flow per rotor 1525 to 1575 gal/h.

Combined flow 3050 to 3150 gal/h

Adjustment is possible by reducing the stroke. No increase in stroke is permissible.

Volumetric efficiency

4. Run the pump at 3000 rev/min. Record the change in flow between delivery pressures of 150 and 1000 lb/in² on each rotor. Record this flow loss which is not to exceed 275 gal/h (gasoline) or 190 gal/h (kerosine).

Note . . .

These limits are basic values quoted for a fuel temperature of 20°C. For temperatures in excess of 20°C, an additional flow difference of 0·75 gal/h for each increment of 1°C is permissible on single pump or 1·5 gal/h combined.

Hydro-mechanical governor pressure characteristic

5. Record the differential pressure across the overspeed governor diaphragm at the following conditions. This must be within the limits stated.

Pump speed (rev/min)	Pump pressure (lb/in²)	Differential pressure (lb/in²)
2490	700	48 to 51 (Datum)
2490	1200	Datum (+1 to +3). Record.
2840	700	Datum +13·5 to 15·5. Record.
2840	1200	That recorded at 700 (+0·1 to +3). Record.
3200	400	To be not more than 4 lb/in² below 1250 value. Record.
3200	1250	Record.

Governor speed setting

6.

Point	Delivery pressure (lb/in²)	Speed (rev/min)
'A'	1250	2900
'B'	400	3020 to 3060 (gasoline) 3010 to 3050 (kerosine)
'C'	400	Within 20 rev/min below point 'B'.
'D'	1200 to 1250	2880 to 2900

Straight endurance

7.

Duration (minutes)	Speed (rev/min)	Flow (gal/h)	Delivery pressure (lb/in²)	Temp. (deg.C)
110	3000	—	1600	—
	(using an external stall valve)			
15	3000	2000	1600	36 to 40
5	3150	—	2200	—
	(at full stroke)			

Cycling endurance

8. Pump stall set at 1900 to 2200 lb/in² on each rotor. With pump stalled to 400 gal/h and speed range from 3000 to 2000 rev/min and back, the stall pressure must be within 1800 to 2200 lb/in². Using the external stall valve for pressure settings, the pump is to complete 4 cycles consisting of:—

5 min at 3000 rev/min, 2000 gal/h and 1600 lb/in².

10 min at 1000 rev/min, 120 gal/h and 1250 lb/in².

Governor endurance

9. Complete 120 full governor cycles at point 'A' conditions (para. 6).

Starting test

10. Set the pump to idling conditions, i.e. 1000 rev/min, 120 gal/h, 1250 lb/in² then stop the rig. Complete 10 starts from rest to idling with no alteration to the rig setting.

Volumetric efficiency

11. Repeat the tests as in para. 4 of this appendix, with limits on individual and combined flows.

Governor setting

12. Repeat the tests as in para. 6 of this appendix.

Servo flow-check

13. Connect the pump as in fig. 37 and measure the servo flow at the following conditions.

Speed (rev/min)	Main flow (gal/h)	Delivery Pressure (lb/in²)	Servo flow (gal/h) Kerosine	Gasoline
2880	150	400	13 to 17	15 to 19
2880	150	1200	20 to 25	23 to 28
3000	1000	1400	Not less than that recorded at 1200 lb/in².	

(a) At the 1200 lb/in² condition, cocks 'A' and 'B' are to be closed in turn. The servo flow must remain within the limits stated. Avoid closing both cocks together. The correct pump delivery pressure for these tests is to be obtained by using an external stall valve.

(b) At 1000 gal/h main flow and the external stall valve pressure increased to 1400 lb/in², vary the speed from 3000 rev/min to 2000 rev/min in decrements of 100 rev/min and return. The change in servo flow must not exceed 5 gal/h (gasoline) or 2 gal/h (kerosine). Repeat the test 5 times and record the results on the last cycle.

Leakage tests

Carbon faced seal

14. Wipe exterior of pump dry. Connect the seal drain on the camplate housing to a measuring glass and run the pump for 5 minutes at each of the conditions; the leakage must not exceed the amount shown.

(a)

Inlet pressure (lb/in²)	Speed (rev/min)	Delivery pressure (lb/in²)	Carbon-faced seal leakage (c.m³./h)
20	2750	Stall pressure	15
40	2750	Stall pressure	30

Garter seal

(b) Connect the pump as in fig. 1 of this appendix, and run the pump for 5 minutes at stall pressure, 2750 rev/min, 15 to 20 lb/in² inlet pressure, and with 10 to 15 lb/in² fuel pressure applied to the seal drain connection. No leakage is permitted.

Examination

15. Dismantle, examine and rebuild the pump. Measure the slipper lift; this must not exceed the lift when measured at initial build by more than 0·003 in. for phospher-bronze slippers, or 0·004 in. for beryllium copper slippers. Also measure the overall length of the piston and slipper assemblies for wear. The reduction in length must not be more than 0·001 in. for phospher-bronze slippers or 0·002 in. for beryllium copper slippers.

RIG TESTING (FINAL)

16. Fuel specification. Gasoline D/ENG/RD.2485 grade 73, or kerosine D/ENG/RD.2494.

Temperature limits	20 to 30°C
Inlet pressure	15 to 20 lb/in²

Leakage test

17. (a) Repeat the test as in para. 14 of this appendix.

(b) Stop the pump and apply inlet pressure gradually from 0 to 20 lb/in². Maximum leakage from the seal drain is 15cm³/h. Increase the pressure slowly to 40 lb/in². Maximum leakage is 30 cm³/h.

Governor endurance

18. Repeat the test as in para. 9 of this appendix.

Minimum stroke settings

19. With blank servo restrictors fitted and delivery through separate rig restrictors, run the pump at 2880 rev/min and open the servo line to atmosphere to reduce the stroke of both pumps to minimum then close both rig restrictors completely. The indicated delivery pressure should be between 200 and 400 lb/in². Adjust by shimming under the minimum flow screw (105) in fig. 38. When satisfactory, reduce speed to 1000 rev/min, and ascertain that there is a positive delivery pressure.

Governor synchronisation check

(a) Separate the two servo systems using test plugs T.206866. Fit a 0·021 in. diameter servo restrictor orifice to each pump. Set stall on each pump to 1900 to 2200 lb/in². With each rotor delivering through a separate restrictor, set each pump at point 'A' conditions of speed and pressure. Increase speed until both pumps have commenced to govern (denoted by a fall in delivery pressure) then continue to increase speed until each pump has achieved or exceeded point 'B'. The differences in the separate pump pressures during the cycle from point 'A' to 'B' are not to exceed 150 lb/in².

(b) Remove the 0·021 in. diameter orifices and refit the standard orifice (low flow orifice in the lower pump). Remove the test plugs T.206866, and check the combined stall which is to be 1900 to 2200 lb/in².

Maximum stroke setting

20. (a) With each rotor delivering through a separate restrictor, set the maximum flow to 1070 to 1100 gal/h at 1250 lb/in² and 2865 rev/min (gasoline); record the total delivery which must be within 2140 to 2250 gal/h.

(b) Maximum flow from each rotor to be set at 1155 to 1185 gal/h (kerosine). Record the total delivery which must be within 2310 to 2420 gal/h.

(c) Record the idling flow at 1000 rev/min and 1250 lb/in² delivery pressure.

Volumetric efficiency

21. At 3000 rev/min and a delivery pressure of 150 and 1000 lb/in² the change in flow must not exceed 150 gal/h (gasoline) and 108 gal/h (kerosine) on the upper rotor; 125 gal/h (gasoline) and 82 gal/h (kerosine) on the lower rotor. Record the total flow loss at 3000 rev/min at 150 and 1000 lb/in² with both rotors discharging to a common restrictor. The limits are 275 gal/h (gasoline) and 190 gal/h (kerosine). The note in para. 4 is applicable.

Governor range

22. With governor point 'A' set at 1250 lb/in² the minimum range of governing must be 2700 to 3300 rev/min.

Governor pressure characteristic

23. Repeat the test as in para. 5 of this appendix.

Hydro-mechanical governor speed setting

24. Repeat the test as in para. 6 of this appendix. Pressure recovery time from point 'C' to point 'D' should be 0·8 to 2·0 seconds, after decreasing the rev/min to point 'A' setting as rapidly as possible.

Servo flow check

25. (a) Repeat the test as in para. 13 of this appendix.

(b) With 200 gal/h flow from the cam-plate housing back to pump inlet, the governed speed must not vary more than 10 rev/min from that recorded at point 'A'

Solenoid test

26. Complete 15 operations at:—

(1) Stall pressure and zero flow.

(2) Stall pressure and 1525 to 1575 gal/h

27. Remove the pump from the rig and complete all wire-locking

Leakage test

28. (a) With the pump connected to an air supply, immerse in kerosine and apply a pressure of 40 lb/in² for 15 minutes with the drain connection open. Release the air pressure gradually to zero. There must be no external leakage other than from the drain connection which must not exceed 10 cm³/min.

(b) Apply an air pressure of 40 lb/in² to the oil seal drain connection for 15 minutes. No leakage is permissible from the garter seals. Air leakage from carbon face seal is not to exceed 10 cm³/min.

Self priming test

29. (a) Refit the pump to the rig.

(b) Run the pump at 500 rev/min with the inlet closed. Record the inlet depression.

Leakage test

30. Repeat the tests as in para. 14 of this appendix.

Solenoid insulation test

31. 1 megohm minimum at 500 volts.

Operating the leakage test rig

32. (1) Open the fuel cock and the exhaust cock to fill the sight glass with fuel; then close the fuel and exhaust cocks.

(2) Open the air cock and adjust the reducing valve to give the required fuel pressure.

(3) Loosen the pipe connection to the pump seal drain to bleed the line, then adjust the fuel level to a 'fixed' mark, and tighten the connection.

(4) Run the pump as stated in this appendix to test seals for leakage; if no leakage occurs, the fuel level will remain constant.

(5) On completion of the leakage test, close the air cock and open the exhaust cock; then disconnect the pipe from the pump seal drain.

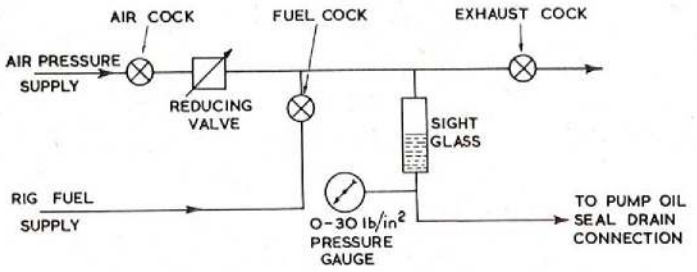

Fig. 1 Pump seal drain leakage test rig

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