Chapter 1

AIR/FUEL RATIO CONTROLS, TYPE A.F.R SERIES

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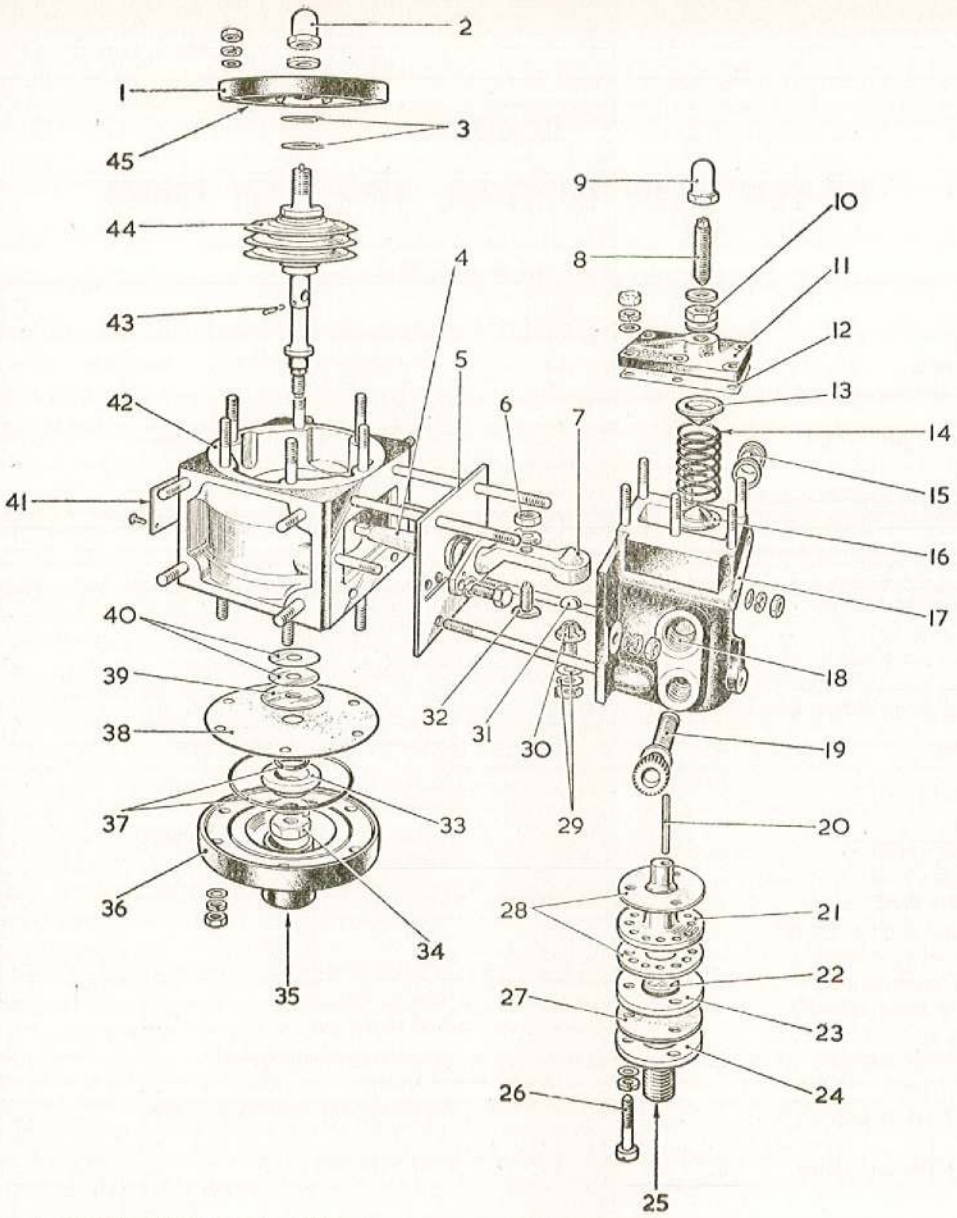

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Fig. I. Dismantled view of the air/fuel ratio control unit, Type AFR

GENERAL

1. The air/fuel ratio control unit is designed to maintain the proportion of fuel flow to air mass flow within certain predetermined limits, and thus to control the combustion temperature to a known value.

2. Variations of the basic type of control unit are available to suit individual installations, the differences being in the calibration values and installation fittings.

3. A typical type number (AFR.2/2A) comprises the basic type designation (AFR.2), followed by a stroke number (/2) which is the code reference indicating a particular installation, and a final letter (A) to indicate the performance schedule to which the particular unit has been calibrated.

4. The instructions contained in this chapter regarding dismantling and reassembling apply generally to all variations of the basic type; essential details and specific calibration figures for the various types are provided in the Appendices to this chapter.

5. It is important that a unit is handled with care at all times and not subjected to severe shocks, otherwise the capsule may suffer damage or the rocker lever operating needle may stick, either of which will disturb the calibration.

6. The importance attached to cleanliness when handling these components cannot be over-emphasized and extreme precautions must be taken at every stage of assembling and testing to ensure that all details are thoroughly clean.

7. Box or ring spanners should be used for nuts, bolts and unions wherever possible to avoid damage to the corners of the hexagons.

8. On time-expired units, joints and other sealing washers must be renewed; split pins, tab washers and locking wire must be renewed whenever they are disturbed.

9. It is recommended that slave unions, nuts and washers should be used in instances where a unit is to be assembled temporarily, namely, for initial testing, but any such components should readily be distinguishable to avoid the possibility of their retention on final assembly.

Special tools

10. Special tools and a test rig are required for the repair and overhaul of the air/fuel ratio control unit as listed.

Tool No.	*Description*
G.56967	Gauge—operating needle adjustment
T.140539	Jig—assembling and dismantling—rocker lever assembly
T.151165	Sealing plate—pressure test—rocker lever assembly
T.161439	Spanner—strainer assembly
T.174675	Spanner—orifice assembly
T.174678	Spanner—valve spring adjusting screw
*T.190702	Fixture—dismantling and assembling
T.194435	Locking plate—diaphragm assembly
T.196217	Extractor—blower pressure diaphragm cover
T.196218	Attachment—dial micrometer—checking rocker lever pre-load
—	Test rig—calibration and performance testing.

*This is being replaced by standard fixture for which adaptor T.196595 is required.

Checks and precautions before dismantling

11. Study any complaints reported with the unit and examine it externally for visible signs of damage or interference, particularly with regard to the locking wire on the valve spring adjusting screw domed lock-nut. Check that all connections have been blanked off with dust caps to exclude foreign matter. Inspect all exposed threads for damage in transit.

12. Remove the installation fittings and, if its condition will allow it to be tested, mount the unit on the test rig and carry out a performance calibration check in accordance with the appropriate test schedule in the relevant Appendix. If the unit is reported to be leaking however, it should be subjected first to a leakage test under the conditions specified in the test schedule in order to locate the source and nature of the leak and facilitate investigation of the cause.

DISMANTLING THE UNIT

General

13. One or more clean and dry metal receptacles should be available and the dismantled components should be placed in the receptacles for safe storage pending inspection.

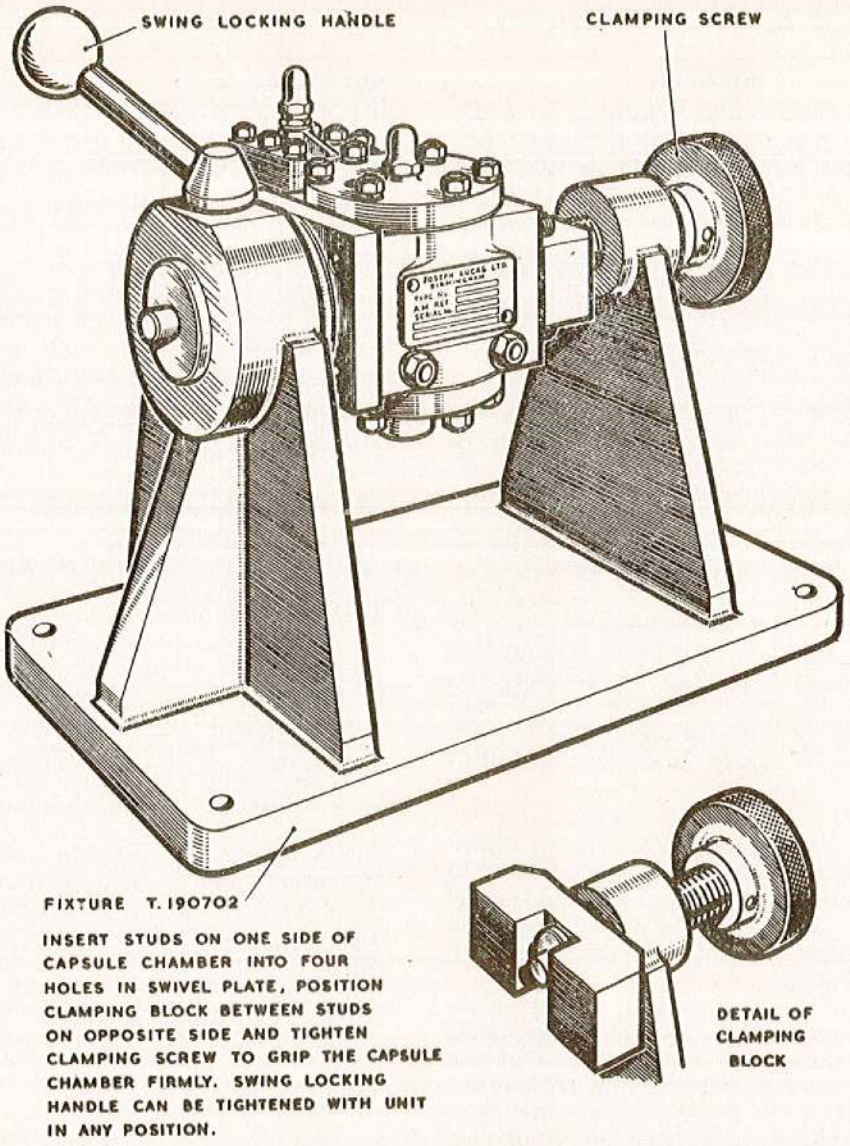


Fig. 2. Dismantling and assembly fixture

14. It is recommended that only one set of components be present on the workbench at any one time in order to avoid the accidental transfer of parts from one assembly to another and to reduce the possibility of shortages of the smaller items on rebuild. Tab-washers, split pins and pieces of locking wire must be discarded as they are removed.

Removing the installation fittings

15. Installation connections are fitted to the pump servo connection, to the pump suction connection and to the blower pressure connection; they comprise banjo pillars and banjo adaptors with suitable sealing washers. Cut and remove all locking wire and remove the fittings including the banjo pillars and their joint washers.

Removing the strainer assembly

16. Use tool No. T.161439 to remove the strainer assembly, which comprises the strainer element, spring and plug; these are assembled permanently and no attempt should be made to separate the details.

Removing the adjusting sleeve assembly

17. Extract the three cheese-headed set-screws which retain the adapter plate and remove the adapter and diaphragm. Check

the piston projection as described in para. 85, as the setting may have been disturbed. Remove the operating piston housing and operating piston, withdraw the adjusting sleeve from the valve chamber and invert the unit to shake the operating needle out of the sleeve bore.

Removing the valve spring

18. Remove the domed nut from the valve spring adjusting screw, slacken the lock-nut and rotate the screw anti-clockwise with spanner T.174678 until it feels free of the spring loading. Slacken the top cover retaining nuts evenly to reduce any remaining load on the spring. When free, remove the cover and withdraw the spring and spring plates.

Separating the chambers

19. Insert a screwdriver blade into the valve chamber and prise back the tabs securing the lock-nut on the small adjusting screw in the rocker lever, remove the lock-nut with a box-spanner and rotate the screw clockwise with a screwdriver until the end of the screw is flush with the surface of the lever. This will allow the screw head to clear the adjacent casting when the rocker lever is being withdrawn.

20. Remove the retaining nuts from the longitudinal studs securing the capsule chamber to the valve chamber and separate the two castings whilst holding the end of the rocker lever with a thumb inserted through the top of the valve chamber. Ease the capsule chamber away gently at first to avoid any possible damage to the pivot plate rubberized surface as the joint breaks down. It may be necessary to loosen the joint by tapping lightly with a hide hammer.

21. Invert the valve chamber so that the half ball will remain in the rocker lever recess then remove the thumb and withdraw the lever and pivot plate assembly, complete with the half ball, from the valve chamber.

22. Should the pivot plate adhere to the valve chamber facing, it may be necessary to ease it by moving the lever gently from side to side.

Note . . .

Do not attempt to move the lever up and down as this may distort the pivot plate and necessitate the renewal of the assembly.

Removing the orifice

23. Bend back the tabs of the tab-washer which secures the orifice and unscrew the orifice with spanner T.174675 inserted through the top of the valve chamber. Remove any shims that may have been fitted under the orifice flange and check and record their thicknesses to assist in replacement of the orifice on rebuild. Store the orifice and shims in a safe place where no accidental damage will be possible.

Removing the blower pressure diaphragm

24. Remove the retaining nuts from the diaphragm cover at the base of the capsule chamber and remove the cover with extractor T.196217. Hold the square on the end of the stem with locking plate T.194435 as shown in fig. 11, and release the diaphragm retaining nut after bending back the locking tabs. Remove the nut and tab washer then draw off the diaphragm retaining plate, sealing ring, diaphragm, top plate and shims (if fitted).

Removing the capsule assembly

25. The capsule can be removed only when the capsule chamber has been separated from the valve chamber and after the blower pressure diaphragm has been removed.

26. Slacken the dome nut in the centre of the top cover, to facilitate removal of the nut later, remove the top cover retaining nuts and lift the cover complete with the capsule assembly. Remove the dome nut completely and withdraw the capsule upper stem from the cover. Examine the stem flange and the counterbore in the cover for any shims which may have been fitted and store these in a safe place after checking their thicknesses to facilitate reassembly.

Dismantling the rocker lever assembly

27. It is not advisable to dismantle the rocker lever and pivot plate unless damage is suspected; the complete assembly normally is supplied for spares. If dismantling is necessary however, the jig No. T.140539 must be used for stripping and reassembling.

28. Remove the adjusting screw from the lever. It is advisable to re-fit the lock-nut

to the screw to avoid the nut becoming mixed with the various retaining nuts, which are the same apparent size but have coarser threads. Any attempt on re-build to fit this special nut to a retaining stud will scrap the nut and the stud threads.

29. Pass the valve end of the lever through the aperture in the jig and align the holes in the pivot plate with the jig dowels, press the plate flat against the jig face and tighten the knurled screw on to the adjusting screw boss on the rocker lever, as shown in fig. 3.

30. Prise back the locking tab from the rocker lever retaining nut and remove the nut, tab-washer and reinforcing washer. Release the knurled screw, withdraw the lever and plate from the jig and separate the plate from the lever.

CLEANING

31. Remove all joint washers. If any defect in the unit is suspected to be due to the presence of foreign matter the parts suspected should be inspected before cleaning, otherwise the cause of the defect may be washed away.

32. The components should be cleaned by pressure-washing in kerosine using an appropriate spray nozzle supplied by a pump having adequate filtering facilities.

33. Hard brushes, cloths and abrasives must not be used for cleaning under any circumstances.

34. After cleaning and drying the components should be placed in clean dry receptacles pending inspection.

INSPECTION

General

35. All visual inspection of the components is described in this section. In instances where dimensional checks of certain components are necessary, the appropriate information will be found in the Schedule of Fits and Clearances, Vol. 2, Part 2 of this Air Publication.

36. Each detail should be examined closely for signs of damage or excessive wear and if considered necessary, with due regard to the nature of the defect and to the function of the component, the part should be discarded and a replacement demanded.

37. To assist in maintaining the high standard of scrupulous cleanliness required, it is recommended that the surface of the inspection and assembly bench be covered with zinc sheeting, bakelized fabric or linoleum. Following inspection the components should be placed in clean receptacles containing a quantity of light oil for safe storage pending re-build.

Distortion checks

38. Distortion checks normally should not be necessary. Suspected distortion of joint faces may be checked with a surface plate and marking blue in accordance with general practice.

Permissible wear

39. All parts which are subject to wear must be checked dimensionally in accordance with the Schedule of Fits and Clearances.

Redundant parts

40. It is usual during inspection to reject all parts rendered redundant by modifications; the inspector, therefore, must have complete information covering modifications so that these can be embodied on re-assembly.

Scores and surface damage

41. Scores and surface damage on moving parts and joint faces generally will impair the operational efficiency of the unit, hence any part so affected should be rejected and a replacement demanded. In certain circumstances however, particularly where the region of operation is an outlying one and spares are not obtainable readily, slight defects which are insufficient seriously to impair the efficiency and safety of the unit may be acceptable at the discretion of the Inspector-in-Charge.

Installation connections

42. Inspect carefully all adapters and unions for cleanliness and general condition and ensure that all threads are undamaged. The joint faces of banjo connections and pillars must be free from damage or scoring which may prove sources of leakage.

Strainer assembly

43. Examine the strainer wire for cleanliness and damage and check that there is no distortion of the coils. Ensure that the threads of the plug are free from damage.

Adjusting sleeve assembly

44. Examine the components generally for any visible defects. The operating needle, adjusting sleeve bore, operating piston and piston sleeve particularly must be free from scoring, corrosion and other damage ; these are the most critical parts of the unit and the smallest defect may result in excessive hysteresis.

45. Inspect dimensionally the operating piston and sleeve, the needle and the adjusting sleeve.

46. Dry the adjusting sleeve bore and operating needle thoroughly and check that the needle will slide freely in the sleeve. Check the operating piston and cylinder in a similar manner.

47. Examine the diaphragm for swelling, excessive stretch or distortion and other damage, renewing it if necessary.

48. Inspect the adapter plate, retaining screws and washers generally for serviceability, ensuring that the threads are clean and undamaged.

Capsule assembly

49. Examine the capsule for distortion and damage and for any signs of corrosion particularly between the plates. Check that the threads at each end of the stem are clean and undamaged and that the pin through the lower stem is not worn unduly. See that the square portion and flats at the upper and lower ends of the stem are undamaged.

Rocker lever assembly

50. Visually inspect the lever and pivot plate for damage and distortion. Check that there is no deterioration on the rubberized surfaces of the pivot plate and examine for indentation of the surface at the edges and around the central hole ; if the indentation is severe a new plate should be fitted on rebuild. There should be no undue wear on the capsule end of the lever and at the other end the half ball recess should be clean and smooth.

51. See that the rocker lever adjusting screw and lock-nut are serviceable, that their threads are clean and undamaged and check that the head of the screw is free from corrosion and indentation due to contact with the end of the operating needle.

Half-ball valve

52. Examine the half-ball for serviceability, ensuring that it is free from corrosion and scoring. Check the sealing surface for flatness with an optical flat ; if more than two colour-bands are apparent the half-ball must be rejected and a new half-ball fitted.

Blower pressure diaphragm

53. Examine the diaphragm for swelling, distortion, excessive stretching and other damage. Slight indentation of the surface by the sealing rings will be apparent and is acceptable provided that in each case it is little more than a surface mark. If the indentation is severe however, the diaphragm must be scrapped.

54. Inspect the diaphragm retaining plate and top plate for damage and see that the surfaces which contact the diaphragm are smooth. Check that the retaining nut is satisfactory and that the threads are clean and undamaged.

Orifices

55. Inspect the lands of the orifice to see that they are clean, smooth and free from damage and corrosion. Check the orifice face for flatness using an optical flat ; if no colour registration is obtainable on the orifice face and on each of the lands the orifice must be rejected and a new one fitted. Ensure that the bore is clean and unrestricted.

Spring plates and spring

56. Check that the spring plates are thoroughly clean and undamaged, particularly in the bottom of their seating recesses and on the spring seatings. Examine the spring for damage, distortion and surface cracks and check that it is thoroughly clean on the end faces and between the coils.

Valve chamber

57. Examine the valve chamber for cleanliness particularly in the filter housing bore and in the orifice retaining bore. Ensure that the joint faces of the top cover and of the connection are free from scoring and other damage which may permit leakage to occur. Check the tapped holes for cleanliness and that the threads are in good condition.

Valve chamber top cover

58. Check the threads in the tapped central hole for cleanliness and general condition. Ensure that the retaining stud holes are clean and that the joint face is free from scoring and other damage which may be a source of leakage. See that the lockwire hole in the cast rib is clear and undamaged. Check that the threads, adjusting square and conical end of the spring adjusting screw are in good condition.

Capsule chamber

59. Inspect the joint faces for freedom from scoring and other damage likely to result in leakage. See that the external cast surfaces are free from damage and check internally and externally for any signs of corrosion. Examine all studs for general condition and damaged threads.

Capsule chamber top cover

60. Check that the joint face is clean and undamaged and that there is no corrosion present. Make sure that the shims have been removed from the counterbore in the underside of the cover and that the face and edges of the counterbore and capsule anti-rotation slot are clean and undamaged. Inspect the gauze air strainer for damage and for restriction due to accumulation of dirt.

Capsule chamber diaphragm cover

61. Inspect the cover generally for damage and corrosion and see that the threads in the central boss are clean and in good condition. See that the rubber sealing ring has been removed and that the groove is clean.

REASSEMBLING THE UNIT

General

62. Ensure that all details, tools and bench are thoroughly clean.

63. When fitting joint washers, smear the joint face lightly with white petroleum jelly to retain the washer whilst offering up the adjacent components. Rubber sealing rings must be soaked in kerosine for a period of not less than 24 hours to permit maximum absorption of fuel before fitting.

64. Certain pressure tests necessary during rebuilding are described in their proper sequence. Test conditions may vary according to installation requirements, consequently reference must be made to the appropriate schedule in the Appendices to this chapter for the specific test and calibration valves.

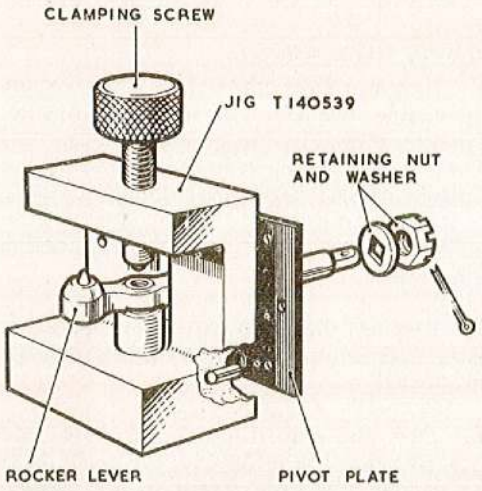


Fig. 3. Assembling the rocker lever and pivot plate

Rocker lever assembly

65. If the rocker lever and pivot plate have been separated the parts must be re-assembled using the jig No. T.140539, as shown in fig. 3.

66. The rubberized material on the pivot plate may be thicker on one side of the plate than on the other, in which case the thickest side should be fitted towards the half ball valve end of the rocker lever, that is, towards the higher pressure side.

67. Insert the rocker lever in the jig plate as shown, pass the pivot plate over the capsule end of the lever and locate the plate on the jig dowel pins. Hold the plate flat against the face of the jig, ensure that the face of the rocker lever flange is in contact with the pivot plate and tighten the knurled screw on to the rocker lever spot-face. Pass the reinforcing washer over the lever, making sure the smooth side with a radiused edge is towards the plate, and locate the washer on the square portion of the lever, then fit the tab-washer and retaining nut and tighten securely. Locate the nut ready for locking but do not bend the tab-washer up until after the assembly has been pressure tested and approved.

Pressure testing the pivot plate

68. Remove the assembly from the jig and fit it to the valve chamber. Secure the pivot plate by fitting the special sealing plate T.151165 and suitable nuts and bolts. A suitable distance tube should be fitted to each of the long studs protruding from the valve chamber (*fig.* 4).

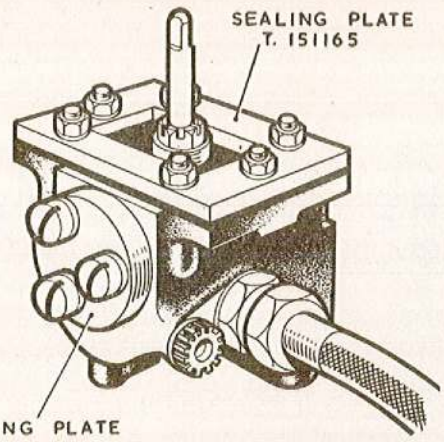


Fig. 4. Pressure testing the pivot plate

69. Fit the top cover, interposing a joint washer, and seal off all apertures with blanking plugs, except for the 'return-to-pump-suction' connection, to which a union suitable for an air line connection should be fitted.

70. Connect an air line, apply the air pressure stated in the appropriate schedule in the Appendix and immerse the assembly completely in kerosine for the specified period. There must be no leakage from the joint face or from around the reinforcing washer on the rocker lever.

Note . . .
It is important that the specified pressure is not exceeded otherwise the pivot plate diaphragm may rupture.

71. When satisfactory remove the sealing plate, top cover and blanking plugs, remove the rocker lever assembly from the valve chamber and lock the tab-washer securely against the retaining nut. Fit the operating needle adjusting screw to the rocker lever, screwing it in until the slotted end is flush with the top surface of the rocker lever. Place the lock-nut where it cannot be mixed with any retaining nuts.

Fitting the orifice

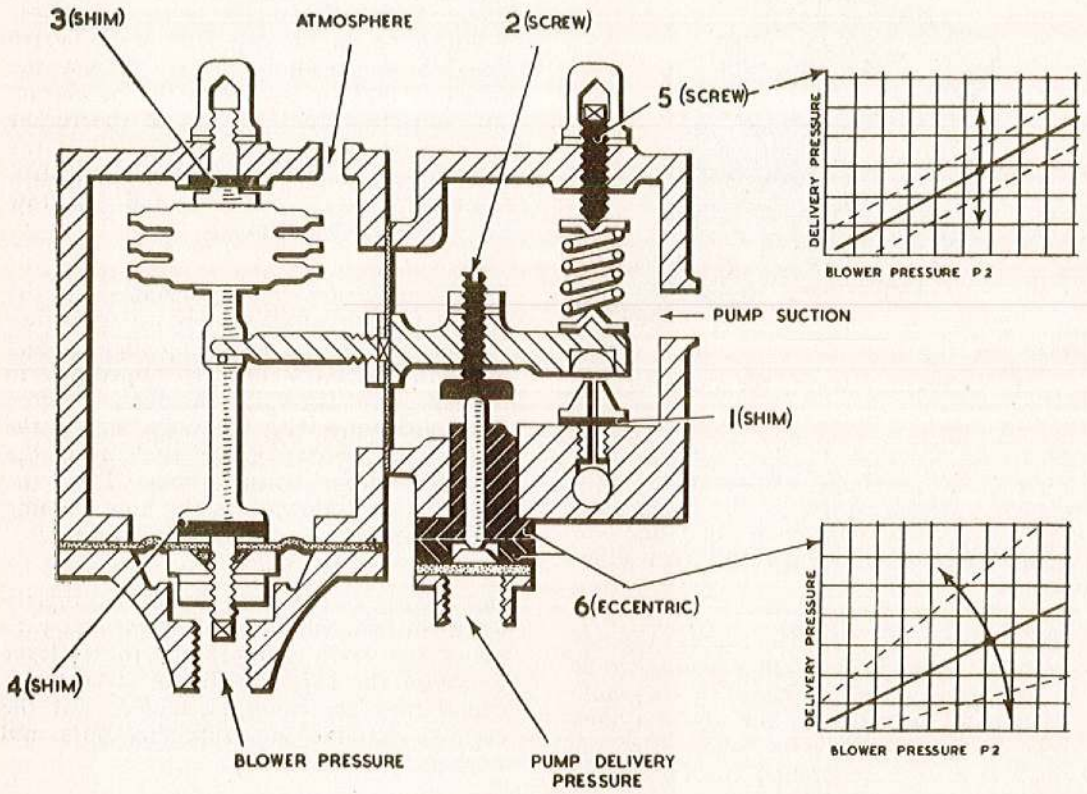
72. The orifice is assembled to the valve chamber and the height adjusted by shimming so that when the rocker lever is in the free position, namely, with no load applied to either end, the half ball is loaded lightly on to the orifice face ; this condition is termed the rocker-lever pre-load.

73. Fit the rocker lever assembly to the valve chamber, fit the capsule chamber and retaining nuts and tighten fully. Place the holder T.196218 complete with a dial test indicator on to the top face of the valve chamber as shown in fig. 6. Adjust the indicator dial to zero with the measuring button resting on the point of the rocker lever spring seating. Lock the dial at the zero setting, remove the complete instrument, separate the chambers and withdraw the rocker lever assembly.

74. Assemble two 0·012 in. shims over the orifice threads, followed by a new tab washer with the tabs bent up slightly, and screw the assembly into the tapped hole in the bottom of the valve chamber. Tighten the orifice fully with the single tab of the tab washer protruding over the edge of the adjusting sleeve housing bore. Prise the end of the tab down into the bore, gaining access through the rocker lever aperture.

75. Fit the rocker lever assembly complete with the half ball. It will be necessary to invert the valve chamber and rocker lever to retain the half ball in the lever recess whilst they are being assembled. Fit the capsule chamber and retaining nuts and washers. Tighten fully.

76. Place the dial test indicator on to the valve chamber face again and note the reading with the measuring button contacting the rocker lever point. The reading now should be 0·003 in. to 0·006 in. on the 'plus' side of the dial, i.e. the half-ball is loaded lightly on to the orifice face and is thus lifting that end of the rocker lever by the amount indicated. If the amount indicated is less than that specified, depress the end of the lever to obtain the 'minus' reading, dismantle the assembly and increase the thickness of the shims beneath the orifice by an amount equal to the difference between the indicated 'minus' figure and the specified figure. Should the indicated amount be greater than that specified the shims must be reduced accordingly. Re-build the assembly as before and check again. This process must be repeated until the required figure is obtained, noting that the orifice must be fitted with its tab washer and must be tightened fully each time. A setting of 0·005 in. is recommended to provide the most desirable pre-load.



Adjustments during assembly

(a) Shim orifice (1) to obtain rocker lever pre-load of 0·003 to 0·006 in., refer to para. 72 to 77.

(b) Adjust (2) to give piston height of 0·004 in. to 0·006 in. above face of cylinder, refer to para. 85.

(c) Assemble (3) initially with two 0·012 in. shims, refer to para. 91 and 92.

(d) Shim (4) initially to set diaphragm level with face of capsule chamber, refer to para. 94 to 96.

Adjustments during calibration

(e) Adjust (5) to set initial datum point, refer to para. 105.

(f) Adjust (3) to obtain fall-away point at blower depression, refer to para. 106 and 107.

(g) Adjust (5) to raise or lower curve bodily, refer to para. 108 to 111.

(h) Adjust (6) to alter slope of curve, refer to para. 108 to 110, 113 and 114. Re-check (f) and (g).

(i) Adjust diaphragm shims (4) only if necessary to balance (5) and (6), refer to para. 116 to 118. Re-check (f), (g) and (h).

Fig. 5. Schematic diagram of adjustments

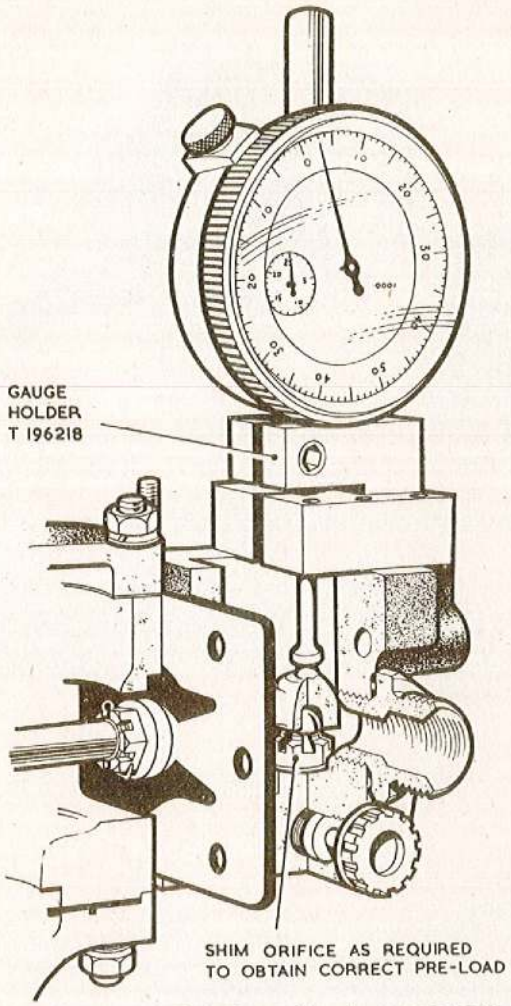


Fig. 6. Adjusting the rocker lever pre-load

77. Should the adjustment required appear excessive it may be found advantageous to reverse or invert the pivot plate on the rocker lever, otherwise a new plate should be tried. If this fails to give a satisfactory result the rocker lever has probably been bent or distorted and a new lever assembly should be fitted. When the specified pre-load has been obtained lock the tab-washer tabs against the orifice hexagon flats.

Pressure testing the half-ball valve

78. Place the spring seating plate in position on the rocker lever, insert the valve spring and top plate, fit the adjusting screw to the top cover and fit the cover, ensuring that the conical end of the adjusting screw is seating in the top spring plate recess. Secure the top cover with its retaining nuts and washers and tighten fully. Rotate the adjusting screw to load the rocker lever, through the valve spring, so that the half ball is firmly but not heavily seated on the orifice face.

79. Insert the strainer assembly complete with an aluminium joint washer, screw in tightly with the tool T.161439, and insert a suitable union in the fuel pump servo connection. Connect a high-pressure pipe from a convenient fuel supply and apply the fuel pressure specified in the appropriate schedule in the Appendix. Maintain the pressure for the period specified in the schedule during which there must be no leakage.

80. In the event of leakage occurring remove the half ball and orifice and check their faces with an optical flat as described in para. 52 and 55; renew whichever is defective.

Assembling the adjusting sleeve

81. De-magnetize the adjusting sleeve and see that it is thoroughly clean. Fit a joint washer over the sleeve body after smearing a little white petroleum jelly on the valve chamber facing, press the washer on to the flange face and align the holes. Insert the sleeve in the valve chamber and push in

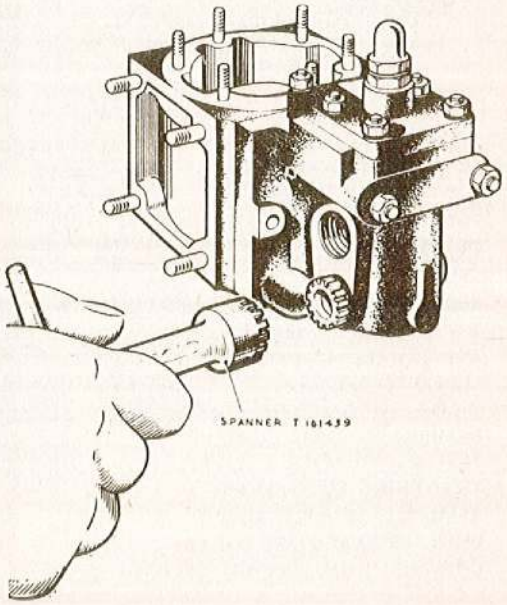


Fig. 7. Fitting the strainer assembly

gently. Rotate the sleeve so that the engraved 'X' on the flange circumference is positioned at the mid-way point, which is at right-angles to the centre-line of the unit.

82. Slacken the valve spring adjusting screw, remove the valve chamber top cover and lift out the spring and spring plates. Rotate the adjusting screw in the rocker lever anti-clockwise until the head of the screw contacts the underside of the lever. Slack the screw a half-turn and fit the tab-washer and lock-nut.

83. De-magnetize the operating needle and insert it in the adjusting sleeve bore.

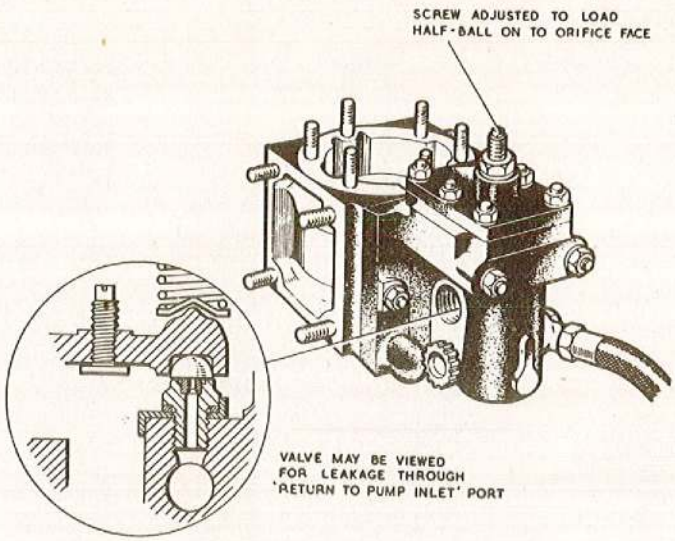


Fig. 8. Pressure-testing the half-ball valve

84. Smear the face of the sleeve with white petroleum jelly and fit a joint washer, then fit the operating piston sleeve; this has an 'X' engraved on its circumference and should be fitted so that the marking coincides with that on the adjusting sleeve. Fit the retaining setscrews with additional washers in place of the diaphragm and adapter plate and tighten the assembly.

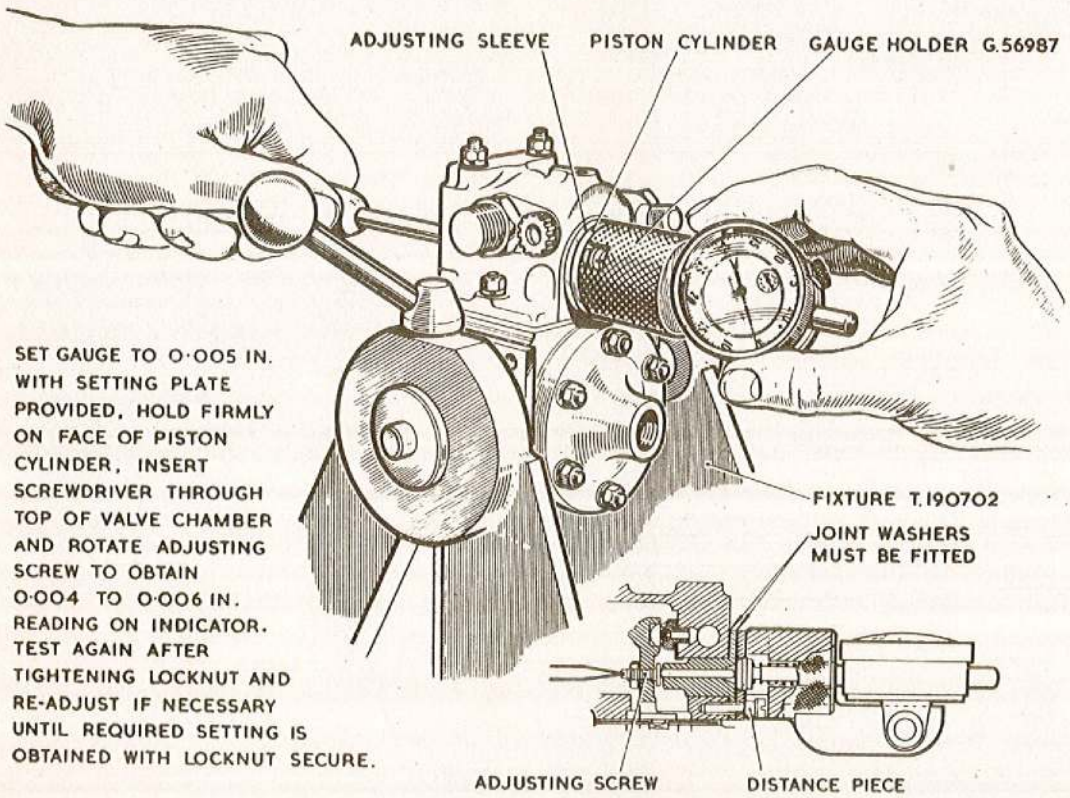


Fig. 9. Adjusting the operating needle

Adjusting the operating needle

85. Invert the unit and insert the piston, small end first, into the operating sleeve. Set the dial micrometer in gauge G.56967 to 0·005 in. using the setting plate provided, place the gauge on the face of the operating cylinder, as shown in fig. 9, and adjust the piston height by rotating the adjusting screw in the rocker lever with a screwdriver inserted through the top of the valve chamber. The screw is to be adjusted until the dial indicates a projection of 0·004 to 0·006 in. with the half-ball seated firmly on the orifice face by finger pressure on top of the rocker lever. When the setting is satisfactory, tighten the adjusting screw lock-nut and check the setting again, correcting it if necessary, before locking the tabwasher.

86. Remove the micrometer, remove the operating sleeve retaining setscrews and fit the operating diaphragm. It may be found that one face of the diaphragm is smooth whilst the other face is coarsely grained; the coarse face should be fitted towards the operating piston.

87. Fit the adapter plate, washers and setscrews and tighten fully.

88. Refit the valve spring and plates, fit the top cover, washers and retaining nuts and tighten fully. Screw in the adjusting screw to restore the valve spring loading, fit the lock-nut and tighten finger tight. Do not fit the dome nut as the loading will require adjustment on test.

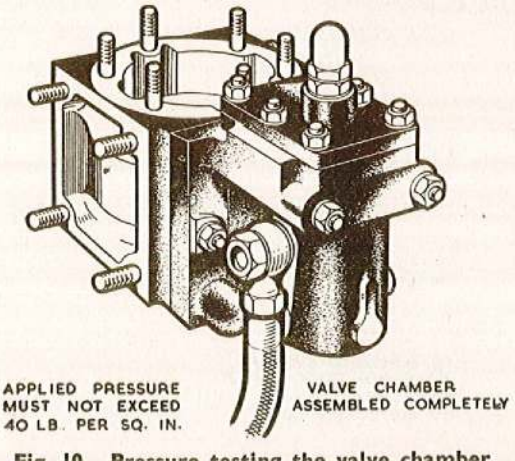


Fig. 10. Pressure testing the valve chamber assembly

Pressure testing the valve chamber assembly

89. With the valve chamber assembled completely fit a suitable adapter to the 'return-to-pump-suction' connection and connect an air supply pipe. Immerse the unit completely in kerosine and apply an air pressure of not more than 40 lb. per sq. in. for a period of 1 minute.

Note . . .

It is important that the specified pressure is not exceeded otherwise the pivot plate diaphragm may rupture.

Fitting the capsule assembly

90. Separate the capsule chamber from the valve chamber taking care to avoid disturbing the rocker lever assembly.

91. Assemble two 0·012 in. shims to the capsule upper stem or refit the shims removed during dismantling.

92. Insert the upper stem of the capsule stack into the capsule chamber cover and ensure that the flats on the stem shoulder engage with the flats in the rim of the counterbore in the cover. Fit the washer and retaining dome nut and tighten finger-

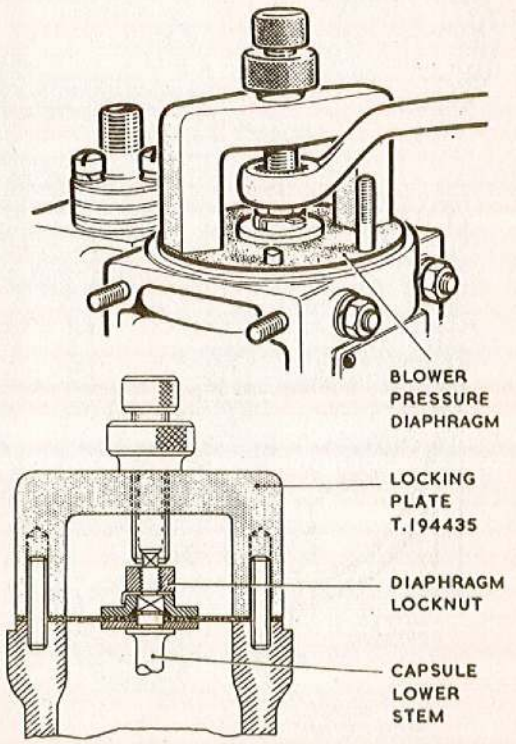


Fig. 11. Tightening the diaphragm locknut

tight. Place the assembly in the capsule chamber and fit two retaining nuts to hold the cover. The cover joint washer must be fitted.

93. Refit the capsule chamber to the valve chamber, ensuring that the aperture in the capsule lower stem passes over the end of the rocker lever. Fit the retaining nuts and washers and tighten fully.

94. Place two shims over the lower end of the capsule stem so that the shims bear against the flange, then fit the diaphragm top plate, diaphragm, retaining plate, washer and nut in that order. Tighten the nut finger-tight.

95. The diaphragm should lie flat and the centre should be level with the periphery when this is in contact with the capsule chamber face. If the diaphragm does not lie level remove the details and adjust by adding or removing shims as required.

96. When satisfactory remove the retaining nut, washer and retaining plate, pass a rubber sealing ring over the end of the stem so that the ring is in contact with the diaphragm, refit the retaining plate and nut, with a plain washer and tighten fully.

97. Place a rubber sealing ring in the groove in the face of the diaphragm cover, fit the cover, plain washers, spring washers and retaining nuts and tighten fully.

Pressure testing the diaphragm

98. Remove the capsule retaining dome nut, top cover retaining nuts and top cover. Fit a suitable adapter to the diaphragm cover and connect an air line. Apply air at the pressure stated in the test schedule in the relevant Appendix for the specified period with the unit immersed completely in kerosine. There must be no leakage through or across the diaphragm.

99. Refit the capsule chamber top cover and capsule retaining dome nut and fit the appropriate unions and adapters for installation on the test rig.

CALIBRATING AND RIG TESTING

General

100. For the calibration and performance test the unit is mounted on the test rig as shown in fig. 12. The calibration values and performance requirements vary according to the requirements of different engine installations, but as the test procedure is

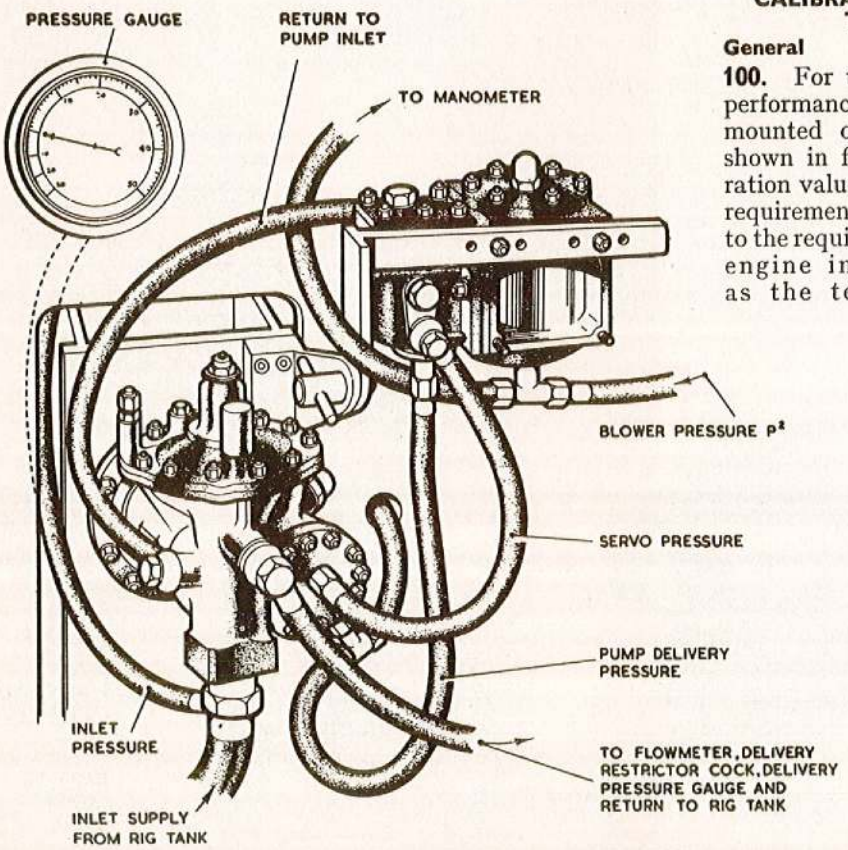


Fig. 12. Installation on the test rig

similar for all types, a standard basic test schedule is described which is applicable to all units.

101. The calibration values and specific performance test requirements for the different types are given in the relevant calibration code in the Appendices of this chapter.

102. During the final test the performance figures are to be recorded on a test certificate and must be approved by an inspector.

Setting the capsule effective range

103. Instal the unit on the rig. Check that the flowmeter cock is open, and that the restricting cock is set to minimum pressure.

104. Start the rig pump and allow the rig to run for a few minutes to stabilize and attain its working temperature.

105. Close the restrictor cock until the flow is as stated for zero blower pressure in the Appendix and set the delivery pressure to within the corresponding specified limits by means of the valve spring adjusting screw; rotate the screw clockwise to increase and anti-clockwise to decrease the pressure. Open the vacuum pump cock gradually and check that the delivery pressure ceases to fall, and remains constant with continued increase in depression, between the limits stated in the test schedule.

106. Should the depression be outside either limit, close the vacuum cock and stop the rig pump. Remove the capsule dome nut and top cover and if the depression required to obtain the constant delivery pressure was greater than the maximum limit stated in the schedule, the thickness of the shims must be increased, whilst the thickness must be decreased if the depression was less than the minimum.

107. Start the rig pump and check again, adjusting the shims as required until a satisfactory result is obtained.

Preliminary calibration

108. Start the rig and when it has stabilized set the blower pressure and flow to a value mid-way up the test schedule calibration table and adjust the restrictor cock to produce the corresponding flow when the delivery pressure should be between the appropriate limits stated in the table.

109. Increase the blower pressure and flow to the maximum value stated and note the indicated delivery pressure; record this as point ' b '. Do not re-adjust the restrictor cock.

110. Reduce the blower pressure and flow to the minimum positive value stated and again note the indicated delivery pressure, recording it as point ' a '.

111. If at point ' a ' and ' b ' the indicated delivery pressure is in both cases either above or below the minimum stated in the table, rotate the valve spring adjusting screw IN to RAISE the pressure or OUT to DECREASE the pressure and set it so that the indicated delivery pressure is just within the minimum limit at point ' a '.

112. Increase blower pressure and flow to point ' b ' and check again. If the delivery pressure is within the stated limits return to the lowest value in the table, which in some schedules may be a depression given as Abs. pressure. Carry out a complete check at each value specified in the schedule and check each at each value again for hysteresis on the return to minimum pressure. The unit may be considered satisfactory if at all values the delivery pressure is within the stated limits and hysteresis does not exceed the permissible figure.

Adjusting the amplification ratio

113. Reverting to the initial check in para. 108 to 110, if it is found that at point ' a ' the indicated delivery pressure is outside either limit whilst at point ' b ' it is outside the opposite limit, that is, outside the minimum limit at point ' a ' and outside the maximum limit at point ' b ', or vice versa, the slope of the performance curve is incorrect (*refer to fig.* 5). This is rectified by rotating the operating needle adjusting sleeve to alter the amplification ratio.

114. After removing the three retaining setscrews from the adjusting sleeve assembly, locate the ' x ' marking on the sleeve flange and cylinder and rotate the assembly one or more holes to move the ' x ' towards the capsule chamber to increase the angle of the slope, that is, to raise the pressure at point ' b ' towards the maximum limit. Conversely, the sleeve is rotated to move the ' x ' marking away from the capsule chamber to lower the

indicated pressure at point 'b', and decrease the slope angle, fig. 5.

Note . . .
Each hole in the adjusting sleeve flange alters the delivery pressure by approximately 40 lb. per sq. in.

115. The blower pressure and flow must now be reduced again to the specified minimum pressure, which may have altered slightly with the alteration in amplification ratio. If the alteration has been sufficient to throw the indicated delivery pressure outside either limit the valve spring adjusting screw must be reset to restore the figure to within the required limits, after which the unit must be tested again over the full range. Before re-adjusting the spring loading however, the capsule effective range (fall-away point) must be re-checked as described in para. 103 to 107, and the shims altered as necessary.

116. If it is found that the calibration cannot be obtained satisfactorily by adjustment of the amplification ratio and valve spring loading as described, a fine adjustment is provided by the shims under the blower pressure diaphragm. These shims compensate for the elasticity of the diaphragm and increasing the thickness of the shimming will have the effect of increasing the delivery pressure slightly at a given blower pressure and flow value, whilst conversely a reduction in shim thickness will have the effect of decreasing the delivery pressure.

117. After making any alteration to the diaphragm shimming the unit must be re-tested over the entire range and the fall-away point, amplification ratio and valve spring loading re-adjusted as necessary.

118. It is essential that the capsule effective range (fall-away point) be re-checked as described in para. 103 to 107, whenever the diaphragm shims, amplification ratio or valve spring loading are altered.

Preliminary test

119. Run the rig in stages at increasing blower pressures and fuel flows in accordance with the values specified in the test schedule. At each stage record the pump delivery pressures, which must be within the stated limits over the full range of the test.

120. When the maximum blower pressure and flow has been reached begin to reduce these values and during the return down the range, pause at each given stage and record the delivery pressure alongside those recorded previously. Any difference between the two readings at any one stage indicates the amount of operating needle hysteresis and must not exceed the hysteresis limit stated in the schedule.

121. In the event of excessive hysteresis, stop the rig, remove the operating needle and adjusting sleeve assembly and examine the needle closely for a slight score or a minute particle of foreign matter or corrosion.

122. Clean the needle and sleeve bore thoroughly and pass the needle through a de-magnetizing coil before refitting it to the adjusting sleeve.

123. If the hysterisis is still excessive fit a new needle or sleeve, whichever is found to be defective. Whenever a new needle or sleeve is fitted the needle adjustment must be checked and re-set if necessary as described in para. 85 and the calibration must be checked and adjusted if required as described in para. 103 to 118.

Initial endurance test

124. Following satisfactory results from the preliminary calibration and test, the unit must be subjected to a cyclic endurance test during which the blower pressure is to be varied over a given range at regular intervals. The range of blower pressure, the time interval of the cycles and the duration of the test are to be as stated in the test schedule in the relevant Appendix.

Strip inspection

125. After completing the initial endurance test the unit is transferred to the assembly bench to be dismantled, when all working parts are to be inspected for wear and possible defects.

126. Remove the operating needle and adjusting sleeve assembly and inspect the parts thoroughly for signs of undue wear or scoring. If blisters are apparent on the operating diaphragm a new diaphragm must be fitted on re-build.

127. Remove the blower pressure diaphragm cover and examine the diaphragm surface for severity of sealing ring indentation, excessive stretch and any signs of deterioration.

128. Slacken the valve spring adjusting screw, remove the valve chamber top cover and remove the spring assembly. Separate the capsule chamber from the valve chamber, remove the rocker lever and the half ball and examine the faces of the half ball and orifice for undue wear. Inspect the pivot plate for any signs of surface deterioration and check for wear on the capsule end of the rocker lever.

129. Should any component prove to be unsatisfactory it must be discarded and a replacement fitted.

130. Following the general inspection of the components, the unit is to be rebuilt. If either the orifice, rocker lever assembly or blower pressure diaphragm assembly have been dismantled they must be rebuilt and pressure tested in accordance with the appropriate instructions under 'Re-assembling the Unit' (para 62.) Inhibit the capsule by pouring oil to Specification DTD.587 into the capsule chamber to cover the capsule, then allow the surplus to drain before re-assembling to the valve chamber.

Final endurance test

131. The unit must be re-calibrated and tested as described in para. 103 to 124 after which it must be subjected to a final endurance test.

132. In the final endurance rig test the blower pressure is to be varied over a given range at regular intervals. The range of blower pressures, the time intervals of the cycles and the duration of the test are to as stated in the appropriate test schedule in the Appendix.

Final calibration

133. Following the final endurance test the unit must be re-calibrated and performance tested as described in para. 103 to 124. The performance and hysteresis figures obtained must be in accordance with the requirements of the test schedule in the Appendix.

134. When the calibration is satisfactory remove the blower pressure diaphragm cover, remove the nut and plain washer from the capsule stem, fit a new tab washer, refit the nut, tighten fully and lock the tab-washer. Refit the diaphragm cover and pressure test as described in para. 98.

Note . . .

The calibration must be re-checked to ensure that the disturbance of the capsule chamber top cover for pressure testing has not affected the fall-away point.

135. The final calibration figures must be recorded on the test certificate and approved by an inspector.

PREPARING FOR DESPATCH

Inhibiting

136. Connect a suitable oil supply to the pump servo inlet connection and flush the valve chamber thoroughly with oil to Specification DTD.587, allowing the surplus oil to

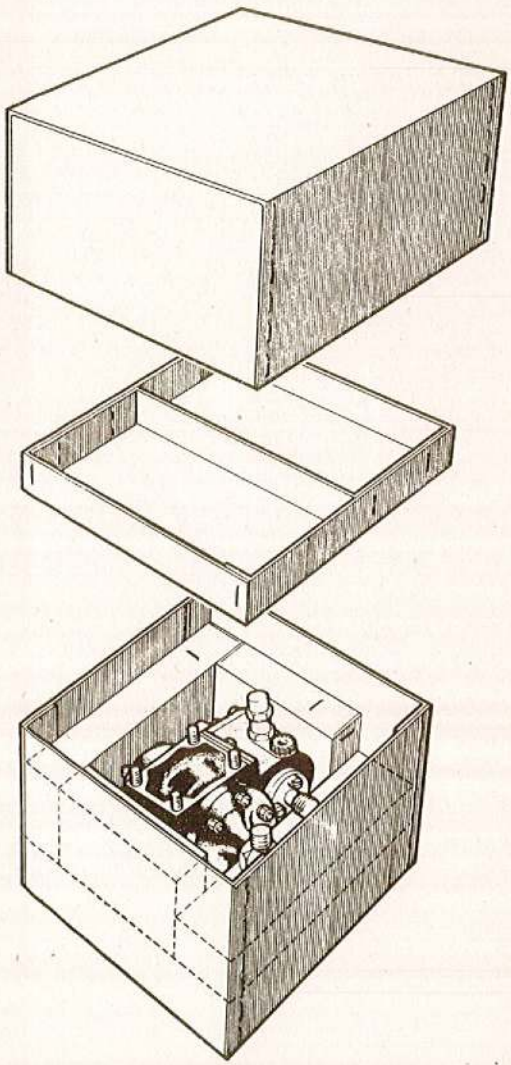


Fig. 13. Transportation box

drain from the pump suction union. The capsule chamber is inhibited for convenience during final re-build as described in para. 130.

Assembling the installation fittings

137. Refit the appropriate installation fittings to the unit in accordance with the particular engine type for which the unit is required. Where rubber sealing washers surrounded by steel washers are used ensure that the rubber is not trapped on the edge of the steel washer before tightening the connection.

Wire locking

138. Wire lock the components where required with stainless steel 22 S.W.G. locking wire.

Final inspection

139. Fit dust caps to all connections, check that the wire locking is satisfactory, that the name plate is secure, and that the information on the plate corresponds with the actual details of the unit and of the test certificate.

140. See that the test certificate is complete and approved by an inspector.

APPENDIX 1

CALIBRATION CODE B

Note . . .

The fuel to use throughout these tests is to be Aviation Kerosine to Specification D.Eng.R.D.2482 and is to be maintained at a temperature of 20 to 26 deg. C.

Fuel inlet pressure.—The fuel pressure at the rig pump inlet is to be maintained at 10 lb. per sq. in. throughout the tests.

The rig pump is to be fitted with a 0·027 in. diameter servo restricting orifice.

Leakage tests

1. With an air pressure of 40 lb. per sq. in., maintained for five minutes, there must be no leakage, refer to para. 70.

2. With a fuel inlet pressure of 1,650 lb. per sq. in. there must be no leakage past the half ball valve, refer to para. 78.

3. With an air pressure of 80 lb. per sq. in., maintained for five minutes, there must be no leakage, refer to para. 98.

Capsule effective range

4. The delivery pressure is to become constant, i.e. cease to decrease with continued decrease in blower pressure, between 8 in. Hg. and 5 in. Hg. blower pressure absolute, refer to para. 105.

Preliminary calibration and test

5. Performance calibration table, refer to para. 108.

Blower pressure (lb. per sq. in.)	Flow G.P.H.	Delivery pressure (lb. per sq.in.) Minimum	Maximum
70	450	1565	1625
60	420	1415	1475
50	400	1260	1310
40	360	1110	1155
30	300	960	1000
20	230	810	840
10	160	660	685
0	80	500	520
10 in. Hg. (Abs.)	30	350	370

6. The amplification ratio is adjustable between 15·2 : 1 and 15·8 : 1, refer to para 113.

7. Hysteresis must not exceed 10 lb. per sq. in., refer to para. 120.

Initial endurance test

8. The blower pressure is to be varied from 0 to 80 lb. per sq. in. (gauge) every two minutes for 30 minutes, refer to para. 124.

Partial strip and rebuild

9. Partially dismantle, inspect for wear and rebuild, refer to para. 125.

10. Repeat leakage tests of pivot plate, half ball valve and blower pressure diaphragm, refer to para. 130.

Final endurance test

11. The unit is to be re-calibrated, refer to para. 131.

12. The blower pressure is to be varied from 0 to 80 lb. per sq. in. (gauge) every two minutes for 1½ hours, refer to para. 132.

Final calibration

13. The unit is to be re-calibrated and performance tested in accordance with the table. The performance test results are to be entered on the test certificate, refer to para. 133.

APPENDIX 2

CALIBRATION CODE 'E'

Note . . .

The fuel to be used throughout the tests is to be Aviation Kerosine to Specification D.Eng. RD.2482 and is to be maintained at a temperature of 20 deg. to 26 deg. C.

Fuel inlet pressure—The fuel pressure at the rig-pump inlet is to be maintained at 5 to 10 lb. per sq. in. throughout the tests. The rig pump is to be fitted with a 0·027 in. dia. servo restricting orifice.

Leakage tests

1. With an air pressure of 40 lb. per sq. in., to be maintained for 5 minutes, there must be no leakage ; refer to para. 70.

2. With a fuel inlet pressure of 2,000 lb. per sq. in., there must be no leakage past the half-ball valve ; refer to para. 78.

3. With an air pressure of 80 lb. per sq. in., to be maintained for 5 minutes, there must be no leakage ; refer to para. 98.

Capsule effective range

4. The delivery pressure is to become constant, i.e., cease to decrease with continued decrease in blower pressure, between 8 in. Hg. Abs. and 5 in. Hg. Abs. blower pressure ; refer to para. 105.

Preliminary calibration and test

5. Performance calibration table ; refer to para. 109.

Blower pressure (lb. per sq. in.)	Flow G.P.H.	Delivery pressure (lb. per sq. in.)	
		Minimum	Maximum
80	500	1,520	1,580
70	460	1,370	1,430
60	430	1,240	1,290
50	400	1,105	1,155
40	350	980	1,020
30	280	845	875
20	220	710	740
10	160	580	600
0	100	450	470
10 in. Hg.(Abs.)	50	315	335

6. The amplification ratio is adjustable between 13·1 : 1 and 14·1 : 1; refer to para. 114.

7. Hysteresis must not exceed 10 lb. per sq. in. After setting the unit, zero blower pressure is to be applied and the servo flow is to be restricted and de-restricted as rapidly as possible for 5 cycles, permitting pump stall pressure to act upon the unit, after which the calibration is to be re-set if necessary prior to endurance test ; refer to para. 121.

Initial endurance test

8. The blower pressure is to be varied from 0 to 120 lb. per sq. in. (gauge) every 2 minutes for 30 minutes ; refer to para. 125.

Partial strip and rebuild

9. Partially dismantle, inspect for wear and rebuild ; refer to para. 126.

10. Repeat leakage tests of pivot plate, half-ball valve and blower pressure diaphragm ; refer to para. 131.

Final endurance test

11. The unit is to be re-calibrated; refer to para. 109 and 132, and para. 5 of this appendix.

12. The blower pressure is to be varied from 0 to 120 lb. per sq. in. (gauge) every 2 minutes for 1½ hours.

On completion of the final endurance test the values of the delivery pressure at each blower pressure setting in the table must not vary by more than 40 lb. per sq. in. from the results obtained in the pre-endurance calibration (para. 132) ; refer to para. 133.

Final calibration

13. The unit is to be re-calibrated and performance tested in accordance with the table, para. 109. The performance test results are to be entered on the test certificate ; refer to para. 134.

CALIBRATION CODE 'F'

Note . . .

The fuel to be used throughout the tests is to be Aviation Kerosine to Specification D.Eng. RD.2482 and is to be maintained at a temperature of 20 deg. to 26 deg. C.

Fuel inlet pressure—The fuel pressure at the rig-pump inlet is to be maintained at 5 to 10 lb. per sq. in. throughout the tests.

The rig pump is to be fitted with a 0·027 in. dia. servo restricting orifice.

Leakage tests

1. With an air pressure of 40 lb. per sq. in., to be maintained for 5 minutes, there must be no leakage ; refer to para. 70.

2. With a fuel inlet pressure of 2,000 lb. per sq. in., there must be no leakage past the half-ball valve ; refer to para. 78.

3. With an air pressure of 80 lb. per sq. in., to be maintained for 5 minutes, there must be no leakage ; refer to para. 98.

Capsule effective range

4. The delivery pressure is to become constant, i.e., cease to decrease with continued decrease in blower pressure, between 8 in. Hg. Abs. and 5 in. Hg. Abs. blower pressure ; refer to para. 105.

Preliminary calibration and test

5. Performance calibration table ; refer to para. 109.

Blower pressure (lb. per sq. in.)	Flow G.P.H.	Delivery pressure (lb. per sq. in.)	
		Minimum	Maximum
70	450	1,565	1,625
60	420	1,415	1,475
50	400	1,260	1,310
40	360	1,110	1,155
30	300	960	1,000
20	230	810	840
10	160	660	685
0	80	500	520
10 in. Hg.(Abs.)	30	350	370

6. The amplification ratio is adjustable between 15·2 : 1 and 15·8 : 1; refer to para. 114.

7. Hysteresis must not exceed 10 lb. per sq. in.

After setting the unit, zero blower pressure is to be applied and the servo flow is to be restricted and de-restricted as rapidly as possible for 5 cycles, permitting pump stall pressure to act upon the unit, after which the calibration is to be re-set if necessary prior to endurance test ; refer to para. 121.

Initial endurance test

8. The blower pressure is to be varied from 0 to 120 lb. per sq. in. (gauge) every 2 minutes for 30 minutes ; refer to para. 125.

Partial strip and rebuild

9. Partially dismantle, inspect for wear and rebuild ; refer to para. 126.

10. Repeat leakage tests of pivot plate, half-ball valve and blower pressure diaphragm ; refer to para. 131.

Final endurance test

11. The unit is to be re-calibrated; refer to para. 109 and 132, and para. 5 of this appendix.

12. The blower pressure is to be varied from 0 to 120 lb. per sq. in. (gauge) every 2 minutes for 1½ hours.

On completion of the final endurance test the values of the delivery pressure at each blower pressure setting in the table must not vary by more than 40 lb. per sq. in. from the results obtained in the pre-endurance calibration (para. 132) ; refer to para. 133.

Final calibration

13. The unit is to be re-calibrated and performance tested in accordance with the table, para. 109. The performance test results are to be entered on the test certificate ; refer to para. 134.

APPENDIX 4

CALIBRATION CODE H

1. The fuel to be used throughout these tests is AVTUR and is to be maintained at a temperature of 20 to 26 deg. C. Fuel pressure at the rig pump inlet is to be maintained at 5 to 10 lb. per sq. in.

Leakage tests

2. With an air pressure of 40 lb. per sq. in. maintained for 5 min. there must be no leakage; refer to para. 70.

3. With a fuel inlet pressure of 2,000 lb. per sq. in. there must be no leakage past the half ball valve; refer to para. 78.

4. With an air pressure of 80 lb. per sq. in. maintained for 5 min. there must be no leakage; refer to para. 98.

Capsule effective range

5. The delivery pressure is to become constant, i.e., cease to decrease, at between 8 in. Hg. Abs. and 5 in. Hg. Abs. compressor delivery pressure; refer to para. 105.

Preliminary calibration and endurance

6. Amplification ratio to be a nominal 13·2, using a single D-pump giving a servo flow 9 to 10·5 g.p.h. at 1,000 lb. per sq. in. and 150 g.p.h. main flow.

7. After setting the unit and with zero P2 pressure, the servo flow to the unit is to be restricted as rapidly as possible for 5 cycles, permitting pump stall pressure to operate on the unit.

8. The calibration of the unit must be reset if necessary prior to the endurance test. Hysteresis should not exceed 10 lb. per sq. in. Refer to para. 121.

Initial endurance test

9. The compressor delivery pressure is to be varied from 0 to 120 lb. per sq. in. (gauge) every 2 min. for 30 min., refer to para. 125.

Partial strip and re-build

10. Partially dismantle, inspect for wear and then rebuild, refer to para. 126.

11. Repeat leakage test as in para. 2, 3 and 4 of the appendix and to para. 70, 78 and 98 of the chapter.

Final endurance test

12. The unit is to be re-calibrated, refer to para. 6 of this appendix and to para. 108 and 132 of the chapter.

Compressor delivery pressure (lb. per sq. in. Gauge)	Flow g.p.h.	Pump delivery pressure (lb. per sq. in. Gauge)	
		Minimum	Maximum
80	1,210	1,620	1,680
70	1,150	1,490	1,550
60	1,100	1,360	1,412
50	1,080	1,230	1,280
40	1,040	1,100	1,145
30	925	970	1,012
20	690	840	877
10	520	710	740
0	340	580	608
10 in. Hg. Abs.	200	450	477

13. The compressor delivery pressure is to be varied from 0 to 120 lb. per sq. in. (gauge) every 2 minutes for $1\frac{1}{2}$ hours. On completion of the final endurance test the valves of the delivery pressure at each compressor delivery pressure setting in the table must not vary by more than 40 lb. per sq. in. (*para.* 132 *and* 133).

Final calibration

14. The unit is to be re-calibrated as in para. 6 of this appendix and para. 109 of the chapter.

15. Performance figures are to be entered on the test certificate.