Chapter 1

COMBINED CONTROL UNITS, TYPE CCU. 11 SERIES

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GENERAL

1. The combined control unit, illustrated in fig. 13 is designed to incorporate the low-pressure fuel filter, throttle valve, shut-off cock and altitude control within a single assembly, to eliminate external piping and facilitate engine servicing.

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

3. A typical complete type number (CCU.11/4F) comprises the basic type designation (CCU.11), followed by a stroke number (/4), which is a code reference indicating the applicable engine installation, and a final letter (F) to indicate the calibration schedule to which the unit has been adjusted and tested.

4. Instructions contained in this chapter regarding dismantling and reassembling generally apply to all derivations of the basic type; essential details and specific calibration figures for the various types are provided in the relevant Appendix to this chapter.

5. It is important that this unit is handled with care at all times and is not subjected to severe shocks otherwise the calibration may be disturbed.

6. The importance attached to cleanliness throughout any handling of the 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. On time expired units joint and other sealing washers must be renewed; split pins tab-washers and locking wires must be renewed whenever they are disturbed.

8. Box or ring spanners should be used for nuts, bolts and unions wherever possible to avoid damage to the hexagons. It is recommended that slave unions, nuts and washers be used in instances where a unit is to be assembled temporarily for initial testing but any such components should be distinguishable to avoid the possibility of their retention on final assembly.

SPECIAL TOOLS

9. Special tools and a test rig are required for the repair and reconditioning of a combined control unit; these are as follows:—

LIST OF SPECIAL TOOLS

Tool No.	*Description*
G.58354	Gauge—angle—T.V. and S.O.C. levers.
T.174097/1-5	Adapters—test rig.
T.175579	Bleed tool—priming bleed valve.
T.190007	Extractor—sealing ring.
T.200430	Extractor—sealing plugs —T.V. and S.O.C. plunger sleeves.
T.200603	Extractor—servo pressure strainer.
T.200611	Extractor—T.V. and S.O.C. pinion assemblies.
T.200612	Ejector — throttle valve plunger sleeve.
T.200613	Ejector — shut-off cock plunger sleeve.
T.200619	Assembly tool — throttle valve plunger sleeve.
T.200620	Assembly tool — shut-off cock plunger sleeve.

Tool No.	*Description*
T.200978	Adapter—holding fixture —throttle valve housing.
T.200618	Assembly tool — throttle valve and shut-off cock plungers.
T.203525	Adapter—holding fixture —capsule chamber.
T.219916	Fixture—flow test—servo pressure strainer.
—	Test rig.

CHECKS AND PRECAUTIONS BEFORE DISMANTLING

10. Study any complaints forwarded with the unit and examine it externally for any visible signs of damage or interference with adjustments, particularly the locking wire on the control piston adjustment locknut. Check that all connections have been blanked off with dust caps to exclude foreign matter from the interior of the unit.

11. Remove all installation fittings from the unit 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 of this chapter. If the unit has been reported as

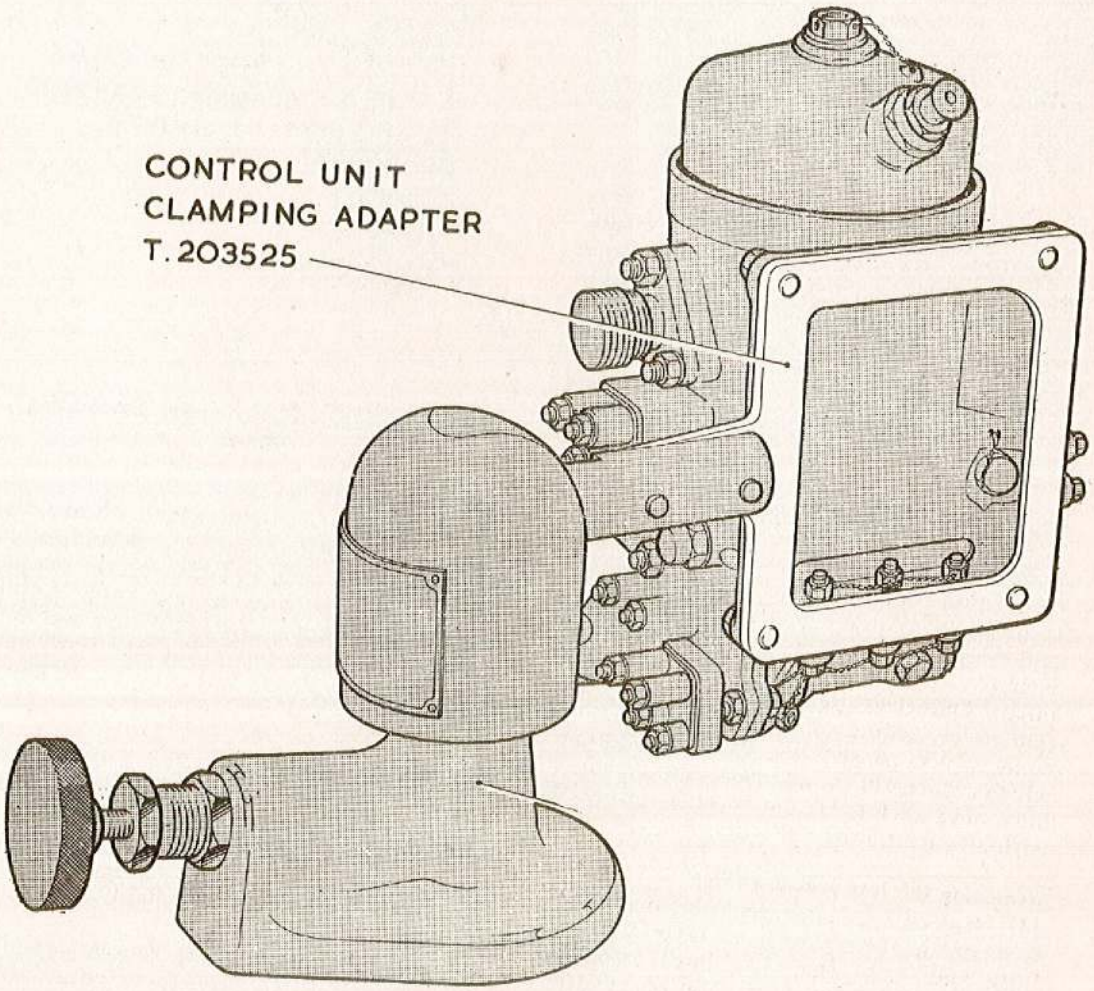


Fig. 1. Control unit dismantling fixture

leaking however, it should be subjected first to a leakage test under the conditions specified in the appendix in order to locate the source and nature of the leak and facilitate investigation of the cause.

DISMANTLING THE CONTROL UNIT

General

12. One or more clean and dry containers should be placed adjacent to the work to receive the components as they are dismantled and so provide safe storage pending inspection. Where it is suspected that a defect is due to the presence of foreign matter, the suspected components should be examined during dismantling otherwise the evidence of such a defect may inadvertently be removed.

13. 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. Tab-washers, split pins, sealing rings and locking wires must be discarded as they are removed.

14. To facilitate dismantling the unit two fixtures are recommended. Fixture T.203525, shown in fig. 1 enables the filter and throttle housing assemblies to be removed from the capsule chamber, which can then be dismantled completely on this fixture. The throttle valve and shut-off cock assemblies should be dismantled from the throttle valve housing on fixture T.200978 as shown in fig. 2.

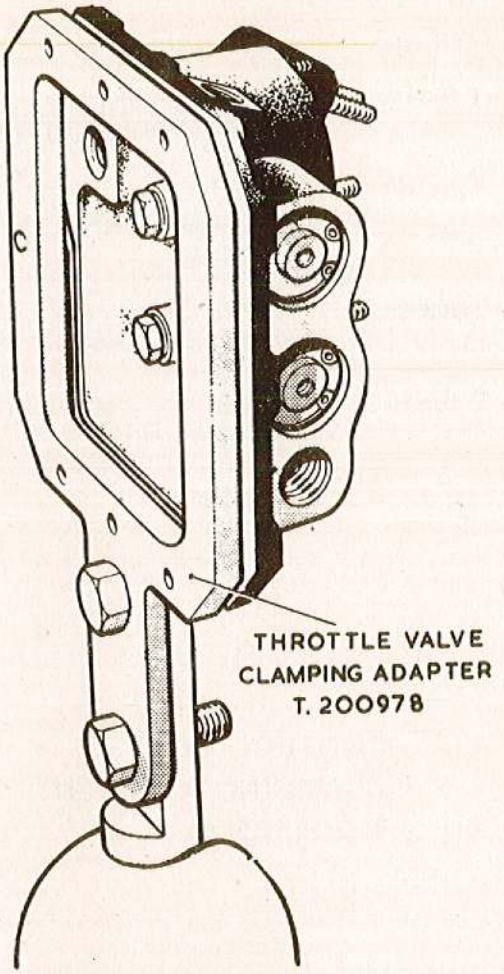


Fig. 2. Throttle valve housing dismantling fixture

Removing the installation fittings

15. Installation details are fitted to the pump servo connection, to the pump suction connection and to the blower pressure connection; they comprise banjo pillars and adapters with suitable sealing washers. Remove the fittings including the banjo pillars and their joint washers; cut and remove all locking wire. Other installation connections consist of flanged adapters which are part of the engine or aircraft pipelines and therefore are not normally returned with a control unit.

Removing the low pressure filter

16. Unlock the central retaining bolt at the base of the filter bowl, unscrew the bolt fully and draw the filter bowl assembly complete from the filter housing in the capsule chamber. Lift out the filter element.

Dismantling the filter bowl

17. Remove the circlip which retains the element and sealing plate on the bolt stem inside the filter bowl and draw off the sealing plate, spring seating sealing ring, spring seating and spring. Withdraw the bolt and sealing bush from the end of the bowl and draw the sealing bush off the bolt. Remove all sealing rings.

18. Unlock the drain valve and body at the side of the filter bowl, slacken the valve and remove it then remove the valve body. Remove the sealing ring from the valve end face and remove the sealing ring and outer steel washer from the valve body.

Removing the throttle valve housing assembly

19. To separate the throttle valve and shut-off cock housing from the capsule chamber

remove the retaining nuts, spring washers and plain washers securing the throttle valve housing joint face to the capsule chamber, remove the nuts and bolts from the joint flanges and lift the throttle valve housing away, tapping lightly with a hide-faced hammer if necessary to free the joint.

Dismantling the capsule chamber

Removing the control piston assembly

20. Unlock and remove the dome nut, cage washer and sealing washer from the control spring adjusting screw, slacken the screw locknut and rotate the screw anti-clockwise until it is relieved of the spring load. Remove the nuts, spring washers and plain washers retaining the spring housing flange and withdraw the spring housing, spring seating, spring, spring cap and the control piston stop plate. Invert the housing, shake out the control cylinder, turn the housing over again and lift out the control piston, piston seal and seal retainer. Invert the housing again and shake out the control needle.

Removing the control lever

21. The control cantilever is secured to a spring plate which is attached to a mounting plate retained to studs on the side of the capsule chamber. Unlock and remove the nuts retaining the mounting plate to the capsule chamber and carefully remove the plate complete with the cantilever. The half-ball servo valve, which will probably fall out of its recess in the cantilever as soon as it clears the orifice, must be retrieved and stored in a safe place until required.

22. Unlock and remove the two nuts retaining the control lever spring plate to the mounting plate, remove the tab-washers, separate the lever and spring plate from the mounting plate and remove any shims fitted from the two retaining studs. Measure these shims and record their thickness and positions for reference during rebuild. Remove the setscrew retaining the spring plate to the lever and separate the lever, plate and plain washer. Unlock and remove the small adjusting screw from the lever.

Removing the capsule assembly

23. The capsule assembly comprises an evacuated capsule joined by a stirrup to a bellows, the assembly being retained in the chamber by a setscrew engaging in the capsule boss and a banjo bolt engaging in the bellows boss. As the barometric pressure connection banjo bolt retaining the bellows should have been removed during removal of the installation fittings, it is necessary only to unlock and remove the setscrew from the capsule boss. The assembly can then be compressed slightly by hand and lifted out of the chamber. Remove the sealing ring from the boss face at each end of the assembly, extract the split pin from one end of the clevis pin in the capsule stirrup and draw out the clevis pin.

Removing the servo pressure orifice assembly

24. Unlock and remove the two nuts and one nut and bolt, complete with plain washers, from the servo orifice cover plate on the end of the casing opposite to the control cylinder and lift off the plate. Remove the sealing ring from the groove in the underside of the plate. Unlock and slacken the retaining nut on the orifice body inside the capsule chamber and remove the nut, when the orifice assembly can be pushed out of the body from within the chamber. One or more shims will probably be found on the orifice body or within the counterbore in the housing ; remove the shims, measure

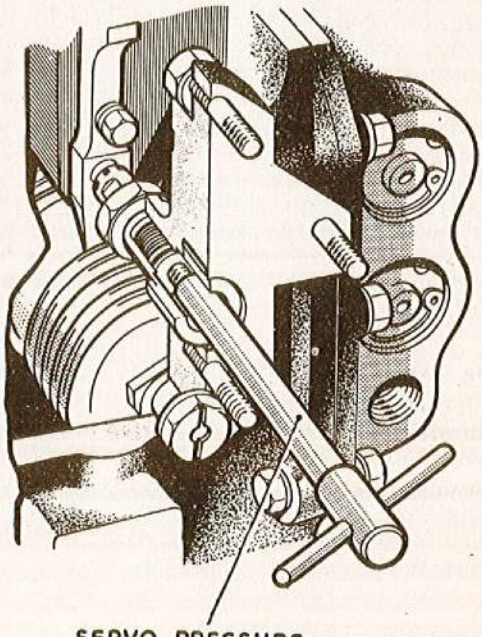


Fig. 3. Extracting the servo pressure strainer

and record the thickness for reference during re-build. Remove the sealing ring from the groove in the orifice housing bore in the capsule chamber.

25. Extract the circlip from within the large end of the orifice body ; as the circlip is removed the plug beneath it will be partially ejected from the bore by the strainer retaining spring. Remove the plug, shake out the spring and insert the threaded end of tool T.200603 into the tapped bore of the strainer. See fig. 3. Withdraw the strainer and remove it from the tool.

Removing the remaining details

26. Push the control needle sleeve out from within the capsule chamber, retrieving it from within the control cylinder housing. Remove the sealing ring from the stem of the sleeve. Remove the blanking plug from within the control unit mounting flange and remove the sealing ring and cage washer from the plug.

Dismantling the throttle valve housing

Removing the delivery body

27. With the throttle valve and shut-off cock housing clamped on fixture T.200978 as shown in fig. 2, unlock and remove the large hexagon plug on the top of the delivery body. Remove the four nuts, spring washers and plain washers from the outer face of the delivery body, remove the nut and bolt from beneath the outlet port and ease the body away from the housing. A light tap with a hide-faced hammer may be required to free the sealing rings. The body is spigoted on the flanges of the throttle and shut-off cock orifices and care must be taken to avoid damaging these as the body is being removed.

28. Withdraw the throttle valve and shut-off cock orifices from the exposed face of the throttle housing and place them in a safe position until required. Remove the orifice sealing rings from the housing, the sealing ring from the fuel delivery transfer bore and one from the shut-off cock orifice counter-bore in the delivery body face.

Dismantling the throttle valve

29. Before attempting to dismantle the throttle valve the backlash between the pinion and plunger teeth should be checked as described in para. 90 to determine the amount of wear.

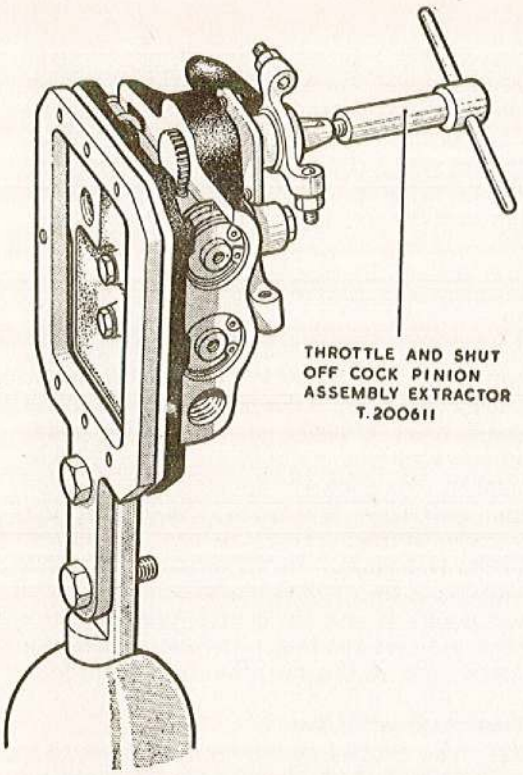


Fig. 4. Extracting the pinion assemblies

30. If the lever has not been removed, unlock and remove the lever pinch-bolt nut and washer, extract the pinch-bolt and draw the lever from the serrated hub. Unlock and remove the hub securing nut and draw the lever hub from the shaft taper, then remove the key from the shaft. Remove the special retaining nuts from the shaft sleeve flange retaining studs ; these nuts have conical inner faces. Withdraw the pinion shaft and sleeve complete, using extractor T.200611 if necessary to obtain a better purchase should the assembly be tight. See fig. 4. When clear of the housing draw the pinion shaft out of the sleeve then remove the sealing ring from beneath the sleeve flange and another from within the outer end of the sleeve bore.

31. When the pinion assembly has been extracted, remove the circlip retaining the sealing plug in the end of the throttle plunger sleeve, screw the end of tool T.200430 into the tapped boss in the plug and extract the plug from the sleeve. See fig. 5. Push the plunger through the sleeve and out of the housing. The plunger should be stored in a safe place until required ; it is advisable to wrap the metering slots end of the plunger

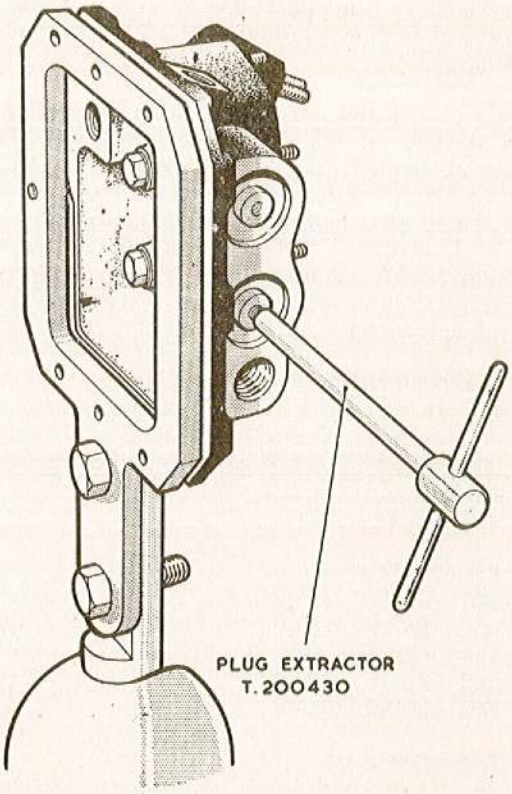


Fig. 5. Extracting the shut-off cock plunger sealing plug

with cloth or blanking tape to ensure that it is adequately protected.

32. To remove the plunger sleeve, first unlock and remove the upper of the two hexagon-headed locating screws from the inner face of the housing (the capsule chamber face), then insert the tool T.200612 through the throttle orifice locating bore and push the sleeve and upper sealing ring out of the housing, as shown in fig. 6. Remove the sealing ring from the orifice end of the exposed bore in the housing. If the unit is being dismantled completely, slacken the locknut on each of the throttle lever stop screws in the flange of the pinion sleeve and remove the screws together with their nuts, spring washers and plain washers.

Dismantling the shut-off cock

33. Before disturbing the shut-off cock pinion assembly the backlash between the pinion and plunger rack teeth should be checked as described in para. 96 to determine the amount of wear.

34. If the lever has not been removed, unlock and remove the lever securing nut and washer and draw the lever from the shaft taper. Remove the key from the shaft. Remove the retaining nuts and washers from the pinion sleeve flange and withdraw the pinion and sleeve complete, using tool T.200611 if necessary to obtain a better purchase should the assembly be tight. See fig. 4. Extract the pinion from the sleeve, remove the sealing ring from the sleeve bore and lift out the special seal from the exposed counterbore in the housing.

35. After extracting the pinion and sleeve, remove the circlip securing the sealing plug in the end of the plunger sleeve and withdraw the plug with tool T.200430. Remove

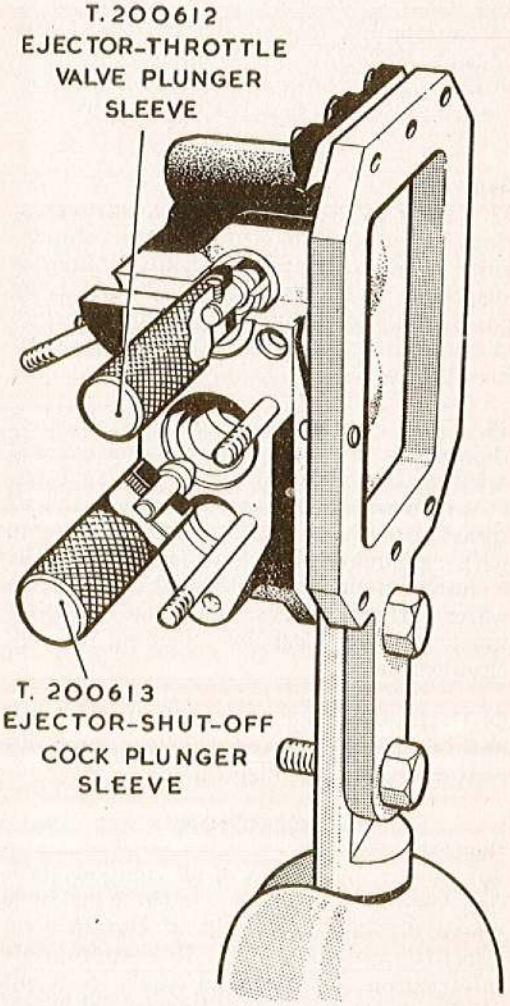


Fig. 6. Ejecting the plunger sleeves

the plunger by pushing it through the sleeve. Unlock and remove the lower hexagon-headed plunger sleeve locating pin from the inner face of the housing (the capsule chamber joint face), insert the tool T.200613 through the shut-off cock orifice locating bore and push out the sleeve and upper sealing ring. See fig. 6. Remove the two adjacent sealing rings from the orifice end of the exposed bore in the housing.

Removing the remaining details

36. Remove the domed nut from the bleed valve on the angular face at the top of the housing, remove the sealing ring, then unscrew the bleed valve body from the housing and remove the sealing ring and cage washer. Do not attempt to dismantle the valve as the spring seating is pressed in during manufacture to form a permanent assembly. Unscrew the two retaining nuts and washers from the flanged blanking plug on the angular face at the bottom of the housing, withdraw the plug and remove its sealing ring. Screw out the two adjacent plugs and remove their sealing washers.

CLEANING

General

37. Prior to cleaning check that all sealing rings have been removed from the components. If any defect in the control unit was suspected to be due to foreign matter the parts suspected should be examined before cleaning, otherwise the cause of the defect may be washed away.

38. The components should be cleaned thoroughly by washing in kerosine and dried off by the use of compressed air blast. It is recommended that a kerosine bath and spray nozzle be used, supplied by a pump with adequate filtering facilities. The compressed air for drying must be free from water. Hard brushes, cloths and abrasives must not be used for cleaning in any circumstances.

39. After cleaning and drying the components should be placed in clean and dry containers pending inspection.

INSPECTION

General

40. Visual inspection of all components is described in this section ; in those instances where dimensional checks of certain components are necessary, the appropriate information will be found in the Schedule of Fits, Clearances and Repair Tolerances in Vol. 2, Part 2 of this Air Publication.

41. Each detail should be examined closely for signs of damage or excessive wear and if necessary, the part should be renewed subject to the approval of the Inspector-in-Charge.

42. To assist in maintaining the high standard of cleanliness required it is recommended that the surface of the inspection and the 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 mineral oil for safe storage pending re-build.

Distortion checks

43. Distortion checks normally should not be necessary. Suspected distortion of joint faces may be checked with a surface plate or straight-edge in accordance with general inspection practice.

Permissible wear

44. All parts which are subject to wear must be checked dimensionally in accordance with the Schedule of Fits, Clearances and Repair Tolerances in Vol. 2, Part 2 of this Air Publication.

Redundant parts

45. It is usual during inspection to reject all parts rendered redundant by modifications ; the inspector, therefore, must have complete information covering modifications so that they can be embodied on reassembly.

Scores and surface damage

46. Scores and other surface damage on moving parts and joint faces generally will impair the operational efficiency of the unit hence any part so affected should be renewed. In certain circumstances however, particularly where 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. Where facilities are available the following parts should be magnetically tested for cracks, noting that the parts must be demagnetised prior to reassembly:—

Control lever	Control needle and sleeve
Control lever spring plate	Control piston and cylinder
Control lever tappet screw	Control piston stop plate
Servo valve half-ball	Control spring caps

Installation fittings

47. Inspect all adapters and unions for cleanliness and general condition and ensure that all threads and joint surfaces are undamaged.

Low pressure filter assembly

48. Inspect the filter bowl generally for damage. Ensure that the drain valve boss on the side of the bowl is clean and undamaged ; check that the adjacent lockwire securing lug is not cracked or broken and that the sealing surface around the central hole in the closed end is free from scoring. Check that the rim at the open end is undamaged.

49. Examine the filter bowl retaining bolt for damage on the threads and cleanliness in the bore and check that the circlip groove in the stem is clean and free from damage on its edges.

50. Ensure that the filter sealing plate, its sealing collar and pressure spring are clean and free from damage and that the spring and plate are not distorted. Check the filter retaining bolt sealing sleeve for damage and see that its sealing ring recesses are clean.

51. Examine the drain valve generally for damage, check that the central bore and crosshole are clean. The inner spigot and the recess in the face surrounding the spigot must be clean and undamaged. See that the valve housing is clean, particularly on the facing at the bottom of the bore and ensure that the threads are serviceable.

Capsule chamber assembly

Capsule chamber

52. Inspect the capsule chamber for crack- or damage to the casting, joint face and flange. Check all drilled fuel passages for cleanliness and ensure that all bores and sealing ring grooves are clean and undamaged. Check that all threads are serviceable.

53. Examine the control cylinder housing for cleanliness and make sure there is no scoring on the wall, particularly in the inner end of the bore ; any scoring in this area, especially linear scoring, may result in leakage across the control piston seal, affecting the control characteristic. Inspect the machined flats which locate the capsule assembly bosses to prevent capsule rotation; the flats must be undamaged. Check that the filter retaining bolt tapped bush is secure in the casting and that the internal threads are in good condition.

Capsule assembly

54. Examine the capsule assembly for corrosion, particularly between the convolutions, and see that there is no cracking or corrosion around the brazed joints between the capsule and bellows bosses and the connecting stirrup. Check that the sealing ring grooves in the end faces of the capsule and bellows bosses are clean and that the threads in the bosses are serviceable.

55. Inspect the capsule clevis pin for severe wear and ascertain that it is a good fit in the stirrup cross-hole. Examine the capsule retaining set-screw and bellows-retaining banjo bolt for serviceability of threads and hexagons.

Servo pressure orifice assembly

56. Inspect the orifice for damage on the face and lands and ensure that the bore is quite clean. Test the orifice face for flatness using an optical flat ; colour bands must be visible on all lands and on the orifice face simultaneously. If this result is not obtained a complete new orifice and body assembly must be selected, in which case the new orifice must be tested also with the optical flat to ensure that it is satisfactory. Ensure that the orifice strainer housing bore in the body is clean and that the strainer retaining spring, end plug and circlip are serviceable.

57. Examine the strainer for cleanliness and damage. Ensure that the strainer is clean internally, that the extraction threads in the bore are serviceable and that the external sealing ring groove is undamaged. Test the strainer for restriction by inserting it into the test block T.219916 and applying the pressure and flow stated in the relevant Appendix ; the pressure drop across the strainer must not exceed the value specified.

Control lever assembly

58. Inspect the control cantilever generally for cleanliness and particularly in the half-ball retaining recess. Check the contact face at the free end of the lever for wear ;

a witness mark of contact with the capsule clevis pin is permissible but if severe wear has occurred the lever must be renewed.

59. Examine the half ball for wear and see that the face is not eroded. Check the face for flatness with an optical flat ; no more than two colour bands are permissible. Should there be more than two colour bands the orifice must be rejected and a new one selected ; test the new half-ball to ensure that it is satisfactory for re-build.

60. See that the cantilever retaining spring plate is clean, undistorted and free from cracks. Check that the mounting plate is undamaged and that the sealing ring groove is clean. The cantilever adjusting shims must be undistorted and free from cracks. Inspect the control needle tappet screw and nut for cleanliness and serviceability of threads ; the small face of the tappet must not show indentation from contact with the control needle. Light lapping is permissible to remove slight indentation but if this is severe the tappet must be renewed.

Control piston assembly

61. Inspect the control needle for corrosion and for small flats on the rounded ends. Should there be excessive flats the needle must be renewed.

62. Ensure that the needle sleeve bore is clean and that the sealing ring groove in the stem is undamaged. Check the fit of the needle in the sleeve bore in accordance with the tolerances specified in the relevant Appendix. Inspect the flat end face of the control piston for indentation due to contact with the control needle. In the event of a witness mark of light indentation the face may be lapped lightly on a surface plate provided that the piston can be held square ; where severe indentation is present the piston must be renewed. See that the piston seal location diameter is clean and free from scoring and examine the outside diameter of the piston head, which is slightly conical, for chipping and scores. Measure the piston head diameter and compare it with the bore of the cylinder ; the clearance must not exceed the figure stated in the schedule of Fits, Clearances and Repair Tolerances.

63. Inspect the control cylinder for damage and see that the bore is free from scores. Measure the clearance between the cylinder bore and the piston as described in para. 62. See that the seal retainer is clean and undistorted ; the piston seal should be renewed.

64. Check that the piston stop plate is flat and clean. Inspect the spring cap and spring seating for general condition, see that the spring is clean and free from distortion and inspect the coils for signs of cracks. Examine the spring housing for cleanliness and damage, ensure that the threads in the central hole are serviceable. The adjusting screw, locknut and domed nut threads must be clean and undamaged ; the nut hexagons must be free from spanner damage and the lockwire holes should be checked for sharp edges and burrs.

Throttle valve and shut-off cock assembly

Throttle housing

65. Inspect the housing generally for cleanliness and damage, check that all studs are straight and that their threads are in good condition. Any loose studs will necessitate reclamation of the tapped hole in the casting. Check that all drilled passages are quite clear after ensuring that all sealing plugs have been removed ; see that all sleeve retaining bores are free from scores and that all sealing faces are undamaged. Make sure that all tapped holes are clean and that their threads are serviceable. Inspect the sealing ring groove in the joint face for damage, making sure also that the groove is clean. Examine the inner faces of the throttle and shut-off cock pinion housing bores ; these faces should be free from severe scoring or wear through pinion contact.

Throttle pinion assembly

66. Inspect the throttle pinion teeth for severe wear indicated by plucking or radial scoring of the tooth flanks and see that there is no chipping on the edges and tips of the teeth. Ensure that the ground diameters of the pinion shaft and taper are free from scoring ; check that the lever hub is undamaged, that its keyway and the key slot in the shaft taper are in good condition and that the key is a good fit in both. Ensure that the shaft threads are free from damage and that the hub retaining nut is serviceable. The hub serrations must be free from damage.

67. Examine the pinion sleeve for cleanliness and freedom from damage generally, check that the bore is free from scoring and

that the sealing ring groove is clean. Inspect the sleeve flange for distortion and cracks around the retaining holes; there should be no excessive wear or scoring on the sleeve end faces due to action of the pinion and lever hub. Check that the stop screws are serviceable and that the tapped holes in the sleeve flange are in good condition.

68. If the lever is available see that it is not distorted, that the internal splines are in good condition and that the pinch bolt and nut are serviceable. Check that the stop lugs on the hub are not cracked and that their faces are not indented through hard contact with the stop screws.

Throttle plunger assembly

69. Examine the throttle plunger carefully for general freedom from scoring and other damage, paying particular attention to the metering slots at the end of the plunger. The slots must be free from erosion and chipping on their edges and the roots must be thoroughly clean. There must be no scoring on the lands between the slots and on the diameter adjacent to the run-out of each slot. Where scoring is excessive it is not permissible to polish the marks out, the plunger, plunger sleeve and orifice must be renewed.

70. Check the central drilling through the plunger for cleanliness and ensure that the tapped extraction threads in the tail end are serviceable. Check that the annular groove at each end of the rack teeth is clean and examine the teeth closely for damage and excessive wear.

71. Inspect the plunger sleeve for scoring in the bore and for general cleanliness. Ensure that the chamfered surface on the outer face of the flange is undamaged and examine the diameter adjacent to the other end for scoring. Inspect the sleeve sealing plug for damage and ensure that the extractor threads in the tapped boss are serviceable. Examine the plug retaining circlip for cracks and distortion.

72. Examine the throttle valve orifice closely for damage, particularly in the bore of the lipped face. This bore is the metering orifice and any scoring, chipping or burring of the bore or the edges will affect the calibration; in this event the orifice must be renewed.

Shut-off cock pinion assembly

73. Inspect the shut-off cock pinion teeth for chipping, cracks, scoring and severe wear. Examine the ground diameters of the shaft for scoring and severe wear and see that the key slot is undamaged. Check that the key is a good fit in the slot. Ensure that the threads on the end of the shaft are in good condition and that the lockwire hole is clear, with no burrs at the edges of the hole.

74. Examine the pinion sleeve generally for damage and check that the retaining flange is undistorted. There should be no severe scoring in the bore and on either end face due to wear by the pinion or lever hub. Check that the sealing ring counterbore in the flange is clean and undamaged.

Shut-off cock plunger assembly

75. Inspect the shut-off cock plunger generally for damage and scoring, particularly on the extreme end of the plunger beyond the wide undercut diameter. This end of the plunger is the sealing diameter which enters the orifice to cut off the fuel flow; the plunger diameter must be measured and compared with the orifice bore diameter to ascertain the worn clearance, which must be within the limits stated in the schedule of Fits, Clearances and Repair Tolerances. Ensure that the plunger bore is clean and that the threads in each end are serviceable. The rack teeth must be free from chipping, plucking and excessive wear and the groove at each end of the rack must be clean.

76. Examine the plunger sleeve generally for cleanliness and see that there is no scoring in the bore. Check that the cross-drillings are clean and that the flange angular face is free from scoring.

77. Check that the sleeve sealing plug is serviceable with no scoring or damage on its chamfered face and see that the tapped hole is clean with the threads in good condition. Inspect the retaining circlip for cracks and distortion.

78. Inspect the shut-off cock orifice for wear, chipping at the edges of the bore and scoring in the bore. Ensure that the flange face surrounding the countersunk bore is undamaged and free from scoring. Measure the bore diameter and see that the plunger clearance is within the limits

specified. Check that the orifice is a good fit in the housing.

Delivery body

79. Inspect the delivery body generally for damage and ensure that the threads in the two tapped holes are serviceable. The sealing faces surrounding the tapped holes, the face surrounding the fuel delivery bore on the outer face and the facings in the inner face are all sealing surfaces and must be free from scoring. See that the lock-wire hole lug adjacent to the top tapped hole is undamaged and that the studs in the outer face are serviceable.

Remaining details

80. Ensure that the bleed valve assembly is clean and in good condition, that the hexagons on the domed nut and valve body are undamaged and that the threads are serviceable. Check that the spring seating is secure in the bore of the body ; the seating is pressed in and must be tight.

81. Examine all studs for tightness and serviceability of their threads and see that the hexagon corners of all nuts and plugs are undamaged.

RE-BUILDING THE SUB-ASSEMBLIES

General

82. Ensure that all details, the assembly bench and all tools are thoroughly clean before commencing to re-build the control unit.

83. All rubber sealing rings must be immersed completely in kerosine for a period of not less than 24 hours prior to assembly to permit maximum swelling to take place under absorption of fuel.

84. Certain pressure tests are necessary during re-building and these are described in their required sequence. The specific test requirements are provided in the appropriate test schedule in the relevant appendix to this chapter. The throttle valve housing should be assembled completely on the holding adapter T.200978 ; the capsule chamber should be rebuilt completely on adapter T.203525 and whilst on this adapter the low pressure filter and throttle valve housing can be added to complete the assembly of the control unit.

Reassembling the throttle valve housing

Fitting the throttle valve plunger sleeve

85. Fit a new sealing ring to the groove in the orifice end of the throttle plunger sleeve

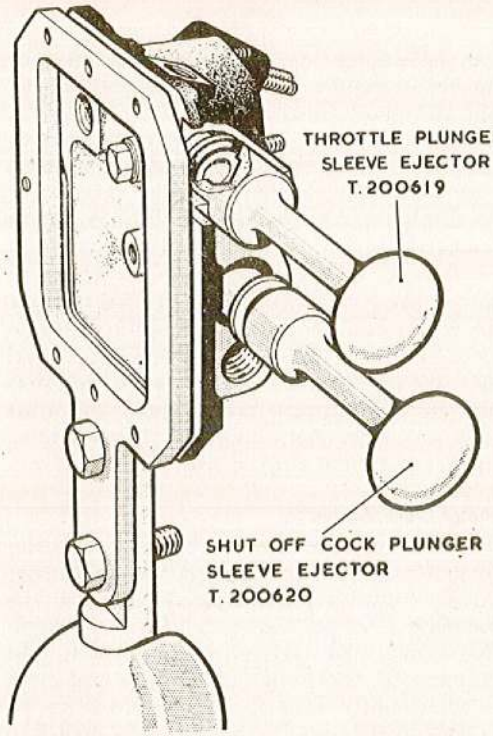


Fig. 7. Inserting the plunger sleeves

locating bore, insert the chamfered end of the sleeve into the counterbored end of the locating bore and check that the locating screw slot in the sleeve is aligned with the corresponding hole in the housing bore ; this will align the cut-away portion automatically to receive the pinion. When aligned satisfactorily push the sleeve in fully with tool T.200619 as shown in fig. 7, and fit the locating screw complete with a plain washer. Tighten the screw fully but do not wire-lock at this stage.

Assembling the throttle valve pinion details

86. Fit a sealing ring to the groove adjacent to the mouth of the sleeve bore and insert the pinion shaft from the opposite end of the sleeve, smearing the taper and adjacent parallel diameter lightly with white petroleum jelly to facilitate entry into the sealing ring. Insert the key into the slot in the shaft taper and fit the lever hub, stop lug side first, on to the taper diameter and key. Fit the plain washer and nut, tighten fully, push the hub against the sleeve face to take up all end play and using feeler gauges measure the clearance between the back face of the pinion and the inner face of the sleeve. The clearance must be not less than 0·025 in. ; if less the face of the sleeve

should be lapped lightly until the required clearance is established. Should the clearance be greater than 0·040 in. however, a new sleeve must be fitted.

Reassembling the throttle valve

87. Fit a sealing ring to the counterbore in the throttle valve orifice locating bore in the housing and insert the orifice. Screw the tool T.200618 into the tail end of the throttle plunger and enter the metering end of the plunger into the flanged end of the sleeve bore. See fig. 8. Align the plunger rack teeth with the pinion bore and push the plunger in gently until it is about to enter the orifice bore. Check that the plunger tip does not foul the edge of the orifice then move the plunger into the orifice.

88. Locate a sealing ring in the counterbore of the pinion sleeve locating bore then insert the pinion assembly. Position the lever stop screw lugs on the sleeve flange so that the OPEN stop is adjacent to the bleed valve tapping in the housing. Register the sleeve flange holes with the retaining studs and push the assembly into the housing until the pinion contacts the plunger. Rotate and slide the plunger slightly either way with a slight pressure on the pinion shaft until the teeth are in alignment.

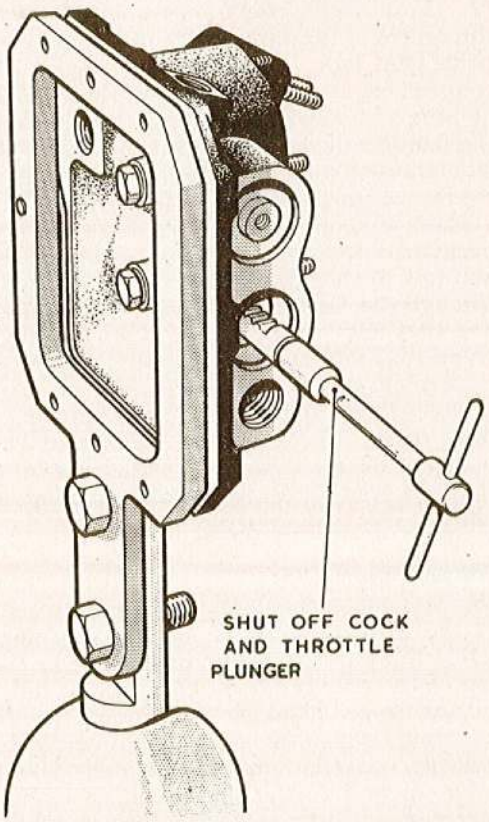


Fig. 8. Fitting the shut-off cock plunger

89. Move the plunger in or out until the tip is flush with the visible face of the orifice, looking on the delivery body joint face of the housing, then holding the plunger steady, rotate the pinion until its OPEN stop lug on the hub is contacting the OPEN lug on the sleeve flange. Exert a light pressure on the pinion shaft and if the teeth will not mesh with the plunger rack, move the plunger slightly further into the orifice until meshing is achieved. Fit the special retaining nuts, conical side first, to the pinion sleeve flange retaining nuts and tighten fully.

90. Check that the plunger moves freely by rotating the pinion gently. Remove the pinion hub retaining nut and fit the quadrant gauge G.58354 over the pinion thread and refit the nut to retain the gauge. Clamp a suitable piece of wire to a convenient adjacent stud and bend the wire to provide a gauge pointer over the quadrant markings. Tighten the hub retaining nut to secure the quadrant and holding the plunger firmly rotate the pinion shaft slightly to check the backlash, which must not exceed ½ deg. on the quadrant scale. If this figure is not obtainable or is exceeded a new pinion or plunger or a new pair should be fitted. When satisfactory, remove the quadrant gauge, refit and tighten the hub nut and remove the holding tool T.200618 from the plunger. Fit a sealing ring into the flange of the plunger sleeve, insert the sealing plug into the counterbore and fit the securing circlip.

Fitting the shut-off cock plunger sleeve

91. Insert a sealing ring into each of the two grooves in the plunger sleeve locating bore. Enter the chamfered end of the sleeve into the housing and align the locating slot with the locating screw hole in the housing. This will automatically align the cut-away portion with the pinion bore. Insert the spigot of tool T.200620 into the flanged end of the sleeve and push the sleeve fully into the housing, as shown in fig. 7. Ensure that the locating slot is correctly aligned with the

locating screw hole, insert the screw, complete with plain washer and tighten fully but do not lock at this stage.

Assembling the shut-off cock pinion details

92. Fit the special flat-section sealing ring into the counterbore in the flange end of the shut-off cock pinion sleeve, insert the pinion shaft into the opposite end of the bore and push in fully. It may be necessary to smear the shaft lightly with white petroleum jelly to facilitate its passage through the sealing ring. Insert the key into the slot in the shaft taper, making sure that it is a good fit, align the lever slot with the key and push the lever on to the taper. Fit the plain washer and retaining nut and tighten fully then push the lever against the sleeve and using a feeler gauge check the clearance between the inner face of the pinion and the sleeve face. If the clearance is less than 0·025 in., dismantle the assembly and lap the sleeve face on a surface plate, taking care to keep it square, until the required clearance can be obtained. Should the clearance be greater than 0·040 in. however, a new pinion sleeve must be fitted. When the clearance is satisfactory remove the lever retaining nut, fit the quadrant gauge G.58354, refit the nut and tighten temporarily.

Reassembling the shut-off cock

93. Fit a sealing ring to the counterbore in the shut-off cock orifice locating bore in the housing and insert the orifice. Screw the tool T.200618 into the tail end (rack end) of the shut-off cock plunger and insert the head of the plunger into the flanged end of the sleeve bore. See fig. 8. Align the rack teeth with the pinion bore and push the plunger gently through the bore until the head contacts the orifice. Check that the plunger tip does not foul the edge of the orifice bore. If fouling does occur, rotate the orifice slightly until the foul is eliminated, then push the plunger about $\frac{1}{4}$ in. into the orifice to locate them both whilst the pinion is being fitted.

94. Insert a sealing ring in the counterbore in the mouth of the pinion sleeve locating bore and insert the pinion assembly. The two tapped lugs on the sleeve flange must be positioned so that they face away from the throttle valve pinion. Align the flange holes with the retaining studs and push the pinion assembly into the housing until the pinion contacts the plunger.

95. Move the plunger outwards slightly so that the plunger tip is approximately $\frac{1}{16}$ in. inside the orifice bore, rotate the pinion lever to the fully open position and adjust the quadrant gauge to align the zero marking with a suitable wire pointer clamped to a convenient stud. Tighten the lever retaining nut to secure the gauge and holding the plunger in the position described, that is just entered into the orifice, rotate the pinion through 29 deg. on the gauge towards the closed position, then mesh the pinion with the plunger teeth as closely as possible to this position.

96. Hold the plunger tightly with the tool T.203094 and rock the shut-off cock lever slightly to check the backlash between the pinion and plunger teeth; the backlash should not exceed $\frac{1}{2}$ deg. on the quadrant scale. Remove the gauge, refit the lever retaining nut and tighten fully, fit the plain washers, spring washers and nuts to the pinion sleeve flange retaining studs and tighten fully. Remove the tool T.200618 from the plunger, fit a sealing ring on to the plunger sleeve flange, insert the retaining plug and fit the retaining circlip securely.

Fitting the delivery body

97. Fit a sealing ring to the counterbore in the centre of the three bores in the delivery body joint face, insert a sealing ring in the counterbore of the lower bore in the throttle housing face (the fuel delivery bore) and fit the body to the housing. Fit plain washers and retaining nuts to the four studs protruding through the housing and fit the bolt, with a plain washer under its head, to the lug beneath the housing, fitting a plain washer and nut to the bolt, which should protrude through the delivery body lug. Tighten all five nuts finger-tight, move the two control levers to check that the throttle and shut-off cock plungers are moving freely in their orifices, then tighten the nuts evenly until fully tight. Check several times that the plungers do not tighten, as this indicates that one or other of the orifices is fouling its plunger, due to uneven tightening.

Fitting the remaining details

98. Assemble an aluminium joint washer to the delivery body large blanking plug, screw the plug into the tapped hole in the top of the delivery body and tighten fully. Fit the flanged blanking plug, complete with a sealing ring, to the angular face below the housing, adjacent to the delivery body retaining bolt, fit the plug retaining washers and nuts and tighten fully. Place a rubber sealing ring over the bleed valve body, fit

the steel outer washer and ensure that it surrounds the rubber ring correctly then screw the bleed valve into the tapped hole at the top of the throttle housing and tighten fully. Fit a similar sealing ring and steel outer washer to the hexagon-headed blanking plug and screw the plug into the alternative bleed position adjacent to the dump connection. Remove the assembly from the holding fixture and unless it is to be assembled to the capsule chamber immediately, pour oil, OX-275 into all open ports until full, drain surplus oil from the housing and blank off all exposed ports for safe storage until required for assembly to the capsule chamber.

Reassembling the capsule chamber

Fitting the capsule assembly

99. If both split pins have been removed from the capsule clevis pin fit a new split pin to one end and turn the legs of the pin round the diameter of the clevis pin. The split pin must not be turned over the clevis pin end nor is it sufficient merely to open the split pin. Place a plain washer over the clevis pin and insert the pin into the capsule stirrup crosshole, fit another plain washer and split pin and secure the split pin as before.

100. Locate a sealing ring in the annular groove in each end boss of the capsule assembly, ensuring that each sealing ring seats correctly. Compress the capsule assembly slightly by hand and insert it into the capsule chamber, noting that the open-ended, or barometric pressure, bellows must be located on the same side as the control cylinder. Position the assembly so that the flat on each boss is located against the machined traps in the chamber, the clevis pin being at right-angles to the plane of the cantilever. Insert the capsule retaining set-screw, complete with a new tab-washer, through the chamber wall and into the evacuated capsule boss. Fit the barometric pressure connection banjo bolt, banjo and appropriate washers to the opposite side of the casing to secure the bellows. Hold the capsule assembly by hand and tighten the set-screw and banjo bolt securely. Do not lock either of them at this stage.

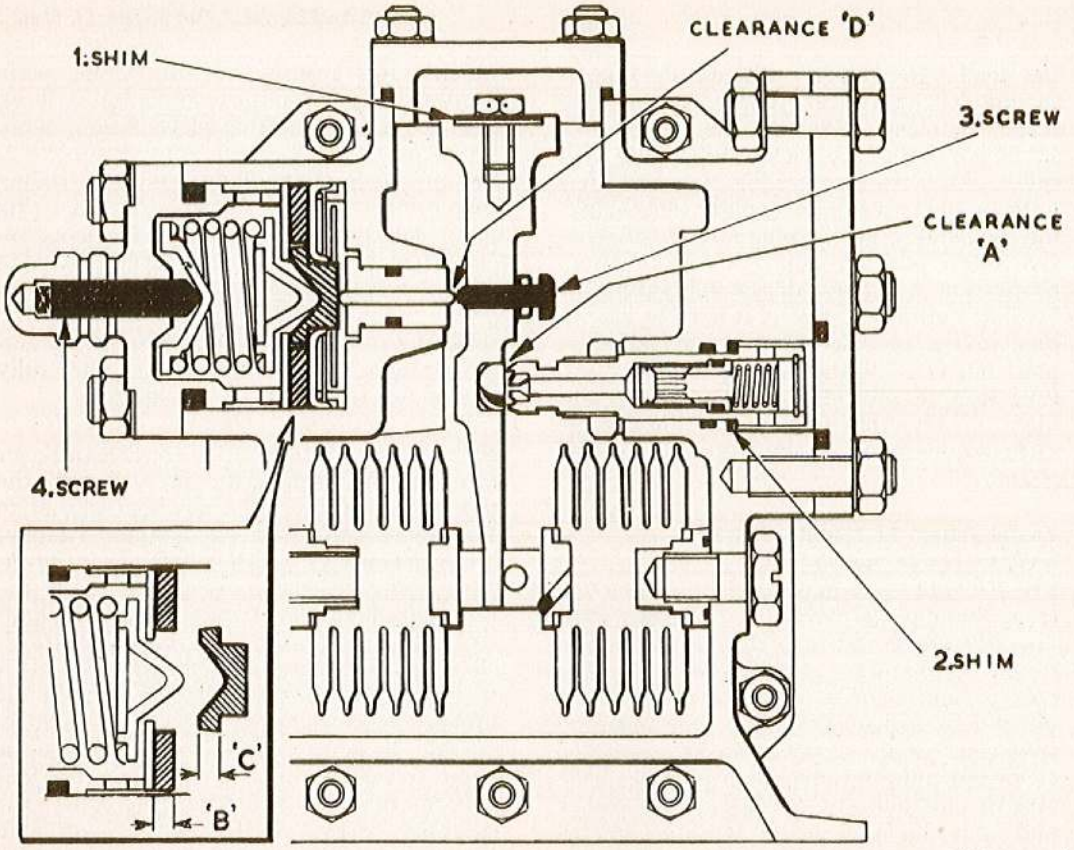
Fitting the control cantilever

101. Assemble the spring pivot plate to the butt end of the cantilever, secure the assembly with the set-screw and plain washer and ensure that the pivot plate locates in the slot in the lever flange. Check that the lever mounting plate is thoroughly clean, particularly in the annular groove in the underside of the flange and fit a sealing ring to this groove; ensure that the ring seats correctly. Locate the shims as recorded in para. 22 on the lever mounting plate, position the assembled lever and pivot plate over the shims and fit the retaining set-screws, complete with new tab-washers. Tighten the set-screws fully but do not lock them at this stage.

102. Screw the locknut on to the cantilever tappet screw, running the nut well up to the top of the thread, fit a new tab-washer to the tappet and screw the assembled tappet into the small tapped hole in the cantilever, noting that the screw must be entered into that side of the lever that locates the half-ball. Insert the cantilever into the capsule chamber and locate the mounting plate over the retaining studs so that the tip of the tappet screw is adjacent to the control cylinder housing; the half ball recess in the opposite side of the lever will therefore face towards the servo orifice locating bore in the chamber. Align the tip of the lever with the wider portion of the slot in the capsule stirrup and push the mounting plate over its studs so that the cantilever tip enters the stirrup on the bellows side of the clevis pin. It may be necessary to compress the evacuated capsule slightly by hand to move the clevis pin clear. Secure the cantilever mounting plate with a plain washer and nut on two diagonally opposite studs and tighten.

103. Fit a sealing ring to the undercut groove in the stem of the control needle sleeve and insert the sleeve into the bore at the bottom of the control cylinder housing. Push the sleeve down fully and insert the control needle. The tip of the needle should contact the centre of the face on the tappet screw. Should the point of contact be off centre estimate the movement required to establish centralization, withdraw the cantilever from the capsule chamber and adjust the shims under the pivot plate accordingly.

104. When the centralization of the needle and tappet is established, refit any shims removed during dismantling to the servo orifice body, fit a sealing ring into the groove in the orifice body locating bore in the



(1) Shim the cantilever mounting to centralize the tappet screw and half-ball with the control needle and orifice respectively. Refer to para. 102 and 103.

(2) Shim beneath the orifice body flange to obtain clearance 'A' of 0·000 in. to 0·003 in. Refer to para. 105.

(3) Adjust the tappet to obtain clearance ' D ', equal to control cylinder thickness (dimension ' B ') minus piston flange thickness (dimension ' C ') plus 0·005 in. (B-C) plus 0·005 in. = D. Refer to para. 108 to 110 inc.

(4) Adjust the spring loading on the test-rig to obtain flow/altitude range. Refer to para. 126 and to para. 6 in the relevant appendix.

Fig. 9. Control unit adjustment diagram

capsule chamber and insert the orifice body into the locating bore, see fig. 9. Fit the lockwasher and locknut over the orifice, insert the half-ball into the cantilever recess and tighten the orifice locknut. Check that the half-ball is centralized with the orifice. If centralization is not established, the shimming under the cantilever pivot plate must be re-adjusted ; in this event, the re-adjustment must be of an order to achieve a compromise between the half-ball and orifice centralization and the tappet screw and control needle centralization.

105. When the centralization is satisfactory fit the remaining plain washers and nuts to the cantilever mounting plate studs and tighten fully. Push the control needle back into its sleeve so that it is clear of the tappet screw, compress the evacuated capsule slightly by hand to hold the clevis pin clear of the cantilever and check that there is a gap between the half-ball and the orifice. If there is no gap, remove the orifice and add a 0·006 in. thick shim to the orifice body, refit and tighten fully, then check the gap again. When a gap has been established, lifting the capsule clevis pin clear each time so that the cantilever is free from all loadings, measure the gap with feeler gauges, then remove the orifice again, if necessary, and adjust the shimming to provide a gap of between 0·000 in. and 0·003 in. In practice it has been found that a gap of 0·001 in. provides the most satisfactory results on performance test. Take care that a false reading is not obtained by the use of too thick a feeler, particularly where the gap is

0·001 in. or less as it is essential that the half-ball is not pre-loaded against the orifice face.

106. When the servo orifice gap has been set satisfactorily rebuild the control piston assembly and set the cantilever tappet gap as described in para. 107 to 111.

Reassembling the control cylinder details

107. Push the control needle into its sleeve again until it contacts the tappet screw in the cantilever, insert the control piston seal retainer, flanged side first, into the control cylinder housing and ensure that the retainer locates correctly on the bottom face of the housing.

108. Measure the thickness of the control cylinder and record the measurement. Measure the thickness of the control piston flange and subtract this figure from the cylinder thickness then add 0·005 in. to the figure obtained; record the resulting dimension, which is the size of the gap to which the tappet is to be set (fig.9, para.110).

109. Assemble the control piston to the piston seal by pushing the piston stem through the seal; the piston must be entered into the back, or flat side, of the seal. Insert the assembled seal and piston, seal lip first, into the control cylinder housing bore and push down fully until the piston face contacts the control needle. Insert the control cylinder, push this into the housing and ensure that it locates correctly over the piston head and seats against the back of the piston seal. Fit the piston retaining plate into the bore, fit the control cylinder housing cover and secure with plain washers and nuts on two diagonally opposite retaining studs. The control spring assembly is omitted at this stage.

110. Slip a thin wedge of soft wood between the back of the cantilever and the adjacent casting immediately behind the half-ball pocket so that the half-ball is held lightly but firmly against the orifice face. Select a feeler gauge of a thickness equal to the figure obtained as described in para. 108, insert the gauge between the control needle tip and the tappet screw face and adjust the tappet screw until the feeler is just nipped. Tighten the tappet locknut fully and recheck the gap to ensure that it has not altered.

111. When the tappet has been set correctly remove the wooden wedge from behind the cantilever, remove the control cylinder housing cover, insert the control piston spring cap and spring, ensuring that the nose of the cap locates correctly in the locating cone in the piston, then fit the spring seating. Locate a sealing ring in the groove beneath the flange of the housing cover, screw the spring adjusting screw into the cover so that the rounded end of the screw protrudes inside the cover by approximately ¼ in., and refit the cover. Fit the cover retaining washers and nuts, tighten them fully, fit a sealing ring and steel outer washer over the adjusting end and fit the screw locknut, tightening this finger-tight as it will require adjustment on the test-rig.

Fitting the servo pressure strainer

112. Fit a sealing ring to the groove in the locating flange on the servo pressure strainer body, screw the strainer on to the end of tool T.200603 and, inserting the strainer into the orifice body, push it in gently until the flange seats against the abutment face in the orifice body bore, then remove the tool. Insert the strainer retaining spring and the spring cap then fit the retaining circlip and ensure that it locates correctly in the retaining groove. Fit a sealing ring to the annular groove in the face of the orifice housing cover plate, locate the cover plate on the two retaining studs, fit the plain washers and nuts to the studs. Insert the bolt, complete with plain washer under its head to the remaining hole in the cover plate, fit a plain washer and nut to the bolt and tighten evenly and fully.

Pressure testing the servo valve

113. Connect an appropriate fuel supply to the servo pressure connection and apply the fuel pressure specified in the relevant appendix. There must be no leakage past the half-ball.

Power limitation check

114. Connect an appropriate air supply to the nacelle pressure connection and apply air at the pressure specified in the relevant appendix. The capsule clevis pin must remain in contact with the tip of the cantilever up to the specified pressure.

Note . . .

An excessive air pressure must be avoided otherwise the bellows assembly may suffer rupture or distortion.

Fitting the remaining details

115. Fit a sealing ring and steel outer washer to the hexagon-headed blanking plug and screw the plug tightly into the end of the servo pressure drilling inside the mounting flange of the unit adjacent to the servo pressure connection.

Reassembling the low pressure filter

Reassembling the filter bowl

116. Fit a sealing ring to the annular groove in the underside of the bolt sealing bush flange and insert the bush, from the outside, into the hole in the bottom of the bowl. Locate a sealing ring in the counterbore in the outer face of the bush and insert the retaining bolt fully into the bush. Invert the housing, slip the pressure spring over the end of the retaining bolt and locate the spring over the central spigot in the base of the bowl. Slide the spring cap, protruding side first, over the bolt and locate the cap on the spring, fit the sealing ring and push the ring down so that it locates in the dished portion of the cap. Fit the filter sealing plate, dished-in side first, over the bolt, locate the plate over the spring cap, push the plate down to compress the spring until the circlip retaining groove is exposed and fit the retaining circlip to secure the assembly. Make sure that the circlip seats correctly in the groove.

Reassembling the filter drain valve

117. Locate a rubber sealing ring and steel outer washer behind the head of the drain valve body and screw the body tightly into the tapped boss protruding from the side of the bowl. Fit a small sealing ring to the annular groove in the end face surrounding the spigot on the threaded end of the drain valve and screw the valve into the body.

Reassembling the control unit

Fitting the throttle valve housing

118. Locate the specially moulded sealing ring in the groove in the joint face of the throttle valve housing and fit the housing assembly to the capsule chamber. Assemble plain washers and nuts to the retaining studs and fit bolts, with plain washers under their heads, to the remaining holes, inserting the bolts towards the capsule chamber. Fit plain washers and nuts to the bolts and tighten, together with the stud nuts, evenly and fully.

Fitting the low-pressure filter

119. Locate a sealing ring in the annular recess in the outer face of the filter housing on the capsule chamber, insert the filter element into the housing and offer up the filter bowl assembly. Engage the retaining bolt with the tapped bush in the inner face of the housing, register the mouth of the bowl with the sealing ring in the housing annulus and align the filter drain valve so that, when looking on the bottom of the filter bowl and using the control unit mounting flange as a datum base, the valve lies at 45 degrees to the horizontal and vertical centre lines and pointing to the right. Looking down the unit in this position the valve should lie on a line midway between the cantilever mounting plate and the servo orifice cover plate. Tighten the retaining bolt fully and remove the complete unit from the assembly fixture in readiness for rig-testing.

CALIBRATING AND RIG-TESTING

General

120. The control unit must be mounted on the test-rig and tested in accordance with the conditions specified in the relevant appendix. During the final test the calibration and performance figures observed are to be recorded on the test certificate and must be approved by the Inspector-in-Charge.

121. The rig pump must be fitted with a servo pressure restricting orifice of the size specified in the appendix.

122. It is essential that the test-rig manometer be adjusted to compensate for the ambient barometric pressure of the day before commencing the tests. The test rig is illustrated diagrammatically in fig. 10.

Test-rig adapters

123. Installation of the control unit on the test rig requires certain special adapters. These are numbered T.174097/1 to T.174097/5 and G.58354 and are to be fitted as follows:—

T.174097/1	Fitted to throttle inlet and shut-off cock outlet (2 required).
T.174097/2	Fitted to low-pressure filter inlet connection.
T.174097/3	Fitted to low-pressure filter outlet connection.
T.174097/4	Fitted to servo pressure inlet connection.
T.174097/5	Fitted to barometric pressure connection.
G.58354	Quadrant gauge fitted to throttle valve and shut-off cock levers.

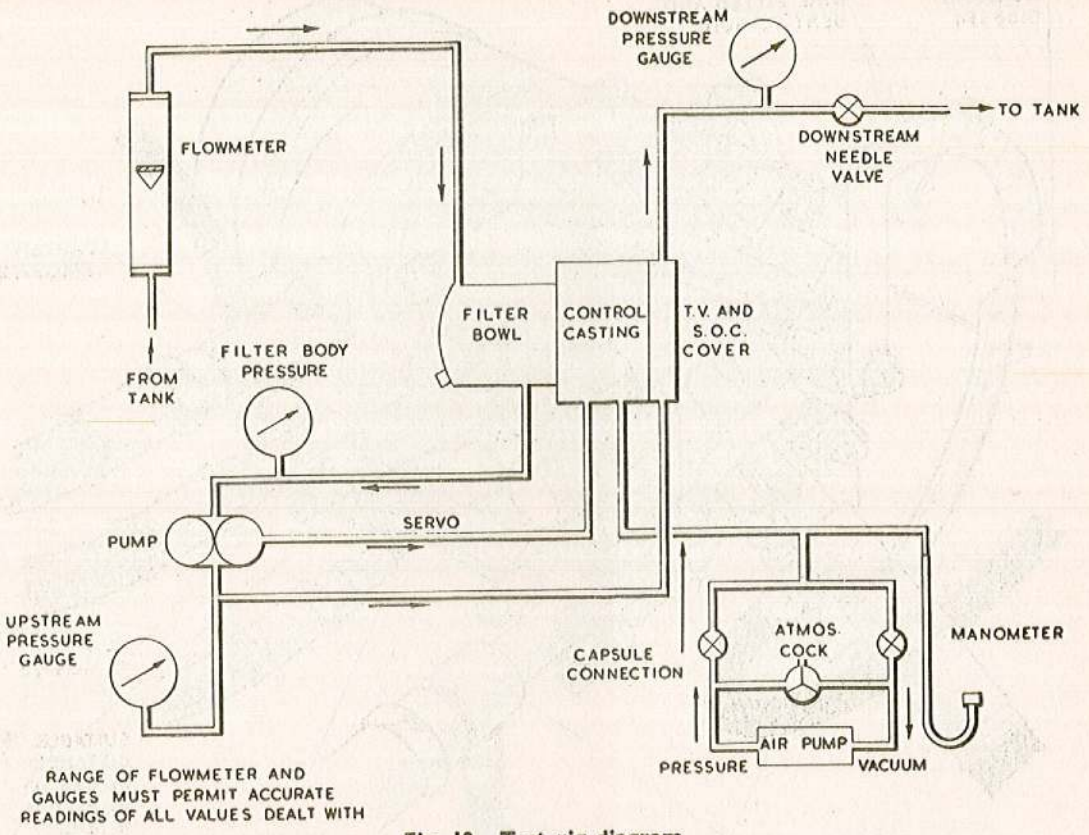


Fig. 10. Test rig diagram

The location of each connection on the control unit is shown in fig. 11 and 12.

Preliminary calibration

124. With the control unit mounted on the test rig, switch on the rig tank pump and prime the unit by inserting tool T.175579 into the bleed valve and spilling fuel until all air is exhausted. Start the rig pump and allow it to run for a few minutes to stabilize the flow and attain its working temperature.

125. Check that the fuel pressure to the control unit low pressure filter inlet is as specified in the relevant appendix, adjust the barometric pressure to the value specified and record the fuel pressure drop across the control unit at the two flow values specified; that is, the difference between the pressures observed on the pump delivery pressure gauge and the control unit delivery pressure gauge.

126. Open the throttle valve to the fully open position specified in the throttle angle / flow table in the relevant appendix, adjust

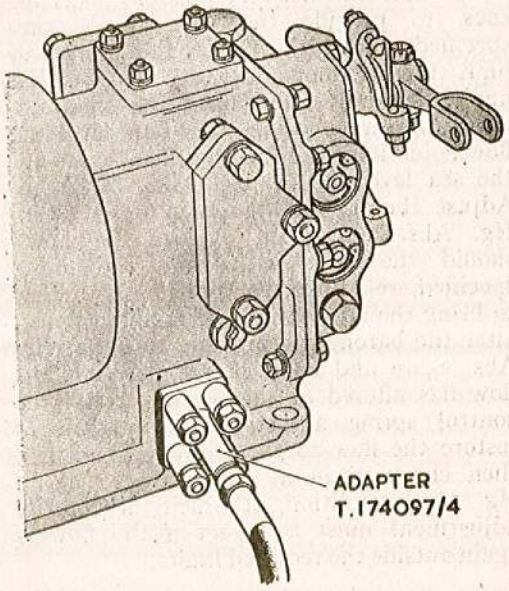


Fig. 11. Test rig adapter

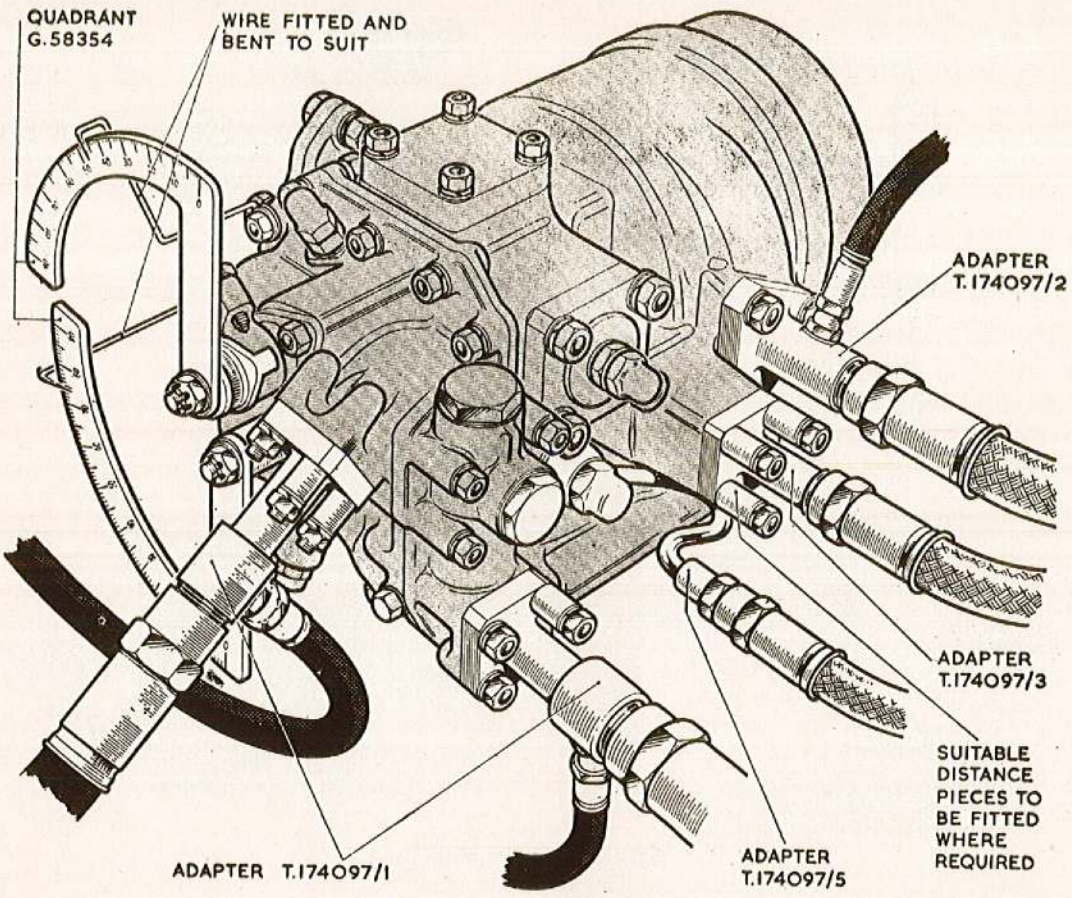


Fig. 12. Test rig adapters

the control unit delivery pressure restrictor cock to provide the delivery pressure specified, adjust the OPEN stop screw to limit further movement at the specified angle, then adjust the control piston spring adjusting screw to vary the flow until the flowmeter indicates the specified value for the sea level (30 in. Hg. Abs.) condition. Adjust the barometric pressure to 10 in. Hg. Abs. and again observe the flow; should the flow be outside the limits specified, re-adjust the throttle stop screw to bring the flow within the required limits, alter the barometric pressure to 30 in. Hg. Abs. again and re-check the flow. If the flow has altered at this setting, re-set the control spring adjusting screw again to restore the flow to the required condition, then check again at the altitude (10 in. Hg. Abs.) condition, at which the throttle adjustment must be re-set if the flow is again outside the required limits.

127. These checks and adjustments between the sea level and altitude conditions must be repeated continuously, balancing the control spring adjustment against the throttle angle adjustment until the requirements at both conditions can be obtained. It should be noted that it is not possible to pre-set these adjustments during assembly to provide an immediate result very close to the required conditions without a great deal of experience in the calibrating of this unit, although provided the cantilever centralization, servo valve gap and cantilever tappet gap (para. 103 to 111) were set accurately, the test rig results should be tolerably close to the requirements. It is possible however, that before the required results can be achieved the balancing process between the two adjustments may have to be repeated many times.

128. Should it be apparent after many attempts that the requirements cannot be achieved, dismantle the control cylinder, draw out the control needle and ensure that

the needle and sleeve bore are thoroughly clean as the needle may be subject to hysteresis. De-magnetize the needle before refitting it. Reassemble the control cylinder and repeat the tests. If it is again apparent that the required results are not being obtained, change the throttle valve plunger and orifice as another assembly will probably have slightly different metering characteristics sufficient to enable the calibration to be obtained.

129. In the event of continued failure to achieve the calibration remove the throttle valve housing and re-check carefully the settings of the cantilever centralization, servo valve gap and tappet clearance and examine the capsule and bellows unit for distortion and punctures. If the re-checking of the settings proves satisfactory, that is, they do not require any alteration, a new capsule unit should be introduced as this may have characteristics slightly different from the previously-fitted capsule sufficient to achieve the calibration figures.

130. When the initial calibration is satisfactory return the throttle lever to the CLOSED position and adjust the CLOSED stop screw until the flowmeter indicates the flow specified for zero degrees throttle lever angle. The control unit delivery pressure restrictor cock must remain unaltered from the previous setting, that is, at the setting providing the delivery pressure specified for the full throttle condition. With the CLOSED position established at the required flow, set the throttle lever angle gauge G.58354 to align the zero marking with the pointer and move the throttle lever progressively to fully OPEN, checking at each angle specified that the flow is within the required limits.

131. Should it be found that the requirements cannot be obtained, the throttle valve plunger or the orifice or both should be changed as another assembly may be found to have slightly different metering characteristics sufficient to obtain the required results. It must be noted however, that in this event the initial calibration (para. 124 to 130) must be repeated.

132. Following the throttle angle versus flow calibration, check the altitude curve in accordance with the altitude calibration table in the relevant appendix. Move the throttle lever to the fully open stop, and set the barometric pressure to the sea level condition (30 in. Hg. Abs.), check that the control unit delivery pressure is still being maintained at the specified value then check that the flow is in accordance with the value specified in the relevant appendix.

133. Increase the barometric pressure to the maximum value stated in the table and check that the flow is within the corresponding limits. Reduce the barometric pressure progressively, checking at each value in the table that the corresponding flow is within the limits specified. When the maximum altitude pressure has been reached, repeat the checks at the same values whilst increasing barometric pressure to the sea level condition and maximum pressure. The flow values observed during the second check must not vary from those observed in the first check by more than the hysteresis value specified.

134. Should hysteresis be observed to be larger than that specified dismantle the control cylinder assembly and examine the control needle and sleeve bore for foreign matter. De-magnetize the needle before re-fitting it. If this fails to rectify the unit fit another control needle and sleeve, noting that this will necessitate re-setting the cantilever tappet clearance. Other possible remedies are to change the control piston and cylinder, or the control capsule assembly either of which again necessitates re-setting the tappet clearance.

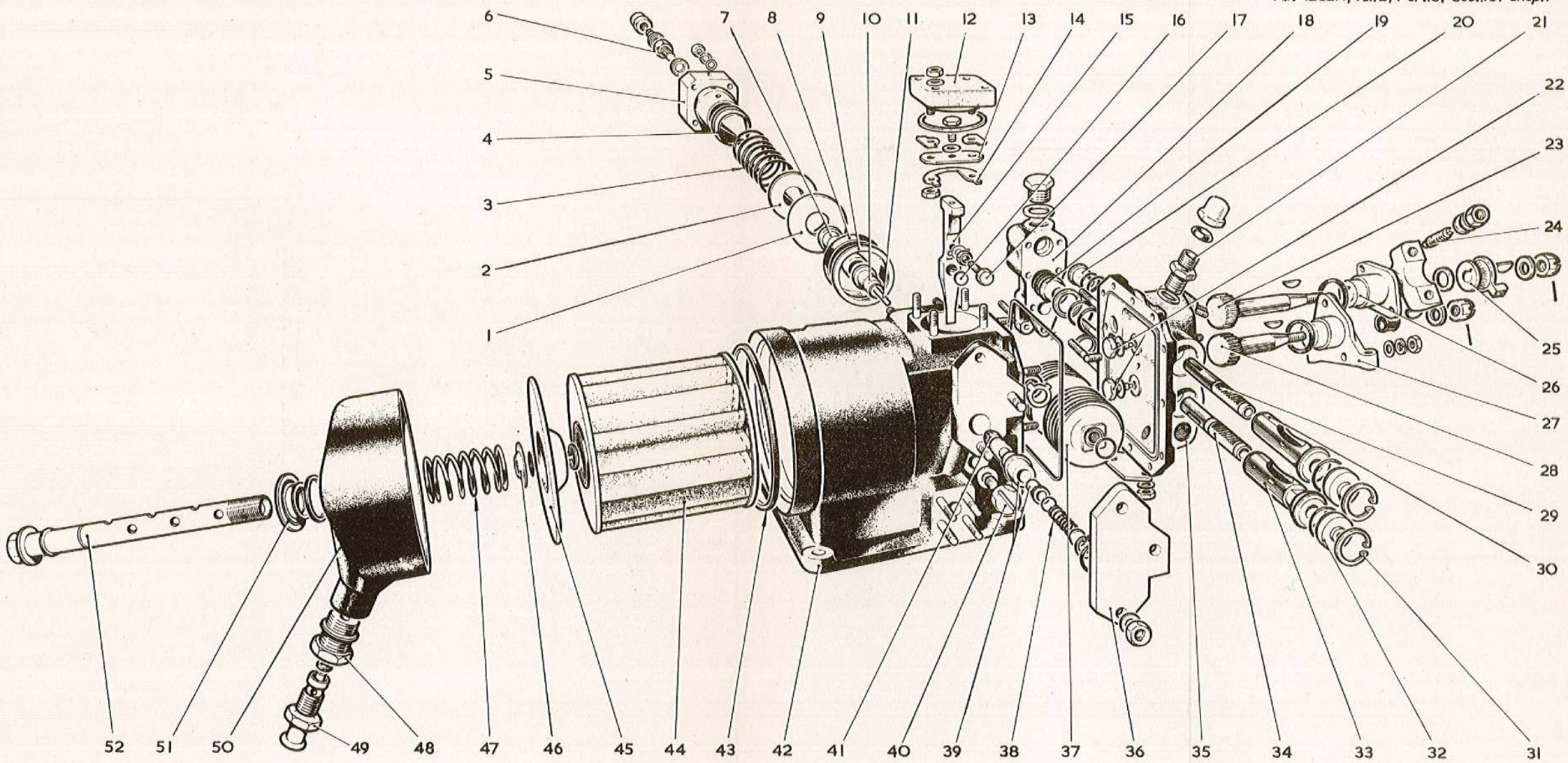
Note . . .

It must be understood that whenever the control cylinder assembly or the capsule assembly is disturbed the entire calibration must be re-checked and re-adjusted as necessary.

135. After completing the calibration check record the flow and capsule pressure at 5 degrees throttle lever angle.

First endurance test

136. In this test the unit is to be operated continuously for a given period, during which the barometric pressure is to be varied with constant regularity and the throttle valve is to be opened and closed at frequent intervals. The duration of the test, the range of barometric pressure and the cyclic periods for the barometric pressure and throttle valve operation are to be as stated in the relevant appendix. The test-rig



1 CONTROL CYLINDER
2 SPRING SEATING
3 CONTROL SPRING
4 SPRING CAP
5 CONTROL CYLINDER END COVER
6 ADJUSTING SCREW AND LOCKNUT
7 CONTROL PISTON
8 PISTON SEAL
9 PISTON SEAL SUPPORT
10 CONTROL NEEDLE SLEEVE
11 CONTROL NEEDLE
12 CONTROL LEVER ANCHORAGE
13 SPRING PLATE
14 TABWASHER
15 CONTROL LEVER
16 HALF BALL
17 TAPPET SCREW
18 DELIVERY BODY
19 SHUT-OFF COCK ORIFICE
20 THROTTLE VALVE ORIFICE
21 BLEED VALVE
22 SLEEVE RETAINING SCREWS
23 THROTTLE VALVE PINION
24 THROTTLE VALVE STOP SCREW
25 THROTTLE VALVE LEVER HUB
26 THROTTLE VALVE PINION SLEEVE
27 SHUT-OFF COCK PINION SLEEVE
28 SHUT-OFF COCK PINION
29 THROTTLE VALVE PLUNGER
30 THROTTLE VALVE PLUNGER SLEEVE
31 RETAINING CIRCLIPS
32 SEALING PLUG
33 SHUT-OFF COCK PLUNGER SLEEVE
34 SHUT-OFF COCK PLUNGER
35 THROTTLE VALVE AND SHUT-OFF COCK HOUSING
36 ORIFICE ASSEMBLY COVER
37 CAPSULE ASSEMBLY
38 ORIFICE STRAINER SPRING
39 ORIFICE STRAINER AND BODY
40 CAPSULE RETAINING SCREW
41 SERVO PRESSURE ORIFICE ASSEMBLY
42 CAPSULE CHAMBER
43 FILTER BOWL SEALING RING
44 LOW PRESSURE FUEL FILTER ELEMENT
45 PRESSURE PLATE
46 SPRING SEATING
47 PRESSURE SPRING
48 DRAIN PLUG HOUSING
49 DRAIN PLUG
50 FILTER BOWL
51 SEALING BUSH
52 FILTER RETAINING BOLT

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Fig.13 Dismantled view of control unit

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should be fitted with a cycling attachment to facilitate the correct procedure of this test.

Initial performance test

137. When the endurance test is completed repeat the calibration checks for throttle angle versus flow and flow versus barometric pressure (para. 130 and 133), to check that all components have settled down. Should the results show that settling-down has been excessive re-calibrate the unit (para. 124 to 134) and extend the endurance test by 50 per cent. Check again and repeat the extended endurance until a calibration check shows that settling is complete. If the settling-down period appears to be unduly prolonged, examine the capsule assembly and control spring, changing either or both if necessary. Where this does occur it is essential that the calibration and endurance test (para. 124 to 135) is repeated.

Strip inspection

138. Following completion of the calibration and initial testing the control unit is to be dismantled for inspection, the extent of the dismantling to be at the discretion of the Inspector-in-Charge in accordance with the results of the calibration and first endurance test. After inspection the unit is to be re-built and all internal locking is to be completed. *It is very important to check that all locking is secure.*

Final endurance test

139. Mount the unit on the test-rig and re-calibrate it in accordance with the preliminary calibration (para. 124 to 135).

140. Endurance test the unit under the conditions specified. These are similar to those required for the first endurance test (para. 136) except for the duration.

Final performance test

141. Re-check the calibration (para. 124 to 135), re-adjusting if necessary, to check that the unit has settled down correctly. Record the results of this calibration on the test certificate.

Flow variation test (varying delivery pressure)

142. Check the flow variation, with varying delivery pressure, at the settings and delivery pressure range specified in the relevant appendix. This is to ascertain that parts subject to delivery pressure have a cancelling effect on one another and do not seriously affect the performance of the unit. The maximum variation in flow must not exceed the value stated.

Flow variation test (varying filter body pressure)

143. Check the flow variation, with varying filter body pressure, at the settings and filter inlet pressure range specified in the appendix. This is to ascertain that the effective areas of the capsule and bellows are equal and cancel out the effect of filter body pressure. The maximum flow variation must not exceed the value stated.

Torque and overlap tests

144. Measure the torque required to open and close the throttle valve. Attach a spring balance to the lever and pull the lever from CLOSE to OPEN and back with the control unit operating under the specified condition. The spring balance must be pulled tangentially to the lever arc to maintain a consistent load and the maximum torque required to open and close the valve must not exceed the specified value.

145. Measure the torque required to open and close the shut-off cock. Attach a spring balance to the lever and pull the lever from OPEN to CLOSE and open again with the control unit operating under the specified conditions. The spring balance must be pulled tangentially to the lever arc to maintain a consistent load and the maximum torque required to open and close the shut-off cock must not exceed the specified value.

146. Check the overlap of the shut-off cock by operating the unit at the conditions specified and closing the shut-off cock ; any rise in filter body pressure must not exceed the value stated.

147. Measure the torque required to close the shut-off cock under emergency conditions by attaching a spring balance and pulling the shut-off cock to CLOSED with the unit operating at the specified conditions. The torque required must not exceed the value stated.

148. Measure the travel of the shut-off cock lever from ' just open ' to ' fully open ', from ' fully open ' to ' by-pass and dump starting to open ' and from ' fully open ' to ' fully feathered '. The operating conditions and degrees of lever movement are to be as specified in the relevant appendix.

Leakage tests

149. Check for leakage from the drain

connection with the shut-off cock open and the unit operating under the conditions stated. Any leakage must not exceed the specified maximum.

150. Check the leakage from drain with the shut-off cock closed and the rig pump stopped. Filter body pressure and shut-off cock lever angle are to be as stated and any leakage must not exceed that specified.

151. Disconnect the burner delivery connection and check for leakage with the shut-off cock in the OPEN and CLOSED positions and the rig pump stopped. Filter body pressure and shut-off cock lever angle must be as stated and any leakage must not exceed the specified maximum.

152. Disconnect the rig pump suction pipe from the filter outlet, disconnect the inlet pipe from the filter and connect the tank supply direct to the rig pump. Apply the capsule pressure, delivery pressure and flow conditions stated and check the leakage from the filter bowl outlet (pump suction) connection ; the leakage must not exceed the specified maximum. This test is to ascertain the extent of any internal leakage within the control unit.

153. Check the filter bowl drain valve by opening the valve with the unit primed fully i.e. after normal running. When in the normal mounting position the valve must be capable of emptying the filter bowl completely. The tank pump and rig pump must be stopped before commencing this test.

154. Dry the exterior of the control unit thoroughly, after re-priming following the previous check, operate the unit at the stated conditions and check that there is no external leakage.

PREPARING FOR DESPATCH

Inhibiting

155. After removing the control unit from the test rig drain all fuel, remove the test rig adapters and flush the unit thoroughly with inhibiting oil OX-275. The unit is to be inhibited in accordance with the detailed instructions contained in A.P.4471A.

Locking

156. Complete all external locking, checking that each nut is fully tight before securing it. In the case of the throttle and shut-off cock lever securing nuts ensure that the split pin legs are secured round the nuts, not across the top. Tab-washer tabs must be bent up firmly against the nuts.

Final inspection

157. Check the serial number and inspection stamp on the name plate, ensure that all locking and sealing is complete and that the name plate details agree with the test certificate. Ensure that the test certificate is complete and signed by an inspector and pack the unit, together with two copies of the test certificate, in the approved box.

APPENDIX 1

CALIBRATION CODE 'F'

General

The fuel to be used throughout the 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 is to be maintained (except where otherwise stated) at 10 to 15 lb. per sq. in., measured at the filter bowl outlet to the rig pump connection.

The rig pump is to be fitted with a servo pressure restricting orifice providing a servo flow of 4·1 to 4·3 g.p.h. at 400 lb. per sq. in. pump delivery pressure and zero flow.

Servo pressure strainer restriction test

1. The pressure drop across the strainer must not exceed 6 lb. per sq. in. at 50 g.p.h. flow.

Servo valve pressure test

2. The valve must remain sealed up to 1,500 lb. per sq. in. static pressure (refer to para. 113).

Power limitation check

3. The capsule clevis pin must remain in contact with the control lever up to a barometric pressure of 43 in. Hg. Abs. (refer to para. 114).

Preliminary calibration

4. Record the pressure drop across the unit with a barometric pressure of 30 in. Hg. Abs. and a flow at 28 g.p.h. and 137 g.p.h. (refer to para. 124).

5. Set the barometric pressure to 30 in. Hg. Abs., the fuel pressure to 200 lb. per sq. in. and check the throttle lever settings to the following table (refer to para. 126 to 131).

Throttle angle (Degrees)	Fuel flow (G.P.H.)	
	Min.	Max.
0	28 (idling stop set)	
5	38·5	42·0
10	51·5	54·5
20	76·5	80·0
30	102·0	104·5
40	128·0	130·0
42–44·5	137 (full throttle stop)	

6. Set the delivery pressure to 200 lb. per sq. in. and check the altitude curve to the following table (refer to para. 132 to 135).

Barometric pressure (In. Hg. Abs.)	Fuel flow (G.P.H.)	
	Min.	Max.
35	149	153
30	137	
25	121	123
20	103·5	105·5
15	84	86·5
10	58	60·5
7	37	40·5

Hysteresis limit 2 g.p.h. (max.).

Record the flow in relation to the barometric pressure at 5 deg. throttle valve angle.

First endurance

7. The endurance time is to be 2 hrs. The barometric pressure cycle is to range from 30 in. Hg. Abs. to 5 in. Hg. Abs. every two minutes (approx.) and the throttle opened and closed 10 times per hour; refer to para. 136.

Initial performance test

8. Check the calibration, as detailed in para. 4 to 6 of this appendix. If the unit has not settled down the endurance test is to be repeated and extended as detailed in para. 137 of this chapter.

Strip inspection

9. The unit is to be dismantled, inspected and reassembled in accordance with the procedure detailed, all internal locking is to be completed.

Final endurance test

10. Repeat the preliminary calibration test detailed in para. 4 to 6 of this appendix. The unit is then to be endurance tested, as detailed in para. 7 of this appendix for *one hour*.

Final performance test

11. Re-calibrate the unit detailed under preliminary calibration para. 4 to 6 of this appendix.

Flow variation test (with varying delivery pressure)

12. At full throttle setting, with the barometric pressure at 30 in. Hg. Abs., and the filter body pressure constant at 5 to 10 lb. per sq. in., the range of delivery pressure is to be varied between 100 and 1,000 lb. per sq. in. The maximum permissible flow variation must not exceed 5 g.p.h., refer to para. 142.

Flow variation test (with varying filter body pressure)

13. At full throttle setting, with the barometric pressure at 30 in. Hg. Abs., and the fuel delivery pressure constant at 200 lb. per sq. in., the filter body pressure is to be varied between 5 to 25 lb. per sq. in. The maximum permissible flow variation must not exceed 2 g.p.h., refer to para. 143.

Torque and overlap test

14. Set the throttle full open, the barometric pressure at 30 in. Hg. Abs., and the fuel delivery pressure at 200 lb. per sq. in. The maximum torque required to open and close the throttle valve must not exceed 6 lb. in., refer to para. 144.

15. At idling conditions with the fuel delivery pressure set as during calibration i.e. 200 lb. per sq. in. the maximum torque required to open and close the shut-off cock must not exceed 5 lb. in., refer to para. 145.

16. At idling conditions check the overlap with the fuel delivery pressure set as during calibration i.e. 200 lb. per sq. in. The pressure rise must not exceed 20 lb. per sq. in., refer to para. 146.

17. At full throttle conditions with fuel delivery pressure set as during calibration, the stall pressure of the rig pump is to be set as on the engine i.e. 1,900 to 2,100 lb. per sq. in.; the maximum torque required to operate the shut-off cock must not exceed 8 lb. in., refer to para. 147.

18. At idling conditions from the position 'just closed' (i.e. when the flowmeter bobbin ceases to indicate flow in a 0 to 100 g.p.h. flowmeter) the shut-off cock angle to 'fully open' must be 29±7 deg. From 'fully open' to 'by-pass and dump starting to open' must not be less than 14 deg. The total travel from 'fully open' to 'fully feathered' to be 76 deg. to 81 deg., refer to para. 148.

Leakage tests

19. At full throttle conditions with fuel delivery pressure 750 lb. per sq. in., the barometric pressure 30 in. Hg. Abs. and the filter body pressure at 10 lb. per sq. in. the maximum leakage must not exceed 40 c.c. per min. from dump, refer to para. 149.

20. With the filter body pressure 10 lb. per sq. in. and the shut-off cock lever 48 deg. from the open position the maximum leakage must not exceed 10 c.c. per min. from dump, refer to para. 150.

21. With the filter body pressure 10 lb. per sq. in. and the shut-off cock lever 48 deg. from the open position the maximum leakage must not exceed 10 c.c. per min. from the burner delivery, refer to para. 151.

22. At full throttle conditions with the barometric pressure 30 in. Hg. Abs., the fuel delivery pressure 750 lb. per sq. in., the flow 125 g.p.h. the maximum internal leakage must not exceed 200 c.c. per min. from suction, refer to para. 152.

23. Check the filter drain in accordance with the details in para. 153.

24. At full throttle conditions with the fuel delivery pressure at pump stall i.e. 1,900 to 2,100 lb. per sq. in., there must be no leakage, refer to para. 154.