# Chapter 2

# AIR/FUEL RATIO CONTROLS, TYPE A.F.C. 10, 14 AND 16 SERIES

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### GENERAL

**1.** The instructions in this chapter apply to the Air/Fuel Ratio control unit with or without P2/P1 pressure ratio valve. Where the unit is fitted with the pressure ratio valve, details concerning this will be found in Supplement 1 or 2 to this chapter. There are two types of pressure ratio valves, one type has two orifices in series, whilst the other has a single venturi. The relevant text in the appendix will indicate which type is fitted to a particular unit.

**2.** A typical complete type number, e.g. A.F.C.10/11G, comprises the basic type designation (A.F.C.10) followed by a stroke number (11) which is a reference indicating the installation code, whilst the final letter (G) indicates the specific calibration schedule to which the unit must be adjusted and tested. A dismantled view of a typical unit is shown in Fig. 1.

**3.** Scrupulous cleanliness is essential at all times and its importance cannot be overemphasized, particularly when servicing or reconditioning.

**4.** It is recommended that slave nuts, washers, connections and other such details be used in those instances where components are to be assembled temporarily.

**5.** All paper joint washers, gaskets, sealing rings, split pins, tab-washers and locking wire must be renewed on re-assembly or whenever they are disturbed.

### SPECIAL TOOLS

**6.** The following special tools are required,

In most instances an illustration of the tool in use is provided adjacent to the appropriate instructions in the text.

| Tool No. | Description |
|---|---|
| G.63006 | Gauge jig, flatness test, servo valve orifice. |
| T.174675 | Spanner, pressure control and flow control servo orifices |
| T.196071 | Plate, pressure testing, fuel pressure control assembly |
| T.196072 | Tool, compressing, servo spring, fuel pressure control assembly. |
| T.196073 | Adapter, inlet and outlet connection, rig-testing |
| T.202315 | Fixture, alignment check, flow control rocker lever in bush |
| T.202762 | Adapter, leakage check, flow control piston servo response orifice. |
| T.203444 | Locating block, removing flow control capsule adjusting screw retaining sleeve. |
| T.203446 | Blanking plate and sealing plugs, leakage test, flow control lever housing. |
| T.205214 | Adapter, dismantling and assembling. |
| T.205215 | Peg spanner, flow control piston servo response orifice housing. |
| T.205216 | Stripping tool, flow control piston servo response orifice and housing. |
| T.205217 | Setting piece, flow control rocker lever. |
| T.205218 | Extractor, flow control cylinder servo pressure orifice strainer. |
| T.205219 | Extractor, flow control cylinder servo pressure orifice cover plate. |
| T.205220 | Adapter, pressure test, fuel pressure control servo valve. |
| T.205221 | Extractor, lever, fuel pressure control |
| T.205222 | Locating block, fuel pressure control assembly |
| T.205223 | Special spanner, slotted plug, fuel pressure control assembly. |
| T.205224 | Locating block, pressure ratio switch assembly. |
| T.205225 | Setting pillar and plate, distance piece, pressure ratio capsule. |
| T.205226 | Extractor, P2 inlet orifice and flow control servo response orifice strainer. |
| T.205227 | Extractor, differential pressure orifice. |
| T.205228 | Setting bush, valve gap, pressure ratio switch. |
| T.205229 | Extractor, P2/P1 orifice tube. |
| T.214183 | Punch and setting ring—half-ball cage-servo orifice. |
| T.214184 | Setting screw—upper limit—flow control cantilever. |
| T.214189 | Clamp, leakage check, flow control piston servo response valve. |
| T.224379 | Slave cover, ring and union, leakage tests. |
| T.230758 | Setting screw—lower limit—flow control cantilever. |

## CHECKS AND PRECAUTIONS BEFORE DISMANTLING

**7.** Study any complaints reported with the unit and examine the exterior thoroughly, including all exposed threads, for any signs of damage. Check that all external locking is intact and that all connections have been covered properly to prevent the ingress of foreign matter to the interior of the unit during transit.

**8.** Remove any dust caps fitted and inspect them internally for signs of foreign matter. If it is suspected that foreign matter is present it is advisable first to flush the unit on the rig.

**9.** If the unit has been reported as leaking it should be subjected 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. When other complaints are reported or where a unit is time-expired, remove all installation fittings and if its condition will allow it to be tested, mount the unit on the test rig and carry out a performance test in accordance with para. 222 to 227 in this chapter, to assist in deciding which parts of the unit require particular attention during dismantling. Following these checks the unit should be dismantled partially or completely in accordance with any faults reported or discovered. A time-expired unit must be dismantled completely.

## DISMANTLING THE UNIT

### General

**10.** The instructions in this section are

## KEY TO FIG. 1

1 NAME PLATE

2 CAPSULE CHAMBER COVER PLATE

3 FLOW CONTROL CAPSULE CLEVIS PIN AND RETAINING CLIP

4 FLOW CONTROL LEVER SERVO VALVE TAPPET SCREW

5 BLANKING PLUG

6 FLOW CONTROL TRIMMING SPRING ADJUSTING SCREW

7 FLOW CONTROL LEVER MOVEMENT STOP PLUG

8 FLOW CONTROL LEVER HOUSING

9 FLOW CONTROL TRIMMING SPRING ANCHOR GUIDE BUSH

10 FLOW CONTROL TRIMMING SPRING

11 FLOW CONTROL SENSING SPRING

12 FLOW CONTROL PLUNGER CLEVIS PIN

13 FLOW CONTROL METERING PLUNGER

14 FLOW CONTROL PISTON SERVO VALVE RETAINING CAGE

15 FLOW CONTROL PISTON SERVO RESPONSE VALVE

16 FLOW CONTROL PISTON SERVO RESPONSE ORIFICE

17 FLOW CONTROL SERVO PISTON

18 FLOW CONTROL PISTON SERVO RESPONSE ORIFICE HOUSING

19 FLOW CONTROL PISTON SERVO CYLINDER HOUSING

20 FLOW CONTROL PISTON STOP SCREW SLEEVE

21 FLOW CONTROL PISTON SERVO RESPONSE STRAINER

22 FLOW CONTROL PISTON STOP SCREW

23 FLOW CONTROL PISTON SERVO VALVE STRAINER RETAINING PLUG

24 PRESSURE CONTROL SERVO VALVE TAPPET ACCESS PLUG

25 PRESSURE CONTROL LEVER SPRING AND SPRING SEATING

26 PRESSURE CONTROL SERVO VALVE RETAINING CAGE

27 PRESSURE CONTROL SERVO VALVE

28 PRESSURE CONTROL SERVO VALVE ORIFICE

29 PRESSURE CONTROL SERVO ORIFICE HOUSING LOCATING DOWEL

30 PRESSURE CONTROL SERVO ORIFICE HOUSING

31 PRESSURE CONTROL ASSEMBLY HOUSING

32 PRESSURE CONTROL SERVO ORIFICE STRAINER

33 PRESSURE CONTROL LEVER HINGE BUSH LOCATING PEG

34 PRESSURE CONTROL PISTON PUSH ROD

35 PRESSURE CONTROL SERVO ORIFICE HOUSING RETAINING NUT

36 PRESSURE CONTROL SPRING SEATING

37 PRESSURE CONTROL CYLINDER RETAIN ING SLEEVE

38 PRESSURE CONTROL SPRING CAP AND SPRING

39 PRESSURE CONTROL SPRING HOUSING COVER PLATE

40 PRESSURE CONTROL SPRING HOUSING ADJUSTING SCREW

41 PRESSURE CONTROL PISTON STOP PLATE

42 PRESSURE CONTROL PISTON

43 PRESSURE CONTROL PISTON CYLINDER

44 PRESSURE CONTROL PISTON SEAL

45 PRESSURE CONTROL PISTON SEAL SUPPORT

46 PRESSURE CONTROL LEVER ACCESS PLUG AND CIRCLIP

47 PRESSURE CONTROL LEVER

48 PRESSURE CONTROL LEVER HINGE BUSH AND HINGE PIN

49 PRESSURE CONTROL LEVER AND SERVO VALVE TAPPET SCREWS

50 PRESSURE CONTROL PISTON UPSTREAM PRESSURE TRANSFER BOBBIN

51 FLOW CONTROL CYLINDER SERVO PRESSURE DRILLING BLANKING PLUG

52 FLOW CONTROL CYLINDER SERVO PRESSURE ORIFICE RETAINING PLUG

53 FLOW CONTROL CYLINDER SERVO PRESSURE ORIFICE STRAINER

54 FLOW CONTROL CYLINDER SERVO PRESSURE ORIFICE

55 FLOW CONTROL PISTON RETAINING SETSCREW

56 FLOW CONTROL PISTON SEAL

57 FLOW CONTROL METERING ORIFICE

58 FLOW CONTROL PLUNGER CLEVIS PIN RETAINING CLIP

59 FLOW CONTROL CAPSULE ADJUSTING SCREW

60 FLOW CONTROL CAPSULE ADJUSTING SCREW RETAINING SLEEVE

61 FLOW CONTROL ROCKER LEVER

62 FLOW CONTROL ROCKER LEVER HINGE PIN

63 FLOW CONTROL LEVER HINGE BUSH

64 FLOW CONTROL CAPSULE

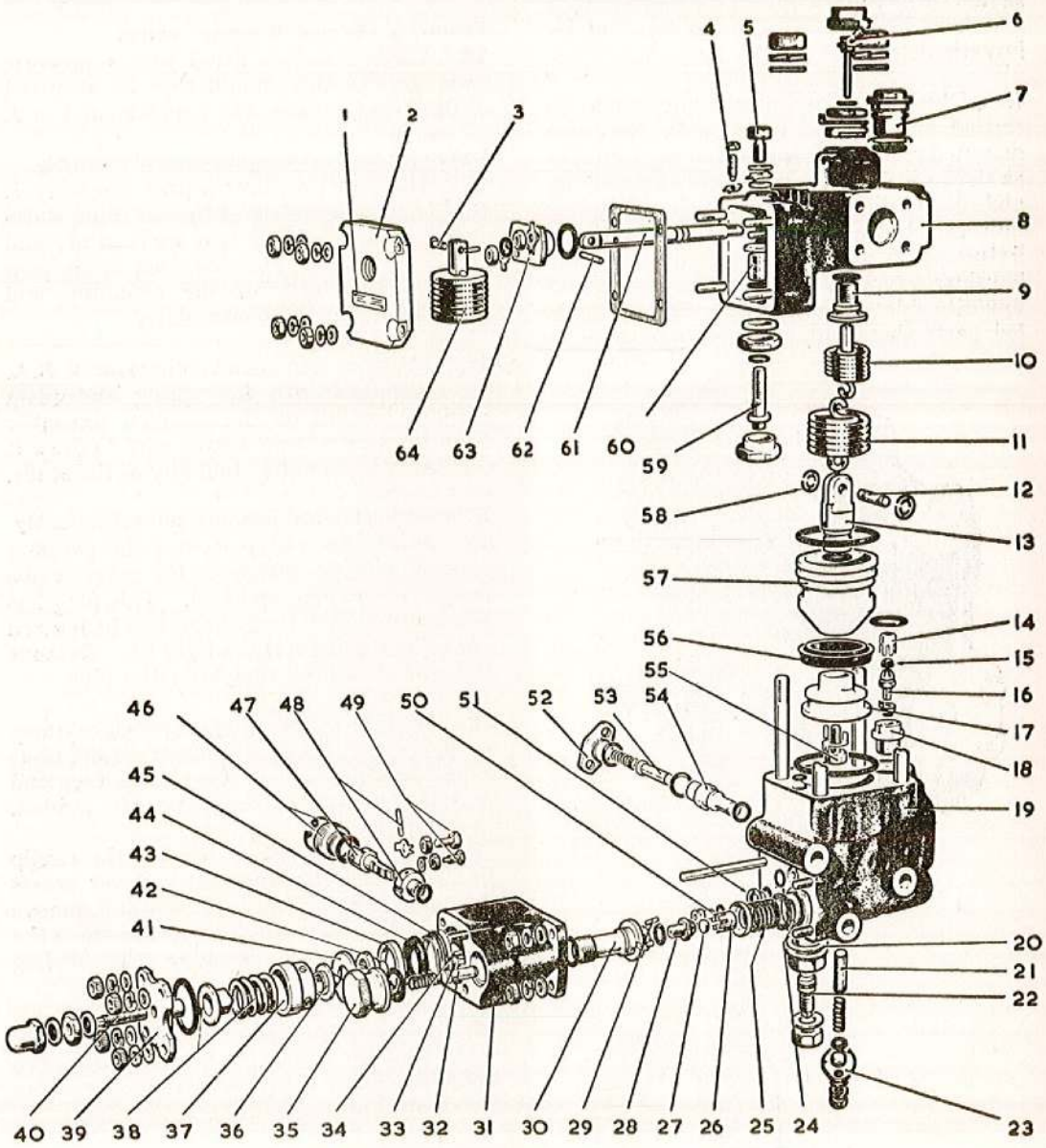



**Fig. 1. Dismantled view of air/fuel ratio control unit**

given in the recommended sequence for the complete dismantling of a unit. The method of removing the sub-assemblies is described and is followed immediately in each case by the method of reducing the sub-assembly to its separate details where this is practicable.

**11.** Complete dismantling may not be necessary in every instance and where a unit has only been in use for a short time the extent of dismantling may be discretionary, depending upon the nature of the suspected fault.

**12.** It is recommended that only one set of components be present on the bench at any one time in order to avoid the accidental transfer of parts from one unit to another and to reduce the possibility of shortages of the smaller items on rebuild. Sealing rings, tab-washers, split pins and locking wire

should be discarded as they are removed; before discarding the sealing rings they should be closely examined for damage that may have been the cause of the defect under investigation.

**13.** Dismantling and assembling should be carried out at all times with the unit mounted on the appropriate fixture T.205214 as shown in Fig. 2. To simplify assembling and dismantling operations the complete unit can be mounted on one side of the fixture or the piston servo cylinder and lever housings, when separated, can be mounted on opposite sides of the fixture. The dismantled parts should be placed in one or more clean dry metal receptacles for safe storage pending inspection and rebuild.

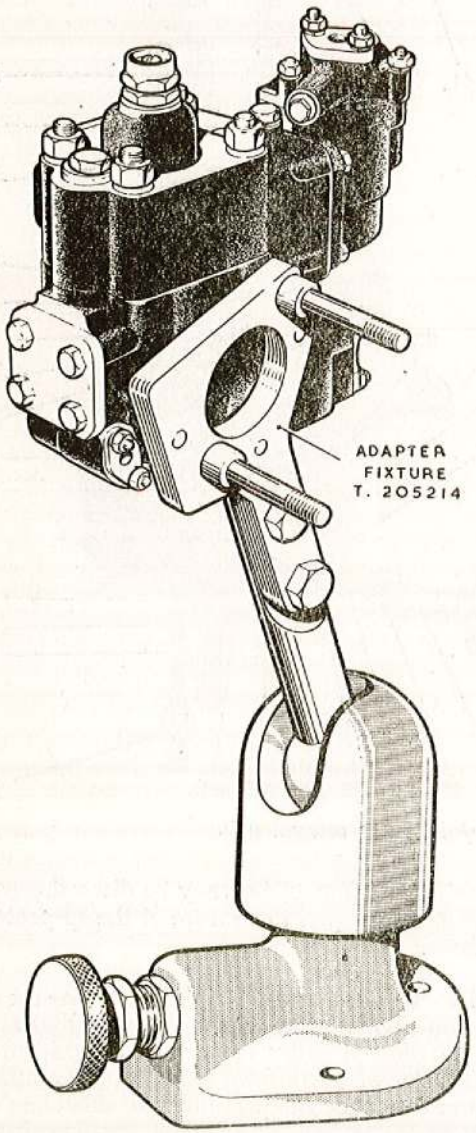



**Fig. 2. Dismantling and assembling fixture**

**Removing the pressure-ratio switch**

**14.** When a unit is fitted with a pressure ratio switch, this should first be removed as described in para. 3 of Supplement 1 or 2.

**Removing the fuel pressure control assembly**

**15.** The fuel pressure control assembly is held to the main body of the Air/Fuel Ratio Control by means of two short studs and two long studs. The two long studs pass through the body of the assembly and serve to retain the cover plate.

**16.** Unscrew and remove the four 2 B.A. nuts together with the spring and plain washers and lift off the complete assembly from the control unit taking care to draw it off evenly so as not to foul any of the studs.

**Dismantling the fuel pressure control assembly**

**17.** From the sealing face of the pressure control housing withdraw the servo valve tappet access plug and seal. This plug has two chamfered flat edges and can be levered out of its seating if it is a tight fit. Remove the rubber sealing ring from the plug.

**18.** Withdraw the upstream pressure transfer bobbin together with rubber sealing rings from the small bore in the seating face and remove both sealing rings from the bobbin.

**19.** Using circlip pliers remove the circlip retaining the pressure control lever access plug in the housing and unscrew and remove the plug, together with sealing ring, using the spanner T.205223. Remove the sealing ring from the plug.

**20.** Remove the dome nut, washer and seal, locknut, washer and seal and the pressure control spring adjusting screw from the control spring housing cover plate.

**21.** Slacken off the remaining two nuts, a few threads at a time, otherwise the loading of the pressure control spring between the cover and piston will tend to tilt the cover and cause it to foul the securing studs. Finally remove both nuts together with the spring and plain washers and remove the rubber sealing ring from the groove on the underside of the cover.

**22.** Remove the outer spring seat, pressure control spring, and inner spring seat then invert the unit and tap lightly on the palm

of the hand when the retaining sleeve, stop plate, piston, push rod, piston cylinder, piston seal, and seal retainer will fall out. Take care not to lose the small push rod from the bore in the piston.

**23.** Unscrew and remove the cap nut from the pump servo pressure orifice and strainer housing and lift out the strainer spring. Remove the seal from the counterbored face of the housing. It will not be possible to remove the strainer until after further dismantling.

**24.** Unlock the tab-washers from both the tappet screws in the servo control lever assembly and, using a box spanner and screwdriver, release the locknuts and remove both tappet screws.

**25.** Compress the servo lever spring using the tool T.196072 and using extractor T.205221 withdraw the pump servo control lever assembly (fig. 3). It is not advisable to remove the lever from the bush unless either shows obvious signs of damage or wear ; if this is necessary, remove the hinge pin and slide the lever out of the bush, taking care not to damage either the bush or the hinge pin, then withdraw the sealing ring from the bush.

**26.** Invert the unit so that the spring, spring seat and orifice and strainer housing fall out together then bend back the tabs of the tab-washer securing the orifice in the housing. Prise off the half-ball retainer and remove the half-ball.

**27.** Refit the orifice and strainer housing, locating it correctly on the dowel and, using the special spanner T.174675, remove the orifice assembly together with sealing ring from the housing as shown in Fig. 4. The orifice assembly consists of orifice, half-ball, and half-ball retainer and will be removed complete. Remove the orifice and strainer housing from the unit, remove the rubber sealing ring from the orifice assembly then push out the strainer.

**28.** Remove the rubber sealing ring from the pressure control assembly seating face on the piston chamber and from the same seating face withdraw the plug bobbin complete with rubber sealing ring. Remove the sealing ring from the bobbin.

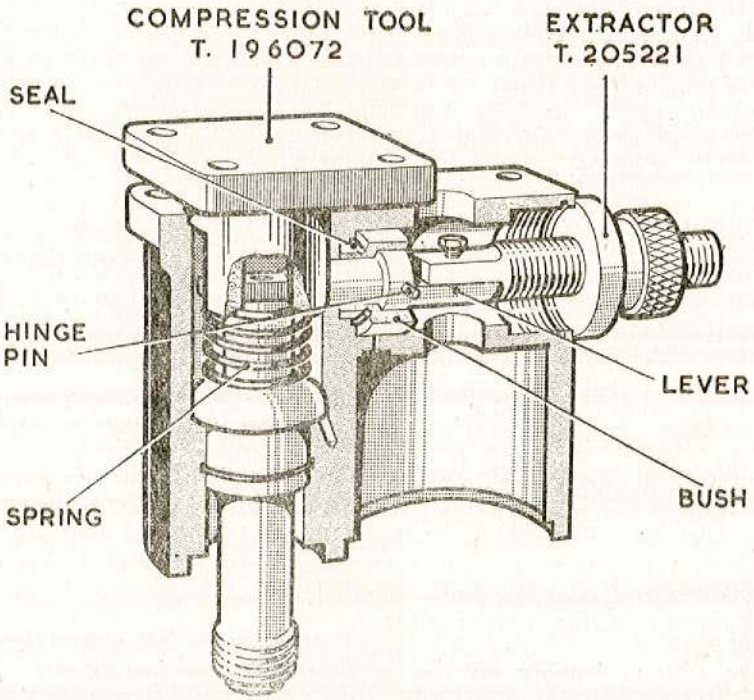



Fig. 3. Withdrawing the servo lever from the fuel pressure control assembly

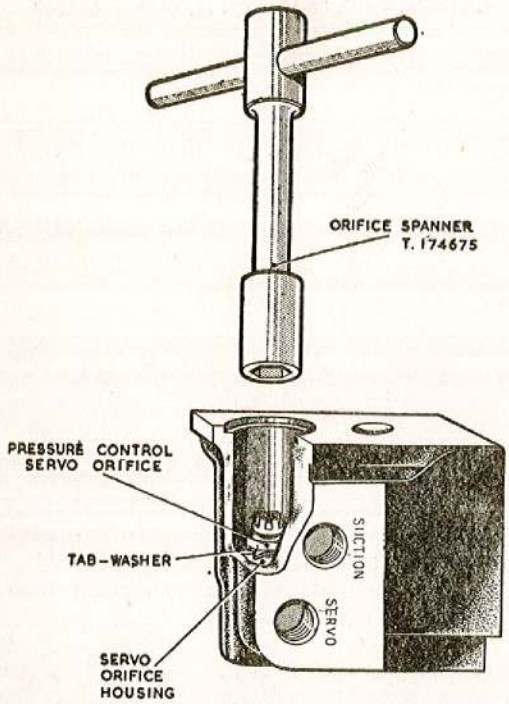



**Fig. 4. Removing the fuel pressure control servo orifice from the servo orifice housing**

**Separating the flow control piston chamber and lever housing**

**29.** Unscrew and remove the four nuts, together with the spring and plain washers from the studs securing the two housings together. Tap the housings lightly with a hide hammer in order to free them. Note that the complete piston assembly will remain on the lever which will still be attached to the lever housing.

**30.** Before separating the housings drain any fuel from the piston chamber by removing the piston stop screw, sleeve, and sealing washer from the base of the chamber. After removing this slacken the stop screw locknut and remove the locknut, washer and screw from the body. Remove the rubber sealing ring from the stop screw waist.

**31.** Remove the rubber sealing ring from the piston chamber sealing face and extract the large rubber sealing ring from the piston chamber bore.

**Dismantling the flow control piston chamber**

*Removing the flow control servo response orifice and servo valve assembly*

**32.** Mount the piston chamber on the assembling and dismantling fixture T.205214 as shown in Fig. 2.

**33.** Unlock the tab-washer locking the response orifice in its housing and, using spanner T.174675 as shown in fig. 5, remove the orifice. Using peg spanner T.205215 unscrew and remove the orifice housing from the piston chamber as shown at ' B ' in fig. 5.

**34.** If when removing the orifice, the housing is released also, unscrew the whole assembly from the piston chamber and mount in stripping tool T.205216 as shown at ' C ' in fig. 5 and then remove the orifice from its housing using spanner T.174675.

**35.** Remove the rubber sealing ring from the orifice and from the orifice housing ; draw off the retainer and separate the half-ball from the orifice.

*Removing the flow control piston servo pressure orifice*

**36.** Unscrew the two 2 B.A. nuts and remove together with grover washers and plain washers and lift off the cover plate. If necessary use the extraction tool T.205219 for withdrawing the cover plate as shown in Fig. 6.

**37.** Remove the rubber sealing ring from the cover plate, lift out the strainer spring then, using the $\frac{3}{8}$ in. B.S.F. extractor tool T.205218, withdraw the strainer and orifice body.

**38.** Remove the extractor, invert the strainer and orifice body and shake out the strainer and orifice plate then remove the rubber sealing ring from the orifice plate.

*Removing the strainer assembly*

**39.** Unlock and remove the two 2 B.A. nuts together with the spring and plain washers and lift off the strainer retainer using, if necessary tool T.205226, as shown in Fig. 7. Remove the rubber sealing ring from the strainer retainer then invert the unit and shake out the spring and strainer.

**40.** The piston chamber is now completely dismantled and none of the studs should be removed ; if any of these are damaged, the piston chamber must be returned for repair.

**Dismantling the flow control lever housing**

*Removing the rocker lever stop plug*

**41.** Unscrew and remove the rocker lever stop plug using a standard box spanner.

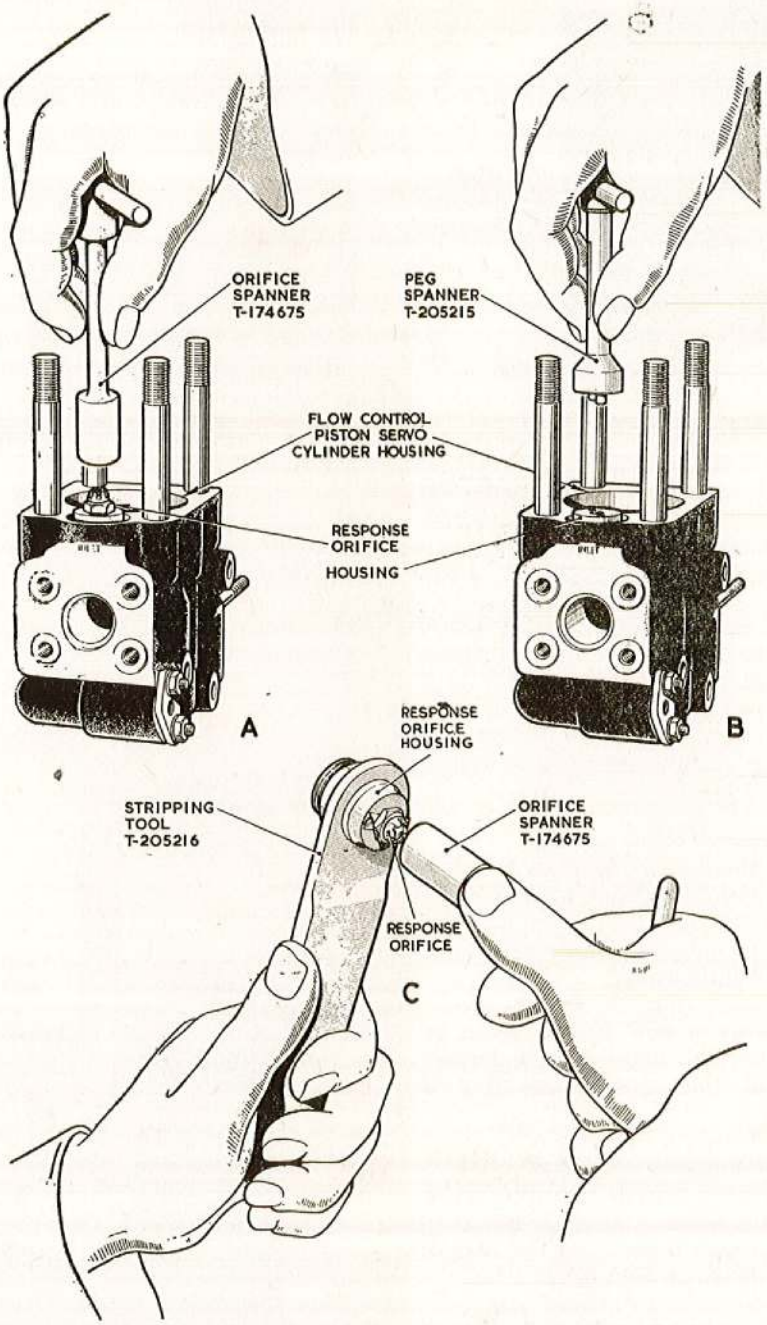



**Fig. 5. Removing flow control piston servo response orifice**

Note and record the number and thickness of shims under the stop plug in order to facilitate re-assembly; remove the sealing ring from the plug.

*Removing the stop screw*

**42.** Unlock the tab-washer and remove the stop screw together with two plain washers and tab-washer from the capsule chamber.

*Removing the capsule adjusting screw*

**43.** Remove the capsule adjustment locknut and the screw and draw the rubber sealing ring from the screw flange. It is not

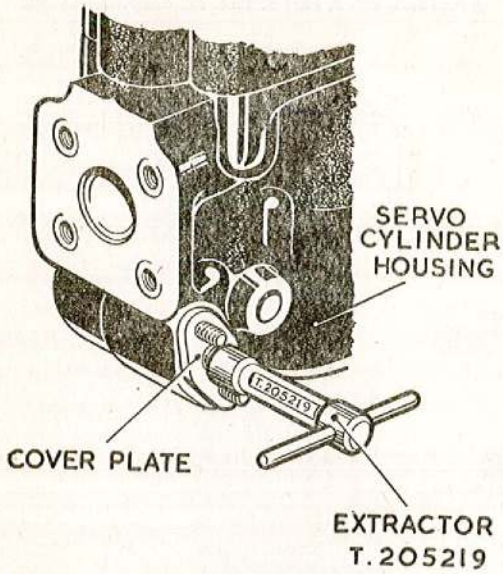



**Fig. 6. Withdrawing the flow control servo pressure orifice cover plate**

advisable to remove the adjusting screw pillar from the housing as this has been carefully sealed and tightened down. If it shows obvious signs of damage, however, or leakage upon testing, it must be removed and the sealing washer renewed as described in para. 46 and 47.

*Removing the flow control capsule assembly*

**44.** Remove the spring clip from the flow control lever clevis pin and push out the pin. A flat on the head of the pin provides clearance for the nut which secures the lever bush plate to the housing.

**45.** The capsule is now free and can be withdrawn from the housing. No further dismantling of the capsule assembly is permissible.

*Removing the capsule adjusting screw pillar*

**46.** To remove the capsule adjusting screw pillar, insert the locating block T.203444 in the housing so that it locks on the flats of the pillar as shown in Fig. 8.

**47.** Using a standard spanner unscrew and remove the nut together with plain washer. Remove the locating block and withdraw the pillar from the housing together with sealing ring. Remove and discard the sealing ring.

*Removing the trimming spring adjusting screw*

**48.** Unscrew and remove the cap-nut from the trimming spring adjusting screw, remove the adjusting screw then remove and discard the sealing ring.

**49.** Unlock the tab-washer and remove the locknut, tab-washer and tab-washer locking plate securing the trimming spring anchor guide bush.

*Removing the flow control piston and metering orifice assembly*

**50.** Unlock the tab-washer on the $\frac{1}{4}$ in. B.S.F. bolt securing the servo piston to the flow plunger, remove the bolt together with tab-washer then separate the plunger from the servo piston and remove the piston seal.

**51.** Withdraw the orifice plate from the plunger and remove the sealing ring from the orifice body.

**52.** Detach the sensing spring loop from the rocker lever and withdraw the spring and plunger assembly from the housing.

**53.** Remove the spring clips from the spring anchor pin, push out the pin and

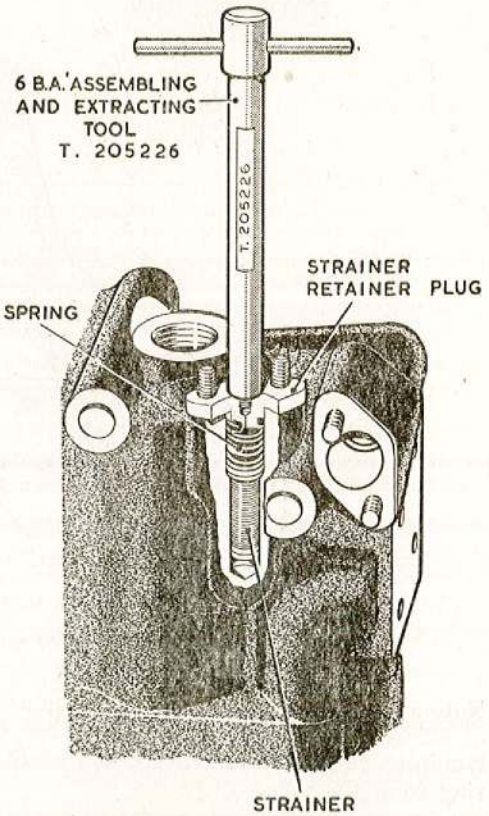



**Fig. 7. Removing flow control piston servo response orifice strainer**

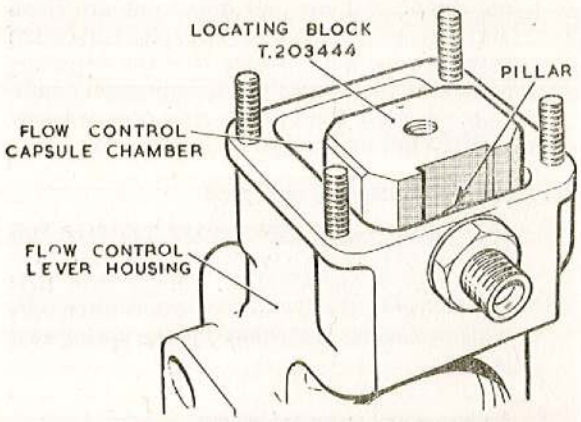



**Fig. 8. Removing the flow control capsule adjusting screw pillar**

separate the flow plunger from the spring. Remove the seal from the flow plunger but do not take out the dowel pin unless it shows obvious signs of damage, in which case it can be withdrawn with pliers.

*Removing the flow control rocker lever assembly*

**54.** Unlock and remove the nuts and tab-washers securing the lever bush plate to the housing. Detach the rocker lever from the trimming spring loop and withdraw the complete rocker lever assembly consisting of rocker lever, lever bush plate, rubber sealing ring and tappet screw. Unlock the tappet screw tab-washer, release the lock-nut and remove the tappet screw from the end of the lever.

**55.** Remove the rubber sealing ring from the lever bush or if it remains in the housing when the lever is withdrawn, remove it from the housing. It is not advisable to remove the rocker lever from the bush unless obviously damaged in which case drift out the hinge pin with a suitable punch and withdraw the rocker lever from the bush. Remove the rubber sealing ring from the recess in the bush.

*Removing the trimming spring assembly*

**56.** Withdraw the trimming spring, spring anchor and spring anchor guide bush from the housing, separate the guide bush from the spring anchor and remove the seal.

**57.** The spring loop clips on to the spring anchor and as considerable force is required to separate them, it is not advisable to do this, unless obvious damage necessitates renewal of either part.

## CLEANING

**58.** The components must be cleaned thoroughly by washing in kerosine. It is recommended that they be pressure-washed using an appropriate bath and spray nozzle supplied by a pump with adequate filtering facilities. Hard brushes, cloths and abrasives must not be used.

**59.** 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.

**60.** After cleaning, the components should be dried thoroughly with a compressed air blast, which must be free from water, and then placed in clean dry containers ready for inspection.

## INSPECTION

**General**

**61.** All visual inspection is described in this section and where dimensional checks are necessary the appropriate dimensions are given in the Schedule of Fits, Clearances and Repair Tolerances (Vol. 2, Part 2).

**62.** Each detail should be inspected closely for signs of damage, corrosion and excessive wear; if considered necessary, with due regard to the function of the component and nature of any defect, the part should be discarded and a replacement fitted.

**63.** Scrupulous cleanliness of the inspection and assembly bench and of all containers and tools in use is essential. It is advisable that the surface of the bench be covered with zinc, linoleum or bakelized fabric to assist in maintaining the high standard of cleanliness required. Following inspection the details should be placed in containers holding a quantity of light oil (OM-13) for safe storage pending rebuild.

**Permissible wear**

**64.** All parts subject to wear must be checked dimensionally in accordance with the Schedule of Fits, Clearances and Repair Tolerances (Vol. 2, Part 2).

**Redundant and consumable parts**

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

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

**Scores and surface damage**

**67.** In general, scores or surface damage on moving parts and joint faces will impair the operational efficiency of the unit, hence any part so affected should be rejected and a replacement demanded. In certain circumstances, however, depending upon the number of hours the unit may be required to operate, the purpose and region of operation and the availability of spares, certain defects may be acceptable at the discretion of the Inspector-in-Charge, provided that the efficiency and safety of the unit is not impaired.

**Magnetic crack detection**

**68.** In a case of suspected cracks or wherever there is the slightest doubt concerning the soundness of any components of ferrous origin they must be tested for cracks by means of an approved magnetic crack detection process and finally demagnetised before assembly.

**Installation fittings**

**69.** Inspect all installation adapters and unions for cleanliness and general condition and ensure that threads and joint faces are undamaged.

**Fuel pressure control assembly**

*Servo valve tappet access plug*

**70.** Examine the plug for cleanliness and the edges of the two flats for burrs.

*Upstream pressure transfer bobbin*

**71.** Make sure that all traces of the sealing rings have been removed from the bobbin, and that its bore is clean.

*Pressure control lever access plug*

**72.** Ensure that the threads on the plug are serviceable and that the slots are not damaged.

*Pressure control spring adjusting screw assembly*

**73.** Check that the threads of the adjusting screw, locknut and dome nut are clean and serviceable, examine the spherical end of the screw for wear and see that the adjusting square at the opposite end is in good condition. Renew the sealing ring cage washers if distorted or fractured.

*Pressure control spring cover plate*

**74.** Ensure that the cover plate is free from cracks and corrosion and that the joint face is undamaged. Make sure that the facing in the bottom of the counterbore which provides the recess for the spring seat is clean.

*Pressure control spring and seatings*

**75.** Inspect the spring for damage and distortion of coils and check that the spring seats are free from sharp edges and cracks likely to damage the spring.

*Pressure control piston and details*

**76.** Inspect the piston generally for severe wear, scoring and other damage, see that there are no cracks developing around the piston and that the seal seating and push rod locating bore are quite clean. Examine the bore for scoring and wear.

**77.** Check that the piston seal retainer and washer are serviceable and that the push rod is not distorted or worn at either end.

**78.** Examine the piston stop plate for fracture and pitting due to wear.

*Servo valve strainer assembly*

**79.** Examine the strainer element closely for damage and distortion and see that it is quite clean. Ensure that the end pieces are secure.

**80.** Ensure that the strainer retainer spring coils are not distorted and are free from sharp edges and cracks; check that the cap-nut is clean and its threads serviceable.

**81.** Examine the orifice and strainer housing for cleanliness and sharp edges or burrs and see that all traces of the sealing rings have been removed from the appropriate grooves.

*Pressure control rocker lever assembly*

**82.** Examine the rocker lever generally for damage and check its fit in the bush.

Examine the hinge pin for signs of wear or distortion and renew if necessary.

**83.** Examine both tappet screws for scoring and other surface damage and see that the threads are in good condition. Inspect the locknuts for damage to the threads and hexagon.

*Pump servo pressure orifice assembly*

**84.** Examine the half-ball for wear on the face and the back, check the face for colour registration against an optical flat. Reject the half-ball if more than two colour bands are apparent.

**85.** Inspect the orifice generally for cleanliness and check that the threads are in good condition. Examine the orifice and surrounding lands closely for damage, burrs and corrosion, also check for wear by the half-ball. Test the orifice face for flatness, using jig. G.63006 and an electrolimit comparator providing an amplification of 2,500 to 1. The maximum error must not exceed 0·00002 in.

**86.** Check that the sealing ring has been removed from the orifice housing flange and bore and see that the groove is clean. Discard the tab-washer. Ensure that the housing locating dowel is free from damage.

**87.** Inspect the half-ball retainer for distortion, burrs or broken claws. If the claws are serviceable, they may need re-setting before being assembled (para. 132).

**88.** Inspect the servo valve spring and its seat generally for cleanliness, damage and corrosion and see that the spring coils are not distorted.

*Lever hinge bush locating peg*

**89.** Examine the peg generally for cleanliness and see that there are no burrs, particularly on the small end.

**Flow control piston chamber**

*Flow control servo response orifice and servo valve assembly*

**90.** Ensure that the orifice is clean, that its seat, lands and threads are undamaged. Check the orifice for flatness as described in para. 85.

**91.** Ascertain that the half-ball is free from damage and that its sealing face is optically flat (para. 84.)

**92.** Inspect the half-ball retainer for burrs or distortion and for broken claws; if necessary, the claws must be re-set as described in para. 132.

**93.** Examine the orifice housing for damage and its threads for serviceability, ensure that it is quite clean and free from burrs.

*Flow control piston servo pressure orifice*

**94.** Check that the cover plate is clean and free from cracks and that the seal retaining groove is free from any trace of rubber.

**95.** Examine the strainer spring for sharp edges and distortion of the coils and check the strainer for damage and cleanliness.

**96.** Examine the strainer and orifice body for damage especially on the seating face for the orifice plate at the bottom of the bore.

**97.** Examine the orifice plate for cleanliness and corrosion and see that there is no obstruction of the orifice itself.

*Response orifice strainer assembly*

**98.** Ensure that the strainer retainer is clean and free from cracks and that the groove is free from traces of the sealing ring.

**99.** Check that the spring has no sharp edges and distortion of the coils.

**100.** Examine the strainer element for cleanliness and make sure that the ends are secure.

*Piston stop screw*

**101.** Examine the threads and the squared end of the stop screw for serviceability. Ensure that the sleeve and lock-nut are in good condition.

**Flow control lever housing**

*Rocker lever stop plug*

**102.** Ensure that the threads are not damaged and examine the shim(s) for fracture and distortion. Ascertain that the groove for the sealing ring is clean and that all traces of the seal have been removed.

*Capsule adjusting screw*

**103.** Inspect the adjusting screw for

scoring and other surface damage on the underside of the flange as this is a sealing face and damage may cause leakage. See that the threads are in good condition and that the spannering square and screwdriver slot are undamaged.

*Flow control capsule assembly*

**104.** Examine the capsule for damage and see that there are no particles of foreign matter between the convolutions.

**105.** Examine the lever clevis pin for wear and distortion and the spring for distortion and fracture. Check that the pin is a good fit in both clevis and lever.

**106.** If removed, examine the capsule adjusting screw pillar for damage, particularly to the threads of the pillar and nut.

*Trimming spring and adjusting screw*

**107.** Examine the adjusting screw for scoring and other surface damage, particularly on the underside of the flange, and check the locknut and cap nut for damage to the threads and hexagon and the tab-washer locking plate for corrosion and distortion.

**108.** Inspect the spring for surface cracks and corrosion, particularly around the attachment loops, and check that the loops are free from distortion.

**109.** Examine the spring anchor adapter for wear and damage.

**110.** If the spring and spring anchor have not been separated, check that the anchor is held securely in the spring loop.

*Flow control servo piston*

**111.** Inspect the piston head generally for severe wear, scoring and other damage. Check that there are no cracks developing around the piston and that the seal seating is quite clean. Check that the threads on the $\frac{1}{4}$ in. B.S.F. bolt are serviceable.

*Flow control plunger*

**112.** Examine the flow plunger for wear, ensure that the threads for the piston securing bolt are clean and serviceable and that the dowel is fixed firmly in its seating. If the dowel has been removed check that the hole is clean and that its edges and bore are undamaged.

**113.** Inspect the spring anchorage end of the plunger for wear in the clevis pin holes and for cracking around the fork lugs. Check the clevis pin for undue wear and corrosion and see that it is an easy push-fit in the spring attachment loop and spring anchorage fork. Check that the retaining clips are not distorted or fractured.

*Flow control metering orifice*

**114.** Examine the orifice for corrosion and wear and for any cracks appearing round the edges. See that the sealing ring groove is quite clean and check that the flow plunger moves freely through the orifice bore without any obstruction or indication of undue wear.

*Sensing spring*

**115.** Inspect the spring for surface cracks and corrosion and check that the spring loops are not distorted.

*Flow control lever assembly*

**116.** Examine the rocker lever and bush generally for damage and corrosion and ensure that the hinge pin is a good fit with no trace of looseness.

**117.** Check that the tapped hole in the end of the lever for the tappet screw is clean and that the threads are serviceable. Ensure that the clevis pin drilling at the other end of the lever is clean and not worn and check the fit of the clevis pin in the drilling.

*Checking alignment of lever with bush*

**118.** Check the alignment of the lever with the bush using the checking fixture T.202315

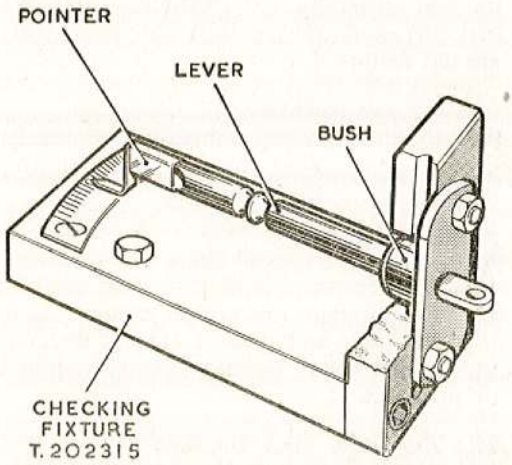



**Fig. 9. Checking the alignment of the flow control rocker lever in the bush**

as shown in Fig. 9. The lever should return to the neutral position from either side; if it fails to do this, separate the lever from the bush by pushing out the hinge pin. Renew the rubber sealing ring inside the bush, then re-assemble and re-check the alignment.

*Lever tappet screw*

**119.** Examine the flow control lever tappet screw for scoring and other surface damage. Check that the threads are in good condition and inspect the locknut for damage to the threads and hexagon.

**Housings**

**120.** Inspect the housings of the various assemblies generally for damage to the casting and studs; ensure that all joint faces are in good condition and free from scoring or other potential sources of leakage and that there are no signs of corrosion.

**121.** Ensure that all traces of joint washers have been removed from the facings, check that all rubber sealing rings have been removed and that their locating grooves are clean. Examine the spot faces around all blanking plug tapped holes and see that they are clean and free from scoring or damage which may result in leakage.

**122.** Ensure that all drillings are clean and free from restriction. Check that all dowel holes are clean and free from foreign matter which may prevent the dowels from entering fully.

**123.** Check that all tapped holes are clean; that they are in good condition and that all tab-washer locating holes are clean and undamaged.

**Remaining details**

**124.** Examine all circlips for freedom from cracks and distortion and see that they fit correctly in their respective grooves.

**125.** Check all blanking plugs for condition of the faces under the heads as scoring or damage may result in leakage. Ensure that the threads are clean and in good condition and that all lockwire holes are clean and free from sharp edges.

**126.** Examine all dowel pins for frettage, wear and any signs of corrosion.

**127.** Inspect all nuts, bolts, setscrews, washers and shims for cleanliness and general condition.

## RE-BUILDING THE CONTROL UNIT

**General**

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

**129.** Certain pressure tests are necessary during re-building and these are described in their appropriate sequence. The specific test requirements are provided in the relevant test schedule in appendices to this chapter. The lever housing should be re-built on one side of the assembling adapter T.205214, whilst the piston chamber is rebuilt on the other side of the adapter then transferred to the housing to complete the main assembly. If a pressure ratio valve is embodied, it must be assembled and tested separately, as described in the Supplements to this chapter, and then added to the main assembly for final calibration.

**Fuel pressure control assembly**

*Pump servo pressure control lever and bush*

**130.** If the servo lever has been removed from the bush, position a new sealing ring in the bush and slide the lever through the bush. Locate the lever crosshole with the holes in the bush and gently push the hinge pin into position.

*Pump servo pressure orifice and strainer assembly*

**131.** Position a tab-washer and seal over the orifice threads, fit a sealing ring in the counterbore in the mouth of the orifice housing, then using the orifice spanner T.174675 screw the orifice tightly into the orifice and strainer housing. This operation is facilitated if the orifice and strainer housing is temporarily located with the dowel peg in its housing bore in the pressure control housing. Do not lock the tab-washer at this stage.

**132.** Before fitting the half-ball on the orifice, check the setting of the retainer cage claws by inserting the claws into the bore of the setting ring T.214183; they should enter to a depth of $\frac{1}{8}$ in. If they require re-setting, rest the cage on the bench, claws uppermost, and use the setting punch T.214133, then check again in the setting ring.

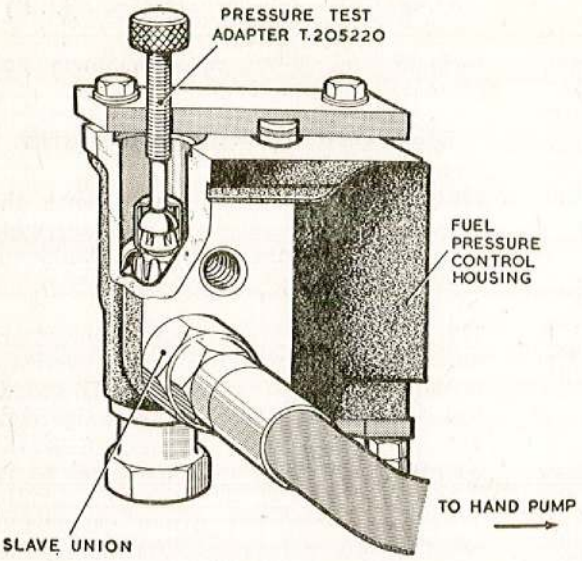



**Fig. 10. Pressure testing the servo valve, fuel pressure control assembly**

**133.** Position the half-ball on the orifice and retain by pressing the cage claws firmly on to the head of the orifice.

**134.** Locate a rubber sealing ring over the orifice and strainer housing and also in the mouth of the locating bore in the pressure control housing.

**135.** Fit the orifice assembly into the pressure control housing, making sure that the locating dowel is in position, align the slot in the orifice housing flange with the dowel and push the assembly in fully. Insert the strainer and retaining spring into the other end of the orifice housing then fit and tighten the cap nut.

*Pressure testing the pressure control servo valve*

**136.** Assemble the pressure test adapter T.205220 and slave union as shown in fig. 10 to the mounting face of the pressure control unit using slave nuts and washers. Connect the hand pump from a tank of kerosine to the unit and raise the pressure to 2,000 lb. per sq. in. No leakage is permissible.

**137.** If any leakage is apparent the half-ball, orifice, orifice seal, and half-ball retainer must be renewed and the pressure test repeated.

**138.** Disconnect the unit from the hand pump and remove the pressure test adapter and slave union. Lock the orifice tab-washer.

*Fitting the pressure control servo lever and bush*

**139.** Lower the spring seat and spring over the orifice assembly making sure that both seat correctly.

**140.** Assemble a tab-washer, locknut and tappet screw to the flat side at the servo valve end of the lever, screwing it down finger-tight only.

**141.** Using the spring compression tool T.196072 as shown in fig. 3, compress the spring and slide the lever into the housing.

**142.** Align the slot by sighting through the locating peg hole offset in the base of the control piston chamber and insert the peg.

**143.** Screw out the adjusting screw sufficiently to ensure that the other end of the lever will clear the push rod when this is assembled.

*Fuel pressure control piston and sleeve assembly*

**144.** Check that the bottom of the pressure control cylinder housing bore is thoroughly clean and insert the large shim washer, taking care to avoid scoring the bore wall.

**145.** Insert the pressure control seal support ring into the bore, flanged face first, so that it rests on the shim washer, then insert the seal, recessed face first, and ease it gently down the bore until it rests on the support ring.

**146.** Fit the piston cylinder into the bore, chamfered face first, so that it rests on the back face of the seal.

**147.** Smear white petroleum jelly on the push rod to retain it in the piston then lower the piston and push rod into the bore and locate it in the piston seal and sleeve at the bottom of the bore.

**148.** Insert the stop plate and spacer ring and fit the cover plate complete with seal; the pressure control spring details are omitted at this stage.

**149.** Hold the cover down by light finger pressure and, using feeler gauges, check the clearance between the cover plate and

housing joint face ; this should be 0·010 in. If incorrect, withdraw the assembly and alter the shim in the bottom of the bore. Assemble the components and check the clearance again.

**150.** Finally assemble and secure the cover plate with slave nuts, grover washers and plain washers.

*Setting the fuel pressure control servo lever tappets*

**151.** First assemble the tappet tab-washer and locknut into the pressure control piston end of the rocker lever. Then rest the unit on the locating block T.205222 and using a depth micrometer measure the distance from the joint face of the housing to the lever face at the servo valve end of the lever when this end of the lever is fully raised by the spring pressure. (Piston push rod tappet slackened off).

**152.** Screw in the tappet screw to raise the lever at the piston end to its fullest extent without using undue pressure (servo valve tappet slackened off). With the depth micrometer, measure again the distance from the joint face of the housing to the lever face adjacent to the adjusting screw.

**153.** Halve the difference between the two readings obtained and by screwing the tappet in a clockwise direction raise the servo end of the lever by an amount equal to this figure. The lever is now in its neutral position.

**154.** Screw in the push-rod tappet to lower the servo end of the lever 0·010 in. and temporarily secure the tappet by tightening the locknut.

**155.** Screw in the servo valve tappet until it contacts the servo valve and holds it on the orifice without excessive pressure, then tighten the tappet locknut. Lock the tab-washer.

**156.** Screw out the tappet at the pressure control end of the lever in order to raise the servo valve end 0·020 in. measured with the depth micrometer (i.e. 0·010 in. above its neutral position).

**157.** Tighten the push rod tappet locknut in this position and bend over the tabs of the tab-washer.

*Fuel pressure control spring*

**158.** Remove the slave nuts and washers from the pressure control cylinder cover and remove the cover. Fit the spring seating spigot into the spring and insert the assembly into the cylinder housing so that the spring cap nose locates in the recess in the head of the control piston. Insert the spring cap into the other end of the spring.

**159.** Fit the cover plate complete with sealing ring and temporarily secure it with slave nuts, plain washers and grover washers then screw in the adjusting screw so that the spring is lightly loaded.

**160.** Fit a plain washer and locknut and tighten the locknut fully. Ease a rubber sealing ring over the servo lever access plug and screw the plug into the housing sufficiently to clear the circlip groove.

**161.** Insert the circlip using circlip pliers and screw the plug back against the circlip using the spanner T.205223.

*Pressure control servo valve, leakage check*

**162.** Assemble a slave union and plain washer to the servo tapping and connect the unit to the hand pump of a kerosine tank. Subject the valve to the pressure specified in the appendix to this chapter and check that there is no leakage.

**163.** Disconnect the unit and remove the union. Ease a sealing ring over the pressure control piston upstream transfer bobbin and push the bobbin into its locating bore ; take care to align the flat on the bobbin flange to clear the servo lever bush.

**164.** Ease the sealing ring into the groove on the servo valve tappet access plug and push the plug firmly into its locating bore in the housing joint face.

*Leakage tests (seals, etc.)*

**165.** Assemble the pressure test plate T.196071 to the joint face of the assembly with nuts, bolts and washers and connect to the rig as shown in Fig. 11. Apply the pressure specified in the appendix and check for leaks.

**166.** Remove the unit from the test rig and remove the pressure test plate, then fit dust caps to the suction and servo inlets and

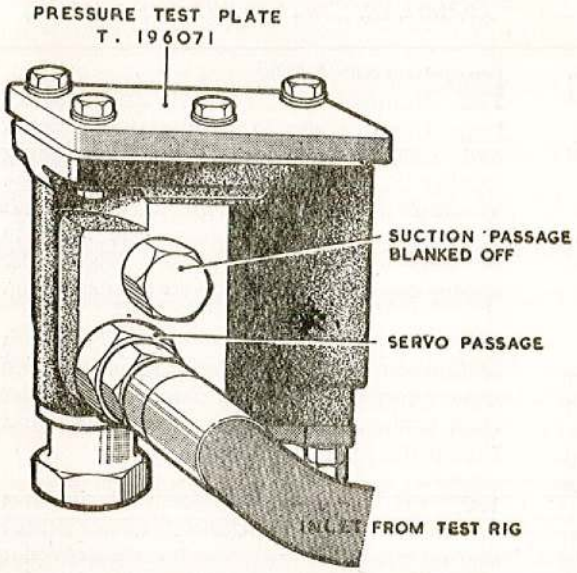



**Fig. 11. Leakage test, fuel pressure control assembly**

store the unit in a box with a lid until required for assembly to the main unit.

**Flow control lever housing and piston chamber**

*Flow control lever and hinge bush*

**167.** The lever and bush is a selective assembly and should not have been dismantled unless damaged. If it was dismantled, the rubber sealing ring must be renewed in the internal recess in the bush and the lever assembled in the bush by pressing the hinge pin firmly into position.

**168.** Check the alignment of the lever and bush as described in para. 118 and illustrated in Fig. 9.

*Flow control servo response orifice and servo valve assembly*

**169.** Position a tab-washer and seal over the orifice and assemble it to the orifice housing by screwing it down finger-tight, then screw the orifice and housing into the piston chamber using the peg spanner T.205215 and tighten fully.

**170.** Position the tab-washer with the bent tab in the drilling in the housing and using the orifice spanner T.174675 tighten the orifice and bend over the tab-washer. Place the half-ball over the orifice and fit the retaining cage.

**Note . . .**

*Before fitting the retaining cage, it may be necessary to re-set the claws as described in para.* 132.

*Fitting the flow control lever and bush*

**171.** If the capsule adjusting-screw pillar was removed when dismantling, it will be necessary to assemble it at this stage. Ease the sealing ring over the pillar and lower it through the bore in the bottom of the housing. Place a plain sealing washer on the sleeve, fit the retaining nut and screw it down lightly, using a box spanner and the locating block T.203444 (*fig.* 8).

**172.** Fit a sealing ring to the body of the lever hinge bush then assemble the tappet, complete with tab-washer and nut, to the lever and screw it finger tight.

**Note . . .**

*The projection of the screw should be approximately equal through each side of the lever to facilitate assembly.*

**173.** Guide the lever assembly into the housing making sure that the hinge bush seats correctly, then secure the bush plate to the housing with two tab-washers and nuts but do not bend over the tabs of the tab-washers at this stage. Unscrew the tappet sufficiently to clear the half-ball and make the locknut finger-tight.

**174.** Assemble the lever housing to the piston chamber using slave nuts and washers.

*Setting the flow control lever tappet*

**175.** Insert the setting screw T.214184 into the capsule chamber blanking plug hole and gently screw it in sufficiently to lift the servo end of the lever to its *highest* position.

**176.** Assemble the setting piece T.205217 to the lever housing and using a depth micrometer as shown in fig. 12, measure the depth from the face of the setting piece to an extreme corner of the lever; record the reading as (A).

**177.** Remove the upper limit setting screw T.205217 and fit the lower limit setting screw T.230758 to the capsule adjusting screw pillar, screwing in to deflect the lever again so that the tappet end is at its *lowest* position, ensuring that the tappet screw is clear of the half-ball. Using the depth micrometer again, measure the depth from

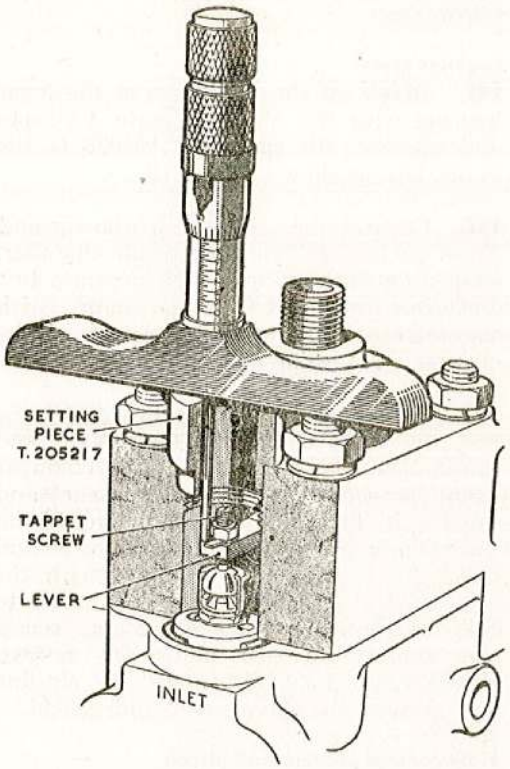



**Fig. 12. Setting flow control rocker lever tappet**

the face of the setting piece to the same corner of the lever in its lowest position; record the reading as (B).

**178.** Add (A) and (B) together and divide the result by two. To the figure thus obtained, which represents the neutral position of the lever, add 0·014 in.; the result is the depth from the setting ring to the lever tip at which the tappet must be set in contact with the half-ball. The following is given as an example :—

1·511 in. (A) High position
Add 1·603 in. (B) Low position
3·114 in.
Divide by 2
1·557 in. Mean position
Add 0·014 in.
1·571 in. Setting position

**179.** Remove the lower limit setting screw and screw the tappet into the lever until the tappet is in light contact with the half-ball, then slacken the tappet back approximately a half-turn. Place the depth micrometer on the setting ring with the micrometer tip contacting the rocker lever again and screw down until the tappet is felt to contact the half-ball. Remove the micrometer and check the readings, which should be the same as the calculated figure (para. 178). If it is not correct, re-adjust the tappet either way as necessary until the setting is satisfactory, i.e., until the measurement is correct with the tappet contacting the half ball.

**180.** Remove the micrometer and setting piece then carefully tighten the tappet locknut and re-check for alteration of the tappet setting. If this has altered, estimate the amount of movement of the locknut and re-set the tappet accordingly until correct then re-tighten and check again.

*Setting the lever stop plug*

**181.** Omit the sealing ring and screw the plug into the unit until it is lightly contacting the servo valve tappet screw, then by means of feeler gauges measure the gap under the shoulder of the plug. Add 0·025 to 0·030 in. to the measurement and select shims to correspond with the final figure. Remove the stop plug, fit the selected shims, then reassemble the plug together with sealing ring and tighten fully using a box spanner. The plug face is thus set 0·025 to 0·030 in. clear of the tappet head.

*Flow control capsule assembly*

**182.** Separate the lever housing assembly from the piston chamber assembly, unscrew and remove the slave nuts and washers and withdraw the lever assembly. Lock the tappet screw tab-washer over the end of the lever and against the nut.

**183.** Attach the capsule assembly to the end of the lever and secure with clevis pin and retaining clip, taking care that the clip seats correctly round the groove on the pin.

*Trimming spring assembly*

**184.** If the spring anchor was removed from the spring loop when dismantling (para. 57) place a plain washer over the spring anchor and clip it into place through the upper loop of the trimming spring.

**185.** Assemble the spring anchor guide bush to the housing together with sealing ring, inserting the guide from the inside of the unit. Lower the tab-washer and locknut over the guide bush from the outside and screw the locknut down tightly with a box spanner. Lock the tab-washer.

**186.** Insert the assembled spring and spring anchor into the guide, ease the sealing ring over the adjusting screw, retain the spring anchor in the guide by means of the adjusting screw, and assemble the cap nut to the guide threads.

**187.** Replace the lever assembly in correct relationship to the spring and lock the spring loop over the groove nearest the tappet end of the lever.

**188.** Fit the tab-washers on to the two retaining studs, locating each bent-over tab in the drillings and secure with two nuts. Tighten the nuts fully and lock the tab-washers.

*Flow control capsule adjusting screw*

**189.** Insert the capsule adjusting screw complete with sealing ring into the retaining sleeve and screw it into the capsule assembly until slight tension is felt. Fit the cap nut finger tight.

**190.** Assemble a plain washer, tab-washer to the blanking plug and insert the plug into the top of the housing tightening down firmly with a box spanner. Lock the tab-washer.

**Leakage tests.**

**191.** Blank off the joint face of the lever housing with the blanking plate T.203446 and assemble the adapter T.196073 to the outlet face as shown in Fig. 13.

**192.** Connect the assembly to the rig and check for leakage into the capsule chamber, subjecting the unit to a high pressure test and a low pressure test in accordance with the relevent appendix at the end of the chapter. No leakage is permissible.

**193.** Disconnect the assembly from the test rig, remove the blanking plate and plugs, then blank off the capsule chamber using the slave plate T.224379 gasket and union (*fig.* 14). Connect an air line to the union, immerse the housing in kerosine and check for leakage in accordance with the relevant test schedule in the appendices to this chapter. If leakage occurs, renew the appropriate seal and then re-test. When satisfactory, disconnect the air line and remove the slave cover and gasket.

**Flow control plunger and piston**

**194.** Adjust the trimming spring adjusting screw to give maximum spring tension.

**195.** Fit a retaining clip to one end of the

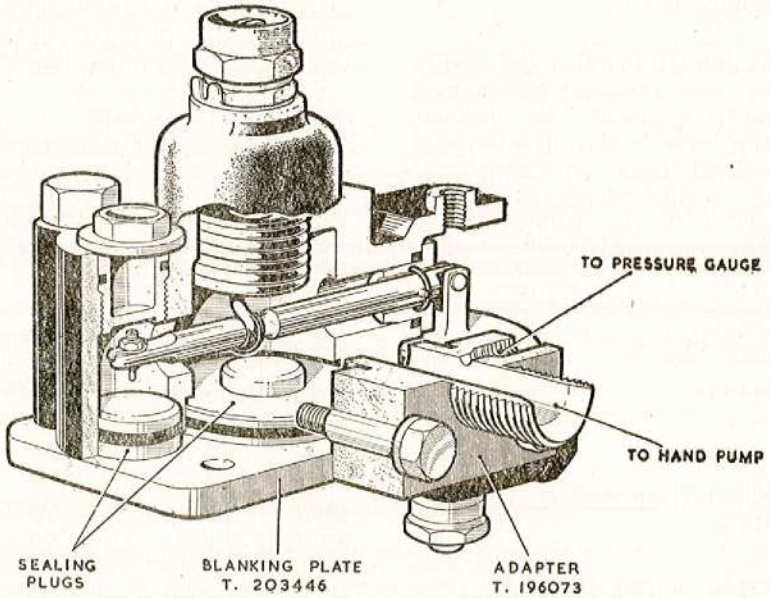



**Fig. 13. Leakage test, flow control lever housing**

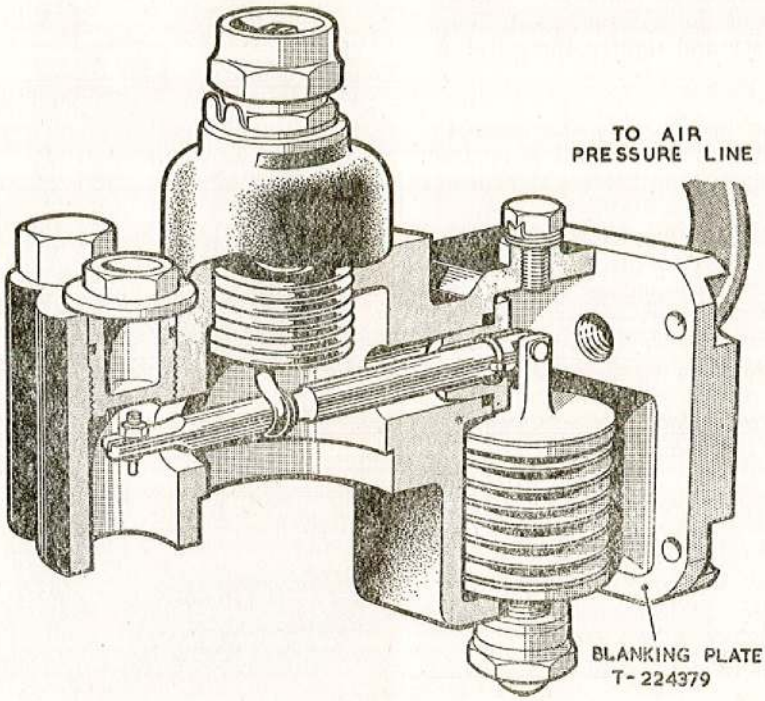



**Fig. 14. Leakage test, flow control capsule chamber**

flow plunger clevis pin, locate the flow control spring closed loop in the plunger clevis and insert the pin, securing the assembly with a second spring clip. Ease a sealing ring into the groove on the flow plunger, making sure that it seats correctly with no twisting.

**196.** Ease a sealing ring into the groove on the large end of the orifice body. Insert the spring and plunger into the housing, spring first, and engage the upper spring loop with the locating groove in the control lever, ensuring, by sighting through the fuel delivery bore, that the loop seats squarely in the groove.

**197.** Set the housing on the assembly fixture so that the plunger and spring are hanging from the lever. Pass the orifice over the plunger, taking care to avoid unhooking the spring from the lever, then set the housing on the assembly adapter so that the fuel delivery port is uppermost and insert a finger through the port to hold the spring loop on the lever. Pass the orifice body, large end first, over the plunger taking care to avoid jamming, as the clearance is of the order of 0·0003 in. and push the orifice squarely into its housing bore, taking care that the sealing ring enters the bore without damage. The plunger may now be allowed to rest in the orifice under its own weight whilst the piston is being prepared for assembly.

**198.** Ease the piston seal on to the piston, recessed face towards the small end of the piston, and ensure that the seal seats correctly in the piston groove. To assist in initial assembly of the piston to the plunger there should be available a round-headed $\frac{1}{4}$ in. BSF setscrew with a head diameter sufficiently small to fully expose the two dowel holes in the piston recessed face. Retain the plunger spring on the control lever again with one finger, assemble the piston to the end of the plunger and insert the round-headed setscrew. Tighten this gently to draw the piston over the plunger sealing ring, ensuring that the dowel hole in the piston is in alignment with that in the end face of the plunger. Draw the piston and plunger together fully, and insert the dowel peg flush with or below the piston face (the dowel must not stand proud of the face), then remove the round-headed setscrew and insert the piston set-

screw, together with a tab-washer, with the locating tab bent down suitably. Engage the tab in one of the appropriate drillings in the piston face and tighten the setscrew finger tight.

**199.** Hold the piston with one hand to retain the spring on the control lever and free the other hand from holding the spring down, then engage a suitable jaw spanner with the two flats on the piston stem. Hold this securely to prevent the assembly from turning, otherwise the spring will become detached from the lever, then tighten the retaining setscrew with a box spanner. Care must be taken to avoid overtightening the assembly as excessive loading may cause the abutment face of the plunger to swell and jamb in the orifice. When secure. lock the tab-washers. Should it be found that excessive tightening would be necessary to align the tab and a flat on the setscrew, slacken off and rotate the washer to engage the locating tab in the other drilling, re-tighten and lock. Slacken off the trimming spring adjusting screw two or three turns ; this will be adjusted finally during rig-testing.

**Assembling the flow control piston chamber and lever housing**

**200.** Fit the rubber sealing rings, one into the groove in the piston chamber round the flow control orifice, one into the servo response groove in the piston chamber round the orifice and the small one in the groove on the seating face round the drilling to the servo valve.

**201.** Lower the lever housing carefully and evenly over the four studs in the piston chamber and secure with plain washers, grover washers and nuts.

**Flow control servo valve leakage check**

**202.** Assemble the adapter T.202762 complete with seal to the unit and fit the half-ball clamp T.214189 over the two studs as shown in Fig. 15. Connect the hand pump from a tank of kerosine to the unit and test at the pressure stated in the appendix. No leakage is permissible.

**203.** Disconnect the unit from the pump and remove the adapter and clamp.

**Remaining details**

*Flow control piston servo pressure orifice and strainer*

**204.** Fit a rubber sealing ring to the orifice spigot and insert it, sealing ring face fore-

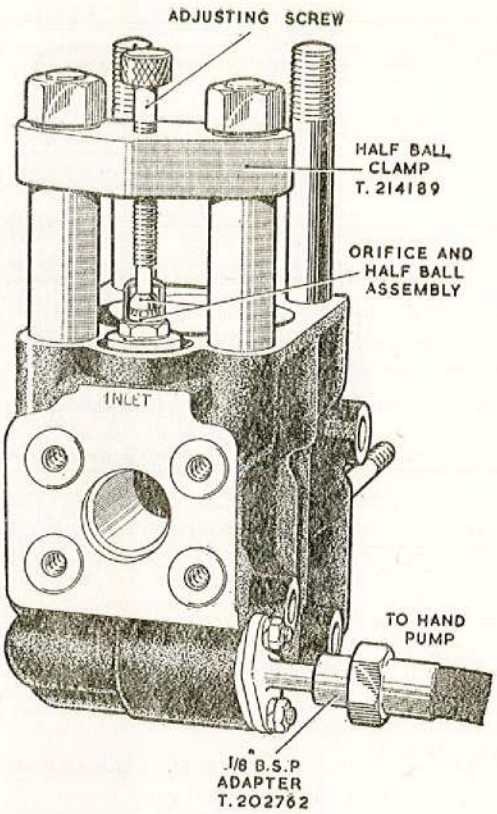



**Fig. 15. Leakage check, flow control piston servo valve**

most, into the strainer and orifice body, pushing it down into its seating with a plastic stick. Insert the strainer and spring into the body.

**205.** Ease the sealing ring over the strainer and orifice body and lower the assembly into the unit. Fit the sealing ring over the cover plate then fit the cover plate evenly over the two studs and secure it with grover washers and 2 B.A. nuts.

*Flow control servo response strainer assembly*

**206.** Insert the strainer and spring into the housing. Fit a sealing ring to the retainer and lower it over the two studs ; secure the assembly with two plain washers, grover washers and 2 B.A. nuts.

*Flow control piston servo drilling blanking plug*

**207.** Ease the rubber sealing ring over the plug bobbin and press the plug firmly into the pressure control unit locating face.

*Flow control piston maximum flow stop screw assembly*

**208.** Assemble a rubber sealing ring and

steel outer washer to the stop screw sleeve and screw the sleeve tightly into the base of the flow control piston servo chamber. Fit a sealing ring to the waist of the piston stop screw and insert the screw into the body, engage the threads, fit the alloy sealing washer and locknut and tighten finger-tight only; the screw is to be adjusted during rig-testing.

**Assembling the fuel pressure control assembly to the piston chamber**

**209.** Fit a small rubber sealing ring to the mouth of the drilling in the pressure control assembly retaining face on the piston chamber, then lower the pressure control assembly on to the retaining studs. When the joint faces are approximately $\frac{1}{4}$ in. apart check that the protruding transfer bobbin in the pressure control housing enters the drilling in the flow control chamber correctly. Fit the plain washers, spring washers and nuts to the retaining studs and tighten fully.

## REPLACEMENTS

**210.** All paper gaskets and rubber sealing rings must be replaced by new ones whenever a seal is disturbed and new split pins, tab-washers and locking wire must always be used.

**Fuel pressure control assembly**

*Rocker lever assembly*

**211.** This assembly comprises—rocker lever, rocker lever bush, sealing ring and hinge pin and is supplied as a complete assembly. If the seal proves faulty however, it is permissible to dismantle the assembly and to renew the rubber sealing ring in the bush providing none of the other parts of the assembly are damaged or worn, in which case, a new assembly must be fitted.

**Piston chamber**

*Half-ball retainer*

**212.** Check and if necessary re-set the retainer claws as described in para. 132.

**Flow control piston chamber**

*Half-ball retainer*

**213.** Check and if necessary re-set the retainer claws as described in para. 132.

**Flow control lever housing**

*Flow control capsule*

**214.** If the capsule is damaged it must be replaced by a new assembly.

**Flow control rocker lever assembly**

**215.** The rocker lever and bush are normally renewed as a complete assembly but the parts can be renewed individually and the alignment of the lever in the bush checked after re-assembly as described in para. 116 to 118 and illustrated in fig. 9.

**Remaining details**

**216.** All other parts of the unit are separately interchangeable but care must be taken to check the fit of all new parts by referring to the Schedule of Fits, Clearances and Repair Tolerances in Vol. 2, Part 2 of this Air Publication.

## RIG TESTING

**General**

**217.** A basic test and calibration procedure is described here which is applicable to all derivations of the basic type of unit. Specific conditions and performance requirements however, may vary according to the requirements of different engine installations. These particular details are provided in separate appendices to this chapter.

**218.** Unless otherwise stated the fuel used throughout these tests is to be AVTUR and is to be maintained at a temperature of 20 degrees to 26 degrees C. The fuel should be checked at regular intervals to ensure that it complies with the above specification.

**219.** The fuel tank boost pump pressure should be between 15 and 20 lb. per sq. in.

**220.** In units to which the P2/P1 pressure ratio switch is fitted, this is endurance tested individually and is then assembled to the control unit for final calibration. In such cases the preliminary rig testing of the control unit is carried out with the blanking plate T.224379 fitted in place of the switch.

**221.** Connect the unit to the test rig as shown in Fig. 16.

**Preliminary rig testing**

*Leakage tests*

**222.** Subject the servo valves to the test detailed in para. 136 and 162.

**223.** Test the flow control unit as described in para. 191 and 192.

**224.** Test the capsule chamber as described in para. 193.

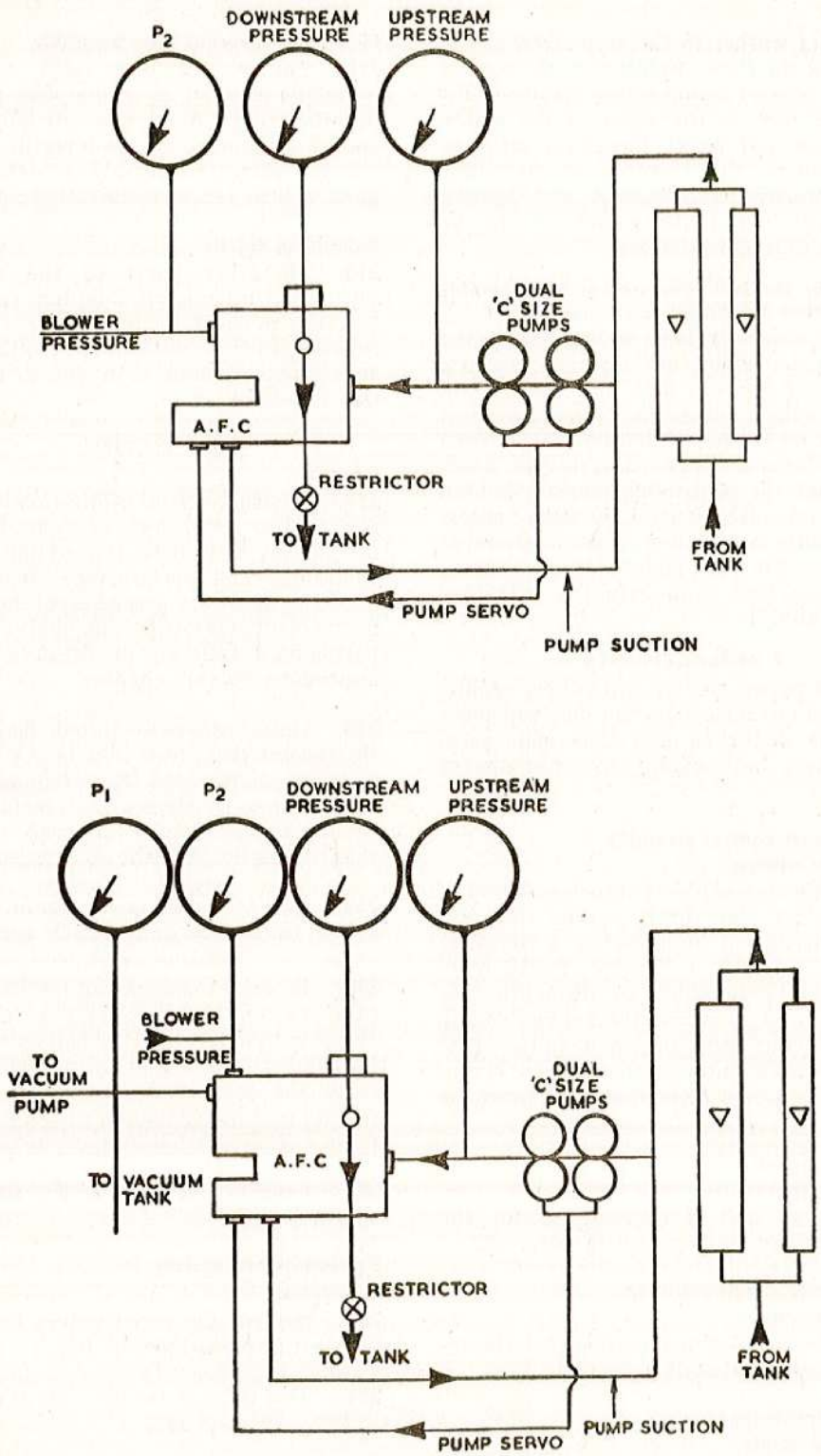



Fig. 16. Diagrammatic layout of test rig

*Preliminary calibration and endurance*

**225.** The unit is to be calibrated as stated in the relevant appendix. Care must be taken not to overload the flow control when setting the unit, i.e., ensure that the flow control piston stop screw is screwed out sufficiently to clear the piston.

(1) Engage the capsule adjusting screw two or three threads, or to such a position that the flow remains constant with varying compressor pressure.

(2) Screw in the trimming spring adjustment.

(3) Set the pressure drop across the unit by means of the pressure control adjustment.

(4) Reduce the tension on the trimming spring until a flow just visible in a 10-100 g.p.h. flowmeter is obtained.

(5) The ground level setting is then made on the flow control capsule adjusting screw and the remainder of the curve acquired by a balance between the adjustment of the trimming spring and the pressure control spring.

(6) When the unit has been calibrated, operate the unit at the maximum P2 pressure shown in the appendix together with the relevant downstream pressure, then screw in the flow control piston stop screw until the flow is established at the correct value.

(7) If it is necessary during the remainder of the test to re-adjust the flow trimming spring, the flow control capsule or the fuel pressure control, it is important that the flow control piston stop screw is then also re-adjusted.

**226.** The unit is to be endurance tested over the range and at the conditions given in the relevant appendix for the specified period.

**227.** The unit is then to be checked to ensure that no excessive calibration change has occurred and that it is still within the limits to which the unit was adjusted in para. 225.

*Partial strip inspection*

**228.** The extent to which the unit must be dismantled for inspection is left to the discretion of the Inspector-in-Charge. The dismantling of the unit or any of its assemblies will follow the same procedure as laid down in para. 10 to 57 or any section applicable to the particular assembly being dismantled.

**229.** All moving parts must be inspected for fracture and wear, etc., and the capsules checked for leakage. Strainers should be thoroughly cleaned.

*Rebuild*

**230.** The unit or any parts of the unit which have been dismantled should be re-assembled and all the leakage tests described in para. 222 to 224 should be repeated. The pressure ratio switch is to be fitted to the control unit as described in the supplements to this chapter.

**231.** Repeat the preliminary calibration and endurance tests described in para. 225 to 227 except for a reduction in the duration of the endurance test.

**Final rig testing**

*Final calibration*

**232.** All the results of this calibration are to be recorded and are to meet the requirements specified in para. 225 to 227.

*Pressure test*

**233.** The unit is to be subjected to a fuel pressure and an air pressure test for the period specified in the relevant appendix. No external leakage is permitted.

*Preparation for despatch*

**234.** The unit is to be flushed with oil to the specification stated in the relevant appendix.

**235.** Assemble transportation cover plates to the inlet and outlet connections securing with bolts, grover washers and nuts, assemble dust caps to pump servo, pump suction and blower pressure connections and assemble a dust plug to the ram pressure connection.

**236.** Check the name plate for accuracy of details and wirelock the unit.

**237.** The test record sheet is to be completed and approved and two copies are to be despatched with the unit which must be carefully packed in a suitable box.

# Supplement 1

# PRESSURE RATIO SWITCH (DOUBLE ORIFICE TYPE)

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



### General

**1.** The double-orifice type of pressure ratio switch has two orifices in series to control KP2 pressure applied to the flow control capsule. The switch is mounted on the end of the control capsule chamber and when removed may be regarded as a completely individual unit which is dismantled, rebuilt and tested independently of the flow control.

**2.** The special tools required are amongst those listed in the tool list at the beginning of this chapter.

### Removing the pressure ratio switch assembly

**3.** Remove the four 2 B.A. nuts, grover washers and plain washers and lift the pressure ratio switch assembly from the retaining studs, together with the gasket. If necessary tap the housing lightly with a hide hammer to free the joint.

### Dismantling

*P2/P1 orifice tube*

**4.** Remove the P2 inlet union and plain washer and withdraw the spring, bobbin and seal from the P2/P1 orifice tube, using extractor T.205226 to remove the bobbin as shown in fig. 2.

**5.** Unscrew and remove the two nuts together with grover washers and plain washers from the orifice tube flange and screw into the orifice tube the $\frac{1}{8}$ in. BSP extractor T.205229. Withdraw the orifice tube and record the number and thickness of shims beneath the flange in order to facilitate re-assembly. Remove the three sealing rings from the P2/P1 orifice tube.

*Differential pressure orifice*

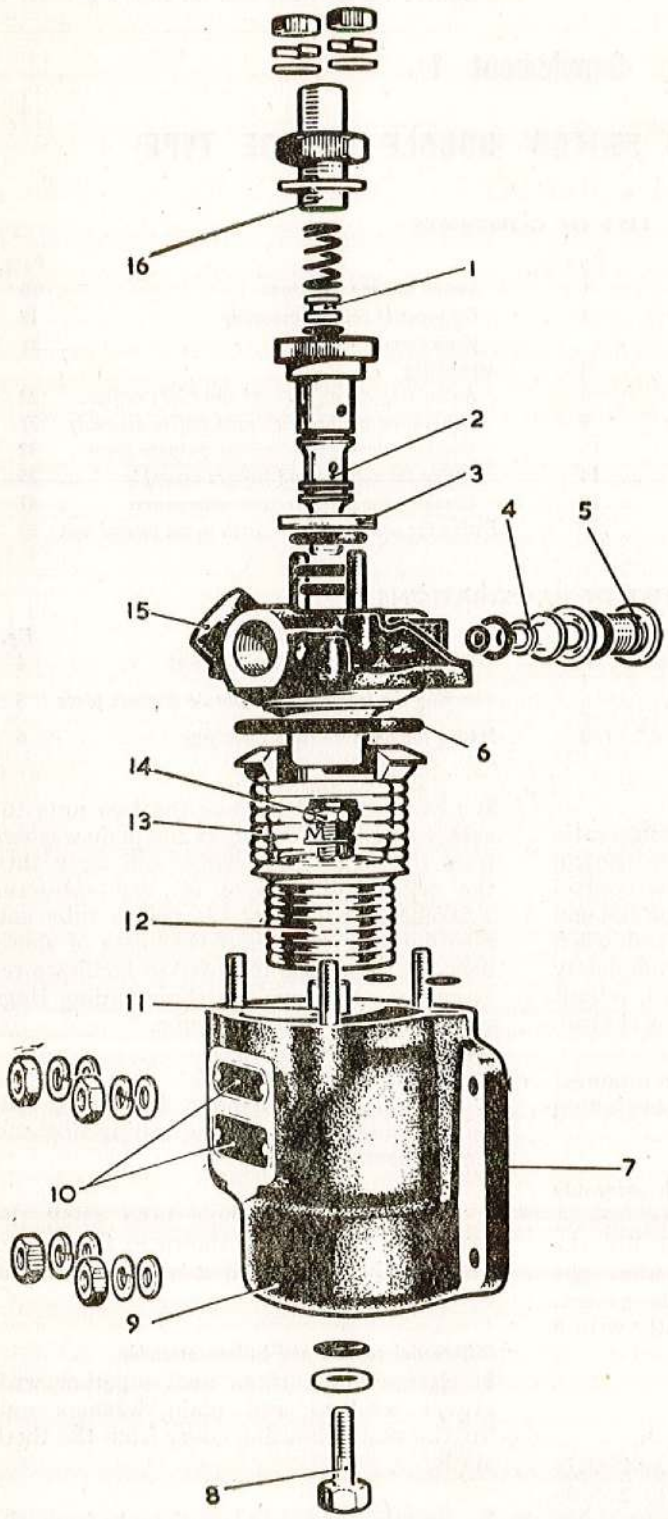
**6.** Unscrew and remove the orifice retaining plug. Remove the sealing ring and washer from the plug.

**7.** Withdraw the orifice tube using the extractor T.205227 as shown in fig. 3, and remove the two sealing rings from the bobbin.

*Differential capsule and bellows assembly*

**8.** Remove the three nuts together with grover washers and plain washers and lift the switch housing cover from the three studs.

**9.** Remove the two small seals from the housing flange and the large sealing ring from the housing counterbore.




1 P2 ORIFICE
2 P2/P1 ORIFICE TUBE
3 SHIMS
4 DIFFERENTIAL PRESSURE ORIFICE
5 ORIFICE RETAINING PLUG
6 BELLOWS SEALING RING
7 MOUNTING FLANGE
8 CAPSULE RETAINING SCREW
9 SWITCH HOUSING
10 NAME AND DATA PLATES
11 CAPSULE DISTANCE PIECE
12 CAPSULE
13 BELLOWS
14 VALVE SCREW
15 SWITCH COVER
16 P2 INLET UNION

**Fig. 1. Exploded view of pressure ratio switch (double-orifice type)**

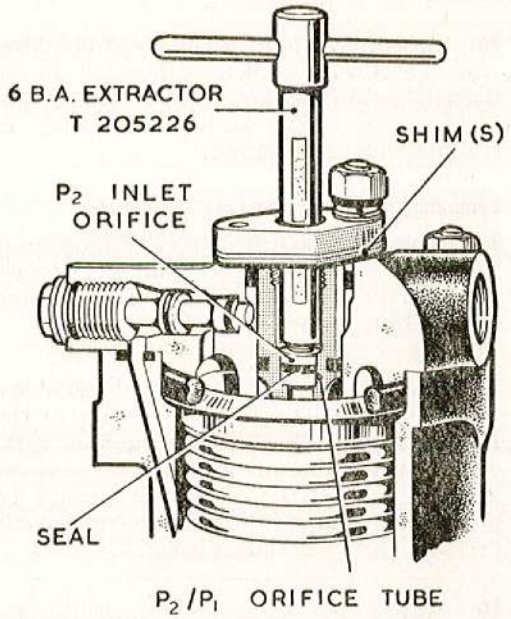



**Fig. 2. Removing the P2 orifice from the orifice tube**

**10.** From the bottom of the housing remove the 2 BA bolt together with the plain washer and sealing ring securing the capsule assembly.

**11.** Lift out the differential capsule assembly complete, invert the housing and the distance piece will fall out from the bottom of the housing.

**12.** Unlock the tab-washer securing the valve screw in the base of the bellows and, using a standard box spanner, remove the valve assembly together with the tab-washer. The differential capsule assembly must not be dismantled.

### Cleaning

**13** For instructions on the cleaning of the components, reference must be made to para. 58 to 60 of this chapter.

### Inspection

**14.** Reference must first be made to para. 61 to 69 of this chapter for inspection instructions of a general nature.

*P2/P1 orifice tube*

**15.** Examine the orifice tube for damage and for foreign matter, particularly round the mouth of the P1 orifice. Check that the grooves (internal and external) for the sealing rings are clean and that all traces of rubber have been removed. Examine

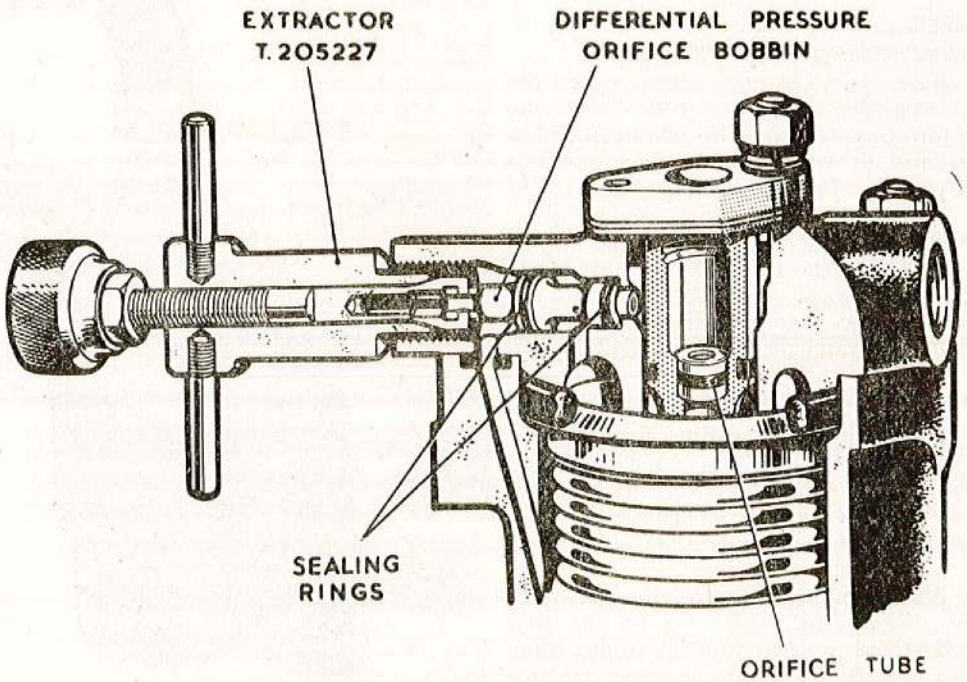



**Fig. 3. Removing the differential pressure orifice**

the bore for cleanliness. Examine the bobbin for damage and corrosion.

**16.** Inspect the spring for damage and distortion, sharp edges and cracks.

*Differential pressure orifice*

**17.** See that the threads on the orifice retaining plug are clean and still serviceable and examine the orifice tube for cleanliness. Ensure that the washer is not cracked nor distorted.

*Switch housing and cover*

**18.** Inspect the housing and cover generally for damage and see that the joint faces are in good condition, free from scoring and that no signs of corrosion are visible.

*Differential capsule assembly*

**19.** Examine the capsule for damage and see that no particles of foreign matter exist between the convolutions.

**20.** Ascertain that the distance piece is clean and free from sharp edges.

*Valve screw*

**21.** Examine the sealing face of the valve screw for signs of wear or damage. As it is not possible to renew the sealing face separately, the valve screw must be discarded if damaged and a new one fitted.

**Assembling**

*Assembling the differential and P2/P1 orifices*

**22.** Ease two sealing rings over the differential pressure orifice tube, insert the tube into the pressure-ratio switch assembly cover and fit the retaining plug complete with joint washer and sealing ring.

**23.** Locate two small sealing rings in the housing joint face transfer drillings, insert the slave bellows ring T.224379 into the housing followed by the large sealing ring. Fit the cover and secure the assembly with slave washers and nuts.

**24.** Assemble three sealing rings to the P2/P1 orifice tube, fit the shims removed during dismantling and insert the tube in the assembled cover, securing the tube flange with washers and nuts.

**25.** Fit a sealing ring to the P2 inlet orifice, screw the orifice on to the tool T.205229 and insert it into the orifice tube. Push the orifice fully into the bore, remove the tool, insert the orifice retaining spring and fit the rig-testing P2 connection banjo pillar, complete with joint washers.

**26.** Assemble a joint washer and blanking plate T.224379, complete with union, to the flanged mounting face of the housing and secure with bolts, washers and nuts in readiness for calibration.

*Calibrating the pressure ratio orifice assembly*

**27.** The pressure ratio orifice calibration is to be checked by connecting an air pressure line and two air pressure gauges, reading 0 to 100 lb. per sq. in.

**28.** The air pressure supply and gauge are to be connected by a double banjo to the P2 inlet connection on the pressure ratio orifice, whilst the union on the slave cover plate is connected to the other gauge to provide a reading of the flow control capsule pressure (KP2) as shown in fig. 4.

**29.** Adjust the air supply until the P2 (upstream) gauge indicates the pressure specified in the relevant Appendix and check the reading on the KP2 (downstream) gauge. If a new orifice assembly has been fitted the KP.2 reading will usually be found to be

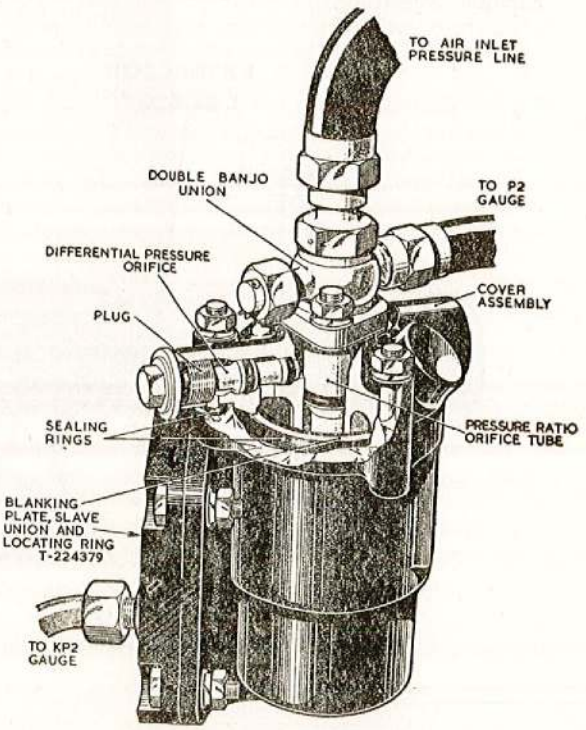



**Fig. 4. Cabibrating the pressure ratio orifices**

low and it will be necessary to ream the P2 orifice slightly to raise the pressure to the required minimum value. The P2 orifice is produced with a bore of 0·041 in. and the P1 spill orifice in the end of the oriffce tube has a bore of 0·035 in. originally. These sizes permit a considerable amount of adjustment and generally it will be found that the required results are achieved with a P1 orifice of approximately 0·044 in. and a P2 orifice of 0·050 in.

**30.** If reaming was necessary re-check the pressures and if the KP.2 pressure is still low continue to ream the P2 orifice, removing only a very small amount of material at a time and re-checking continually until the desired result is achieved. Should the KP.2 pressure, however, be too high then the P1 orifice should be reamed slightly to lower the KP.2 pressure. In any event the P2 orifice must not be reamed beyond 0·060 in. dia. If the required pressures cannot be obtained at this size the orifice assembly should be discarded and a new set obtained.

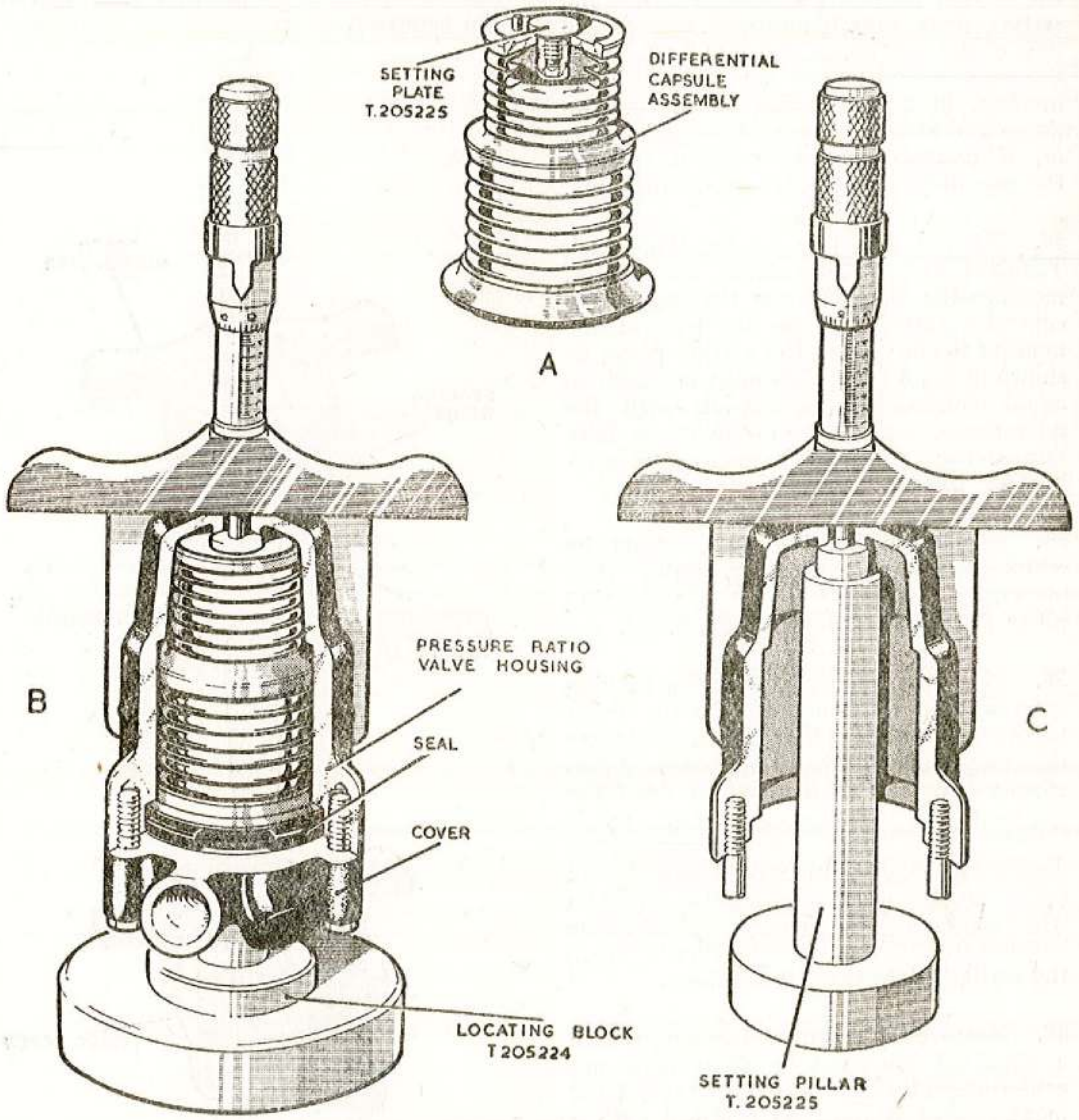



**Fig. 5. Checking the length of the capsule distance piece**

**31.** When the calibration is satisfactory remove the assembly from the rig in readiness for assembly to the pressure-ratio switch housing.

*Checking the capsule locating distance piece*

**32.** Before attempting to fit the differential capsule and bellows assembly, it is necessary to ensure that the distance piece locating the capsule in the base of the housing is of the correct length. This is measured with a depth micrometer, a locating block T.205224 and setting plate and pillar T.205225 as shown in fig. 5.

**33.** Measure and record the thickness of the setting piece T.205224 then insert the setting piece into the tapped hole in the base of the bellows, as shown in fig. 5, insert the capsule and bellows assembly into the housing, fit a sealing ring on the bellows flange and fit the pressure ratio switch cover, or, if available, a slave cover. Retain the assembly with plain washers and nuts.

**34.** Fit the assembly on locating block T.205224 and, with a depth micrometer, measure the distance from the face of the central external boss on the base of the housing to the face of the setting piece, as shown in fig. 5 (B). Care must be taken to avoid compressing the capsule with the micrometer and thus obtaining a false measurement. Record the micrometer reading for later reference.

**35.** Remove the housing cover, extract the sealing ring and bellows assembly then invert the housing and rest it on setting pillar T.205225, as shown in fig. 5, (C).

**36.** Place the micrometer on the housing external boss face and measure the depth to the face of the setting pillar. Subtract this measurement from that obtained previously (para. 43) then add to the result the thickness of the setting piece (para. 42); the resultant figure is the required length of the distance piece to ensure that the capsule and bellows are not pre-loaded in either direction when retained in the housing. Remove the housing from the setting pillar and remove the setting plate from the bellows.

**37.** Measure the distance piece length with a standard micrometer; if it does not conform exactly with the required calculated measurement it must be replaced with a distance piece of the correct length.

*Fitting the capsule and bellows assembly*

**38.** Fit the pressure ratio valve screw complete with tab-washer into the tapped hole in the base of the differential bellows. Tighten the screw, taking care to avoid damaging the face of the valve, but do not lock the tab-washer at this stage. Insert the capsule retaining setscrew complete with washer and sealing ring into the hole in the base of the pressure-ratio switch housing and fit the distance piece over the projecting end of the setscrew inside the housing. Insert the capsule and bellows assembly into the housing, engage the setscrew threads with the tapped hole in the base of the capsule. Ensure that the distance piece is in position then tighten the setscrew.

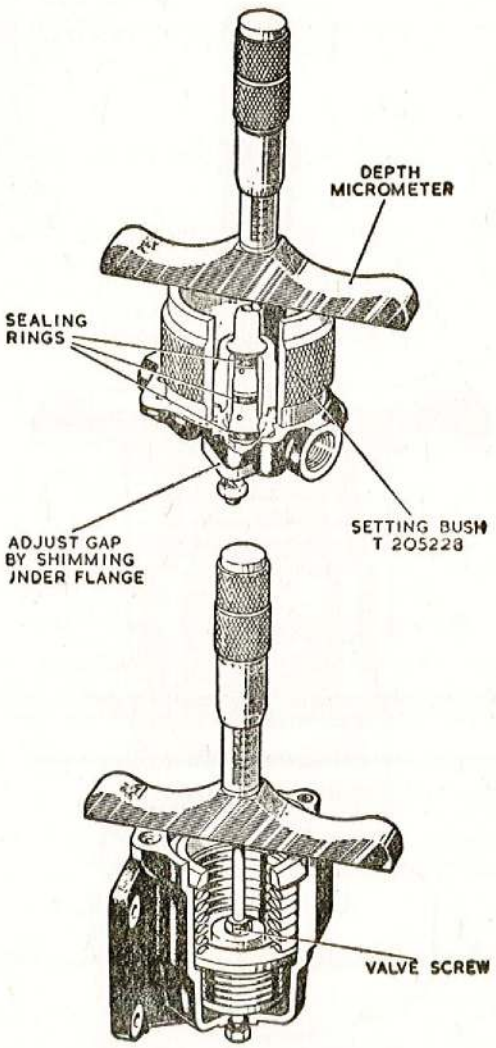



**Fig. 6. Setting the pressure ratio valve gap**

**39.** Place the depth micrometer on the face of the housing and measure the depth to the face of the valve screw (*fig.* 6). Record this measurement as dimension A and place the housing aside temporarily.

**40.** Remove the P2/P1 orifice tube, complete with shims from the assembled switch cover, remove the shims and refit the tube to the cover, tightening the securing nuts fully. Invert the cover, measure the length of setting bush T.205228 and record the measurement as dimension B, then locate the bush on the cover joint face (*fig.* 6).

**41.** Measure with a depth micrometer the distance from the bush face to the tip of the P2/P1 orifice tube ; record this measurement as dimension C. Remove the micrometer and setting bush.

**42.** Refer to the recorded dimensions A (para. 48), B (para. 49) and C (para. 50). Subtract dimension C from B ; the figure obtained should be noted as dimension D and represents the actual depth of the P1 orifice face from the cover joint face.

**43.** Subtract the calculated dimension D from dimension A. The resultant figure is the actual gap between the orifice face and valve face ; record the gap figure as dimension E.

**44.** The valve gap must be set to between 0·020 and 0·040 in. Taking the intermediate figure of 0·030 in., the difference between this and the dimension E figure is the thickness of shims to be positioned under the P2/P1 orifice flange to achieve a 0·030 in. gap.

**45.** Remove the P2/P1 orifice tube from the cover, fit shims of the required thickness re-fit the orifice tube to the cover, fit the washers and retaining nuts and tighten them.

**46.** Insert the bellows flange sealing ring on to the flange in the switch housing, fit the assembled cover to the housing and secure it with plain washers, spring washers and nuts.

*Checking the pressure-ratio change-over*

**47.** Connect the assembled switch to the test-rig and check the change-over point in accordance with the specified requirements in the Appendix.

**48.** If the change-over is too low, the switch is closing too early and the shim thickness beneath the P2/P1 orifice flange must be increased (not exceeding a 0·040 in. gap) until the specified change-over is obtained. Conversely the shim thickness must be reduced (to not less than a 0·020 in. gap) if the change-over occurs at too high a pressure.

**49.** When the change-over is satisfactory remove the switch assembly from the test-rig, remove the cover assembly, lock the valve screw tab-washer inside the bellows and re-fit the cover.

**50.** Remove the rig-testing plate T.224379 from the valve assembly mounting flange and discard the paper gasket.

**51.** Store the unit, together with a new gasket, in a clean box with a well-fitting lid until required for assembly to the control unit.

**Fitting the pressure ratio switch to the control unit**

**52.** Ensure that the joint faces are clean, fit a new joint washer over the studs on the control unit then position the pressure ratio switch on the studs and secure it with plain washers, spring washers and nuts.

# Supplement 2

# PRESSURE RATIO SWITCH (VENTURI TYPE)

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



### General

**1.** The venturi type pressure ratio switch uses a venturi tube to control the value of KP2 pressure applied to the flow control capsule in the air/fuel ratio control unit. A drilling in the venturi throat enables a depression to be created in the capsule chamber when air is flowing through the venturi whilst a pressure is created when the mouth of the venturi is closed by the switch.

**2.** The special tools required are amongst those in the tool list at the beginning of this chapter. The tools are illustrated adjacent to the relevant text in this Supplement.

### Removing the pressure ratio switch assembly

**3.** Remove the four 2 B.A. nuts, spring washers and plain washers securing the switch assembly to the control unit and draw the switch from the retaining studs. It may be necessary to tap the housing lightly with a hide faced hammer in order to free the joint. Remove the gasket.

### Dismantling

*Removing the venturi tube*

**4.** Remove the P2 inlet union and plain washer, then remove the two nuts together with grover washers and plain washers from the top of the venturi flange and screw into the flange the $\frac{1}{8}$ in. B.S.P extractor T.205229. Withdraw the venturi and record the number and thickness of shims beneath the flange in order to facilitate re-assembly. Remove the three sealing rings from the venturi tube.

*Removing the differential pressure orifice*

**5.** Unscrew the orifice retaining plug and remove the sealing ring and washer from the plug.

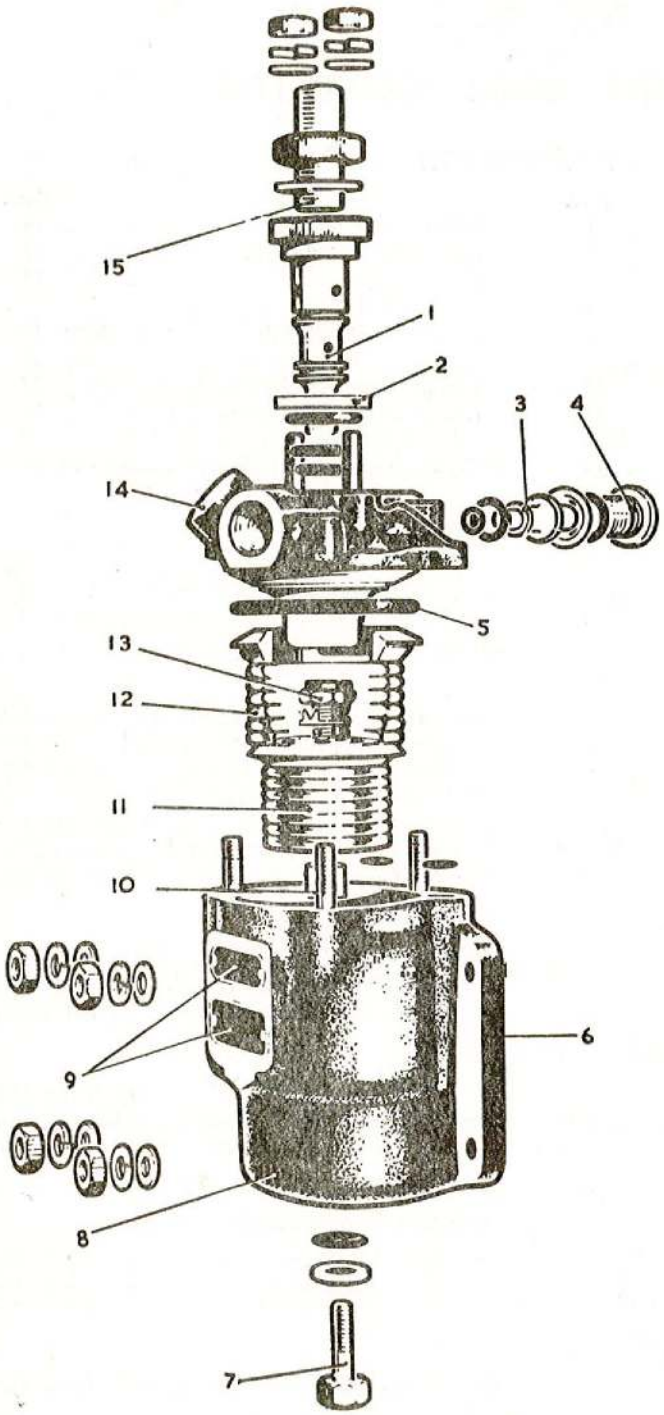
**6.** Withdraw the orifice bobbin using the extractor T.205227 as shown in fig. 2., and remove the two sealing rings from the bobbin.

*Removing the capsule and bellows assembly*

**7.** Unscrew and remove the three nuts together with grover washers and plain washers and lift the switch housing cover from the three studs.

**8.** Remove the two small seals from the housing flange and the large sealing ring from the housing counterbore.

**9.** From the bottom of the housing remove the 2BA bolt together with the plain




1 P2 VENTURI TUBE
2 SHIMS
3 DIFFERENTIAL PRESSURE ORIFICE
4 ORIFICE RETAINING PLUG
5 BELLOWS SEALING RING
6 MOUNTING FLANGE
7 CAPSULE RETAINING SCREW
8 SWITCH HOUSING
9 NAME AND DATA PLATES
10 CAPSULE DISTANCE PIECE
11 CAPSULE
12 BELLOWS
13 VALVE SCREW
14 SWITCH COVER
15 P2 INLET UNION

**Fig. 1. Exploded view of pressure ratio switch (venturi type)**

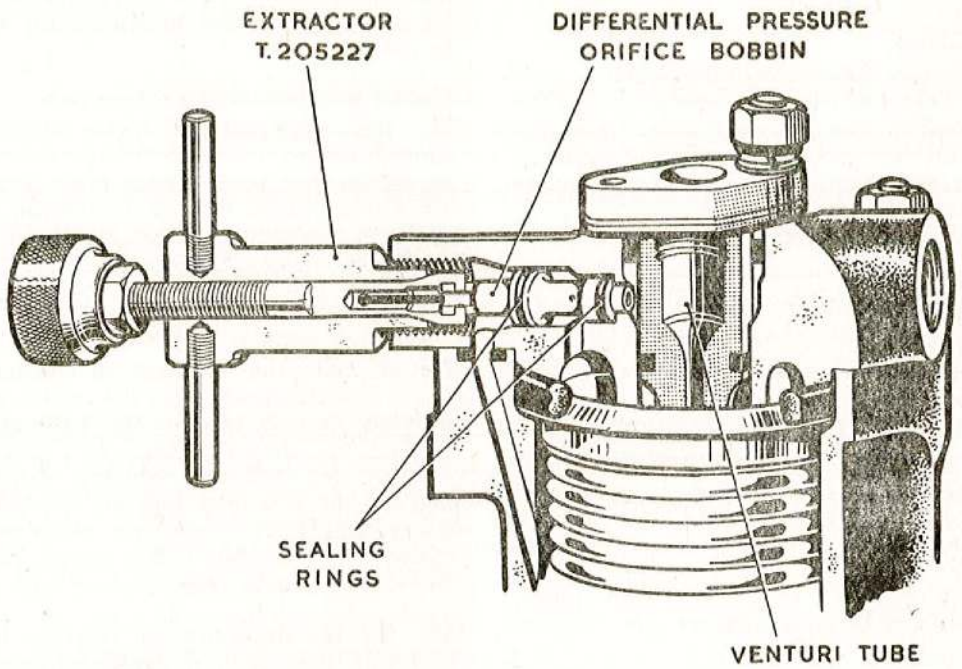



**Fig. 2. Removing the differential pressure orifice**

washer and sealing ring securing the capsule assembly.

**10.** Lift out the differential capsule assembly complete, invert the housing and the distance piece will fall out from the bottom of the housing.

**11.** Unlock the tab-washer locking the valve screw in position centrally in the base of the bellows and, using a standard box spanner, remove the valve screw assembly together with the tab-washer.

**Cleaning**

**12.** For instructions on the cleaning of the components, reference must be made to para. 58 to 60 of this chapter.

**Inspection**

**13.** Reference must first be made to para. 61 to 69 of this chapter for inspection instructions of a general nature.

*P2/P1 venturi tube*

**14.** Examine the orifice tube for damage and for foreign matter, particularly round the mouth of the bore. Check that the grooves (internal and external) for the sealing rings are clean and that every trace of rubber has been removed.

*Differential pressure orifice*

**15.** See that the threads on the orifice retaining plug are clean and still serviceable, examine the orifice tube for cleanliness and make sure that all traces of rubber have been removed from the grooves. Ensure that the washer is not cracked nor distorted.

*Switch housing and cover*

**16.** Inspect the housing and cover generally for damage and see that the joint faces are in good condition, free from scoring and that no signs of corrosion are visible.

*Differential capsule assembly*

**17.** Examine the capsule for damage and see that no particles of foreign matter exist between the convolutions. Ascertain that the distance piece is clean and free from sharp edges.

*Valve screw*

**18.** Examine the sealing face of the valve screw for signs of wear or damage. Discard and renew if necessary. As it is not possible to renew the seating face

separately, the valve screw must be discarded if damaged and a new one fitted.

**Assembling**

*Assembling the differential and venturi orifices*

**19.** Ease two sealing rings over the differential pressure orifice tube, insert the tube into the pressure ratio switch assembly cover and fit the retaining plug complete with joint washer and sealing ring.

**20.** Locate two small sealing rings in the housing joint face transfer drillings, insert the slave bellows ring T.224379 into the housing followed by the large sealing ring. Fit the cover and secure the assembly with slave washers and nuts.

**21.** Assemble three sealing rings to the P2/P1 venturi tube, fit the shims removed during dismantling and insert the tube in the assembled cover, securing the tube flange with washers and nuts. Fit the rig-testing P2 connection banjo pillar, complete with joint washers.

**22.** Assemble a joint washer and blanking plate T.224379, complete with union, to the flanged mounting face of the housing and secure with bolts, washers and nuts in readiness for calibration.

*Calibrating the pressure ratio orifice assembly*

**23.** The pressure ratio orifice calibration is to be checked by connecting an air pressure line and two air pressure gauges, reading 0 to 100 lb. per sq. in.

**24.** The air pressure supply and gauge are to be connected by a double banjo to the P2 inlet connection on the venturi tube flange, whilst the union on the slave cover plate is connected to the other gauge to provide a reading of the flow control capsule pressure (KP2) as shown in fig. 3.

**25.** Adjust the air supply until the P2 (upstream) gauge indicates the pressure specified in the relevant Appendix and check the reading on KP2 (downstream) gauge. If the specified pressures cannot be obtained, a new venturi tube must be fitted. Each venturi is calibrated during manufacture and must not be interfered with. It is recommended that several venturi tubes be kept in stock so that a range is available for selective assembly in order to facilitate calibration of the unit.

**26.** When the calibration is satisfactory remove the assembly from the rig in readiness for assembly to the pressure-ratio valve housing.

*Checking the capsule locating distance piece*

**27.** Before attempting to fit the differential capsule and bellows assembly, it is necessary to ensure that the distance piece locating the capsule in the base of the housing is of the correct length. This is measured with a depth micrometer, a locating block T.205224 and setting plate and pillar T.205225 as shown in fig. 4.

**28.** Measure the thickness of the setting piece T.205224 then insert the setting piece into the tapped hole in the base of the capsule, as shown in fig. 4, insert the capsule and bellows assembly into the housing, fit a sealing ring on the bellows flange and fit the pressure ratio switch cover, or, if available, a slave cover. Retain the assembly with plain washers and nuts.

**29.** Fit the assembly on locating block T.205224 and, with a depth micrometer, measure the distance from the face of the central external boss on the base of the

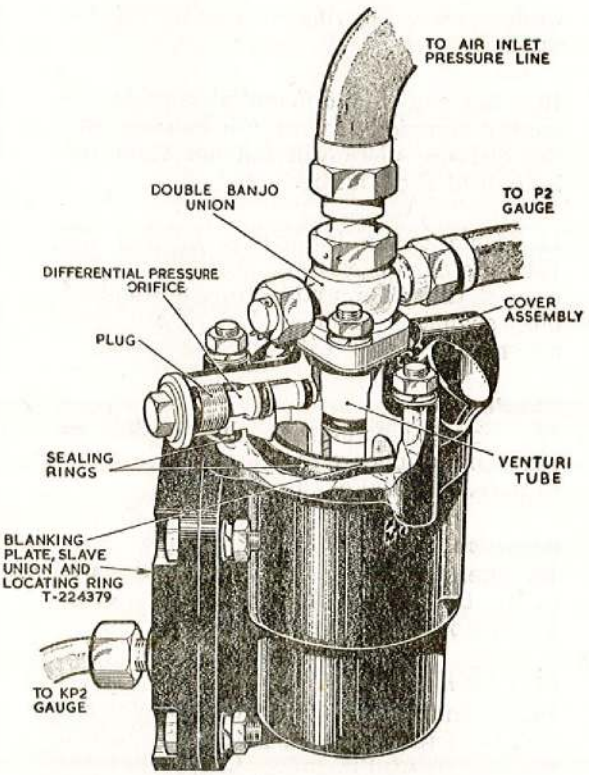



**Fig. 3. Calibrating the pressure ratio orifices**

housing to the face of the setting piece, as shown in fig. 4 (B) Care must be taken to avoid compressing the capsule with the micrometer and thus obtaining a false measurement. Record the micrometer reading for later reference.

**30.** Remove the housing cover, extract the sealing ring and bellows assembly then invert the housing and rest it on setting pillar T.205225, as shown in fig. 4 (C).

**31.** Place the micrometer on the housing external boss face and measure the depth to the face of the setting pillar. Subtract this measurement from that obtained previously (para. 38) then add to the result the thickness of the setting piece (para. 37); the resultant figure is the required length of the distance piece to ensure that the capsule and bellows are not pre-loaded in either direction when retained in the housing. Remove the housing from the setting pillar and remove the setting plate from the capsule.

**32.** Measure the distance piece length with a standard micrometer; if it does not

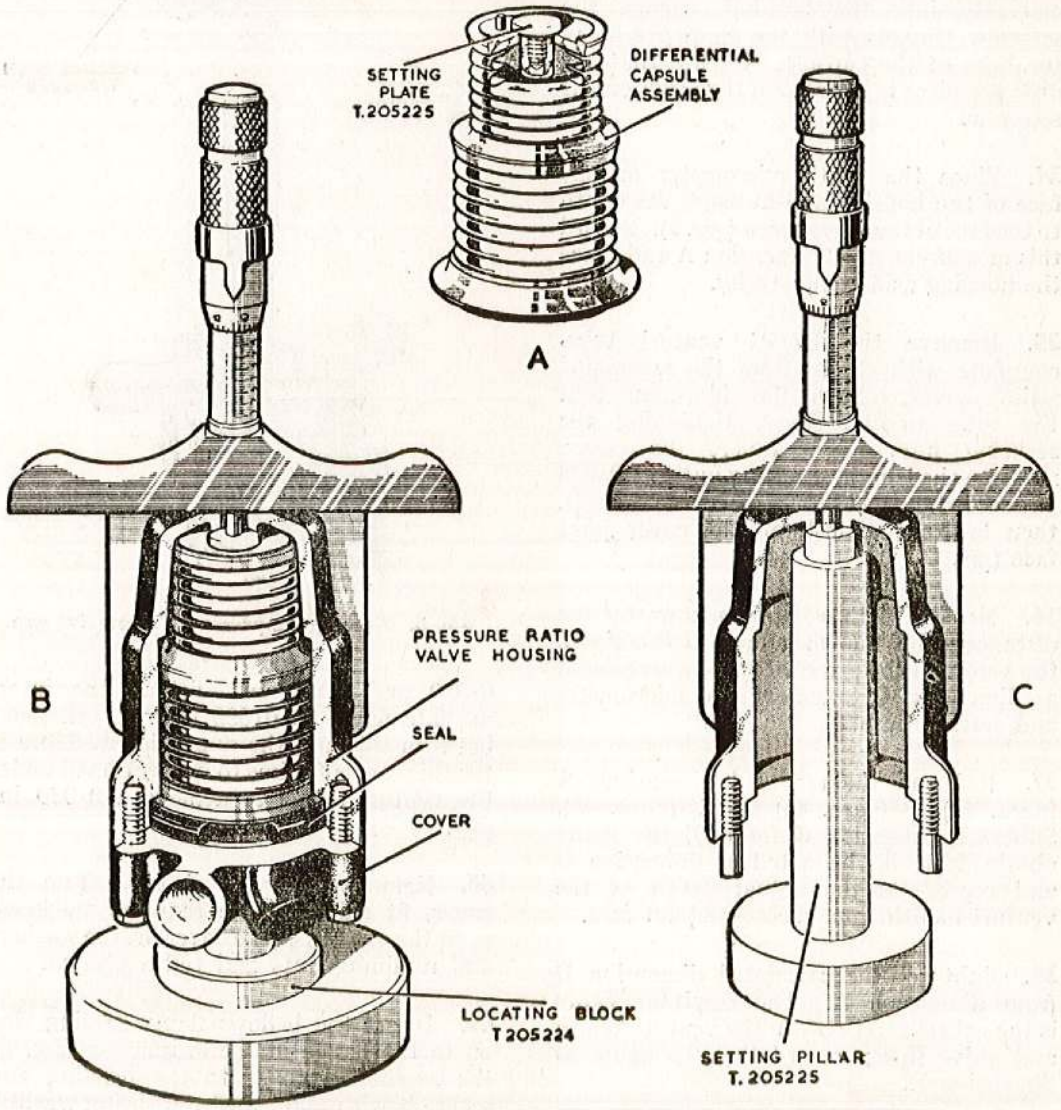



**Fig. 4. Checking the length of the capsule distance piece**

conform exactly with the measurement obtained it must be replaced with a distance piece of the correct length.

*Fitting the capsule and bellows assembly*

**33.** Fit the pressure ratio valve screw complete with tab-washer into the tapped hole in the base of the differential bellows. Tighten the screw, taking care to avoid damaging the sealing face of the valve ; do not lock the tab-washer at this stage. Insert the capsule retaining setscrew complete with washer and sealing ring into the hole in the base of the pressure-ratio switch housing and fit the distance piece over the projecting end of the setscrew inside the housing. Insert the capsule and bellows assembly into the housing, engage the setscrew threads with the tapped hole in the base of the capsule. Ensure that the distance piece is in position then tighten the setscrew.

**34.** Place the depth micrometer on the face of the housing and measure the depth to the face of the valve screw (*fig.* 5). Record this measurement as dimension A and place the housing aside temporarily.

**35.** Remove the P2/P1 venturi tube, complete with shims, from the assembled switch cover, remove the shims and refit the tube to the cover, tightening the securing nuts fully. Invert the cover, measure the length of setting bush T.205228 and record the measurement as dimension B, then locate the bush on the cover joint face (*fig.* 5).

**36.** Measure with a depth micrometer the distance from the bush face to the tip of the venturi tube ; record this measurement as dimension C. Remove the micrometer and setting bush.

**37.** Refer to the recorded dimensions A (para. 43), B (para. 44) and C (para. 45). Subtract dimension C from B, the figure obtained should be noted as dimension D and represents the actual depth of the venturi mouth from the cover joint face.

**38.** Subtract the calculated dimension D from dimension A. The resultant figure is the actual gap between the venturi mouth and valve face ; record the gap figure as dimension E.

**39.** The valve gap must be set to between

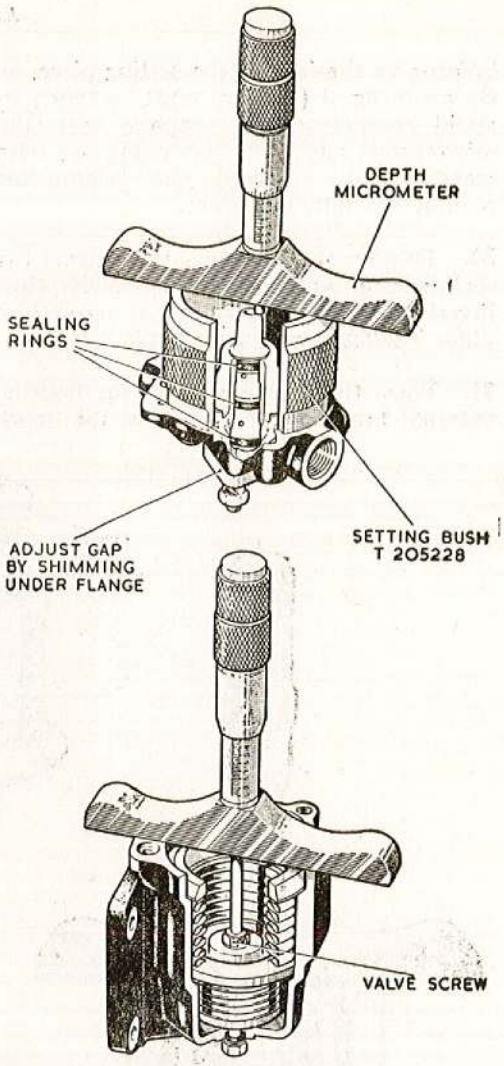



**Fig. 5. Setting the pressure ratio valve gap**

0·020 and 0·040 in. Taking the intermediate figure of 0·030 in., the difference between this and the dimension E figure is the thickness of shims to be positioned under the venturi flange to achieve a 0·030 in. gap.

**40.** Remove the venturi tube from the cover, fit shims of the required thickness re-fit the venturi to the cover, fit the washers and retaining nuts and tighten them.

**41.** Insert the bellows flange sealing ring on to the flange in the switch housing, fit the assembled cover to the housing and secure it with plain washers, spring washers and nuts.

*Checking the pressure ratio change-over*

**42.** Connect the assembled switch to the test-rig and check the change-over point in accoroance with the specified requirements in the Appendix.

**43.** If the change-over is too low, the valve is closing too early and the shim thickness beneath the venturi tube flange must be increased (not exceeding a 0·040 in. gap) until the specified change-over is obtained. Conversely the shim thickness must be reduced (to not less than a 0·020 in. gap) if the change-over occurs at too high a pressure.

**44.** When the change-over is satisfactory remove the switch assembly from the test-rig, remove the cover assembly, lock the valve screw tab-washer inside the bellows and re-fit the cover.

**45.** Remove the rig-testing plate T.224379 from the valve assembly mounting flange and discard the paper gasket.

**46.** Store the unit, together with a new gasket, in a clean box with a well-fitting lid until required for assembly to the control unit.

**Fitting the pressure ratio switch to the control unit**

**47.** Ensure that the joint faces are clean, fit a new joint washer over the studs on the control unit then position the pressure ratio switch on the studs and secure it with plain washers, spring washers and nuts.

**APPENDIX 1**

# CALIBRATION CODE 'G'

**Note . . .**
*The fuel to be used throughout the tests detailed in this appendix is to be AVTUR and is to be maintained at a temperature of 20 to 26 deg. C. The fuel inlet pressure is to be 15 to 20 lb. per sq. in. Reference must be made to the particular paragraphs in the text for further details.*

**Leakage tests**

*Servo valves*

**1.** No leakage allowed at 2,000 lb. per sq. in. refer to para. 136 to 162.

*Lever housing*

**2.** No leakage allowed at 2,000 lb. per sq. in. for 10 min. No leakage allowed at 3 to 5 lb. per sq. in. for 10 min.

*Main assembly*

**3.** No leakage at 150 lb. per sq. in. air pressure for 5 min. refer to para. 191 and 192.

**Preliminary calibration and endurance**

*P2/P1 pressure ratio orifice*

**4.** The P2/P1 pressure ratio orifice assembly is to be tested separately before assembly into the P2/P1 pressure ratio valve to the following table, refer also to para. 225.

| P2 (lb. per sq. in. abs.) | KP2 (lb. per sq. in. abs.) | |
|---|---|---|
| | Min. | Max. |
| 30 | 23·5 | 26·5 |
| 50 | 39·5 | 42·5 |

**5.** The pressure ratio orifice is then to be assembled into the P2/P1 pressure ratio valve which is to be calibrated separately as detailed in the following paragraph.

*P2/P1 pressure ratio valve independent calibration (para. 182)*

**6.** With P1 pressure of 14·7 lb. per sq. in. absolute the change-over point must occur at a P2 pressure of between 45 to 48 lb. per sq. in. absolute. At a P2 pressure of 53 lb. per sq. in. absolute KP.2 must equal P2.

**7.** With a P1 pressure of 5 lb. per sq. in. absolute the change-over point must occur at a P2 pressure of between 14·8 lb. per sq. in. to 16·8 lb. per sq. in. absolute. At a P2 pressure of 21 lb. per sq. in. absolute KP.2 must equal P2.

*Control unit independent calibration P2/P1 pressure ratio valve omitted*

**8.** The A.F.C. unit is to be calibrated without the P2/P1 control, a slave cover being used on the capsule chamber for P2 pressure. The calibration is to be taken on a dual 'C' size pump rig using standard pump servo restricting orifice.

| Compressor delivery Pressure P2 (lb. per sq. in. abs.) | Downstream Pressure (lb. per sq. in. gauge) | Flow (G.P.H.) | |
|---|---|---|---|
| | | Min. | Max. |
| 75 | 630 | 1,300 | — |
| 40 | 425 | 390 | 430 |
| 25 | 390 | 242 | 268 |
| 15 | 370 | 142 | 157 |
| 10 | 365 | 95 | 105 |
| 5 | 360 | — | 75 |

**9.** Hysteresis not to exceed 5 per cent. of the flow with increasing and decreasing P2 up to 45 lb. per sq. in. Abs.

**10.** At 45 lb. per sq. in. P2 pressure, the pressure consciousness from 100 lb. per sq. in. to 1,000 lb. per sq. in. downstream pressure must not exceed 7 per cent. of the flow

**11.** There must not be any hunting of flow.

**12.** With increasing P2 pressure the response time from 100 lb. per sq. in. to 1,000 lb. per sq. in. downstream pressure is to be between 2 to 3 seconds.

**13.** The A.F.C. unit and the P2/P1 pressure ratio valve are to be endurance tested separately by coupling in parallel to the compressor pressure which is to be varied from 0-150 lb. per sq.in. (Gauge) with 500 lb. per sq. in. maximum downstream pressure on the A.F.C. unit.

**14.** The A.F.C. unit and the P2/P1 pressure ratio valve are to be checked to ensure that there is no excessive calibration change and that they are still within the limits of their respective calibrations given in para. 4 of this appendix.

**Partial strip**

**15.** The capsules are to be tested for leakage by immersing in light oil OM-13 at 80° C. to 100° C. No leakage is permitted, refer to para. 228.

**Rebuild**

**16.** Repeat the tests as detailed in para. 1, 2 and 3 of this appendix.

**17.** Set the P2/P1 pressure ratio valve independently to the calibration shown in para. 4 of this appendix. The control unit is then to be fully assembled and set to the calibration shown in para. 20 of this appendix, refer also to para. 230.

**18.** Endurance test at 0 to 150 lb. per sq. in. (Gauge) P2 pressure with 500 lb. per sq. in. maximum downstream pressure, for approximately 15 cycles.

**19.** The unit is to be cycled for half an hour. During this period the P1 pressure is to be varied between 5 lb. per sq. in. Abs. and atmospheric pressure at least 10 times

**Final calibration**

**20.** The calibration is to be taken on a dual 'C' size pump rig using standard pump servo restriction orifices, refer also to para. 232.

| P2 pressure abs. lb. per sq. in. at constant P1 | | | Downstream Pressure (lb. per sq. in. gauge) | Flow (G.P.H.) | |
|---|---|---|---|---|---|
| P1, 5 lb. per sq. in. | P1, 10 lb. per sq. in. | P1, 14·7 lb. per sq. in. | | Min. | Max. |
| 5 | — | — | 360 | — | 75 |
| 10 | — | — | 365 | 82 | 90 |
| 14·8–16·8 | — | — | | P2/P1 change-over | |
| — | 20 | — | 375 | 160 | 175 |
| — | 25 | — | 385 | 200 | 220 |
| | 30–33 | — | | P2/P1 change-over | |
| — | — | 30 | 390 | 247 | 272 |
| — | — | 35 | 400 | 286 | 314 |
| — | — | 40 | 410 | 328 | 362 |
| — | — | 45–48 | | P2/P1 change-over | |
| — | — | 75 | 630 | 1,300 | — |

**21.** When testing the P2/P1 change-over point, the flow downstream of the A.F.C. is to be unrestricted.

**22.** Hysteresis not to exceed 5 per cent. of the flow with increasing and decreasing P2 up to the reading before each change-over point. There must be no oscillation of flow.

**23.** At 40 lb. per sq. in. Abs. P2 pressure, with P1 connection open to atmosphere, the downstream pressure is to be varied from 100 lb. per sq. in. to 1,000 lb. per sq. in. during which the flow must not vary by more than 7 per cent.

**24.** At increasing P2 pressure with P1 connection open to atmosphere, the response time, from 100 lb. per sq. in. to 1,000 lb. per sq. in. downstream pressure, is to be between 2 and 3 seconds.

**Pressure test**

**25.** The unit is to be pressure tested at 1,500 lb. per sq. in., downstream pressure, for five minutes. Repeat the test detailed in para. 3 of this appendix and refer also to para. 233.

APPENDIX 2

# CALIBRATION CODE 'J'

**Note . . .**

*The fuel to be used throughout the tests detailed in this appendix is to be AVTUR and is to be maintained at a temperature of* 20 *to* 26 *deg. C. The fuel inlet pressure is to be* 15 *to* 20 *lb. per sq. in. Reference must be made to the particular paragraphs quoted in the text for further details.*

**Leakage tests (para. 291)**

*Servo valves*

**1.** No leakage allowed at 2,000 lb. per sq. in. refer to para. 136 to 162.

*Lever housing*

**2.** No leakage allowed at 2,000 lb. per sq. in. for 10 min. No leakage allowed at 3-5 lb. per sq. in. for 5 min.

*Main assembly*

**3.** No leakage at 150 lb. per sq. in. air pressure for 5 min. refer to para. 191 and 192.

**Preliminary calibration and endurance**

**4.** The unit is to be calibrated using a dual pump rig with a combined servo flow of 11·4 to 11·6 g.p.h. at 1,000 lb. per sq. in. Stall pressure 150 g.p.h. main flow to the following table, refer also to para. 225.

| Compressor delivery Pressure P2 (lb. per sq. in. Abs.) | Downstream Pressure (lb. per sq. in. gauge) | Fuel flow | |
|---|---|---|---|
| | | Min. | Max. |
| 5 | 400 | 65 | 75 |
| 10 | 480 | 110 | 122 |
| 15 | 520 | 153 | 169 |
| 20 | 560 | 198 | 217 |
| 25 | 590 | 242 | 265 |
| 30 | 625 | 287 | 312 |
| 35 | 650 | 331 | 360 |
| 40 | 680 | 375 | 407 |
| 45 | 700 | 418 | 455 |
| 48 | 720 | 445 | 494 |
| 53 | 820 | 580 | — |
| 80 | 1,300 | 1,900 | — |

**5.** Hysteresis is not to exceed 5 per cent. of the flow with increasing and decreasing P2 pressure within the range of 5-45 lb. per sq. in. absolute. There must be no hunting of flow.

**6.** At 35 lb. per sq. in. P2 pressure, downstream pressure is to be varied from 100-1,000 lb. per sq. in. Flow must not change in excess of 7 per cent. Record the pressure drop across the unit.

**7.** With the unit set at the 80 lb. per sq. in. absolute P2 pressure conditions tabulated above, close and open the P2 rig supply cock. The response time from 100 to 1,000

**9.** Set the maximum flow stop at 1,800 to 1,850 g.p.h. at 85 lb. per sq. in. abs. P2 and 430 lb. per sq. in. downstream pressure.

**10.** Hysteresis must not exceed 5 per cent. of this flow with increasing and decreasing P2 up to 55 lb. per sq. in. abs.

**11.** At 40 lb. per sq. in. abs. P2 pressure the pressure consciousness from 100 to 1,000 lb. per sq. in. downstream pressure must not exceed 7 per cent. of this flow and there must be no hunting of flow.

**12.** With the P2 pressure set at 85 lb. per sq. in. abs. and downstream pressure set at 450 lb. per sq. in. close and open the rig P2 supply cock. The deceleration time from P2 shut-off to the collapse to the 100 lb. per sq. in. downstream pressure must not exceed 3 sec. The acceleration time from P2 open to the increase to 400 lb. per sq. in. downstream pressure must not exceed 3 sec.

**Endurance test**

**13.** The main unit and the P2/P1 control may be endurance tested separately or combined over the range of 0 to 150 lb. per sq. in. (gauge) with a maximum downstream pressure on the unit of 500 lb. per sq. in.

The test is a continuous cycling one of 2 hours duration at a normal 3 cycles per min.

**Intermediate calibration**

**14.** The main unit and the P2/P1 control are to be checked (*para.* 4 *to* 11) to ensure that there is no excessive calibration change and that they are still within their respective calibrations.

**Partial strip**

**15.** Test the bellows for leakage by immersing in oil OM-13 at 80 to 100 deg. C. No leakage is permitted.

**Rebuild**

**16.** Repeat tests as in para. 1 to 3. Set the P2/P1 control separately to calibration indicated in para. 4 to 6. Fully assemble the unit and set to calibration as in para. 4 to 11.

**17.** Endurance test the unit from 0 to 150 lb. per sq. in. (gauge) P2 pressure with 500 lb. per sq. in. maximum downstream pressure. The unit is to be cycled for 30 minutes, during which time the P1 pressure is to be varied between 5 lb. per sq. in. abs. to atmospheric pressure at least 10 times.

**Final calibration**

**18.** The calibration given in the following table must be made on a dual C size pump using standard pump servo restriction orifices (0·037 in. dia.). When testing the change-over point, the cock controlling the fuel flow downstream of the unit must be fully open.

| P2 pressure Abs at constant P1 | | | Downstream pressure | Increasing flow (g.p.h.) | |
|---|---|---|---|---|---|
| 5 lb. per sq. in. | 10 lb. per sq. in. | 14·7 lb. per sq. in. | Lb. per sq. in. (gauge) | Minimum | Maximum |
| 5 | | | 150 | — | 80 |
| 10 | | | 150 | 97 | 107 |
| 15 | | | 155 | 147 | 160 |
| 20 to 22 | | | | P2/P1 CHANGEOVER | |
| | 20 | | 165 | 200 | 218 |
| | 25 | | 175 | 250 | 272 |
| | 35 | | 200 | 350 | 381 |
| | 40 to 43 | | | P2/P1 CHANGEOVER | |
| | | 30 | 185 | 300 | 325 |
| | | 40 | 205 | 400 | 435 |
| | | 50 | 225 | 500 | 545 |
| | | 60 to 63 | | P2/P1 CHANGEOVER | |
| | | 75 | 430 | 1,800 | — |

**19.** Set the maximum flow stop to reduce the maximum flow to 1,800 to 1,850 g.p.h. at 85 lb. per sq. in. abs. P2 pressure and 430 lb. per sq. in. downstream pressure.

**20.** Hysteresis must not exceed 5 per cent. of the flow with increasing and decreasing P2 up to the reading before each change-over point.

**21.** At 40 lb. per sq. in. abs. P2 pressure and with P1 connection open to atmosphere, the pressure consciousness of the unit from 100 to 1,000 lb. per sq. in. downstream pressure must not exceed 7 per cent. of the flow. There must be no hunting of flows.

**22.** With P2 pressure set at 85 lb. per sq. in. abs. and downstream pressure set at 450 lb. per sq. in. close and open the rig P2 supply cock. The deceleration time from P2 shut-off to the collapse to 100 lb. per sq. in. downstream pressure must not exceed 3 sec. The acceleration time from P2 open to increase to 400 lb. per sq. in. downstream pressure must not exceed 3 sec.

**Pressure test**

**23.** The unit is to be pressure-tested at 1,500 lb. per sq. in. downstream pressure for 5 minutes.

**Inhibiting**

**24.** Inject oil OM-11 into all connections except the P2 and P1 connections.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