# Chapter 2

# COMBINED CONTROL UNITS, TYPES FRFC 16 AND 17

## LIST OF CONTENTS



(A.L. 52, June 57)

## LIST OF CONTENTS—*Continued*



## LIST OF ILLUSTRATIONS



### General

**1.** The type number (FRFC 16/15H) comprises the basic type designation (FRFC 16) followed by the stroke number (/15) which indicates the engine installation and therefore the connections required, whilst the final letter (H) indicates the calibration schedule to which the unit is adjusted and tested.

**2.** A Schedule of Fits, Clearances and Repair Tolerances is provided in A.P.4282A, Vol. 2, Part 2, and the dimensions specified must be adhered to.

**3.** Calibration settings and performace tests are given in the Appendix to this chapter.

**4.** Scrupulous cleanliness is essential at all times, particularly when assembling the unit.

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

**6.** Sealing rings, gaskets, tab-washers and locking wire must be discarded during dismantling and renewed on assembly.

**7.** The following special tools are required and in most instances an illustration of the tool in use is provided adjacent to the relevant instructions in the text.

| *Part No.* | *Description* |
|---|---|
| G.63006 | Jig, electrolimit comparator |
| G.80008 | Quadrant, 0 to 90 degrees, throttle valve |
| T.174335 | Box spanner, $\frac{7}{16}$ in. B.S.F. |
| T.177125 | Box spanner, $\frac{1}{4}$ in. B.S.F. |
| T.178005 | Outlet connection, test-rig |
| T.193939 | Box key, lever adjusting screw |
| T.200609 | Extractor, throttle valve plunger |
| T.200627 | Blanking plugs, altitude plunger bore |
| T.201778 | Box key, 0·157 in. adjusting screw |

| *Part No.* | *Description* |
|---|---|
| T.204658 | Adapter plate, flow control housing |
| T.204658/H | Hydraulic assembly fixture |
| T.212145 | Extractor, throttle valve pinion stop-plate |
| T.214183 | Setting punch, half-ball retainer |
| T.218106 | Extractor, metering plunger push-rod guide |
| T.218107 | Box spanner, flow control servo response valve orifice |
| T.218109 | Spring compression tool, sensing spring |
| T.218112 | Extractor, flow control servo response valve orifice plug |
| T.218113 | Pressure-drop test fixture, strainers |
| T.218115 | Extractor, metering plunger guide sleeve |
| T.218116 | Locating tool, shut-off cock orifice piston |
| T.219117 | Extractor, shut-off cock control orifice |
| T.218118 | Extractor, fuel transfer bobbin |
| T.230217 | Extractor, fuel transfer bobbin |
| T.240215 | Extractor, throttle valve plunger sleeve |
| T.240219 | Mounting bracket, test-rig |
| T.240220 | Combination spanner, potentiometer adjustment |
| T.240221<br>T.240222<br>T.240223 | Blanking plugs, used with T.178005 |
| T.241670 | Adapter plate, assembling the throttle valve/shut-off cock housing |
| T.247828 | Spring compression tool, trimming spring |
| T.249077 | Jig, assembling flow control cantilever assembly |

**8.** Before dismantling, consider any complaints which were reported with the unit as these may show which parts of the unit require attention and, if the running-time is short, may save unnecessary dismantling.

**9.** Remove the dust caps and drain the inhibiting oil. Check that the external locking devices are intact and examine the exterior of the unit, including the threads, for damage.

**10.** If the unit appears to be in running condition it should be tested as for preliminary calibration. This test is to give an indication of any defects and the parts requiring attention.

**11.** To enable the preliminary test to be made, remove the blanking plate from the inlet connection and, using the extractor T.218112, withdraw the sealing plug from the connection to pump inlet. Remove the outlet connection blanking plate.

**12.** Mount the unit on the rig and test it as described for preliminary calibration.

**13.** After the tests, dismantle the unit partially or completely as necessary. A time-expired unit must be completely dismantled.

## DISMANTLING

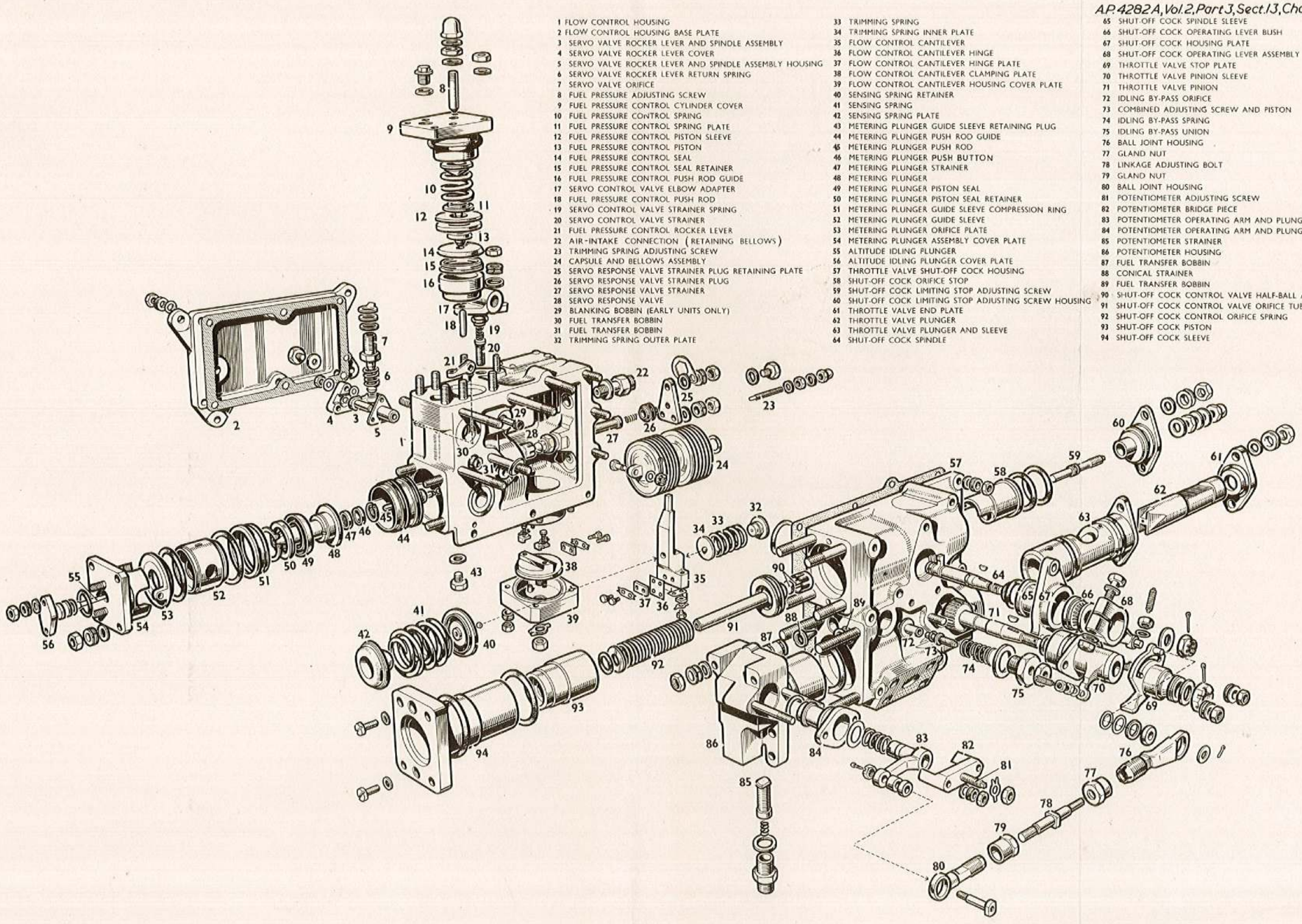
### General

**14.** In the following paragraphs the method of removing each sub-assembly is described, and in each instance is followed immediately by the method of reducing the sub-assembly to its separate details where that is permissible.

**15.** 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 when rebuilding.

**16.** Mount the unit on the hydraclamp (T.204658) as shown in fig. 2. By removing the base plate the whole unit can be mounted on the bracket T.204658, then, after separating the two housings, the flow control housing will remain on the same bracket for dismantling. Another bracket T.241670 is available for dismantling the throttle valve/shut-off cock housing (*fig.* 9).

**17.** The dismantled components should be placed in clean, dry metal boxes.



1 FLOW CONTROL HOUSING
2 FLOW CONTROL HOUSING BASE PLATE
3 SERVO VALVE ROCKER LEVER AND SPINDLE ASSEMBLY
4 SERVO VALVE ROCKER LEVER COVER
5 SERVO VALVE ROCKER LEVER AND SPINDLE ASSEMBLY HOUSING
6 SERVO VALVE ROCKER LEVER RETURN SPRING
7 SERVO VALVE ORIFICE
8 FUEL PRESSURE ADJUSTING SCREW
9 FUEL PRESSURE CONTROL CYLINDER COVER
10 FUEL PRESSURE CONTROL SPRING
11 FUEL PRESSURE CONTROL SPRING PLATE
12 FUEL PRESSURE CONTROL PISTON SLEEVE
13 FUEL PRESSURE CONTROL PISTON
14 FUEL PRESSURE CONTROL SEAL
15 FUEL PRESSURE CONTROL SEAL RETAINER
16 FUEL PRESSURE CONTROL PUSH ROD GUIDE
17 SERVO CONTROL VALVE ELBOW ADAPTER
18 FUEL PRESSURE CONTROL PUSH ROD
19 SERVO CONTROL VALVE STRAINER SPRING
20 SERVO CONTROL VALVE STRAINER
21 FUEL PRESSURE CONTROL ROCKER LEVER
22 AIR-INTAKE CONNECTION (RETAINING BELLOWS)
23 TRIMMING SPRING ADJUSTING SCREW
24 CAPSULE AND BELLOWS ASSEMBLY
25 SERVO RESPONSE VALVE STRAINER PLUG RETAINING PLATE
26 SERVO RESPONSE VALVE STRAINER PLUG
27 SERVO RESPONSE VALVE STRAINER
28 SERVO RESPONSE VALVE
29 BLANKING BOBBIN (EARLY UNITS ONLY)
30 FUEL TRANSFER BOBBIN
31 FUEL TRANSFER BOBBIN
32 TRIMMING SPRING OUTER PLATE
33 TRIMMING SPRING
34 TRIMMING SPRING INNER PLATE
35 FLOW CONTROL CANTILEVER
36 FLOW CONTROL CANTILEVER HINGE
37 FLOW CONTROL CANTILEVER HINGE PLATE
38 FLOW CONTROL CANTILEVER CLAMPING PLATE
39 FLOW CONTROL CANTILEVER HOUSING COVER PLATE
40 SENSING SPRING RETAINER
41 SENSING SPRING
42 SENSING SPRING PLATE
43 METERING PLUNGER GUIDE SLEEVE RETAINING PLUG
44 METERING PLUNGER PUSH ROD GUIDE
45 METERING PLUNGER PUSH ROD
46 METERING PLUNGER PUSH BUTTON
47 METERING PLUNGER STRAINER
48 METERING PLUNGER
49 METERING PLUNGER PISTON SEAL
50 METERING PLUNGER PISTON SEAL RETAINER
51 METERING PLUNGER GUIDE SLEEVE COMPRESSION RING
52 METERING PLUNGER GUIDE SLEEVE
53 METERING PLUNGER ORIFICE PLATE
54 METERING PLUNGER ASSEMBLY COVER PLATE
55 ALTITUDE IDLING PLUNGER
56 ALTITUDE IDLING PLUNGER COVER PLATE
57 THROTTLE VALVE SHUT-OFF COCK HOUSING
58 SHUT-OFF COCK ORIFICE STOP
59 SHUT-OFF COCK LIMITING STOP ADJUSTING SCREW
60 SHUT-OFF COCK LIMITING STOP ADJUSTING SCREW HOUSING
61 THROTTLE VALVE END PLATE
62 THROTTLE VALVE PLUNGER
63 THROTTLE VALVE PLUNGER AND SLEEVE
64 SHUT-OFF COCK SPINDLE
65 SHUT-OFF COCK SPINDLE SLEEVE
66 SHUT-OFF COCK OPERATING LEVER BUSH
67 SHUT-OFF COCK HOUSING PLATE
68 SHUT-OFF COCK OPERATING LEVER ASSEMBLY
69 THROTTLE VALVE STOP PLATE
70 THROTTLE VALVE PINION SLEEVE
71 THROTTLE VALVE PINION
72 IDLING BY-PASS ORIFICE
73 COMBINED ADJUSTING SCREW AND PISTON
74 IDLING BY-PASS SPRING
75 IDLING BY-PASS UNION
76 BALL JOINT HOUSING
77 GLAND NUT
78 LINKAGE ADJUSTING BOLT
79 GLAND NUT
80 BALL JOINT HOUSING
81 POTENTIOMETER ADJUSTING SCREW
82 POTENTIOMETER BRIDGE PIECE
83 POTENTIOMETER OPERATING ARM AND PLUNGER ASSEMBLY
84 POTENTIOMETER OPERATING ARM AND PLUNGER ASSEMBLY SLEEVE
85 POTENTIOMETER STRAINER
86 POTENTIOMETER HOUSING
87 FUEL TRANSFER BOBBIN
88 CONICAL STRAINER
89 FUEL TRANSFER BOBBIN
90 SHUT-OFF COCK CONTROL VALVE HALF-BALL AND RETAINER
91 SHUT-OFF COCK CONTROL VALVE ORIFICE TUBE
92 SHUT-OFF COCK CONTROL ORIFICE SPRING
93 SHUT-OFF COCK PISTON
94 SHUT-OFF COCK SLEEVE

Fig.1. Dismantled view of unit



2508 189804 7/57 1500 C.B&S.LTD GP.55.

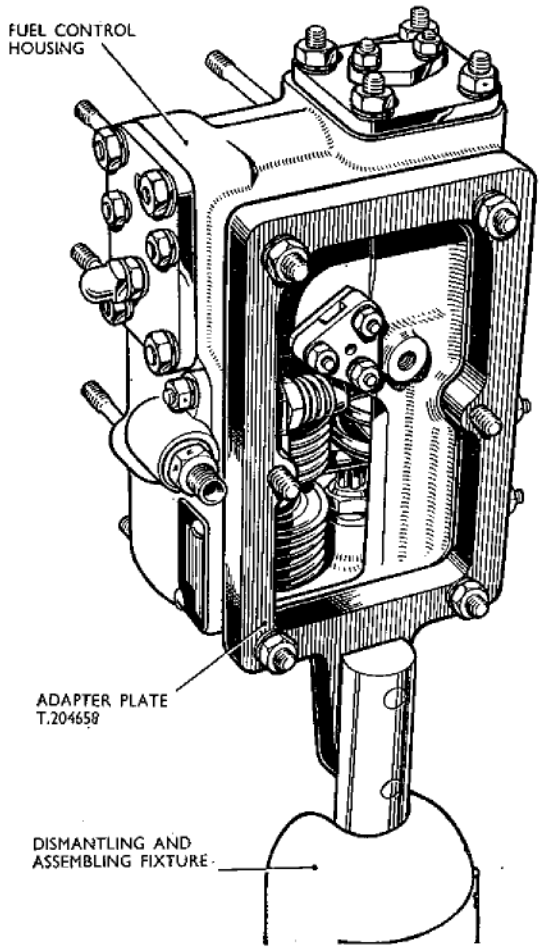



**Fig. 2. Dismantling and assembling fixture (flow control housing)**

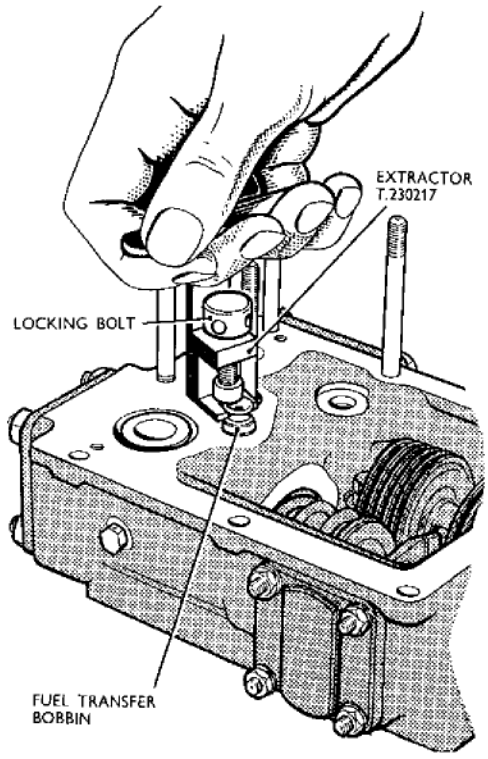



**Fig. 3. Removing the fuel transfer bobbins**

**Separating the flow control housing and throttle valve/shut-off cock housings**

**18.** Remove the nuts together with grover and plain washers and lift off the base plate from the studs. Using the box spanner T.177125 release and remove the seven nuts, together with grover and plain washers, securing the two housings together. Separate the housings by lifting off the throttle valve/shut-off cock housing from the studs in the flow control housing. If tight, a light tap round the joint with a hide hammer will free them.

**19.** Remove the gasket from round the central stud in the flow control housing joint face, and the large sealing ring from the recess round the main flow from throttle delivery to metering plunger passage.

**20.** A small bobbin transfers the fuel across the seating face from the altitude chamber to inlet and a larger bobbin from the pressure drop chamber to the potentiometer valve. Remove both bobbins by using the extractor T.230217 and T.218118 as shown in fig. 3.

**21.** Remove the upper sealing ring from each bobbin and locate the foot of the extractor in the groove from which the sealing ring has been removed. Screw down the knurled bolt tightly to secure the extractors in position and pull the bobbin from its housing.

**Note . . .**

*Earlier units which have been converted to a potentiometer throttle have a blanking bobbin in the original pressure-drop chamber to shut-off cock fuel passage and this must also be withdrawn.*

**22.** The two locating pegs in the face of the housing need not be removed unless they are damaged in which case they must be withdrawn with pliers and renewed when assembling.

## DISMANTLING THE FLOW CONTROL HOUSING

### Altitude idling plunger

**23.** Remove the two 2BA nuts, grover and plain washers and lift off the small cover plates ; take care to retain the spacer plug.

**24.** Remove the four nuts and washers and lift off the large cover plate together with sealing rings and altitude idling plunger. Remove the altitude plunger from the large cover plate.

### Trimming spring adjusting screw

**25.** Remove the dome nut, two plain washers, locknut and then the adjusting screw.

### Flow control servo response valve strainer

**26.** Remove the three nuts together with grover and plain washers and lift off the triangular strainer plug retaining plate and shims and also the locking plate for the air-intake union. Record the number and thickness of shims. Withdraw the strainer plug and sealing ring by using the extractor T.218112 (*fig.* 4). Withdraw the helical spring and strainer from the orifice housing.

### Flow control cantilever assembly

**27.** Using the compression tools, T.218109 for the sensing spring and T.247828 for the trimming spring, locate them on the unit (*fig.* 5) and by rotating the handle of each tool compress the springs until their locating plates clear the lever assembly.

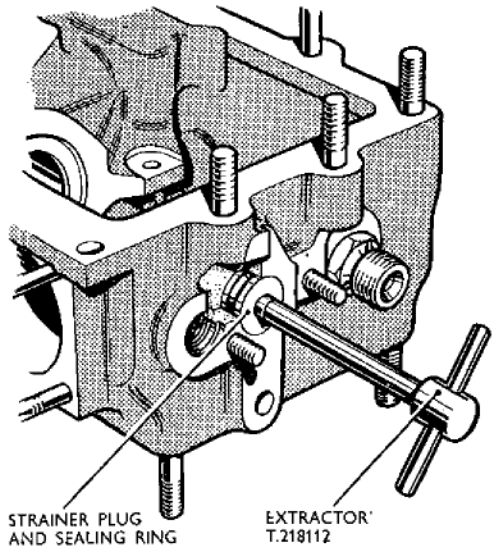



**Fig. 4. Removing the flow control servo response valve strainer plug**

**28.** Remove the four nuts, grover washers and plain washers and withdraw the cover plate and cantilever assembly from the unit.

**29.** On earlier units remove the four nuts and lift off the cantilever housing cover plate. This will expose two 4BA nuts which must be removed together with the locking plate from the two retaining studs. Lift the outer lever bearing clamping plate from the studs and withdraw the complete lever assembly from the casting. Dis-

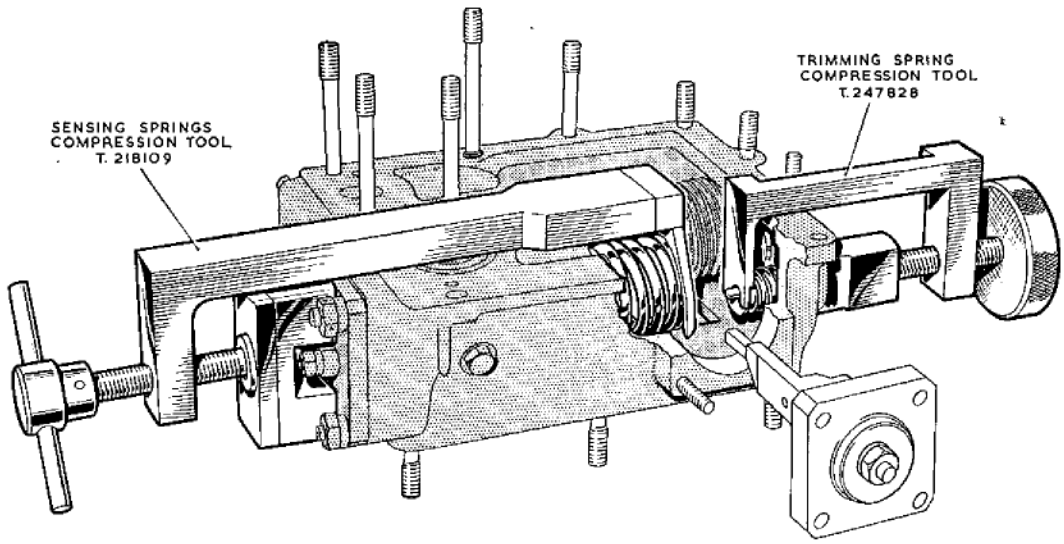



**Fig. 5. Compressing the springs for removal of lever**

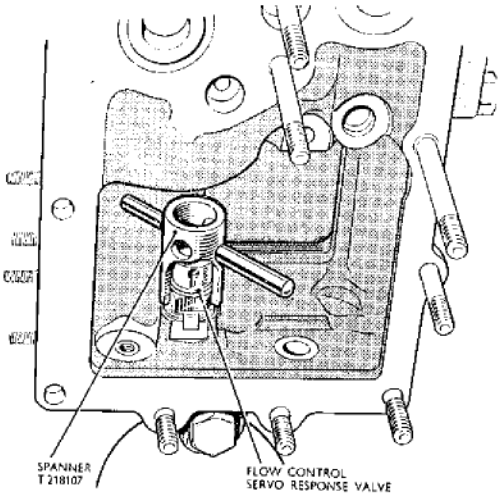



**Fig. 6. Removing the flow control servo response valve orifice**

mantling the lever assembly is not recommended unless the bearing shows obvious signs of damage or severe wear in which case the peg must be driven out with a fine punch and the lever ball can then be drawn off the end of the lever.

**30.** Release the compression tool and remove the two sensing springs (one on earlier units), the spring retainer assembly and the spring plate. Take care to retain the thrust balls between the push rod and retainer and the lever and spring plate. The latter will probably remain in the recess in the lever and can be removed when dismantling the lever assembly. Release the compression tool and remove the trimming spring and its inner and outer location plates.

**31.** Unlock the tab-washer, remove the nut from the centre of the cover plate and lift the plate from the lever anchor.

**32.** Unlock all tab-washers on the lever assembly. Remove the two bolts and washers from the anchor and also the two from the lever together with hinge plates and separate the lever and leaf spring from the anchor and leaf spring. Remove the remaining two bolts and washers from the anchor and lift off the leaf spring and hinge plate. Remove the remaining two bolts and washers from the lever and lift off the leaf spring and hinge plate.

**Flow control servo response valve**

**33.** Unlock the tab-washer and using the spanner T.218108 or the short box spanner T.218107 as shown in fig. 6, remove the orifice together with the half-ball valve and cage. Spring the cage from the orifice to release the half-ball and remove from the threaded body of the orifice the tab-washer, combination washer and shims. Note the number and thickness of the shims.

**Air-intake connection**

**34.** Release and unscrew the air-intake union and washer from the housing.

**Capsule and bellows**

**35.** Remove the split pin, castle nut, washer and bolt, slightly compress the assembly and lift it out of the housing. The capsule and bellows assembly must not be dismantled.

**Fuel pressure control servo valve**

**36.** Remove the union and washer. Unscrew the two nuts and lift off the elbow adapter. Withdraw the helical spring and strainer.

**37.** Remove the three nuts and washers and lift off the triangular cover and shim washers. Record the number and thickness of shims. Withdraw the servo valve rocker lever assembly and brass housing and lift out the spring and half-ball valve. The control cylinder rocker-lever will be removed from the other side after drawing out the servo valve rocker lever and spindle assembly.

**38.** Unlock the tab-washer and unscrew and remove the fuel pressure control servo orifice, tab-washer, shims and combination washer. Record the number and thickness of shims.

**Fuel pressure control cylinder**

**39.** Remove the dome nut, washer, locknut and washer from the cover and screw out the adjusting screw, also remove the threaded plug and washer.

**40.** Remove the six nuts and washers and lift off the cover plate.

**41.** Lift out the fuel pressure control spring and both spring plates, also the stop plate, piston, piston sleeve, seal and seal retainer. The push rod and guide will fall out if the unit is inverted and tapped lightly with a hide hammer.

**Metering plunger**

**42.** The covers for this assembly having

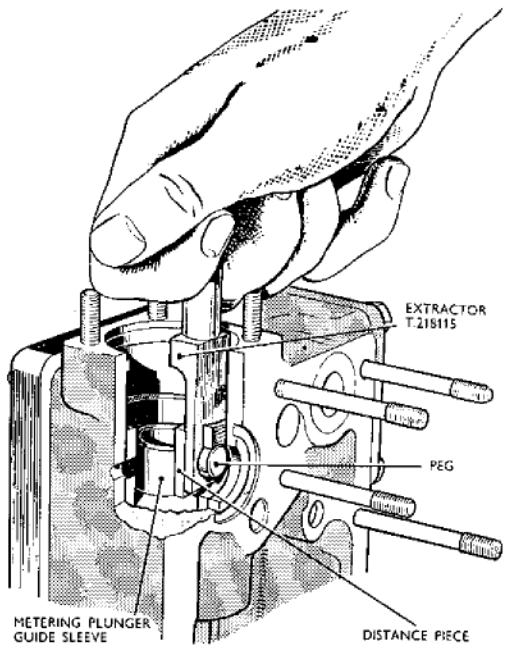



**Fig. 7. Removing the metering plunger guide sleeve**

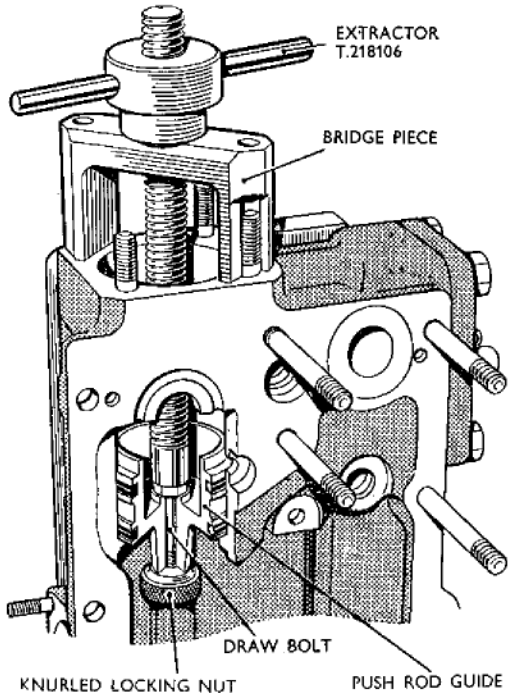



**Fig. 8. Removing the metering plunger push rod guide**

already been removed, lift out the metering plunger orifice plate and seal which remains in the unit. Screw out the guide sleeve retaining plug and sealing washer from the cylinder.

**43.** To withdraw the metering plunger guide sleeve together with two sealing rings, use the extractor T.218115 (*fig.* 7).

**44.** Lower the tool into the sleeve and locate the peg in the fuel delivery drilling. Secure the tool in position by lowering the square distance piece between the tool and the walls of the guide and with a steady pull on the handle, draw out the sleeve.

**45.** The complete metering plunger, consisting of plunger, circlip, plunger push button and strainer, piston seal, piston seal retainer and circlip can now be withdrawn from the cylinder.

**46.** Remove the circlip, lift off the seal retainer and piston seal. Remove the circlip and lift out the plunger push button and strainer. On earlier units unlock the tab-washer and screw out the push button.

**47.** Draw out the push rod from its guide and withdraw the guide by using the extractor T.218106 as shown in fig. 8. Locate the draw bolt through the push rod guide and the bridge piece over the studs on top of the cylinder. Secure in position by screwing the knurled nut on to the draw bolt from the other side of the guide. Turn the handle in a clockwise direction and draw the push rod guide out of the cylinder.

#### Remaining details

**48.** Unscrew and remove the two high pressure seal plugs and washers from the high pressure drilling. The fuel control housing being now completely dismantled; remove it from the hydraclamp and detach the adapter plate.

### DISMANTLING THE THROTTLE VALVE/SHUT-OFF COCK HOUSING

**49.** Fit the adapter T.241670 to the hydraclamp and mount the housing on the adapter (*fig.* 9).

#### Potentiometer linkage

**50.** Remove the split pin and washer from the throttle valve stop pillar and lift the linkage assembly from the throttle valve

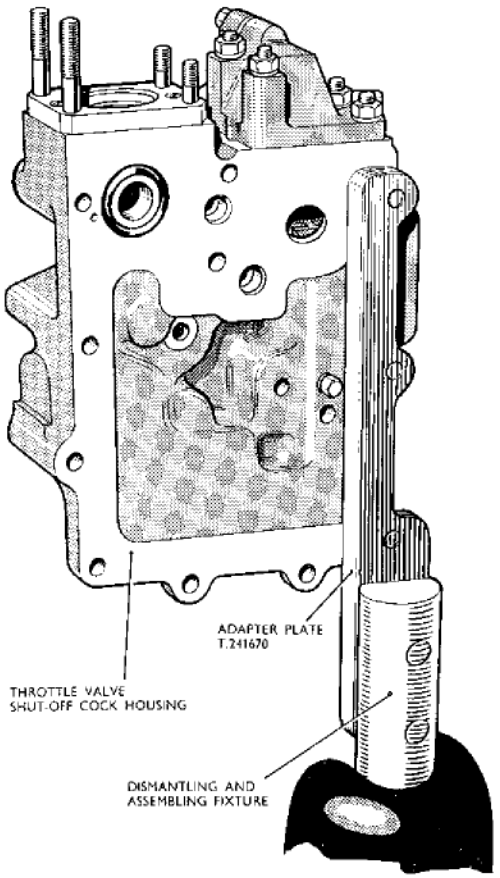



**Fig. 9. Dismantling and assembling fixture (Throttle valve/shut-off cock housing)**

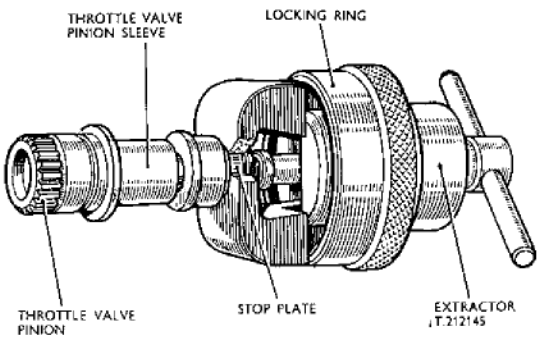



**Fig. 10. Removing the throttle valve pinion stop plate**

stop pillar. Remove the split pin and nut from the potentiometer lever bolt and then the linkage assembly can be lifted off the unit. Take care to retain the distance piece from the potentiometer lever bolt.

**51.** On earlier units, remove the two split pins, one from the throttle lever stop plate and one from the potentiometer arm. Unscrew the nut from the potentiometer arm and remove the linkage assembly.

**52.** Release both locknuts and remove the linkage adjusting bolt. This has a right-hand thread at the throttle valve end and a left-hand thread at the potentiometer end.

**53.** On earlier units unlock the tab-washers,

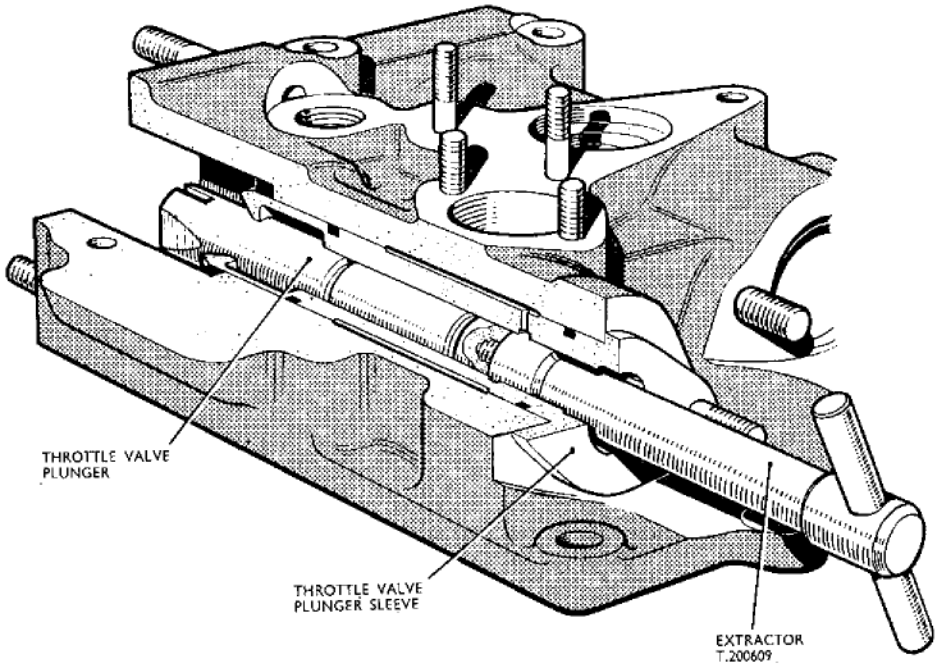



**Fig. 11. Removing the throttle valve plunger**

slacken-off the locknuts and unscrew the linkage adjusting bolt. From the throttle-valve side remove the circlip and lift off the ball and sleeve then from the potentiometer side unlock the tab-washer and remove the adjusting screw bush, tab-washer and shim washers; record the number and thickness of the shims. Lift out the ball pin and the aluminium-bronze ball seats.

**Potentiometer valve**

**54.** Unscrew the two nuts and lift off the potentiometer bridge piece. Remove the locknut, tab-washer and adjusting screw from the bridge piece.

**55.** Remove the potentiometer operating arm and valve assembly together with the sleeve, and withdraw the arm and valve assembly from the sleeve. Remove the sealing ring, spring and washer from the valve.

**56.** Remove the four nuts, grover and plain washers and withdraw the housing together with the two transfer bobbins and strainer. Remove two sealing rings from each bobbin, one from the bottom of the chamber in the casting and one from the recess round the housing.

**Throttle valve pinion and sleeve**

**57.** Remove the two nuts and withdraw the throttle valve pinion and sleeve from the housing. Extract the split pin and remove the nut and washer from the throttle valve pinion.

**58.** To draw off the stop plate use the special extractor T.212145 as shown in fig. 10. Locate the feet of the extractor under the flange on the stop plate and screw down the locking ring. Turn the handle of the tool in a clockwise direction until the stop plate is drawn off the pinion. Remove the tool from the stop plate and withdraw the pinion from the sleeve.

**59.** To remove the adjustable stop-screws, from the closed position remove two nuts, shims and the stop screw and from the open position remove one nut, shim and the stop screw; note the number and thickness of the shim washers in order to facilitate re-assembly.

**Throttle valve plunger and sleeve**

**60.** Draw out the throttle valve plunger by using extractor T.200609 as shown in fig. 11. To avoid damage to the plunger it is recommended that the metering end be wrapped with tape or other protective material.

**61.** To withdraw the sleeve use the extractor T.240215 (*fig.* 12). Locate the tool in the bore of the sleeve as shown in the illustration and screw down the handle thus opening the collet to lock the tool in position. A strong pull on the handle will draw the sleeve out of the bore in the casting. The metering orifice at the end of the sleeve is as important as the metering plunger and should be protected in a similar manner.

**Shut-off cock operating lever assembly**

**62.** Unscrew the nut from the clamping bolt and pull the operating lever assembly from the lever spindle.

**Shut-off cock sleeve and spindle**

**63.** Remove the castle nut and plain washer from the shut-off cock lever spindle and withdraw the bush. Release the two remaining nuts, grover and plain washers and lift off the shut-off cock housing plate, (the third nut was removed when separating the two castings). Withdraw the shut-off cock sleeve and sealing ring. Pull the lever spindle out of the housing. From the inner end of the housing lightly tap out the shut-off cock bush and sealing ring.

**64.** Remove the dome nut, two plain washers locknut and plain washer from the limiting stop adjusting screw. Release the two nuts and lift out the assembly. Remove the sealing ring from the adjusting screw housing or from the bore in the casting if it remained there when withdrawing the assembly. Unscrew the limiting stop adjusting screw from the inner end of the housing.

**Shut-off cock piston and sleeve assembly**

**65.** Unscrew the two setscrews and withdraw the shut-off cock sleeve taking care to retain the locating peg if it is loose. Withdraw the piston together with sealing ring, washer and spring.

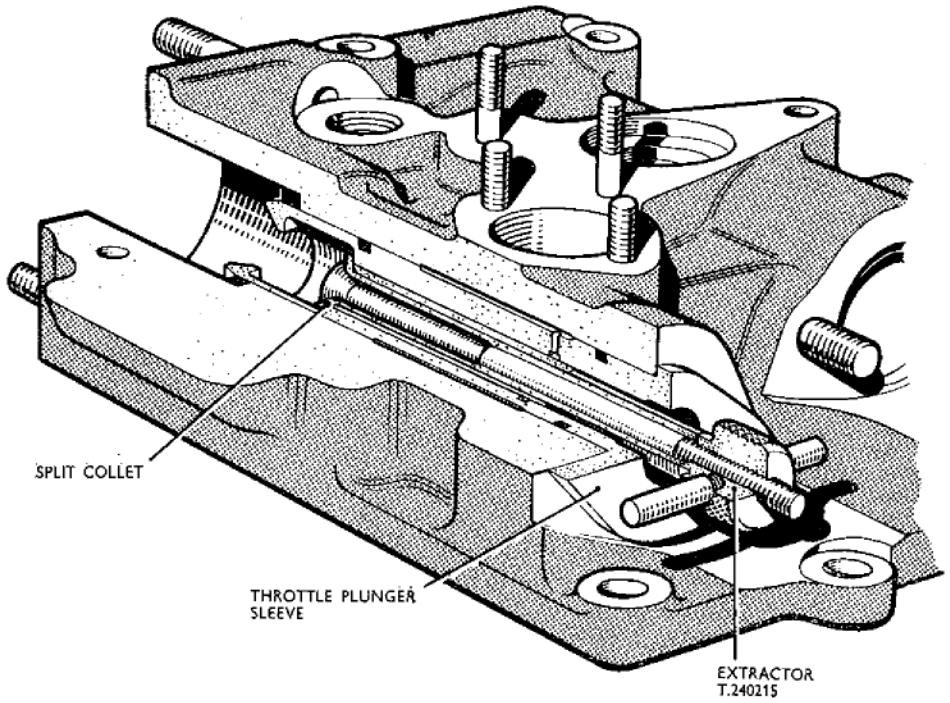



**Fig. 12. Removing the throttle valve sleeve**

**66.** Remove the two sealing rings from the sleeve or from the bore of the casting if they remained there when withdrawing the sleeve.

**Shut-off cock control orifice**

**67.** Secure the draw-plate of the extractor T.218117 over the housing as shown in fig. 13. Screw the knurled nut of the tool right back on the location bolt, pass the bolt through the hole in the draw plate and screw it into the threaded end of the shut-off cock control orifice plate. Insert the tommy bar and screw the knurled nut down against the draw-plate then withdraw the orifice. Separate the half ball retainer and half-ball. Using a wooden drift, tap out the shut-off cock orifice stop.

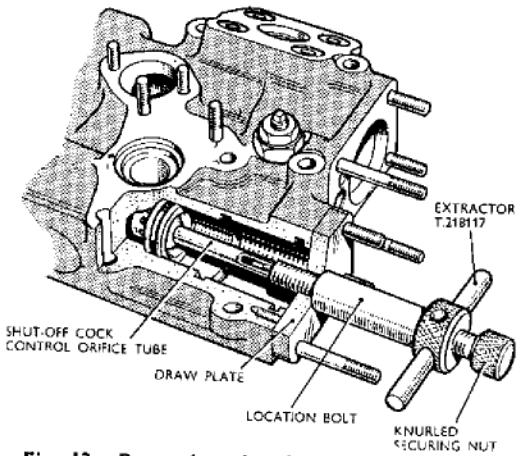



**Fig. 13. Removing the shut-off cock control orifice**

**Idling by-pass valve**

**68.** Unscrew and remove the locknut then screw out the valve adjusting screw to its full limit. Unscrew the idling by-pass valve body and remove it together with the washer and valve. Unscrew the valve from the body. Lift out of the housing the washer, spring, and orifice.

## CLEANING

**69.** If any defect in the unit is suspected to have been due to the presence of foreign matter, the parts should be examined before cleaning, otherwise the cause of the defect may be washed away.

**70.** The parts must be thoroughly cleaned and washed by using a parawash machine having a kerosine bath and spray gun. Hard brushes, abrasives or rag must not be used.

**71.** After cleaning, all components must be dried thoroughly with compressed air and then placed in clean, dry, covered containers to await inspection.

## INSPECTION

### General

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

**73.** Scrupulous cleaniness is essential with regard to the inspection and assembly bench and to all containers and tools in use. After being inspected the components should be placed in covered containers holding a quantity of light oil.

**74.** All parts subject to wear must be checked dimensionally in accordance with the Schedule of Fits, Clearances and Repair Tolerances given in A.P.4282A, Vol. 2, Part 2.

**75.** It is usual during inspection to reject any parts rendered redundant by modifications; and therefore, information covering modifications must be at hand.

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

**77.** Scores or surface damage on moving parts and joint faces will impair the operational efficiency of the unit, and any part so affected should be rejected and a replacement fitted. 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 accessibility of spares, certain defects may be acceptable at the discretion of the inspector in charge.

**78.** In a case of suspected cracks or where there is doubt concerning the soundness of ferrous components they must be tested for cracks by means of approved magnetic crack detection equipment.

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

**80.** Inspect carefully all adapters and unions for cleanliness and general condition and ensure that all threads are undamaged. The joint faces, where applicable, must be free from damage or scoring.

## FLOW CONTROL HOUSING

### Body assembly

**81.** Inspect the joint faces for cracking and oxidation, particularly in the deeper recesses. See that the two location pegs are not damaged, loose, or distorted. Ensure that all traces of gaskets and sealing rings have been removed, that tapped holes and studs are clean and the threads in good condition. See that no trace of the small gasket remains round the base of the central stud between the fuel transfer bobbins. Inspect the machined faces which locate the capsule/bellows assembly and ensure they are free from scores, corrosion or any other surface damage. Make sure that the sealing-ring groove round the main flow from throttle delivery to metering plunger passage is quite clean and not damaged.

**82.** Check that all the drilled fuel passages are clear and see that there is no flaking nor chipping occurring around the edges, or indentations round the sealing-ring grooves caused by incorrect seating of the sealing rings when the castings are bolted together.

**83.** The bores which house the pressure conscious control piston and the metering plunger servo orifice strainer body must be clean and free from scores, oxidation and damage.

### Cantilever assembly

**84.** Inspect the lever for distortion and for corrosion particularly the coned seats and contact tip, which must also present a highly polished appearance. Slight witness marks are permissible but if serverely worn the component must be replaced. Deep indentations on the contact tip where it contacts the capsule striker pin are not permissible and the components must be replaced. Check all bolt heads, spring plates and spring leaves for damage, distortion and cracks. On later types check that the locating dowel is a firm fit.

**85.** On earlier types, the lever ball clamping plates must be clean and free from burrs, especially round the edges, also the seating faces must be smooth and free from corrosion. Assemble the clamping plates to the lever, hold them tightly together and check the movement of the lever; this should move freely on the pin without looseness. The pivot pin is a free fit in the ball and an interference fit in the lever. The ball should be securely clamped with no movement in any direction when the two plates are held tightly together.

#### Sensing spring

**86.** Inspect the spring for signs of corrosion, distortion and cracks. See that the retainer and plate are free from cracking and corrosion particularly around the retaining flanges. Examine the seating for the thrust ball on the retainer and on the rounded peg on the plate. Also examine the thrust balls for signs of wear and chipping.

#### Flow control servo response valve

**87.** Ensure that the strainer is clean and uncorroded. Also inspect the strainer spring for corrosion, distortion and cracks. Examine the half-ball for corrosion, particularly on the sealing face. Using an optical flat check the face for flatness. No more than two colour bands are permissible. If this result is not obtained the half-ball must be rejected and a new one selected; test the new half-ball to ensure that it is satisfactory. See that the half-ball cage is not cracked or distorted.

#### Orifice

**88.** Inspect the orifice for crumbling on the lands and orifice bore face and see that the bore is quite clean and free from any restriction. Also check that the thread on the orifice body is serviceable and that the strainer housing is clean and in good condition.

**89.** The orifice must also be checked for flatness of the lands in relationship to each other and in relationship to the orifice face. To enable this test to be carried out, an instrument which is capable of measuring to the very fine limits required must be available. One type of instrument, the electrolimit comparator, is shown in fig. 14. In this instance the test is made as follows:—

(1) Gently rub the orifice face on very soft paper, place it on the spring-loaded needle on the jig and spin it round two or three times.

(2) Compress the needle, place the assembly under the comparator as shown in the illustration and release the needle so that the face of the orifice is brought into contact with the flat surface of the upper arm of the fixture mounted on the comparator.

(3) Slide the orifice on the jig in the four directions at right angles two or three times and note the deflections on the dial indicator. Maximum reading must not exceed $\pm$ 0·000002 in. (two millionths in.).

#### Altitude idling plunger

**90.** Inspect the spacer plug for corrosion and see that it is clean and that both faces are smooth and free from burrs. Ensure that the bore in the cover plate is free from oxidation. Inspect the plunger for signs of wear, corrosion and pit marks particularly on the tapered portion.

#### Trimming spring

**91.** Inspect the spring for signs of distortion, corrosion and cracks. See that the spring plates are free from corrosion and cracks particularly round the seating flanges. Examine for wear in the seating cone and contact point. Inspect the adjusting screw and locknut for serviceability and for corrosion and wear on the small spigot on the end of the screw.

#### Capsule and bellows

**92.** Examine the convolutions for corrosion and the brazed joints for corrosion and cracks. Ensure that the connecting pieces at each end of the assembly are serviceable, particularly the thread which takes the air intake union and the drilling through which the securing bolt passes at the other end. See that the clevis pin is not loose and check for signs of fouling of the lever against the squared recess.

#### Fuel pressure control servo valve

**93.** The spring must show no signs of corrosion, distortion and cracks and the strainer must be clean and free from corrosion and damage.

**94.** Examine the servo lever spindle bush for wear, corrosion and score marks in the bore, and the servo lever for corrosion and cracks especially in the half-ball seating cup. Also see that the squared end of the servo lever spindle is serviceable and that

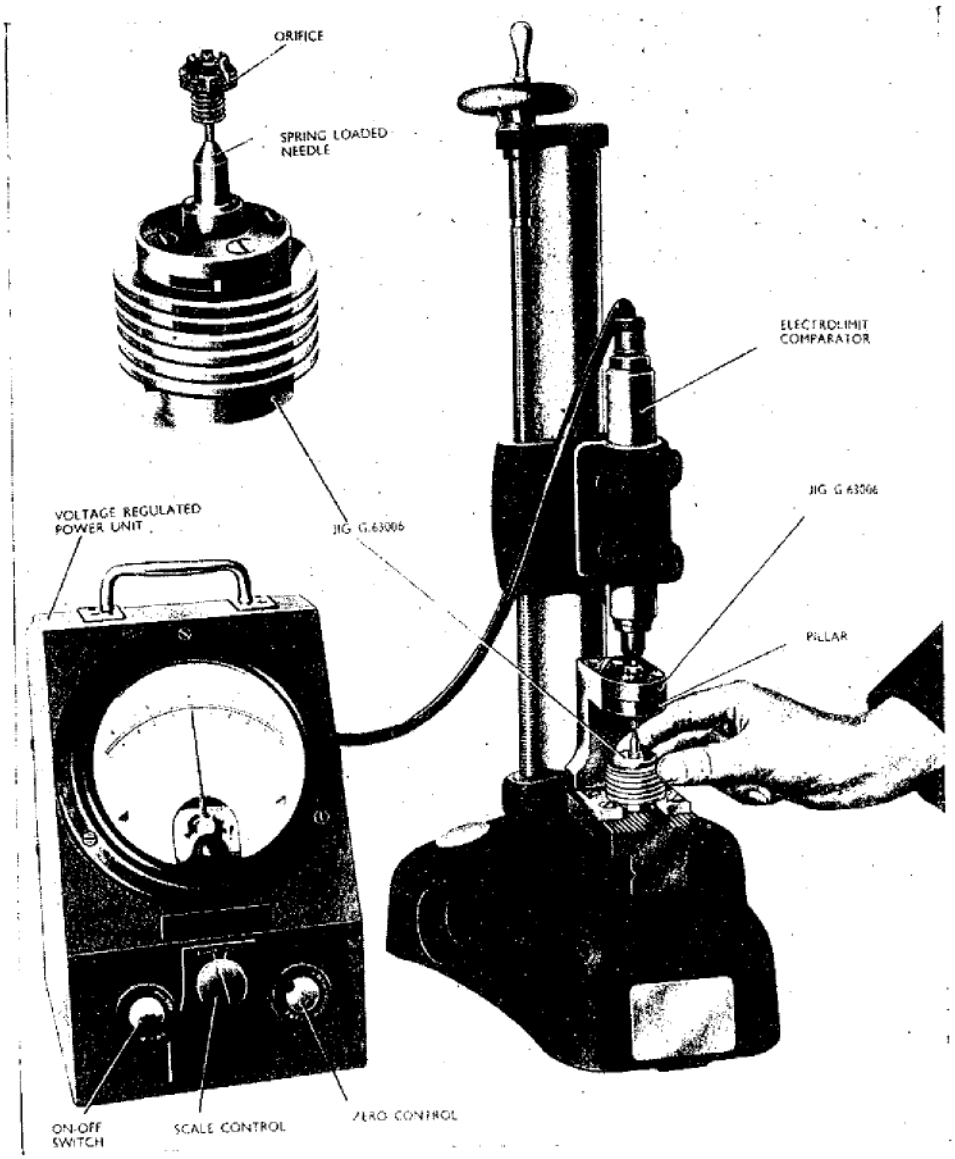



**Fig. 14. Checking the orifice face**

the servo lever spring is free from corrosion, distortion and cracks. The half-ball and orifice must be checked for flatness of the seating faces with an optical flat.

**Fuel pressure control cylinder assembly**

**95.** Inspect the adjusting screw and locknut serviceability of the threads and ensure that there is no corrosion or wear on the rounded end or on the squared end of the screw. See that the cover is not damaged, that the sealing ring grooves are clean and that the threaded drilling for the adjusting screw is serviceable. Check the spring for corrosion, cracks and distortion and also the spring plates, particularly round the seating flanges and contact points. Inspect the piston for cleanliness and see that there are no signs of wear in the seating indentations due to contact with the push rod and spring plate. See that there are no signs of corrosion nor chipping on the sealing

diameter. Examine the stop plate and piston sleeve for corrosion and chipping around the edges of the bore and outside circumference. Examine the push rod for corrosion, fretting and for excessive wear on the rounded ends, and the push rod guide for wear and fretting in the bore. It is recommended that the piston seal and seal retainer be renewed.

#### Metering plunger

**96.** The orifice plate must be completely free from any defect. Using a magnifying glass, inspect the metering edge for cracks or damage. If there is any defect, the plate must be renewed. Similarly inspect a new plate which is to be fitted.

**97.** Examine the metering plunger guide for corrosion and scores, particularly in the bore. The compression ring must not have collapsed and must be clean and free from distortion. The condition of the metering plunger is important as the slightest defect is likely to affect adversely the metering characteristics. The metering profile must be clean and free from corrosion and scores both externally and in the bore. There must be no signs of chipping, cracks, pitting nor wear. Also see that the circlip groove and the seal seating flange are clean and free from corrosion.

**98.** Examine the hardened face of the push button for wear and indentation at the point of contact with the push rod. Only a very shallow indentation is permissible otherwise the button must be renewed. Also see that there is no damage on the edges of the hexagon.

**99.** Examine the push rod for corrosion, fretting and for wear on the rounded ends and the push rod guide for any signs of wearing and fretting in the bore. Check that the sealing ring grooves are quite clean.

#### Remaining details

**100.** Inspect all nuts, bolts and plugs for serviceability and fuel transfer bobbins for corrosion and traces of the sealing rings in the grooves. See that shims are free from corrosion and cracks.

**101.** The pump servo orifice strainer and the metering plunger servo orifice strainer must be tested for pressure drop by using the test fixture T.218113 as shown in fig. 15. First check that the sealing rings are correctly assembled to the fixture, then connect the main rig delivery pipe and the pressure gauge union to the fixture. Adjust the test rig for a flow of 50 gal. per hr. and note the reading on the gauge. Disconnect the rig delivery pipe from the fixture, assemble the strainer as shown in the illustration and reconnect the rig pipes. Adjust the flow again to 50 gal. per hr. and note the pressure drop on the gauge. The pressure drop across the pump servo orifice strainer must not exceed 5 lb. per sq. in. and that across the metering plunger servo orifice strainer 8 lb. per sq. in.

**102.** To remove the strainer from the fixture, first remove the plug and the strainer can then be pushed out; replace the plug in the fixture.

### THROTTLE VALVE/SHUT-OFF COCK HOUSING

#### Body

**103.** Inspect the housing and retaining studs, for serviceability. Check that the drilled passages are clear and that there are no traces of joint washers and sealing rings on the faces, bores and recesses. See that the sealing faces are not corroded nor scored, and that there are no indentations round the sealing ring grooves due to incorrect seating of the seals. Inspect for cracks and oxidation, particularly in the deeper recesses, and for flaking and chipping round the edges of the drilled passages.

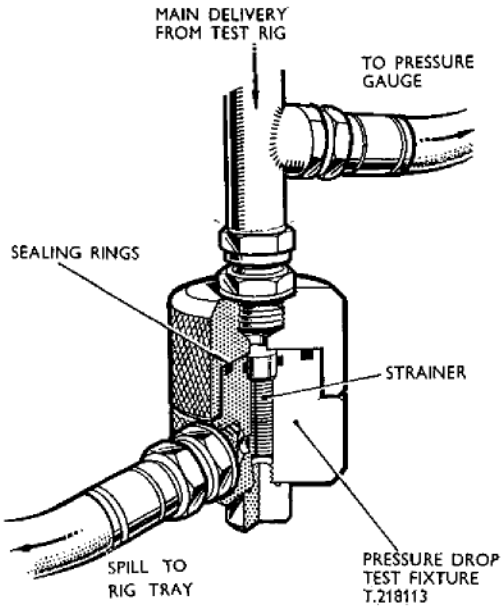



**Fig. 15. Pressure-drop testing the strainers**

**Linkage**

**104.** There must be no free play in the linkage system. Examine the threads on the linkage adjusting bolt and locknuts for serviceability. Check that the balls and sleeves are a tight fit but with no restriction of movement. On earlier types examine the ball-end of the ball pin seats for wear and scores. See that the adjusting screw bush and shim washers are free from corrosion and cracks and that the thread on the bush is serviceable.

**Potentiometer**

**105.** Examine the bridge piece for corrosion and distortion and the fine threads on the adjusting screw, locknut and bridge piece for serviceabiity. See that the operating arm is not distorted and that the valve and the bore of the sleeve are free from scores and corrosion. The valve must be a free fit in the sleeve but not loose or worn. There must be no free play between the pin, the operating arm and the valve. See that the sealing ring groove on the valve is undamaged and is clean. The sharp edges on the valve helix profile must show no signs of chipping, cracks or wear. Examine the square aperture in the sleeve also for chipping and cracks. See that the small helical spring is not distorted or corroded. The micro finish on the end of the adjusting screw and on the top face of the valve must be unblemished.

**Throttle-valve pinion and sleeve**

**106.** Inspect the throttle pinion teeth for wear indicated by plucking and radial scoring of the flanks. Ensure that the teeth are free from corrosion, particularly in their roots, and the pinion shaft and keyway are free from scores or corrosion. See that the thread on the end of the pinion shaft is serviceable.

**107.** Inspect the pinion sleeve for corrosion and see that all traces of the internal and external sealing rings have been removed. Examine the sleeve for cracks and for distortion of the retaining flange and see that the sealing ring grooves are clean. Ensure that the threads on the adjusting stop screws and locking nuts are serviceable and that both the rounded contact ends and the squared adjusting ends of the screws are not worn or damaged.

**108.** Inspect the throttle lever stop plate for damage and corrosion especially in the tapered bore and the key slot; at the same time inspect the key for signs of fretting. The camplate face must be unworn and quite smooth and the contacting pillar firmly secured in the plate.

**Throttle valve plunger and sleeve**

**109.** Inspect the throttle plunger, especially in the root and at the extreme edges of the metering slots at the end of the lever. It is important that the contours of these slots and particularly the edges at the small or inner end of each slot are completely free from erosion, chipping and any other defect which may affect the correct metering of the fuel. The rear metering edge also must be sharp and free from chipping. Ensure that the central bore is clean and that the two grooves on the outside diameter are clean and not corroded. Examine the teeth on the rack for wear, radial scores in the flanks and corrosion in the roots.

**110.** Examine the sleeve for corrosion or scores, and the throttle metering orifice for damage. Check the fit of the plunger in the sleeve.

**Shut-off cock operating lever**

**111.** See that the clamping bolt and nut are serviceable and that the operating lever is not damaged nor distorted, particularly the actuating peg which engages with the camplate slot. Examine the bush for damage in the tapered bore, key slot and truncated thread. See that the key shows no signs of fretting.

**112.** Examine the shut-off cock sleeve housing plate for corrosion, cracks, and distortion.

**Shut-off cock sleeve and spindle**

**113.** Inspect the sleeve for corrosion and scoring and check that the seating flange is free from distortion.

**114.** Inspect the spindle for corrosion, cracks and scores and see that the thread is serviceable, also see that the key slot is clean and free from fretting. Check that all traces of the sealing rings have been removed from the grooves. Ensure that the drillings are clear.

**Shut-off cock limiting stop**

**115.** Inspect the threads on the adjusting

screw, locknut and dome nut for serviceability. Also see that the rounded end of the screw is not worn. Inspect the adjusting screw housing for cleanliness and the threaded bore for serviceability. See that the shut-off cock orifice stop is clean and that there is no corrosion. The sealing surfaces in the bore must also be clean and there must be no evidence of the cadmium plating having lifted or flaked.

#### Shut-off cock piston and sleeve

**116.** Examine the shut-off cock piston for scoring on the outside diameter and for corrosion or damage. Examine the bore and sealing ring recess, through which the orifice stem passes, for wear. The spring and washer must show no signs of corrosion nor distortion. Inspect the piston sleeve for score marks. and the seating faces, sealing surfaces and retaining flange for corrosion.

#### Shut-off cock control orifice

**117.** Examine the orifice stem inside and out for any trace of scoring or corrosion. See that the thread has not been damaged in the end of the bore by misuse of the withdrawal tool. Ensure that there is no obstruction in the two fuel passages and that the sealing ring groove is quite clean. The orifice and half-ball must be checked with an optical flat.

#### Idling by-pass valve

**118.** Examine the valve for general condition and also the sealing ring seat for corrosion. See that the thread is in good condition and that the adjustment square is not damaged. Ensure that the tapered portion and the land show no signs of corrosion, wear, cracks or any other damage. The orifice must be free from corrosion, cracks and pitting, and the slot must be clean. See that the valve retaining spring is serviceable. Check that the adapter sealing surfaces and the locknut are clean and in good condition.

#### Remaining details

**119.** Inspect all nuts, bolts and plugs for cracking and serviceability of the threads, fuel transfer bobbins for corrosion and cleanliness of the sealing ring grooves and see that the small conical strainer out of the potentiometer inlet passage is clean. Shim washers must be free from corrosion and cracks.

**120.** Inspect the plating on all plated components and if it shows any signs of lifting, flaking or has worn through, the components must be replaced.

## REPLACEMENTS

#### General

**121.** Sealing rings, paper gaskets, tab-washers, locking plates, split pins, combination washers, circlips and locking wire must be renewed when assembling.

**122.** When the half-ball retaining cages are removed, the claws must re-set before assembling. The half-ball and orifice can be replaced separately if necessary but the replacements should receive the tests with the optical flat.

#### Body

**123.** No attempt may be made to replace any loose or damaged studs, a body with faulty studs must be renewed. Any damage to the body, particularly the machined and seating faces and housing bore, will necessitate replacement of the component.

#### Flow control cantilever

**124.** On earlier units, if it is necessary to replace the lever hinge ball the hinge pin must be an interference fit in the lever, and a free fit in the ball; this is essential for correct movement of the lever. The ball must be clamped securely between the clamping plates when assembled, with no movement whatsoever.

#### Sensing springs

**125.** The spring plate must be renewed if necessary as a complete assembly. The rounded peg is riveted in place and should not be removed.

#### Flow control servo response valve

**126.** If it is necessary to disturb the orifice body, the shims must be checked and adjusted if necessary. The strainer can be removed for examination, without disturbing the orifice, by removing the access plug and spring. A new strainer should be pressure-drop tested as described previously.

**Altitude idling needle**

**127.** Replacement of the altitude idling needle will necessitate re-checking and shimming accordingly to obtain the correct idling flow as stated in the calibration code.

**Capsule and bellows**

**128.** These cannot be dismantled and must be replaced as a complete assembly.

**Metering plunger**

**129.** The plunger, orifice plate and guide must be renewed as a complete assembly, otherwise it will not be possible to obtain the clearances necessary to give the required calibration.

**Linkage**

**130.** The ball and sleeve assemblies are complete and the sleeve is a selective push fit in the body. If the correct fit cannot be obtained it is recommended that the body is reamed out with an expanding reamer. Measure the diameter of the sleeve and set the reamer accordingly to remove only a small amount of material at a time, adjusting the reamer as necessary, until the sleeve can just be pushed fully into the bore by finger pressure only.

**Potentiometer**

**131.** The plunger, sleeve and arm are a matched assembly and no part can be renewed individually.

**Throttle valve pinion and sleeve**

**132.** The pinion shaft and sleeve are a lapped fit and must be replaced as a complete assembly.

**Throttle valve plunger and sleeve**

**133.** These are mated together and must not be replaced as separate items.

**Shut-off cock operating lever**

**134.** The actuating peg is riveted to the lever and cannot be removed.

**Shut-off cock sleeve and spindle**

**135.** The spindle shaft and sleeve are lapped together and must not be renewed individually.

**Shut-off cock piston and sleeve**

**136.** This is a lapped assembly and must be renewed complete.

**Idling by-pass valve**

**137.** The adjusting screw and plunger cannot be changed without the slotted orifice as they are lapped together.

**Remaining details**

**138.** All items not mentioned are separately interchangeable but all new parts must be checked by referring to the Schedule of Fits, Clearances and Repair Tolerances in A.P.4282A, Vol. 2, Part 2.

## ASSEMBLING

**General**

**139.** The components should again be cleaned thoroughly, preferable in parawash equipment. Ensure that the assembly bench and all tools are clean.

**140.** In the following instructions the fuel control housing and throttle valve/shut-off cock housing; are regarded as separate assemblies which are finally fitted together.

### FLOW CONTROL HOUSING

**141.** Mount the housing on the hydraclamp fixture as shown in fig. 2 and adjust it to a convenient position.

**Metering plunger**

**142.** Ease the two rubber sealing rings into the external grooves round the push-rod guide and insert the lower edge of the guide into the bore in the body as far as the sealing ring will permit. Using the draw bolt and handle of the tool T.218106 (*fig.* 8) insert the drawbolt in the guide and push the guide to the bottom of the bore making sure that it seats correctly. Insert the compression ring and then the sealing ring into the bore.

**143.** Ease the piston seal on to the piston, fit the seal retainer and the circlip. Position the strainer, push button and circlip in the end of the plunger. On earlier units, locate the bent tab of the tab-washer in the hole in the piston, insert and screw down the push button and secure it by bending up the remaining tab.

**144.** Place the metering plunger carefully into its housing, taking care to avoid

damaging the piston seal when locating it in the push rod guide.

**145.** Fit the compression ring, sealing ring and the metering plunger guide sleeve, line up the locating recess in the latter to receive the retaining plug and then carefully ease the sealing ring into position pressing it well down with the fingers. Screw into the wall of the housing the retaining plug and sealing washer.

**146.** Insert the orifice plate, lugs outward. Fit the sealing ring and cover and secure it with four plain washers, four grover washers, three plain nuts and one nut drilled for wirelocking to the locating plug.

**147.** Insert the sealing ring into the idling plunger bore in the cover plate and fit the idling plunger. Fit the sealing ring to the groove in the small cover plate, place the spacer plug on to the idling plunger. Fit the small cover plate on to the two studs and secure it with two plain washers, grover washers and nuts.

#### Capsule and bellows

**148.** Place the sealing ring in the groove round the capsule and plate, compress the assembly slightly and lower it into the housing then fit the air-intake union and washer into the assembly through the wall of the body. Insert the bolt through the capsule-end of the assembly and secure it with a plain washer and nut. See that the assembly is in correct alignment, then tighten down the air-intake union and the bolt and insert the split pin.

#### Flow control servo response valve

**149.** Check that the half-ball retaining cage claws are set correctly by using the setting ring, T.214183; the claws should just enter the mouth of the bore in the setting ring. If incorrect, re-set the claws by placing the cage, claws uppermost, on the bench, then locate the recessed end of the setting punch T.214183 over the claws and tap with a light hammer. Check again and repeat the process until the claws will just enter the setting ring bore. Fit the half-ball to the retainer and press it into place on the orifice until the retainer claws engage in the groove round the orifice head. Assemble the shims, combination washer and tab-washer to the orifice body and screw the orifice into the housing, using the spanner T.218108 (*fig.* 6). Do not lock the tab-washer at this stage as the valve gap is to be checked after fitting the lever, and may require adjustment to the shims.

#### Sensing springs

**150.** Before assembling the springs insert the metering plunger push rod in the guide and the thrust ball in the spring retainer. The thrust ball may be retained in position by smearing it with petroleum jelly. Locate the retainer and the plate on the sensing springs, lower them into the unit and compress the springs by using the compression tool T.218110 (*fig.* 5). The tool is to remain in position on the unit, with the springs compressed until after the lever assembly has been fitted and the response valve set.

#### Trimming spring

**151.** Locate the spring plates on the trimming spring, lower them into the unit and compress the spring with the compression tool T.247828 (*fig.* 5). The tool is to be left in position with the spring compressed.

#### Cantilever assembly

**152.** To assemble the cantilever use the jig T.249077 (*fig.* 16). First assemble the rectangular leaf springs to the end face of the lever which must be mounted in a vertical position on the locating base of the jig as shown in (A of *fig.* 16). Locate the two leaf-springs on the upright pillars of the jig, align the holes with those in the end of the lever and secure them with the two right angled hinge plates, tab-washers and setscrews; lock the tab-washers. Place the lever anchor on the mounting bracket of the jig, with the spring-loaded dowel on the bracket located in the hole in the anchor flange (B of *fig.* 16). Place the square leaf-spring on the anchor, and secure it with the hinge plate, double tab-washer and two setscrews; lock the tab-washer. Release the anchor, turn it through 180 degrees and lock in this position with the leaf spring now on the underside. Remove the lever and mount it in a horizontal position on the base (C of *fig.* 16) locating the end of the lever on the spring and the recess in the lever on the spring-loaded ball on the jig. Release the mounting bracket, by means of the locking handle and slide it along the base of the jig until the holes in the leaf spring are in alignment with the tapped holes in the lever then lock the mounting bracket. Secure the anchor and spring leaf to the lever by means of a hinge plate double tab-washer and two setscrews, tighten and

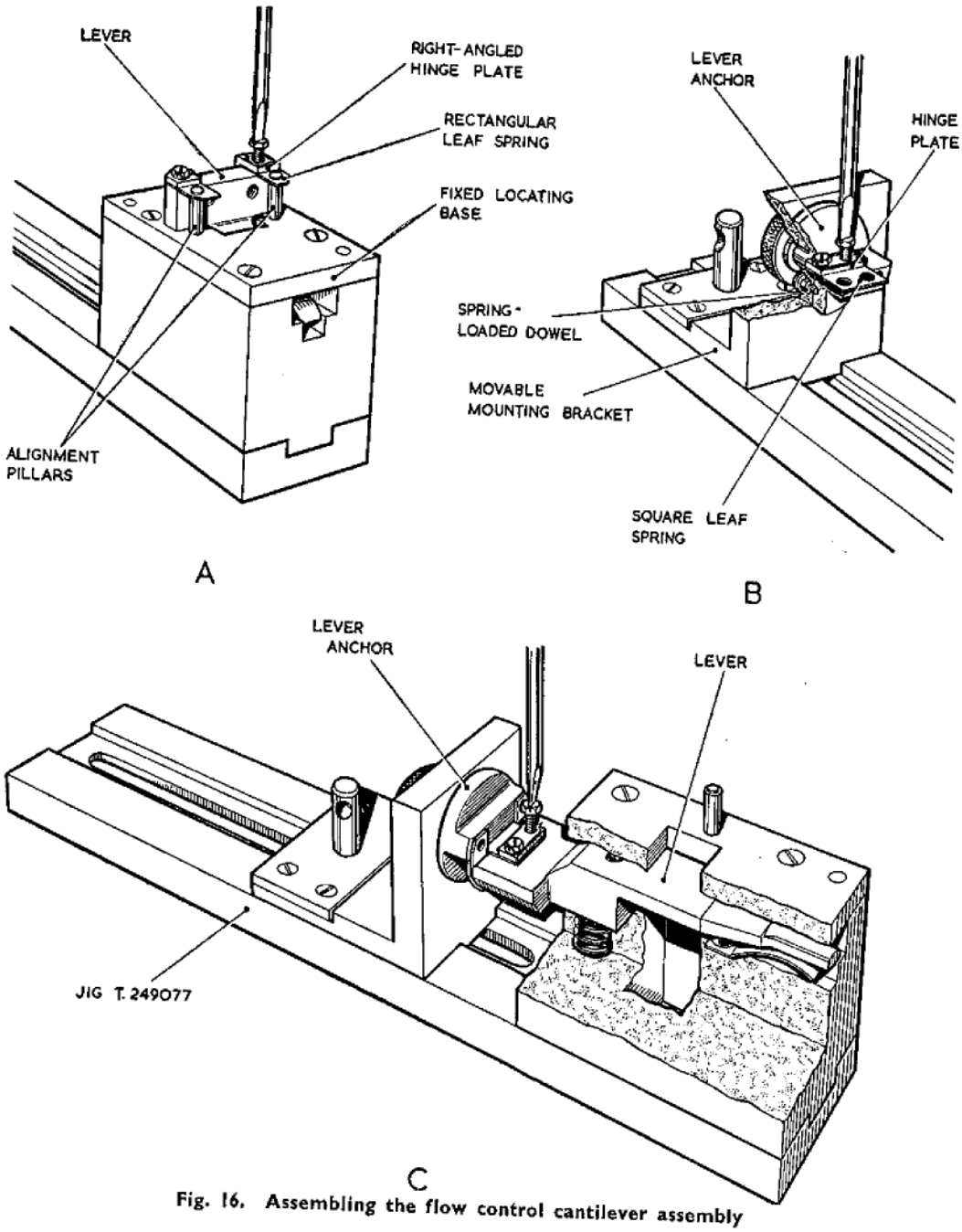



**Fig. 16. Assembling the flow control cantilever assembly**

lock the setscrews. Remove the lever from the jig and fit the remaining two tab-washers, hinge plates and setscrews. Tighten and lock all four setscrews. Smear the thrust ball with petroleum jelly in order to retain it in position and then insert it into the recess in the lever.

**153.** Replace the sealing ring on the anchor spigot and fit the cover to the anchor, locating it on the dowel. Fit a tab-washer and nut to the anchor tail in the cover recess, tighten the nut but do not lock it at this stage. Lower the assembly into the unit, locating the end of the lever on the

striker pin in the capsule assembly. The lever must rest on the half-ball but must not touch the half-ball retainer when the capsule is pressed down lightly. The end of the lever must also be evenly spaced in the rectangular aperture and must be horizontal on the striker pin in the capsule assembly. Failure to do this indicates distortion of the capsule/bellows assembly, the lever or the leaf springs. Secure the lever and cover assembly in position with four nuts, grover and plain washers.

**154.** On earlier units to assemble the cantilever, place the inner clamping plate over the end of the lever followed by the lever ball. Align the drilling through the ball with that through the lever. Drive in the lever peg ; this is an interference fit in the lever and a free fit in the lever ball. The ball must be held securely when the two clamping plates are brought together so that movement only takes place between the peg and ball. Lower the assembly into the housing, locate the clamping plate on the two studs followed by the outer clamping plate and the locking plate and then secure it with two nuts but do not lock them at this stage.

#### Setting the flow control servo response valve

**155.** The fitting of a new tab-washer and combination washer under the servo response valve orifice will necessitate re-setting the gap between the half-ball and lever. If the same shims are fitted, however, the setting will be approximately correct.

**156.** Remove the partly built unit from the assembling fixture and connect the air-intake union to vacuum on the test rig. Reduce the pressure in the capsule to 3 in. Hg. then, using feeler gauges, measure the gap between the half-ball and lever, this should be 0·002 to 0·005 in. If necessary, correct the shims under the orifice housing to obtain this gap. Remove the unit from the test rig and mount it on the assembling fixture. Remove the two spring compression tools T.218110 and T.247828 from the unit. Ensure that the springs seat correctly on their respective plates and that all pivoting points are correctly located.

**157.** Secure the lever and cover assembly in the housing and lock the two nuts securing the lever assembly to the unit. Place the sealing ring in the recess round the lever housing cover plate and secure the plate in position with four plain washers grover washer and nuts.

**158.** Insert the servo response valve strainer and spring into the orifice bore, place a sealing ring on to the strainer plug, and using the tool T.218112 (*fig.* 4) press the plug firmly into the bore. Fit the locking plate over the air-intake union and one of the studs, followed by the shim washer(s). Fit the triangular retaining plate and secure with three plain washers, grover washers and nuts.

**159.** Screw in the trimming spring adjusting screw to give slight tension against the spring then fit a combination washer, nut, a second combination washer, locknut and dome nut and make them finger tight only. The adjusting screw is finally set and locked on the test rig.

**160.** Screw the plug and seal into the threaded high-pressure drilling.

#### Fuel pressure control servo valve (preliminary build)

**161.** Fit the shims to the orifice body together with a new tab-washer and combination washer, then screw the orifice into the unit. Do not lock the tab-washer.

**162.** Push the lever sleeve and sealing ring into the housing bore locating the triangular flange over the studs. Assemble the servo valve rocker lever and half-ball above the orifice (the spring is omitted at this stage). Hold in position and fit the squared aperture of the pressure control rocker lever to the squared end of the spindle.

**163.** Place the shims over the three studs and fit the triangular cover plate and thrust ball. Secure the plate with three washers and nuts. The shims under the cover plate should allow free rotary movement of the lever assembly but no end play.

#### Setting the fuel pressure control servo valve gap

**164.** Before this gap can be set the pressure-drop control details must be assembled temporarily, omitting the end-cover seal.

**165.** Insert into the housing the push-rod sleeve, push rod, seal retainer, piston seal, piston, piston sleeve and stop plate. Fit the spring plate, spring, spring cap and cover plate then secure with six washers and nuts. Screw in the adjusting screw sufficiently to give slight spring pressure.

**166.** With feeler gauges measure the gap between the orifice and half-ball, this should be 0·015 to 0·021 in. If necessary adjust the shims under the orifice to obtain this gap.

**Fuel pressure control servo valve (final build)**

**167.** Remove the two levers and also all the components from the pressure drop bore, screw the orifice down tightly and lock the tab-washer.

**168.** Insert the spring, re-assemble the two levers as before and tighten the three nuts securing the cover plate.

**169.** Fit the strainer and helical spring assembly into the housing, position the sealing ring on the elbow adapter seating face, then assemble the adapter to the orifice bore. Secure it with two plain washers, grover washers and nuts.

**Fuel pressure control cylinder assembly**

**170.** Assemble the push-rod guide and push rod, seal retainer, piston seal, piston, piston sleeve, stop plate, spring plate, spring and spring cap, in that order.

**171.** Fit the two sealing rings to the cover plate, one to the groove in the joint face and the other to the external groove round the body. Fit the cover into the housing and secure it with six plain washers and nuts. Screw the adjusting screw into the cover then fit the washer, locknut, washer and dome nut finger tight only. Also loosely fit the threaded plug and washer to the tapped drilling in the cover.

**172.** Screw into the high pressure fuel passage the remaining threaded plug and sealing washer. The plug was fitted on the other side of the unit at an earlier stage.

**Checking the fuel pressure control servo valve for leakage**

**173.** Connect the static hand pump to the union in the elbow adapter (*fig.* 17). Raise the pressure to 1,500 lb. per sq. in. and examine for leakage from the orifice. If any leakage does occur, the half-ball or orifice or both must be replaced.

**Remaining details**

**174.** The fuel control housing is now completely assembled with the exception of the fuel transfer bobbins, plug seals, etc., in the seating face. Do not fit these until the fuel control housing and throttle valve/shut-off cock housing are assembled together.

**175.** It is recommended that the assembled housing is placed in a box, together with the following items :—

(1) The large sealing ring for the recess round the main flow from throttle delivery to metering plunger passage.

(2) The main gasket and the small gasket for the control stud.

(3) The altitude chamber to inlet fuel transfer bobbin.

(4) The pressure-drop chamber to potentiometer fuel transfer bobbin.

(5) The seals and the blanking bobbin and seals on earlier units.

(6) The two location pegs, if withdrawn when dismantling.

## THROTTLE VALVE/SHUT-OFF COCK HOUSING

**Throttle valve**

**176.** Check the fit of the sleeve in the housing before assembling the sealing rings.

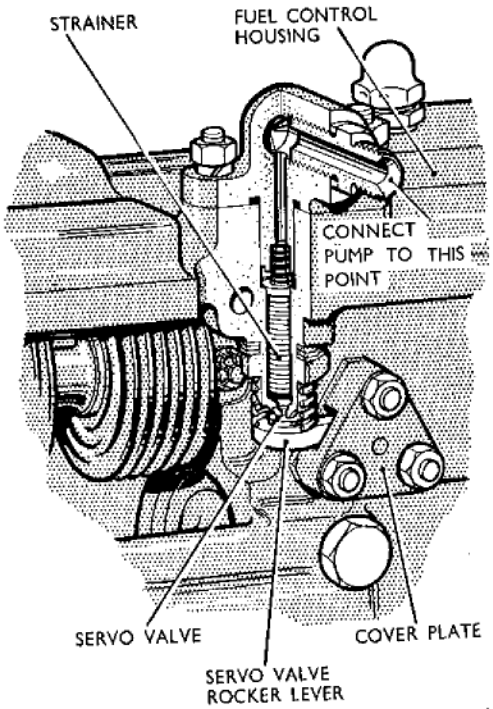



**Fig. 17. Checking the fuel pressure control servo valve for leakage**

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Ease the sealing rings into the external grooves round the sleeve and push the sleeve into the bore in the housing. Screw the extractor T.200609 (*fig.* 11) into the throttle valve plunger and insert the plunger into the sleeve taking care not to damage the metering edges.

**177.** Remove the extractor and fit the setting gauge G.80008 (*fig.* 18). By inserting a finger in the casting push the throttle valve plunger back against the gauge. The plunger must remain in this position whilst assembling the throttle valve pinion and sleeve.

**Throttle valve pinion and sleeve**

**178.** It is recommended that a new woodruff key is fitted, and this must be polished to fit by rubbing gently on a sheet of superfine emery paper and checking continually until it fits the slot on the pinion shaft.

**179.** Ease the two sealing rings into the internal and external grooves on the throttle valve pinion sleeve and assemble the throttle valve pinion shaft to the sleeve. Insert the woodruff key in the slot on the pinion shaft. Secure the throttle valve stop plate to the throttle valve pinion shaft with a plain washer and castle nut.

**180.** Lower the assembled throttle-valve pinion and sleeve into the casting and secure with the two nuts in the throttle valve closed position. Check the end play of the pinion and also check for ease of movement.

**181.** Fit a split pin to the castle nut. Remove the setting gauge G.80008 from the throttle valve housing.

**182.** Ease a sealing ring on to the throttle valve end plate and secure it to the unit with two plain washers and wire-locked nuts. Re-check the ease of movement of the throttle valve plunger and pinion.

**Potentiometer transfer bobbins and strainer**

**183.** Insert the sealing ring into the internal groove around the throttle valve sleeve bore then fit a sealing ring to the groove round the cover. Insert the strainer into its housing in the throttle valve/shut-off cock housing. Ease the sealing rings on to the two bobbins and fit these to the bores in the cover, then secure the cover to the studs in the throttle valve/shut-off cock housing with plain washers, grover washers and nuts. Again check the ease of movement of the throttle valve plunger and pinion.

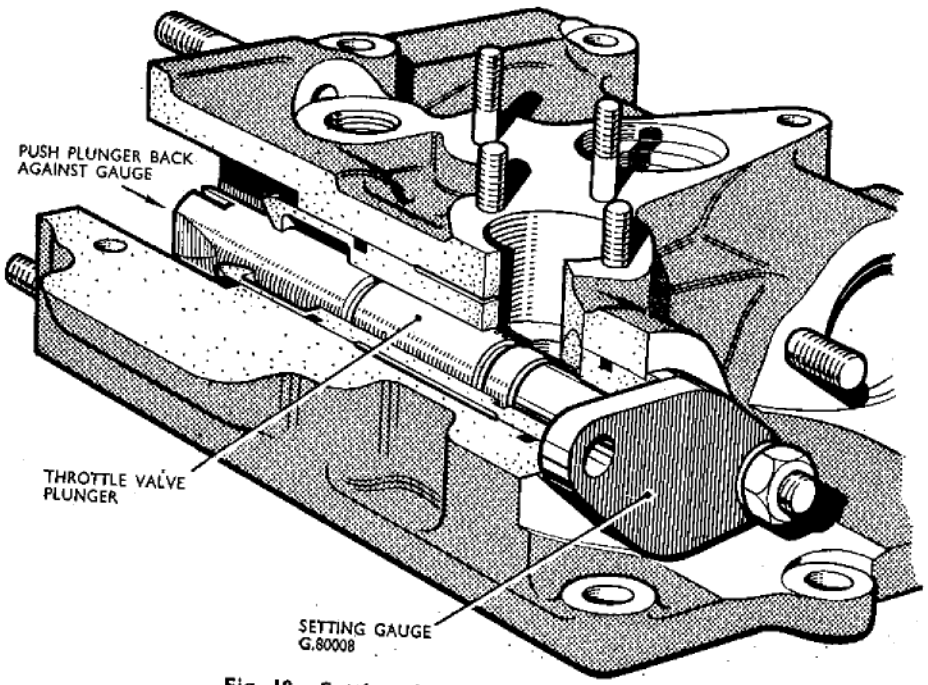



**Fig. 18. Setting the throttle valve plunger**

**Idling by-pass valve**

**184.** Insert the idling by-pass slotted orifice and the helical spring. Fit the sealing ring and washer to the piston, and screw the piston into the body. Assemble the plain washer to the body, screw it into the housing and tighten it with the box spanner T.174335. Screw on to the threaded end of the piston the small locking nut, finger tight only.

**Shut-off cock sleeve and spindle**

**185.** Fit a sealing ring to the shut-off cock bush, insert it into the housing and ensure that it seats correctly at the bottom of the bore. Assemble the three sealing rings to the external grooves round the shut-off cock spindle and fit the spindle in the bush. Place the sealing ring round the shut-off cock spindle sleeve against the seating flange and position the sleeve over the spindle into the bore. Fit the cover plate over the spindle and studs, and secure it with two plain washers, grover washers and nuts.

**186.** Place the woodruff key in the slot on the spindle and press the bush on to the shaft. Check the spindle for freedom of movement and then fit a washer, castle nut and split pin.

**Shut-off cock limiting stop**

**187.** Fit the shut-off cock orifice into its housing and ensure that it is in the correct position to allow free movement of the lever, then place a sealing ring in the bore over the orifice stop, pressing it well down into the recess. Place a sealing ring round the groove on the limiting stop adjusting screw and turn the screw well back into the housing. Place a sealing ring round the flange on the housing and lower the assembly into the bore, locating the seating flange of the housing over the studs. Secure it in position with plain washers and wire-locked nuts. Fit a washer, nut, two washers and dome nut, finger tight, to the adjusting screw.

**Shut-off cock control orifice**

**188.** Check the setting of the claws of the half-ball retainer with the setting ring T.214183; the claws should enter $\frac{1}{16}$ in. into the ring bore. If they do not, place the retainer, claws uppermost, on a block and reset the claws with the punch T.214183. When satisfactory, place the half-ball into the retaining cage and fit them to the orifice, ensuring that the claws engage securely in the orifice groove.

**189.** Fit a sealing ring in the shut-off cock piston bore followed by the seating washer and spring. Fit the orifice assembly to the shut-off cock piston and clamp the spring with the tool T.218116 (*fig.* 19). Place a sealing ring in the groove in the control orifice flange.

**190.** Fit the sealing rings to the two stepped diameters of the shut-off cock sleeve and assemble the piston and orifice to the sleeve. Place the dowel in the sleeve and lower the whole assembly into the housing. Fit two set screws and grover washers, tighten the screws and then remove the compression tool T.218116.

**Potentiometer**

**191.** Ease two sealing rings on to the external grooves round the potentiometer sleeve and fit the sleeve into the housing. Place a sealing ring on the plunger, fit the small helical spring and a plain washer then insert the plunger and operating arm into the sleeve.

**192.** Fit the adjusting screw to the bridge piece and screw on the locking nut together with washer. Place the bridge piece on to the securing studs and secure it with two plain washers, grover washers and nuts.

**Linkage assembly**

**193.** Place a self-aligning ball in each of the two ball-joint bodies; the body with the left-hand internal thread goes on the throttle valve stop-plate pillar and the other, with a right-hand thread, on the potentiometer side. Fit the two locknuts to the linkage adjusting bolt and the adjusting bolt to the two ball-joint bodies. To engage both threads together sight them through the holes provided.

**194.** Insert the potentiometer-lever bolt into the self-aligning ball at the potentiometer end of the linkage, fit the distance piece, castle nut and split pin.

**195.** On the throttle valve stop plate pillar place a plain washer and two shim washers. Lower the other end of the linkage assembly on to the pillar and secure with a plain washer and split pin.

**196.** On earlier units place the ball pin in the potentiometer lever, then fit the washer, castle nut and split pin. Place the woodruff key in the slot in the throttle valve pinion shaft, fit the throttle valve pinion stop plate and secure it with shim washer(s) castle nut and split pin. The assembly must be a tight fit on the pinion. Assemble the two ball seatings, concave faces together, to the ball-joint body and locate them on the ball pin. Screw the locking screw with tab-washer and shimwashers into the body. The shims should allow a good fit, with no play in the ball and socket joint ; lock the tab-washer. Fit the two nuts, one left-hand thread, and tab-washer to the linkage adjusting bolt. Press the ball and sleeve assembly into the stop plate, screw the adjusting bolt into the ball-joint body and the stop plate assembly on to the other end of the adjusting bolt. Connect the ball and sleeve to the throttle valve lever and lock with a split pin. Do not lock the tab-washers as further adjustment is to be made on the test-rig.

## ASSEMBLING THE FLOW CONTROL THROTTLE VALVE/SHUT-OFF COCK HOUSING TOGETHER

**197.** Remove the throttle valve/shut-off cock housing from the hydraulic assembly fixture, change the adapter T.241670 for the adapter T.204658 (*fig.* 2) and mount the flow control housing on this fixture, joint face uppermost.

**198.** Fit the large paper gasket and the small gasket round the central stud on the seating face of the housing.

**199.** Fit a large sealing ring in the recess round the main flow from throttle delivery to metering plunger passage.

**200.** Ease the sealing rings on to both fuel transfer bobbins and push them into their respective bores in the face of the casting. On earlier units also fit the two sealing rings on to the blanking bobbin and insert this in the original pressure-drop to shut-off cock fuel passage.

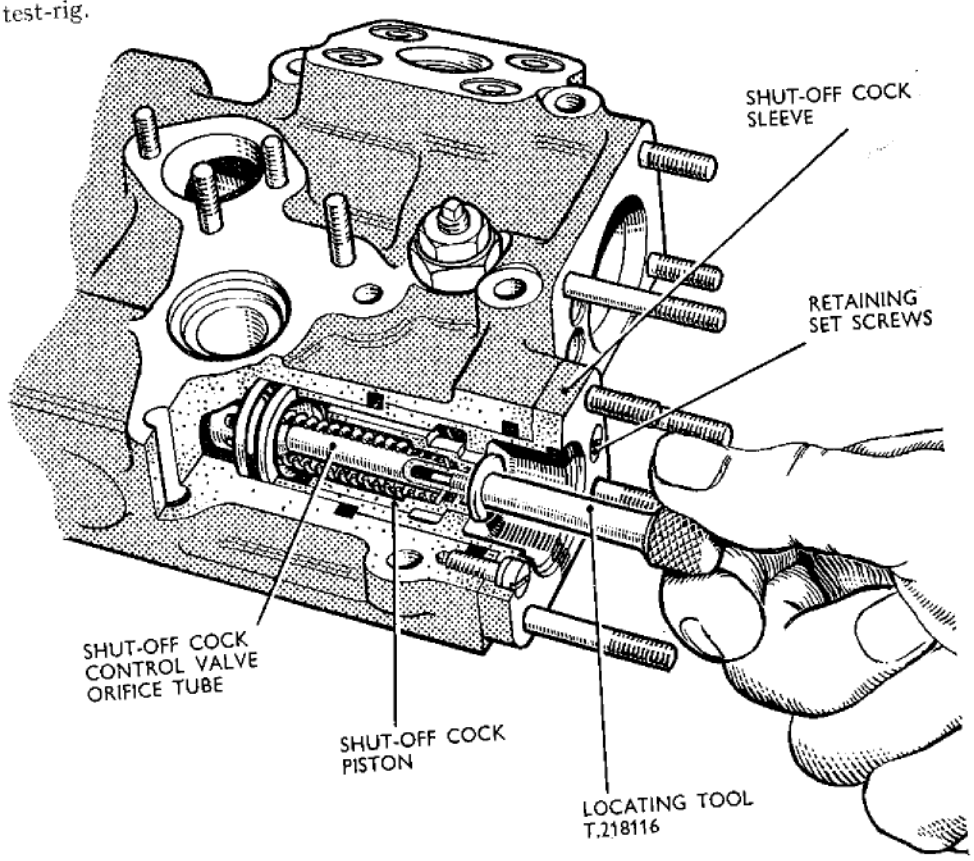



**Fig. 19. Clamping the shut-off cock control orifice spring**

**201.** If the two location pegs were removed, fit new ones.

**202.** Lower the throttle valve/shut-off cock housing over the studs on the flow control housing, easing it and pressing it down at the same time; it is important that none of the gaskets or sealing rings are pinched or distorted. Press the two housings together and secure them with seven nuts, grover washers and plain washers, one wire locking nut and three nuts and bolts.

**203.** Remove the unit from the assembling fixture, fit the base plate over the six studs and secure it with nuts, grover and plain washers. Do not tighten the nuts, as the base plate must be removed later when fitting the unit to the test-rig bracket.

**Fitting the test-rig adapters**

**204.** Attach the outlet connection and distance plate T.178005 to the outlet port with slave nuts, and the inlet connection, and T.178005, to the inlet port with slave bolts. Secure the quadrant G.80008 to the throttle valve pinion shaft and lock it in position by attaching the link plate to the bracket on the quadrant and to the bottom right-hand bolt of the inlet connection.

**205.** Remove the plug from the fuel pressure control cyclinder cover plate and insert a $\frac{1}{8}$ in. BSP union and combination washer.

**206.** Remove the base plate from the unit but leave the gasket in position. Mount the unit on the test-rig bracket T.240219 and secure it with slave nuts and washers.

## TESTING

**General**

**207.** The control unit is to be adjusted and performance tested as described in the following paragraphs and the Appendices in this chapter. During final calibration the performance figures are to be recorded and approved. This recorded information must be entered on the test certificate.

**208.** The control unit is to be installed on the test rig (*fig.* 20), and connected up as shown diagrammatically in fig. 21. The test-rig manometer must be adjusted to compensate for ambient barometric pressure before commencing the tests.

**209.** The fuel specification, temperature limits and rig tank pump must be as specified in the relevant appendix.

**Pressure test, servo valves**

**210.** Test the sealing of the pressure control servo valve and the flow control servo valve at the pressure stated (*fig.* 17).

**Altitude control bellows pre-load test**

**211.** Check the altitude control bellows and capsule pre-load at the atmospheric pressure stated. The striker pin in the bellows stirup must remain in contact with the tip of the control lever up to the pressure stated.

**Preliminary calibration**

**212.** Check the pressure-drop across the unit and set it in accordance with the details stated in the Appendix.

**213.** Test the throttle valve at increasing increments of throttle lever angle. The flow should increase progressively throughout the range of opening, and all readings must be within the stated limits. The idling range also must be within the required limits.

**214.** Test the altitude control at increasing and decreasing increments of bellows (P1) pressure. Variation in flow must be progressive and within the limits at the specified conditions. Hysteresis must not exceed the amount stated.

**Endurance test**

**215.** The unit is to be operated continuously over the stated range of bellows (P1) pressure for the specified time. This is to ensure that all moving parts are endurance tested over the whole of the operating range and are settled down correctly. Lock nuts must be checked for tightness before commencing the endurance test.

**Final calibration**

**216.** First check the unit against the figures obtained in the preliminary calibration. There must be no excessive variation from these figures.

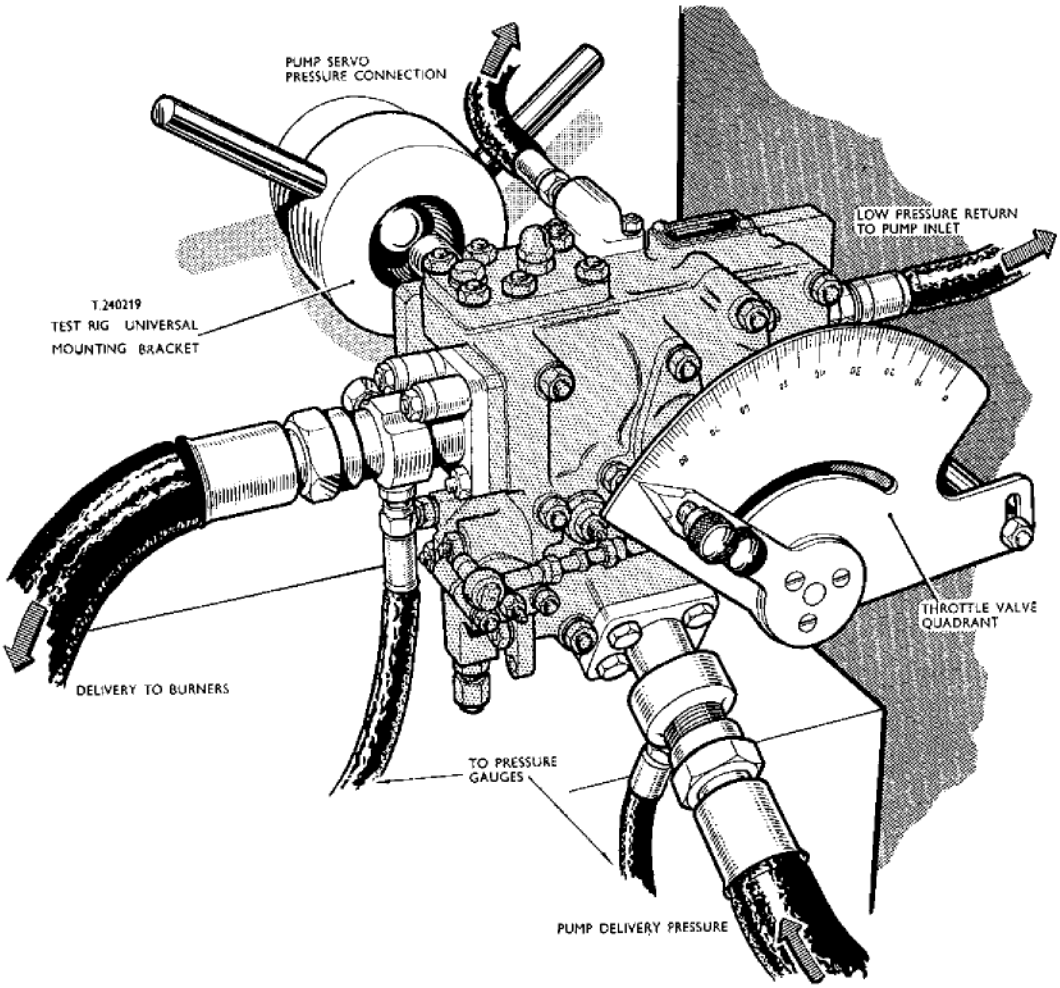



**Fig. 20. Unit mounted on test-rig**

**217.** Check the variation in flow at the delivery pressure given in the tables in the Appendix. Any variation must not exceed the amount stated.

**218.** Check the variation in flow at the control pressure with the body pressure varied as stated in the table in the appendix. Any variation in flow must not exceed the specified amount.

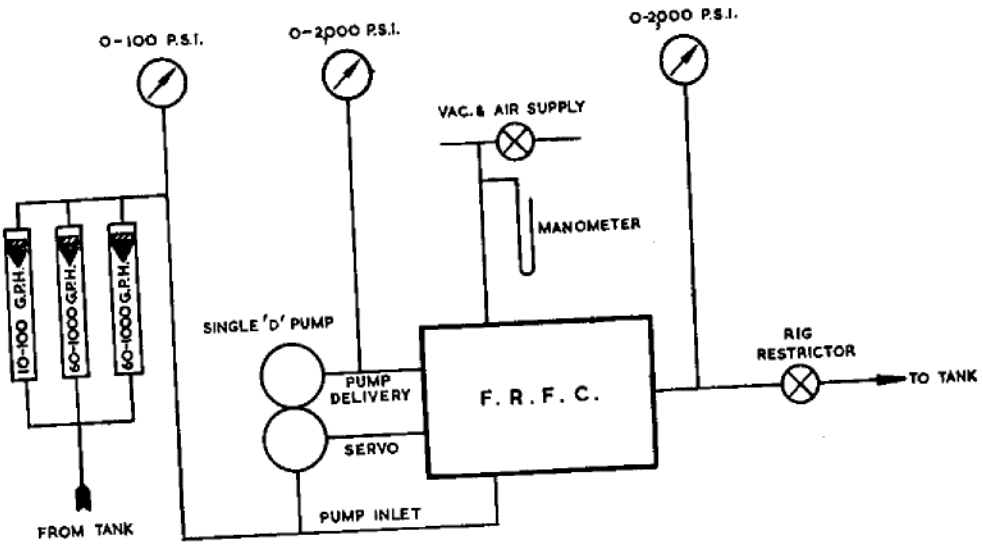
**Torque and overlap tests**

**219.** The maximum torque required to open and close the throttle valve is measured as the product of the lever radius and the load indicated on a spring balance. The balance is to be attached to the lever clevis hole and the lever pulled through the angle of movement by means of the balance, the axis of which must be kept at right angles to the lever over the full range of movement. The unit must be set to operate at the specified conditions and the torque must not exceed the amount stated.

**220.** The maximum torque required to operate the shut-off cock valve is to be measured by the method described for the throttle valve.

**221.** The shut-off cock overlap must be checked by shutting down from the required conditions, when the pressure upstream of the shut-off cock should not rise by more than the amount stated.

**222.** The time required for the shut-off cock to open and close is to be measured at the stated conditions.



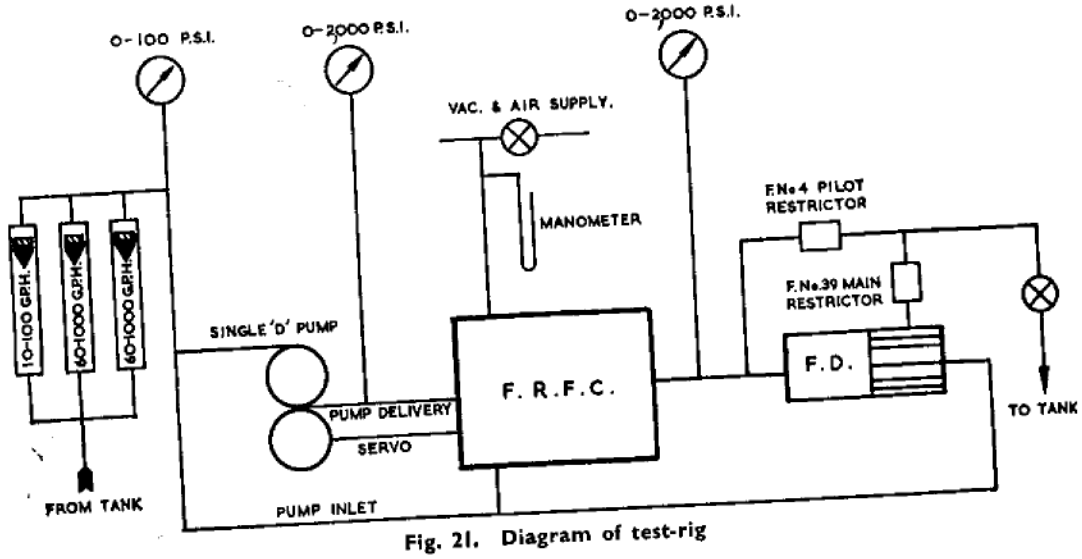




**Fig. 21. Diagram of test-rig**

**223.** The rise in body pressure of the control unit when closing the shut-off cock from the conditions stated is to be recorded.

**Leakage tests**

**224.** With the shut-off cock closed and the burner delivery connection disconnected, any leakage from the burner delivery union must not exceed the amount stated.

**225.** To check the total internal leakage. The unit must be operated at the stated conditions so that the servo valve is closed, i.e. less flow is delivered to the unit than the

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controlling flow. The leakage is to be measured from the return to inlet connection on the control unit body cover plate and must not exceed the amount given in the Appendix.

**226.** Dry the exterior of the unit thoroughly and examine for leakage from joint faces and seals when operating at the conditons specified.

**227.** The unit is to be drained of fuel and pressure tested by sealing all the connections except one and, with the unit completely immersed in kerosine, applying air to this connection at the pressure stated.

**Inhibiting and final checks**

**228.** The unit is to be inhibited by draining the fuel and flushing thoroughly with oil OM.11. Unions and other apertures are then to be sealed with dust caps or masking tape. All external locking must be completed and checked for security.

**229.** Check that the unit serial number, modification standard or other relevant details are marked on the data plate.

# Appendix 1

# CALIBRATION CODE H

**General**

**1.1** The fuel to be used is to be Aviation Kerosine to Specification D.Eng.RD.2482.

**1.2** The rig pump inlet (tank pump) pressure must be maintained at between 15 and 20 lb. per sq. in. unless otherwise stated and the fuel temperature at 20 to 40 deg. C.

**1.3** The servo valves must remain sealed up to a static pressure of 1,500 lb. per sq. in.

**1.4** The altitude bellows striker pin must remain in contact with the tip of the control lever up to a bellows pressure of 3 in. Hg. Absolute.

**1.5** At an air pressure of 75 lb. per sq. in. applied to the return to pump inlet connection, and with the unit immersed completely in fuel, there must be no leakage.

**Preliminary calibration**

**2.1** This test must be made with a rig pump servo flow of 9 to 10 gal. per hour and with a rig pump delivery pressure of 1,000 lb. per sq. in. at a flow of 150 gal. per hour and a speed of 2,865 r.p.m.

**2.2** The total pressure-drop across the unit must be approximately 300 lb. per sq. in. with the throttle lever angle set at 90 deg. and with an altitude pressure (P1) to 30 in. Hg. Abs.

**2.3** With the throttle lever angle set at 10 deg. the total pressure drop across the unit is to be approximately 1,000 lb. per sq. in. with an altitude pressure (P1) of 30 in. Hg. Abs.

**Note . . .**

*When setting the pressure-drop initially the upstream pressure tapping must be taken from the control unit inlet (pump delivery) connection. The delivery pressure (downstream) tapping is to be taken from the pressure-drop control cover plate. For all further calibration and recording of the pressure drop during final calibration, the delivery pressure tapping is to be taken from the burner delivery connection so as to take into account the pressure-drop across the shut-off cock and to simulate engine conditions.*

**Throttle valve and shut-off cock performance check**

**2.4** (1) The control unit is to be operated at the flow and delivery pressure stated for the 10 deg. throttle angle in the following table (item 2.5) and the two lock nuts set at this position and locked together, then the closed stop is to be set at 10 deg. lever angle from this (idling) position and the single nut locked to the boss face.

(2) The maximum throttle stop is to be set and locked at 90 deg. lever angle from the closed stop.

(3) Check that the unit will shut down (i.e. delivery ceases) between 5 deg. and 2 deg. throttle lever angle. Flow through the throttle valve should commence to return to pump inlet between 9 deg. and 6 deg. throttle lever angle.

(4) The shut-off cock half-ball valve should be shut completely at 2 deg. throttle lever angle, when the throttle lever must be capable of closing to zero deg. lever angle. The shut-off cock lever is to be adjusted by rotating the screwed rod in the connecting linkage.

(5) The throttle valve idling by-pass should be capable of providing a range of flow varying by 15 g.p.h. at 100 lb. per sq. in. with the unit operating at a throttle opening of 10 deg. lever angle at 30 in. Hg. Abs. altitude pressure.

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**2.5** Throttle valve calibration at 30 in. Hg. Abs.

| Lever angle (deg.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Delivery pressure (lb. per sq. in.) |
|---|---|---|---|
| 10 | 40 | 55 | 155 |
| 20 | 80 | 95 | 325 |
| 30 | 145 | 160 | 380 |
| 40 | 230 | 275 | 455 |
| 50 | 410 | 445 | 590 |
| 60 | 625 | 660 | 690 |
| 70 | 850 | 885 | 800 |
| 80 | 1,080 | 1,140 | 950 |
| 90 | 1,300 | 1,340 | 1,060 |

**2.6** Throttle valve calibration at 5 in. Hg. Abs.

| Lever angle (deg.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Delivery pressure (lb. per sq. in.) |
|---|---|---|---|
| 10 | 15 | 30 | 150 |
| 20 | 50 | 65 | 155 |
| 30 | 95 | 110 | 360 |
| 40 | 120 | 140 | 375 |
| 50 | 150 | 165 | 440 |
| 60 | 160 | 185 | 450 |
| 70 | 185 | 215 | 455 |
| 80 | 220 | 260 | 460 |
| 90 | 255 | 290 | 470 |

**2.7** Checking the altitude control. The hysteresis is to be checked over each of the ranges tabulated and must not exceed 20 g.p.h. at 90 deg. throttle lever angle, 20 g.p.h. at 70 deg. and 10 g.p.h. at 10 deg. On all these calibrations the control must be capable of reducing the flow down to a control pressure of 3 in. Hg. Abs.

**2.8** Altitude calibration at 90 deg. throttle lever angle.

| Control pressure (in. Hg. Abs.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Deliveyr pressure (lb. per sq. in.) |
|---|---|---|---|
| 30 | 1,300 | 1,340 | 1,060 |
| 20 | 950 | 980 | 850 |
| 10 | 495 | 530 | 630 |
| 5 | 255 | 280 | 470 |
| 4 | 220 | 250 | 450 |

**2.9** Altitude calibration at 70 deg. throttle lever angle.

| Control pressure (in. Hg. Abs.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Delivery pressure (lb. per sq. in.) |
|---|---|---|---|
| 45 | 1,060 | 1,130 | 940 |
| 40 | 995 | 1,075 | 900 |
| 30 | 840 | 885 | 800 |
| 20 | 650 | 685 | 710 |
| 10 | 350 | 390 | 570 |
| 5 | 180 | 210 | 450 |
| 4 | 150 | 180 | 400 |

**2.10** Altitude calibration at 10 deg. throttle lever angle.

| Control pressure (in. Hg. Abs.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Delivery pressure (lb. per sq. in.) |
|---|---|---|---|
| 45 | 50 | 60 | 265 |
| 40 | 50 | 60 | 240 |
| 30 | 45 | 50 | 155 |
| 20 | 35 | 45 | 155 |
| 10 | 20 | 35 | 155 |
| 5 | 15 | 30 | 155 |
| 4 | 15 | 30 | 155 |

**Endurance test**

**3.1** The endurance time is one hour at 90 deg. throttle lever angle and half an hour at 10 deg. throttle lever angle.

**3.2** During the one hour period at 90 deg. lever angle the control (capsule) pressure is to be varied as follows :—

(1) From 29 in. to 4 in. Hg. Abs. for 30 minutes, the rate of variation is to be approximately 8 times every minute.

(2) From 45 in. to 30 in. Hg. Abs. for 30 minutes, the rate of variation is to be approximately 8 times every 3 minutes.

**3.3** During the 30 minutes at 10 deg. lever angle the control (capsule) pressure is to be varied as follows :—

(1) From 29 in. to 4 in. Hg. Abs. for 15 minutes the rate of variation to be approximately 8 times every 3 minutes.

(2) From 45 in. to 30 in. Hg. Abs. for 15 minutes, the rate of variation is to be approximately 8 times every 3 minutes.

**3.4** The throttle valve is to be closed and opened again to the specified angle approximately 10 times during each of the two main periods, i.e., 5 times during each 30 minute period and 5 times during each 15 minute period.

**Final calibration**

**4.1** The preliminary calibration (item 2.1 to 2.10) is to be repeated. There must be no excessive change from the results recorded during the preliminary calibration.

**4.2** The pressure consciousness of the flow, with the delivery pressure being varied between 600 and 1,000 lb. per sq. in., must not exceed that stated in the following table. The unit must be checked for unstability at the 5 in. Hg. Abs. conditions; during these checks the body pressure must remain constant.

| Control pressure (in. Hg. Abs.) | Lever angle (deg.) | Max. flow variation (g.p.h.) |
|---|---|---|
| 30 | 90 | 35 |
| 30 | 10 | 10 |
| 5 | 90 | 60 |
| 5 | 10 | 5 |

**4.3** The pressure consciousness of the flow with the body pressure (tank pump pressure) being varied through a range of 20 lb. per sq. in. must not exceed that stated in the following table. During the check the delivery pressure must be maintained constant at the normal working value (*para.* 2.1)

| Control pressure (in. Hg. Abs.) | Lever angle (deg.) | Max. flow variation (g.p h.) |
|---|---|---|
| 30 | 90 | 30 |
| 30 | 10 | 5 |

**Torque and overlap tests**

**5.1** At a delivery pressure of 1,000 lb. per sq. in. 90 deg. throttle lever angle and a control pressure of 30 in. Hg. Abs., the throttle lever closing and opening torque (90 deg. to 10 deg. to 90 deg.) must not exceed 10 lb. in.

**5.2** With the delivery pressure and flow at normal idling conditions the shut-off cock closing and opening torque (10 deg. to 2 deg. to 10 deg.) measured on the throttle lever must not exceed 10 lb. in.

**5.3** With the delivery pressure and flow at normal idling conditions, upon closing the shut-off cock the upstream pressure must not rise by more than 5 lb. per sq. in.

**5.4** With the delivery pressure and flow at normal idling conditions move the throttle lever to zero degrees as quickly as possible. The time from the closing of the lever to the cessation of the flow must not exceed one second. The lever must then be returned to 10 deg. as rapidly as possible, when the time required for the flow to recover to idling conditions must not exceed one second.

**5.5** The shut-off cock is to be closed from normal idling conditions and the rise in body pressure recorded.

**Leakage tests**

**6.1** With an inlet pressure of 20 lb. per sq. in., the shut-off cock closed, the rig pump stopped, and the burner delivery line disconnected, any leakage from the burner delivery connection must not exceed 5 c.c. per min.

**6.2** With a flow of 1,050 to 1,100 g.p.h., obtained by adjusting the rig pump camplate angle, and a control unit delivery pressure of 1,000 lb. per sq. in. at 90 deg. throttle lever angle, the internal leakage, measured at the return to pump inlet connection, must not exceed 400 c.c. per min. Adjust the rig pump camplate angle to normal after this test.

**6.3** After the exterior of the unit has been dried thoroughly it must then be operated at a delivery pressure of 2,000 lb. per sq. in., with an inlet pressure of 20 lb. per sq. in. and a throttle lever angle of 90 degrees, for a period of 5 minutes. There must be no external leakage. If leakage is suspected but is not immediately apparent the suspected area may be dusted with french chalk.

**6.4** Blank off all connections except the low pressure connection on the body cover plate, to which an air line is to be connected. The unit must thence be submerged in fuel and an air pressure of 75 lb. per sq. in. applied for 5 minutes. There must be no air leakage.

# Appendix 2

# CALIBRATION CODE J

**General**

**1.1** The fuel to be used is to be Aviation kerosine to Specification D.Eng. RD.2482.

**1.2** The rig pump inlet (tank pump) pressure must be maintained at between 15 and 20 lb. per sq. in. unless otherwise stated and the fuel temperature at 20 to 40 deg. C.

**1.3** The servo valves must remain sealed up to a static pressure of 1,500 lb. per sq. in.

**1.4** The altitude bellows strike pin must remain in contact with the tip of the control lever up to a bellows pressure of 3 in. Hg. Abs.

**1.5** At an air pressure of 75 lb. per sq. in. applied to the return to pump inlet connection, and with the unit immersed completely in fuel, there must be no leakage.

**Preliminary calibration**

**2.1** This test must be made with a rig pump servo flow of 9·3 to 9·7 gal. per hour and with a rig pump delivery pressure of 1,000 lb. per sq. in. at a flow of 150 gal. per hour and a speed of 2,865 r.p.m.

**2.2** The total pressure drop across the unit must be approximately 300 lb. per sq. in. with the throttle lever angle set at 90 degrees and with an altitude pressure (P1) of 30 in. Hg. Abs.

**2.3** With the throttle lever angle set at 10 deg. the total pressure drop across the unit is to be approximately 100 lb. per sq. in. with an altitude pressure (P1) of 30 in. Hg. Abs.

**Note . . .**

*When setting the pressure-drop initially the upstream pressure tapping must be taken from the control unit inlet (pump delivery) connection. The delivery pressure (downstream) tapping is to be taken from the pressure-drop control cover plate. For all further calibration and recording of the pressure drop during final calibration, the delivery pressure tapping is to be taken from the burner delivery connection so as to take into account the pressure drop across the shut-off cock and to simulate engine conditions.*

**2.4** Throttle valve and shut-off cock performance check.

(1) The control unit is to be operated at the flow and delivery pressure stated for the 10 degree throttle angle in the following table (item 2.5) and the two locknuts set to this position and locked together, then the closed stop is to be set at 10 degrees lever angle from this (idling) position, and the single nut locked to the boss face.

(2) The maximum throttle stop is to be set and locked at 90 degrees lever angle from the closed stop.

(3) Check that the unit will shut-down (i.e. delivery ceases) between 4 degrees and 2 degrees throttle lever angle. Flow through the throttle valve should commence to return to pump inlet between 9 degrees and 6 degrees throttle lever angle.

(4) The shut-off cock half-ball valve should be shut completely at 2 degrees throttle lever angle, when the throttle lever must be capable of closing to zero degrees lever angle. The shut-off cock lever is to be adjusted by rotating the screwed rod in the connecting linkage.

(5) The throttle valve idling by-pass should be capable of providing a range of flow varying by 15 gall. per hour at 100 lb. per sq. in. with the unit operating at a throttle opening of 10 degrees lever angle at 30 in. Hg. Abs. altitude pressure.

**2.5** Throttle valve calibration at 30 in. Hg. Abs.

| Lever angle (deg.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Delivery pressure (lb. per sq. in.) |
|---|---|---|---|
| 10 | 45 | 60 | 185 |
| 20 | 90 | 105 | 380 |
| 30 | 165 | 180 | 465 |
| 40 | 250 | 295 | 545 |
| 50 | 450 | 485 | 650 |
| 60 | 685 | 720 | 750 |
| 70 | 920 | 965 | 845 |
| 80 | 1,180 | 1,240 | 960 |
| 90 | 1,450 | 1,490 | 1,090 |

**2.6** Throttle valve calibration at 5 in. Hg. Abs.

| Lever angle (deg.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Delivery pressure (lb. per sq. in.) |
|---|---|---|---|
| 10 | 15 | 30 | 160 |
| 20 | 55 | 70 | 240 |
| 30 | 105 | 120 | 400 |
| 40 | 130 | 150 | 450 |
| 50 | 165 | 180 | 470 |
| 60 | 175 | 200 | 485 |
| 70 | 195 | 225 | 510 |
| 80 | 240 | 280 | 520 |
| 90 | 275 | 310 | 550 |

**2.7** Checking the altitude control
The hysteresis is to be checked over each of the ranges tabulated and must not exceed 20 gall. per hour at 90 degrees throttle lever angle, 20 gall. per hour at 70 degrees and 10 gall. per hour at 10 degrees. On all these calibrations the control must be capable of reducing the flow down to a control pressure of 3 in. Hg. Abs.

**2.8** Altitude calibration at 90 degrees throttle lever angle.

| Control pressure (in. Hg. Abs.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Delivery pressure (lb. per sq. in.) |
|---|---|---|---|
| 30 | 1,450 | 1,490 | 1,090 |
| 20 | 1,020 | 1,055 | 870 |
| 10 | 520 | 555 | 675 |
| 5 | 275 | 306 | 550 |
| 4 | 235 | 265 | 520 |

**2.9** Altitude calibration at 90 degrees throttle lever angle.

| Control pressure (in. Hg. Abs.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Delivery pressure (lb. per sq. in.) |
|---|---|---|---|
| 45 | 1,155 | 1,225 | 950 |
| 40 | 1,085 | 1,165 | 925 |
| 30 | 920 | 965 | 845 |
| 20 | 710 | 745 | 760 |
| 10 | 380 | 420 | 620 |
| 5 | 195 | 225 | 500 |
| 4 | 165 | 195 | 450 |

**2.10** Altitude calibration at 10 degrees throttle lever angle.

| Control pressure (in. Hg. Abs.) | Flow (g.p.h.) Min. | Flow (g.p.h.) Max. | Delivery pressure (lb. per sq. in.) |
|---|---|---|---|
| 45 | 57 | 67 | 260 |
| 40 | 55 | 65 | 240 |
| 30 | 50 | 55 | 160 |
| 20 | 37 | 47 | 160 |
| 10 | 20 | 35 | 160 |
| 5 | 15 | 30 | 160 |
| 4 | 15 | 30 | 160 |

**2.11** Altitude calibration at 20 degrees throttle lever angle should be recorded. Downstream pressures are as follows :—

| in. Hg. Abs. | 4 | 5 | 10 | 20 | 30 | 40 | 56 |
|---|---|---|---|---|---|---|---|
| Downstream pressures | 215 | 240 | 315 | 350 | 380 | 400 | 400 |

**Endurance tests**

**3.1** The endurance time is 1½ hours ; one hour at 90 degrees throttle lever angle and half an hour at 10 degrees throttle lever angle.

**3.2** During the one hour period at 90 degrees lever angle the control (capsule) pressure to to be varied as follows :—

(1) From 29 in. to 4 in. Hg. Abs. for 30 minutes, the rate of variation is to be approximately 10 times every minute.

(2) From 45 to 30 in. Hg. Abs. for 30 minutes, the rate of variation is to be approximately 10 times every 3 minutes.

**3.3** During the 30 minutes at 10 degrees

lever angle the control (capsule) pressure is to be varied as follows :—

(1) From 29 in. to 4 in. Hg. Abs. for 15 minutes, the rate of variation to be approximately 8 times every 3 minutes.

(2) From 45 to 30 in. Hg. Abs. for 15 minutes, the rate of variation is to be approximately 8 times every 3 minutes.

**3.4** The throttle valve is to be closed and opened again to the specified angle approximately 10 times during each of the two main periods, i.e., 5 times during each 30 minute period and 5 times during each 15 minute period.

**Final calibration**

**4.1** The preliminary calibration (item 2.1 to 2.10) is to be repeated. There must be no excessive change from the results recorded during the preliminary calibration.

**4.2** The pressure consciousness of the flow, with the delivery pressure being varied between 600 and 1,000 lb. per sq. in., must not exceed that stated in the following table. The unit must be checked for instability at the two 5 in. Hg. Abs. conditions ; during these checks the body pressure must remain constant.

| Control pressure (in. Hg. Abs.) | Lever angle (deg.) | Max. flow variation (g.p.h.) | Pressure range (lb. per sq. in.) |
|---|---|---|---|
| 30 | 90 | 50 | 600— 1,000 |
| 30 | 10 | 10 | 100— 600 |
| 5 | 90 | 60 | 300— 700 |
| 5 | 10 | 5 | 100— 600 |

**4.3** The pressure consciousness of the flow with the body pressure (tank pump pressure) being varied through a range of 20 lb. per sq. in. must not exceed that stated in the following table at the conditions specified. During the check the delivery pressure must be maintained constant at the normal working value (para. 2·1).

| Control pressure (in. Hg. Abs.) | Lever angle (deg.) | Max. flow variation (g.p.h.) |
|---|---|---|
| 30 | 90 | 30 |
| 30 | 10 | 5 |

**Torque and overlap tests**

**5.1** As a delivery pressure of 1,000 lb. per sq in. 90 degrees throttle lever angle and a control pressure of 30 in. Hg. Abs., the throttle lever closing and opening torque (90 deg. to 10 deg. to 90 deg.) must not exceed 10 lb. in.

**5.2** With the delivery pressure and flow at normal idling conditions the shut-off cock closing and opening torque (10 deg. to 2 deg. to 10 deg.) must not exceed 10 lb. in.

**5.3** With the delivery pressure and flow at normal idling conditions, upon closing the shut-off cock the upstream pressure must not rise by more than 5 lb. per sq. in.

**5.4** With the delivery pressure and flow at normal idling conditions move the throttle lever to zero degrees as quickly as possible. The time from the closing of the lever to the cessation of flow must not exceed one second. The lever must then be returned to 10 degrees as rapidly as possible when the time required for the flow to recover to idling conditions must not exceed one second.

**5.5** The shut-off cock is to be closed from normal idling conditions and the rise in body pressure recorded.

**Leakage tests**

**6.1** With an inlet pressure of 20 lb. per sq. in., the shut-off cock closed, the rig pump stopped and the burner delivery line disconnected, any leakage from the burner delivery connection must not exceed 5 c.c. per min.

**6.2** With a flow of 1,050 to 1,110 g.p.h. obtained by adjusting the rig pump camplate angle and a control unit delivery pressure of 1,000 lb. per sq. in. at 90 degrees throttle lever angle, the internal leakage measured at the return to pump inlet connection, must not exceed 400 c.c. per min. Re-adjust the rig pump camplate angle to normal after this test.

**6.3** After the exterior of the unit has been dried thoroughly it must then be operated at a delivery pressure of 2,000 lb. per sq. in., with a tank inlet pressure of 20 lb. per sq. in. and a throttle lever angle of 90 degrees for a period of 5 minutes. There must be no external leakage. If leakage is suspected

but is not immediately apparent the suspected area may be dusted lightly with finely powered french chalk to assist in determining the possibility and source of leakage.

**6.4** Blank off all connections except the low pressure fuel connection on the body cover plate to which an air line is to be connected. The unit must then be submerged in fuel and an air pressure of 75 lb. per sq. in. applied for 5 minutes. There must be no air leakage.

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