Chapter Thirty-nine

THE D.H. FUEL CONTROL VALVE ASSEMBLY

Contents

Illustrations

THIS CHAPTER describes the de Havilland fuel control valve assembly components, and contains instructions for their overhaul and testing. **This assembly is fitted to Ghost 48 Mk. 1 only.**

It is assumed that personnel having the requisite skill and experience will be employed to overhaul and test these units, and that the necessary tools and equipment will be available. It is sound practice unless the fitter is thoroughly conversant with these particular units, to make written notes of the location or to label all small parts such as washers, packing pieces, etc., during dismantling, so that each part can be refitted with absolute certainty in its original position during reassembly.

DESCRIPTION

The control valve assembly (Fig. 1) is situated in the fuel system between the high pressure filter and the fuel flow distributor, and is mounted on the starboard side of the rear of the sump. The assembly consists of a light alloy body containing a graduated metering needle, or throttle valve, which is connected to the pilot's throttle lever, and a high pressure (H.P.) fuel cut-off valve, which is connected to the H.P. cut-off lever in the cockpit.

The body of the control valve assembly consists of a light alloy block machined to accommodate the throttle valve and the cut-off valve and drilled to provide the necessary fuel passages.

The throttle valve plunger is of stainless steel and its centre portion is profiled to a graduated cross section. The valve slides in a bronze sleeve containing a number of orifices aligning with inlet and outlet passages in the body, and the profiled portion of the throttle valve, so that movement of the valve alters the effective area of the metering orifice through which the fuel supply to the burners passes. The upper end of the throttle valve is machined to form an eye to which the pilot's throttle lever is linked. Both ends of the throttle

Fig. 1. Control valve assembly.

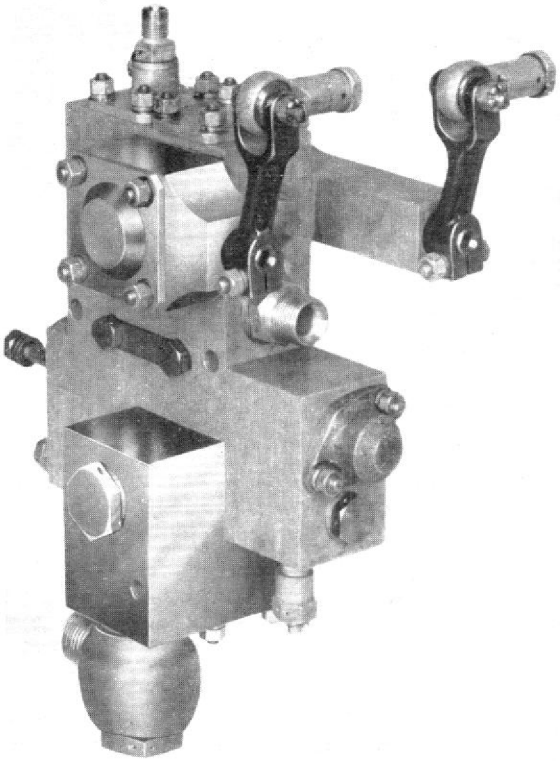
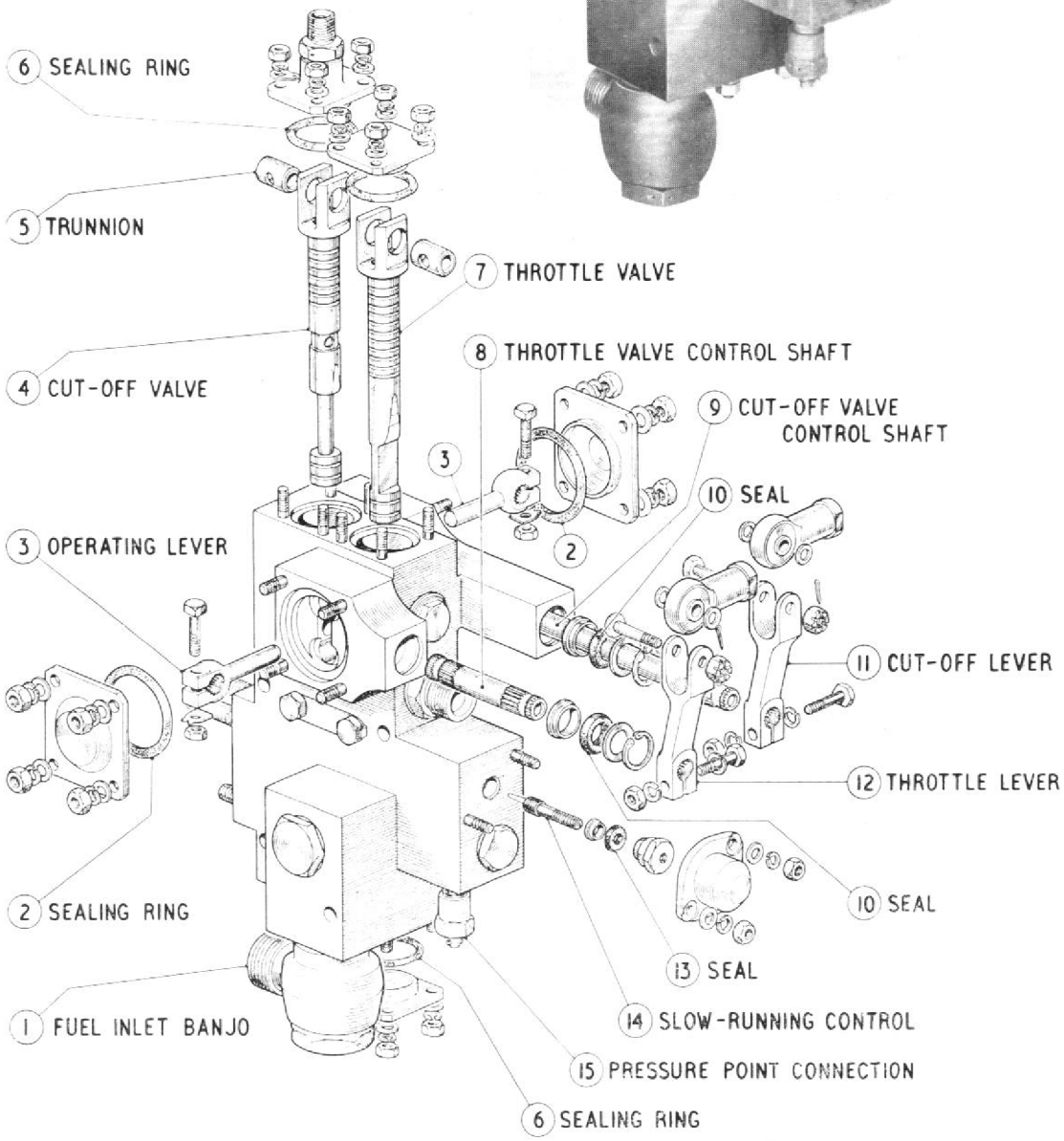


Fig. 2. Exploded view of control valve assembly.



Revised by Amendment No. 112
February, 1954

valve bore in the body are enclosed by blanking caps, leakage being prevented by a rubber sealing ring housed in a recess formed in the body at each end of the bore.

The steel cut-off valve operates in a second bronze sleeve parallel to the throttle valve. To obviate the risk of hydraulic hammer due to the sudden closing of the cut-off valve, a bleed hole is drilled in the cut-off valve to divert the fuel delivery back to the low pressure side of the fuel system. Mod. 726 introduced an annular groove around the bleed hole and increased the size of the bleed hole to $\frac{3}{16}$ in. When mod. 470 is embodied, flats are machined to form a taper (see Fig. 2) on the shank of the cut-off valve to facilitate its use as a coarse throttle should the normal throttle control fail for any reason. The valve bore in the body is blanked and sealed by a blankng cap and rubber sealing ring at each end.

Both the throttle valve sleeve and the cut-off valve sleeve are a close fit in the body, but to ensure against leakage which would destroy the metering quality of the throttle valve, three rubber sealing rings have been fitted to each sleeve, grooves being machined in the sleeves to receive them. The adjustable slow-running bleed is fitted in the body at right angles to the throttle valve.

The pilot's throttle control is linked to the throttle valve lever on the control valve assembly, this lever is in turn linked to the operating lever which is in the body of the assembly. A short shaft serrated at either end connects the two levers, the serrations on the shaft corresponding to internal serrations in the levers. Each lever is firmly clamped to the shaft by means of a bolt, nut, and two spring washers. The operating lever engages with a hole machined in a trunnion which is inserted in the eye end of the throttle valve; movement from the throttle lever being transmitted through the serrated shaft to the operating lever which in turn transmits it via the trunnion to the throttle valve. A seal, distance piece, washer, and circlip are inserted in the body at the throttle lever end of the shaft to prevent any leakage.

The operating lever assembly is enclosed in the body by a blanking cap, fitted with a rubber sealing ring and secured by four nuts, spring and plain washers.

The cut-off valve linkage is identical with that of the throttle valve.

Fuel from the engine-driven fuel pumps flows into the body inlet connection and through the throttle valve sleeve; the flow being governed by the position of the throttle valve in relation to a shoulder in the bronze sleeve. The position of the valve is selected by the pilot according to the engine speed required. The throttle valve is designed so that over the first part of its travel there are equal increments of r.p.m. for equal amounts of lever movement whilst over the latter part of its travel (at higher engine speeds) there are equal increments of thrust—not r.p.m.—for equal amounts of lever movement. To enable the small fuel flow required for idling to be adjusted conveniently there is a subsidiary orifice which by-passes the throttle control orifice and which is adjustable—on the ground—by means of a pointed screw which is set and locked.

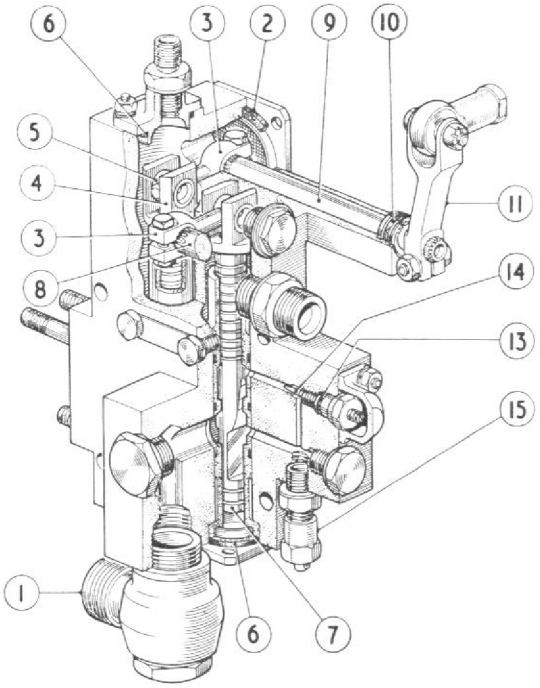


Fig. 3. Throttle and cut-off lever assembly; for key to numbers, see Fig. 2.

The H.P. fuel cut-off valve, which is in effect a cock in the main fuel outlet passage for the con-

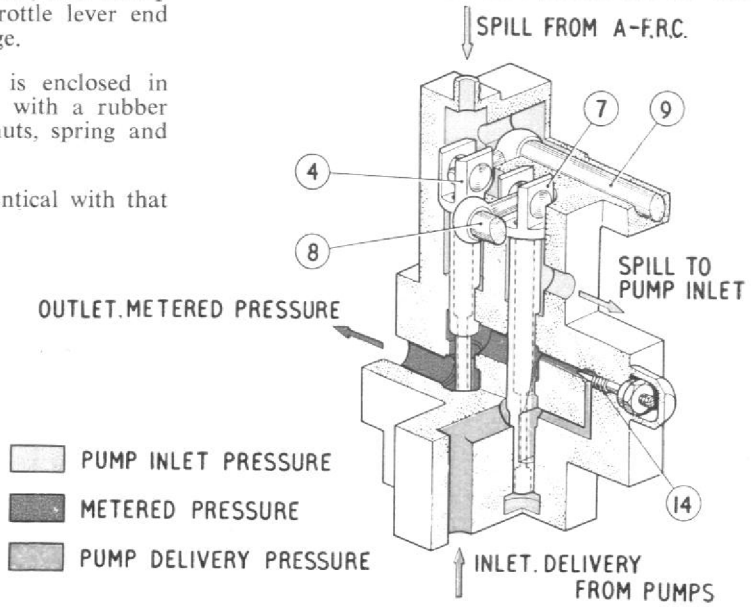


Fig. 4. Fuel flow diagram; for key to numbers, see Fig. 2.

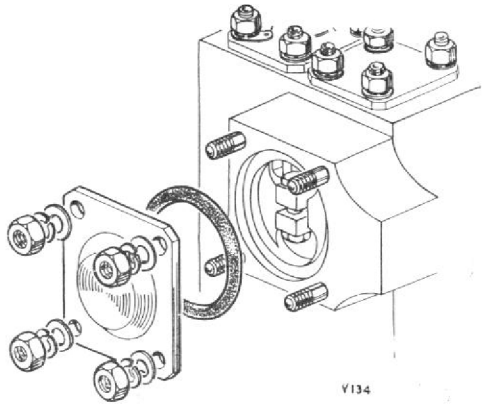


Fig. 5. Crank bore blanking cap.

trol valve assembly, enables the pilot to stop the engine positively both when shutting down normally and in an emergency. When the cut-off valve is in the open position, there is a free passage for fuel from the throttle valve to the control valve outlet connection and thus to the distributor and burners. As already mentioned, when the cut-off valve is in the closed position the outlet is closed and the fuel diverted back to the low pressure side of the fuel system.

INSTALLATION AND REMOVING

Removal and refitment of the control valve assembly on an installed engine is covered by the instructions contained in chapter 14, and on an engine being completely dismantled and reassembled in chapters 23 and 34.

SERVICING

Instructions for servicing the control valve assembly are given in chapter 14, Fuel System, Servicing and Maintenance.

DISMANTLING

The importance of taking meticulous care and of scrupulous cleanliness during all dismantling, reassembling and testing cannot be too highly stressed. The control valve assembly is of precision manufacture and irrepairable damage can be caused by dropping or by haphazard or incorrect use of tools.

To avoid unnecessary repetition throughout the following instructions, it is assumed that the fitter will remove all locking wires and split pins, and bend back all tab washers and similar locking devices before attempting to remove the various bolts, nuts and screws.

Consumable parts such as split pins, tab washers, joint washers, etc., must be discarded as they are removed so that there is no risk of their being used again.

The following instructions for dismantling the control valve are in the recommended sequence.

THROTTLE VALVE LEVER ASSEMBLY

In the following instructions for the removal of the throttle valve lever assembly, the lever on the outer end of the control shaft, which is linked directly with the pilot's throttle control in the cockpit, is called the throttle lever, whilst the lever on the inner end of the shaft, which transmits the movement to the actual throttle valve is called the throttle operating lever (see Fig. 3).

Unscrew the four 2 B.A. nuts which retain the crank bore blanking cap, and remove the four spring and plain washers. Lift off the crank bore blanking cap and extract the sealing ring from the recess in the body or from the spigot on the blanking cap as the case may be. Release the locking tabs, and, using a 2 B.A. ring spanner, unscrew and remove the nut clamping the operating lever to the inner end of the serrated control shaft, remove the bolt ; the control shaft can now be withdrawn complete with the throttle lever. Mod. 785 introduced a square-headed clamping bolt for the operating lever. Withdraw the throttle operating lever from the body of the control valve assembly. Unscrew and remove the 2 B.A. nut clamping the throttle lever to the control shaft, and draw the lever from the shaft.

Extract the circlip from the control shaft bore in the body followed by the washer, seal and distance piece. Where mod. 263 is embodied the circlip retaining the seal for the throttle control shaft is provided with legs to facilitate its removal. Where mod. 263 is not embodied a plain circlip without eye ends will be fitted.

THROTTLE VALVE

Particular care must be taken throughout the following operations to ensure that the throttle valve is not bent or damaged in any way.

Uncrew and remove the four nuts, spring, and plain washers from the throttle bore blanking cap, and remove the blanking cap. Extract the sealing ring from the bore in the control valve assembly body, and withdraw the throttle valve complete with the trunnion. Once away from the control valve assembly separate the trunnion from the eye of the throttle valve.

CUT-OFF LEVER ASSEMBLY

The cut-off valve lever assembly is dismantled in precisely the same manner as the throttle valve

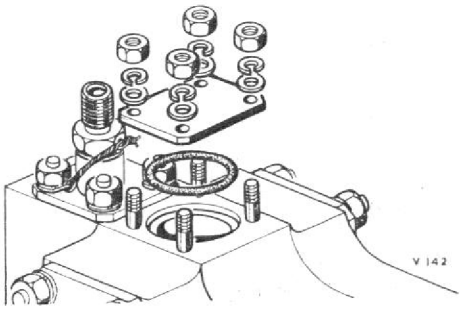


Fig. 6. Valve bore blanking cap.

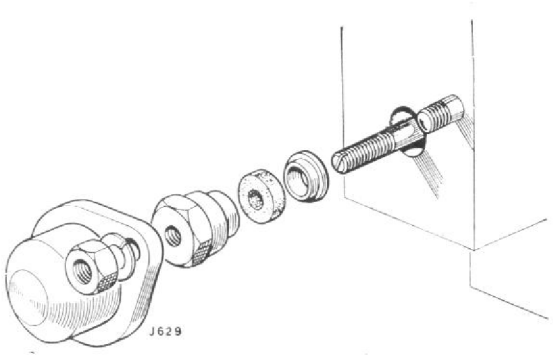


Fig. 7. Slow-running bleed screw.

lever assembly ; instructions for which are given on page 4.

CUT-OFF VALVE

The cut-off valve is also dismantled in a similar manner to the throttle valve as described on page 4.

SLOW-RUNNING ADJUSTING SCREW

Unscrew and remove the 2 B.A. plain nuts which secure the slow-running control blanking cap, and remove the two spring and plain washers followed by the blanking cap.

Unscrew and remove the locking nut; difficulty may be experienced in removing this nut, as adjustment of the slow-running screw is apt to splay the screwdriver slot ; in which event the slow-running screw should be screwed out complete with the locking nut, and the slot squeezed gently in a vice thus permitting removal of the locking nut and seal. The distance piece which is of larger diameter than the seal can be removed over the forward or larger diameter end of the adjusting screw.

THROTTLE AND CUT-OFF VALVE SLEEVES

As the throttle and cut-off valve sleeves are shrunk into position in the body, they must on no account be removed from the control valve assembly body during dismantling.

Complete the dismantling operations of the control valve assembly by unscrewing and removing the fuel inlet banjo bolt and pillar complete with its two aluminium washers, followed by the removal of the fuel drain connection. It is not necessary to remove the various blanking plugs and washers.

CLEANING

Each individual component must be thoroughly cleaned in kerosene and finally flushed off in gasoline. Only approved cleaning processes may be employed, see chapter 25, and all passages of the body must be blown through with an airline at a pressure of not less than 20–25 lb. per sq. in. to ensure the removal of any foreign matter which might cause obstruction and possible failure of the control valve assembly.

INSPECTION

The inspector should ascertain the existing modification standard of the individual control valve assembly and the approved modifications requiring embodiment to bring the control valve assembly up to the required standard. All rejected parts must be segregated so that there is no possibility of their being refitted.

To facilitate the inspection of the control valve assembly a John Bull intercheck small bore gauge and the following four setting rings will be required. T.73131 valve sleeve bore, T.73129 throttle and cut-off valve eye end bore, T.74107 operating lever bore in trunnion, T.74108 control shaft bore in body.

When using the John Bull gauge for small bore measurement, the manufacturers recommend that the pistol grip should be removed, and the trigger turned to the position allowing the finger piece to lie parallel with the body of the gauge, as this gives a greater degree of control on the instrument.

Select the relevant setting ring, press the trigger on the gauge, thus contracting the contacts and

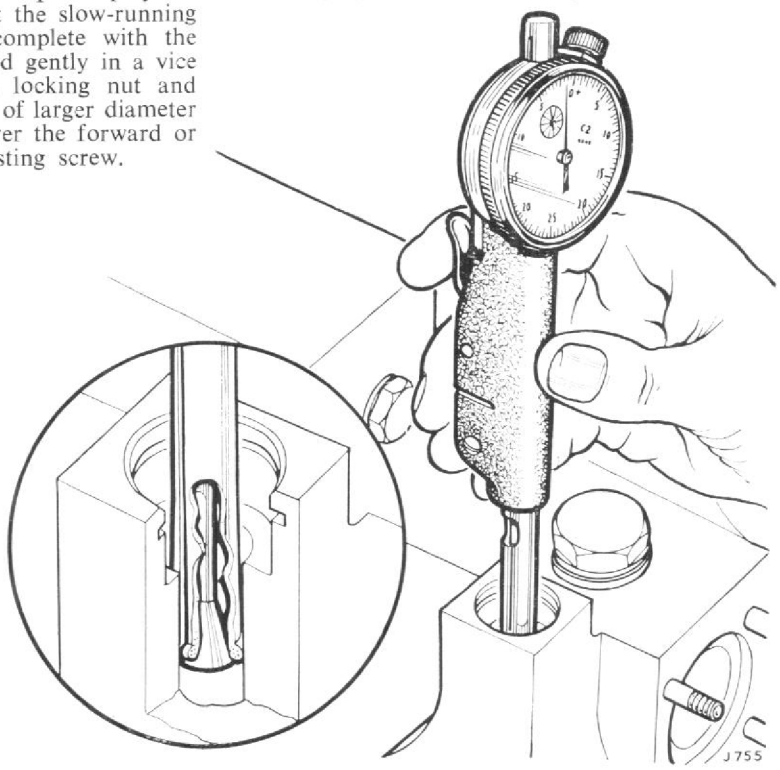


Fig. 8. John Bull intercheck small bore guage.

insert them into the setting ring ; release the trigger allowing the contacts to expand into the bore of the setting ring, rock the instrument axially to determine the true reading and then set the dial indicator to zero ; press the trigger again and insert the contacts into the bore to be measured, release the trigger, rock the instrument, and the reading shown on the dial indicator will give an accurate reading of the amount the bore being checked differs from the bore of the setting ring.

CONTROL VALVE ASSEMBLY BODY

During manufacture the control valve assembly body is anodically treated and during the initial assembling is subjected to static and working tests calculated to show up any defects. It is not anticipated that the serviceability of any unit will be impaired subsequently by either corrosion or porosity.

Examine the body carefully for damage, and inspect all female threads in the body, and by marrying with the corresponding part, check for signs of slackness. Check that all studs receive their nuts without any trace of binding ; replace any studs that have stripped or damaged threads. Test each stud for security in the body ; any showing signs of, or suspected of pulling away must be renewed. Using a square, check that all studs are square to their faces.

THROTTLE AND CUT-OFF VALVE SLEEVES

As the throttle and cut-off valve sleeves are virtually an integral part of the control valve assembly body, being a shunk in fit and also (premod. 273) having been drilled when in position, the three components must be inspected together. Using a John Bull intercheck small bore gauge 0·250–0·500 and the setting ring T.73131 check the dimensions of the bores against the figures specified in the table of fits and clearances, and carefully examine them visually for any signs of scoring. High spots adjacent to minor scoring can be removed by blending with the fine emery cloth.* Deep scores justify rejection, in which event the control valve assembly must be returned to the manufacturers for rectification.

CUT-OFF VALVE

Check the diameter of the cut-off valve. If wear exceeds that permitted by the table of fits and clearances and the stipulated clearance between the cut-off valve and its sleeve cannot be maintained, a replacement valve must be fitted. Carefully examine the valve for sign of scoring ; slight score marks may be carefully blended out by discreet use of fine emery cloth.* Inspect the eye end of the cut-off valve for wear, and using a John Bull intercheck small bore gauge 0·250–0·500 and the setting ring T.73129 check the dimensions of the bore in the cut-off valve, and using a micrometer, the outside diameter of the trunnion.

THROTTLE VALVE

Carefully examine the plunger for any signs of scoring ; slight marks may be carefully polished out using fine emery cloth.* Inspect the eye end of the valve for wear and check the dimensions of both the bore in the throttle valve using a John Bull intercheck small bore gauge 0·250–0·500 and the setting ring T.73129 and the outside diameter of the trunnion using a micrometer.

Dimensionally check the diameter of the throttle valve, if wear is in excess of the figures given in the table of fits and clearances, and the stipulated clearance between the throttle valve and sleeve cannot be maintained a replacement valve must be fitted.

CUT-OFF VALVE LEVER ASSEMBLY

Carefully inspect the cut-off valve operating lever and the cut-off lever for general suitability for further service. Using a John Bull intercheck small bore gauge 0·250–0·500 and the setting ring T.74107 check the operating lever bore in the cut-off valve trunnion, similarly with the John Bull intercheck gauge using the setting ring T.74108 check the control shaft bore in the control valve assembly body. Using a micrometer check the outside diameter of the control shaft.

THROTTLE VALVE LEVER ASSEMBLY

Examine the throttle valve lever assembly carefully in a similar manner to the cut-off valve lever assembly given in the previous paragraph.

SLOW-RUNNING ADJUSTING SCREW

Pay special attention to the condition of the lock nut, the hexagon of which may have been damaged through repeated adjustment. Carefully examine the screw for condition of thread, screwdriver slot, and tapered end ; any imperfections justify replacement. Check the screw in its location in the control valve assembly body to ensure that it receives the screw without binding. Visually examine the slow-running screw cap.

MISCELLANEOUS

Detail inspection of the control valve assembly should include examination of the fuel inlet banjo and bolt, and the fuel drain.

REASSEMBLING

Meticulous care and scrupulous cleanliness are essential throughout the reassembly. Components into which replacement studs have been fitted or which have been subjected to polishing, machining or similar operations, must again be thoroughly flushed, and all passages blown through with clean dry air, at a pressure of not less than 20–25 lb. per sq. in. to ensure complete freedom from swarf

** We recommend blue twill crocus cloth and blue twill emery 00 (manufactured by John Oakey & Sons, Ltd.). The preference for cloth rather than emery paper is because it can be torn into strips for use whereas paper, when torn into strips soon disintegrates. Comparable emery papers, however, are 000 emery (manufactured by John Oakey & Sons, Ltd.) and 0000 rouge (manufactured by J. G. Naylor & Co., Ltd.).*

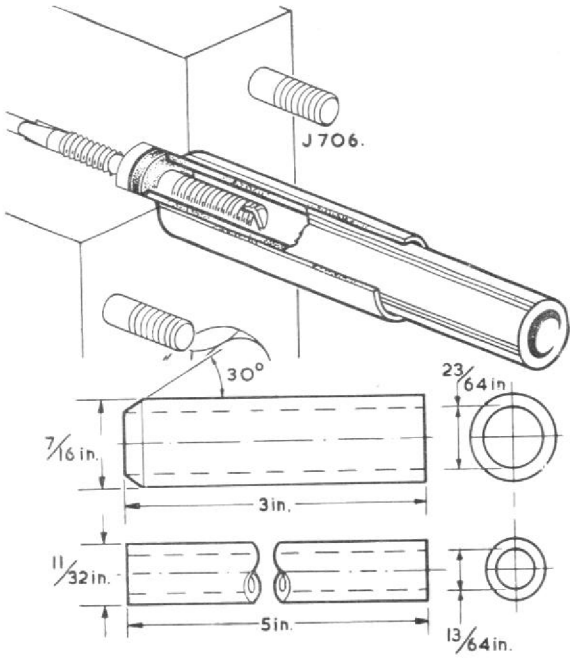


Fig. 9. Locally made tool for assembling the slow-running-adjusting-screw seal and distance piece.

or dirt. Special attention must be given to the correct fitting of glands and seals at all the various points throughout the rebuild. The fitting of new tab washers, joint washers, and similar non-reusable items is essential.

CUT-OFF VALVE ASSEMBLY

Before reassembling the cut-off valve insert the several small components forming the seal assembly into the control shaft bore in the control valve assembly body as follows: insert the distance piece into the counterbore in the body, and renew the seal, inserting it with its groove located over the distance piece, replace the washer and secure with the circlip. Assemble the trunnion into the eye end of the cut-off valve, and insert the cut-off valve complete with trunnion into its sleeve in the body. Assemble the operating lever through the crank bore into the trunnion.

Insert the cut-off valve control shaft through the washer, seal, and distance piece just assembled, so that the serrations on its inner end mate with the serrations machined in the operating lever. Clamp the control shaft in position with the 2 B.A. bolt, special tab washer (N.7985) and nut. Care must be taken that the locking washer does not turn whilst the nut is being tightened as it may foul the crank bore thus restricting the free movement of the cut-off valve. Assemble the cut-off valve lever to the outer end of the serrated control shaft, and secure with the 2 B.A. retaining bolt and two spring washers.

Position the crank bore sealing ring and assemble the crank bore blanking cap, secure with four nuts, spring and plain washers. Replace the sealing ring at either end of the valve bore and assemble the two blanking caps, secure with four nuts, spring and plain washers.

Upon completion of this assembly check that the valve operates under its own weight.

THROTTLE VALVE ASSEMBLY

The reassembly of the throttle valve is precisely the same as the cut-off valve and therefore when reassembling reference should be made to the preceding paragraphs.

SLOW-RUNNING ADJUSTING SCREW

To facilitate replacement of the seal a locally made tool on the lines indicated in Fig. 9 should be used.

Screw the larger diameter end of the slow-running screw into the control valve assembly body. Position the seal over the distance piece and place them both over the end of the slow-running screw, and then, using the locally made tool as shown in Fig. 9 press the seal and distance piece into position. Screw the locking nut on to the end of the slow-running screw and replace the slow-running control blanking cap, do not tighten its two securing nuts until after the final adjustment.

MISCELLANEOUS

Complete the reassembling operations by re-fitting the fuel inlet banjo bolt and pillar with its two aluminium washers, the fuel drain connection and its washers and any blanking plugs which might have been removed.

The control valve assembly is now completely reassembled and ready for testing.

TESTING

The test instructions contained in this chapter are based on de Havilland Gas Turbine Test Specification T.T.S.29 issue 8. As these Test Specifications are subject to continual revision it is always desirable to check with the de Havilland Engine Co., Ltd., whether this is the latest specification before commencing to test a control valve assembly.

Carefully record all calibrations and test results for subsequent entry into the official test record sheet. It must be remembered that unless new parts have been fitted all tests and calibrations carried out after overhaul are in the nature of check calibrations and normally no adjustment should be necessary.

The fuel used throughout the test is aviation kerosene to specification D.Eng.R.D.2482. The temperature of the fluid entering the control valve assembly must be between 20 deg. C. and 25 deg. C. and must be supplied through a fabric or fine mesh filter.

The test equipment necessary is illustrated diagrammatically in Fig. 10. The air-fuel ratio control drain connection, if fitted, must be blanked

off before testing. Care must be taken to isolate the low pressure gauges before high pressure tests are carried out.

Damage will occur to the gauges if the rate of pressure rise in the system is too high. Before opening the cut-off valve against the full supply pressure, it is important to first close fully the throttle valve.

DETERMINATION OF BASIC LEAKAGE

For the following test the outlet pressure regulating valve must be fully open.

Remove the slow-running adjustment blanking cap, and with the adjustment fully closed, the throttle valve fully closed and the cut-off valve open, apply an inlet pressure of 1240 lb. per sq. in. The leakage past the outlet connection must not exceed 350 lb. per hour.

SETTING THE THROTTLE VALVE FOR CALIBRATION TESTS

Remove the throttle valve bore blanking cap and fit a micrometer attachment to measure the control valve travel. Open the throttle valve until the condition indicated in the calibration table for the 1·000″ position with an outlet pressure of 15 lb. per sq. in. is obtained. Reduce the valve position at which this condition is obtained by 1·000″ and use this as the datum (zero position) for subsequent calibration.

SETTING THE SLOW-RUNNING ADJUSTMENT

With the throttle valve in the 0·100″ position adjust the slow-running screw to give a total flow of 800 lb. per hour with an inlet pressure of 1190 lb. per sq. in. and an outlet pressure of 15 lb. per sq. in. Lock the slow-running adjustment in this position and refit the blanking cap.

THROTTLE VALVE FLOW TEST (Table below)

By means of the micrometer adjustment provided on the test rig, open the throttle valve progressively from the zero position in the steps indicated in the calibration table and measure the flow at each stage with the specified inlet pressure and a constant outlet pressure of 15 lb. per sq. in. Plot these values and compare with the design flow given in the table. The flow must lie on a smooth curve within the limits given and if necessary the slow-running adjustment, the datum position and finally the valve profile may be adjusted to give the best agreement with the design curve. The flow from the drain connection (combined leakage along the cylindrical portions of the valves) must not exceed 250 lb. per hour with the throttle valve in any position. When a satisfactory calibration has been completed remove the micrometer attachment and replace the throttle valve bore blanking cap.

THROTTLE LEVER LOAD TEST

Close the throttle valve, and apply an inlet pressure of 1340 lb. per sq. in., and with an unrestricted outlet, the force (applied to the throttle lever) necessary to move the throttle valve from the closed position to the fully open position and back to the closed position must not exceed 15·0 lb. in.

CUT-OFF LEVER LOAD TEST

With the throttle valve fully open, and with an inlet pressure which gives a flow of 5000 lb. per hour with an unrestricted outlet, the force (applied to the cut-off lever) necessary to move the cut-off valve from the open position to the closed position and back to the open position must not exceed 15·0 lb. in.

CUT-OFF VALVE LEAKAGE TEST

Close the throttle valve and the cut-off valve and with the outlet unrestricted apply an inlet pressure of 1240 lb. per sq. in. the leakage from the outlet connection must not exceed 15 lb. per hour.

HIGH PRESSURE TEST

During the following test the drain connection must on no account be shut.

With the throttle valve open the high pressure cut-off valve open, and the outlet regulating valve closed apply an inlet pressure of 3200 lb. per sq. in. There must be no visible leakage from the control valve assembly at any point.

LOW PRESSURE TEST

Apply a pressure of 30 lb. per sq. in. at the drain connection. There must be no visible leakage from the control valve seals or any other joint.

FINAL INSPECTION

Upon the satisfactory completion of the tests, the control valve assembly must be submitted to

CALIBRATION TABLE

Valve travel (inches)		ZERO	·1	·2	·3	·4	·5	·6	·7	·8	·85	·9	·925	·95	·975	1·000
Inlet pressure (lb. per sq. in.)		1215	1190	1165	1135	1100	1055	980	885	760	655	493	385	256	162	115
Flow lb./hr.	Min.	740	785	970	1410	1940	2540	3150	3750	4350	4650	4950	5090	5250	5410	5550
	Max.	815	815	1070	1525	2070	2700	3350	3990	4620	4950	5270	5430	5690	6080	6330

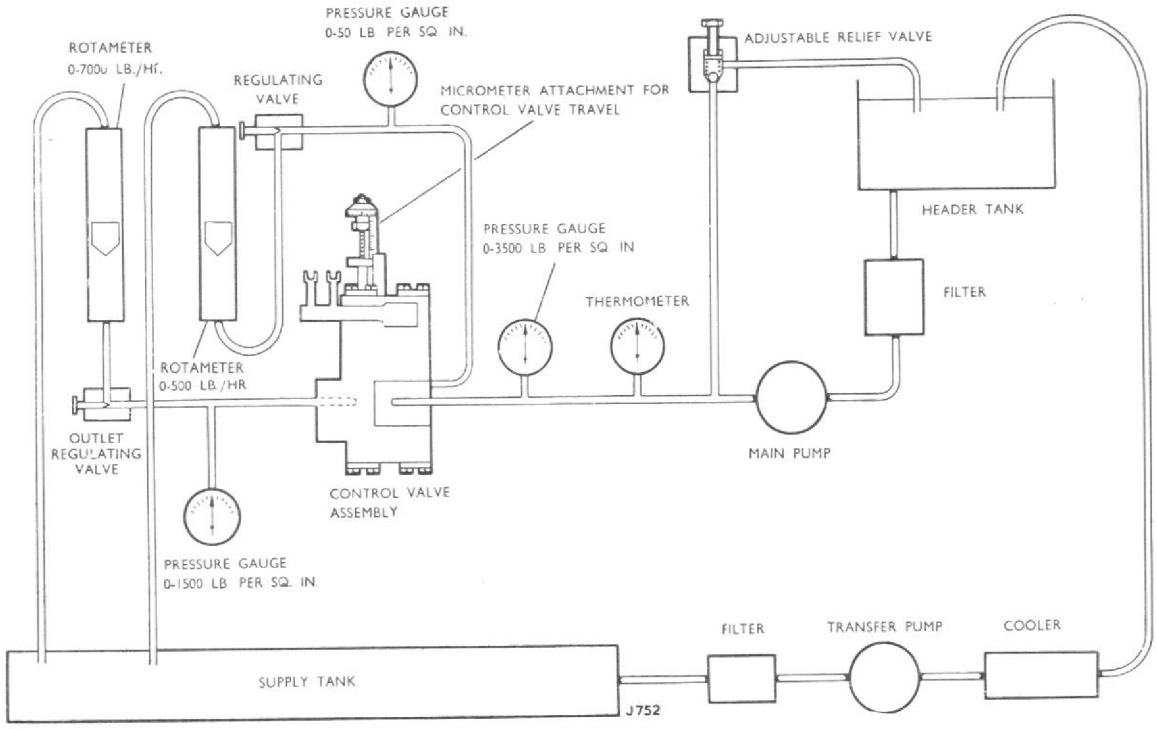


Fig. 10. Diagrammatic layout of test rig.

the inspector concerned for final examination and acceptance.

The inspector must ensure that all nuts and bolts are secure, and also test manually the satisfactory operation of the working parts. It will be noted that all external locking and wiring operations will be carried out at installation.

All relevant information, including the current issue number, must be entered on the job card, which must then be signed for final acceptance of the control valve assembly.

INHIBITING AND PREPARATION FOR DISPATCH

Drain off all surplus fuel after test, and flush through with clean oil to specification DEF.2001, or D.Eng.R.D.2490. Blank off all orifices with approved air-tight blanks. Check all connections and blanks for tightness and wire lock.

Cover any external steel parts with anti-corrosive fluid to specification D.T.D.121 and wrap the complete unit in grease-resisting paper. Pack in approved containers, together with a copy of the test record card.