Chapter 9

LOW PRESSURE SHAFT GOVERNOR, TYPE LPG. 101

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LIST OF ILLUSTRATIONS

Introduction

1. During normal running, the engine is controlled by the fuel control unit sensing the speed of the high pressure (H.P.) shaft as described in Sect. 2 Chap. 14 of this publication. Under certain atmospheric conditions, however, there is a tendency for the low pressure (L.P.) shaft to over-speed; this is controlled by the L.P. shaft governor (fig. 1), which also provides an emergency over-speed control.

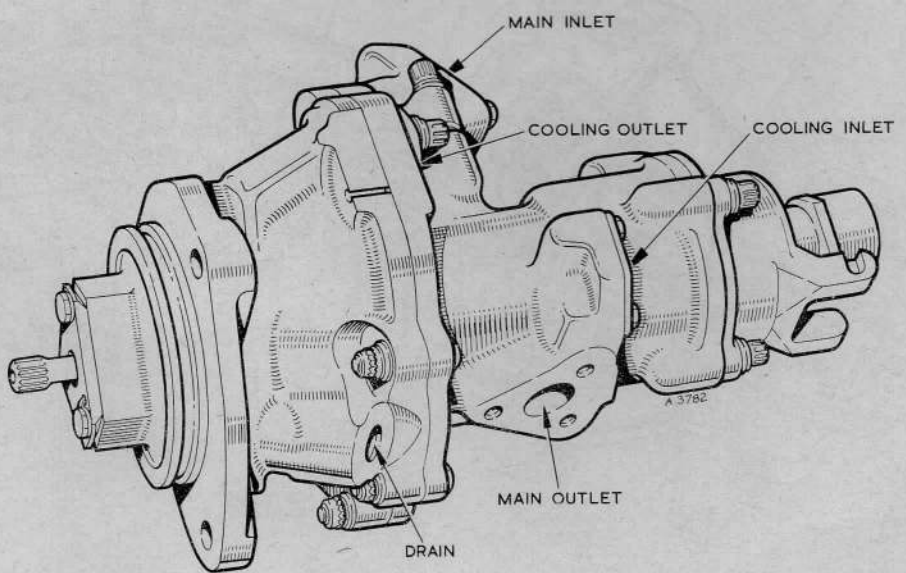

Fig. 1. External view of governor

2. Since the main fuel flow scheduled by the fuel control unit passes to the fuel spray nozzles via the L.P. shaft governor, this unit is able to override the main control in the event of the L.P. shaft overspeed. The governor effects this control by restricting the fuel flow through itself, thus creating an increase in the pressure drop across the H.P. fuel pump servo-piston (Sect. 2, Chap. 14), which reduces the pump delivery and limits the engine speed.

Description

3. The unit consists basically of a centrifugal governor which senses L.P. shaft speed and transmits thrust and rotational movement to a metering plunger which rotates within a closely fitting sleeve drilled with metering ports and outlet ports. Owing to the size and disposition of the metering ports, axial movement of the plunger is capable of altering the fuel system pressure drop, i.e. the H.P. fuel pump servo-piston pressure drop.

4. A dashpot piston fitted at the end of the plunger ensures controlled axial movement, and a spring is provided to balance the centrifugal forces which cause this movement; the loading of the spring may, under certain circumstances, be reduced by means of a datum re-set device.

5. All rotating components run in carbon bearings which eliminate the risk of seizure even though the fuel has very low lubricating properties; the bearings are cooled by fuel which is separate from the main flow.

Centrifugal governor

6. The centrifugal governor consists of a carrier fitted with four flyweights which are ball-race mounted upon pivot pins; these pins are retained by cotter pins; each weight has an arm which bears against the end face of the plunger. This assembly is shrouded to prevent turbulence of the fuel in which the weights rotate.

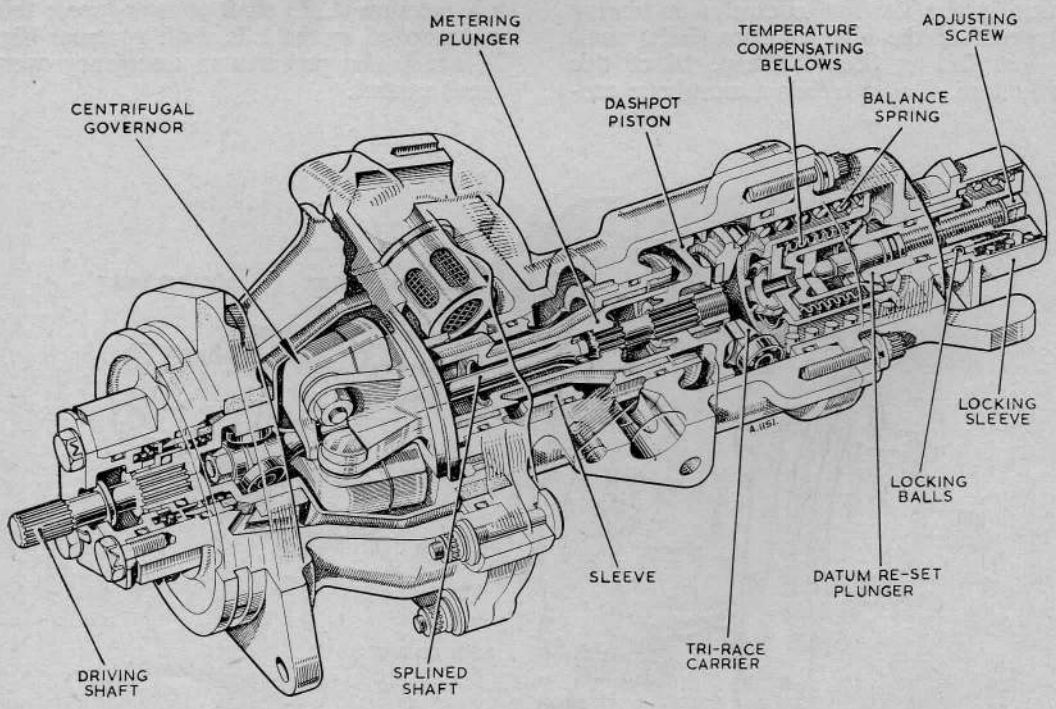

Fig. 2. Cutaway view of governor

7. Rotational drive is transmitted from the governor to the plunger by a small-diameter splined shaft fitted with three small ball races engaging tracks machined in the weight carrier. At the end opposite to the governor, the plunger thrusts against a further tri-race carrier; this part provides a seat for the balance spring, and its three ball races engage tracks machined in the spring housing, thus it will be appreciated that axial movement of the plunger is not affected by side loads from the drive or the spring.

Cooling flow

8. Since the main flow passes through the metering sleeve only, it is necessary to maintain a separate cooling flow around the carbon bearings at each end of the unit. This is done by tapping the bleed circuit of the fuel control unit and leading this fuel into the chamber containing the balance spring; ducts through the governor body communicate with the chamber containing the governor, and an exit connection is provided in this chamber through which the cooling flow passes to the H.P. fuel pump inlet.

9. The cooling flow also has a pressure balancing effect on the plunger, which means that the balance spring can be kept to a reasonable size.

Dashpot piston

10. The dashpot piston gives a controlled rate of axial movement to the plunger, thus avoiding fluctuating performance due to small changes in centrifugal force; the piston is surrounded by the cooling flow and therefore hydraulically damps-out extraneous movement.

Datum re-set device

11. The datum re-set device consists of a re-set plunger which carries an adjusting screw and, under 'in-flight' conditions, is locked in a position which gives the spring its normal operating load. The locking arrangement consists of a number of steel balls which are accommodated within holes in the wall of the spring housing, but which also engage a groove machined around the plunger; a spring-loaded locking sleeve retains the balls.

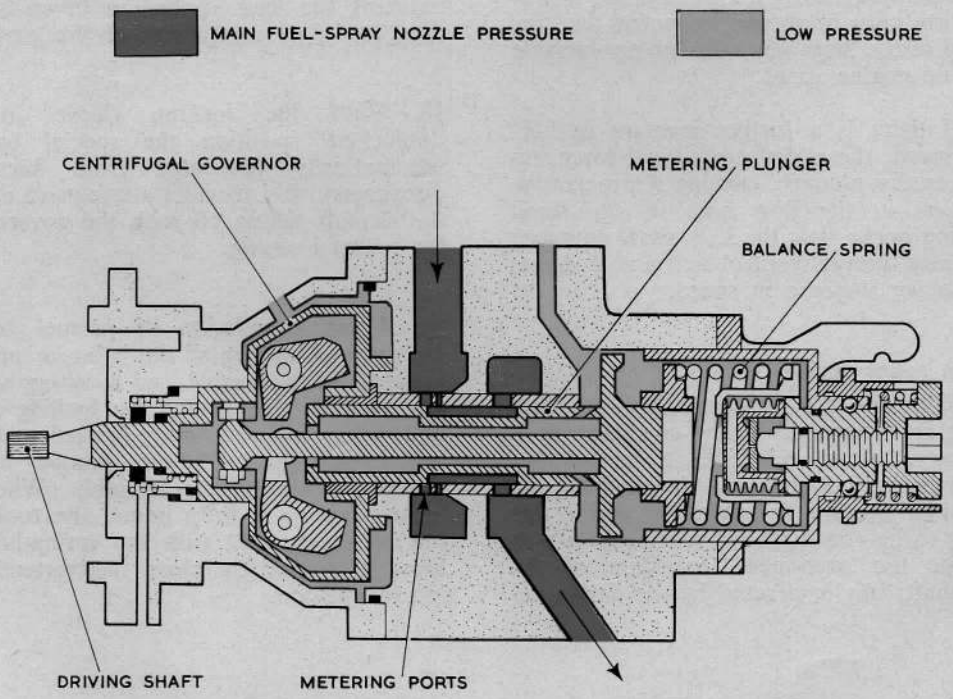

Fig. 3. Functional diagram of governor

12. When adjustment of the balance-spring load is carried out on the test rig, locking of the adjusting screw against vibration is automatic; this is ensured by a retainer which is friction-loaded against the adjusting-screw threads by the locking sleeve spring.

13. The inner face of the retainer has a slotted boss which is engaged by a tongue at the end of the spring housing, thus the retainer is prevented from unscrewing itself off the adjusting screw. A tongue at the end of the re-set plunger also engages this boss, so preventing the plunger from rotating and affecting the adjustment. Correct alignment of the locking sleeve flange is ensured by a slot cut in the sleeve which engages a tab on the retainer.

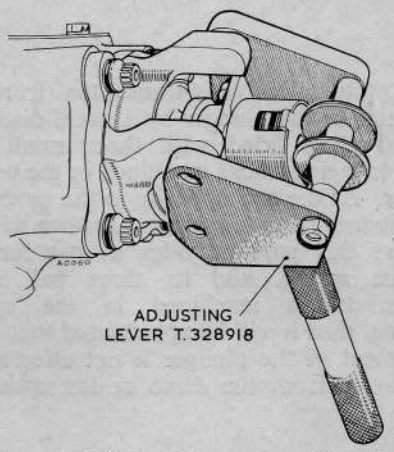

Fig. 4. Using datum re-setting tool

OPERATION

General principle

14. When the speed of the L.P. shaft approaches a pre-determined maximum, the centrifugal effect of the flyweights will have moved the plunger until the large metering ports are covered. The centrifugal force now equals the spring loading, therefore the plunger is in balance; fuel flow, as scheduled by the fuel control unit, now passes to the main fuel spray nozzles via the small metering ports only· it should be noted that the closing of the large ports has no appreciable effect on engine speed.

15. If there is a further increase in L.P. shaft speed, the added centrifugal force unbalances the plunger, causing a progressive reduction in the flow area of the small metering ports; thus the L.P. shaft governor over-rides the fuel control unit and prevents any further increase in speed.

Datum re-set device

16. Since the L.P. governor has no effect during most normal running conditions it is necessary, before each flight, to ensure that the emergency factor is still available by functionally testing the unit. To enable this testing to be accomplished it is necessary to simulate the over-speed condition of the L.P. shaft; this is effected by the datum re-set device which reduces the loading of the balance spring and hence causes the governor to operate at a lower engine speed.

17. When ground testing is to be carried out, a special tool (T.328918) is used which engages lugs on the spring housing (fig. 4) and thrusts the locking sleeve outwards, until a groove in its bore is coincident with the balls. This unlocks the plunger, and the balance spring is able to expand hence reducing the load applied in opposition to the centrifugal component of the governor.

18. With the locking sleeve in the "unlocked" position the special tool is automatically prevented from becoming disengaged; this provides a safeguard against the aircraft taking off with the governor at the reduced setting.

19. Upon completion of ground testing, the original loading of the balance spring is restored by the special tool thrusting against the retainer, this causes the locking sleeve and re-set plunger to move inwards until the balls re-engage with the groove in the plunger, so locking the assembly. When the locking sleeve is fully home, the tool falls out of engagement with the spring-housing lugs, it cannot therefore inadvertently be left in position.