Chapter 4

HIGH-PRESSURE FUEL PUMPS, TYPE GB 2/3 SERIES

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LIST OF ILLUSTRATIONS

Introduction

1. The fuel pump type GB 2/3 is a positive displacement variable stroke multi-plunger type incorporating an amplifier valve mechanism which acts as a relief valve and an overspeed governor. The amplifier valve prevents excessive pressure, such as would occur in the event of an obstruction in the pump delivery line, and the function of the governor is to limit the engine speed to a predetermined maximum. The installation detail and calibration of the pump are denoted by suffix numbers and letters. For example the GB.2/5C pump which is fitted to R.R. Avon engines derives its designation from the installation number '5' and the calibration letter 'C'.

2. To meet the fuel system requirements of certain engines, pumps are fitted in pairs in which instance it is common practice for one pump to incorporate a solenoid servo isolating valve (e.g., the G.B.3/6C, as fitted to the R.R. Avon engine). Each pump is a self-contained unit with a common delivery and with the servo control system of each pump interconnected. In the event of any defect causing excessive leakage in the common servo control system the otherwise reduced delivery from both pumps (which normally deliver approximately equal quantities) is obviated by the solenoid valve which is provided for use in such emergencies. It enables the servo system of an inoperative pump to be isolated thereby permitting full delivery from the remaining pump.

3. The description in the following paragraphs cover the GB 2/3 Series fuel pumps generally; the type of pump used with any particular engine is specified in the Leading Particulars of the engine Air Publication.

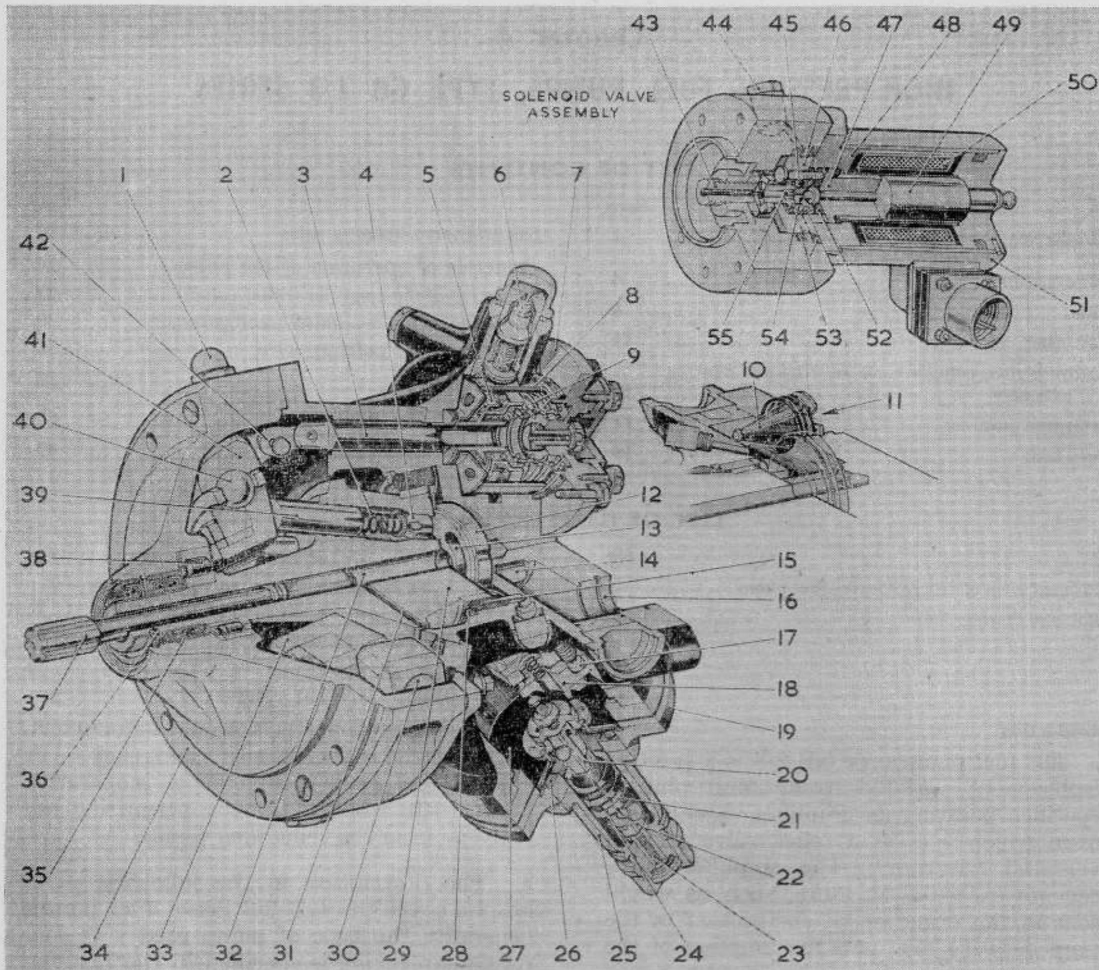
DESCRIPTION

4. The pump is driven off the engine and for calibration 'C' has a delivery of 600-610 gallons per hour at a pump speed of 5,250 r.p.m., at a pressure of 1250 lb. per sq. in.; the stall pressure is set between 1800 and 2100 lb. per sq. in. The dry weight of the basic unit is 13 lb. 2 oz. and this weight is increased to 14 lb. 14½ oz. with the solenoid valve fitted.

5. The pump is illustrated in fig. 1, 2, 3 and 4 and reference should also be made to the schematic diagram (*fig.* 3) in Chapter 1 and fig. 2 of Chapter 2.

Rotor

6. The rotor (*fig.* 2) is fitted at either end with plain sleeves which form bearing journals. The larger diameter journal runs



1 BLEED VALVE	20 FORKED MEMBER (INNER)	38 ROLLER BEARING
2 RETURN SPRING	21 SPRING ASSEMBLY	39 PISTON
3 PISTON ROD	22 FORKED MEMBER (OUTER)	40 CAMPLATE BEARING
4 SPRING GUIDE	23 ADJUSTING SCREW	41 CONTROL RING
5 CONTROL PISTON	24 HELICAL SPRING	42 LINK
6 RESTRICTING ORIFICE	25 SPRING HOUSING	43 STOP
7 END COVER	26 SPACE BELOW DIAPHRAGM	44 OUTLET TO ALTITUDE CONTROL UNIT (SERVO)
8 STEEL LINER	27 DIAPHRAGM	45 SPRING
9 SPRINGS	28 CIRCLIP	46 VALVE CARRIER
10 GAUZE STRAINER	29 ROTOR	47 PUSH ROD
11 PUMP INLET	30 TRUNNION	48 SOLENOID FIXING PLATE
12 PORT INSERT	31 RADIAL DRILLING	49 SOLENOID PLUNGER
13 KIDNEY SHAPED PORT	32 AXIAL BORE	50 SOLENOID WINDING
14 PUMP OUTLET PASSAGE	33 CAMPLATE	51 SOLENOID CASE
15 CARBON BEARING	34 CAMPLATE HOUSING	52 VALVE CHAMBER
16 PUMP OUTLET	35 OIL SEALS	53 OIL SEALS
17 HALF BALL VALVE	36 CIRCLIP	54 VALVE PLATE
18 ROCKER LEVER	37 SPLINED QUILL SHAFT	55 ORIFICE
19 COVER PLATE		

Note.—On the G.B. 3 type the solenoid valve assembly (43-55) replaces the control piston cylinder cover (7) fitted on G.B. 2 types.

Fig. 1. Sectioned view of G.B. 2/3 Series fuel pump

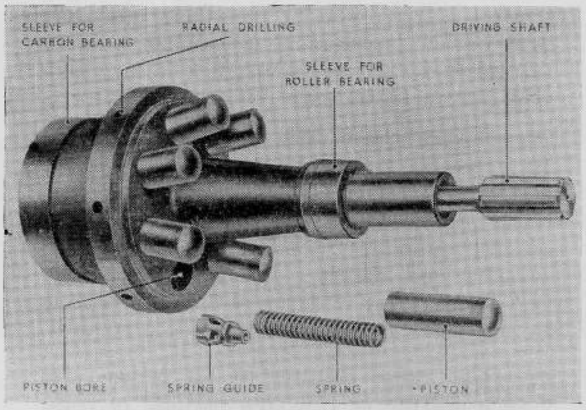


Fig. 2. Rotor and driving shaft

in a carbon bearing (15, *fig.* 1), which is secured in the main pump body by a circlip (28); the smaller journal runs in a roller bearing (38) carried in the camplate housing (34), which is spigoted into the pump body and secured by screws and nuts.

7. The driving shaft (37) is fitted into the axial bore of the rotor, its quill form preventing any slight misalignment from stressing the pump components.

8. Three U-sectioned synthetic rubber seals (35) with garter retaining springs together with spacers and washers are fitted over the drive shaft to prevent leakage from the pump and to ensure that lubricant from the drive housing does not enter the pump.

9. The rotor (29) has seven inclined cylinders accommodating hardened steel pistons (39). The pistons have helical return springs (2) fitted beneath them which are carried on spring guides (4) located on flanges at the inner ends of the piston bores.

10. Seven radial drillings (31) extend from the central axial bore of the rotor to its periphery. These drillings provide a means of producing the pressure required to operate the overspeed governor.

Port insert

11. A disc-shaped port insert (12) is fitted at the end of the rotor housing and is located by a dowel. The insert has two kidney-shaped ports (13) (one port only being shown in fig. 1), communicating respectively with the inlet and outlet passages of the pump body. The insert forms a high pressure seal to the end face of the rotor.

Control piston, camplate control ring and bearing assembly

12. The control piston, camplate, control ring and bearing assembly is shown in fig. 3. The radiused heads of the pistons (39, *fig.* 1) locate against a hardened steel camplate (33) which is free to rotate on large steel ball bearings (40) in the control ring (41).

13. The control ring has two spigots on the outside diameter to form trunnions (30); these are pivoted in blocks which are interposed between the camplate housing and the pump body and located with dowels to the latter. This allows the inclination of the camplate to be altered and hence the stroke of the rotor pistons varied.

14. The control piston (5) is a disc-shaped member forming an integral part of the piston rod (3) and is fitted with a synthetic rubber seal on its periphery. It is located in a cylindrical housing, in the main pump body, to which is fitted a liner (8). The end of the rod remote from the piston has a forked end in which is pinned a link (42). This link pivots in the forked end of the rod and is secured to an integral fork on the camplate control ring.

15. Helical springs (9) are fitted between the control piston (5) and the cylinder cover (7), which is secured to studs in the pump body with nuts. These springs bias the piston towards that end of the cylinder remote from the cover.

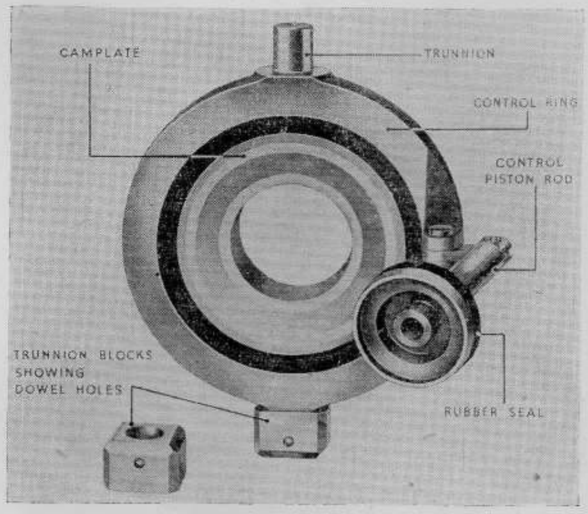


Fig. 3. Control piston, camplate control ring and bearing assembly

16. The ends of the cylinder on either side of the piston are connected by a passage in which is fitted a restricting orifice (6).

Overspeed governor

17. The diaphragm (27, *fig.* 1) of the overspeed governor is interposed between a flange in the pump housing and the cover plate (19), the cover plate being secured to the studs in the flange by nuts. In the centre of the outer face of the diaphragm is a forked member (20) to which is attached one end of a helical spring (24) which loads the diaphragm. The other end of the spring is secured in a second forked member (22) carried in a cup-shaped housing (25) fitted on the cover plate (19). An adjusting screw (23) in the outer forked member (22) enables the diaphragm loading to be varied as required.

18. The centre of the inner face of the diaphragm is provided with a hardened steel button which contacts the end of a spring-loaded rocker lever (18). The opposite end of the lever is fitted with a tungsten carbide half-ball valve (17) which seats on an orifice fitted in the base of the amplifier valve assembly and which is in direct communication with the outer end of the control piston cylinder. A view of the amplifier valve assembly is shown in fig. 4.

Main body

19. The main body of the pump is of light alloy construction and is sub-divided into three main chambers for the rotor, diaphragm and control piston assemblies. Passages in the main body connect the rotor, diaphragm, control piston cylinder chambers and inlet and outlet passages. A conical filter is provided in the inlet passage, and a cylindrical filter is fitted under the control orifice.

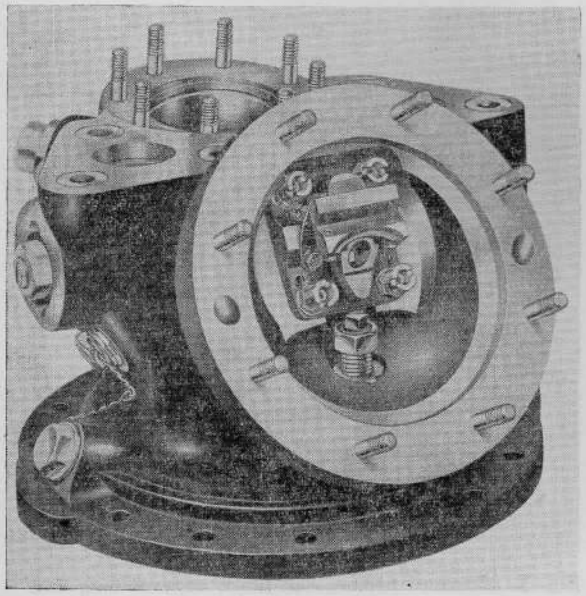


Fig. 4. View of amplifier valve assembly

Solenoid servo isolating valve

20. Certain applications necessitate the fitting of a solenoid servo isolating valve to the pump and this is fitted on the end of the control cylinder in place of the normal cylinder end cover. The valve assembly (*fig.* 1, inset) has an outlet (44) for connecting to the servo valve of the altitude control unit.

21. The valve consists of an orifice (55) with a seating of tungsten carbide in communication with the pump servo cylinder through which fuel is normally fed at servo pressure to the altitude control unit. When the solenoid (50) is energised, a valve plate (54) which is normally held clear of the orifice by a spring (45) is moved by the solenoid plunger (49) and push rod (47) to close the orifice.

22. The orifice is incorporated in the valve carrier (46) which, together with the solenoid fixing plate (48) forms the valve chamber (52).

23. Normally when the valve is open, fuel passes from the pump servo cylinder via the axial hole in the stop (43) (which limits movement of the control piston) and the axial hole in the orifice (55) into the valve chamber (52). From this chamber communication is made with the altitude control unit servo connection via a drilling in the valve carrier to a groove in its outer periphery bounded by seals (53) and thence to the altitude control unit connection (44) by means of a drilling in the control cylinder end cover.

PRINCIPLE OF OPERATION OF THE PUMP

24. Under operating conditions the functioning of the fuel pump is inter-dependent on the action of the altitude control unit and the throttle control. The operation of the fuel pump should be read in conjunction with the description of the complete fuel system in Chapter 1 of Section 1. Reference should also be made to fig. 3, Chap. 1 of this section.

25. The rotor is driven by its splined quill shaft which engages with an engine accessory drive. The pistons are maintained in contact with the camplate face by the helical return springs and due to the inclination of the camplate and the rotation of the rotor the reciprocating motion of the pistons, produces the pumping action.

26. Fuel is fed into the body of the pump through the inlet passage (11) and passed into the pump rotor cylinders and axial bore via the inlet port of the insert (12); the fuel also passes to the amplifier valve on the underside of the diaphragm (27). As the rotor revolves the piston in the cylinder to which fuel is being supplied moves outwards towards the end of its suction stroke, as determined by the inclination angle of the camplate. On completion of the suction stroke the piston motion is reversed and fuel at high pressure is ejected, via the outlet port of the insert (12) to the pump outlet (16). This cycle of operations is repeated in turn for each of the seven pistons in the rotor.

Operation of the amplifier (relief valve)

27. A passage off the pump outlet duct feeds fuel into the servo control cylinder below the piston, a second passage from the outlet duct supplies fuel via a restricting orifice to the upper side of the piston.

A duct from the cylinder on the outer side of the piston is normally closed by the amplifier valve (17) when the control piston is in a state of pressure balance; the camplate is then at maximum inclination due to the loading of the helical springs (9) interposed between control piston and end cover.

28. When the fluid pressure on the side of the control piston remote from the helical springs exceeds the loading of the spring of the rocker lever (18), the half ball valve (17) will open and the servo fluid thus spilled will cause a pressure drop across the restricting orifice (6) and accordingly on the inner side of the control piston (5).

29. The pressures on either side of the control pistons are thus unbalanced causing the piston to move and so reduce the inclination of the camplate and hence the rotor piston stroke and pump delivery. By this means the pump is safeguarded against excessive pressures.

Operation of the maximum speed governor

30. The overspeed governor assembly consists of the spring-loaded flexible diaphragm (27) which, under certain conditions, operates the valve (17) through the rocker lever (18). The governing pressure required to operate the diaphragm is provided by the centrifugal pressure rise set up by the ejection of fluid from the central axial bore (32) of the rotor via the radial drillings (31) in the rotor. This centrifugal pressure rise acts on the outer side of the diaphragm and is opposed on the other side of the diaphragm by fluid at pump inlet pressure plus the tension exerted by the spring (24).

31. Rotation of the rotor will cause the pressure of the fluid in the pump housing surrounding the rotor, also that directed through two ducts in the main pump body (shown in fig. 4) on the outer side of the diaphragm to exceed the pump inlet pressure on the other side of the diaphragm by an amount proportional to the square of the rotor speed.

32. At a pre-determined rotor speed the centrifugal pressure rise operating on the outer side of the diaphragm (27) is sufficient to move the diaphragm against the spring assembly (21). Movement of the diaphragm will depress the rocker lever (18) to cause the valve (17) to be lifted from its seat. This will result in a reduced output from the pump as already described in para. 28 and 29, until the governed speed is restored, when the valve will reseat.

33. The pump speed at which governing commences is set accurately by an adjusting screw (23) which varies the loading of the diaphragm spring (24).

34. When the engine speed is decreased by throttling back, thereby reducing the supply of fuel to the burners, the centrifugal pressure acting on the outer side of diaphragm (27) is also reduced. This results in an upward movement of the diaphragm, which allows the rocker lever (18) to move and close the valve (17). The pressure on the spring side of the control piston is thus increased and the resultant movement of the piston will cause the camplate (33) to move and increase pump stroke.

Operation of the isolating valve

35. Reference to fig. 2, Chapter 3 of this section should be made to observe the effect of operation of the solenoid valve on the fuel system generally. When the solenoid is energised to close the valve and thereby isolate the servo system of one pump from any exterior bleed, the isolated pump will deliver fuel as controlled by its own servo system. This will mean that if operating correctly the pump will be at full stroke, while the other pump will deliver fuel as controlled by its servo system in conjunction with the altitude control unit.

36. As the combined pump delivery pressure acts on the altitude control unit, any change in pressure will cause the altitude control unit to attempt to compensate for that change by increasing or decreasing the fuel flow of the only pump it now controls. Operation of the isolating valve will thus separate the flow control of the two pumps, making one available in the event of defective operation of the other servo system. With no defect in the fuel system, full combined pump delivery is always available.

37. A more detailed description of the isolating valve in relation to the entire fuel system components of the engine is given in the relevant engine Air Publication.

INSTALLATION

38. Installation details are fully covered in the relevant engine Air Publications.

INHIBITING AND PACKING

39. This procedure is as described in Vol. 2, Part 3, Sect. 2, Chap. 1.

SERVICING

40. The servicing instructions given in Chap. 1 of this section are applicable but note that the bleed valves are provided either on the upper periphery of the camplate housing or adjacent to it in the pump body.

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LIGHTNING
COVER PITOT HEAD