Chapter 10

HIGH PRESSURE FUEL PUMP, TYPE G.B.B. SERIES (with centrifugal governor)

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LIST OF ILLUSTRATIONS

Introduction

1. The G.B.B. series of fuel pumps are of the multi-plunger type and are capable of developing high pressures, particularly at low speeds. The volumetric capacity of the seven plungers is variable through a stroke mechanism incorporating a servo control. Fuel delivery is regulated by an automatic speed and excess pressure control valve.

2. The constructional features of the pumping element ensure smooth running irrespective of the non-lubricating nature of such fuels as aviation gasoline.

3. At normal rated speeds and delivery pressures a fuel flow of over 400 G.P.H. is available; the average dry weight of the unit is approximately $8\frac{1}{2}$ lb.

4. The letters G.B.B. are type symbols, the last letter, i.e. "B" is the dimensional classification of the pistons and, therefore, an indication of the pump capacity, so that performance details are similar to pump type G.B.200, described in chapter 6. Identification series number following the basic type symbols indicate a particular model of the series; installation and calibration details vary according to the engine requirements and they are indicated by a suffix number and letter i.e., a typical unit is designated G.B.B. 6/1Y, thus the type is "6", installation code "1" and calibration code "Y".

5. Installation differences include connections for fuel control units or gauge recording points and are located off the camplate housing, pump body and diaphragm cover.

6. Certain types within this series are arranged for special purposes but this description is based upon a standard reference model i.e. GBB.6.

DESCRIPTION

7. The pump is housed within two light-alloy castings (fig. 2 and 3). The larger casting is the body (4) which houses the bulk of the pumping element. The smaller casting encloses the camplate and forms a cover (2) to the body; it also has an attachment flange, for installing the pump to the engine wheelcase.

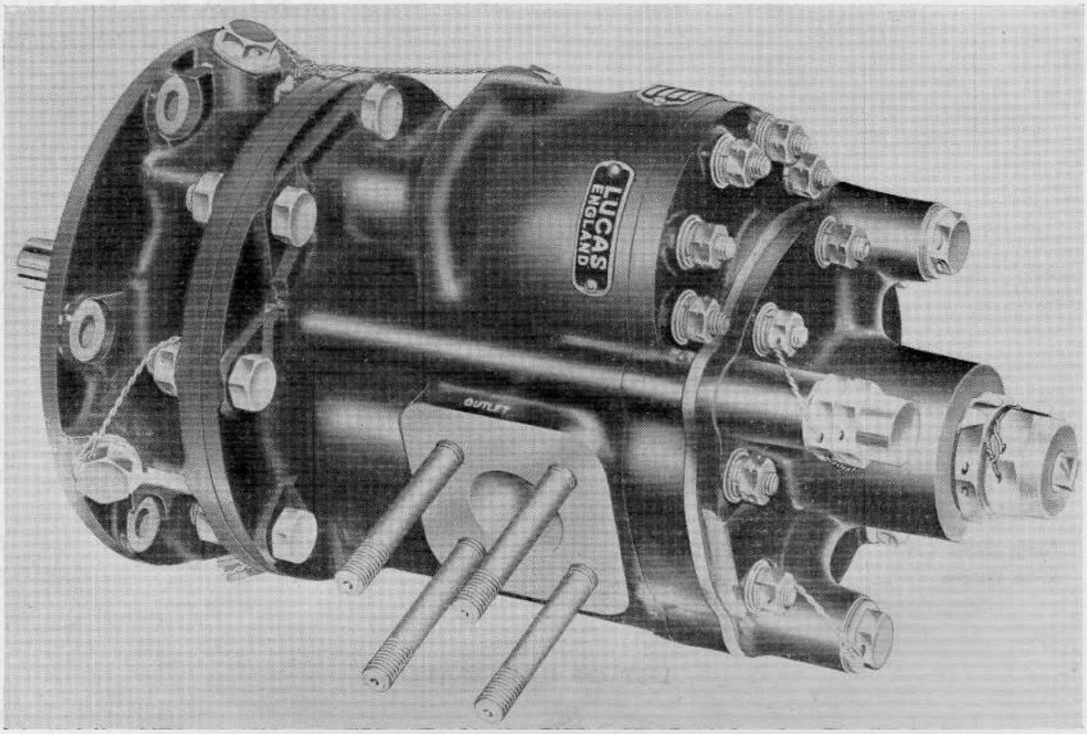


Fig. 1. General view of G.B.B. Series fuel pump

8. Between the circular joint flanges of the body and the camplate cover a gasket is fitted and the two casings are secured by eight nuts and bolts.

9. A frustum shaped rotor (19) with an attached drive shaft is positioned within the body and camplate cover. The rotor is located within the body and is supported by a large carbon bearing (9) which is locked by a circlip; an extension to the rotor together with the drive shaft is supported within the camplate cover by a small carbon bearing (23) and locked by a circlip.

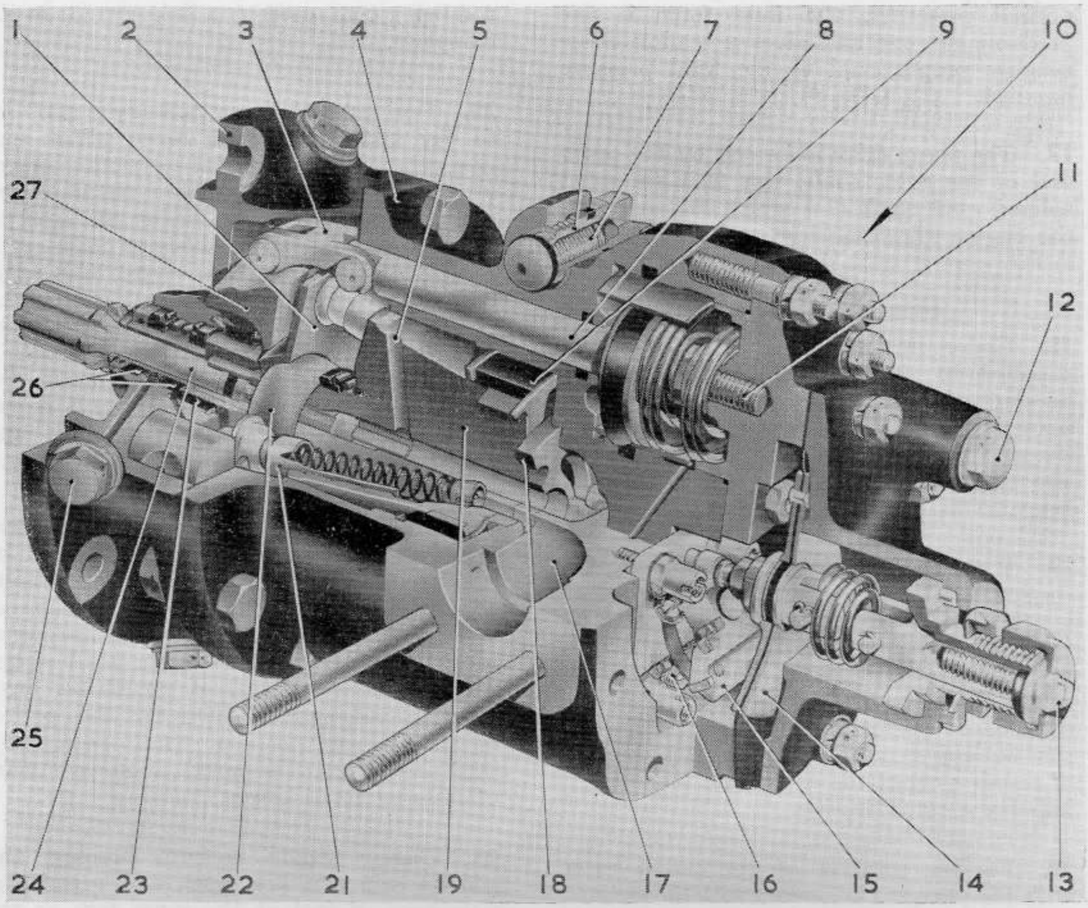
10. To prevent leakage of fuel or ingress of lubricating oil, the shaft aperture in the camplate cover has two carbon faced seals which are fitted with sealing rings (26) and are spring loaded. Leakage between the rotor and shaft splines is prevented by a rubber seal housed in a groove in the shaft.

11. The rotor has seven equally spaced inclined bores, each housing a spring-loaded plunger (21). The heads of the plungers are ball shaped and accommodate a plated slipper head which forms a socketed joint to permit free angular movement.

12. The plunger slipper heads are located against a shaped non-rotating camplate (27) which pivots on two trunnion bearings and allows the angle of inclination to be varied.

13. An auxiliary camplate (1), supports each plunger slipper against the camplate face. It rotates with the rotor and is mounted upon a spherical thrust ball (22) which is spring-loaded against the rotor extension; the auxiliary camplate assists the suction stroke of the plungers and prevents chatter.

14. A small central hole, drilled through the ball-shaped head from the hollow interior of each plunger, feeds a cooling supply of fuel to the underside of the slipper heads; the latter are similarly drilled to allow a graduated supply of fuel to reach the bearing surface of the camplate for lubrication and cooling.



1 AUXILIARY CAMPLATE
2 CAMPLATE COVER
3 LINK FORK
4 BODY
5 RADIAL PORTS
6 SERVO PRESSURE RESTRICTING ORIFICE
7 STRAINER
8 SERVO CONTROL ROD AND PISTON
9 CARBON BEARING (LARGE)
10 INDICATION OF FUEL INLET PORT POSITION
11 MINIMUM STROKE ADJUSTING SCREW
12 ALTERNATIVE AIR BLEED VALVE POSITION
13 GOVERNOR ADJUSTING SCREW
14 SPACE BEHIND DIAPHRAGM
15 ROCKER LEVER
16 SERVO CONTROL ORIFICE
17 FUEL OUTLET
18 KIDNEY SHAPED FUEL PORT
19 ROTOR
21 PISTON WITH ATTACHED SLIPPER HEAD
22 THRUST BALL
23 CARBON BEARING (SMALL)
24 SPLINED QUILL SHAFT
25 OIL SEALS DRAIN
26 OIL SEAL RINGS
27 CAMPLATE

Fig. 2. Sectional view of pump

15. The rotor plunger bores are plated to resist wear and are machined with annular grooves to retain fuel and reduce frictional contact.

16. The lower areas of the bores are stepped in diameter, and the smaller inner ends terminate as seven ports in the flat face of the rotor, which locates against a hardened port-insert (18). The latter is positively retained and has two kidney shaped ports which communicate respectively, with the fuel inlet and delivery ports. A pressure tight seal is made by the rotor being pressed against the insert (18), by the force exerted by the seven plunger return springs

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and the fluid pressure acting upon the stepped portions of the plunger bores. At normal pressures, the fluid force is the predominant one and gives a sealing effect roughly proportional to the fluid pressure handled.

17. The pump drive is formed by the outer end of the rotor shaft, this is a six sided splined quill shaft (24) which engages with the engine wheelcase drive.

PRINCIPLE OF OPERATION

18. Under normal operation the fuel is supplied to the inlet port at a boosted pressure of up to 15 lb. per sq. in. It then passes through a strainer and to the kidney shaped fuel port. The fuel inlet passage is also ducted to the rocker lever chamber beneath the governor diaphragm.

19. With the rotation of the pump, the suction stroke of the plungers is provided by their outward movement due to centrifugal force acting along their inclined axes together with the loading of the plunger return springs. The pump therefore is capable of satisfactory operation under an inlet depression but this is not desirable for long periods of running, when the life of the pump is an important consideration.

20. Further rotation of the pump rotor with the plungers in contact with the inclined camplate face will reverse the motion of the plungers which will move inwards, to eject fuel through the kidney shaped outlet port. Each plunger will thus complete one suction and one delivery stroke for the complete rotation of the rotor.

Pump stroke control

21. Pump stroke (i.e. volumetric capacity of the plungers) and therefore pump output, is varied through a servo pressure system. Control orifices are sometimes used to apply trims and these orifices may be situated either within the pump itself or within a control unit forming part of a particular fuel system. This description is applicable to the pump where one control orifice serves a dual purpose as described in para 27 to 30.

Servo System

22. Control of the pump stroke is effected through a servo mechanism (fig. 3). A servo piston with an integral piston rod is accommodated in the pump body, the piston rod being connected by a link arm (3) to the camplate.

23. Fuel pump delivery pressure is supplied to the underside of the servo piston and also, via a servo pressure restricting orifice (6), to the head of the servo piston. Two compression springs located at the head of the piston move this assembly to position the camplate at its maximum angle; this angle is set by a screw (20) during calibration. A bleed of servo pressure from the chamber above the piston head, passes through a control orifice and varies the pressure on the underside of the piston. This causes movement against the spring loading and progressively reduces the camplate angle.

24. The orifice controls the bleed of servo pressure according to an excess speed or pressure signal. This orifice assembly consists of a rocker lever with a half-ball valve at one end sealing a passage in communication with the servo pressure at the head of the piston. The other end of the rocker lever is depressed and deflected by the action of the speed control (see para. 29). The rocker lever is mounted on two pairs of cross torsional hinges.

25. During steady uniform running, the control orifice is just open and permitting a leakage of fuel at the same rate as the pressure is made up through the restricting orifice (6). This allows the servo piston to remain stationary and maintain a constant pump output.

26. Movement of the servo piston is arranged to control the camplate angle from zero, i.e. when the camplate is 90 deg. to the rotor axis, through approximately 15 deg. to give maximum piston stroke.

Maximum pressure control

27. When acting as a maximum pressure control valve (relief valve), any excess pressure, such as that caused by a line blockage, or the inadvertent closing of the high pressure cock, will be felt in the servo pressure system beneath the half-ball valve. This causes the valve to lift from the orifice seat and allows the servo pressure to escape to the pump inlet, thus effecting a reduction in both pump output and pressure.

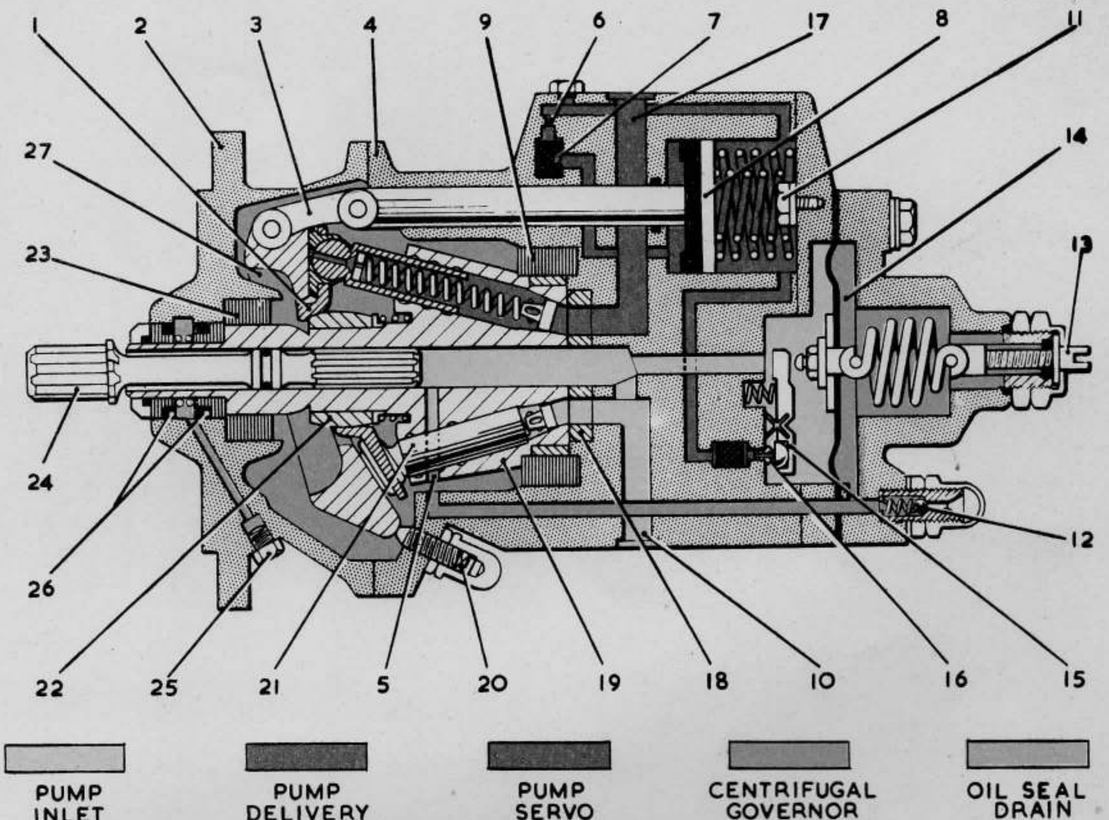

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Fig. 3 Schematic diagram of G.B.B. series fuel pump

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Maximum speed control

28. When functioning as part of the speed control, the half-ball is arranged to be lifted by a force which is related to the speed of rotation of the pump rotor.

29. From the fuel inlet port a passage is taken along the centre of the rotor and a series of radial ports (5) in the rotor body connect this passage with the interior of the pump body. On rotation a centrifugal pressure rise is generated within the pump body casing, this force is transferred through a drilling to one side of the flexible diaphragm (14), loaded by a spring which is connected to the governor adjusting screw (13). When the centrifugal force is sufficient to exceed the spring loading, the diaphragm is deflected and a small hardened button in the centre of the diaphragm contacts the end of the rocker lever and lifts the half-ball valve.

30. This will allow fuel to bleed through the control orifice from the servo pressure chamber, causing the servo piston to reduce the angle of the camplate and thereby decrease the stroke of the pistons. The amount of fuel delivered will also be reduced to prevent any further increase in speed.

INSTALLATION

31. The cleanliness of the fuel is most important and adequate filtering should be provided, particularly in the suction line to the pump.

32. The fuel ports are situated on opposite sides of the pump body casting and are clearly marked INLET and OUTLET. Viewed from the rear end with the servo piston cover uppermost, the inlet port (10) is on the right at 90 deg. to the line of the drive shaft and rotor, and the outlet port (17) is similarly located on the left of the body casting.

33. Installation details vary according to engine requirements, specific information being given in the relevant engine Air Publication. The direction of rotation of the drive shaft is clockwise when viewed from the end of the shaft.

INHIBITING AND PACKING

34. The pump must be inhibited in accordance with the instructions contained in A.P.4471A.

35. Fit packing gaskets over the fuel ports, attach the specially shaped blanking plates and secure them with slave washers and nuts. Screw dust caps on exposed connections and carefully pack the unit in a suitable container.

SERVICING

36. An air bleed valve (12) is provided on the diaphragm cover and use of this, together with the setting of the governor adjusting screw is the only routine servicing which is permitted.

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