Chapter I

H.P. FUEL PUMP, TYPE GC12 SERIES

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LIST OF ILLUSTRATIONS

Introduction

1. The fuel pump type GC12 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, as would occur in the event of an obstruction in the pump delivery line, and the governor limits the engine speed to a safe maximum. The installation detail and calibration of the pump, which may vary according to differing engine requirements, are denoted by suffix letters and numbers. For example, the GC12/7K pump, which is fitted to Derwent Mk. 5 engines, derives its designation from the installation number "7" and the calibration letter "K". The following description applies to all pumps of the GC12 series, and the type of pump used with any particular engine is usually specified in the Leading Particulars of the engine Air Publication.

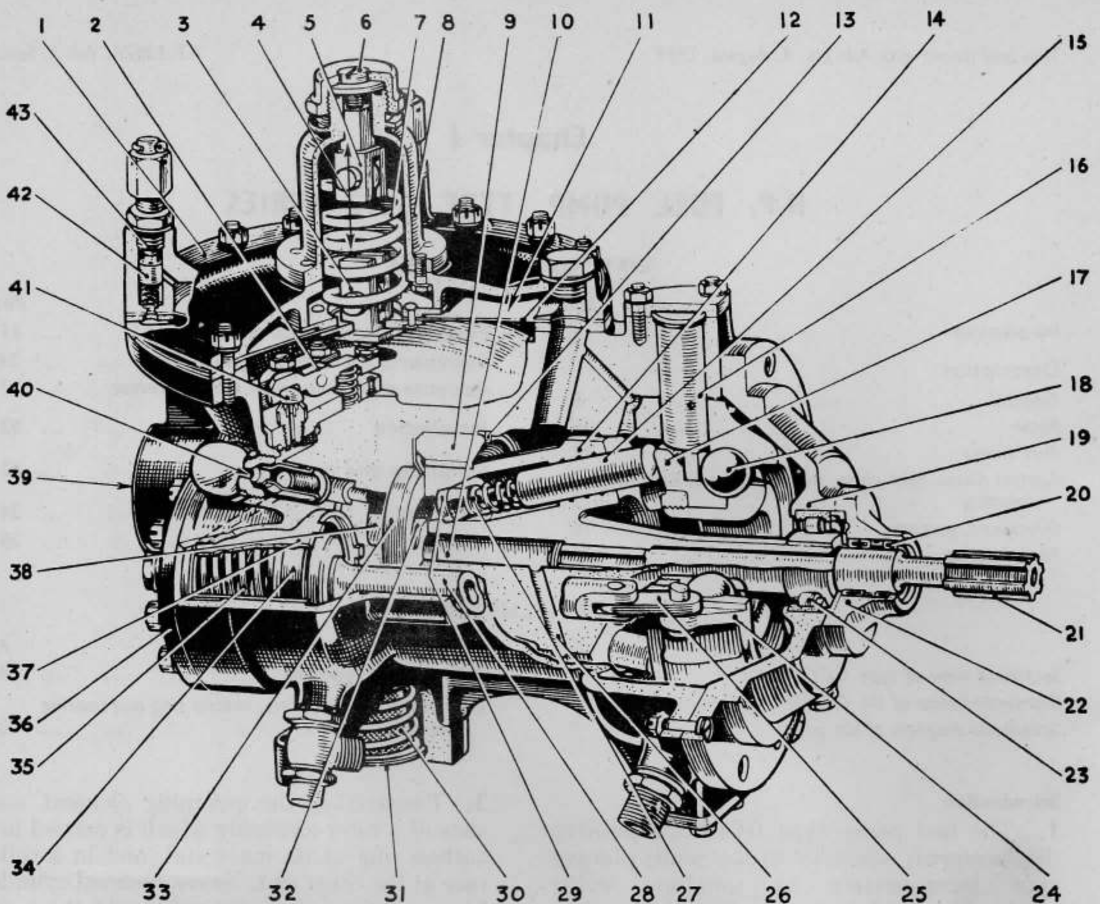
DESCRIPTION

General

2. The pump is driven off the engine and, for calibration "K", has a delivery of 610 gallons per hour, at a speed of 3,500 revolutions per minute, at a pressure of 1,400 lb. per sq. in. The dry weight of the pump is 14 lb.

3. Essentially, the pumping element consists of a rotor assembly which is carried in a carbon ring at its inner end, and in a roller race at the other end. Seven inclined cylinder bores are formed in the rotor and these are fitted with pistons, springs and spring guides. The ends of the pistons, which project from their bores, press against a cam-plate carried on ball bearings in a control ring. The control ring is mounted on trunnion pins, and its position relative to the pistons can be varied through an angle of approximately 15 deg. The piston bores in the rotor are stepped in diameter at their inner extremity and terminate as seven ports in the face of the rotor in contact with a port insert. Two kidney-shaped ports provided in the insert lead respectively to the inlet and outlet passages of the pump.

4. The pump plunger stroke, which determines pump output, is controlled by a servo system which includes a control piston carried in a housing integral with the main pump body. Movement of the piston is transmitted to the control ring by a piston rod and link. Springs on the outer side of the piston bias the piston and consequently the cam-plate, into the position giving maximum delivery of the pump. The inner side of the piston is connected directly to the delivery side of the pump and also communi-



1 COVER PLATE
2 ROCKER LEVER
3 FORKED MEMBER
4 SPRING ASSEMBLY
5 FORKED MEMBER
6 ADJUSTING SCREW
7 HELICAL SPRING
8 HOUSING
9 CARBON RING
10 AXIAL BORE
11 SPACE ABOVE DIAPHRAGM
12 DIAPHRAGM
13 CIRCLIP
14 ROTOR
15 PISTON
16 TRUNNION PIN
17 CAM-PLATE
18 CAM-PLATE BEARING
19 CAM-PLATE HOUSING
20 OIL SEALS
21 SPLINED QUILL SHAFT
22 SEAL HOUSING
23 ROLLER BEARING
24 CONTROL RING
25 LINK
26 RADIAL DRILLING
27 RETURN SPRING
28 PISTON ROD
29 SPRING GUIDE
30 GAUZE STRAINER
31 PUMP INLET
32 KIDNEY-SHAPED PORTS
33 PORT INSERT
34 CONTROL PISTON
35 SPRINGS
36 END COVER
37 STEEL LINER
38 OUTLET PASSAGE
39 PUMP OUTLET
40 RESTRICTING ORIFICE
41 HALF-BALL VALVE
42 PISTON
43 BLEED VALVE

Fig. 1. Sectioned view of type GC12 pump

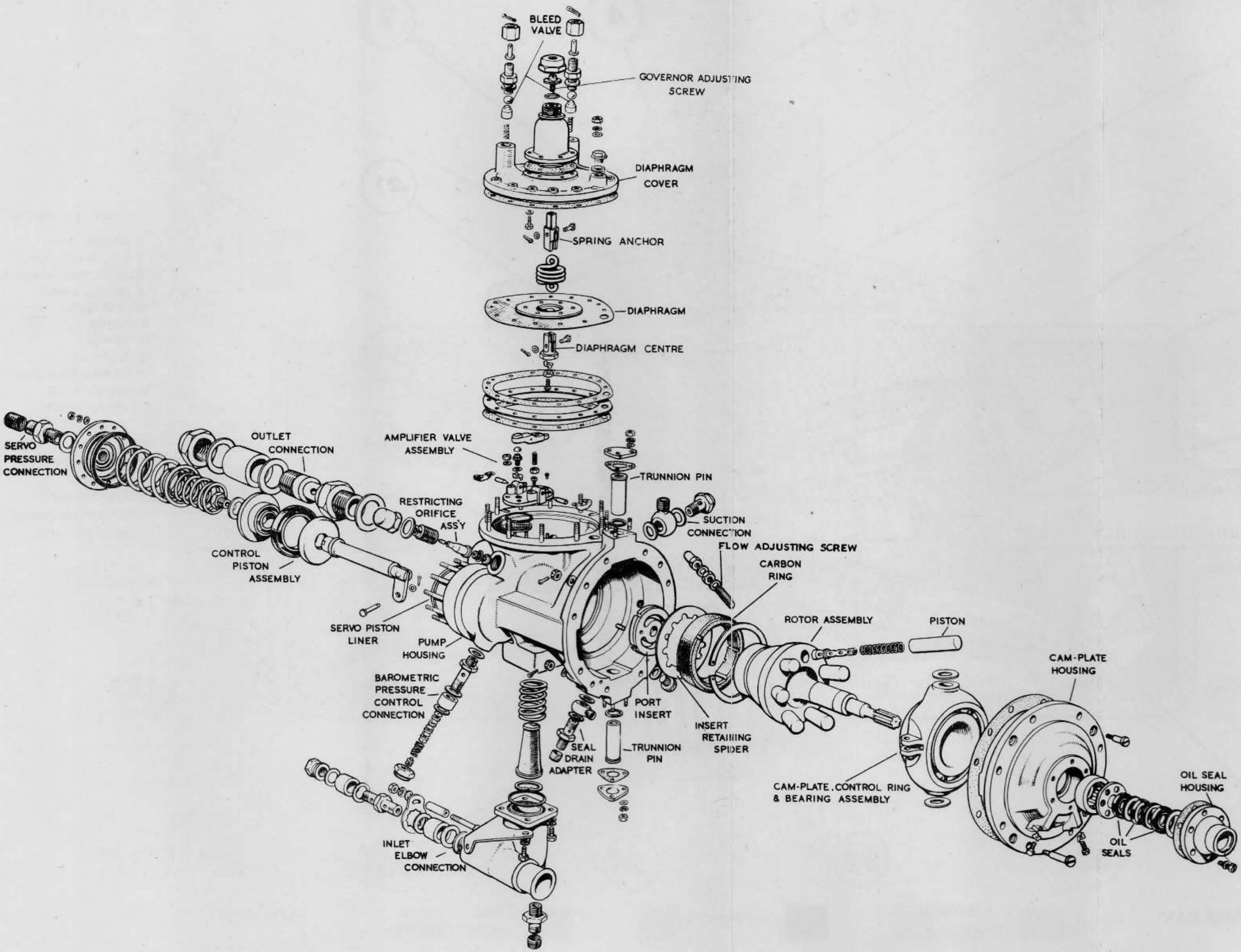


FIG. 2. DISMANTLED VIEW OF THE GC 12/7K TYPE PUMP

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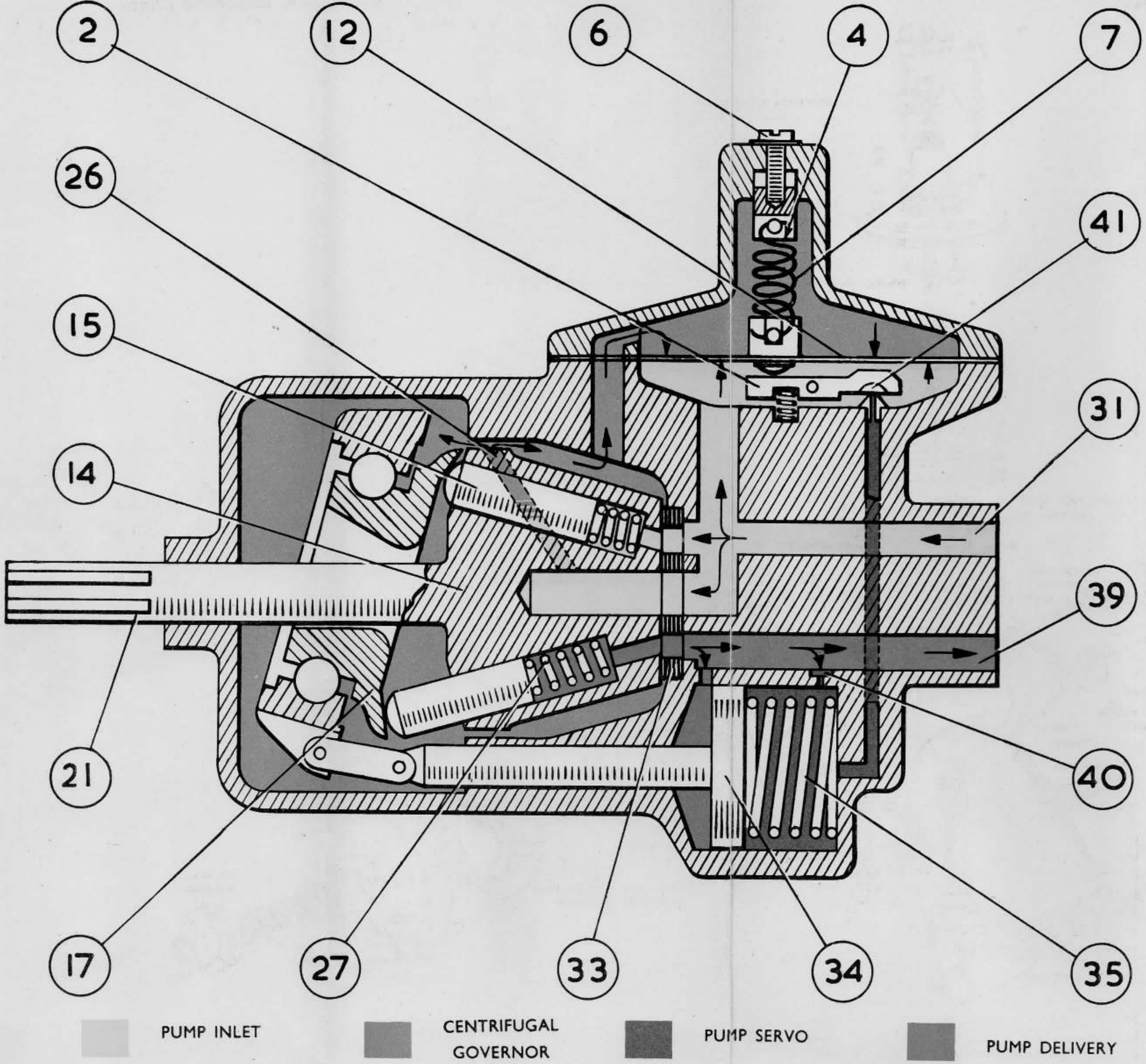

FIG. 3 SCHEMATIC DIAGRAM OF THE PUMP

KEY TO FIG. 3

2 ROCKER LEVER
4 SPRING ASSEMBLY
6 ADJUSTMENT SCREW
7 HELICAL SPRING
12 DIAPHRAGM
14 ROTOR
15 PISTON
17 CAM-PLATE
21 SPLINED QUILL SHAFT
26 RADIAL HOLES
27 RETURN SPRING
31 PUMP INLET
33 INSERT
34 CONTROL PISTON
35 SPRINGS
39 PUMP OUTLET
40 RESTRICTING ORIFICE
41 AMPLIFIER VALVE

cates via a restricting orifice with the outer side of the piston. The pump cover, which is fitted at the end of the control piston housing, is provided with an outlet which is connected to the barometric pressure control unit, and there is also a passage from the outer side of the piston which is responsive to speed and to delivery pressure.

5. The pump is illustrated in fig. 1 and 2, and in the following description of the main sub-assemblies reference should be made to fig. 1 and 2 in conjunction with fig. 4 and 5.

Rotor

6. The rotor (*fig.* 4) is made in an aluminium bronze alloy and is fitted at either end with plain steel sleeves which form bearing journals. The larger diameter journal at the inner end runs in a carbon ring (*fig.* 1, 9) which is secured in the main pump body by a circlip (13); the smaller journal runs in a roller bearing (23) carried in the cam-plate housing (19) which is spigoted into the pump body and secured by four screws.

7. The steel driving shaft (21) is splined into the hollow rotor shaft, and being in the form of a quill, provides a flexible drive to prevent any slight misalignment from stressing the pump components.

8. Three U-sectioned synthetic rubber seals (20) with garter retaining springs, together with a duralumin spacer and spring steel 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. The seals, spacer and washers are carried in a duralumin seal housing (22), which is located in the cam-plate housing and secured with six screws.

9. The rotor (14) has seven inclined cylinders accommodating hardened steel pistons (15). Helical return springs (27) are fitted beneath the pistons; these springs are carried on spring guides (29) which locate on flanges at the inner ends of the piston bores.

10. Seven radial drillings (26) extend from the central axial bore (10) of the rotor to its periphery. These drillings provide a means for producing the pressure required to operate the overspeed governor.

Port insert

11. A disc-shaped port insert (33) is fitted at the end of the rotor housing and is located by a dowel. The insert has two kidney-shaped ports (32) (one port only is shown in fig. 1), communicating respectively with the inlet and outlet passages of the pump body.

12. The insert forms a high-pressure seal to the end face of the rotor.

Control piston, cam-plate, control ring and bearing assembly

13. The control piston, cam-plate, control ring and bearing assembly is shown in fig. 4. The radiused ends of the pistons (*fig.* 1, 15) locate against a hardened steel cam-plate (17) which is free to rotate on large steel ball bearings (18) in the steel control ring (24)

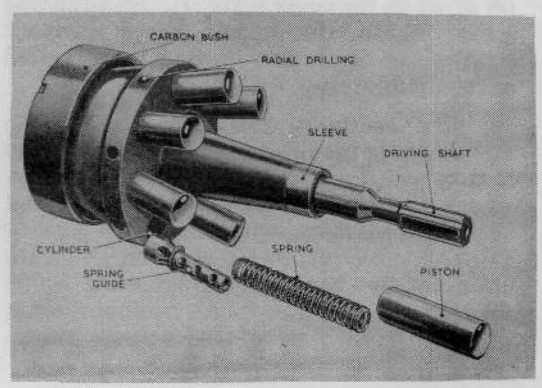

Fig. 4. Rotor and driving shaft

14. The control ring is carried on two steel trunnion pins (16) fitted in the pump body; this arrangement allows the cam-plate to be moved, with consequent variation of the stroke of the pistons.

15. The control piston (34) is a disc-shaped steel member having a synthetic rubber seal fitted to its outer periphery. It is fitted in a cylindrical housing which forms part of the main pump body and which has a hardened steel liner (37). A steel rod (28) is attached to the centre of the piston, and the end of the rod remote from the piston has a forked end in which is pinned a steel link (25). The link pivots in the forked end of the rod and is pinned at the other end to a fork on the cam-plate control ring.

16. Helical springs (35) are fitted between the control piston (34) and the end cover (36), which is secured to studs in the pump body with twelve nuts. The springs bias the piston to the end of the cylinder remote from the cover.

17. The ends of the cylinder on either side of the piston are connected by a passage in which is fitted a restricting orifice (40)

Overspeed governor

18. The diaphragm (*fig.* 1, 12) of the overspeed governor is interposed between a flange in the pump housing and the cover plate (1); the cover plate is secured to the flange by twelve nuts. In the centre of the outer face of the diaphragm is a forked member (3) to which is attached one end of a helical spring (7) which loads the diaphragm. The other end of the spring is secured in a forked member (5) carried in a cup-shaped housing (8) fitted on the cover plate (1). An adjusting screw (6) in the upper forked member enables the diaphragm loading to be varied as required.

19. 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 (2). The opposite end of the lever is fitted with a tungsten carbide half-ball valve (41) which seats on an orifice fitted in the base of the amplifier valve assembly; which is in direct communication with the outer end of the control piston cylinder.

Main casting

20. The main casting 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 casting connect the rotor, diaphragm, control piston cylinder chambers and inlet and outlet passages. A conical filter is provided in the inlet passage and a flat filter is fitted under the control orifice.

PRINCIPLE OF OPERATION OF THE PUMP

21. Under operating conditions the functioning of the fuel pump is interdependent on the action of the barometric control unit and the throttle control. Consequently, the following description of the operation of the pump should be read in conjunction with the description of the complete fuel system in Chapter 1 of Section 1.

22. The rotor (*fig.* 3, 14) is driven by the splined quill shaft (21) which engages with an engine accessory drive. The pistons (15) are maintained in contact with the cam-plate face by the helical return springs (27), and due to the inclination of the cam-plate (17), movement of the rotor imparts a reciprocating motion to the pistons, producing the pumping action.

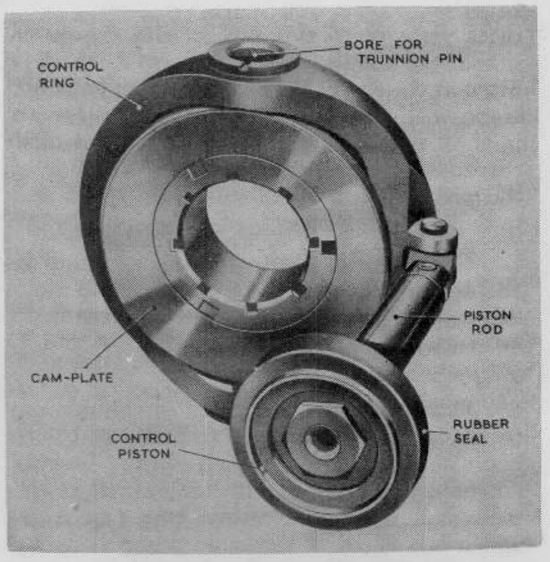

Fig. 5. Control piston, cam-plate, control ring and bearing assembly

23. Fuel is fed into the body of the pump through the inlet passage (31), and is passed into the pump rotor cylinders and axial bore via the inlet port of the insert (33); the fuel also passes to the amplifier valve chamber on the underside of the diaphragm (12). As the rotor revolves, the piston in the cylinder to which fuel is being supplied moves outwards to the end of its suction stroke, as determined by the inclination angle of the cam-plate. 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 (33), to the pump outlet (39). This cycle of operations is repeated in turn for each of the seven pistons in the rotor.

Operation of the amplifier (relief) valve

24. A passage off the pump outlet duct feeds fuel into the servo control cylinder below the piston; and a second passage from the outlet duct supplies fuel, via a restricting orifice, to the upper side of the piston. A passage from the cylinder, on the upper side of the piston, is normally closed by the amplifier valve (41). Under normal conditions the control piston is thus in a state of pressure balance, the cam-plate tending to be kept at maximum inclination through the thrust exerted by the helical springs (35) on the upper side of the control piston.

25. When the fluid pressure on the lower side of the control piston exceeds the value determined by the spring loading of the amplifier valve rocker lever (2), the valve (41) opens and the resulting flow through the system causes a pressure drop across the restricting orifice (40) and on the upper side of the control piston (34).

26. The pressures on either side of the control piston are thus unbalanced, and the control piston moves to reduce the inclination of the cam-plate and, consequently, the rotor piston stroke and the pump delivery. By this means the pump is safeguarded against excessive pressures.

Operation of the maximum speed governor

27. The overspeed governor assembly consists of the spring-loaded flexible diaphragm (12) which operates the valve (41) through the rocker lever (2). The governing pressure required to operate the diaphragm is provided by the centrifugal pressure rise set up by the radial drillings (26) in the pump rotor. This centrifugal pressure rise acts on the upper side of the diaphragm whilst the opposing pressure on the lower side of the diaphragm is provided by the pump inlet pressure plus the tension exerted by the spring (7).

28. When the rotor is driven, the governor pressure in the pump casing surrounding the rotor and above the diaphragm (12) exceeds the pump inlet pressure (below the diaphragm) by an amount proportional to the square of the rotor speed.

29. At a predetermined rotor speed the centrifugal pressure rise operating on the upper side of the diaphragm (12) is sufficient to move the diaphragm against the spring assembly (4). Movement of the diaphragm depresses the rocker lever (2), causing the valve (41) to be lifted from its seat. This results in a reduced output from the pump, as already described in para. 25, until the governed r.p.m. is restored.

30. The pump speed at which the governing action commences may be set accurately by an adjusting screw (6) which varies the loading of the diaphragm spring (7).

31. When the engine speed is decreased by throttling back, thereby reducing the supply of fuel to the burners, the centrifugal pressure acting on the upper side of diaphragm (12) is also reduced. This results in an upward movement of the diaphragm, which allows the rocker lever (2) to move and close the valve (41). The pressure on the spring side of the control piston is thus increased and the resultant movement of the piston causes the cam-plate (17) to move and increase the pump stroke.

INSTALLATION

32. The fuel pump is secured to studs on the starboard side of the wheelcase with eight $\frac{1}{4}$ in. plain nuts and washers around the flange of the pump. In addition the following pipe unions are provided on the pump:—

(1) Connection for the large diameter flexible fuel delivery pipe.

(2) Connection for three small diameter flexible pipes from the barometric pressure control unit.

(3) Connection for a small return pipe to the pump inlet.

(4) Connection for the pipe from the pump seal drain.

(5) Connection for the inlet pipe to the pump.

Additional connection points may be provided to suit individual installations.

INHIBITING AND PACKING

33. The inhibiting and packing procedure is described in Vol. 2, Part 3, Section 2, Chapter 1.

SERVICING

34. With the fuel pump once installed no servicing is necessary except for a regular check of all pipe connections and unions for tightness, as no leakage is permissible. In the event of leakage, inspect suspected faulty joint washers and replace with new washers if necessary. If joint washers are to be examined ensure that the low pressure cock is CLOSED before any pipes are disconnected.

Priming

35. Whenever pipe connections or washers are disturbed it is important that the fuel system is primed to remove all air from the system. Priming of the system will also be necessary if the fuel tanks have been drained or if the low pressure cock has been closed before the high pressure whilst the engine is running.

36. Two bleed valves are provided on the diaphragm cover of the pump for bleeding the low pressure side of the fuel system and either may be used depending upon ease of access. A special bleed attachment is provided in the engine tool kit which screws on to the bleed adapter on the pump after the removal of the blanking cap. Tightening of the knurled screw in the bleed attachment will depress the bleed valve and allow fuel to flow to bleed the system. In addition, a bleed union is provided on the accumulator unit to remove all air from the high pressure side of the system. The procedure for priming the fuel system is fully described in the relevant engine Air Publication.