

Chapter 5

HIGH PRESSURE FUEL PUMPS, TYPE GC.200 SERIES

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Introduction

1. The type GC.200 Series fuel pumps are of the positive displacement, variable stroke, multi-plunger type and incorporate a servo control mechanism, overspeed governor, and relief valve mechanism. They have been

designed for operation with aviation spirit, and while similar in many respects to existing kerosene pumping units they have additional features to ensure smooth running in view of the non-lubricating nature of the fuel handled.

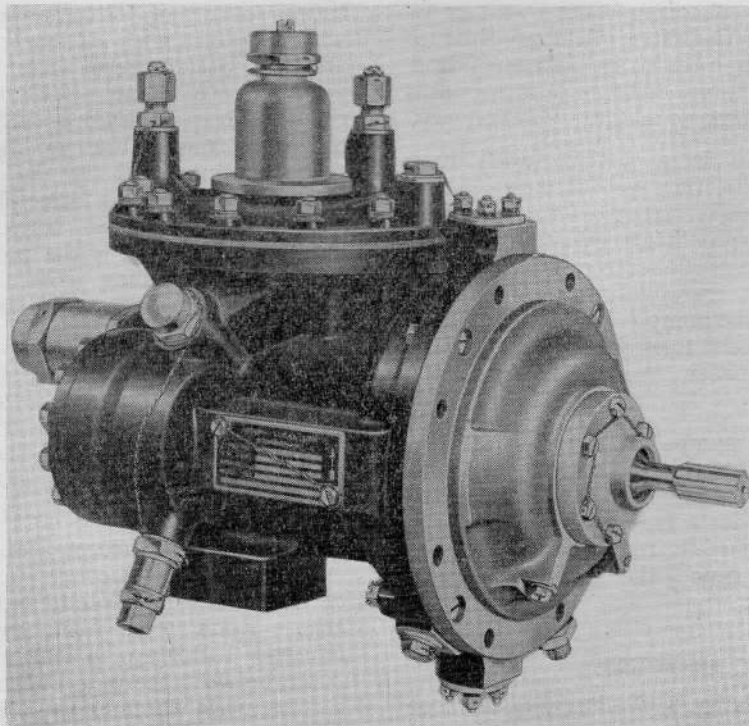


Fig. 1. Complete view of typical unit

R E S T R I C T E D

FUEL SYSTEM COMPONENTS (LUCAS) FOR GAS-TURBINE AERO-ENGINES

This is Amendment List No. 20 to Air Publication 4282A, Volume I
Section 2. List of Chapters: delete "(to be issued later)" after the title of Chapter 5 and write "(A.L.20)", in the outer margin against the deletion. Insert this Chapter 5 to follow Chapter 4. Record the incorporation of this A.L. in the Amendment Record Sheet.

ENGINEER

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2. These additional features include ball-ended rotor pistons with slipper pads, a fixed non-rotating camplate and a spring-loaded auxiliary camplate, a carbon bearing instead of a roller bearing for the second rotor bearing point, and a carbon-faced seal for the rotor.

3. The units are supplied to specific installation and calibration standards to suit the particular requirement of the engine installation. For example in a type GC.207/17N unit the pump has installation details to code '17' and is calibrated to 'N' standard.

4. Installation differences include bleed points, which may comprise one or more tappings off the diaphragm cover or a tapping off the housing for the trunnion pin; sometimes access to bleed points is facilitated by a flexible extension pipe. Similar connections may be fitted to seal drains where required.

5. On dual pump installations it is common practice for a solenoid servo isolating valve to be fitted to one pump (or both pumps on some installations) in place of the control cylinder end cover. This type of valve is provided as an additional safety factor for take-off or in an emergency; it enables the control systems of the two pumps to be isolated in the event of failure in the altitude control unit, acceleration control unit or in the servo connecting pipes. It allows the fuel supply to the burners to be continued, and in the event of failure of either pump permits the operating pump to maintain full delivery.

6. Each pump is a self-contained unit incorporating its own servo control and governor assembly, but their use together with a common delivery entails hydraulic inter-connection of the servo control systems. In dual pump installations the governor mechanism in one pump is set to control at a higher engine speed than the other to prevent interaction between the two pumps for control.

7. When two pumps are installed, a non-return valve is fitted in the outlet connection of each unit to prevent fuel from being pumped back into a failed pump, causing it to motor and thereby reducing the effective pressure and hence the delivery of the operating pump.

DESCRIPTION

8. As shown in fig. 2, the pumping element consists of a rotor (7) supported at each end by carbon bearings (4) and (14). Seven

inclined cylinders accommodating hardened steel pistons (8) are formed in the rotor. The ends of the pistons are ball-shaped to take socketed slippers (11) which engage with an appropriately shaped camplate (10). The camplate is mounted in a control ring (15), the angle of inclination of which is controlled by a servo piston (23) from zero plunger stroke (when at 90 degrees to the rotor axis) to maximum stroke (when moved through approximately 15 degrees).

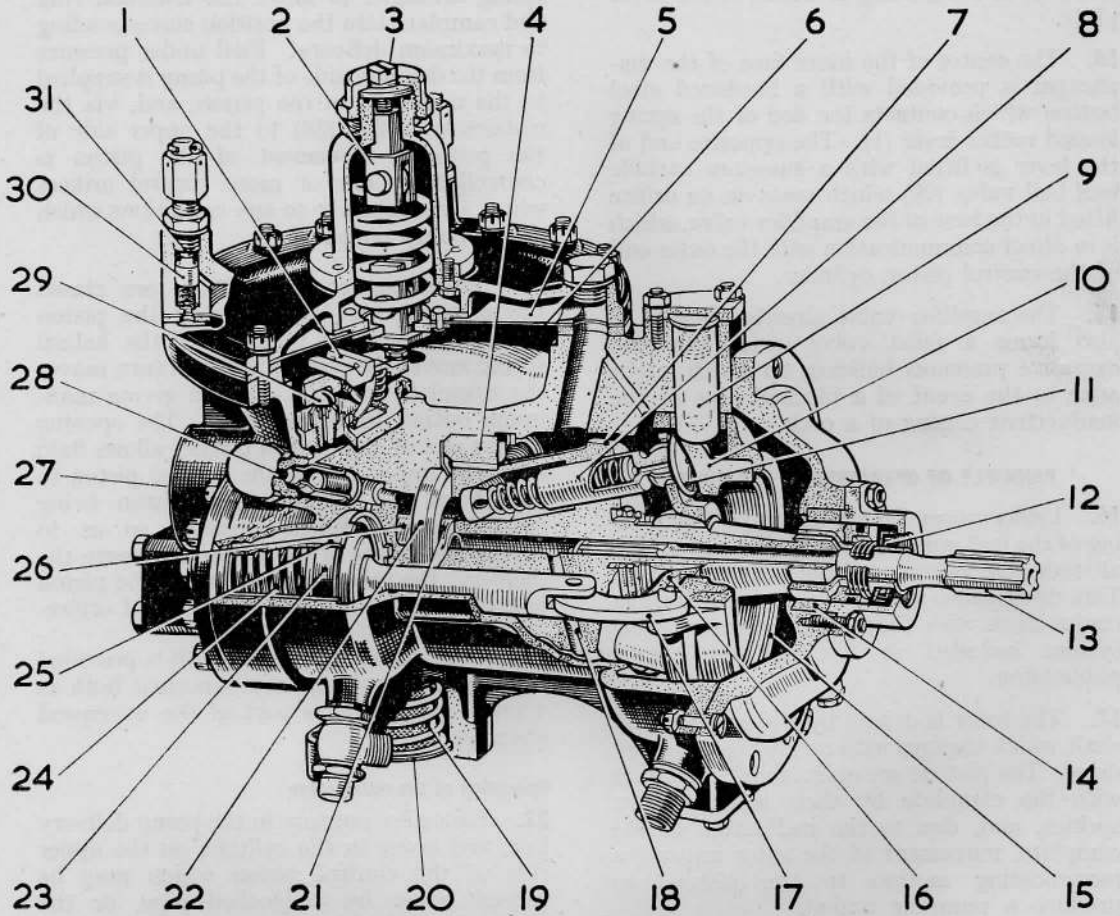
9. A slipper retaining plate or auxiliary camplate (16) is drilled to take the slipper pad shanks and this supports the slippers in position against the camplate face. At its centre, it runs on a hemispherical, cadmium-plated phosphor bronze bush, which is spring-loaded to give a slight fore-and-aft play, thus avoiding any possibility of seizure, whilst at the same time preventing chatter.

10. From the underside of each piston, a central hole is drilled through the ball-shaped end, to provide a cooling film of fuel to the underside of the slipper. A very small central hole in the slipper face permits a graduated leakage to the bearing surfaces of the slipper and the camplate, for the same purpose.

11. The piston bores in the rotor are stepped in diameter, the smaller inner ends terminating as seven ports in the flat face of the rotor, which engages with an insert (22) in which are cut kidney-shaped inlet and delivery ports (21). A pressure-tight seal is made by the rotor being pressed against the insert by the force exerted, both by the seven piston return springs and by the fluid pressure acting on the annulus formed by the stepped portion in the piston bores. At normal pressures this force is the predominant one and gives a sealing effect approximately proportional to the fluid pressure to be handled.

12. In the suction stroke the outward force on the piston is provided both by the return spring and by centrifugal force along the inclined axis of the piston. The pump is thus capable of operating satisfactorily under an inlet depression.

13. The pump incorporates an overspeed governor which prevents a certain predetermined pump speed, and consequently engine r.p.m. from being exceeded. This governor consists of a diaphragm (6) interposed between the pump housing flange and a cover plate which houses a forked member (2) carrying a spring attached at its other end to a similar forked member in the diaphragm



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|----|------------------------------|----|------------------------|
| 1 | ROCKER LEVER | 17 | LINK |
| 2 | FORKED MEMBER, WITH SPRING | 18 | RADIAL DRILLING |
| 3 | ADJUSTING SCREW | 19 | INLET STRAINER |
| 4 | CARBON BEARING | 20 | PUMP INLET |
| 5 | CENTRIFUGAL PRESSURE CHAMBER | 21 | KIDNEY SHAPED PORT |
| 6 | DIAPHRAGM | 22 | PORT INSERT |
| 7 | ROTOR | 23 | CONTROL PISTON |
| 8 | PISTON | 24 | SPRINGS |
| 9 | TRUNNION PIN | 25 | CONTROL CYLINDER LINER |
| 10 | CAMPLATE | 26 | OUTLET PASSAGE |
| 11 | SLIPPER PAD | 27 | PUMP OUTLET |
| 12 | OIL SEAL | 28 | RESTRICTING ORIFICE |
| 13 | SPLINED QUILL SHAFT | 29 | HALF BALL |
| 14 | CARBON BEARING | 30 | BLEED VALVE |
| 15 | CONTROL RING | 31 | PISTON |
| 16 | AUXILIARY CAMPLATE | | |

Fig. 2. Cut-away sectioned view of unit

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centre. Adjustment to the spring loading of the diaphragm is provided by an adjusting screw (3) in the housing attached to the cover plate.

14. The centre of the inner face of the diaphragm is provided with a hardened steel button which contacts the end of the spring loaded rocker lever (1). The opposite end of the lever is fitted with a tungsten carbide half ball valve (29) which seats on an orifice fitted in the base of the amplifier valve, which is in direct communication with the outer end of the control piston cylinder.

15. The amplifier valve already referred to also forms a relief valve which prevents excessive pressures building up which might arise in the event of a blocked pipe or the inadvertent closing of a cock.

PRINCIPLE OF OPERATION OF THE PUMP

16. Under normal conditions the functioning of the fuel pump is inter-dependent on the altitude control unit and the throttle control. This description should therefore be read in conjunction with that of the complete fuel system included in the relevant engine publication.

17. The rotor is driven by the splined quill shaft which engages with an engine accessory drive. The pistons are maintained in contact with the camplate by their helical return springs, and, due to the inclination of the camplate, movement of the rotor imparts a reciprocating motion to the pistons to produce a pumping action.

18. Fuel is supplied to the inlet connection (fig. 3, 20) of the pump from the aircraft boost tank. The fuel enters the rotor cylinders via the inlet kidney shaped port of the insert (21) and also passes to the amplifier valve chamber on the underside of the diaphragm (6). As the rotor revolves the piston into which fuel is fed moves outwards to the extremity of the suction stroke as set by the angle of inclination 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, to the pump outlet (27). This cycle of operations is repeated in turn for each of the seven pistons in the rotor.

Operation of the servo system of the pump

19. The control of the pump is effected by its servo or relay operated system. This system comprises a piston (23) operating in a cylinder (25) against the pressure of

helical springs (24), the piston being coupled to the trunnion ring of the pump and the spring arranged to move the trunnion ring and camplate into the position corresponding to maximum delivery. Fuel under pressure from the delivery side of the pump is supplied to the underside of the piston, and, via the restricting orifice (28) to the upper side of the piston. Movement of the piston is controlled by one or more control orifices which are responsive to any conditions which define pump output.

20. When the control orifices are closed the pressures on both sides of the piston are equal, but the reaction of the helical spring moves the piston, which in turn moves the camplate into the position giving maximum output from the pump. The opening of any one of the control orifices allows fluid from the upper side of the control piston to spill from the cylinder, the piston being moved against spring pressure so as to reduce the stroke of the pump and hence the delivery; the rate of movement of the piston is controlled by the size of the bleed orifice.

21. Only one control orifice (29) is provided in the pump itself and this functions both as a relief valve and as part of the overspeed governor.

Operation of the relief valve

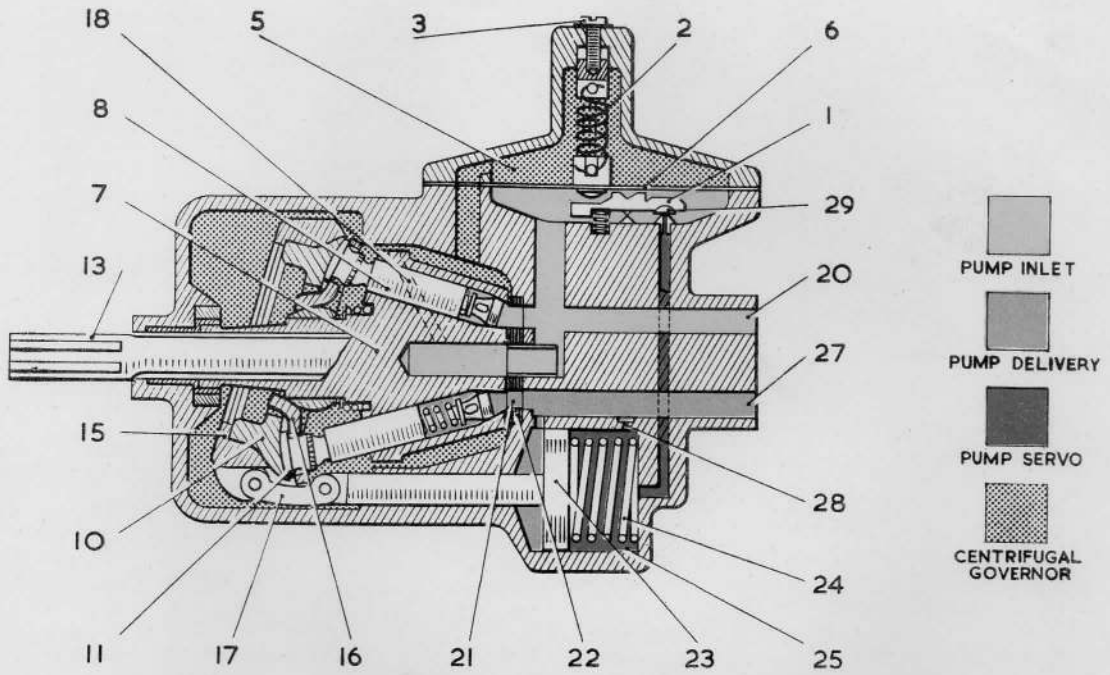
22. Excessive pressure in the pump delivery line, and hence in the cylinder on the upper side of the control piston which may be caused either by a blocked pipe, or the inadvertent closing of a cock, will lift the half ball to open the control orifice and thus reduce both delivery and pressure.

Operation of the overspeed governor

23. The overspeed governor is controlled by a force which is set up by the speed of rotation of the pump. With the rotor in motion a centrifugal pressure rise is created by the series of radial holes (18) in the rotor and is caused by the outward movement of the fuel from the axial hole in the rotor. This centrifugal pressure is directed, via a duct in the pump casing, on to the opposite side of the diaphragm (6) to the amplifier valve chamber.

24. At a predetermined rotor speed the centrifugal pressure on this diaphragm is sufficient to overcome the spring loading of the diaphragm, and cause its central hardened steel button to contact and depress the spring-loaded rocker lever (1). This lever is mounted on two pairs of crossed spring

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| 15 | CONTROL RING | 29 | HALF BALL |
| 16 | AUXILIARY CAMPLATE | | |

Fig. 3. Schematic diagram of unit

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blades, and diaphragm pressure lifts the half ball sealing member (29) off the control orifice.

25. This causes the control piston to move and so restrict the fuel supply (as already described in para. 20) and thus prevent any further increase in speed.

Operation of the dual pump installation

26. Particulars of a typical solenoid valve and the operation of a typical dual pump installation are given in Chapter 3 of this section to which reference should be made. Some installations however, may incorporate a solenoid valve on each pump, thereby permitting take-off with full delivery from both pumps (up to governed capacity), where additional fuel supply is required for thrust augmentation by means of reheat or water injection, or if failure of the control system or its pipe work occurs. This is advantageous when operating under high load conditions from an airfield at some considerable altitude, or when a shortened take-off run, or boosted climbing or combat conditions are necessary.

INSTALLATION

27. Installation details are fully covered in the relevant engine publication.

INHIBITING AND PACKING

28. Thoroughly flush the unit by injecting inhibiting oil (Specification DTD.587) into the inlet connection. Fit the special protection cap (7083/841X) with gasket (7083/853) over the quill shaft, and secure it to the flange of the camplate housing with four bolts, washers and nuts, and screw dust caps on all exposed connections. Position a Viscap seal over the inlet connection. Ensure that all locking is satisfactorily completed and pack in the container.

SERVICING

29. Once the unit is installed on the aircraft no servicing is required except for a regular watch on all pipes and connections for leakage. No leakage is permissible.

30. In the event of leakage, trace and rectify, and if pipes or connections are disturbed for this reason always bleed the complete system as described in the relevant engine publication.

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