

## Chapter 7

## HIGH PRESSURE FUEL PUMPS, TYPE GTD AND MGTD SERIES

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*Types of GTD and MGTD fuel pumps* ... 1

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1. The GTD type of pump is fitted with a centrifugal governor, whilst the MGTD series has a hydro-mechanical governor; the latter type provides for the use of fuels of differing densities. Other differences in these series of pumps are shown in the table at the end of the chapter.

## DESCRIPTION

2. All the pumps are basically alike and they each consist of two pump units operating together, with inter-connected servo controls but with only one governor. For ease of description, only one of the twin pumping units is described.

## Gear assembly and end cover

3. The drive from the engine is through two splined shafts, one for each pump unit, these being interconnected through normal spur

type gears. An additional spur gear drive is made to the governor rotor from a gear on the lower pump unit.

4. The main gear assemblies are dished and drilled to assist engine oil drainage and each is supported by double ball-races. The drive gears are secured to the race supports by six fitted bolts through common holes for both the gear and race support. The race is locked on to the bearing sleeve by a cup washer and ring nut. The bearing sleeve is secured to the end cover by studs, nuts and tab washers.

5. The end cover is an aluminium alloy casting through which the rotor splined shaft is taken; located at its forward end is a garter seal, spring, and a carbon faced seal. The end cover which also houses the rotor carbon bearing locates with the camplate cover and is secured by eight  $\frac{1}{4}$  in. B.S.F. studs, nuts and tab washers.

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### **Camplate housing**

6. The housing is shaped to cover both rotors which protrude from the main body, and the centre division forms the end bearing for the governor drive shaft. In this division, location is provided for a combined sealing ring, carbon faced seal, spring and also a ball race, the whole being secured with an internal circlip. The drive for the governor is a splined gear fitting on to the central splined shaft held by a cup locking washer and a ring nut. On the end facing of the casting, provision is made for seal drainage and a pressure tapping.

### **Rotor**

7. Each pumping element consists of a rotor, supported at each end by carbon bearings, located in the main body and end cover. The rotor bearing journals are sleeves pressed on each end of the rotor.

8. The rotor and quill shaft form a single unit, the latter splining into the rotor and being secured by a circlip in the rotor bore. Interposed between rotor and shaft are two sealing rings to prevent leakage of fuel along the quill shaft.

9. Seven radial drillings extend from the central axial bore of the rotor to its periphery to provide fuel for cooling purposes and to expel air from the system via the centrifugal rotor. In the rotor are seven inclined bores each accommodating a spring guide, spring, spring seat, and a hardened hollow steel plunger. The bottom of the plunger bores, which are stepped, terminate as seven ports on a flat face which is silver plated to provide a good bearing surface, and to prevent pick-up between the end face and the port insert. The lower and upper pump assemblies are identical except for the plunger springs; these are coiled in the opposite direction to each other.

10. The outer ends of the rotor plungers are ball-shaped to take socketed slippers. A central hole in the plunger head affords passage for a cooling film of fuel to the underside of the slipper. A very fine central hole in the slipper admits this graduated leakage to the bearing surface between the slipper and camplate to ensure lubrication and cooling. The slipper pads are retained by an auxiliary camplate which supports the plungers against the camplate face. At its centre the auxiliary camplate runs on a cadmium plated thrust ball which is spring-loaded to allow slight vertical movement.

The holding action of the auxiliary camplate minimizes possible damage to the pump in the event of plunger seizure.

### **Camplate and servo control system**

11. The slipper pads of the rotor plungers locate against the spherical surface of the steel camplate the integral trunnions of which are supported in lead-bronze bearing blocks. An integral lug 90 deg. from the trunnions forms a simple fork attachment for the servo control piston rod.

12. The servo piston and control rod are integral and control of the pump is effected by means of the servo system. It comprises for each of the pump units, a piston with seal operating in a cylinder against the loading of a pair of helical springs coiled in opposite directions. The springs tend to move the piston and hence the camplate to the maximum delivery position. Each set of piston springs are located against its servo cylinder end cover which contains a screw adjustable by shim washers to form a piston stop. On some types a solenoid servo isolating valve is fitted to the control cylinder cover of the upper pump.

### **Main body**

13. The main body of the pump is of light alloy construction and is sub-divided into six main chambers comprising two rotor housings, two control piston cylinders, the governor housing, and the over-speed control housing. Strainers are located in the base of the centre of each rotor bore and fuel is directed via the hollow centre of the rotor and out through the radial drillings. Dowel pegs locate each disc-shaped port insert which has two kidney-shaped ports communicating respectively with the inlet and outlet fuel passages. Vertical movement of the port insert is prevented by a spring spider washer, on top of which the main carbon bearing is retained by a circlip. Non-return valves are fitted to the delivery ports. Adjacent to the camplate cover face is a small passage fitted with a strainer unit connecting the two rotor chambers. The governor rotor bore holds a spring-loaded pressure balanced carbon faced seal and combined bearing face seal. On the machined facing between the body and the camplate cover is a connecting seal ring, which prevents leakage from the governor rotor bore; the opposite facing carries seals to prevent leakage from the amplifier valve housing and upper pump

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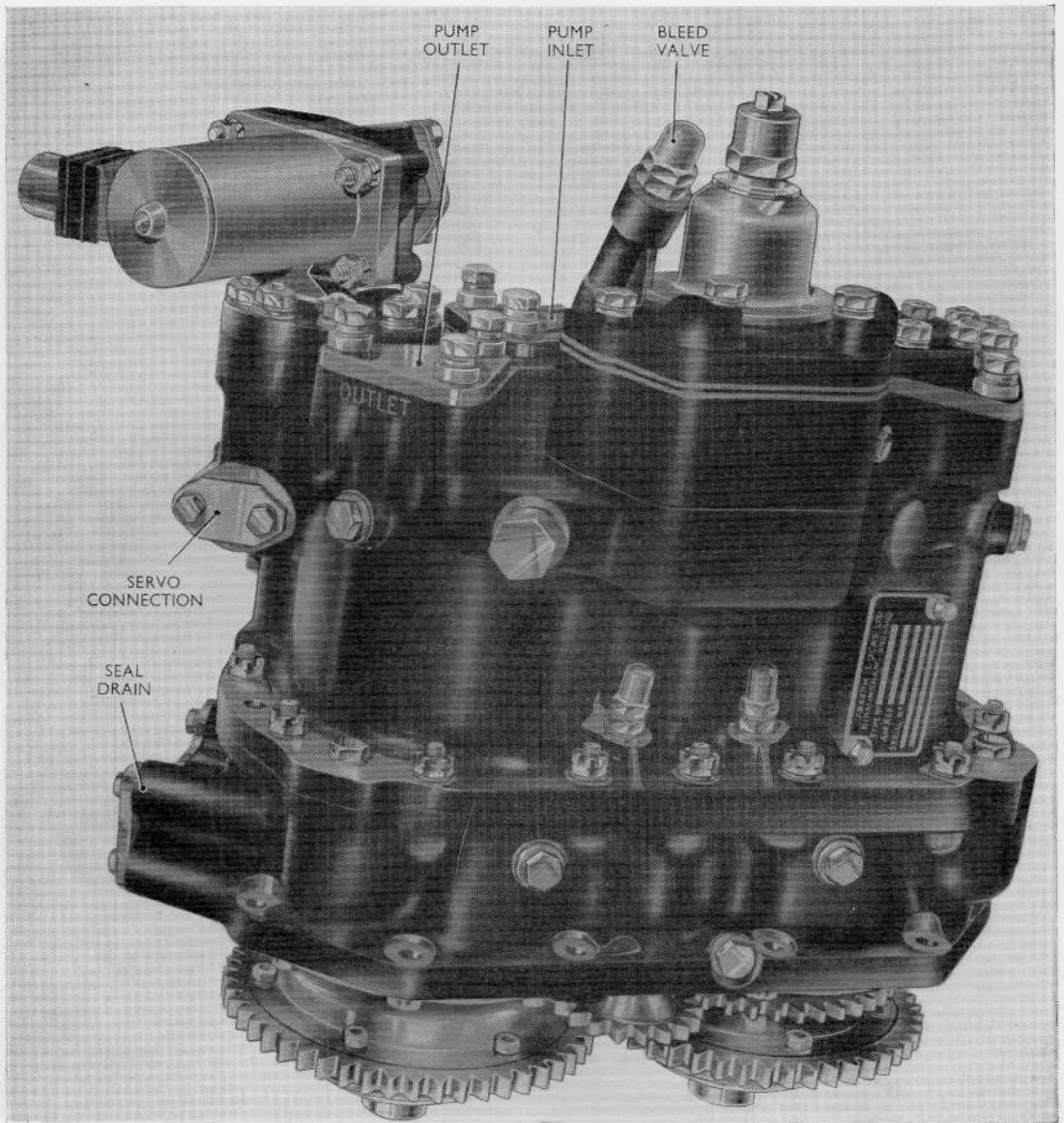


Fig. 1. GTD series fuel pump

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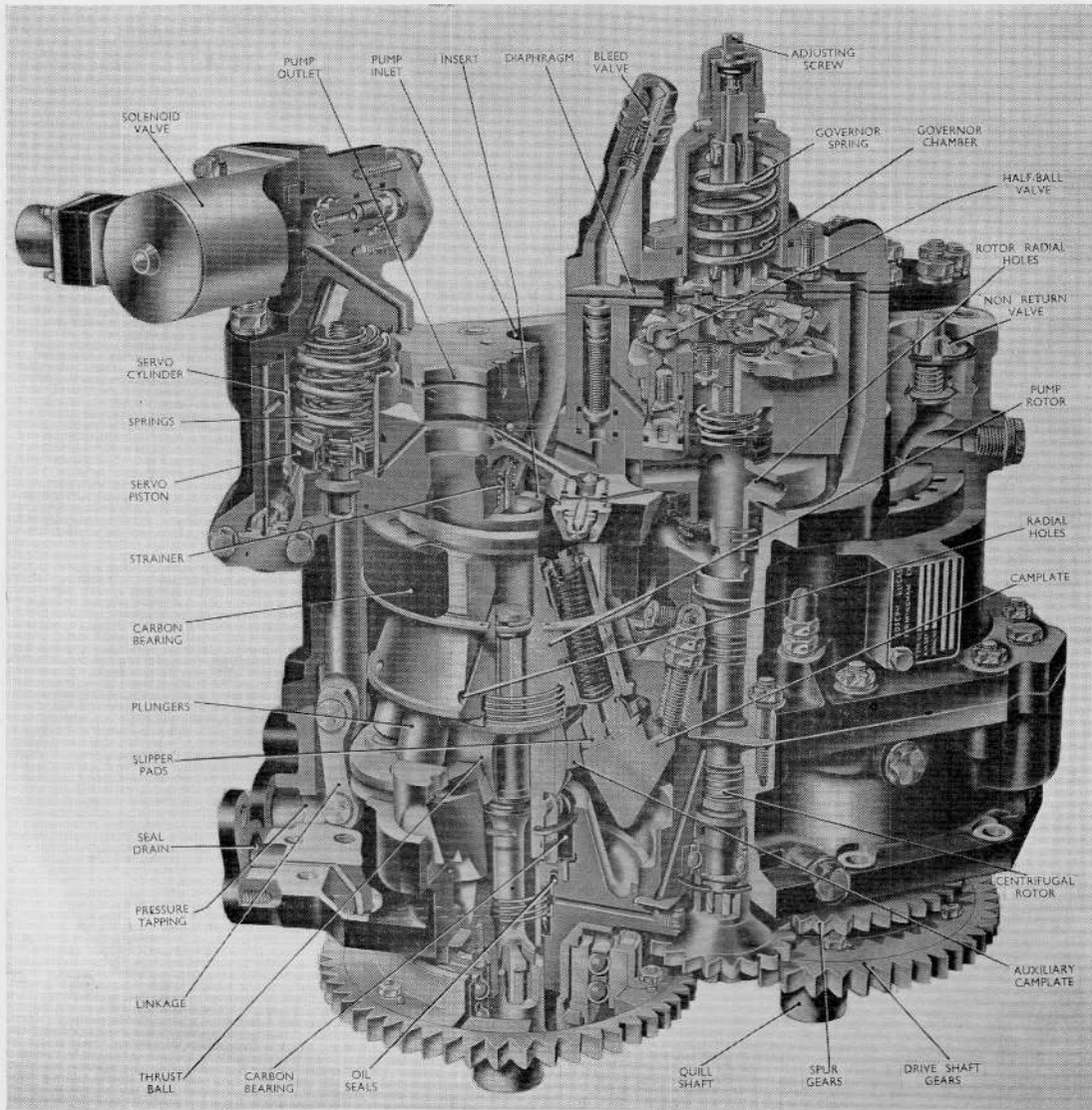


Fig. 2. Interior of GTD series fuel pump

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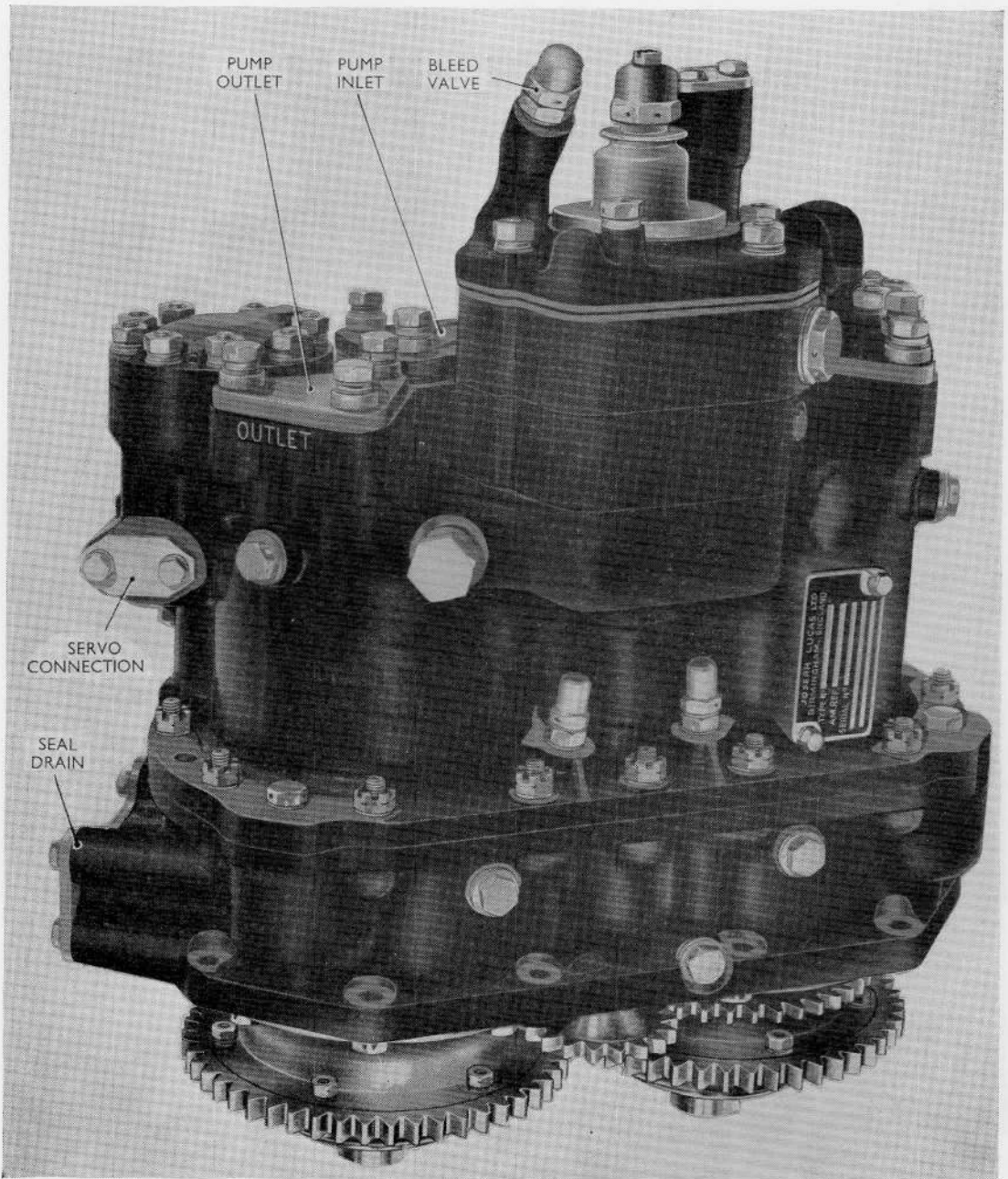


Fig. 3. MGTD series fuel pump

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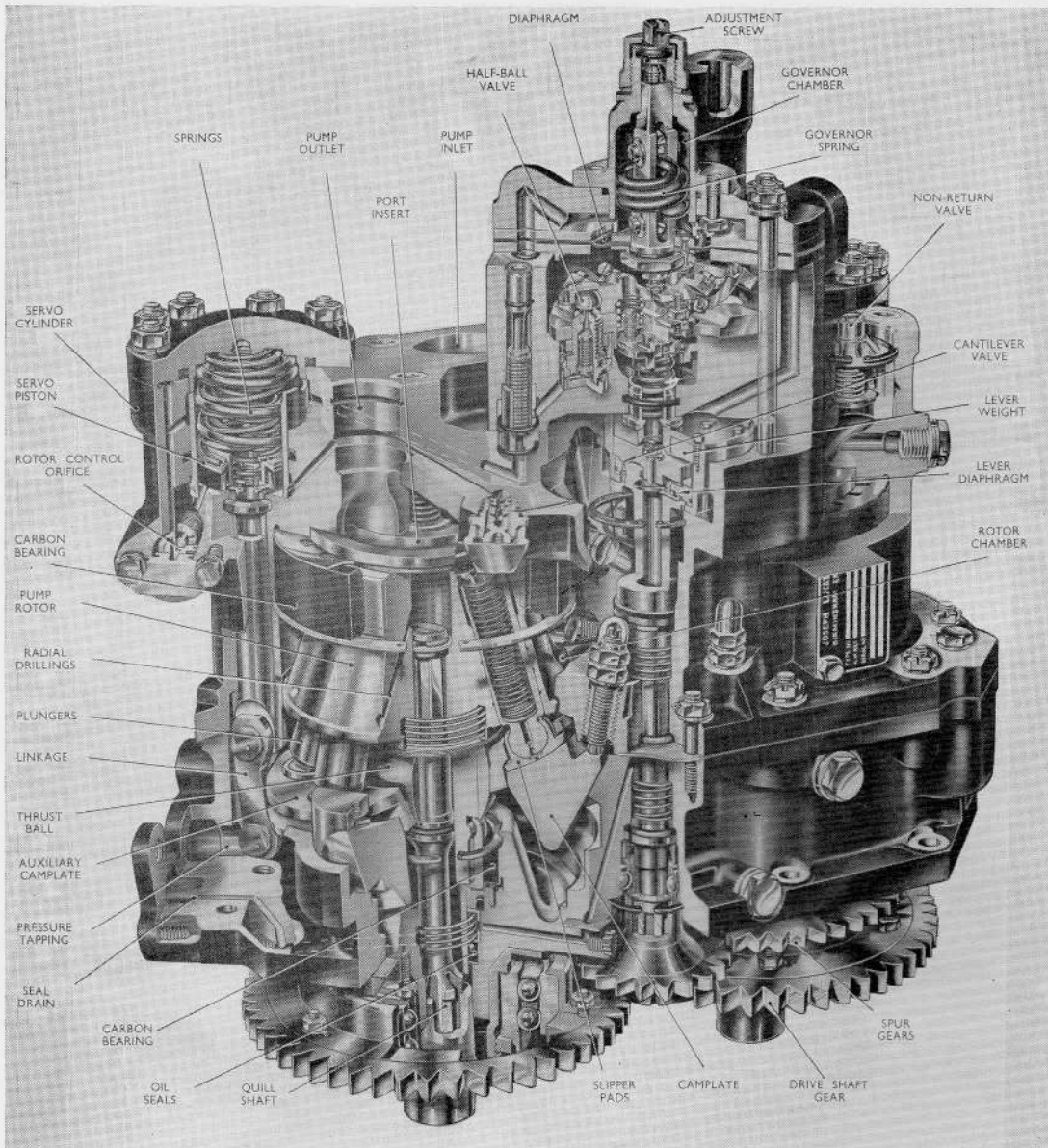


Fig. 4. Interior of MGTD series fuel pump

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solenoid attachments. Maximum fuel flow is adjusted by external stop screws limiting the camplate angle.

#### Centrifugal governor

14. A small cylindrical chamber centrally situated in the main body houses a steel rotor which is supported by a carbon bearing at the rotor end and a ball race at the driving end, the drive is effected through spur gears. The rotor itself is of circular shape with six radially drilled holes connecting to its hollow centre. Immediately above the rotor is located a spring-loaded face seal and then the amplifier valve housing.

15. There are two amplifier valves, one for each pump unit and each serves as a control orifice. Each consists of an independent rocker-lever loaded against torsion hinges. At the extreme end of each rocker lever is a half-ball valve and when the delivery pressure of the pump creates a force sufficiently high to lift the half-ball valve away from its seating, a bleed is led away from the front of the servo piston thus cutting down the pump stroke and thereby output pressure.

16. The speed governor is the means of setting the maximum engine speed and is fitted above the amplifier housing. It consists of a diaphragm shaped to the housing and is loaded against a spring which can be varied by an adjustable screw. Centrifugal governor pressure is felt over the diaphragm area and when the spring pressure is overcome the diaphragm moves downwards and causes a centrally situated tappet to engage with the tail of each rocker lever. The cover incorporates a bleed valve from which all air may be bled from the pump units.

#### Hydro-mechanical governor

17. A cylindrical chamber in the main body houses a rotor at the end of a shaft which is supported by a carbon bearing at the rotor end and a ball race at the driving end. The rotor consists of a cantilever valve and a lever to which is attached a weight. The amplifier valves and speed governor are as previously described.

### OPERATION

#### Pump

18. On the inlet stroke, the outward force upon each plunger is provided by both the

return spring and by centrifugal force acting along the inclined axis of the plunger. The pump is thus capable of satisfactory operation under an inlet depression. Under normal operation fuel is boosted from an outside source to the inlet port and operates under conditions approximating to 15-20 lb./in<sup>2</sup> head of fuel.

19. The rotation of the rotor causes the plungers, which are located against an inclined camplate, to produce the reciprocating motion of the pumping action. The upper pump revolves in a clockwise direction and the lower pump anti-clockwise.

20. Fuel is fed into the body of the pump through a common inlet port, which communicates internally with each pump unit and passes to the base of the rotors via the respective inlet ports of the kidney-shaped inserts. An additional centre port of the rotor leads fuel through small strainer units to the hollow centres of the rotors and thence by the radial drillings to give a cooling proportion of fuel to the rotor chambers. Fuel also passes around the amplifier valves on the underside of the governor diaphragm and to the centrifugal rotor.

21. As the rotors revolve fuel is fed in through the inlet port to each piston cylinder in turn, the length of the inlet stroke depending on the camplate angle. Contact with the inclined camplate face forces the plungers inwards to eject the fuel via the outlet port of the kidney-shaped insert, the springs assisting in the return stroke. Thus, according to the position over the port insert each plunger is alternately in the inlet and delivery stroke once per revolution. The fuel outlet connections from the pump body which are entirely separate for each unit incorporate a non-return valve assembly in each delivery port.

#### Servo system

22. High pressure fuel from the delivery side of the pump is supplied to the underside of the control piston and via a restricting orifice to the cylindrical chamber in which the servo piston springs are housed. This pump servo pressure is also transmitted to one or more control orifices which are controlled by certain engine requirements.

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23. The loading of the servo springs is sufficient to maintain the control piston in the maximum stroke position. During normal engine running conditions the half-ball valves are just balanced, permitting a slight servo bleed which is made up at the same rate by the restricting orifice, in this way the position of the servo control piston remains steady.

24. Each of the pumping units incorporates a half-ball valve retained in a spring-loaded rocker lever mounted in cross torsional hinges. Excessive pump delivery pressure in the cylindrical chamber on the upper side of the control piston causes the half-ball valve to lift. The resultant servo leakage unbalances the equalizing forces across the piston and the latter moves against spring pressure to reduce the pump stroke and hence the delivery from the pump. By this means the pump is safeguarded against excessive pressures.

#### Centrifugal governor

25. The control orifice in both pump units also forms part of the overspeed governor and is arranged to be controlled by a common force dependent on the rotational speed of the pump. Fuel fed to the hollow centre of the governor rotor creates a centrifugal pressure rise in the six radial drillings which is transmitted to one side of a diaphragm loaded by an adjustable tension spring. Pump delivery fuel through a variable orifice provides additional governor pressure. As the pump speed increases the pressure on this side of the diaphragm, which is proportional to the square of the rotor speed, increases and the diaphragm moves against the spring assembly, its control tappet contacting the rocker levers and causing the half-ball valve to be lifted off its seat. This will reduce pump output.

26. The advantage of a common governor for the two pumping elements is that one signal only is given to the governor diaphragm, which eliminates the possibility of surging if two diaphragms were fitted.

#### Hydro-mechanical governor

27. To form an overspeed governor, the control orifice of each pumping unit is arranged to be controlled by a force dependent on the rotational speed of the pump. Fuel at pump delivery pressure is fed to the governor rotor chamber, the only outlet flow

from which is through the rotor control orifice and then through the rotor and face plate to pump inlet. The pressure in the rotor chamber depends upon the balance between the pressure drop across each of the inlet and outlet orifices and, as the inlet orifice pressure drop is constant for a given pump pressure, then any adjustment to the pressure drop across the rotor orifice will modify the chamber pressure.

28. In operation the control orifice pressure drop is regulated by the rotor cantilever valve. This is sensitive to speed under the influence of the mechanical centrifugal loading on the lever weight. The chamber pressure opposes this centrifugal loading through the lever diaphragm. By this means, the chamber pressure balances the centrifugal loading of the lever. The pressure is therefore a measurement of the centrifugal force and consequently is a measurement of rotor speed. As speed varies so the loading varies, this puts out of balance the forces on the lever and causes it to move and modify the orifice flow, which in turn modifies the chamber pressure until the opposing forces on the lever are again equalized; the modified chamber pressure being a measurement of the altered speed. The chamber pressure is a speed reference therefore and this is applied to the overspeed control or any other control unit in the fuel system requiring a speed term. The governor setting is varied by the governor control spring adjustment screw.

#### Isolating valve

29. The operation of the solenoid servo isolating valve is described in Chap. 3 of this section and a description of the isolating valve in relation to the entire fuel system of the engine is given in the relevant engine Air Publication.

### INSTALLING AND SERVICING

30. Installation details, which vary according to the engine requirements, are covered in the relevant engine Air Publication.

31. A bleed valve on the overspeed control housing is to be used when it is necessary to prime the system.

32. Except for the adjustment of the governor setting, no servicing is required.

33. Instructions for inhibiting are given in A.P.4471A.

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**TABLE 1**  
**Types of GTD and MGTD fuel pumps**

Type	Remarks
GTD 3	Basic pump as previously described.
GTD 4	Solenoid removed. Link pins on servo piston positively retained.
GTD 5	As GTD 3 but with plunger heads made to closer limits to reduce wear.
GTD 14	AS GTD 4, with cropped governor rotor, and plunger heads made to closer limits.
GTD 15	Water methanol application. No solenoid. Positively retained link pins on servo piston rods. Cropped governor rotor. Plunger heads made to closer limits.
GTD 17	Solenoid fitted. Plunger heads made to closer limits.
GTD 21	As GTD 3, but with plunger heads made to closer limits.
GTD 42	Solenoid fitted. Plunger heads made to closer limits to reduce wear. Fitted with beryllium copper slippers.
GTD 44	As GTD 42 water-methanol application. No solenoid. Positively retained link pins on servo piston rods. Plunger heads made to closer limits. Cropped rotor governor. Beryllium copper slippers.
GTD 46	Positively retained link pins on servo piston rods. Cropped rotor governor. Plunger heads made to closer limits. Beryllium copper slippers.
MGTD 30	As GTD 42 with hydro-mechanical governor. Cast iron piston rings on servo pistons. Dissimilar servo restrictors and increased diameter N2 restrictor. Revised governor feed orifice assembly in modified pump body, stainless steel ring introduced between orifice and bore in pump body. Bonded seals replace combination washer.
MGTD 31	As GTD 44 with hydro-mechanical governor. Cast iron piston rings fitted to servo pistons. Revised governor feed orifice assembly in a modified pump body, stainless steel ring introduced between orifice and bore in pump body. Re-designed sealing arrangement for pump servo amplifier valve filter.
MGTD 32	As MGTD 30 with re-designed sealing arrangement for pump servo amplifier valve filter.
MGTD 53	As MGTD 31 with dissimilar servo restrictors.
MGTD 100	As MGTD 31 with T1 sensing unit on overspeed control. Adjustable altitude idling flow stop (lower pump). Addition of strainer and orifice upstream of restrictor in hydro-mechanical governor return to pump inlet.
MGTD 123	As MGTD 100 less T1 sensing unit.

Previous to the MGTD 100, the basic type number of each pump, as given above, is followed by a second figure, e.g. /1. This indicates the particular engine installation for which the pump is adapted, and is followed by a letter signifying the calibration code to which the pump must be tested. On the MGTD 100 and later types the basic number alone identifies the specific engine installation and the calibration code.

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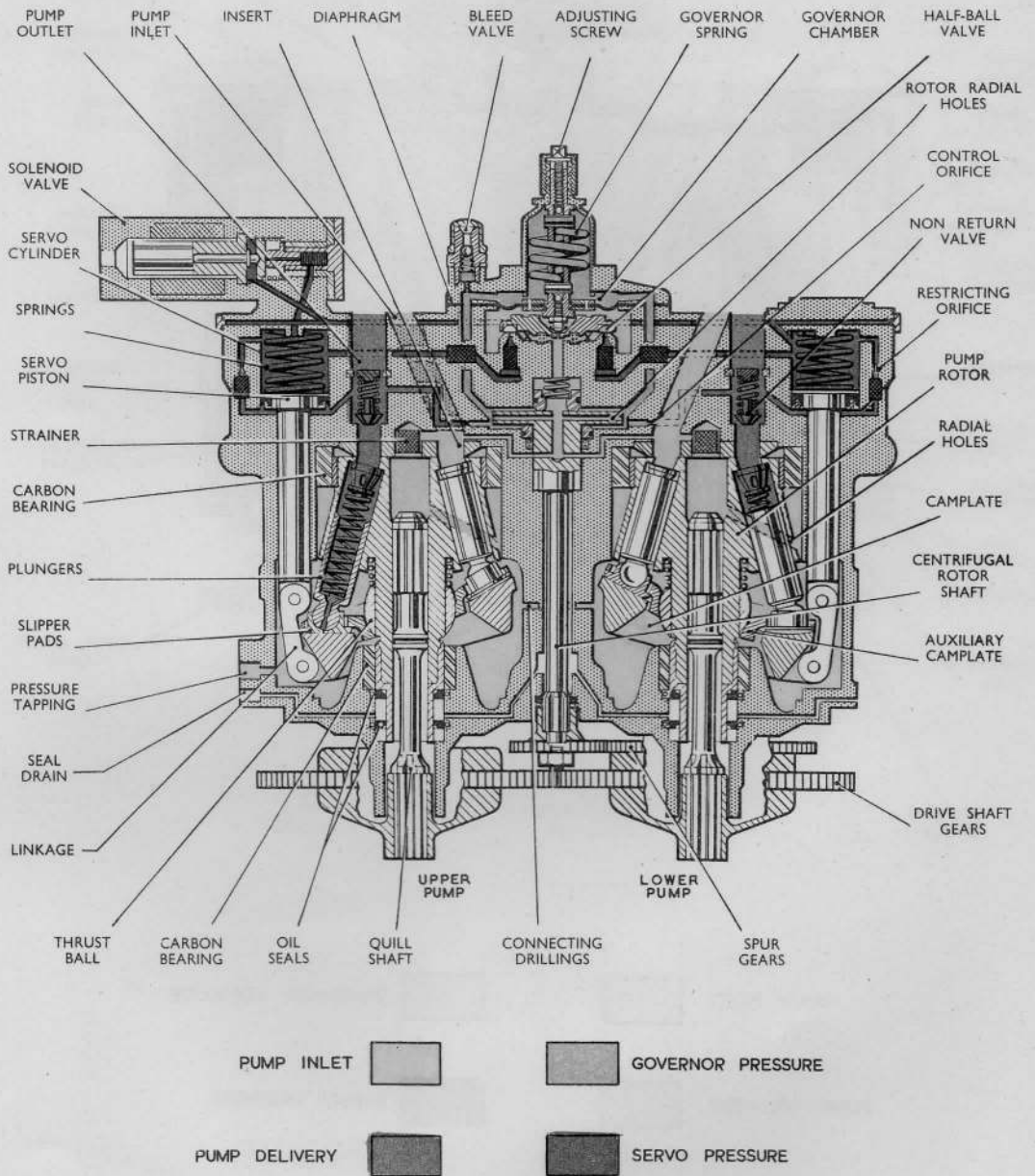
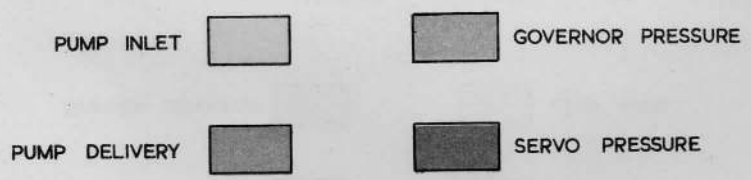
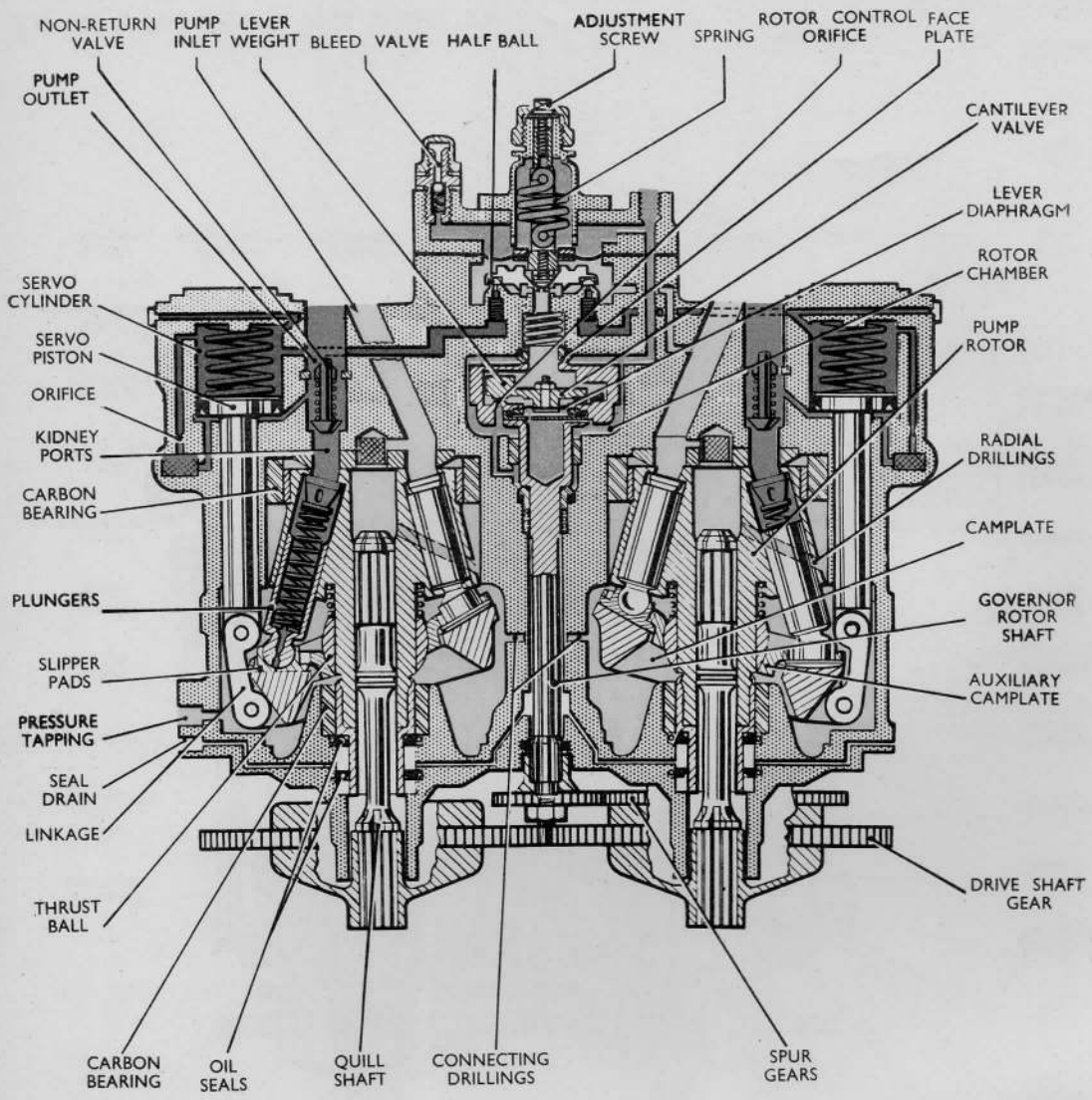


FIG. 5 FUNCTIONAL DIAGRAM OF GTD SERIES FUEL PUMP

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(A.L. 50, Dec. 57)



**FIG. 6 FUNCTIONAL DIAGRAM OF MGTD SERIES FUEL PUMP**

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