Chapter 9

HIGH-PRESSURE FUEL PUMPS, TYPE RH.1 AND RH.3 SERIES

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LIST OF ILLUSTRATIONS

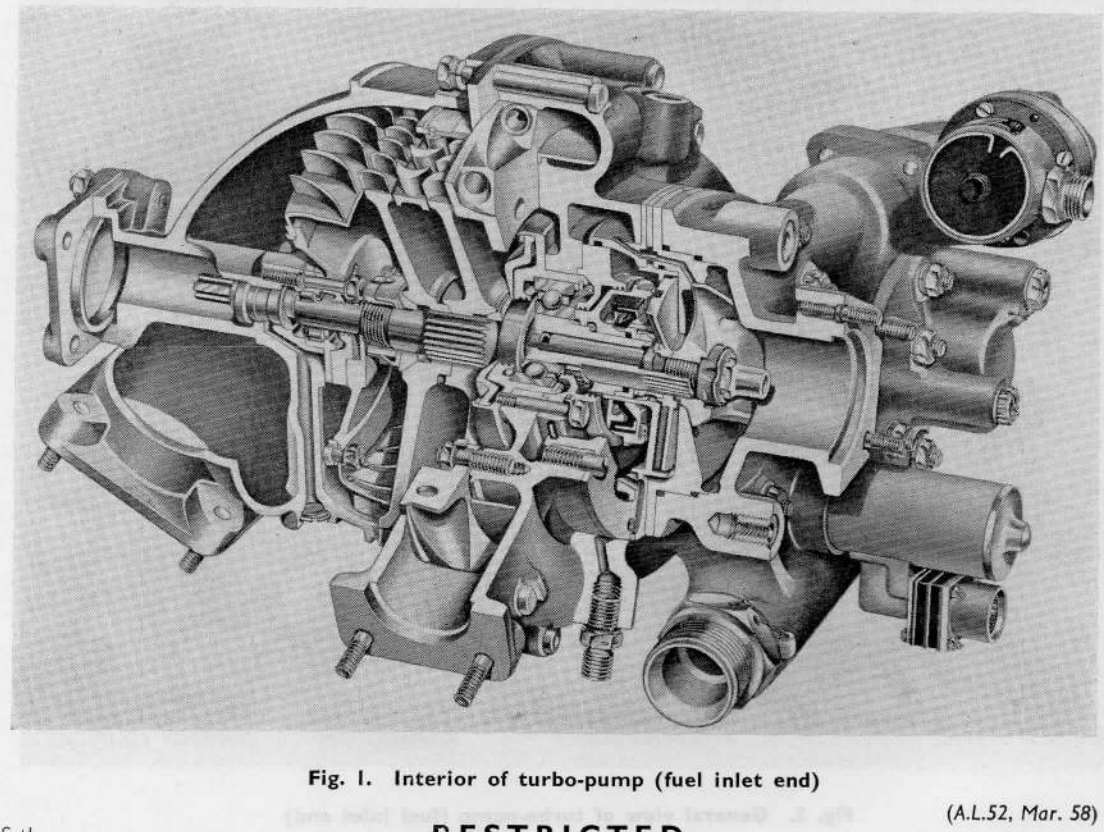

Fig. 1. Interior of turbo-pump (fuel inlet end)

1. The turbine-driven fuel pump, Type RH.1, is basically a high-speed single-stage centrifugal pump driven by a two-stage air turbine, the pump impeller and turbine rotors being mounted on a common shaft carried in two bearings as illustrated in fig. 1.

2. Fuel is delivered to the pump impeller at tank booster pump pressure. The pump is designed to meet all the requirements of Mach 0·75 under I.C.A.N. Sea Level conditions and I.C.A.N. + 40 deg. C. conditions. Air is admitted to the turbine entry nozzles at compressor delivery pressure, the maximum air mass flow required being of the order of 0·69 lb. per sec. After passing through the turbines the air is exhausted to atmosphere.

3. Compartments integral with the pump casing, as shown in fig. 2 and 3, house a servo-pressure operated shut-off cock and its solenoid-operated servo pressure control valve, a fuel delivery pressure switch to control the operation of the jet pipe nozzle shutters, and a non-return outlet valve. The latter prevents low-pressure leakage in the event of shut-off cock failure and gas leakage, from the jet pipe into the pump, when re-heat is not in operation.

PUMP ASSEMBLY

4. The pump assembly comprises a five-vane centrifugal impeller, as shown in fig. 4, running between two close-fitting casings and rotating in a clockwise direction when looking on the impeller face. Fuel enters the pump through a central inlet bore and is discharged from the vane tips tangentially through a venturi-shaped diffuser passage leading to the shut-off cock. The venturi form of the diffuser passage is designed to convert the tangential kinetic energy of the fuel to pressure in the shut-off cock chamber.

5. The rotor shaft is carried in a main ball bearing located immediately forward of the 1st stage turbine and a roller tail bearing located in the exhaust casing behind the 2nd stage turbine. In addition to journal loads the ball bearing also resists axial thrust loads on the turbines.

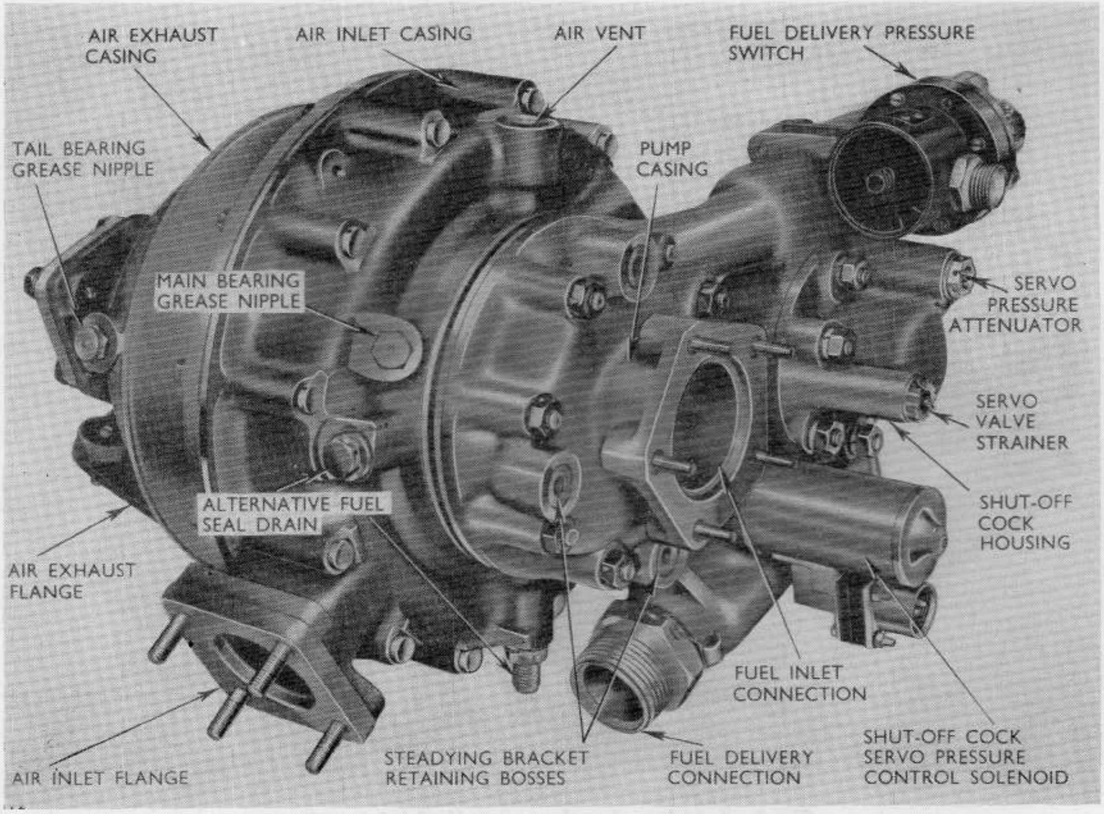

Fig. 2. General view of turbo-pump (fuel inlet end)

cock solenoid servo valve. Thus, the operation of the complete system is so controlled that the shutters cannot open until the correct fuel pressure is available, and the shut-off cock cannot open until the shutters are open by the required amount.

30. Downstream of the shut-off cock the fuel passes to the outlet valve, which is a spring-loaded poppet valve loaded to a pressure of 60 lb. per sq. in. This valve is provided to prevent fuel at pump inlet pressure passing to the burners in the event of the shut-off cock failing to close and also to prevent entry to the pump of exhaust gas from the jet pipe.

OPERATION

31. When re-heat is required the engine throttle lever is moved from its normal maximum position into the segment marked RE-HEAT. This will cause the nozzle warning lamp to light, indicating that the nozzle is still closed; when the light goes out, in approximately 2·5 seconds, it indicates that the nozzle has opened and that re-heat is in operation.

32. Upon selecting re-heat, a solenoid-operated valve in the control system opens causing primary fuel from the main engine fuel pump to be injected into the re-heat burner cone. At the same time a booster coil is energized to supply a high-tension spark at the igniter plug which ignites the primary fuel. (A time delay in the booster coil circuit keeps the coil energized for 30 seconds). In addition a P4 (jet pipe pressure) bleed solenoid valve is opened and an air shut-off cock in the re-heat control unit is energized. When the P4 bleed solenoid is energized, one of two plate valves controlling servo pressure to an air throttle piston is closed and, due to resultant out-of-balance forces, the servo piston moves, opens the air throttle and permits compressor delivery air to enter the re-heat pump air inlet casing.

Note . . .

For further information regarding the re-heat control system, reference should be made to the relevant engine Air Publication.

33. The pressure energy generated in the re-heat pump air inlet casing is converted, by the turbine entry nozzles, into kinetic energy which, on being transferred to the blading, causes the turbines to rotate. The fuel impeller, which is receiving fuel at tank booster pump pressure, commences to generate a radial flow of fuel in the pump chamber and builds up pressure in the shut-off cock chamber, as shown in fig. 12.

34. This pressure is sensed by the fuel pressure switch and, when the pressure reaches 80 to 85 lb. per sq. in., the switch contacts close and energize three other circuits, which operate as follows:—

(1) The air valves controlling the nozzle actuators are energized and the nozzle shutters commence to open.

(2) The main burner fuel delivery shut-off cock solenoid valve in the pump housing is energized and spills fuel from the shut-off cock chamber. This unbalances the pressures across the shut-off cock diaphragm, lifting the plate valve and permitting pump delivery fuel to pass to the non-return outlet valve, which opens when the pressure reaches approximately 60 lb. per sq. in. and permits the fuel to flow to the main re-heat burner.

(3) The P4 bleed solenoid valve originally opened (para. 32) is closed and puts the air/fuel ratio control unit in control of re-heat fuel flow.

35. When re-heat is no longer required it is cancelled by returning the engine throttle lever to its normal maximum position, whereupon all the control solenoids are de-energized, permitting the re-heat pump air and fuel cocks and the jet pipe nozzle shutters to close instantaneously.

INSTALLATION

36. The pump is secured to a cradle in the airframe by a strap passed over a machined diameter around the turbine exhaust casing; in addition, a steady bracket is retained by setscrews to bosses on the pump inlet casing. To remove a pump proceed as follows:—

(1) Disconnect the electrical leads from the pressure switch and shut-off cock solenoid.

(2) Remove the five nuts and washers securing the fuel supply pipe to the pump inlet flange.

(3) Remove the four nuts and washers securing the air inlet pipe to the inlet flange on the centre casing.

(4) Remove the four nuts and washers securing the air exhaust pipe to the exhaust casing flange.

(5) Disconnect the fuel delivery pipe from the pump outlet connection.

(6) Disconnect the drain pipe from the connection at the bottom of the air inlet casing.

(7) Remove the setscrews securing the steady bracket to the pump inlet casing.

(8) Unlock and unscrew the clamping bolt on the retaining strap around the exhaust casing, open the two halves of the strap and lift the pump off the mounting cradle.

37. Installing is the reverse of removal. New joint washers must be fitted to the fuel and air inlet flanges and to the air exhaust flange. Care must be taken to ensure that the anti-fret strips on the cradle and retaining band are undamaged and that they are positioned correctly. The retaining band clamping bolt and the steady bracket retaining setscrews must be wire-locked securely after tightening.

SERVICING AND INHIBITING

38. When the pump is installed on the aircraft a careful check should be kept on all pipelines and electrical connections. Ensure that all wire-locking is secure and that the protective gauze screens are clean and unbroken.

39. Both bearings must be lubricated by using a pressure lubricator on the grease nipples provided on the pump casing. Lubrication must be undertaken at periods specified in the aircraft Servicing Schedule when the rear bearing must be replenished with 2 cc. of grease and the main bearing with 10 cc. The lubricator should be of a type which delivers 1 cc. per shot and must be filled with grease, XG–275. No other grease may be used and no deviation from the quantities and the time specified is permissible.

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

TYPE RH.3 SERIES

Description

41. The RH.3 type of pump is used for the injection of water-methanol into gas turbine power units as a means of restoring take-off thrust under conditions of high ambient temperatures, or augmenting thrust at temperate conditions. The water acts as a coolant, whilst the methanol prevents it freezing at low temperatures.

42. This pump is identical to the RH.1 except for the following items:—

(1) The shut-off cock and solenoid are removed.

(2) The fuel delivery switch is deleted and its communicating passage is utilized for the main delivery duct. The non-return valve operates as a pressure relief valve to by-pass fuel to the inlet side of the pump.

Operation

43. When water-methanol injection is required, the engine throttle is operated and the control system opens a valve to allow fuel to pass to the eye of the impeller. At the same time an air throttle is opened and engine compressor delivery air is admitted to the pump inlet casing.

44. The pressure generated in the casing is converted into kinetic energy by its passage through the turbine entry nozzles and is then transferred to the turbine causing it to rotate.

45. The rotation of the turbine and the pump impeller generates a radial flow of water-methanol in the pump chamber which is discharged through the venturi-shaped diffuser passage to a combined shut-off cock and filter in the fuel delivery line.

46. When the water-methanol is no longer required, the engine throttle is returned to its normal position; this de-energizes the control system and cuts off the air and fuel supply to the pump.

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