Chapter 1

AIRBORNE PUMPS

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LIST OF ILLUSTRATIONS

Introduction

1. Fuel booster pumps produced by various manufacturers differ in design, dependent on their particular application. This chapter will not attempt to describe any one pump in detail, but will be confined to general principles. Basic constructional features employed by manufacturers in the various types of fuel booster pumps are described in the following chapters. For information on any particular type of pump, reference should be made to A.P.4343D, Vol. 1, and Vol. 6, Sect. 7, 8, 10, and 11.

DESCRIPTION

General

2. Booster pumps designed for aircraft installations are each produced for a particular application. Various types of fuel are used in these pumps, dependent on the aircraft requirement, hence their performances differ, according to the particular function required of each pump.

3. These pumps are used primarily for boosting the supply of aviation fuel to the aircraft engine-driven pump; they are also adapted for pumping aviation fuel for engine priming, de-icing fluid for de-icing requirements, kerosene for torch ignition for gas turbine engines, or for supplying methanol/water under pressure to the engine during aircraft take-off by injection into the cylinders, in order to prevent detonation at high boost pressure.

4. The pumps are designed to operate from a position external to the aircraft fuel tank, or when completely immersed in fuel within the tank.

5. A fractional horse-power electric motor is used to operate the pump, and when fitted with the immersed type of pump, essential details in their construction to ensure liquid tightness are provided. A general chapter on the care and maintenance of motors will be found in A.P.4343, Vol. 6, Sect. 16 and 17.

6. In instances where information appearing in A.P.4343D, Vol. 1, and Vol. 6, Sect. 7, 8, 10 and 11 contradicts that given in this chapter, the former is to taken as the overriding authority.

Cooling

7. Various methods are employed in the design of booster pumps to keep the temperature during operational periods within safe limits.

8. In the immersed type of pump a cooling jacket is provided, through which the fuel flow passes to cool the pump motor. Another method is the provision of a cooling fan on the motor armature shaft providing circulating air to and from the motor to atmosphere, via cored-out ventilating ducts within the pump, the greater part of which is immersed in fuel.

9. With the type of pump mounted on the outside of the fuel tank a ventilating fan is fitted on the motor armature shaft. Gauze-covered apertures are provided around the motor casing to allow cooling air to and from the motor.

Fuel sealing glands

10. The fuel sealing gland prevents fuel from causing possible damage to the pump driving motor. The gland is fitted between the motor and the pump impeller on the armature shaft extension, and so forms a seal around the rotating impeller shaft. There are various designs of sealing glands produced by fuel pump manufacturers; they comprise mainly the flexibox gland, the metal bellows gland and the not so recent rubber and spring gland. Each serves the same purpose.

Gland drain

11. Gland drains are fitted in the majority of pumps to allow any leakage of fuel past the fuel sealing gland to be drained away.

By-pass valve

12. By-pass valves are fitted in a large number of pumps, and are located in the fuel delivery outlet duct. The by-pass valve comprises an annular seating, to which is hinged a flap valve. When the pump is in operation the flap is kept closed by the pressure of fuel in the delivery outlet. When the pump is idle the pressure on the valve flap is relieved; as a result the valve opens, allowing fuel to pass from the tank directly into the delivery outlet duct, drawn by the action of the aircraft engine-driven pump. In some later types of fuel booster pumps the by-pass valve is fitted external to the pump, and placed in the fuel line within the tank. This valve performs the same function in either position.

Electrical connection

13. The method of providing an electrical supply to the pump motor is much the same with all types of pumps. The electrical cable input is via a Breeze-type socket, which mates with a Breeze-type plug fitted on a machined boss (in a convenient position) on the pump. In pump design the manufacturers endeavour to maintain good insulation by locating the electrical connection to that part of the pump which is to atmosphere. In some aircraft installations, however, the design is such that the electrical connection of the motor is immersed within the fuel tank; in this case, to maintain good insulation, a special liquid-tight connection is used with the mated plug and socket (*fig.* 1).

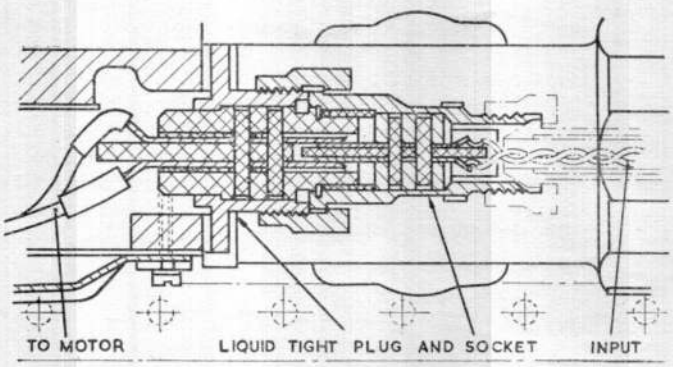

Fig. 1. Sectional view of plug and socket

OPERATION

14. The principle of operation of all booster pumps is much the same, whatever the design changes necessary to conform to aircraft installation requirements. A fractional horse-power electric motor drives a centrifugal-vaned impeller, which is fitted on the same shaft, direct, or, where the aircraft space is limited within thin wing sections, the motor drive is diverted at right-angles through suitable bevel gear to the impeller shaft (*para.* 21). Fuel from the tank enters the pump

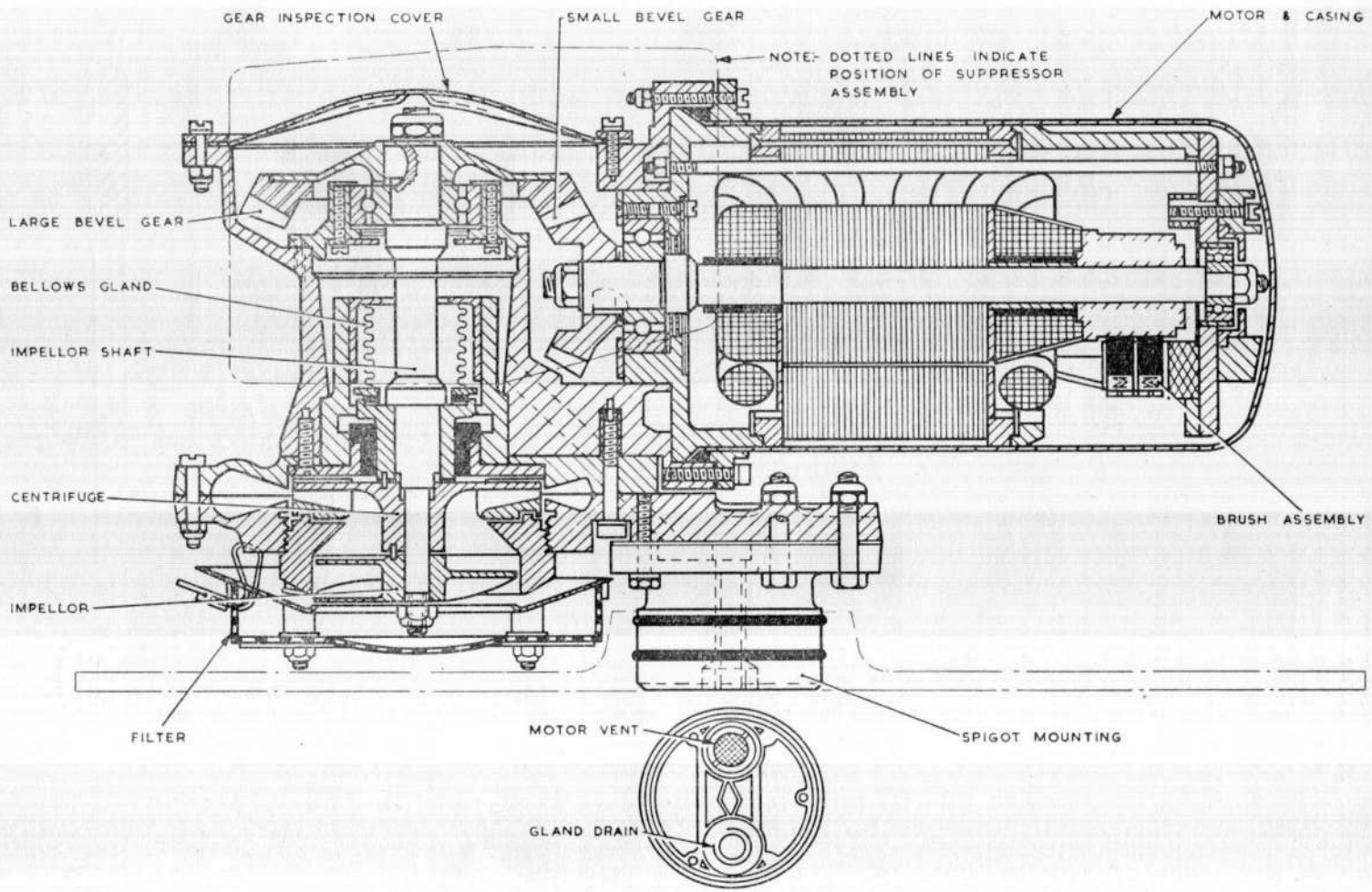

Fig. 2. Sectional view of bottom flush mounting type fuel pump with right angled drive

through a gauze filter, where the impeller helix, driven by the motor, draws the fuel stream into the centrifuge at the lower end of the impeller. From thence it is forced into the spiral volute, and via the pump delivery outlet to the fuel line of the aircraft engine-driven pump.

INSTALLATION

15. Various types of mountings are provided with the many different pump designs to meet any particular aircraft installation requirement.

16. Among the principal types of pump mountings are the bottom flush mounting, the bottom sump mounting, the side or hanging type mounting, and the inclined bottom sump mounting.

17. The pump with the bottom flush mounting is located within the fuel tank, with no part of the pump protruding beyond the limits of the tank (*fig.* 2).

18. The bottom sump mounting is fitted with a sump, or dished baseplate, into which the fuel flows before passing into the pump, thus allowing the tank to be completely emptied, either by the action of the pump or by the removal of the drain plug situated in the baseplate (fig. 3.)

19. Some bottom sump mountings are inclined at an angle from the horizontal axis of the pump-driving motor. This type of mounting is intended to be used in fuel tanks where the bottom is sloped to suit the configuration of the aircraft (*fig.* 4).

20. With the bottom mounting type of pump the body of the pump is inserted through a suitable reinforced hole in the fuel tank, and the unit is secured in a vertical position by securing the flange of the pump base to the bottom of the tank (*fig.* 5).

21. The side or hanging type of pump mounting is designed to meet aircraft installation requirements where the fuel tank depth is restricted within thin wing sections (*fig.* 6).

22. Thus the design of booster pumps is governed by the particular aircraft requirement, and in some instances the height of the pump is necessarily restricted by the shape of

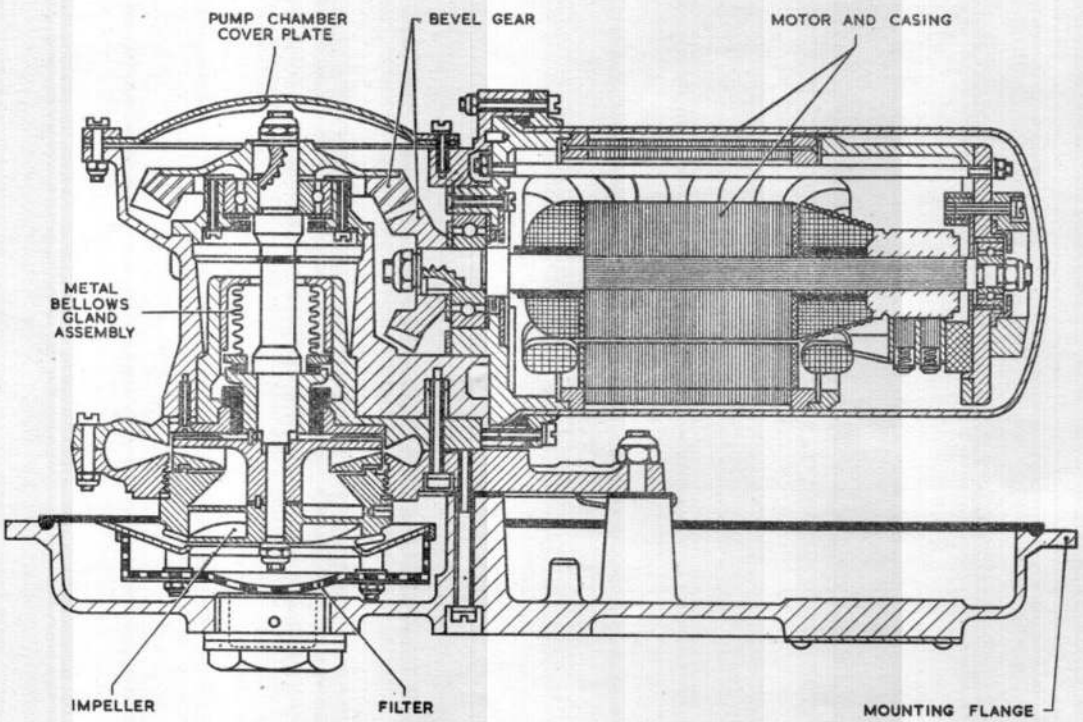

Fig. 3. Sectional view of bottom sump mounting type fuel pump with right angled drive

the aircraft. The space allocated, though sufficient to install a pump with a lower output, might not be capable of dealing with the aircraft's operational needs. To overcome this particular installation and operational problem, various pumps of sufficient capacity, and reduction in height, have been designed, comprising an electric motor driving a centrifugal impeller through suitable bevel gear, the axis of the motor drive shaft being at right-angles to the axis of the impeller shaft (*fig.* 2, 3 *and* 4).

23. When fitting a new pump ensure that the fuel tank has been emptied before removing the old pump. This may be checked by easing off the large plug below the delivery pipe.

24. Having ensured that the tank is empty, disconnect the fuel delivery pipe, the gland drain pipe, and the electrical supply cable from the Breeze plug. Next remove the nuts securing the pump to its seating on the fuel tank, and carefully withdraw the pump from the tank. Suitable bolts screwed into the two $\frac{1}{4}$ in. B.S.F. tapped extractor holes in the pump flange will assist in the latter operation.

25. Before fitting a new pump ensure that it is clean externally and that the jointing ring on the mounting flange is in good condition. Carefully insert the pump through the aperture in the fuel tank and tighten up the securing nuts around the mounting flange.

26. Ensure that the pump is free from foreign matter internally prior to connecting the fuel supply pipe. This may be done by connecting the electrical supply cable and switching on the motor. A small quantity of fuel put into the tank will then be delivered by the pump into a suitable receptacle, and in passing through the pump the fuel will carry any impurities with it. When this has been done the pump delivery outlet may be connected with the fuel supply line.

27. When received from Stores the gland drain outlet will be found to be fitted with a screwed plug. When the pump has been installed this plug should be removed and the outlet connected to the drain pipe. Omission to do this may result in fuel, which may have seeped through the fuel sealing gland, accumulating and washing away the grease from the lower bearing, thereby causing possible failure of the bearing.

SERVICING

Electrical test

28. When electrical tests are made periodically to ascertain that the pump motor is functioning efficiently such tests should be undertaken only with the motor on load. Therefore, with the immersed type of pump, ENSURE THAT THE PUMP IS IMMERSED IN FUEL.

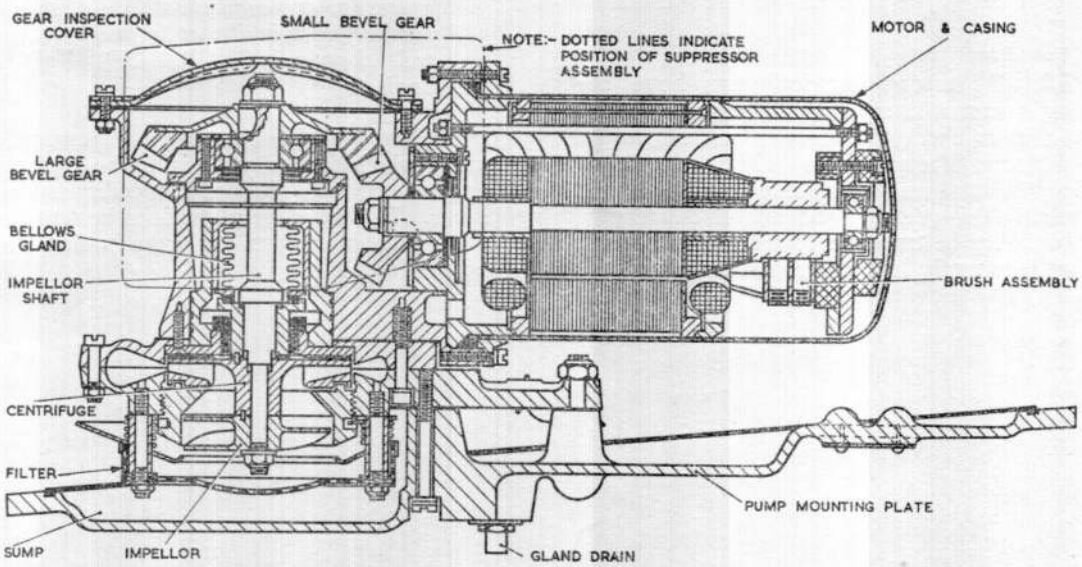

Fig. 4. Sectional view of inclined bottom sump mounting type fuel pump with right angled drive

29. Before applying the electrical test ascertain the position of the aircraft pump test socket and switches by reference to the appropriate Aircraft Handbook. When this has been done proceed as follows:—

(1) Close all fuel cocks between pumps and engines to ensure that no fuel can flow.

(2) Connect a testmeter, Type D, adjusted to its correct ammeter setting, to the test socket on the test panel (see note para.).

(3) Switch on the pump by depressing the test-push-switch on the test panel and note the reading of the ammeter for a period of not less than half a minute.

30. The interpretation of the readings obtained in the test detailed in the previous paragraph is as follows:—

(1) A steady reading not exceeding the current as laid down by the makers indicates that the motor is satisfactory (see note para.).

(2) A reading in excess of this current indicates a faulty motor.

(3) A fluctuating reading indicates faulty contacts, brushes or commutator.

(4) A zero reading indicates an open circuit and is consistent with a blown fuse, defective switch, faulty wiring, or, in extreme cases, complete motor failure.

31. When these tests have been completed, release the test switch and disconnect the testmeter, Type D, from the test sockets.

Functional test

32. When the electrical tests have been satisfactorily completed the pump should be tested to check the pressure and rate of fuel delivery. The pressure should be as laid down by the makers (see note para.). Failure to obtain this pressure and rate of delivery will probably be traceable to a damaged impeller or incorrectly loaded fuel sealing gland.

Periodic inspection

33. At the appropriate inspection periods care should be taken, when examining the pump, to conform with the following points:—

(1) Check the fuel outlet pipe coupling, gland drain coupling, and Breeze plug connection for tightness and ensure that the flame preventer gauze to the motor breather is in good condition.

(2) Test the pump as detailed in para. 28 to 32. If the pump is found to be defective it must be removed from the fuel tank and a replacement fitted as described in para. 23 to 27.

(3) Ensure that the by-pass valve if fitted is functioning correctly. To do this, turn on the tank selector cock and the appropriate engine master cock; then switch on the pump and observe the fuel pressure as indicated by the aircraft fuel pressure gauge or fuel pressure warning light. Very low pressure or failure to extinguish the warning light indicates that the by-pass valve is not functioning efficiently. In certain installations the fuel pressure warning light may be set to operate at a pressure higher than that at which the pump is rated. The light setting for the particular installation should therefore be checked before rejecting a suspected pump.

Note . . .

The test figures for maximum current under "no fuel flow" conditions, also the fuel pressure and rate of delivery test figures for any individual type of pump, will be found in the appropriate section and chapter of A.P.4343D, Vol. 1, Book 2.

34. Should it be necessary to remove a pump which is faulty, it is to be replaced by a new or reconditioned pump drawn from Stores. The defective pump is to be returned to the manufacturers for examination and reconditioning.

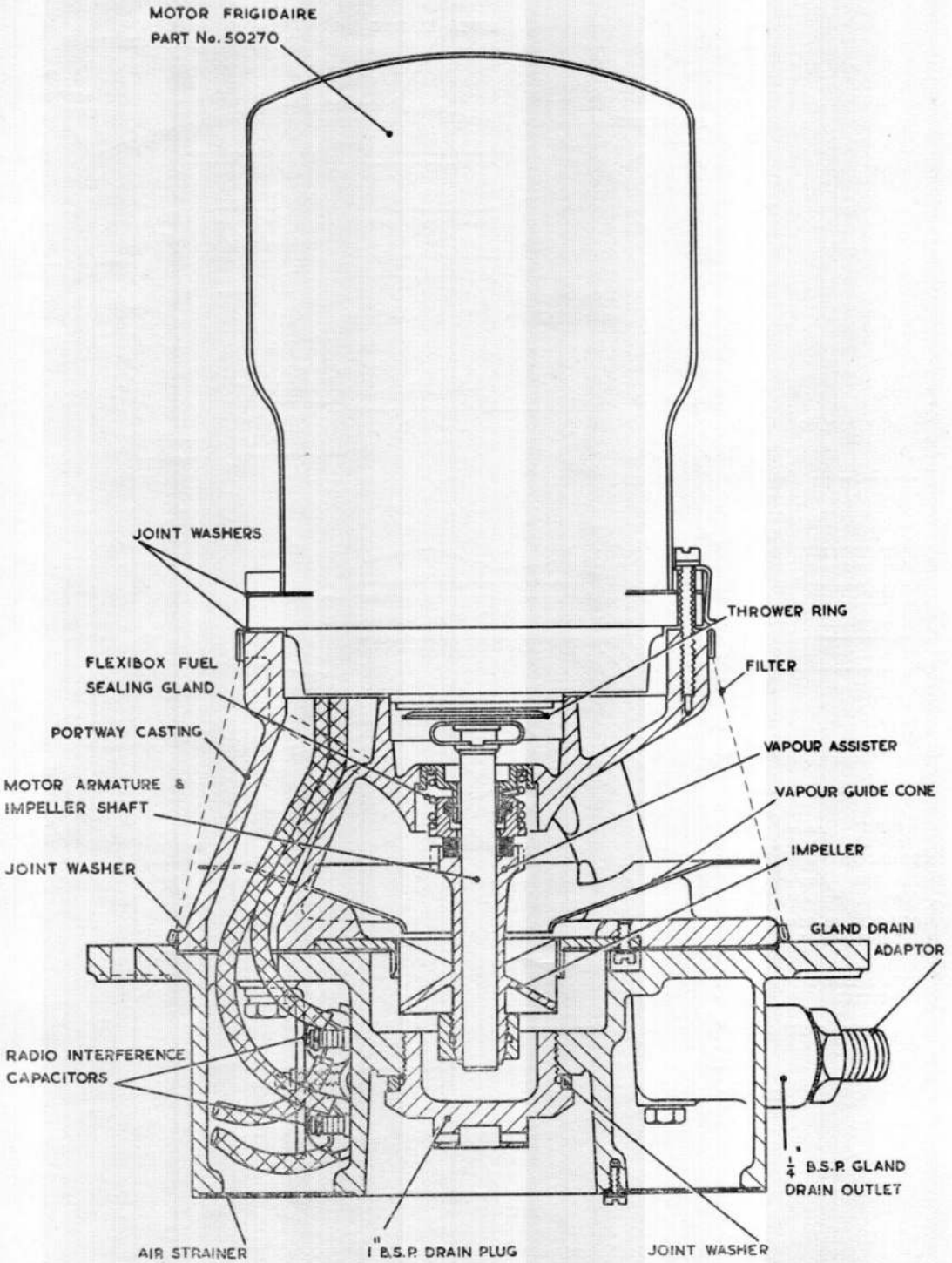

Fig. 5. Sectional view of bottom mounting type fuel pump

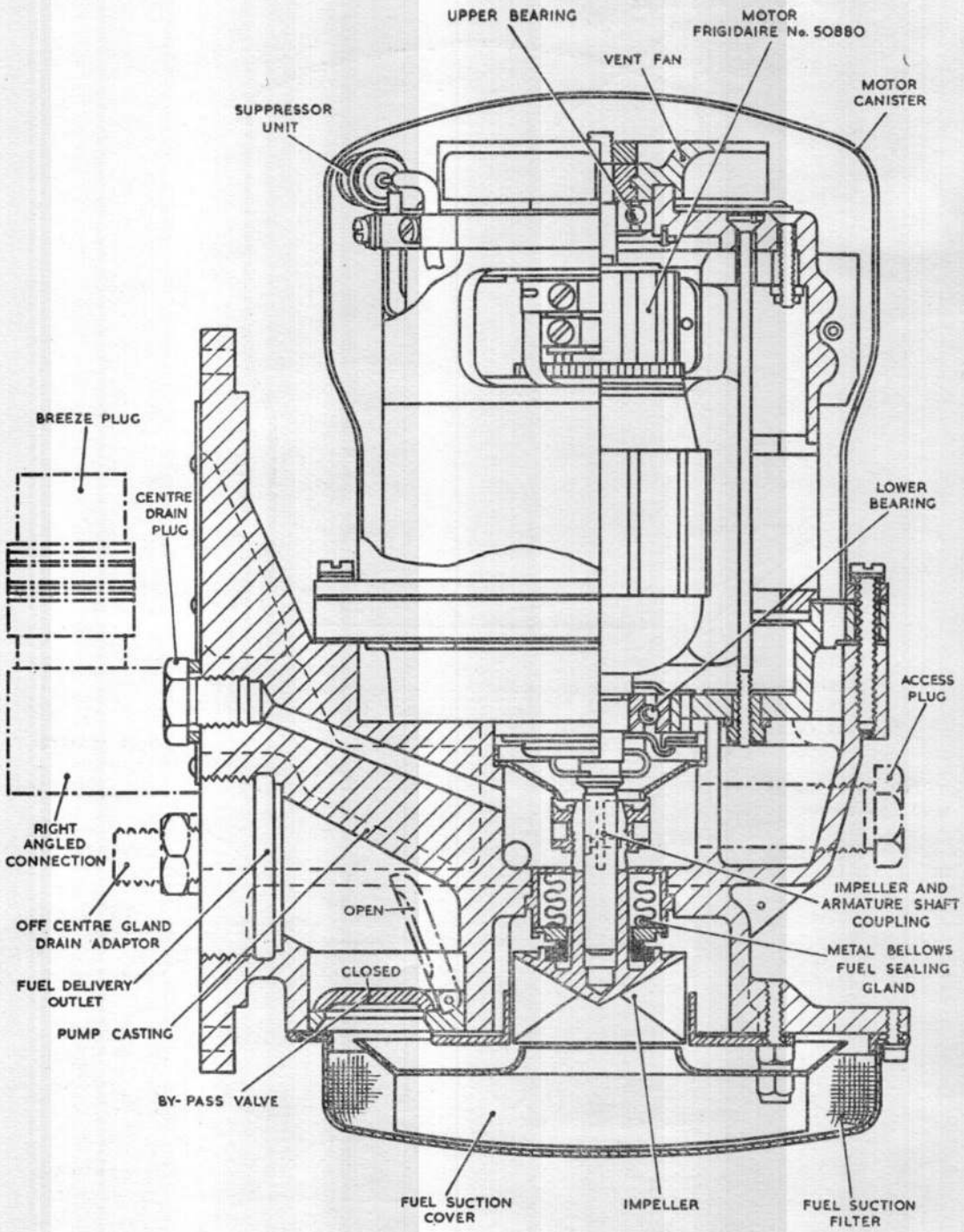

Fig. 6. Sectional view of side mounting type fuel pump

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