# Chapter 16

# PUMP, FUEL, B.P.3 SERIES

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### Introduction

**1.** Type B.P.3 series fuel pumps are electrically driven, self-contained units designed to supply fuel under pressure to the aircraft engine-driven pump, or alternatively to transfer fuel from auxiliary to main tanks. They are of the direct drive type and are installed in the base of the fuel collector box, or sump; the enclosed electric motor, and the pump inlet being contained within the tank. In certain installations the pump is fitted in an inverted flight valve, which enables it to supply fuel at normal delivery pressure under negative-g conditions. Rated operating voltage is 24V d.c. Leading particulars for the various mark numbers are detailed in the appendices to this chapter.

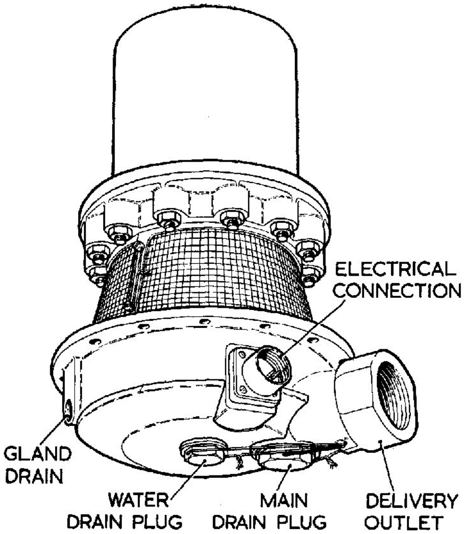


**Fig. 1. External view of typical B.P.3 fuel pump**

## DESCRIPTION

### General

**2.** General and sectional views of a typical pump assembly are illustrated in Fig. 1 and 2. Differences between the mark numbers are detailed in the appendices.

### Motor unit

**3.** The motor unit is a flameproof, d.c., compound wound machine suitable for use on a supply voltage of 22·0/28·8V d.c. Brush gear is of unit construction, comprising four brushes, two on each side in pairs, producing two brush tracks. The armature shaft is supported by two shielded ball bearings, both of which are pre-packed during manufacture with an anti-freeze/high melting point grease; the bearings cannot be re-lubricated. The upper bearing is retained in a steel sleeve, and the inner race of the lower bearing is locked to the armature shaft by a screwed ring. This ring incorporates a thrower which flings off any fuel which may seep past the main gland (*para.* 5), before it can enter the motor unit. The complete motor unit spigots into a recess in the pump upper base casting and is totally enclosed in a fuel tight alloy casing.

### Pump unit

**4.** The two-stage pump unit comprises a combined first stage helical and a second stage centrifugal impeller, mounted on the extended shaft of the armature. The centrifugal impeller, which is closely housed in the lower base casting, forces fuel into a spiral volute and thence to the delivery line. The volute is an integral part of the lower base casting.

**5.** The upper base casting mainly comprises two circular ends separated by two cored-pillars, one of which is used as a conduit for the electrical supply leads and also as a breather for the motor unit, while the other pillar is used as a gland drain. The motor unit is located in an annular recess at the upper end of this casting, and the lower base casting is secured to a stud ring which forms the lower end. The housing for the metallic bellows type gland is located between the two ends of the upper base casting to prevent ingress of fuel into the motor unit. Details of the gland assembly fitted to any particular mark of pump are given in the appropriate appendix at the end of this chapter.

**6.** The lower base casting is the only part of the pump assembly which projects outside the tank after installation. In addition to housing the centrifugal impeller (*para.* 4), it also carries the 1¼ in. B.S.P. fuel outlet, ¼ in. B.S.P. gland drain and the electrical connection plug. At the delivery end of the cast volute, a by-pass flap-valve is fitted which enables fuel to be drawn directly from the tank by the engine driven pump whenever the booster pump becomes idle. This valve is normally held closed by fuel booster pump delivery pressure. The base casting is also provided with a mounting flange for securing the pump assembly to the tank stud ring.

**7.** The inlet to the impeller system is surrounded by a vapour guide cone, the function of which is to direct away from the impeller inlet, accumulation of air and vapour evolved in the fuel under various flight conditions. A wire mesh filter conpletely surrounds the pump inlet to prevent ingress of foreign matter into impeller and delivery line.

## OPERATION

**8.** Fuel from the tank enters through the wire mesh filter into the eye of the combined helico-centrifugal type impeller which is driven by the motor unit. Fuel is then forced through the spiral volute, in the lower base casting, into the delivery line.

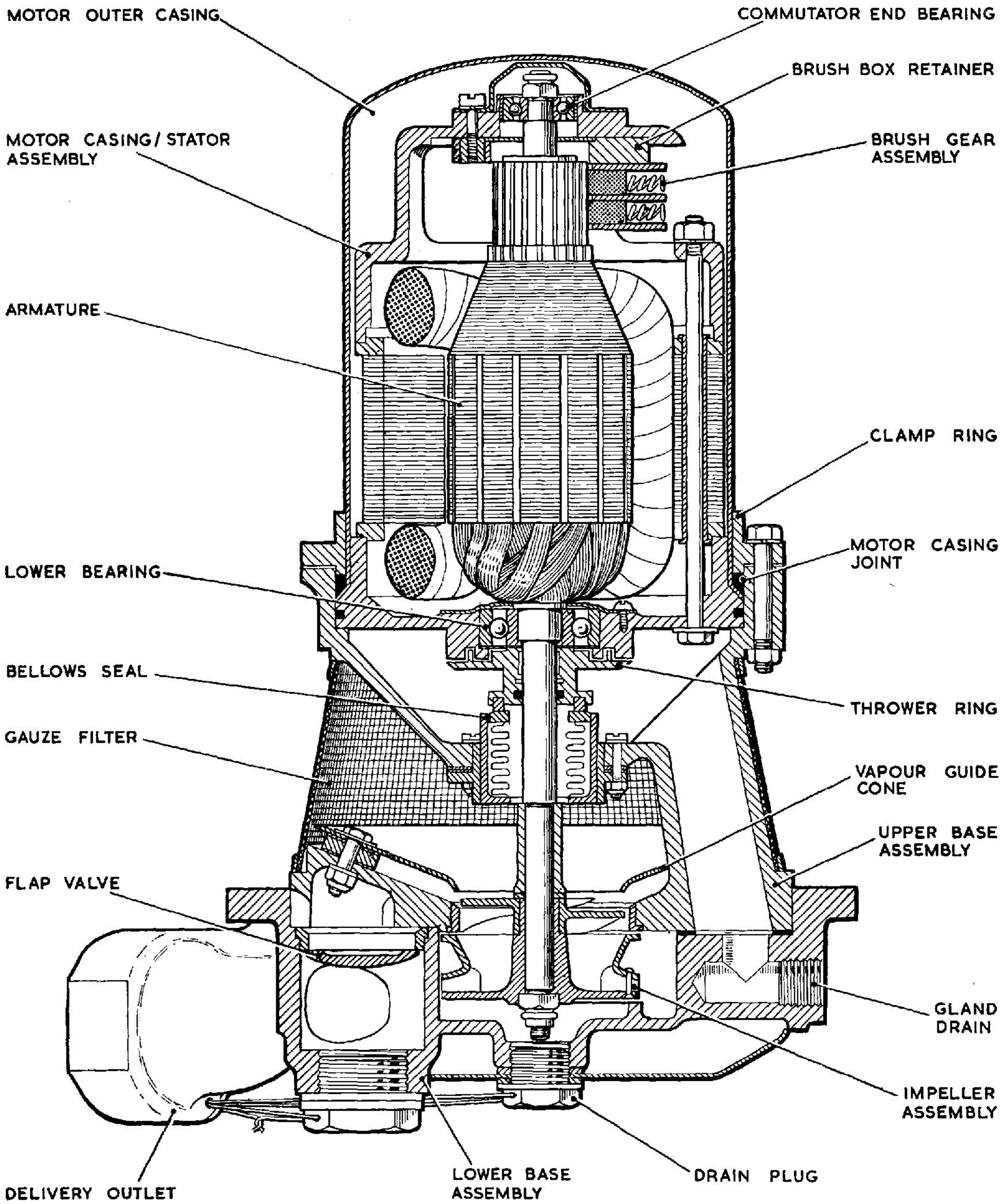


**Fig. 2. Sectional view of B.P.3 Mk. 4 fuel pump**

**9.** Under conditions in which the flow from the pump is low, due to reduced engine requirements, the impeller continues to rotate at approximately normal speed without causing an excessive increase in delivery pressure.

**10.** When the pump is idle, the pressure on the underside of the by-pass valve is relieved, allowing the valve to open and enabling the engine-driven pump to draw fuel direct from the tank without passing through the pump impeller system.

## REMOVAL AND INSTALLATION

### Removal

**11.** Before attempting to remove a pump, ensure that the tank has been drained of fuel and that the electrical supply to the pump has been switched off. The former can be checked by easing the drain plug in the delivery outlet of the lower base casting, when, if there is any fuel left in the tank, it will have a free flow through the by-pass valve and volute passage of the pump to the drain plug.

**12.** The precise method of removing a B.P.3 series pump will be detailed in the appropriate Aircraft Handbook. In general terms it will consist of disconnecting the fuel delivery and gland drain pipes and the electrical connection socket. The pump can then be removed by releasing the fourteen nuts securing it to the tank mounting ring. Take care to support the weight of the pump during this operation. Two $\frac{1}{4}$ in. B.S.F. screws can be used, if necessary, in the tapped lower base casting flange holes to assist in separating the casting flange from the mounting ring.

**Note . . .**

*When B.P.3 pumps are fitted to inverted flight valves, the above procedure can be followed to separate the pump from the valve or alternatively the complete pump and valve assembly can be removed (refer to the appropriate Aircraft Handbook).*

### Pre-installation checks

**13.** The installation of a new pump should be preceded by the following checks:—

(1) Ensure that the pump has not been stored for longer than the specified maximum period (i.e. 12 months in the original packing and carton as supplied by the manufacturer, or three years when special packing has been provided). Pumps stored for longer periods must not be used without being dismantled, examined and tested as detailed in Vol. 6.

(2) Examine the exterior of the pump for damage, security of locking wires and for corrosion. Blend out slight areas of corrosion and apply a protective finish (e.g. chromic acid solution) to the unprotected area. Ensure that the pump is clean.

(3) Remove any transit plugs and/or tape from the delivery outlet, gland drain and electrical connections and from the motor breather gauze.

(4) It is advisable to make a starting check on the pump before installation. Apply a 24V d.c. supply to the electrical connection. The pump must start immediately. Repeat the test several times. If the pump fails to start immediately it should be returned to an overhaul base for further serviceability testing using approved equipment.

### Installation

**14.** The above pre-installation checks apply to all aircraft installations of these pumps. For detailed procedure covering installation in a particular aircraft, reference should be made to the appropriate Aircraft Handbook.

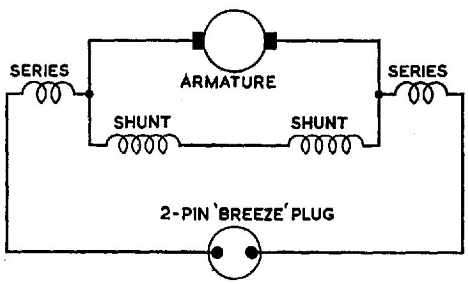


**Fig. 3. Circuit diagram**

**15.** As a general example, installation in the aircraft will comprise the following operations:—

(1) Ensure that a new gasket is available for use between the pump mounting flange and the tank stud ring.

(2) Secure the pump mounting flange to the tank stud ring with fourteen 2-B.A. nuts.

(3) Re-connect the electrical supply, together with the delivery and gland drain pipes. Check that the open end of the gland drain pipe is facing towards the rear of the aircraft to avoid possible pressurisation in flight.

(4) Wire lock all pipe connections to the pump.

## SERVICING

### Routine inspection

**16.** At routine inspections the following general procedure should be adopted:—

(1) Check the fuel delivery pipe and gland drain coupling and the electrical supply socket for tightness. Examine wire locking. Examine motor breather gauze for possible blockage.

(2) Test the pump as detailed in para. 17-23. If the pump performance is found to be unsatisfactory in any way, the pump must be removed from the aircraft and a new or reconditioned unit must be fitted. No in-situ maintenance is possible.

(3) Ensure that the by-pass valve is functioning correctly by completing the tests detailed in the appropriate Aircraft Handbook.

(4) At the periods laid down in the appropriate Servicing Schedules, all pumps must be replaced by new or reconditioned pumps drawn from stores. Time expired and faulty pumps must be returned to a Maintenance Unit or to the manufacturer for repair and reconditioning.

### Electrical test

**17.** A periodic electrical check in accordance with the appropriate Servicing Schedule should be made to ascertain that the motor is functioning satisfactorily. The pump must be replaced by a new or reconditioned unit if there is any indication of erratic performance such as excessive current consumption. These tests must only be made with the motor 'on-load'—i.e. immersed in fuel and running.

### *'No fuel flow' electrical test*

**18.** Before applying the electrical test at 'no fuel flow' ascertain the position of the aircraft pump test socket and switches by reference to the relevant Aircraft Handbook. When this has been done, proceed as follows:—

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

(2) Connect a suitable portable ammeter to the test socket on the test panel. Note that when using a clip-on type ammeter, open and close the tongs smartly prior to use to reduce the hysteresis error.

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

**19.** Interpret the readings obtained as follows:—

(1) A steady reading not exceeding that indicated by the graph (*fig.* 4), indicates that the motor unit is functioning satisfactorily.

**Note . . .**
*The graph (fig. 4) is provided as a guide to pump performance under no-load conditions and figures derived from it are not to be interpreted as forming part of the approved acceptance test specification for the pump.*

(2) A reading in excess of that shown by the graph indicates a faulty motor unit, a rise in torque loading due to the obstruction of moving parts, or a restriction of the fuel flow.

(3) A fluctuating reading indicates faulty commutation, or that the bearings or other rotating parts are binding.

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

**20.** When the above tests have been completed, release the test switch and disconnect the ammeter from the socket.

### *Operational test*

**21.** Subject to the electrical tests being satisfactory, the pump should be tested where possible for proof of performance and checked against the performance figures quoted in the appropriate appendix to this Chapter. Refer to the appropriate Aircraft Handbook for procedure details. Failure to obtain the quoted pressures and rate of fuel

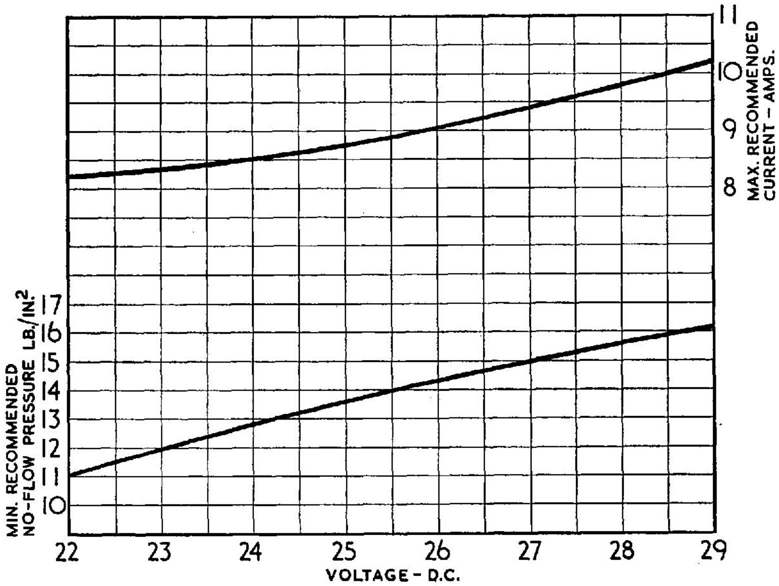


**Fig. 4. 'No fuel flow' electrical test graph**

delivery could be caused by a faulty motor unit, damaged impeller, or incorrect loading of the gland. The pump should be removed to ascertain the cause of failure.

*Gland drainage*

**22.** During the above tests, an examination must be made of the gland drain exit for fuel leakage. Leakage must not exceed two drops per minute while the pump is running or one drop per minute while stationary. Any evidence of leakage in excess of these figures will necessitate removal of the pump.

*Insulation resistance test*

**23.** Using a 500-volt insulation resistance tester, measure the insulation resistance between the electrical connection pins and earth. When a pump is drawn from stores, the insulation resistance must not be less than 2 megohms. After installation, due to humidity prevalent in aircraft at dispersal points, the minimum insulation resistance permissible is 50,000 ohms.

**TABLE 1**

**Faults, possible causes and rectification**

| Fault | Possible cause | Rectification |
|---|---|---|
| Gland leakage .... .... | (1) Bad finish between gland seal faces.<br>(2) Incorrect loading of gland. | All these conditions will necessitate dismantling the pump with subsequent rectification and testing. |
| Excessive current consumption | (1) Excessive loading on gland<br>(2) Faulty motor unit.<br>(3) Fouling of impeller by foreign matter. | Return pump to Maintenance Unit or manufacturer. |
| Low delivery pressure .... | Faulty motor unit. | |
| Pressure surge .... .... | (1) Tight or pre-loaded bearings.<br>(2) Excessive loading on gland. | |
| Low insulation resistance .... | Dampness in motor windings. | |

# Appendix 1

## PUMP, FUEL, B.P.3 MK. 3

### LEADING PARTICULARS

| | |
|---|---|
| **Pump, fuel. Type B.P.3 Mk. 3** .... .... | **Ref. No. 5UE/4983** |
| *Motor unit* .... .... .... | *24V d.c. flameproof single speed* |
| *Voltage range* .... .... .... .... .... .... | *22·0/28·8V d.c.* |
| *Rated voltage* .... .... .... .... .... .... .... | *24·0V d.c.* |
| *Rated output at 24·0V d.c.* .... .... .... .... .... | *400 g.p.h.* |
| *Delivery pressure at rated voltage* .... .... .... | *10·5 lb/in² (min.)* |
| *Maximum current consumption (at rated output/voltage)* | *9·0A (max.)* |
| *Maximum no-flow delivery pressure at 28·8V d.c.* .... | *19·0 lb/in²* |
| *Minimum no-flow delivery pressure* .... .... | *See Fig. 4 basic chapter* |
| *Electrical connection (Plessey 2CZ.111402)* .... .... | *Ref. 5X/7143* |
| *Delivery outlet* .... .... .... .... .... .... | *1¼ in. B.S.P.* |
| *Gland drain* .... .... .... .... .... .... | *¼ in. B.S.P.* |
| *Weight of unit* .... .... .... .... .... .... .... | *12 lb.* |

**Introduction**

**1.** The main features of the B.P.3 Mk. 3 fuel pump are as described in the basic chapter. The metallic bellows type gland in the upper base casting is assembled with the seal face downwards as shown in App. 1, Fig. 1. The independent rotating carbon seal face is assembled into a component designed to assist with the dispersion of vapour from the fuel entering the impeller system.

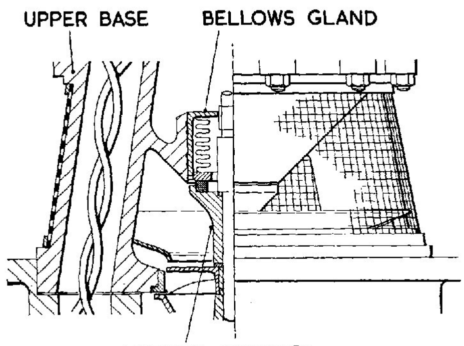


**Fig. 1. Gland arrangement—B.P.3 Mk. 3 fuel pump**

## Appendix 2

# PUMP, FUEL, TYPE B.P.3 Mk. 4

### LEADING PARTICULARS

| | |
|---|---|
| **Pump, fuel, Type B.P.3 Mk. 4** .... .... | **Ref. No. 5UE/6536** |
| *Motor unit* .... .... .... .... | *24V d.c. flameproof single speed* |
| *Voltage range* .... .... .... .... .... .... | *22·0/28·8V d.c.* |
| *Rated voltage* .... .... .... .... .... .... .... | *24·0V d.c.* |
| *Rated output at 24·0V d.c.* .... .... .... .... .... | *400 g.p.h.* |
| *Delivery pressure at rated voltage* .... .... | *10·5 lb/in² (min.)* |
| *Maximum current consumption (at rated output/voltage)* .... .... .... .... | *9·0A (max.)* |
| *Maximum no-flow delivery pressure at 28·8V d.c.* .... .... | *19·0 lb/in²* |
| *Minimum no-flow delivery pressures* .... .... | *See Fig. 4 basic chapter* |
| *Electrical connection (Plessey 2CZ.111402)* .... .... | *Ref. 5X/7143* |
| *Delivery outlet* .... .... .... .... .... .... | *1¼ in. B.S.P.* |
| *Gland drain* .... .... .... .... .... .... | *¼ in. B.S.P.* |
| *Weight of unit* .... .... .... .... .... .... .... | *12 lb.* |

**Introduction**

**1.** The main features of the B.P.3 Mk. 4 fuel pump are as described in the basic chapter. The pump differs from the Mk. 3 version in the following details:—

(1) A rubber seal is fitted between the upper base casting and the motor unit base at the electrical supply cable inlet.

(2) The main gland has been repositioned and the rotating seal member incorporated in a re-designed labyrinth seal type thrower nut securing the lower motor unit bearing (basic chapter, fig. 2).

(3) Seal washers are fitted under the heads of the motor unit tie-bolts.

(4) An improved lower motor unit bearing is fitted.