# Chapter 10

# PUMP, FUEL, PUL 900 SERIES

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## Introduction

**1.** The pumps in this series are designed for mounting within the fuel tank, being completely immersed in fuel, except for the electrical connection, the gland drains, and the fuel delivery outlet, which are to atmosphere. ▲There are two types in this series, one arranged as a side fitting unit and the other as a base fitting unit, the latter being designed to fit the base of the aircraft fuel tanks, fuel collector box, or sump.▲

**2.** The pump is electrically driven and self-contained, operating at between 24 and 26 volt d.c., and is intended primarily for use as a booster pump, to maintain the fuel supply to the engine-driven pump under all conditions of fuel temperature, rate of climb, altitude, etc., which can be experienced in flight.

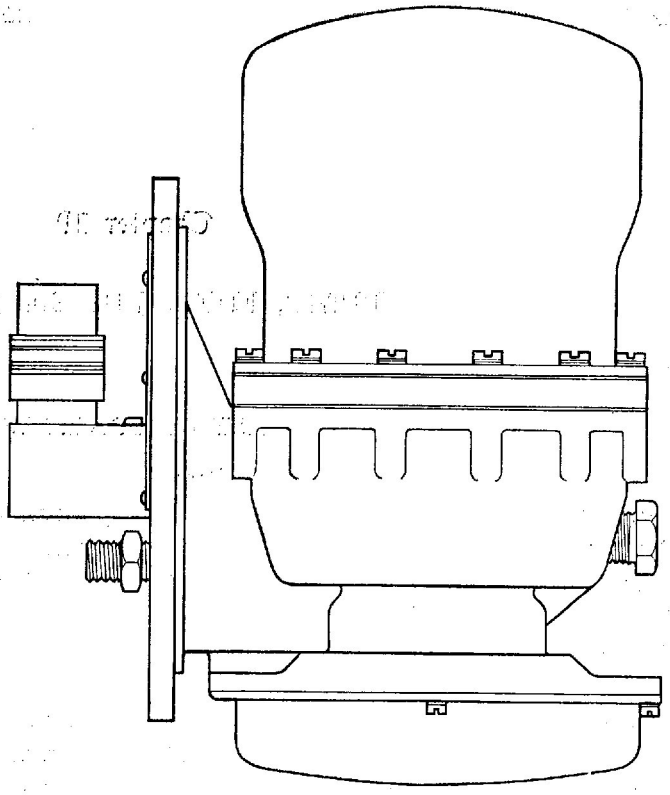

**Fig. 1. General view of side fitting pump**

## DESCRIPTION

### General

**▲3.** The pumps described (side fitting and base fitting) in this chapter are typical of this range. The main differences from these pumps and specific types will be found in the appropriate appendix to this chapter. A sectional view of a side fitting pump is shown in (*fig.* 2), and that of a base fitting type in (*fig.* 3). Both pumps are basically similar and the following description of the side fitting pump covers the common features in both types. The essential differences between the side fitting pump and the base fitting pump are mentioned in paragraph 17. The pump▲ consists mainly of a driving motor, supported in the upper end of the pump body. A canister, which covers the motor, is secured to the pump body flange by twelve B.S.F., ch.hd. screws, and associated washers. Fourteen $\frac{7}{32}$ in. clearance holes, equally spaced around the pump body flange, are provided, to permit the complete pump unit to be bolted to the interior side of the aircraft fuel tank. Two $\frac{1}{4}$ in. B.S.F., diametrically opposite, tapped holes, are also provided in the pump flange, to assist in breaking the joint, when it is necessary to remove the pump from the tank.

**4.** The motor, which is mounted above the pump impeller, is protected from the ingress of fuel by a cansiter, which completely surrounds the outside of the motor, and from below the motor lower bearing, by a gland, assisted by a gland sealing cone. The motor armature shaft extends downwards through the gland. The impeller, which is secured to the lower end of the shaft extension, is positioned within the volute, formed by the design of the pump casting.

### Motor

**5.** The motor is a totally enclosed, two-pole, compound wound, flame proof, fan cooled machine, and is designed to operate at high, medium, and low speeds, and is fitted for radio noise suppression.

**6.** The motor comprises a commutator and armature of the high speed type, the shaft of which is supported at each end in ball bearings, lubricated with high melting, low freezing point grease. The bearings are housed in the respective end frames of the motor body, the centre, or yoke, contains the motor field windings. The end frames, and the yoke are held together by two through bolts passing, via the yoke, from one end frame to the other.

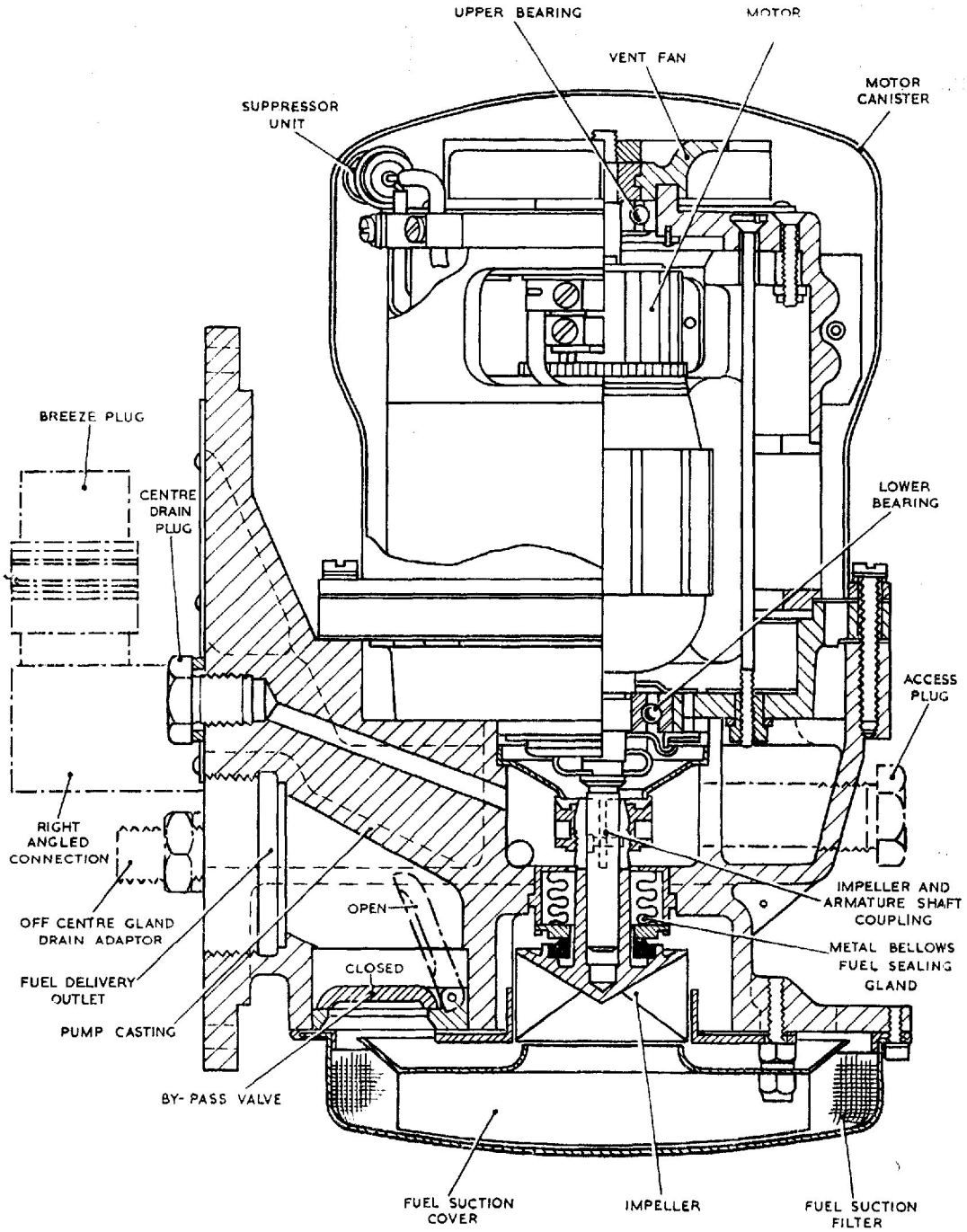


**Fig. 2. Sectional view of side fitting pump**

7. The commutator end frame houses the commutator and brush-gear, special twin sets of carbon brushes are fitted for efficient operation at high altitudes, apertures are provided in the end frame for access to the brushes. An extension on the end frame carries the six-bladed fan which draws cooling air through the interior of the motor. The commutator

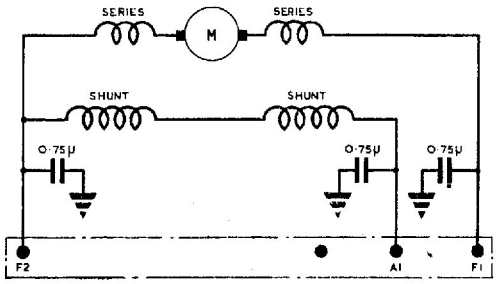


**Fig. 3. Circuit diagram**

end frame is closed by a metal disc, secured in position by a circlip, sprung into a groove machined in the interior of the end frame. The drive-end frame is secured by a twiclip which is sprung into a groove, machined in the end frame, backed by two distance washers and a bearing retainer; the distance washers providing the required tension on the shaft locking device.

8. A suppressor unit comprising three 0·75 micro-farad capacitors, is included in the motor circuit, to reduce, or eliminate radio noise interference (*fig.* 3).

**Pump body assembly**

9. The pump body assembly is designed to hold the impeller, fuel sealing gland and by-pass valve. The impeller is secured to the lower end of the armature shaft, which extends downwards through the casting. The pump casting is shaped at its lower centre to form a volute chamber, in which the impeller rotates. Passages are cored out, to provide drain ducts from the fuel sealing gland,and a fuel delivery duct from the impeller to the outlet. An annular ring is machined in the fuel delivery outlet duct to seat the by-pass valve in the closed position.

10. Two $\frac{1}{4}$ in. B.S.P. gland drain outlets tapped $\frac{7}{16}$ in. deep are provided in the pump casting. The centre outlet is for use when the pump is working in the inverted position, but is plugged for normal mounting position. The other outlet, which is located off-centre in the pump side flange face secured to the fuel tank, is for use when the pump is working in the normal mounting position, but is plugged for inverted mounting. The fuel delivery outlet is a $1\frac{1}{4}$ in. B.S.P. connection, located on the lower-centre of the pump side flange face. The electrical leads to the motor, terminate at a 4-pin Breeze type plug, which is fitted to a right-angled bracket; this bracket is the only part of the pump which protrudes from the pump to atmosphere.

**Impeller**

11. The impeller is of the single-entry, end-suction type, and is designed to give maximum performance at high altitudes. It is mounted on the end of the motor shaft by means of a slotted cone nut collet coupling device, similar to a chuck in operation, which when tightened up, grips the driving motor extension shaft. In order to avoid the possibility of the impeller slipping round the motor shaft, the coupling is provided with a small shouldered pin, passing through a hole bored at right-angles to the axis of the shaft. When the impeller is assembled over the shaft, the pin passes down any one of the four slots cut in the impeller hub, until the impeller is in its correct axial position, i.e., when the tips of the blades are flush with the suction cover. The motor extension shaft enters a blind hole in the hub of the impeller, to prevent fuel by-passing the gland from the inlet side. The periphery of the impeller runs in the bore of the suction cover with a coarse running clearance, to reduce pressure leakage, but at the same time, to permit the escape of vapour and air, back to the suction space.

**Fuel sealing gland**

12. This fuel sealing gland is located on the armature shaft, directly above the impeller, and is fitted to prevent fuel seeping through to the motor lower bearing, and causing damage to the motor. A gland sealing cone is fitted above the fuel sealing gland, and assists in deflecting any fuel leakage from the motor lower bearing.

*Metal bellows gland*

13. The metal bellows gland comprises a brass backplate, to which is sweated a brass bellows, with a bronze seal ring to the other end. The seal ring is guided by four splines, cut round its outer circumference, and engaging with four lugs projecting from the backplate. These parts form a gland unit which is pressed into the pump casing. The bronze seal ring, which is stationary, rubs against a rotating carbon ring, shrunk permanently into the back of the impeller.

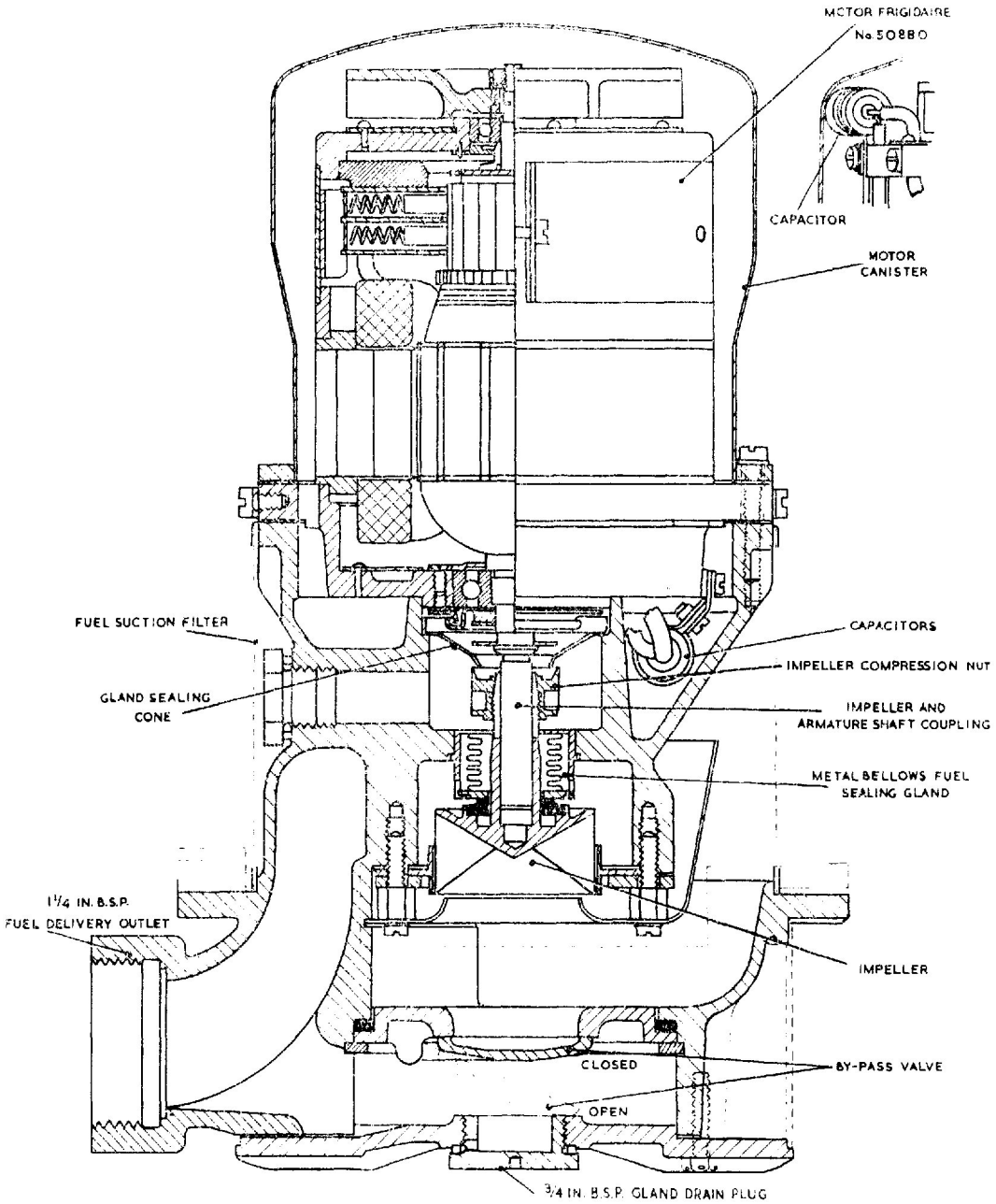


**Fig. 4. Sectional view of base fitting pump**

*Flexibox gland*

**14.** In the later types of PUL pumps the flexibox fuel sealing gland is fitted. This gland consists of a carbon ring which is fitted to the rotating impeller sleeve. The carbon ring rubs against a stationary steel-lapped face held by a spring at pre-determined pressure, thus preventing fuel seeping through to the lower motor bearing.

**By-pass valve**

**15.** The by-pass valve is located in a recess adjacent to the fuel delivery outlet duct. The valve is hinged to an annular flange, which ensures an efficient seating in the closed position. When the pump is idle, there is no pressure on the valve, allowing the valve to open, and the engine driven pump to continue to draw fuel from the tank.

**Filter**

**16.** A suction strainer, or gauze filter, is fitted at the fuel inlet, which is located at the base of the pump, below the impeller, to prevent foreign matter being drawn into the pump, due to suction caused by impeller rotation.

**Base fitting pumps**

▲**17.** The essential differences of this type of pump from the side fitting pump can be seen in the sectional view (*fig.* 3). An additional feature in this pump is the incorporation of passages cored out in the pump body for draining away fuel leakage, and also to provide ventilation to and from the motor through an air strainer located in the side of the pump body. One $\frac{1}{4}$ in. drain outlet tapped $\frac{1}{2}$ in. deep is located in the side of the pump base, the other $\frac{3}{4}$ in. drain outlet being in the centre of the pump base. The fuel delivery outlet and a base holding the Breeze plug are also located in the base.▲

## OPERATION

**18.** The impeller, driven at high, medium, or low speed, accepts fuel from the tank, and as the pressure builds up, forces fuel through the delivery outlet, and thence to the fuel line.

**19.** Under conditions when the pump is supplying fuel in excess of engine requirements, the impeller continues to rotate, but the pressure is maintained within pre-determined limits.

**20.** When the pump is idle, the pressure on the underside of the by-pass valve is relieved, the therefore opens, allowing fuel to pass from the tank, through the pump, whilst the engine driven pump continues to draw fuel from the tank.

**21.** The type of impeller used in the pump ensures maximum performance of the pump under conditions of sudden, and rapid de-aeration due to high rates of climb, or other manœuvres. It also assists in quick recovery from vapour locking, caused by the temporary removal of fuel from the vicinity of the impeller.

## INSTALLATION

**22.** When fitting a new pump, ensure that the fuel tank has been emptied, before removing the old pump, by easing off the joint of the fuel delivery pipe. If there is any fuel left in the tank, it will have a free passage through the by-pass valve, which is open when the pump is idle.

**23.** When it is certain that the tank is empty, disconnect the fuel delivery pipe, and the electrical supply from the Breeze plug connection. Next, remove the studs and associated nuts and washers securing the pump to its seating on the side of 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 provided in the pump flange will assist in this operation.

**24.** Before fitting the new pump, make sure that it is clean externally, and that any adhesive tape, or plugs, serving as protection over the pump apertures have been removed. In addition, ensure that the jointing ring on the mounting flange of the pump is in good condition. Insert the pump through the reinforced flanged hole in the fuel tank, and tighten up the securing nuts, with their associated washers, to the studs which are provided for securing the pump to the tank.

**25.** To ensure that the pump is free from foreign matter, prior to finally connecting the fuel supply pipes, the electrical supply cable should be connected to the pump, and the motor switched on. A small quantity of fuel put into the tank will 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 outlet may be connected with the fuel supply line.

**26.** When received from Stores the gland drain exit will be fitted with a plug. When the pump has been installed, and tested, this plug should be removed, and a drain pipe fitted. This pipe should be installed

in such a manner that the level of the pipe is at no point higher than the connection, when the aircraft is on the ground, or in level flight. The outlet end of this pipe must be external to the aircraft, and should terminate in a low pressure area. The end of the pipe should be cut at 45 degrees with the chamfer facing aft. Failure to fit this pipe may result in fuel, which may have seeped through the sealing gland, washing away the grease from the motor lower bearing, and may cause possible failure of the bearing.

**Note . . .**

*In all instances where any doubt exists with regard to the method of installing or removing a pump from the aircraft, reference should be made to the appropriate Aircraft Handbook.*

## SERVICING

### Electrical test

**27.** A routine electrical test must be made to ascertain that the motor of the fuel pump is operating correctly. ENSURE THAT THE PUMP IS IMMERSED IN FUEL WHEN THESE TESTS ARE IN PROGRESS.

**28.** Having ascertained the position of the aircraft fuel pump test socket and switches, by reference to the appropriate Aircraft Handbook, proceed as follows:—

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

(2) Connect a testmeter, Type D (Ref. No. 10S/10610), adjusted to its 15 amp. d.c. range, to the socket on the test panel.

(3) Switch on the pump by pressing the switch on the test panel, NOT THE NORMAL FUEL PUMP SWITCH, for a period of not less than half a minute.

During this period the current consumption of the motor should be noted, and the readings, as registered by the testmeter, should be interpreted as follows:—

▲(1) A steady reading not in excess of the value of the current given in the Leading Particulars for the pump indicates that the motor is satisfactory.▲

(2) A reading in excess of the figure given in (1) indicates that the pump motor is faulty.

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

(4) A zero reading is consistent with, either a blown fuse, defective wiring or switch, or complete motor failure.

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

### Operational test

**30.** When the electrical tests have been completed, the pump should be tested to observe the pressure of fuel being delivered. The values for minimum pressure should correspond to those given in the Heading Particulars of the appropriate Appendix. If this pressure is not obtained the fault may probably be traced to a damaged impeller, or incorrectly loaded bellows gland.

### Routine inspection

**31.** When examining the pump at the appropriate inspection periods, care must be taken to conform with the following points:—

(1) Examine the fuel outlet pipe coupling, and Breeze plug connection for fuel tightness.

(2) Test the pump as detailed in Para. 26 to 29. If the pump is found to be faulty it must be returned to Stores, and a replacement fitted.

(3) Ensure that the by-pass valve 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 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 operating correctly. In certain installations the fuel pressure warning light is set to operate at a pressure higher than that which the pump can deliver. Therefore, observe the light setting before rejecting a suspected pump. The pump

is unlikely to be defective if it delivers fuel at a pressure in excess of the specified values.

▲**32.** At the periods laid down in the appropriate Servicing Schedule the condition of the motor commutator and brush gear should be examined and specified servicing carried out. Unserviceable pumps should be sent for repair and new or reconditioned pumps fitted.

**Note . . .**

*Where it has been found necessary to strip the pump to check the brush lengths, commutator wear and condition of bearings, it is important that the pump when re-assembled, is subjected to a full acceptance test.*▲

# Appendix 1

# PUMP, FUEL, PUL 901 Mk. 1, 2 & 3

## LEADING PARTICULARS

| | |
|---|---|
| *Pump, fuel, PUL 901 Mk. 1* ... ... ... | *Ref. No. 5UE/5444* |
| *Pump, fuel, PUL 901 Mk. 2* ... ... ... | *Ref. No. 5UE/6220* |
| *Pump, fuel, PUL 901 Mk. 3* ... ... ... | *Ref. No.* |
| *The following data is common to above Pumps* | |
| *Motor unit* ... ... ... ... ... ... | 3 *speed, flameproof, fan cooled.* |
| (1) *Fuel delivery rate nominal* ... ... ... | 900 *g.p.h.* } |
| (2) *Fuel delivery pressure at rated voltage* ... ... | 11 *lb/in.*$^2$ } *medium* |
| *Rated voltage*... ... ... ... ... ... | 26*v d.c.* } *speed* |
| *Average current consumption at condition* (1) *and* (2) ... ... ... ... ... ... | 12 *A* |
| *Voltage limits* ... ... ... ... ... | 22-29 *volt d.c.* |
| *Electrical connection Plessey CZ* 50374 ... ... | *Ref. No. 5X/6327* |
| *No-flow delivery pressure (max.)* ... ... ... | 23 *lb/in.*$^2$ |
| *Brush, Type KCEG*11 ... ... ... ... | *Ref. No. 5UE/6222* |
| *New brush length* ... ... ... ... ... | 0·425 *in.* |
| *Minimum permissible brush length* ... ... | 0·330 *in.* |
| *Minimum permissible diameter of commutator* ... | 1·312 *in.* |
| *Undercut commutator segments* ... ... ... | *width* ·026 *to* ·028 *in.* *depth* ·025 *to* ·035 *in.* |
| *Maximum commutator eccentricity with shaft bearings* ... ... ... ... ... ... | ± ·0003 *in.* |
| *Bearings* ... ... ... ... ... ... | *Pre-packed* |
| *Weight of unit* ... ... ... ... ... | 12·75 *lb.* |

The fuel pump PUL 901 is a side mounting pump and is similar to that described and illustrated in the main chapter. The differences in the Mark numbers are as follows:—

Mk. 1. Basic design.

Mk. 2. Similar to Mk. 1 but includes Flexibox Gland seal.

Mk. 3. Similar to Mk. 2 but has an improved lower bearing seal.

# Appendix 2

## PUMP, FUEL, PUL 903 Mk. 1, 2, 3 & 4

### LEADING PARTICULARS

| | |
|---|---|
| *Pump, fuel, PUL* 903, *Mk.* 1 ... ... ... | *Ref. No.* 5UE/5545 |
| *Pump, fuel, PUL* 903 *Mk.* 2 ... ... ... | *Ref. No.* 5UE/6166 |
| *Pump, fuel, PUL* 903 *Mk.* 3 ... ... ... | *Ref. No.* 5UE/6219 |
| *Pump, fuel, PUL* 903 *Mk.* 4 ... ... ... | *Ref. No.* 5UE/ |
| *The following data is common to above Pumps* | |
| *Motor unit* ... ... ... ... ... ... | 3 *speed flameproof fan cooled.* |
| (1) *Fuel delivery rate (nominal)* ... ... ... | 900 *g.p.h.* } |
| (2) *Fuel delivery pressure at rated voltage* ... ... | 11 *lb/in.*$^2$ } *medium* |
| *Rated voltage*... ... ... ... ... ... | 26*v d.c.* } *speed* |
| *Average current consumption at condition* (1) *and* (2) | 10·5 *A* |
| *Voltage limits* ... ... ... ... ... | 22-29*v d.c.* |
| *Electrical connection* (*Plessey*) *CZ* 5037*A* ... | *Ref. No.* 5*X*/6327 |
| *No-flow delivery pressure* (*max.*) ... ... ... | 23 *lb/in.*$^2$ |
| *Brush, Type, KCEG*11 ... ... ... ... | *Ref. No.* 5UE/6222 |
| *New brush length* ... ... ... ... ... | 0·425 *in.* |
| *Minimum permissible brush length* ... ... ... | 0·330 *in.* |
| *Minimum permissible diameter of commutator* ... | 1·312 *in.* |
| *Undercut commutator segments* ... ... ... | *width* ·026 *to* ·028 *in.* — *depth* ·025 *to* ·035 *in.* |
| *Max. commutator eccentricity with shaft bearings* | ± ·0003 *in.* |
| *Bearings* ... ... ... ... ... ... | *Pre-packed* |
| *Weight of unit* ... ... ... ... ... | 12·9 *lb.* |

The fuel pump PUL 903 is a base mounting pump and for a general description and illustration of a typical pump reference should be made to the main chapter. The differences in the Mark numbers are as follows:—

Mk. 1. Basic design.

Mk. 2. Similar to Mk. 1 but with improved motor ventilation.

Mk. 3. Similar to Mk. 2 but includes Flexibox type gland seal.

Mk. 4. Similar to Mk. 3 but improved lower bearing seal.

# Appendix 3

# PUMP, FUEL, PUL 907, Mk. 1, 2 & 3

## LEADING PARTICULARS

| | |
|---|---|
| *Pump fuel, PUL 907 Mk. 1* ... ... ... | *Ref. No. 5UE/5796* |
| *Pump, fuel, PUL 907 Mk. 2* ... ... ... | *Ref. No. 5UE/6236* |
| *Pump, fuel, PUL 907 Mk. 3* ... ... ... | *Ref. No. 5UE/6778* |
| *The following data is common to the above pumps:* | |
| (1) *Motor unit* ... ... ... ... ... ... | *Single speed, flameproof fan cooled.* |
| (2) *Fuel delivery rate (nominal)* ... ... ... | 900 *g.p.h.* |
| (3) *Fuel delivery pressure at rated voltage* ... ... | 10 *lb/in.*$^2$ |
| *Rated voltage...* ... ... ... ... ... | 26*v d.c.* |
| *Maximum current consumption at conditions* (1), (2) *and* (3) ... ... ... ... ... ... | 12 *A* |
| *Voltage limits* ... ... ... ... ... | 22-29 *volts d.c.* |
| *Electrical connection Plessey CZ 2750 (Mk. 1)* ... | *Ref. No. 5X/4007* |
| *Plessey CZ 28095 (Mk. 2 and 3)* ... ... ... | *Ref. No. 5X/6026* |
| *No-flow delivery pressure (max.)* ... ... ... | 22 *lb/in.*$^2$ |
| *Brush, Type KCEG 11* ... ... ... ... | *Ref. No. 5UE/6222* |
| *New brush length* ... ... ... ... ... | 0·425 *in.* |
| *Minimum permissible brush length* ... ... | 0·330 *in.* |
| *Minimum permissible diameter of commutator* ... | 1·312 *in.* |
| *Undercut commutator segments* ... ... ... | *width* ·026 *to* ·028 *in.* *depth* ·025 *to* ·035 *in.* |
| *Max. commutator eccentricity with shaft bearings* | ± ·0003 *in.* |
| *Weight of unit* ... ... ... ... ... | 12·75 *lb.* |

The fuel Pump PUL 907 is a side mounting pump and is similar to that described and illustrated in the main chapter. The differences in the Mark numbers are as follows:—

Mk. 1. Basic design.

Mk. 2. Improved motor ventilation.

Mk. 3. Double shielded bearings introduced with improved vapour deflector.

# Appendix 4

## PUMP, FUEL, PUL 908, Mk. 1

### LEADING PARTICULARS

| | |
|---|---|
| *Pump, fuel, PUL* 908 *Mk.* 1 ... ... ... | *Ref. No.* 5*UE*/6224 |
| (1) *Motor unit* ... ... ... ... ... ... | *Single speed, flameproof fan cooled.* |
| (2) *Fuel delivery rate (nominal)* ... ... ... | 900 *g.p.h.* |
| (3) *Fuel delivery pressure at rated voltage* *Rated voltage*... ... ... ... ... ... | 10 *lb/in.*$^2$ 26*v d.c.* |
| *Maximum current consumption at conditions* (1), (2) *and* (3) ... ... ... ... ... ... | 12 *A* |
| *Voltage limits* ... ... ... ... ... | 22-29*v d.c.* |
| *Electrical connection, Plessey CZ* 2750/2, (*Mk.* 1) | *Ref. No.* 5*X*/4007 |
| *No-flow delivery pressure* ... ... ... ... | 22 *lb/in.*$^2$ |
| *Brush, Type KCEG* 11 ... ... ... ... | *Ref. No.* 5*UE*/6222 |
| *New brush length* ... ... ... ... ... | 0·425 *in.* |
| *Minimum permissible brush length* ... ... | 0·330 *in.* |
| *Minimum permissible diameter of commutator* ... | 1·312 *in.* |
| | *width* *depth* |
| *Undercut commutator segments* ... ... ... | 0·026 *to* ·028 *in.* ·025 *to* ·035 *in.* |
| *Maximum commutator eccentricity with shaft bearings* ... ... ... ... ... ... | ± ·0003 *in.* |
| *Bearings* ... ... ... ... ... ... | *Hoffman* 107*PP*, 112*PP* |
| *Weight* ... ... ... ... ... ... | 13 *lb.* |

The fuel Pump PUL 908 Mk. 1 is a basic design and is similar to the PUL 907, but is fitted with radio interference suppressors.

For a general description and illustration of a side mounting pump, reference should be made to the main chapter.



DN. 7924/1,750/11.60/B. & S. Ltd./1437