

## Chapter 25

### PUMP, FUEL, SPE 403, Mk. 1

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#### Introduction

1. The SPE 403, Mk. 1 pump is one of the SPE group, for which general repair instructions are given in A.P.4343, Vol. 6, Section 16, Chap. 1.

2. This pump is designed for vertical mounting in the base of the aircraft fuel tank, fuel collector, or sump. Its design is

such as to ensure efficient operation under conditions of high rate of climb, or other manoeuvres.

3. The rating of the SPE 403, Mk. 1 pump is 400 gallons per hour, at 10 lb. per sq.in. minimum pressure when operating on a nominal voltage of 24 volt., and pumping 100 octane fuel.

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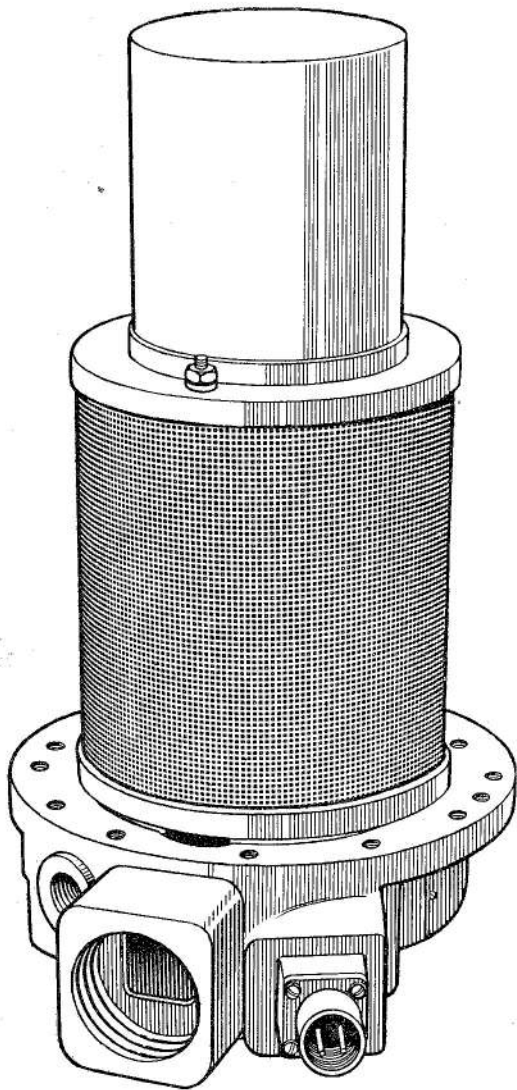


Fig. 1. General view of SPE403, Mk. 1 pump

KEY TO FIG 2

- 1 BY-PASS VALVE
- 2 VAPOUR GUIDE CONE
- 3 FILTER
- 4 VAPOUR ASSISTER
- 5 GLAND ASSEMBLY
- 6 THROWER RING
- 7 GREASE SHIELD, LOWER BEARING
- 8 LOWER BEARING
- 9 END PLATE SECURING SCREW
- 10 BEARING RETAINER PLATE
- 11 CLAMPING BOLT (LONG)
- 12 ARMATURE
- 13 SCREW, SECURING BRUSH ASSEMBLY
- 14 UPPER BEARING DUST SHIELD
- 15 UPPER BEARING
- 16 BEARING SLEEVE
- 17 LOCKING NUT
- 18 DUST COVER, UPPER BEARING
- 19 BRUSH BOX RETAINER
- 20 BRUSH BOX
- 21 BRUSH
- 22 MOTOR CASING
- 23 FIELD WINDING
- 24 MOTOR OUTER CASING
- 25 MOTOR CLAMPING RING
- 26 MOTOR CASING SEALING RING
- 27 CLAMPING BOLT (SHORT)
- 28 MOTOR END PLATE
- 29 PORTWAY CASTING
- 30 VAPOUR ASSISTER SEALING WASHER
- 31 VAPOUR CONE LOCATING PIN
- 32 GASKET
- 33 PUMP BASE CASTING
- 34 FLAME EXCLUDER
- 35 IMPELLER
- 36 SIMMONDS NUT
- 37 DRAIN PLUG
- 38 SEALING WASHER
- 39 STUD

RECONDITIONING

Special tools

4. In addition to the normal workshop tools and equipment, the following demandable items will be required for reconditioning the SPE 403, Mk. 1 pump :-

Nomenclature	Part No. (SPE)	Stores Ref. (SUE)	Fig. No.
Vapour assister extractor	9078	5124	4
Extractor rod	8216	5120	5
Guide, broaching	8181	5582	5
Bearing sleeve pad	8186	5584	8
Bush guide pillar and pilot extension	8184	5583	8
Base block	8218	5122	8 & 9
Sleeving collar	8255	5580	8
Thrower ring locking spanner	8214	5119	7
Aligning bush	8217	5121	9
Guide pin	8219	5123	9
Collar and clock assembly	8222	5194	10
Stem and weight assembly	8225	5195	10
Supporting plate	8215	5196	10

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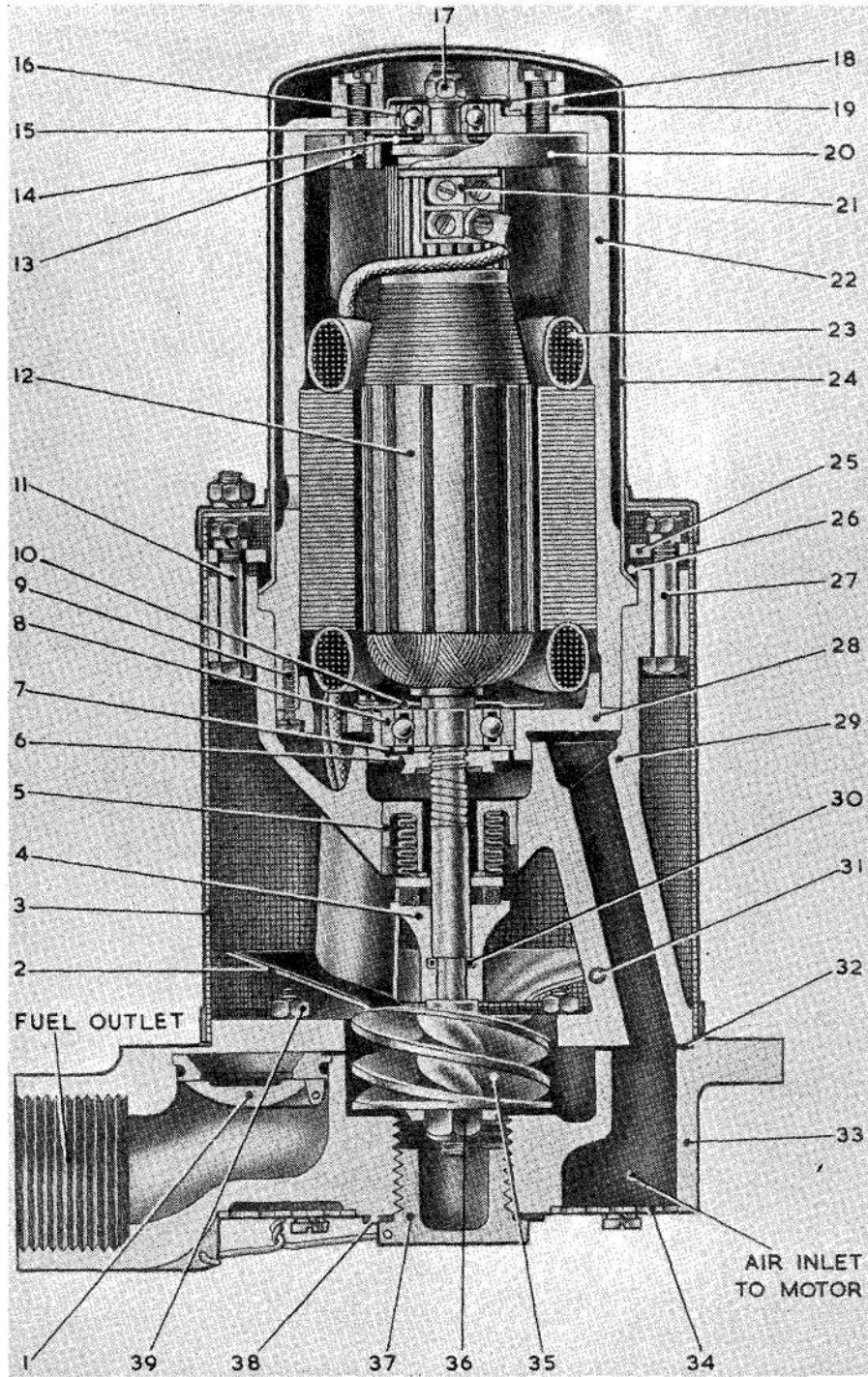


Fig. 2. Sectional view of SPE403, Mk. I pump

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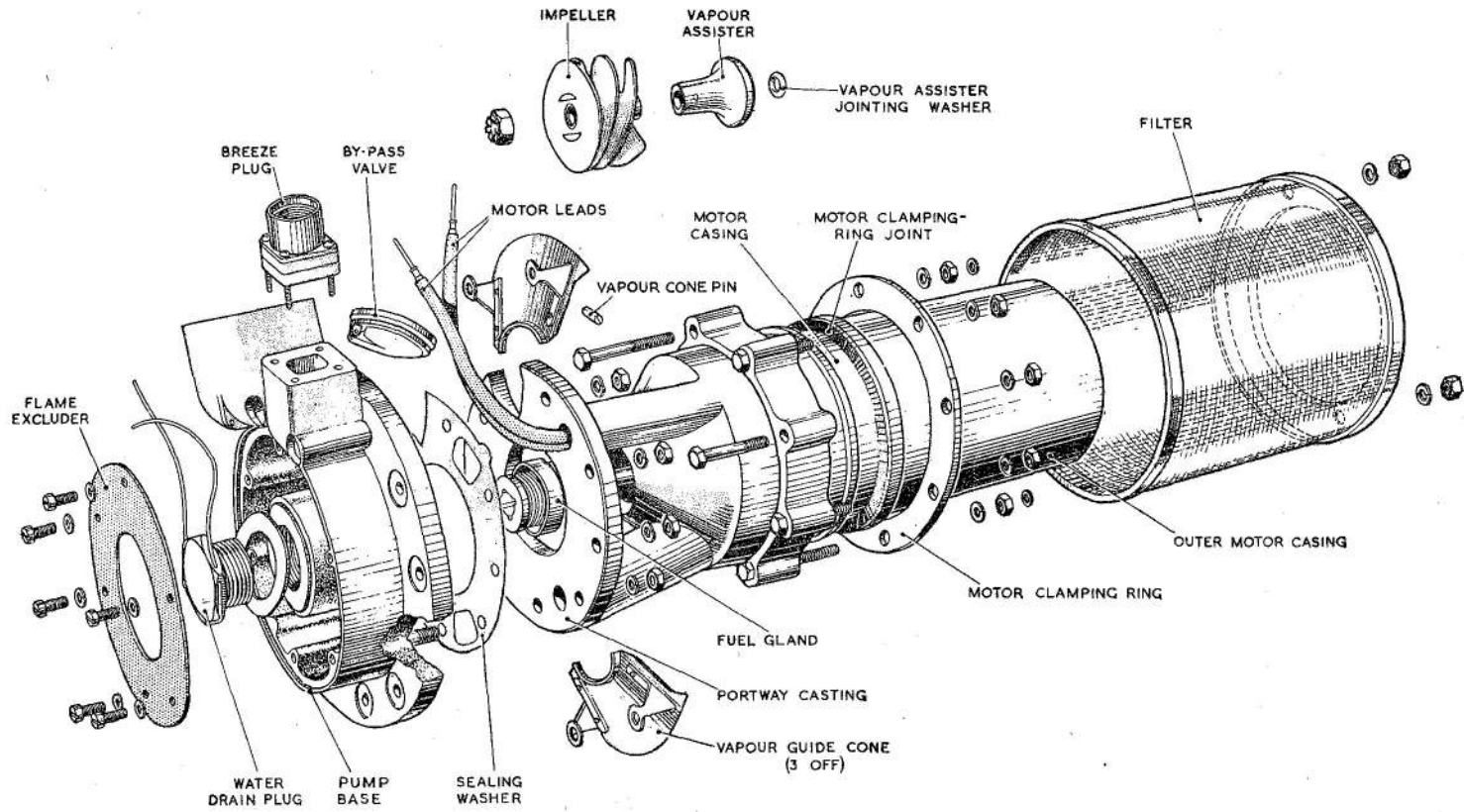


Fig. 3. Exploded view of SPE403, Mk. I pump

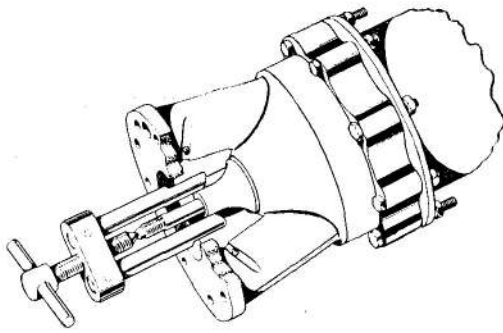


Fig. 4. Extraction of vapour assister

In addition, a servicing jig, embodying a hand press, SPE 8180 (Stores Ref. 5UE/5581) will be required. This is illustrated in A.P. 4343, Vol. 6, Sect. 16, Chap. 1.

#### DISMANTLING

5. When dismantling the SPE pump the precautions given in A.P.4343, Vol. 6, Sect. 16, Chap. 1 must be observed, especially with regard to cleanliness, avoiding damage to the impeller, marking mating parts, and safe retention of small components. Reference to fig. 2 and 3 should assist in the dismantling operations.

6. Remove the two filter securing nuts and slide the filter over the motor. This will reveal the eight nuts which secure the portway casting to the pump base casting. These nuts, as well as the four screws which secure the electrical Breeze plug, must be removed, the plug lifted, and the motor leads to the plug detached.

7. Tap the portway casting free from the pump base casting, using a raw hide mallet to break the joint; the paper gasket at the joint will be damaged and should be discarded. Then detach the three sectors of the vapour guide cone (fig. 2 and 3) by sliding them off their locating pins (fig 3) in the legs of the portway casting.

8. Complete dismantling of the pump base casting assembly may be effected by carefully lifting the by-pass valve from its housing and removing the perforated flame proof cover. Normally, unless the associated gasket is thought to be faulty, there is no need to remove the drain plug.

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9. Hold the armature shaft with a good fitting spanner on the flats at the end of the shaft, unscrew the nut which retains the impeller, and slide the impeller off the shaft.

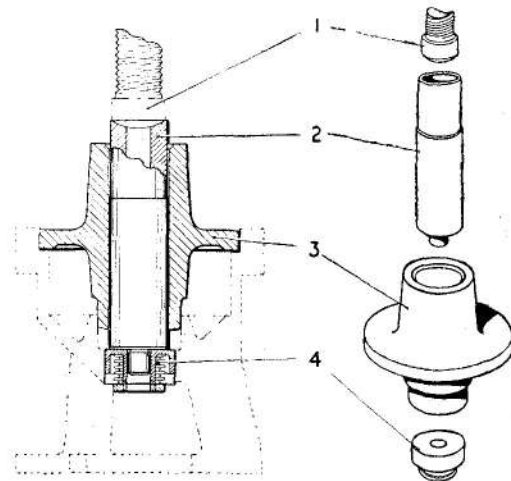
10. Remove the vapour assister with the extractor (Stores Ref. 5UE/5124) as shown in fig. 4. When this has been done, the joint washer behind the assister may be removed. In instances where the condition of the vapour assister is not satisfactory, reference should be made to para. 13.

11. Remove the eight nuts and bolts round the motor clamping ring and remove the ring. This will permit the motor outer casing, complete with sealing ring, to be lifted clear of the motor. The motor will now be free in the portway casting of the pump body, and should be withdrawn carefully from its seating to avoid damaging the armature spindle.

12. The bellows gland assembly, which will still be in the portway casting, will not normally need disturbing. If, however, its condition does not appear to be satisfactory, the procedure given in the following paragraphs should be adopted.

#### Bellows gland/vapour assister assembly

13. The base of the cone of the vapour assister is fitted with a carbon ring which



- 1 PRESS RAM
- 2 EXTRACTOR ROD (5UE/5120)
- 3 GUIDE (5UE/5582)
- 4 GLAND ASSEMBLY

Fig. 5. Extraction of bellows gland

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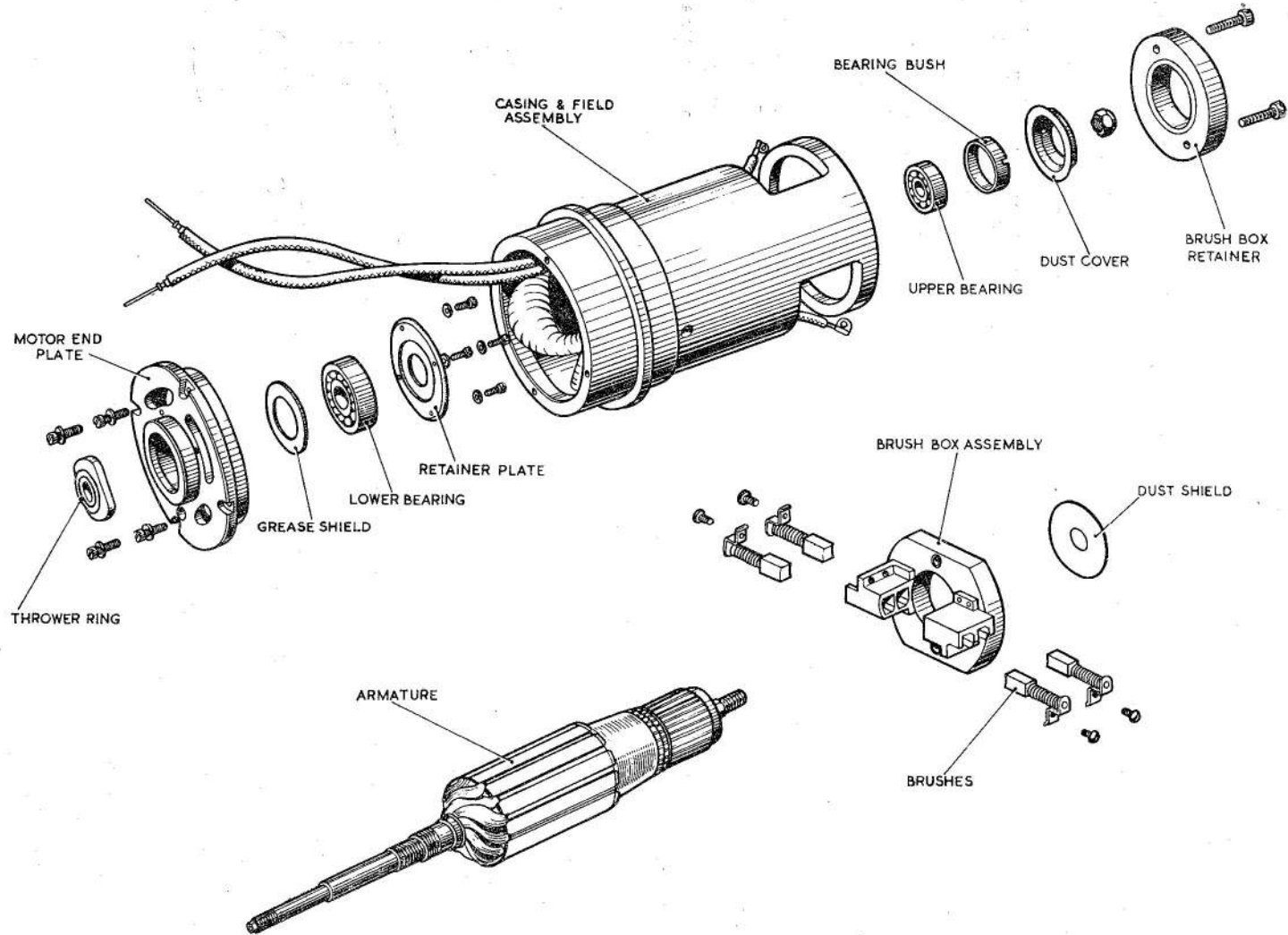


Fig. 6. Motor details

rotates against a highly polished, stationary, phosphor bronze face on the end of the bellows portion of the gland. Any indication of fuel leakage past this seal must be rectified by lapping the faces. Alternatively, if there is deep scoring of the faces, a new vapour assister and bellows gland assembly must be fitted (para. 26).

14. To extract the bellows gland from the portway casting, place the casting in the hand press (para. 4) mounted in a vice, and, using extractor rod (Stores Ref. 5UE/5120) and broaching guide (Stores Ref. 5UE/5582), press the gland out of the casting by turning the handle of the press. Fig. 5 shows the general set-up for the operation.

**Motor**

15. Fig. 6 shows details of the motor, which may be dismantled by following the sequence detailed in the following paragraphs.

16. Remove the four brushes by unscrewing the four round headed screws which secure them to the brush box assembly, and, holding the thrower ring with the locking spanner (Stores Ref. 5UE/5119), remove the locking nut on the commutator end of the armature shaft with a box spanner.

**Note ...**

*When removing the brushes, they should be marked to ensure that they are returned to the boxes from which they were removed.*

17. Mark the position of the motor end-frame relative to the casing, remove the four securing screws, and lightly tap the end-frame from the casing. Withdraw the

armature, complete with end-frame, and then separate the end-frame from the armature, taking care not to damage the armature shaft. If the end-frame appears to be tight, it may be removed by suspending the armature loosely in one hand (the weight of the armature being supported by the end-frame on top of the hand), and then lightly tapping the end of the shaft with a raw hide mallet.

**Note ...**

*The armature shaft must be tapped squarely, and the armature held slightly above the work bench, to avoid damage.*

18. After marking the position of the brush assembly relative to the motor casing, remove the brush box retaining screws, the brush box retainer, and the dust cover. Then carefully bend the field coil leads, to permit the brush box assembly to be slid free from the motor casing.

19. Should it be necessary to renew the motor bearing, the commutator end bearing must be pressed inwards, because the bush is secured by metal being peened into its slots from outside the frame. The lower bearing at the pump end of the motor may, however, be extracted, by removal of the four screws and associated retaining plate.

**INSPECTION AND REPAIR**

20. Whilst dismantled, all components should be examined, and, if necessary, the motor parts dealt with in accordance with instructions given in A.P.4343, Vol. 6, Sect. 18, Chap. 1. In addition, reference should be made to the following table for reconditioning the complete unit.

**TABLE I**  
**Inspection and remedial action**

Component	Inspection for :—	Action if faulty
Armature	(1) Insulation between windings and shaft (use a 500 Volt. insulation resistance tester) (2) Loose conductors on commutators (3) Dirty commutator (4) Scoring of commutator and burnt segments — also for short and open circuits	Prolonged drying (footnote 1) then thoroughly clean, until infinity resistance is obtained Reject for rewiring Clean (footnote 1) Skim and undercut commutator (footnote 1) ; minimum permissible dia. is 0.945 in. and maximum eccentricity with shaft not to exceed 0.001 in.

TABLE I—cont.

Component	Inspection for :—	Action if faulty
	(5) Fouling of armature on field poles, and for concentricity of shaft	Check eccentricity of shaft, also side play of bearings (footnote 2)
Field winding	(1) Insulation resistance to frame (use a 500 volt insulation resistance tester) (2) Continuity and general condition (3) Condition of field winding lead coverings (4) Total resistance of field winding (53.0 to 59.0 ohm.)	Prolonged drying (footnote 1) then clean, until infinity resistance is obtained Reject and fit new field assembly Repair by fitting new or additional sleeving Renew complete field assembly
Brush-gear	(1) Damage or corrosion (2) Wear of brushes (3) Freedom of brushes in boxes (4) Spring pressure on brushes	Renew Renew (footnote 2) Remove carbon dust collected in the corner of the brush boxes Renew (footnote 2)
Ball-races	(1) Cleanliness (2) Damaged or broken cage, roughness in turning, excessive side play or end play in excess of 0.005 in.	Clean (footnote 1) Renew
Bellows gland	(1) Scoring of seal face (2) Damage to bellows	If slight, lap to mirror finish ; if excessive, renew complete gland Renew
Vapour assister	(1) Scoring or wear of seal face	If slight, lap to mirror finish ; if excessive, renew
Filter	(1) Damaged gauze	Renew
Electricity plug assembly	(1) Damaged insulating plates, threads or contact poles	Renew
By-pass valve	(1) Efficient seal between flap and seating faces	Renew where relapping is impracticable
Motor sealing ring, port-way sealing and pump base sealing rings		Renew whenever pump is dismantled

Note . . . (1) See A.P.4343, Vol. 6, Sect. 18, Chap. 1  
(2) Refer to "Schedule of fits and clearances" (App. 1 of this chapter)

**ASSEMBLING**

**Motor**

21. In instances where it has been necessary to fit a new commutator end ball bearing, and/or sleeve, make sure that the slot in the bearing sleeve registers with the metal of the casing which has been peened in to prevent rotation in the housing. Fig. 7 shows the tools for resleeving the bearing.

22. Place the lower bearing retainer plate on the armature shaft, making sure that it is fitted with the clamping face towards the driving end (fig. 2). Press the bearing on to the shaft, making sure that the bearing is adequately lubricated. Fit the associated grease shield in position in the motor end-frame, press the frame on to the bearing, and secure the bearing retaining plate to the end-

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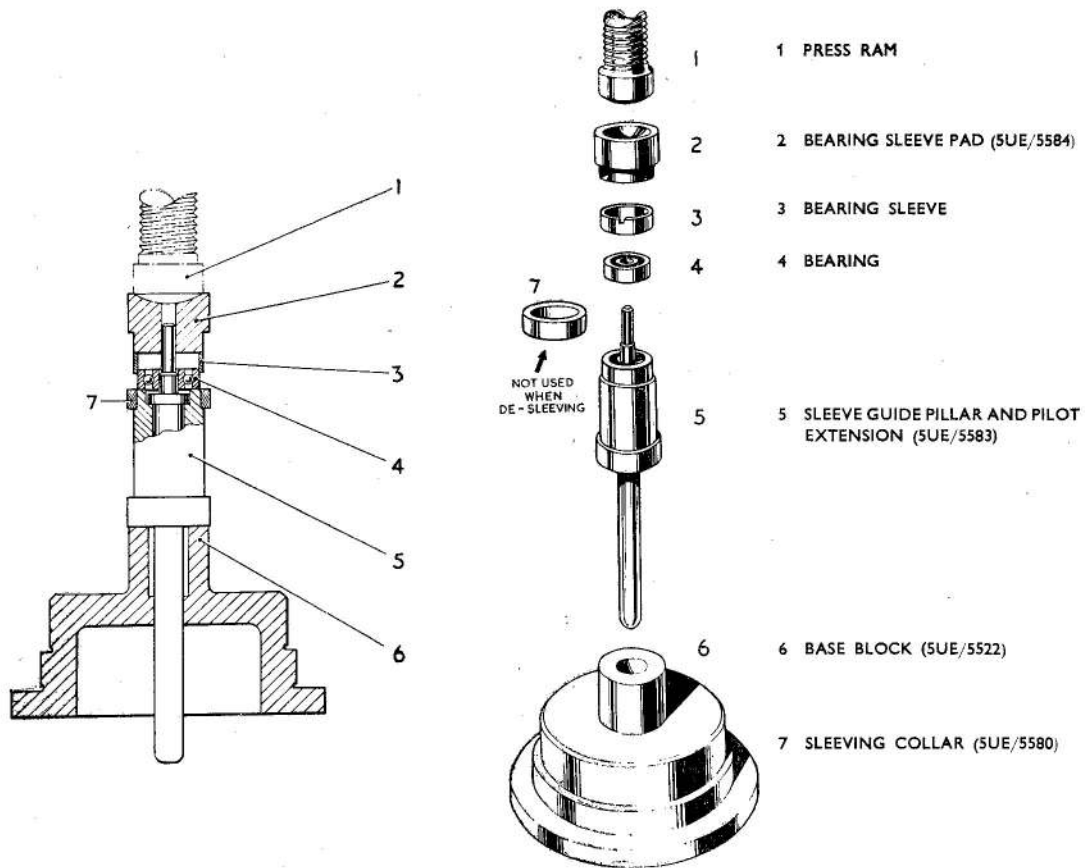


Fig. 7. Tools for re-sleeving upper bearing

frame. Lightly smear the thread of the thrower ring with gasoline proof jointing compound, and screw the ring home on the shaft, using the special spanner (fig. 8).

**23.** Fit the dust shield in its recess in the brush box carrier, and fit the brush assembly to the motor casing. Then fit the dust cover over the top of the upper bearing, and fit the brush box retainer. Lightly screw these components in position and adjust the brush box assembly until its mating marks agree with those on the motor casing. Tighten the securing screws and ensure that the leads of the field windings are in position prior to assembling the armature to the casing.

**24.** Enter the armature into the motor casing, thread the motor leads through the aperture in the motor end-frame and guide the armature shaft evenly into the upper

bearing. With a raw hide mallet, tap the end-frame evenly on to the motor casing and tighten the four screws (with spring washers), which hold the end-frame in position. Spin the armature to ensure that it rotates freely, then fit and tighten the lock-nut on the commutator end of the shaft.

**25.** Finally, insert the four brushes and springs in their correct positions and secure the pigtail leads and field coil leads with the appropriate screws.

#### Pump

**26.** In instances where a new bellows gland is required, place the gland assembly on the guide pin (fig. 9). Then, after ensuring that all traces of the oil sealing compound have been removed from the gland housing in the portway casting, lightly smear the outside shroud of the gland bellows with an approved gasoline proof jointing compound.

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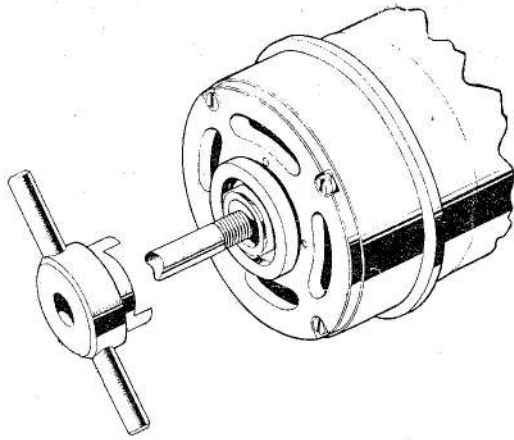


Fig. 8. Throwing ring locking spanner

Centralize the inverted portway casting over the gland and carefully press the gland into its housing in the casting. At this stage it is important that any compound on the sealing surface of the gland be cleaned off.

27. Pass the motor leads down the hollow leg of the portway casting and locate the motor in the casting by registering the hole in the motor end-frame on the dowel pin in the portway casting. Fit the motor casing, a new motor casing sealing ring and motor clamping ring. Insert the four clamping ring bolts (the two longer ones being diametrically opposite) and tighten the nuts on the spring washers. To ensure that the sealing ring is compressed evenly, the diametrically opposite nuts (pairs) should be tightened in turn.

28. Slide the vapour assister into position on the armature shaft and use the fixture shown in fig. 10 to ascertain that the loading on the gland assembly is  $2.0 \pm 0.5$  lb. This may be done by fitting a sealing washer of appropriate thickness between the vapour assister and the shoulder on the impeller shaft. The correct thickness of the washer is determined by the fixture (the dial indicator being set initially to zero). When the

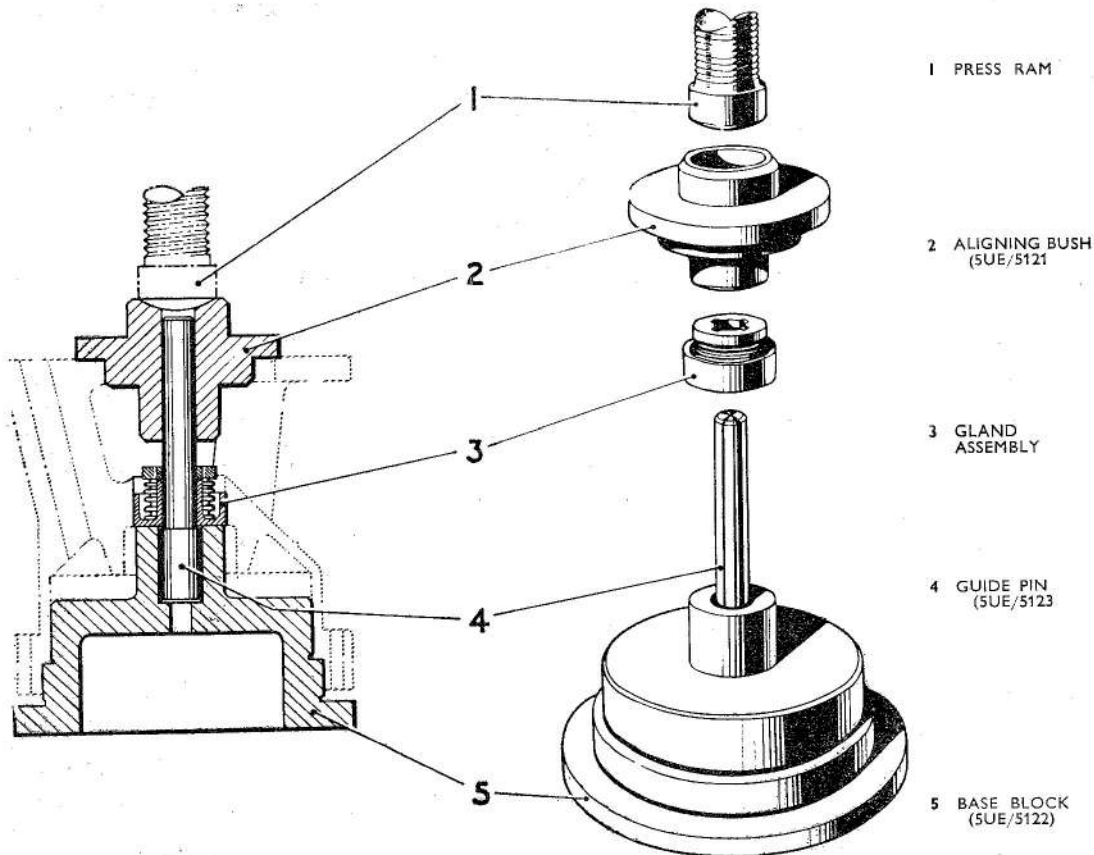
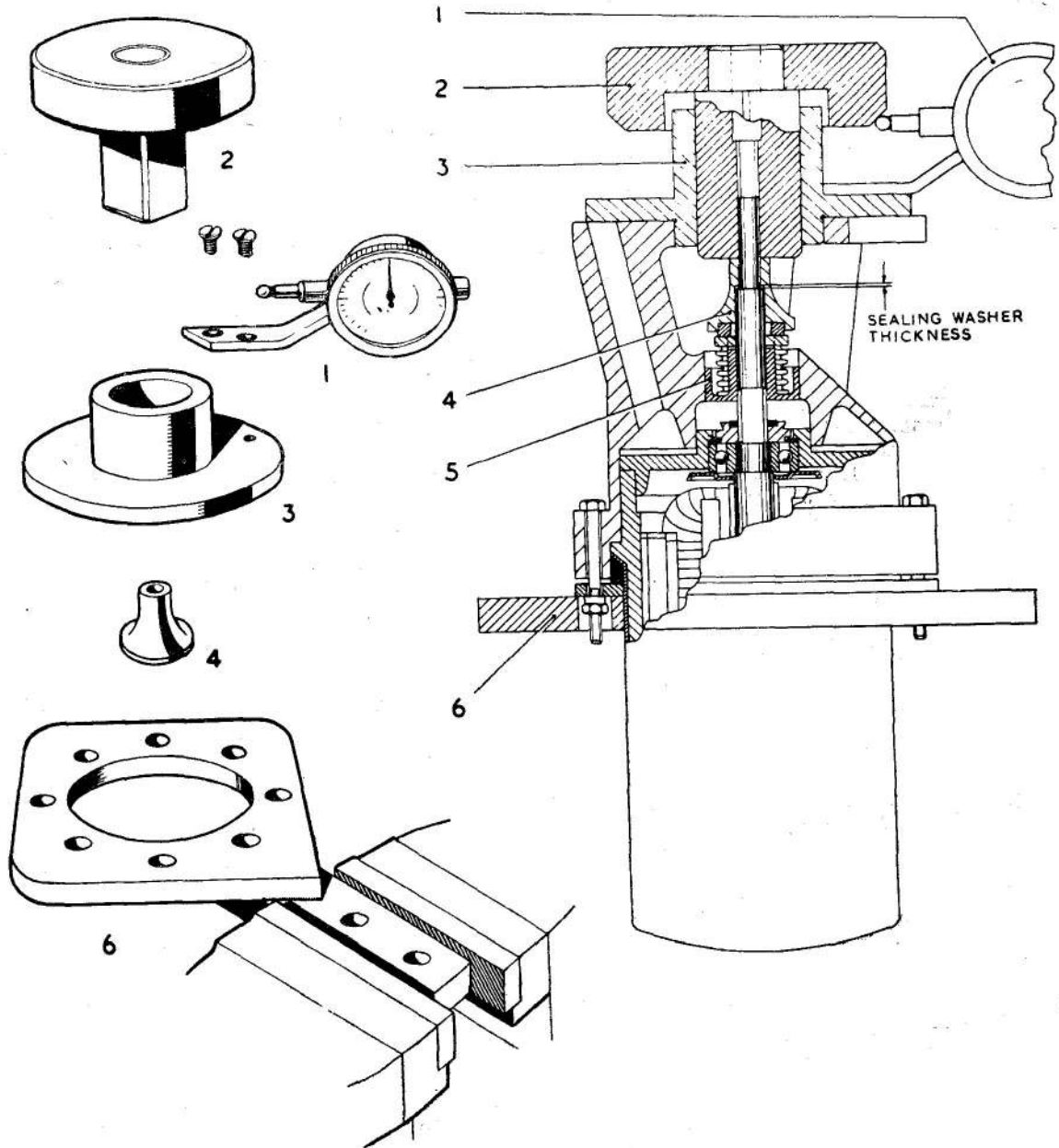


Fig. 9. Fitting new bellows gland

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- 1 DIAL INDICATOR
- 2 STEM AND WEIGHT (SUE/5195)
- 3 COLLAR (PART OF SUE/5194)

- 4 VAPOUR ASSISTER
- 5 GLAND ASSEMBLY
- 6 SUPPORTING PLATE (SUE/5196)

Fig. 10. Checking bellows gland loading

weight (2) is fully depressed, the requisite washer thickness will be indicated on the dial. Four thicknesses of washer are available (in steps of 0.25 mm., from 0.25 to 1.0 mm.) the suffix letters A, B, C, and D after the part number (SPE 8209 A-D) providing the necessary coding.

29. When a washer of the correct thickness has been selected, lightly smear it with sealing compound, fit it in the vapour assister and slide the assister into position on the motor shaft. Follow this with the impeller and tighten up the whole assembly with the Simmonds lock-nut at the end of the shaft.

30. Lightly smear the mating faces of the portway and base casting with gasoline proof jointing compound, and with a new paper sealing gasket interposed between them, assemble the portway casting to the base casting. It is important that no sealing compound be allowed on the by-pass valve, and essential that the two castings seat properly. Any leakage at the joint would allow fuel to enter the motor via the hollow legs of the portway casting.

31. Slide the three vapour guide cone sectors (fig 3) into the slotted pins fitted in the legs of the portway casting and secure them in position with the associated nuts and spring washers.

32. Connect the motor leads to the Breeze plug and secure the latter to its seating on the base casting. Fit and secure the fire-proof perforated cover over the base of the pump, screw in the drain plug (complete with washer) and secure the cylindrical filter over the fuel inlet with two nuts and spring washers.

**Note . . .**

*After testing the pump, in accordance with the following paragraphs, the drain plug should be locked in position by a short length of 22 S.W.G. soft tinned copper wire, the ends of which should be anchored in the small hole below the pump outlet.*

**TESTING**

**Equipment**

33. A test rig, basically similar to that shown in A.P.4343, Vol. 6, Sect. 16, Chap. 1, App. 4 will be required. In addition, a torque test rig, on the lines of that shown

in A.P.4343, Vol. 6, Sect. 16, Chap. 1, as well as a stroboscope (for speed checking) will be required.

**Fuel substitute**

34. In order to minimize fire risks during tests, an approved distillate will be used as a testing medium. Therefore in the following paragraphs, the word "fuel" will imply distillate in each instance.

**Motor torque test**

35. The motor must be suitably loaded to give 27 oz/in. torque at  $7,500 \pm 50$  r.p.m. at 24 volts. At this loading, the maximum current must not exceed 10.0 amp.

**Dry test**

36. With the pump mounted in the test rig, but with the fuel tank empty, run the pump for 5 minutes at 28.8 volts. The current consumption must not exceed 4.0 amp.

**Starting test**

37. The minimum voltage for reliable starting shall be ascertained by a series of tests, commencing at 12 volts, and must in no case be greater than 16 volts. The pump shall have been maintained completely submerged by fuel at an ambient temperature not exceeding  $-40$  deg. C. for a period of not less than 3 hours immediately preceding the tests, and the tests must be run under this condition.

**Pressure test**

38. With a 6-inch head of fuel over the fuel inlet, run the pump for 15 minutes at 28.8 volts, with the flow regulator valve closed. During this run, the maximum pressure must not exceed 16 lb. per sq. in. and the leakage from the fuel gland must not exceed 2 drops per minute.

39. Adjust the fuel level in the test tank to provide a 12-inch head of fuel and pressurize the tank to 10 lb. per sq. in. for 15 minutes; the gland leakage must not exceed 2 drops per minute.

**Proof test**

40. With a 6-inch head of fuel over the pump inlet and with the flow regulator valve of the test rig adjusted to deliver 400 gallons per hour, run the pump for one hour under each of the following conditions.

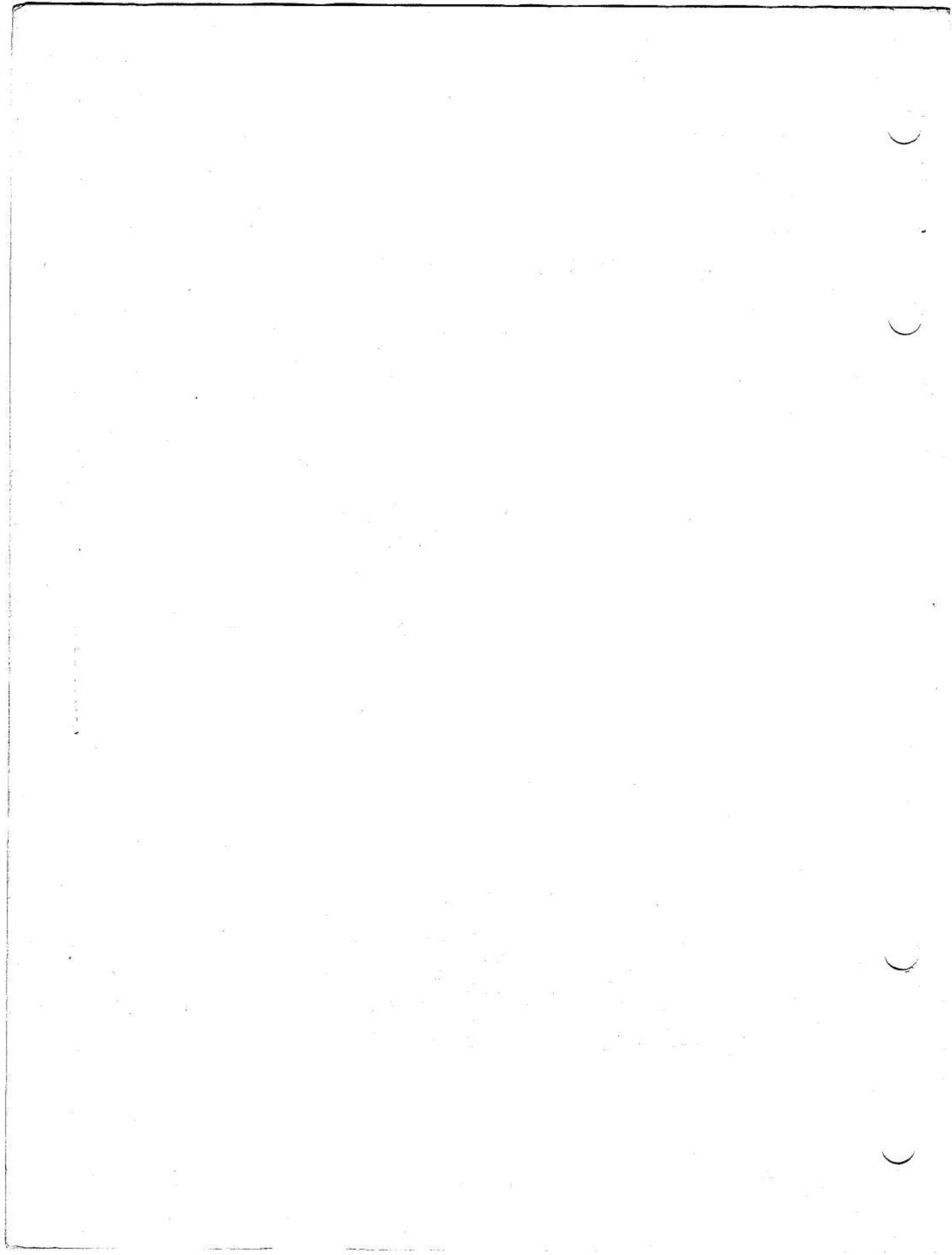
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Gasoline (using equivalent distillate)

- (1) 22.0 volt., 8.5 lb. per sq. in. (min.),  
9.5 amp. (max.).
- (2) 24.0 volt., 10 lb. per sq. in. (min.),  
10 amp. (max.).
- (3) 28.8 volt., 13 lb. per sq. in. (min.),  
11 amp. (max.).

**Insulation resistance test**

**41.** This test is to be carried out immediately following the preceding tests, whilst the motor is still warm. The insulation resistance (tested with a 250 volt insulation resistance testmeter) is not to be less than 2 megohms.



APPENDIX I

SCHEDULE OF FITS, CLEARANCES, AND REPAIR TOLERANCES

(SPE403, Mk. I PUMP)

Item No. (1)	Part and description (2)	Dimension New (3)	Permissible Worn Dimension (4)	Clearance New (5)	Permissible Worn Clearance (6)	Remarks (7)		
1	BRUSH ASSEMBLY	Brush length	11.7mm.	10.5mm.	—	—	Brush shortens by approx. 0.02 in. (0.508 mm.) in 500 hours	
		Brush spring	—	—	—	—	Pressure to be 4 oz. ± 0.5 oz. when compressed to 0.375 in.	
2	COMMUTATOR	Diameter	24.9 to 25.1mm.	24.0mm.	—	—	Diameter reduces 0.102 mm. (0.004 in.) in 500 hours	
		Concentricity	—	—	—	—	Maximum permissible eccentricity (with reference to shaft) 0.001 in.	
3	ARMATURE	End float	—	—	—	0.005in. (0.127mm.)	—	
		Concentricity	—	—	—	—	Maximum permissible eccentricity 0.001 in.	
		{ Shaft dia. (driving end) Ball race bore	8.995 to 8.985mm.	—	—	—	—	{ Inner race clamped to shaft on both faces
			9.0 to 8.990mm.	—	—	—	—	
Shaft diameter (commutator end)	5.995 to 5.985mm.	—	—	—	—			

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APPENDIX I (continued)

SCHEDULE OF FITS, CLEARANCES, AND REPAIR TOLERANCES

(SPE403, Mk. I PUMP)

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Item No. (1)	Part and description (2)	Dimension New (3)	Permissible Worn Dimension (4)	Clearance New (5)	Permissible Worn Clearance (6)	Remarks (7)
3	ARMATURE (continued) —Ball race bore  { Bearing sleeve diameter { Motor casing bore	6.0 to 5.990mm.  20.59 to 20.58mm.  20.60 to 20.61mm.	—  —	—  } 0.01 to 0.03mm.	—  0.04mm.	{ Inner race clamped to shaft on both faces  —
4	VAPOUR ASSISTER Bellows gland seal seat thickness	3.73mm.	3.53mm.	—	—	Reduces in thickness by approximately 0.050mm. (0.002 in.) in 500 hours
5	BELLOWS GLAND Length	16.99mm.	16.764mm.	—	—	Load = $2 \pm \frac{1}{2}$ lb. at working length (16.99 mm.)
6	IMPELLER Shroud face and face of portway casting— } clearance	—	—	0.127 to 0.254mm.	0.127 to 0.254mm.	Clearance can be adjusted by shim

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