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Chapter 21

PUMP, FUEL, AI, Mk. 4 and 5

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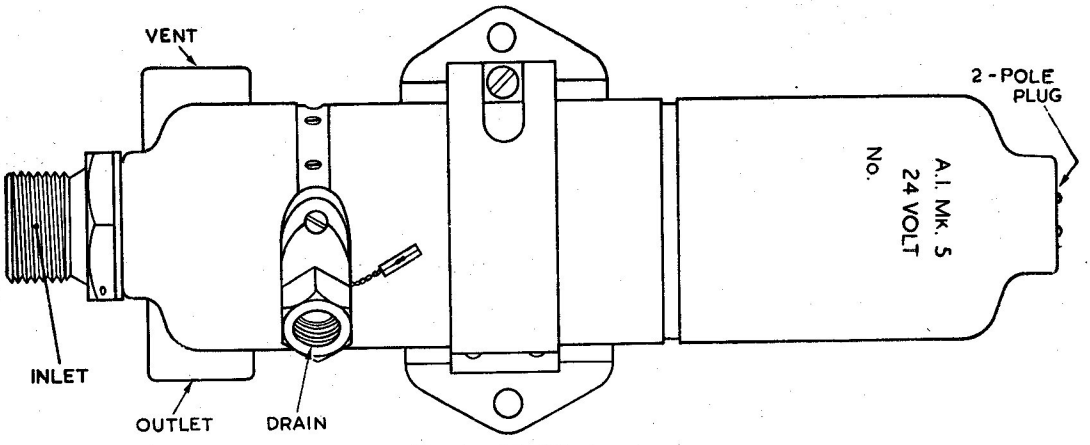

Fig. 1. AI, Mk. 5 pump

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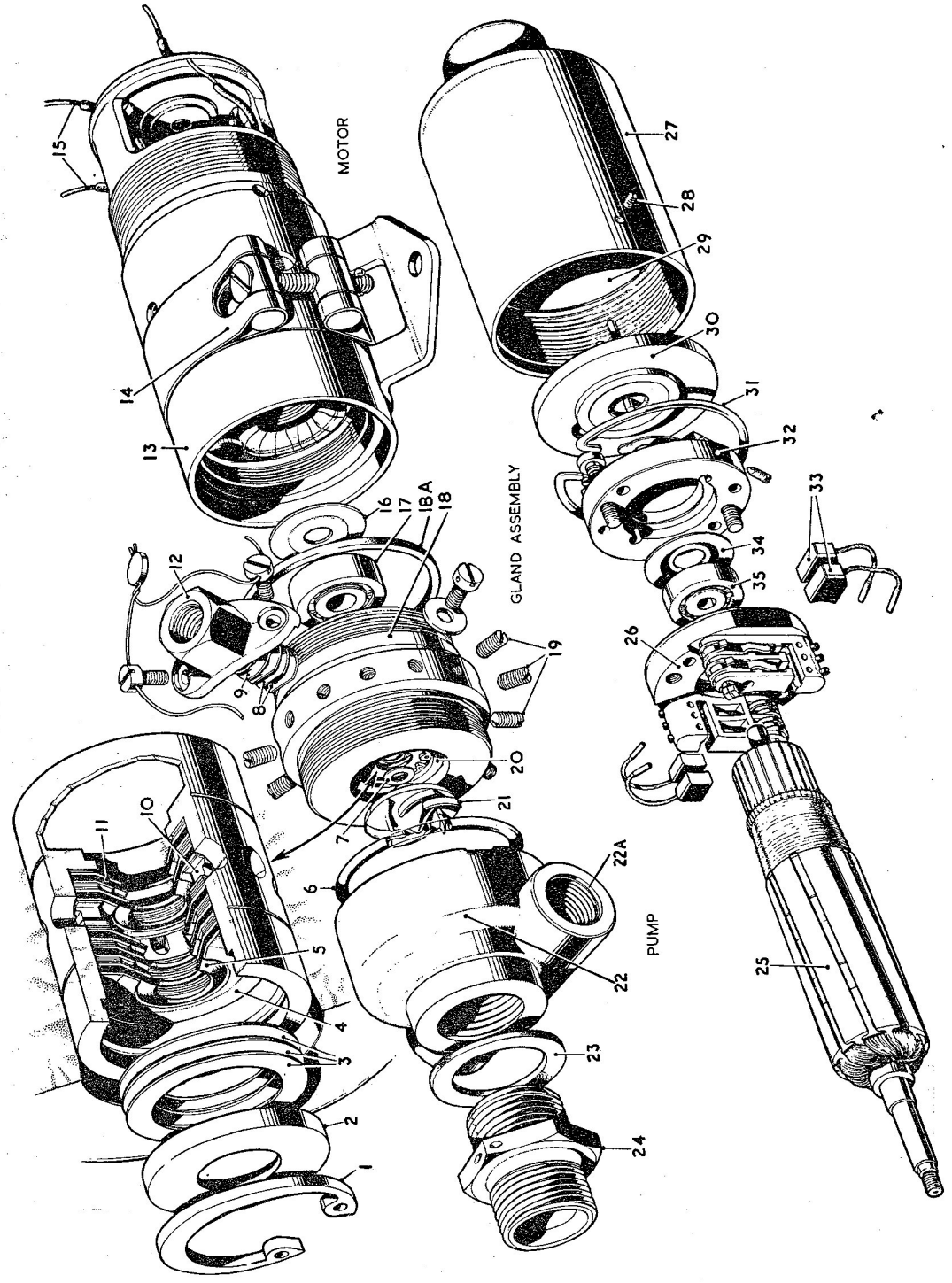

Fig. 2. Pump and Motor details

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KEY TO FIG. 2

1 CIRCLIP
2 GLAND PACKING WASHER
3 GLAND SPACING WASHER
4 GLAND FORMER PLATE (LOWER)
5 GLAND WASHER (RUBBER)
6 JOINT RING
7 IMPELLER SHIM
8 DRAIN CONNECTION WASHER (OUTER)
9 DRAIN CONNECTION WASHER (INNER)
10 GLAND DRAIN RING
11 GLAND FORMER PLATE (UPPER)
12 DRAIN CONNECTION BRACKET
13 MOTOR BODY
14 MOUNTING BRACKET
15 MOTOR LEADS
16 BEARING DUST SHIELD
17 BALL BEARING
18 GLAND HOUSING
18A JOINT RING
19 GRUB SCREWS
20 GLAND BODY
21 IMPELLER
22 PUMP BODY
22A OUTLET CONNECTION
23 SEALING RING
24 INLET CONNECTION
25 ARMATURE
26 BRUSH-BOX ASSEMBLY
27 MOTOR CASING
28 GRUB SCREW
29 INSULATION INSERT
30 PLUG ASSEMBLY
31 CIRCLIP
32 SPRING CONTACT ASSEMBLY
33 BRUSHES
34 BEARING RETAINING PLATE
35 BALL BEARING.

Introduction

1. The A1, Mk. 5 pump is designed for use in 24 volt installations and may be used for pumping either high octane fuel or de-icing fluids. Its windings are suitably impregnated to resist the corrosive action of de-icing fluid, and the pump differs only in this respect from the Mk. 4 pump. The windings of the latter not being impregnated renders the Mk. 4 pump unsuitable for use with de-icing fluid.

DESCRIPTION

2. The part exploded view (*fig.* 2) shows the essential details of the three main assemblies, i.e., pump chamber, gland and motor. The labyrinth gland (top left-hand corner) is shown removed from the gland housing and has been drawn to a larger scale for clarity.

Pump chamber

3. This is a casting which embodies the pump inlet (tapped $\frac{1}{2}$ in. B.S.P.) as well as the outlet and vent connections (both tapped $\frac{1}{4}$ in. B.S.P.). The larger end of the housing is provided with a spiral volute, within which the impeller rotates. A rubber jointing ring between the pump body and the gland body prevents leakage at the joint.

Gland assembly

4. The gland housing, which screws directly into the pump chamber, contains the labyrinth gland. The latter is built up of rubber washers separated by former rings and spacing rings to prevent the ingress of fuel or de-icing fluid to the motor. The end of the housing furthest away from the pump body is machined to receive the ball bearing for the driving end of the motor shaft. Mounted on the side of the gland housing is a gland drain connection bracket, the bore of which is tapped $\frac{1}{8}$ in. B.S.P. A joint ring (fitted between the gland assembly and the motor body) prevents leakage at the junction of the gland housing and motor.

Motor

5. The compound-wound motor is flame-proof, the laminated field assembly being shrunk into the main casing. The latter is threaded internally at the driving end to screw on to the gland body, and the commutator end is machined to house the armature ball-bearing. Windows in the

commutator end facilitate fitting and inspection of the brush gear and connections.

Brush gear

6. This is of unit construction, the two brush-boxes being secured to a Bakelite carrier. The complete assembly is retained in position by two screws, which also secure the spring contact assembly (32, *fig.* 2) to the closed end of the motor housing.

Electrical contact

7. A 2-pole plug assembly (30, *fig.* 2), which locates within the shouldered end of the motor outer casing, makes contact with the spring contact assembly (*para.* 6) and, for external connection, mates with a Breeze socket (Stores Ref. 5X/162).

RECONDITIONING

Special tools

8. In addition to normal workshop equipment, certain special tools will be required. These are listed below and are illustrated as indicated in the list. The SPE part numbers shown are allocated by the manufacturers and should be used pending the allocation of Stores Ref. numbers. In instances where the latter are quoted these should be used.

DISMANTLING

9. Details of the Mk. 4 and 5 pumps are shown in fig. 2 and should assist when dismantling in accordance with the following instructions.

10. Remove the split pin from the clamping screw of the mounting bracket (14), loosen the screw and slide the band off the motor body. Next remove the two screws securing the drain connection bracket (12) together with the two inner joint-washers (9) and three outer joint-washers (8).

11. Remove the grub screw (28), unscrew the motor outer casing (27) together with the motor casing insulation insert (29), thereby exposing the brush gear assembly. Then, lifting the brush fingers, pull the four carbon brushes clear of the brush-boxes; do not remove the brush lead tags from their holes at this stage.

12. Grip the motor body with locking spanner SPE 11249, engaging the pin of the latter in the hole provided in the motor body. Next remove one of the grub screws (19) in the gland housing and, engaging the pin of 'C' spanner in the hole, use the two spanners to unscrew the motor from the pump assembly in an anti-clockwise direction. This will separate the gland housing,

Title	Part No. (S.P.E.)	Stores Ref. (5UE/)	Fig.
Locking spanner	11249		3
Packing tube	T1436		3
Tommy bar	11247		3
'C' spanner	11246		3
Nose piece	11267		3
Aligning pad	11260		4, 6
Bearing press extension	11259		4, 6
Adapter plate	11257		4, 6, 7
Locating ring	11261		4
Bearing press pad	9556	5998	5, 8
Extractor rod	9555		5
Locating base	9554		5, 8
Collar	11262		6
Locating spigot	11258		6, 7
Aligning pad	11264		7
Collar	11256		8

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.

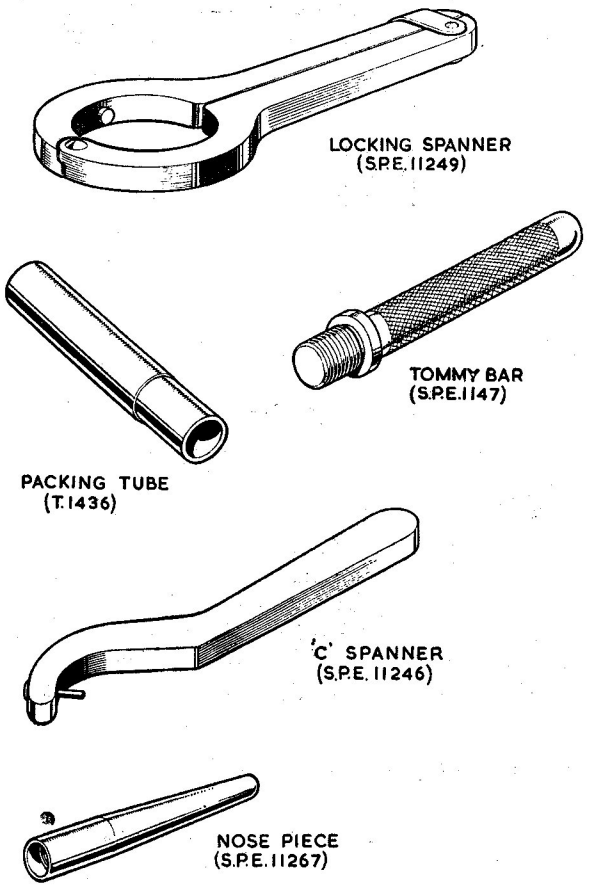

Fig. 3. Special tools

complete with the pump chamber, from the motor body, the armature being withdrawn from the motor body still attached to the gland housing by the lower bearing (17).

13. Unscrew and remove the inlet union (24) and its joint washer. Then, using the 'C' spanner SPE 11246 on the gland housing, and tommy bar SPE 11247 (*fig.* 3), screwed into the outlet connection (22A), unscrew in an anti-clockwise direction to separate the pump body (22) from the gland housing, complete with armature.

14. Hold the armature firmly in one hand, with the gland housing supported on the work-bench, and strike the impeller (21) with a small piece of wood (e.g. a pencil) in an anti-clockwise direction. Unscrew the impeller and remove the shims (7), if fitted. Screw the nosepiece SPE 11267 (*fig.* 3) on to the armature spindle and mount the assembly in a vice or suitable rest.

15. Remove the circlip (1) and packing washer (2) from the gland housing bush (top left-hand corner of fig. 2); then, with a pair of tweezers or similar implement, extract the gland washers, former plates, etc., lifting them out one by one.

16. Use a hide-faced hammer to tap the nosepiece (*para.* 4) until the armature spindle is free to be removed from the bearing in the gland housing.

17. If renewal of the bearing in the gland housing is necessary, it may be removed by using the rig and tools as shown in *fig. 4.*

18. Loosen the four grub screws in the brush-box assembly (26) and remove the four carbon brushes, taking care to mark the brushes to enable them to be returned to their correct boxes if they are in good condition. If the brushes are worn below the permissible dimensions or show signs of damage, they must be renewed.

19. Loosen the two remaining grub screws in the brush-box assembly, disconnect the two field coil leads, carefully bending them clear of the brush-box assembly. Loosen the two grub screws in the terminal blocks in the outer face of the spring contact assembly (32) and feed the field leads back through the motor housing and clear of the brush-box assembly.

20. Mark the position of the brush-box assembly relative to the motor housing. Then unscrew the two brush-box carrier screws, remove the spring contact assembly and the bearing retaining plate (34). When this has been done, the brush-box assembly will be free and may be extracted through the aperture in the commutator end of the motor housing.

21. If necessary, the bearing (35) may be removed from the motor housing by using the rig and tools shown in fig. 5.

22. The plug assembly (30) is retained within the outer end of the motor casing by a spring circlip (31) which is sprung into a groove in the inner periphery of the casing. Dismantling may be effected, if necessary, by removing the circlip and withdrawing the plug assembly.

INSPECTION AND REPAIR

23. 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 Table 1 for reconditioning the complete unit.

Field coils

24. In the event of field coils being unserviceable, the complete motor casing with field windings must be renewed, no attempt being made to effect repairs. Field coil leads, if faulty, may be repaired by fitting new insulation sleeving, and baking of the complete field assembly may be resorted to when the presence of moisture is thought to be the cause of low resistance.

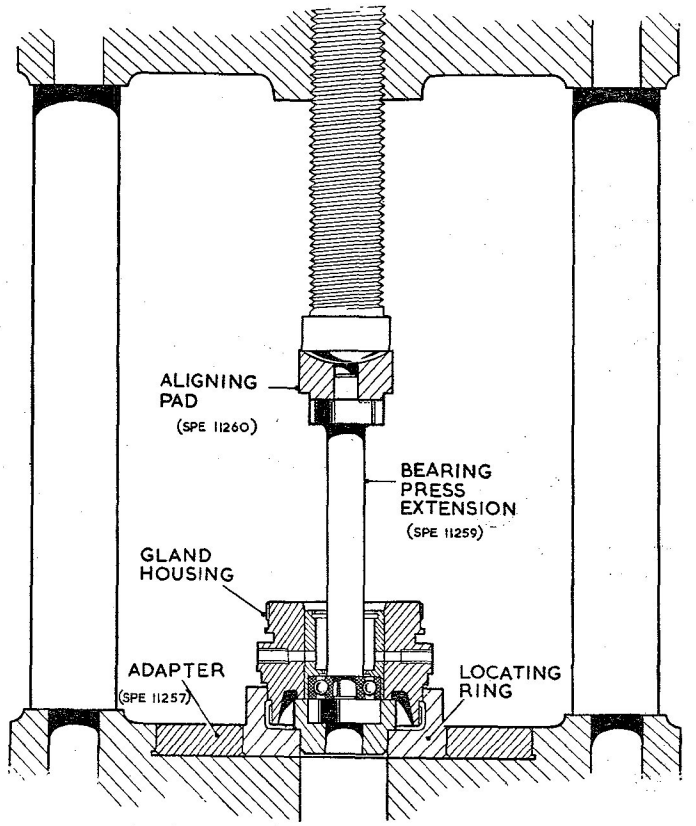

Fig. 4. Removing gland housing bearing

TABLE 1
Inspection and remedial action

Component	Inspection for :—	Action if faulty
Armature	(1) Insulation between windings and shaft (Use a 500V insulation resistance tester)	Prolonged drying when thoroughly clean (*footnote* 1) until infinity resistance is obtained
	(2) Loose conductors on commutator	Reject for re-wiring
	(3) Dirty commutator	Clean (*footnote* 1)
	(4) Scoring and burnt segments on commutator	Skim and undercut commutator (*footnote* 1) ; minimum permissible dia. is 0·594 in. maximum eccentricity with shaft not to exceed 0·001 in.
	(5) Short or open circuited conductors (use voltage drop tester or growler)	If unsatisfactory after skimming and undercutting commutator, reject and demand a new armature
	(6) Fouling of armature on poles	Check eccentricity of shaft, also side play of bearings (*footnote* 2)

TABLE I—*cont.*

Component	Inspection for :—	Action if faulty
Armature—*cont.*	(7) Wear on armature shaft where in contact with gland rubbers	Repolish shaft with crocus paper to a mirror finish ; minimum permissible dia. of shaft 0·155in.
Field winding	(1) Insulation between windings and frame (use 500V insulation resistance tester)	Prolonged drying when clean (*footnote* 1) until infinity resistance is obtained
	(2) Continuity and general condition	Reject and demand a new motor body and field assembly
	(3) Condition of leads	Repair by fitting new or additional sleeving
	(4) Total resistance of windings (58·47 to 64·63 ohm)	Reject and demand a new motor body and field assembly
Brush gear	(1) Damage or corrosion	Demand new component
	(2) Wear of brushes	Renew (*footnote* 2)
	(3) Freedom of brushes in boxes	Remove carbon dust collected in the corners of boxes
	(4) Spring pressure on brushes	Renew brush-box assembly (*footnote* 2)
Ball races	(1) Cleanliness	Clean (*footnote* 1)
	(2) Damaged or broken cage, roughness in turning, excessive side play or end play in excess of 0·005 in.	Renew (*para.* 28)
Gland	No inspection—renew whenever dismantled	
Joint rings and washers	No inspection—renew whenever dismantled	
Outer motor casing	Cleanliness of insulating sleeve within casing	Remove all oil and dirt ; paint with air drying insulation varnish
Plug assembly (30, *fig.* 2)	Loose pins or damaged insulation	Renew
Spring contact assembly (32, *fig.* 2)	Dirty contacts	Clean

Note . . .

(1) *See A.P.4343, Vol. 6, Sect. 18, Chap. 1.*

(2) *Refer to " Schedule of fits and clearances " (App. 1 to this chapter).*

Armature and brush gear

25. The commutator may be lightly skimmed and polished, making sure that the final diameter is not less than 0·594 in. The commutator must run true with the armature shaft to within 0·001 in. clock reading.

26. That portion of the armature shaft which runs in contact with the labyrinth gland should be cleaned to remove adhesions of rubber and must be finally polished to a mirror finish with crocus paper.

Note . . .

In the event of the shaft being scored or grooved to render it less than 3·93 mm. (0·155 in.) dia. at any point along the length within the gland limits, the armature must be rejected.

27. Examine the brushes for wear and freedom in their boxes and renew them if

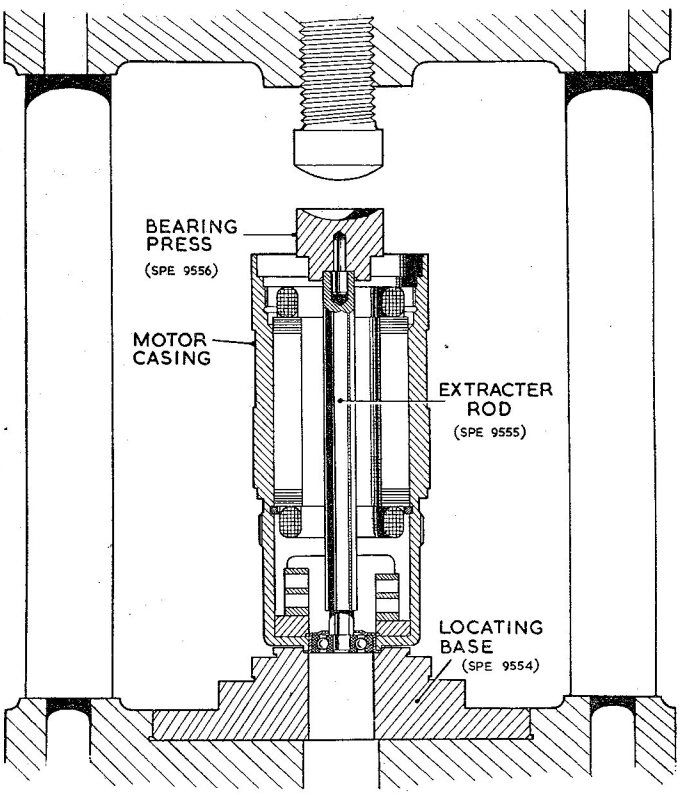

Fig. 5. Removing commutator end bearing

they do not meet the requirements of Appendix 1 to this chapter.

Bearings

28. Remove all the grease from the ball races with lead-free gasoline and examine the condition of the bearings. Then check the ball cages for cracks or broken fragments and, holding the outer race between the fingers, slowly rotate the inner race, feeling for roughness of tracks. Also check for excessive side or end play. If faulty, the complete bearing must be renewed. Renewal of bearings must be done by selective assembly; details of fits and clearances are given in Appendix 1 to this chapter.

Note . . .

It is important that only the tools listed in para. 8 are used for removing or fitting bearings. The bearings must be packed with grease XG-275 (Stores Ref. 34G/222).

ASSEMBLING

29. It is important to observe the normal procedure with regard to cleanliness, and to use only the correct tools for a specific operation. The numbers shown after certain items in the following text refer to fig. 2, to which reference should be made as necessary.

Motor

30. Press the gland housing bearing (17) into the gland housing, using the tools shown in fig. 6. Then fit the bearing dust shield on the armature shaft, ensuring that the dished centre of the shield protrudes towards the impeller end of the shaft and fit the armature shaft into the bearing. The tools and method for the latter operation are shown in fig. 7.

31. Press the commutator end bearing (35) into the motor body (13), using the tools shown in *fig.* 8. Then enter the brush-box assembly (26) through one of the inspection apertures at the end of the motor body, holding it in position while the spring contact assembly is placed against the adjacent end or end frame of the motor body. Ensure that the bearing retaining plate (34) is correctly placed in position with the outer flange against the bearing and lightly screw the brush-box assembly and spring contacts together through the elongated screw holes in the end frame.

32. Thread the two long field coils through the holes in the brush-box and spring contact assemblies and connect them to the two terminal blocks on the contact assembly. Rotate the brush-box assembly until the previously made mating marks coincide, and tighten the two securing screws (which can be seen partially entered through item 32 in *fig.* 2). Then connect and secure the two short field leads to the appropriate terminal points on the brush-box assembly

33. Discard the two joint rings (6 and 18A) and fit new rings in their places. Then assemble the gland housing, complete with armature, to the motor body, ensuring that the armature shaft at the commutator end enters squarely into the bore of the bearing (35). For the assembly operation use the 'C' spanner, SPE 11246 and the locking

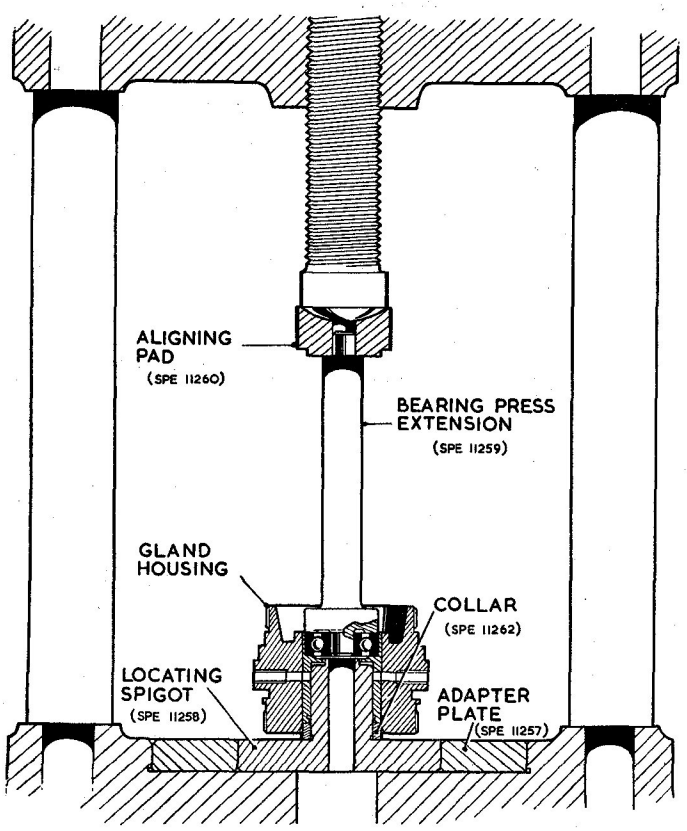

Fig. 6. Fitting gland housing bearing

spanner, SPE 11249 shown in *fig.* 3. After the two components are securely screwed together, the edge of the gland housing should be peened into the slot provided on the motor body.

34. Raise the finger springs on the brush-box assembly, insert the brushes in their correct boxes and secure the lead tags in their terminal holes. Then, using a tension gauge (Stores Ref. 1H/58), ensure that the brush spring pressure is 2·5 oz. (70 grammes) and run the motor without load on 24 volts for approximately 3 hours or until the brushes bed over at least 80 per cent of their area.

35. At the end of the bedding-in operation, whilst the motor is still warm, the insulation resistance should be not less than 10 megohms (measured with a 500 volt insulation resistance testmeter).

Gland

36. The complete gland comprises a gland body (20) shrunk into the gland housing, containing a built-up labyrinth gland of spacing washers (3), former plates (4 and 11), packing washer (2) and circlip. All these components may be considered unsuitable for further use and new components as detailed in the next paragraph must be requisitioned.

37. Before assembling the gland, lay out all the components on the work bench in order of assembly (preferably from left to right), as shown in Table 2 overleaf.

38. Screw the nosepiece, SPE 11267 (*fig.* 3) in position on the impeller end of the armature shaft, and taking the gland components (*para.* 37) from left to right, pack them one by one into the gland body, making sure that the former plates are the correct way round (*fig.* 2) and that no damage is caused to the inner contact edges of the rubber gland washers. Use the packing tube, T1436 (*fig.* 3) for bedding down the spacing washers under the packing washer (2) until pressure is required to insert the circlip (1).

39. Screw the outer casing (27) on to the motor body, after ensuring that the plug assembly (30) is held securely in position by the circlip (31) and that the insulating insert (29) is free from oil or dirt. After screwing on the casing, insert and tighten the locking grub screw (28), finally sealing the screw with a drop of air drying varnish.

40. At this stage, the motor shaft to gland surfaces should be run in. The recommended procedure is to submerge the gland housing assembly vertically in a mixture of 10 parts petrol and 1 part oil and run the motor on 24 volts for two hours. When this operation is complete, the assembly should be torque tested (*para.* 49).

Pump to motor

41. Screw the impeller on to the motor

TABLE 2
Order of assembly of gland components

No. off	Description	Part No. (S.P.E.)	Fig. 2 Item No.	Remarks
2	Spring washers	1146	3	
1	Former plate	1147A	11	
1	Gland washer	7262	5	See footnote
1	Former plate	1147B	4	
3	Spacing washers	1146	3	
1	Former plate	1147A	11	
1	Gland washer	7762	5	See footnote
1	Former plate	1147B	4	
1	Spacing washer	1146	3	
1	Spacing ring (drain)	11081	10	
3	Spacing washers	1146	3	
1	Former plate	1147A	11	
1	Gland washer	7262	5	See footnote
1	Former plate	1147B	4	
3	Spacing washers	1146	3	
1	Former plate	1147A	11	
1	Gland washer	7262	5	See footnote
1	Former plate	1147B	4	
3	Spacing washers	1146	3	
1	Former plate	1147A	11	
1	Gland washer	7762	5	See footnote
1	Former plate	1147B	4	
6	Spacing washers	1146	3	See para. 38
1	Packing plate	7265	2	
1	Circlip	21	1	

Note . . .
Immediately prior to insertion in the gland body, the gland washers (SPE 7262) must be dipped in colloidal graphite.

shaft, taking care to insert shims (7) so that, when the pump body (22) is screwed on, the impeller just fouls the face of the spiral volute in the pump chamber. Then unscrew the pump body and remove one of the shims (0·005 in. check) to give the correct clearance.

42. Assemble the pump body to the gland housing assembly, using tommy bar, SPE 11247 and 'C' spanner, SPE 11246, renew the joint sealing ring (23) and screw the inlet connection (24) into the pump body. Fit two new inner joint washers (9) and three outer joint washers (8) under the drain connection bracket (12) and secure the latter with its cheese head screws.

43. Fit the cheese head sealing screw shown just above the three grub screws (19) in *fig.* 2), taking care that its washer seats into the appropriate recess in the edge of the pump body. Then lock this screw, and those securing the gland drain connection, by threading a length of 22 S.W.G. soft tinned copper wire through their drilled heads, the ends of the wire being clamped in a lead seal.

44. Finally, ensure that the seven drain hole screws (19) are screwed into position in the gland housing, and fit the complete mounting bracket (14) to the motor body.

Note . . .
One hole in the periphery of the gland housing must be left clear to serve as a gland vent.

TESTING

Equipment

45. *Fig.* 9 shows a schematic arrangement

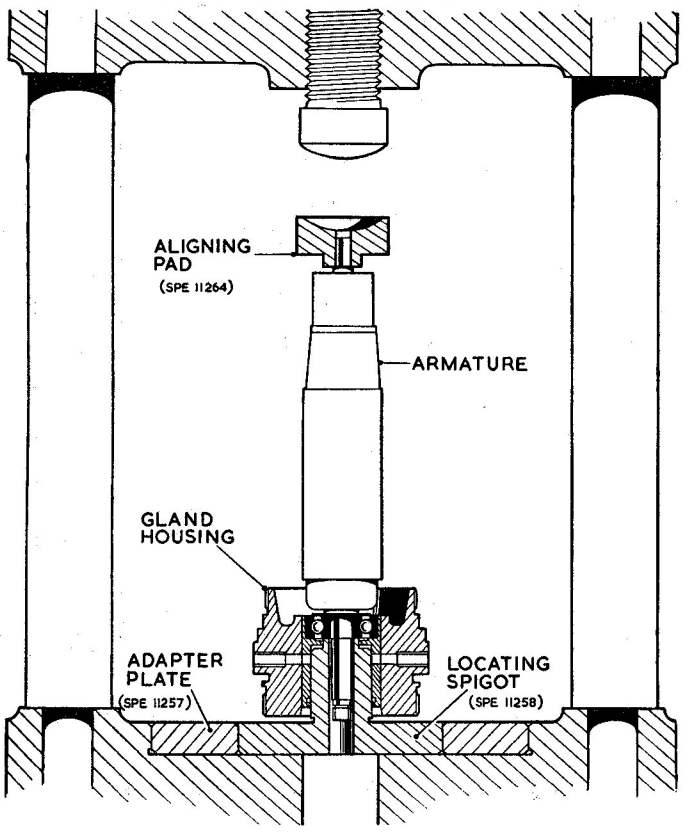

Fig. 7. Fitting armature to gland housing bearing

for a suitable test rig, which, pending the development of a standard test rig, could be used for testing the performance of the A1, Mk. 5 pump. The tank should have a capacity of approximately 5 gallons and be capable of withstanding pressurization at 10 lb. per sq. in. from an air pressure line. Pressure should be controlled by a regulator valve inserted in the pressure line. The fuel used for testing should be 100 Octane.

46. The inlet feed to the pump should be 8-10 in. of $\frac{1}{2}$ in. B.S.P. and the outlet line, incorporating a 0-25 lb. per sq. in. pressure gauge, should be approximately 2 ft. of $\frac{1}{4}$ in. B.S.P. to the 0-50 gal. per hr. flowmeter. The fuel pipe connected to the upper end of the flowmeter should return to the tank, with a flow regulator valve in the line.

47. The switchboard panel should incorporate a 0-40 voltmeter, a 0-10 ammeter and a variable resistance element to control the voltage input to the pump motor. The electrical cable should be as short as possible to ensure minimum voltage drop in the line.

48. In addition to the test rig (*para.* 45 *to* 47) a torque test rig will be necessary. This will comprise a calibrated fan or a suitable dynamometer used in conjunction with a stroboscope. A suitable type of fan, for screwing on to the motor shaft, is shown in *fig.* 10.

Torque test

49. The motor should be tested without and with the gland as follows :—

(1) Whilst the gland components are stripped, the motor should be loaded to 2·1 oz./in. torque at 18,000 r.p.m. minimum, at 24 volts input, when the maximum current consumption should be 2·5 amp.

(2) After 2 hours running-in, with the gland assembled, the motor must be loaded to 1·5 oz./in. torque at 18,000 r.p.m. minimum, at 24 volt input, when the maximum current consumption should be 2·5 amp.

Dry test

50. With pump on test rig (*fig.* 9) but without fuel; run for 5 minutes at 28·8 volt. Current should not exceed 2·0 amp.

Starting test

51. With a 6 in. head of fuel over the pump inlet, the pump should start with an input of below 16 volt.

Pressure test

52. (1) With a 6 in. head of fuel over the pump inlet, and with the flow regulator valve closed, run the pump for 15 minutes at 28·5 volt. Observe the joints and gland drain for any signs of leakage. The maximum permissible leakage from the gland drain is 2 drops

per minute. When this test is complete, switch off the electric supply.

(2) With the pump at rest and with a 12 in. head of fuel over the pump inlet, apply air pressure at 10 lb. per sq. in. over the fuel for 15 minutes. Observe for any leakage at gland.

Proof test

53. With a 12 in. head of fuel over the pump inlet, run the pump for one hour under each of the following conditions :—

Volt	Gal / hr.	lb. per sq. in. (min.)	amp. (max.)
22·0	7	12	2·0
24·0	7	15	2·25
28·8	7	21	2·75

Record the performance at the beginning and at the end of each test run. The maximum pressure at 28·8 volt is not to exceed 23 lb. per sq. in. at 2·5 amp. max.

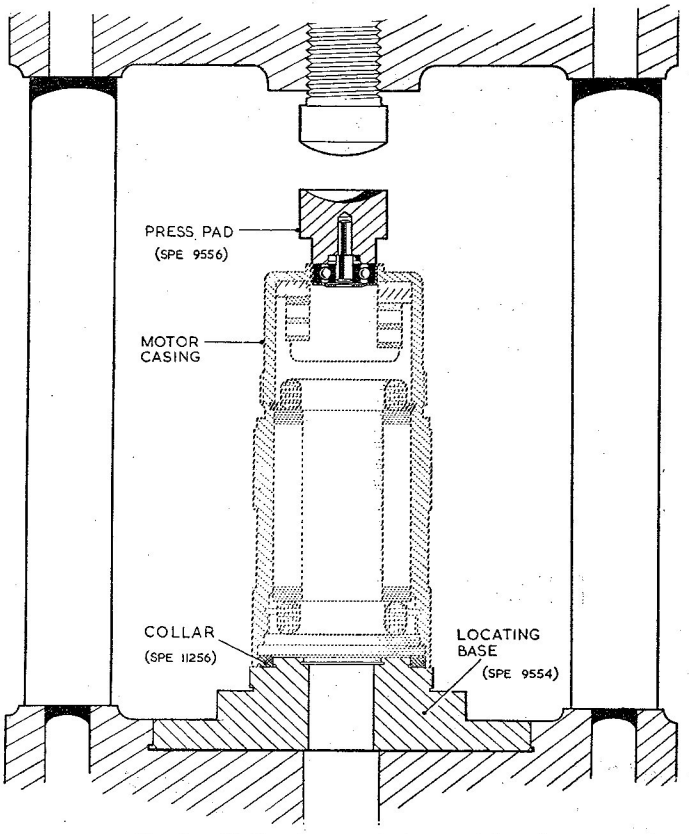

Fig. 8. Fitting commutator end bearing

Insulation

54. Immediately following the foregoing tests, whilst the motor is still warm, check the insulation resistance. This should be checked with a standard 500 volt insulation resistance testmeter and should not be less than 2 megohm.

Failure on test

55. Some probable causes of failure are shown below :—

Fault	Probable cause	Remedy
Gland leakage	(1) Damaged gland rubbers	Dismantle and renew
	(2) Scoring of armature shaft within gland	Repolish armature (*para.* 26)
Excessive current	(1) Gland rubbers tight on armature shaft	Run in as detailed in para. 40 (maximum current 2·5 amp.)
	(2) Faulty motor	Check condition of brushes and commutator
	(3) Fouling of impeller	Dismantle pump. Examine impeller and face of pump chamber for scoring. If not damaged, thoroughly clean
Low delivery pressure	Faulty motor	Check speed and brush-gear setting. Adjust if necessary

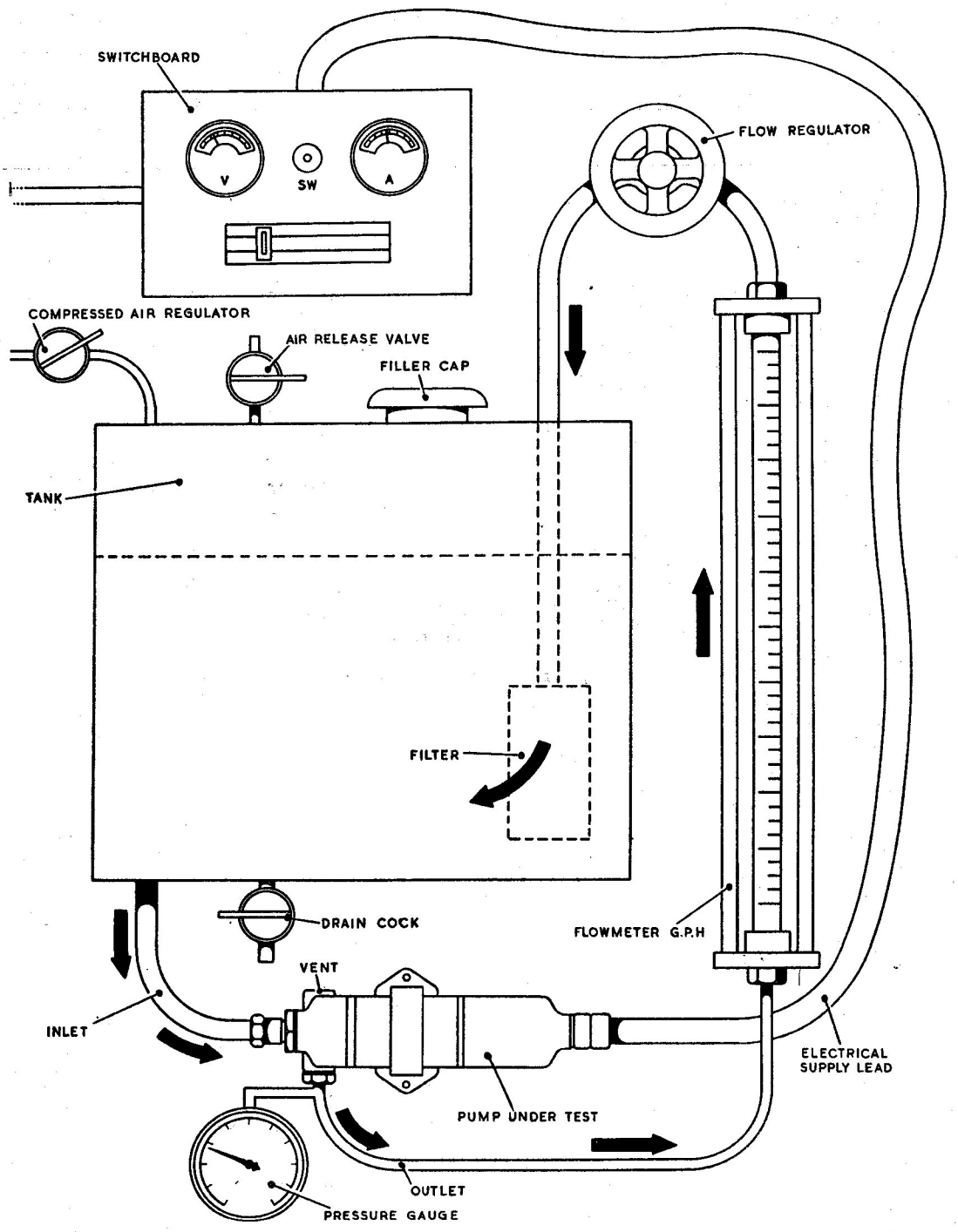

Fig. 9. Schematic test rig

Fault	Probable cause	Remedy
Pressure surge	(1) Tight or pre-loaded bearings	Check fits and ease of rotation
	(2) Tight gland	Run in to requirements of *para.* 40
Low insulation	Dampness in motor windings	Prolonged drying (at 120 deg. C) of armature and field.

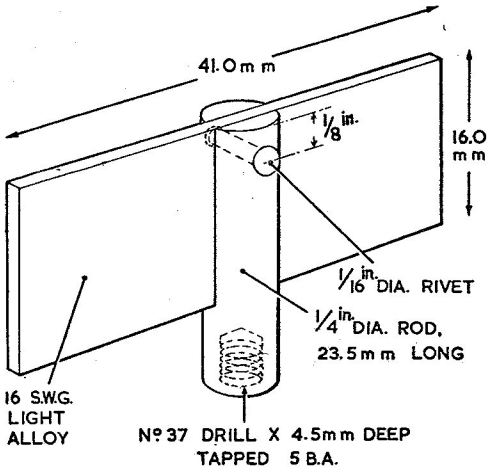

Fig. 10. Fan brake for torque test

7033 469365 10/54 1,650 C.B.&S.Ltd. Gp.30

APPENDIX I — SCHEDULE OF FITS, CLEARANCES, AND REPAIR TOLERANCES (A.I., Mk. 5 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	8·7 mm.	6·5 mm. (0·256 in.)	—	—	Brush shortens by approx. 0·02 in. (0·508 mm.) in 500 hours
2	COMMUTATOR	Diameter	15·4 to 15·6 mm.	15·1 mm. (0·594 in.)	—	—	Diameter reduces 0·102 mm. (0·004 in.) in 500 hours
3	ARMATURE	End float	—	—	—	0·127 mm. (0·005 in.)	
		Shaft dia. (in labyrinth gland)	4·00 to 3·96 mm.	3·93 mm. (0·155 in.)	—	—	Renew gland components after dismantling
		Shaft dia. (in gland housing ball race	6·008 to 5·995 mm.	—	—	—	Interference fit to be 0·005 mm. (0·0002 in.); obtained by selective assembly
		Gland housing bearing—bore	6·00 to 5·99 mm.	—	—	—	
		Shaft dia. (commutator end)	4·00 to 3·99 mm.	—	0·003 mm. (0·00012 in.)	0·006 mm. (0.00024in.)	Clearance to be obtained by selective assembly
		Ball race bore	4·00 to 3·99 mm.	—	—	—	
4	IMPELLER	Clearance to face of pump chamber	—	—	0·127 to 0·254 mm. (0·005 to 0·100 in.)	0·127 to 0·254 mm. (0·005 to 0·010 in.)	—

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