Chapter 8

PUMPS, FUEL, TYPE SPE.404 SERIES

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Introduction

1. Reconditioning instructions in this chapter are given for the SPE.404 Mk. 1G fuel pump with appendices covering differences in the procedure for earlier and later pumps in the series. A general description of the SPE.404 series fuel booster and transfer pump is given in A.P.4343D, Vol. 1, Book 2, Sect. 8, Chap. 8 and details of the variations between the different mark numbers are given in the appendices to the chapter.

TABLE 1

SPECIAL TOOLS AND EQUIPMENT

Nomenclature		Part No.	Fig. No.	Ref. No.
Hand press		SPE. 10143	—	
Pump shaft nut spanner		SPE. 19875	4	
Helix casing extractor		SPE. 14450	5	
Impeller extractor		SPE. 17339	6	
Bevel gear holding key		SPE. 16982	7	
Bevel gear extractor		SPE. 16983	7	
Punch	Stationary seal seat removal	SPE. 19874	8	
Location/guide block		SPE. 19872		
Location/guide block		SPE. 19873		
Base plate		SPE. 10766		
Motor bearing housing holding block		SPE. 14270	11	
Holding key		SPE. 14268	11	
Locking ring spanner		SPE. 14257	11	
Motor pinion extractor		SPE. 14667	12	
Setting brush and spring assembly	Determining geometric neutral axis	SPE. 17404	13	
Setting brush and locking device		SPE. 17405	13	
Calibration Fan		SPE. 14451		
Punch	Stationary seal seat assembly	SPE. 19874	16	
Location/guide block		SPE. 19872		
Location/guide block		SPE. 19873		
Base plate		SPE. 10766		
Impeller positioning spacer shim		SPE. 10786/A	17	
Pump shaft disc		SPE. 14266	18	
Motor shaft disc		SPE. 14267	18	
Clamping ring		SPE. 14448	18	
Starwheel	Backlash check	SPE. 14449	19	
Gear alignment checking fixture		SPE. 16026		
Blanking plate	Pressure test fixing	SPE. 16997	20	
Blanking plate gasket		SPE. 16998		

2. The pump assembly comprises a pump unit driven through right-angled reduction gearing by a 112V d.c. motor. Dismantling for reconditioning is carried out in three stages — (1) separation of the pump and motor units followed by dismantling of (2) the pump unit and (3) the motor unit. Conversely, during assembly the motor unit and pump unit are built up as two separate sub-assemblies which are then brought together and assembled as a third stage.

RECONDITIONING

Tools and test equipment

3. In addition to the standard bench tools the special tools listed in Table 1 or their equivalent are required to overhaul type SPE.404 Mk. 1G fuel pump. The universal test rig should be used to test this fuel pump and details of this rig is available in A.P.4343S, Vol. 1, Book 2, Sect. 10.

DISMANTLING

(The numbers in brackets in the text apply to the illustrations quoted following the paragraph heading unless otherwise indicated).

General

4. Cut the locking wires to the seals on the gear box cover, the outer motor casing, the suppressor chamber cover plate assembly and the base bearing assembly.

Disconnecting the electrical connection

5. (1) Refer to Fig. 1. Remove the five cheese-head screws (43) and shakeproof washers (44) securing the cover plate assembly (46) to the end face of the pump casting.

(2) Refer to Fig. 10. Withdraw the cover plate as far as the leads to the electrical connections will allow. Unscrew and remove the four nuts (50) and shakeproof washers (49) securing the plug to the cover, and separate the pins from the moulded plates of the plug.

(3) Remove the cover sealing gasket.

Removing the suppression units (fig. 1)

6. (1) Remove the two cheese-head screws (5) and shakeproof washers (6) securing the suppressor assembly to the pump body casting and withdraw the assembly as far as the connecting leads to the motor field coils will allow.

(2) Unsolder the connections taking care not to damage the capacitor tags.

Key to Fig. 1

1 RUBBER SLEEVE (¾ IN.)
2 IDENTIFICATION SLEEVE 'A'
3 IDENTIFICATION SLEEVE 'B'
4 INSULATING PAPER
5 CH.-HD. SCREW } CAPACITOR BRACKET
6 SHAKEPROOF WASHER } SECURING
7 CAPACITOR
8 CH.-HD. SCREW } CAPACITOR
9 SHAKEPROOF WASHER } FIXING
10 SPRING DOWEL
11 GEAR BOX COVER ASSEMBLY
12 DRIVE KEY (GEAR)
13 ADJUSTING SHIM (GEAR)
14 GEAR & PINION (PAIRED COMPONENTS)
15 SELF-LOCKING THIN NUT
16 CH.-HD. SCREW } GEAR BOX COVER
17 SHAKEPROOF WASHER } SECURING
18 DRIVE KEY (PINION)
19 SEAL
20 SEAL SEATING RING
21 CLAMPING BOLT RING
22 OUTER CASING
23 HX.-HD. BOLT OUTER CASING CLAMPING
24 RUBBER SEALING RING
25 INNER SEAL RING
26 MOTOR SEALING RING
27 SPRING WASHER } OUTER CASING
28 NUT } CLAMPING
29 ADJUSTING SHIM (PINION)
30 DELIVERY OUTLET SLEEVE
31 RUBBER JOINT RING
32 BONDING STRIP
33 SELF LOCKING NUT } DELIVERY OUTLET/
34 STUD } BY-PASS FIXING
35 FLAP VALVE & BY-PASS ASSEMBLY
36 DELIVERY OUTLET CASTING
39 STUD (SHORT)
40 STUD (LONG)
41 UNION JOINTING WASHER
42 GLAND DRAIN UNION
43 CH.-HD. SCREW } COVER PLATE
44 SHAKEPROOF WASHER } SECURING
45 COVER PLATE GASKET
46 COVER PLATE ASSEMBLY
47 CAPACITOR BRACKET
48 RH.-HD. SCREW } ELECTRICAL CONNECTION
49 SHAKEPROOF WASHER } SECURING
50 NUT
51 ELECTRICAL CONNECTION

(3) Separate the capacitor (7) from the suppression bracket (47) by removing the two cheese-head screws (8) and shakeproof washers (9) under each unit.

Separating the motor and pump units (fig. 1)

7. (1) Check whether the gear and pinion are marked with meshing points. If not scribe an X on two adjacent gear teeth and on the meshing pinion tooth.

(2) Separate the motor unit from the pump unit by removing the eight nuts (28) and spring washers (27), and with-

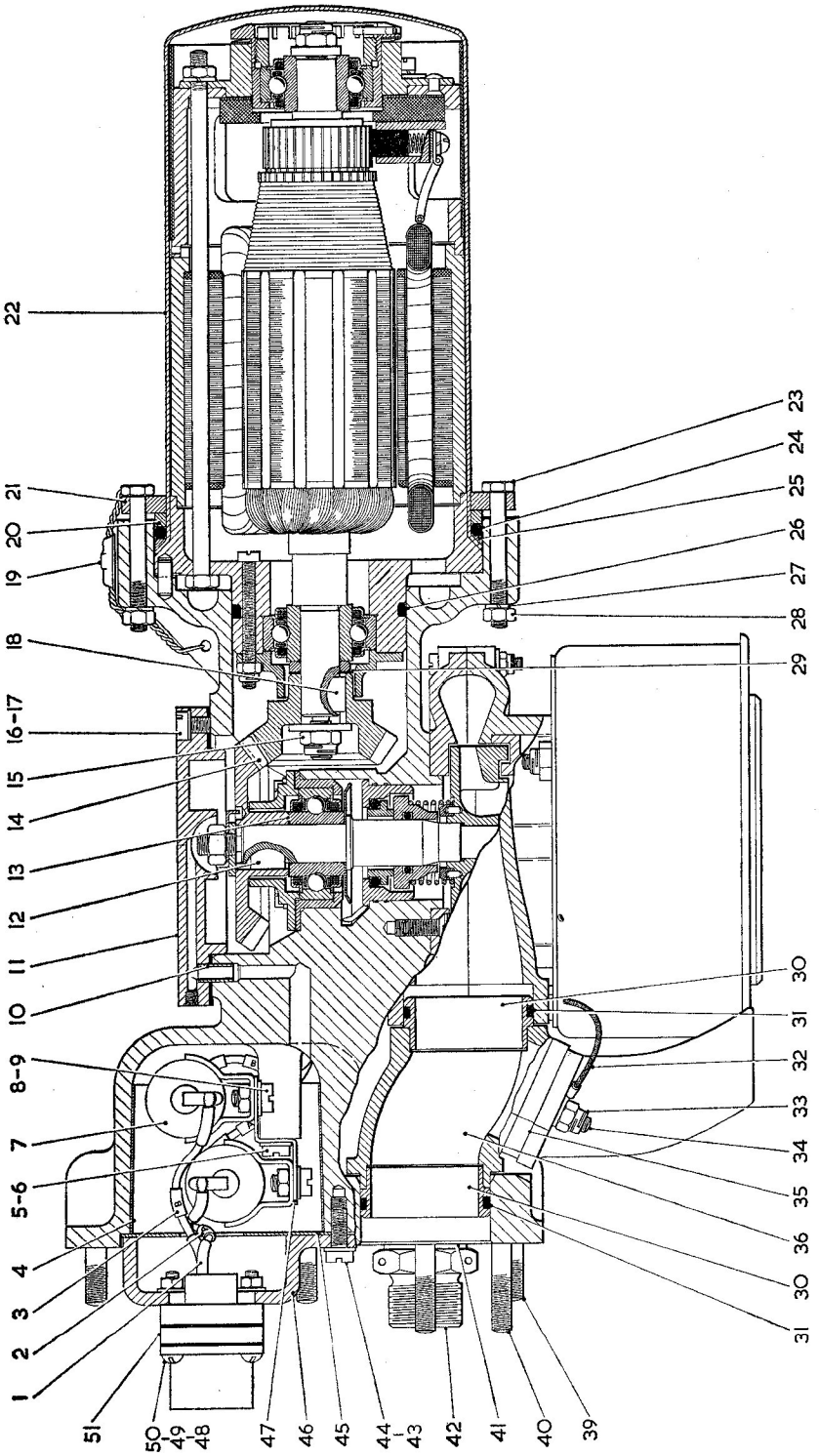


Fig. 1. Sectional view of pump/motor assembly

drawing the eight bolts (23), securing the motor clamping bolt ring (21) to the pump casing.

(3) Remove the clamping bolt ring and withdraw the light alloy outer motor casing (22) to free the seal seating ring (20) the sealing ring (24) and the inner seal ring (25).

(4) Ease the motor unit from the pump casting assembly taking care not to break the field coil leads when pulling them back through the small conduit in the pump casting. The pump unit and motor unit can now be separately dismantled.

Dismantling the pump unit (fig. 1)

Removing the gear box cover

8. (1) Unscrew and remove the six cheese-head screws (16) and shakeproof washers (17) securing the gear box cover (11) to the top of the pump casting. Remove the gear box cover assembly (11). This cover (11) locates on a $\frac{5}{32}$ in. dia. spring dowel (10) which need only be removed if it is damaged.

(2) Remove as much grease as possible from the gear box. Do not use solvents.

Removing the inlet shroud and base bearing assembly (fig. 2)

9. (1) Unscrew and remove the three round head screws (108) securing the

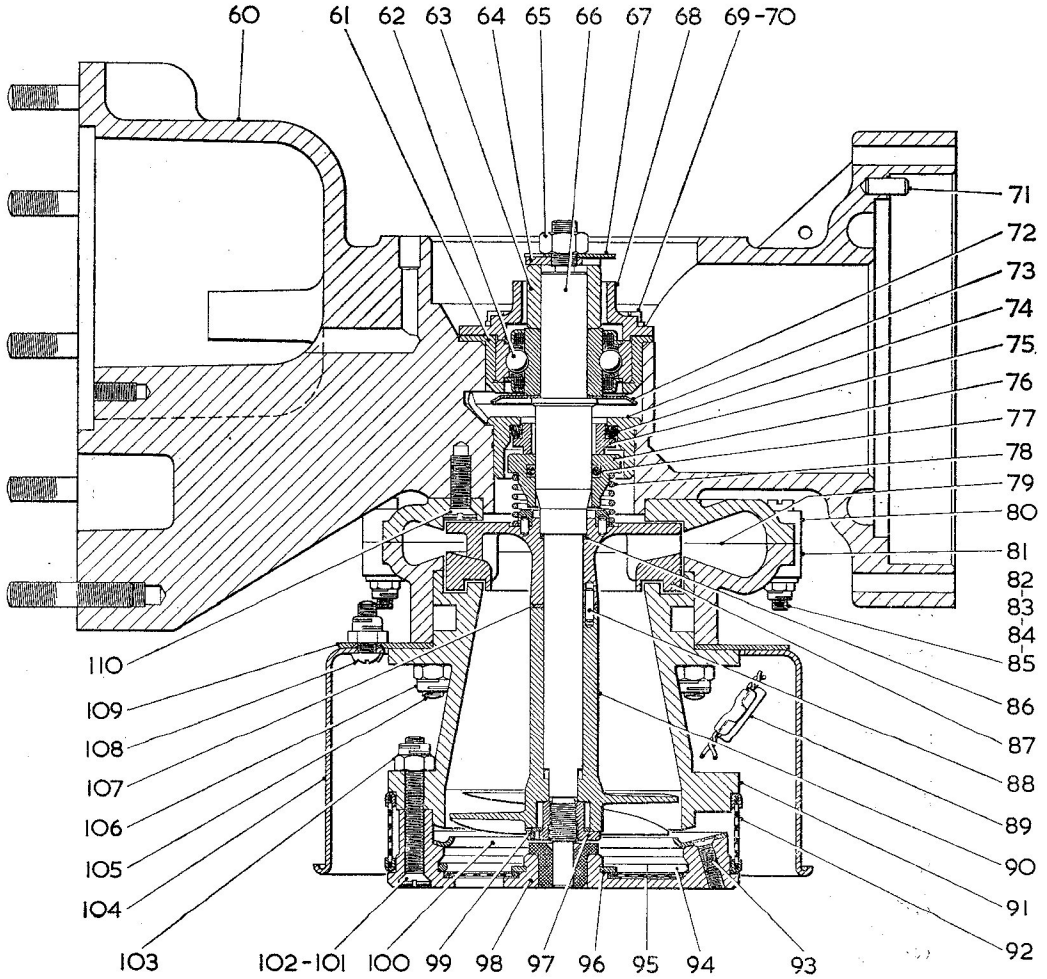


Fig. 2. Sectional view of pump assembly

inlet shroud (104) to the fixing plate assembly (109) and withdraw the shroud.

(2) Unscrew the three nuts (103) and remove the three countersunk-head screws (101-2 off: 102-1 off) securing the base bearing assembly to the helix casing (91).

(3) Remove the base bearing housing together with the filter assembly (98) which is freely mounted between the two castings. Take care not to damage the exposed helix blades.

Dismantling the base bearing housing assembly (fig. 2)

10. (1) Unscrew the three countersunk-head screws (93) securing the vapour guide cone (100) to the bearing housing.

(2) Remove the steel circlip (96) and locking ring (94) which hold the flat circular base filter (95) in position.

(3) If it is necessary to renew the plain carbon bearing the complete base bearing housing sub-assembly (98) must be renewed. This sub-assembly includes the base filter and vapour guide cone.

Removing the by-pass casting assembly (fig. 1)

11. Remove the two self-locking nuts (33) release an end tag of the bonding strip (32) and withdraw the by-pass casting and flap valve sub-assembly (35).

Withdrawing the helix (fig. 2)

12. (1) Bend the tag of the locking washer (99) flat and using the special spanner SPE. 19875 (fig. 4) unscrew the locknut (97) securing the helix (90).

(2) Withdraw the helix together with any shims (107) fitted.

Key to Fig. 2

60 PUMP CASTING
61 BEARING HOUSING
62 BALL BEARING
63 DISTANCE PIECE
64 CLAMP WASHER
65 NUT
66 PUMP SHAFT
67 SPECIAL TAB WASHER
68 BEARING RETAINING PLATE
69 CH.-HD. SCREW } BEARING RETAINING
70 SPRING WASHER } PLATE SECURING
71 MOTOR LOCATING DOWEL
72 SLINGER
73 STATIONARY SEAL SEAT
74 STATIONARY SEAL 'O' RING
75 STATIONARY SEAL RING
76 ROTARY SEAL RING
77 ROTARY SEAL 'O' RING
78 RIGHT HAND SPRING
79 VOLUTE ASSEMBLY
80 UPPER VOLUTE CASTING
81 LOWER VOLUTE CASTING
82 DOWEL PIN
83 CH.-HD. SCREW
84 WASHER
85 SELF LOCKING NUT
} UPPER/LOWER VOLUTE CASTING LOCATING AND CLAMPING
86 IMPELLER SEAL WASHER/SHIM
87 IMPELLER ASSEMBLY
88 IMPELLER/HELIX LOCATING DOWEL
89 SEAL
90 IMPELLER HELIX
91 HELIX CASING
92 FILTER ASSEMBLY (CYLINDRICAL)
93 CSK.-HD. SCREW. VAPOUR GUIDE CONE FIXING
94 CIRCLIP. FILTER RETAINING (OUTER)
95 FILTER ASSEMBLY (FLAT)
96 CIRCLIP. FILTER RETAINING (INNER)
97 HELIX LOCKNUT
98 BASE BEARING SUB-ASSEMBLY
99 HELIX LOCKWASHER
100 VAPOUR GUIDE CONE
101 CSK.-HD. SCREW } BASE ASSEMBLY
102 SPECIAL CSK.-HD. SCREW } HELIX CASING FIXING
103 SELF-LOCKING NUT
104 INLET SHROUD
105 STUD } VOLUTE ASSEMBLY/HELIX
106 SELF LOCKING NUT } CASING FIXING
107 HELIX ADJUSTING SHIM
108 RD.-HD. SCREW. INLET SHROUD SECURING
109 INLET SHROUD FIXING PLATE ASSEMBLY
110 CSK.-HD. SCREW. VOLUTE ASSEMBLY SECURING

Withdrawing the centrifugal impeller (fig. 2)

13. (1) Unscrew the six self-locking nuts (106) securing the helix casing (91) to the volute studs (105) and withdraw the casing using the special fixture SPE. 14450 (fig. 5).

(2) Remove the inlet shroud fixing plate (109).

(3) Withdraw the centrifugal impeller assembly (87) from the pump shaft using the extractor tool SPE. 17339 (fig. 6).

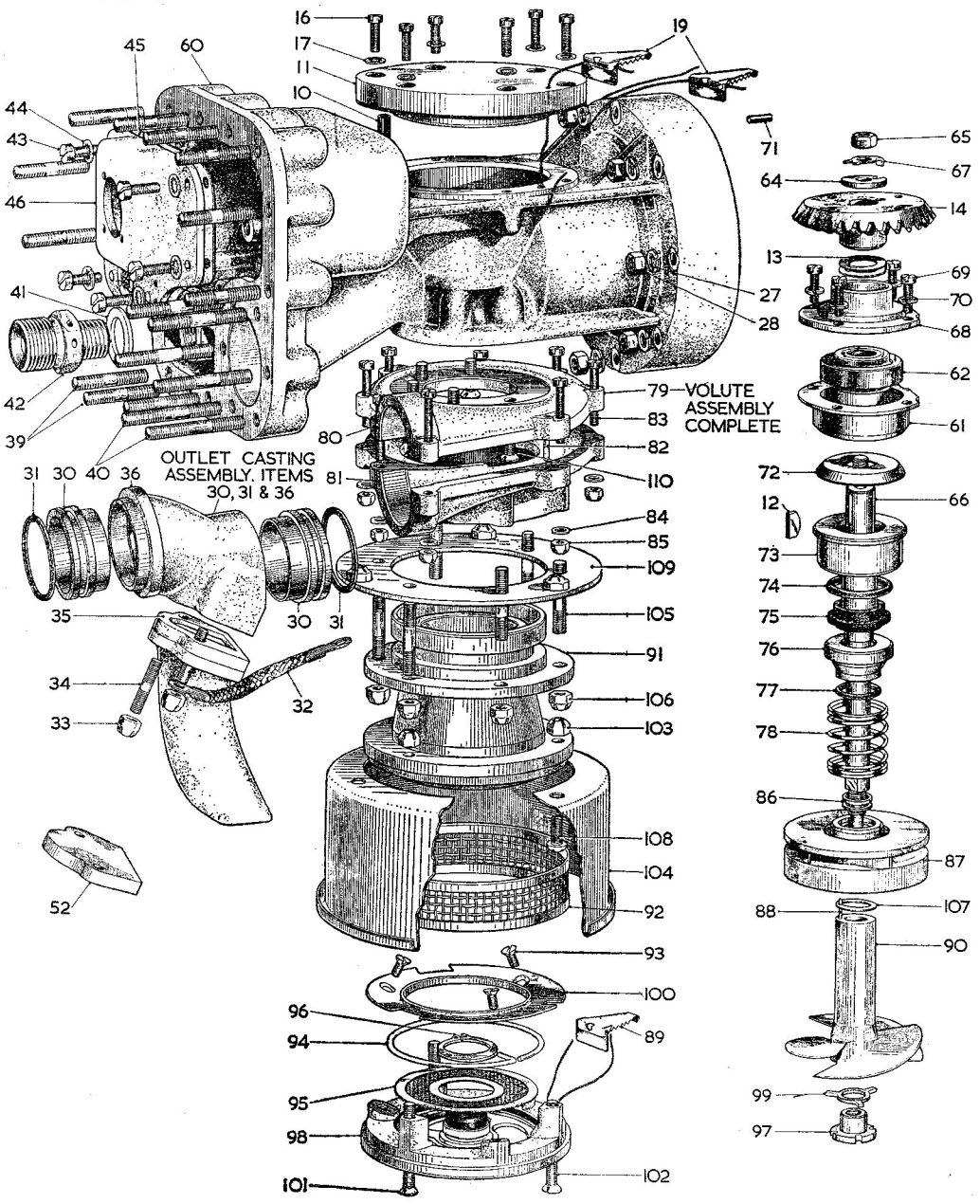


Fig. 3. Exploded view of pump unit

Key to Fig. 3

10 SPRING DOWEL
11 GEAR BOX COVER ASSEMBLY
12 DRIVE KEY (GEAR)
13 ADJUSTING SHIM (GEAR)
14 GEAR AND PINION (PAIRED COMPONENTS)
16 CH.-HD. SCREW } GEAR BOX COVER
17 SHAKEPROOF WASHER } SECURING
19 SEAL
27 SPRING WASHER } OUTER CASING CLAMPING
28 NUT }
30 DELIVERY OUTLET SLEEVE
31 RUBBER JOINT RING
32 BONDING STRIP
33 SELF LOCKING NUT } DELIVERY OUTLET/
34 STUD } BY-PASS FIXING
35 FLAP VALVE AND BY-PASS ASSEMBLY
36 DELIVERY OUTLET CASTING
39 STUD (SHORT)
40 STUD (LONG)
41 UNION JOINTING WASHER
42 GLAND DRAIN UNION
43 CH.-HD. SCREW } COVER PLATE
44 SHAKEPROOF WASHER } FIXING
45 COVER PLATE GASKET
46 COVER PLATE ASSEMBLY
52 BLANKING PLATE (ALTERNATIVE TO ITEM 35)
60 PUMP CASTING
61 BEARING HOUSING
62 BALL BEARING
63 DISTANCE PIECE
64 CLAMP WASHER
65 NUT
66 PUMP SHAFT
67 SPECIAL TAB WASHER
68 BEARING RETAINING PLATE
69 CH.-HD. SCREW } BEARING RETAING PLATE
70 SPRING WASHER } SECURING
71 MOTOR LOCATING DOWEL
72 SLINGER
73 STATIONARY SEAL SEAT
74 STATIONARY SEAL 'O' RING
75 STATIONARY SEAL RING
76 ROTARY SEAL RING
77 ROTARY SEAL 'O' RING
78 RIGHT HAND SPRING
79 VOLUTE ASSEMBLY
80 UPPER VOLUTE CASTING
81 LOWER VOLUTE CASTING
82 DOWEL PIN } UPPER/LOWER VOLUTE
83 CH.-HD. SCREW } CASTING LOCATING
84 WASHER } AND CLAMPING
85 SELF LOCKING NUT }
86 IMPELLER SEAL WASHER/SHIM
87 IMPELLER ASSEMBLY
88 IMPELLER/HELIX LOCATING DOWEL
89 SEAL
90 IMPELLER HELIX
91 HELIX CASING
92 FILTER ASSEMBLY (CYLINDRICAL)
93 CSK.-HD. SCREW. VAPOUR GUIDE CONE FIXING
94 CIRCLIP FILTER RETAINING (OUTER)
95 FILTER ASSEMBLY (FLAT)
96 CIRCLIP. FILTER RETAINING (INNER)
97 HELIX LOCKNUT
98 BASE BEARING SUB-ASSEMBLY
99 HELIX LOCKWASHER
100 VAPOUR GUIDE CONE
101 CSK.-HD. SCREW } BASE ASSEMBLY
102 SPECIAL CSK.-HD. SCREW } HELIX CASING FIXING
103 SELF LOCKING NUT }
104 INLET SHROUD
105 STUD } VOLUTE ASSEMBLY/
106 SELF LOCKING NUT } HELIX CASING FIXING
107 HELIX ADJUSTING SHIM
108 'PHILIPS' RH.-HD. SCREW. INLET SHROUD SECURING
109 INLET SHROUD FIXING PLATE ASSEMBLY
110 CSK.-HD. SCREW. VOLUTE ASSEMBLY SECURING

(4) Remove any shims (86) fitted between the impeller assembly and the shaft shoulder together with the rotating parts (75, 77 and 78) of the mechanical seal.

Removing the bevel gear (fig. 3)

14. (1) Locate the holding key SPE. 16982 (fig. 7) in the holes, in the top face of the bevel gear (14). With a suitable tool bend the ears of the tag washer (67) flat and remove the 2-B.A. nut (65).

(2) Remove the tag washer (67) and clamp washer (64). Use the special tool SPE.16983 (fig. 7) to withdraw the bevel gear (screw the two arms of the tool into the tapped holes in the face of the gear, and withdraw the gear by tightening the centre screw on to the end of the pump shaft).

Note . . .

It is recommended that a new set of gears is fitted at each servicing period. If, however, it is intended to refit the removed gear, it must be used with the pinion of the motor unit removed from the pump assembly. (Identify the removed gear wheel with the pinion of the motor unit).

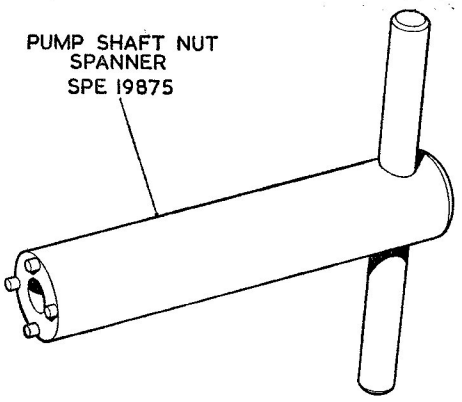


Fig. 4. Pump shaft nut spanner

Removing the upper bearing housing (fig. 3)

15. (1) Remove the four cheese-head screws (69) and spring washers (70) securing the bearing retainer (68).

(2) Extract the bevel gear driving key (12).

(3) Remove any adjusting shims (13) fitted.

(4) Screw two 4 BA screws into the tapped extraction holes in the flange of the bearing housing (68) and withdraw this part complete with ball race and pump shaft.

(5) Remove pump shaft (66) which is an easy fit on the bearing, and release the slinger (72).

(6) Press the bearing (62) out of its housing.

Removing the volute assembly (fig. 3)

16. (1) Withdraw the five 4 BA countersunk-head screws (110) securing the volute assembly (79) to the underside of the pump casting.

(2) Break the joint between the volute and the pump castings, and holding the two apart a sufficient amount to clear the central spigot on the base of the pump casting, withdraw the volute assembly together with the outlet casting assembly attached sideways, so as to free the outlet connection from the pump casting.

(3) Separate the outlet casting assembly from the volute casting assembly.

(4) If it is necessary to further dismantle the volute assembly, remove the eight self-locking nuts (85) the cheese-head screws (83) and washers (84) that secure the upper and lower volute castings, (80) and (81) respectively.

(5) Break the seal and separate the two volute halves, which are located by two spring dowels (82).

Note . . .

The volute outlet bore is machined after assembly of the two halves, therefore these should be kept together as a pair if the joint is broken.

Dismantling the outlet casting (fig. 3)

17. (1) Take the outlet casting previously removed and extract the valve joint rings (31) located in a groove in each outlet sleeve (30). Extract the sleeves from the outlet casting (36).

Removing the seal seating (fig. 3)

18. (1) Remove the stationary seal ring (75) and 0-ring (74).

(2) If damaged or otherwise faulty the seal seat (73) should be removed by preheating the casting to approximately 200°F, using the special tools illustrated in Fig. 8 to press the seat from the casting.

(3) Remove the gland drain union body (42) and washer (41) to complete the dismantling of the pump unit.

Dismantling the motor unit (fig. 10)

Disconnecting the brushes

19. (1) Remove the insulating sleeve (135) wrapped round the commutator-end motor casing.

(2) Disconnect the motor leads from the brush tags by unscrewing and removing the two screws (137) together with the spring washers (138).

(3) Withdraw the two carbon brushes complete with the spring and tag.

Note . . .

If the brushes are being refitted for a further period of service identify each brush with the brush box in which it is fitted. This will facilitate brush bedding on re-assembly.

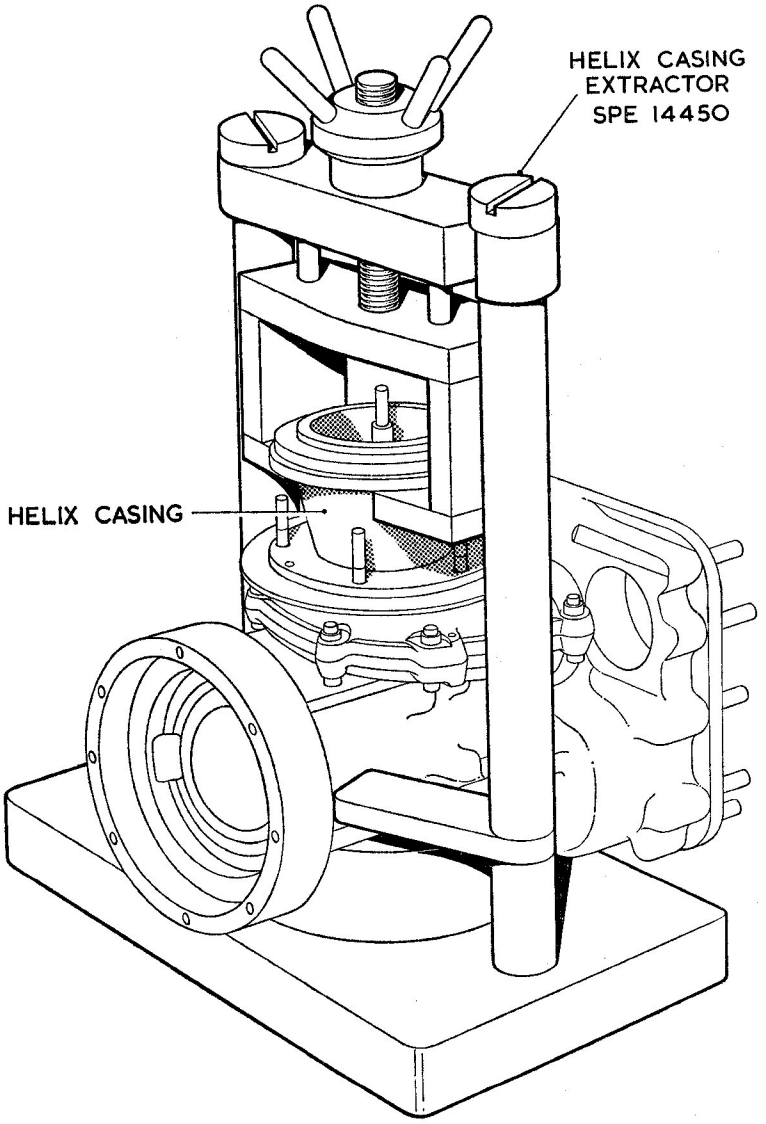


Fig. 5. Helix casing extractor

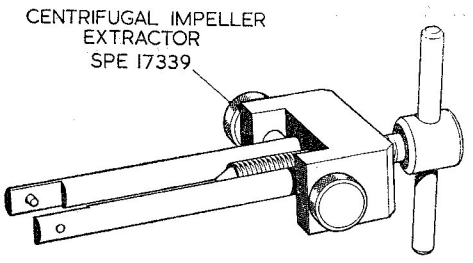


Fig. 6. Centrifugal impeller extractor tool

Withdrawing the motor unit tie-bolts (fig. 10)

20. (1) Hold the bevel pinion (14) to prevent the motor shaft turning, and unscrew and remove the commutator-end bearing nut (129) together with the washer (128).

(2) Unscrew and remove the two motor-tie bolt nuts (123) with the spring washers (122) and withdraw the tie-bolts (124).

Separating the motor end-casings (fig. 10)

21. (1) To facilitate re-assembly mark the position of the motor end casings relative to the yoke and field coil assembly (119).

(2) Using a hide-faced mallet, very carefully tap the end of the armature assembly to free the commutator drive-end casing.

Note . . .

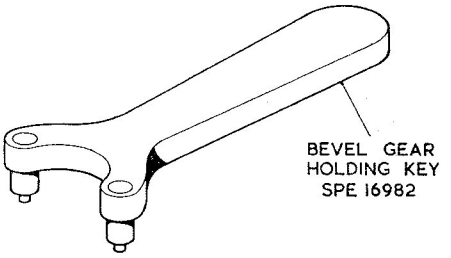
Take care not to scratch the commutator on the brush-holder when withdrawing the armature.

(3) Separate the yoke and field coil assembly and the drive-end assembly by withdrawing the yoke and field assembly carefully over the armature.

Dismantling the commutator-end casing sub-assembly (fig. 10)

22. (1) For reference purposes mark the position of the brush box assembly (120) relative to the motor casing (136).

(2) Unscrew and remove the two brush box securing screws (132) and spring washers (133) together with the brush retainer plates (134). Remove the brush box assembly and brush box rivet insulator plate (121).



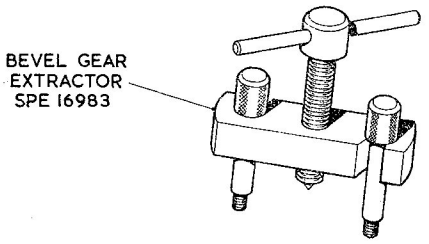


Fig. 7. Bevel gear removal and assembly tools

(3) Press the commutator-end ball race housing out of the end casing. This frees the armature end-load spring washer (125), which should be renewed at each overhaul of the pump.

(4) Withdraw the split pin (131) securing the locking ring (127).

(5) Place the housing assembly in the special holding block SPE. 14270 (fig. 11). Holding the bearing housing (126) with the key SPE. 14268 (fig. 11), use the special tool SPE. 14257 (fig. 11) to unscrew and remove the locking ring (127).

(6) Press the bearing (130) out of its housing.

Removing the bevel pinion and drive-end bearing (fig. 10)

23. (1) Using a 2 BA box spanner unscrew and remove the securing nut (15) on the end of the armature shaft together with the clamp washer (145) and spiral bevel pinion (14). Use the extractor tool SPE. 14667 (Fig. 12).

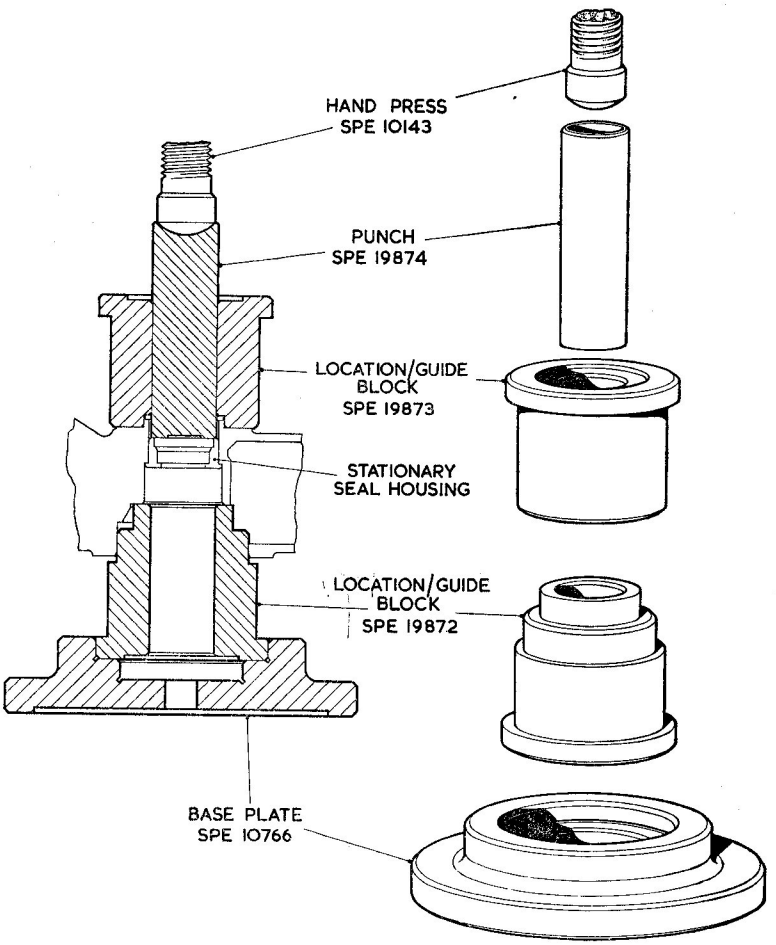


Fig. 8. Tools for removing the stationary seal seat

(2) Unscrew and remove the four self-locking nuts (116) and cheese-head screws (115) securing the drive-end bearing retainer (117).

(3) Remove the bevel pinion driving key (18).

(4) Withdraw any shims (29) fitted together with the spacing piece (142).

(5) Withdraw the armature assembly from the bearing (141).

(6) Press the bearing (141) out of its housing by hand pressure.

General

24. Do not attempt to remove the field coils from the yoke assembly.

CLEANING, EXAMINATION & REPAIR

Cleaning

25. Immerse the armature and field assembly in white spirit and use a soft bristle brush to dislodge the carbon deposits, etc. Clean thoroughly, blow off surplus spirit and allow to dry out for several hours. Complete the drying in a ventilated oven at approximately 105°C.

26. Ensure that all dried jointing compound is removed from mating pump and motor unit surfaces, using an approved agent if necessary. All parts except the electrical connection, bearings and synthetic material rubber components should be cleaned in a dry-cleaning solvent or if excessively dirty, in a heavy duty degreasant. After cleaning, allow to dry out for several hours and complete the drying process in a ventilated oven at approximately 105°C.

27. The bearings used on this pump are of the double-shielded pre-packed type, and should last between major servicing periods when they should be renewed.

28. Synthetic rubber components should be replaced with new on re-assembly. If it is absolutely necessary to re-use such a component, it must only be cleaned in a lead free gasoline — not in trichlorethylene or similar degreasant.

Examination

General

29. Inspect all metal compounds for cleanliness, distortion, cracking (visual), scoring, denting, visual evidence of wear, deterioration of protective finishes (corrosion), serviceability of threads, security of sub-assemblies not dismantled (e.g. rivetting) and discolouration due to over heating. Examine the reusable rubber components and electrical cable insulation for cleanliness, chafing, cracks, cuts, overheating, fluid soakage and general deterioration.

30. All seal rings must be renewed on reassembly. It is also recommended that bearings are renewed at each servicing period of the motor and pump units.

Detailed procedure

31. Parts should be in accordance with Table 2 and checked for conformity with the Schedule of Fits, Clearance and Repair tolerances given in Table 3.

Lapping (mechanical) seal faces

32. Details of the hand lapping procedure for stationary and rotary seal rings is given in Chapter 6A of this section.

Pre-brush bedding

33. Brushes should be pre-bedded in accordance with the method described in A.P.4343, Vol. 1, Sect. 1. To avoid repetition the method is not given for this pump motor, but should be allowed for at the appropriate assembly stage.

TABLE 2

DETAILED INSPECTION OF COMPONENTS

Item	Examination	Action if faulty
Armature	Lamination and end windings for signs of fouling or other damage.	Reject armature for re-winding.
	Commutator for loose conductors.	Reject for re-winding.
	Local discolouration of the commutator.	Suspect faulty windings. Check using voltage drop method.
	Insulation resistance between armature and shaft. Use a 500-volt standard insulation resistance tester, Resistance must be not less than 50 megohms.	Clean the armature thoroughly in white spirit to remove every trace of dust from the windings. Dry for a prolonged period at 105°C in a ventilated oven. Allow armature to cool. Re-check insulation resistance. If below this figure continue drying process. Cool. Re-check.

TABLE 2 (Continued)

Item	Examination	Action if faulty
Armature (Cont.)	Commutator for eccentricity-total indicator reading must not exceed 0·001 in.	If execessive, reject. Check for high micas and raised commutator segments. Difference in height between adjacent segments is not to exceed 0·0001 in.
	Commutator for scoring.	Skim commutator. Minimum permissible diameter for further use is 24·0 mm. (0·945 in.). Surface finish must be free of all machine marks. Undercut micas 0·000 in. deep × 0·030 in. wide. Check that no copper burrs are shorting across the segments — remove by gentle application of the finest steel wool. Check concentricity of commutator with shaft bearings. Maximum eccentricity permissible 0·001 in. total indicator reading.
	Shorting or open-circuited conductors. Use voltage drop tester or growler.	Clean undercutting of micas between commutator segments. Remove copper burrs or slivers of mica. If still unsatisfactory, reject the armature.
	Check that the width of the Keyway is within limits 0·0635 in. and that it is undamaged.	Reject armature.
Field	Charring or other evidence of overheating.	Renew complete assembly.
	Connections and insulation coverings of windings and leads to be secure and undamaged.	Replace damaged lead. Cut back old lead, bare old and new lead for $\frac{5}{16}$" minimum and clean wires. Twist bared wires together and solder using solder Ref. No. 30B/9105043. Bind joint with silk tape and cover with 'Systoflex' sleeving 3 mm. i/dia. Varnish with air drying varnish to Ref. No. 33B/9433454. If more than one lead has to be repaired, stagger the joints to facilitate passage of the leads through the casting channels.
	Total resistance of windings measured and corrected to 20°C. 486·3 ohms ±5%	Renew complete assembly.

TABLE 2 (Continued)

Item	Examination	Action if faulty
Field (Cont.)	Insulation resistance of coils to frame.	Clean thoroughly using white spirit (para. 25). Dry for prolonged period at 105°C in a ventilated oven. Allow to cool. Check that the insulation resistance reading is not less than 50 megohms. If below this figure continue drying process. Cool. Re-check.
Brush gear	Brushes for wear.	Refer to Fits and Clearances (Table 3).
	Examine brush pigtail leads for fraying and looseness in brush carbon.	Renew the brush.
	Fit of brush in brush box.	Brushes should slide freely in the brush boxes. Carbon dust should be removed.
Bearings (*Motor and pump units*)	It is recommended that new ball bearings are fitted at each overhaul of the pump.	
Plain carbon bearing (*Pump unit*)	Damaged or cracked carbon. Excessive wear (*Refer to Table* 3).	Renew base bearing assembly complete.
By-pass flap valve	Scored or damaged seating face. Worn Pivots. Tendency of valve to stick.	Renew assembly. Renew assembly.
Mechanical seal	Carbon (*stationary seal ring*) worn (*Refer to Table* 3).	
	Rotary seal ring worn (*Refer to Table* 3).	Relap and polish. (*Refer to para.* 32 *this chapter*). **Note . . .** *Seal packing rings must be renewed at each overhaul.*
Gear and pinion assembly (*Paired components*)	It is recommended that a new gear and pinion assembly are fitted at each overhaul of the pump. If it is necessary to re-use the existing components, check for damaged teeth and keyways.	
	Excessive wear will become evident during gear alignment on assembly.	
Capacitors	Examine tags for fractures at bends.	Renew capacitor.

TABLE 2 (Continued)

Item	Examination	Action if faulty
Capacitors (Cont.)	Each capacitor should be individually checked with a 250-volt insulation resistance tester. Insulation between one terminal and earth to be not less than 50 megohms.	
Filters	Damaged wire mesh.	Renew.
Electrical plug	Chipped bakelite plates, damaged pins or threads.	Renew.
Helix	Damaged blades.	Renew.

ASSEMBLING

General

34. Maintain absolute cleanliness of the work-bench and tools throughout the assembly of the pump. Retain the bearings in their wrappings until they are required for assembly. Use the special tools or their equivalents whenever specified.

Motor unit

Assembling the drive-end motor casing (fig. 10)

35. (1) Pre-select a new bearing (141), that is a firm slide fit under thumb pressure both on the armature shaft and in the drive-end motor casing (118). Suitably mark the armature and the motor casing so that they can be paired with the selected bearing at a later assembly stage. Check that the selected bearing is smooth running with no roughness of the tracks when the inner race is rotated by hand.

(2) Check that the bearing housing in the drive-end casing is perfectly clean and that the wall surface is smooth and free of score marks, burrs and adhering swarf.

(3) Fit the selected bearing in the housing; position the bearing retainer (117) and secure with four screws (115) and self-locking nuts (116). Note that the screws are inserted from the inside of the casing so that the nuts tighten directly on to the retainer.

Assembling the commutator-end bearing (fig. 10)

36. (1) Pre-select a bearing (130) that is a firm slide fit under thumb pressure in the commutator end housing (126) and also on the selected armature shaft (para. 33). Identify the bearing housing with the armature so that they can be paired at a later assembly stage. Check that the selected bearing is smooth running with no roughness of the tracks when the inner race is rotated by hand.

(2) Fit the selected bearing (130) into the housing. Place the housing in the holding block SPE. 14270 (fig. 11) and screw in the locking ring.

(3) Holding the rim of the housing with the special ring spanner SPE. 14268 (fig. 11) tighten up the locking ring hard against the outer race of the bearing using the special spanner SPE. 14257 (fig. 11). Ease the locking ring sufficiently to align one of the twelve slots with one of the small holes in the rim of the housing.

(4) Fit a split pin (131) and lock the ring by splaying the ends of the pin.

TABLE 3 (Continued)

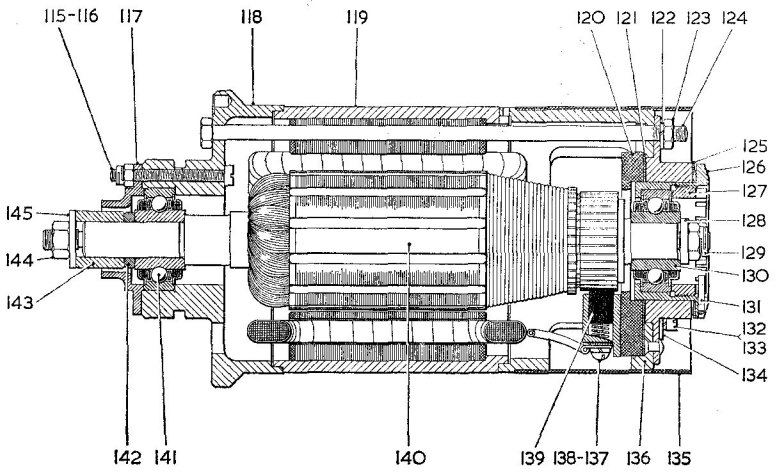
Part and description	Dimensions New	Permissible worn dimensions for re-use	Clearance New	Permissible worn clearance for re-use	Remarks
PUMP UNIT					
PUMP SHAFT IN BALL-RACE dia.	8·995 mm. / 8·985 mm. (0·3541 in.) / (0·3537 in.)	—	—	—	Selective assembly.
bore	9·000 mm. / 8·990 mm. (0·3543 in.) / (0·3539 in.)				
PUMP SHAFT IN PLAIN CARBON BEARING dia.	3·938 mm. / 3·928 mm. (0·1550 in.) / (0·1546 in.)	—	—	—	Free running shaft in supported bearing.
bore	3·987 mm. / 3·972 mm. (0·1569 in.) / (0·1563 in.)				

TABLE 3 (Continued)

Part and description	Dimensions New	Permissible worn dimension for re-use	Clearance New	Permissible worn clearance for re-use	Remarks
STATIONARY SEAL RING — OVERALL LENGTH	6·0 mm ± 10·5 mm.	5·5 mm. min.	—	—	Surface scores etc. to be removed by lapping.
ROTARY SEAL RING	3·5 mm. ± ·05 mm.	3·2 mm. min.			
CENTRIFUGAL IMPELLER TO VOLUTE CASTING — CLEARANCE	—	—	0·40 mm. / 0·15 mm. (0·0157 in.) / (0·059 in.)	0·40 mm. / 0·15 mm. (0·0157 in.) / (0·059 in.)	Clearance can be adjusted by means of shims inserted between impeller and pump shaft shoulder.

TABLE 3 (Continued)

Part and description	Dimensions New	Permissible worn dimension for re-use	Clearance New	Permissible worn clearance for re-use	Remarks
IMPELLER HELIX TO PLAIN CARBON BEARING — CLEARANCE	—	—	1·25 mm. / 1·00 mm. (0·049 in.) / (0·039 in.)	1·25 mm. / 1·00 mm. (0·049 in.) / (0·039 in.)	Clearance can be adjusted by means of shims inserted between helix and distance piece.



115 CH.-HD. SCREW } BEARING RETAINING PLATE CLAMPING
116 SELF LOCKING NUT }
117 BEARING RETAINING PLATE
118 MOTOR CASTING (DRIVE END)
119 MOTOR CASING & STATOR ASSEMBLY
120 BRUSH BOX ASSEMBLY
121 BRUSH BOX RIVET INSULATOR
122 SPRING WASHER } MOTORFRAME CLAMPING
123 NUT }
124 HX.-HD. TIE BOLT }
125 PRE-LOAD WASHER
126 BEARING HOUSING
127 LOCK RING
128 CLAMP WASHER
129 SELF LOCKING THIN NUT
130 BALL BEARING (COMMUTATOR END)
131 SPLIT COTTER PIN
132 CH.-HD. SCREW } BRUSH BOX SECURING
133 SPRING WASHER }
134 BRUSH BOX RETAINER
135 INSULATING SLEEVE
136 MOTOR CASING ASSEMBLY (COMMUTATOR END)
137 RD.-HD. SCREW } BRUSH TAG SECURING
138 SPRING WASHER }
139 BRUSH & SPRING ASSEMBLY
140 ARMATURE ASSEMBLY
141 BALL BEARING (DRIVE END)
142 DISTANCE PIECE (SHORT)
143 DISTANCE PIECE (LONG)
144 NUT
145 CLAMP WASHER

Fig. 9. Sectional view of motor unit

Assembling the commutator-end motor casing (fig. 10)

37. (1) Place a new pre-load washer (125) in position over the body of the bearing housing (126).

(2) Lubricate the outside of the housing with MDS grease grade WPM, and press the assembly into the commutator-end casing (136).

(3) Place the brush-box rivet insulator (121) in position in the casing; align the brush-box assembly (120) and secure it in position with two cheese-head screws (132) and spring washers (133). Fit a brush box retainer plate (134) between each spring washer and the motor casing. Check that the clearance between the end face of the casing and the bearing housing, containing the pre-load washer, is as detailed in Table 3.

Note . . .

If an earlier mark (up to Mk. 1E) of the pump is being brought up to Mk. 1G standard and the original brush box is being re-fitted, the back of the carrier must be machined so that the width of the carrier plate is 5·55mm. (0·218in.). This machined face must then be coated with a mixture of 1 part 'Durameg TS' hard-drying varnish A.S.5233 and 1 part thinners A.S.5236 and the assembly baked for 2 hours at 145±5°C.

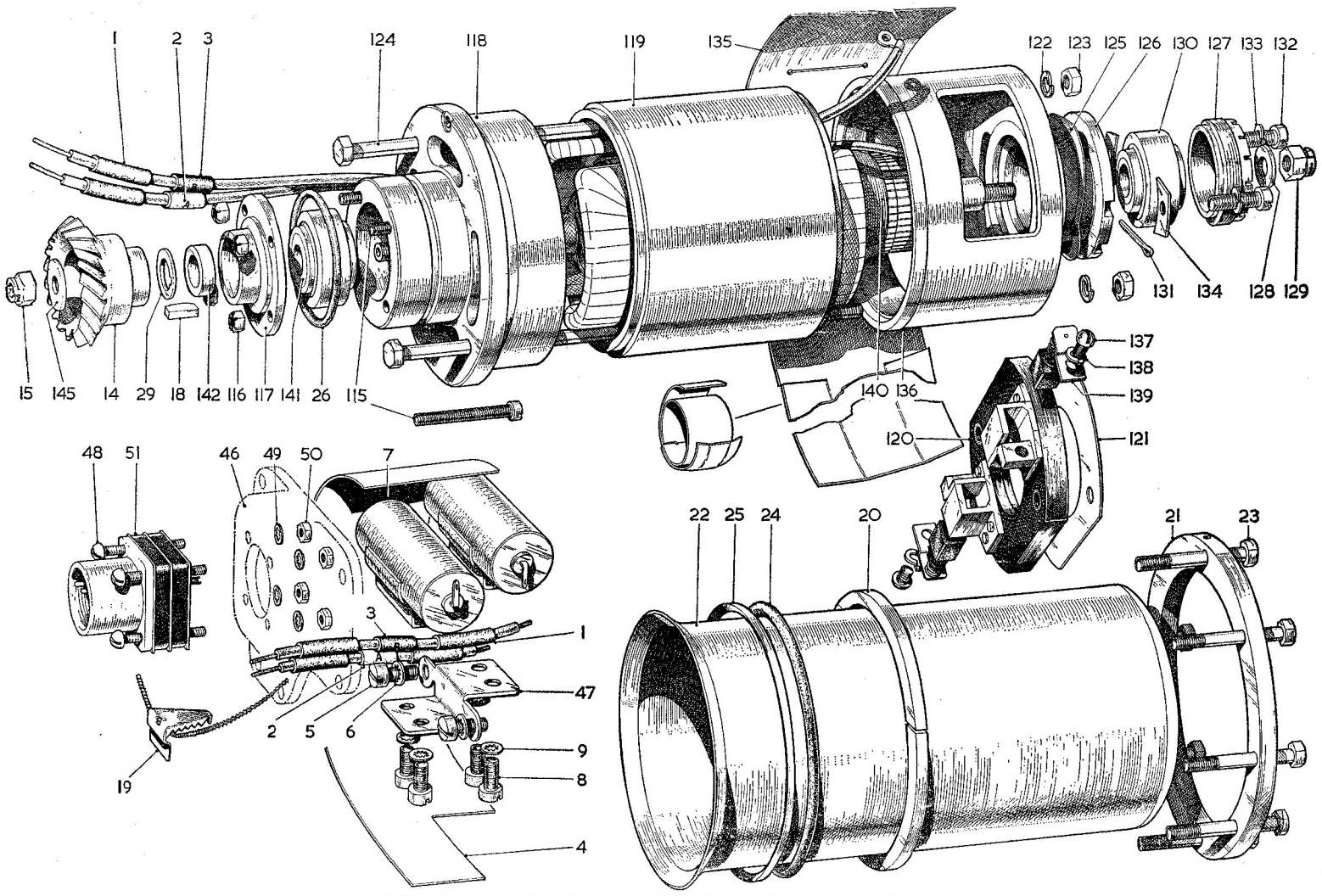


Fig. 10. Exploded view of motor unit components

Key to Fig. 10

1 RUBBER SLEEVE (¾ IN.)
2 IDENTIFICATION SLEEVE 'A'
3 IDENTIFICATION SLEEVE 'B'
5 CH.-HD. SCREW } CAPACITOR BRACKET
6 SHAKEPROOF WASHER } SECURING
7 CAPACITOR
8 CH.-HD. SCREW } CAPACITOR FIXING
9 SHAKEPROOF WASHER } CAPACITOR FIXING
14 PINION
15 SELF LOCKING THIN NUT
18 DRIVE KEY (PINION)
19 SEAL
20 SEAL SEATING RING
21 CLAMPING BOLT RING
22 OUTER CASING
23 HEX.-HD. BOLT — OUTER CASING CLAMPING
24 RUBBER SEALING RING
25 INNER SEAL RING
26 MOTOR SEALING RING
29 ADJUSTING SHIM (PINION)
46 COVER PLATE ASSEMBLY
47 CAPACITOR BRACKET
48 RD.-HD. SCREW } ELECTRICAL
49 SHAKEPROOF WASHER } CONNECTION
50 NUT } SECURING
51 ELECTRICAL CONNECTION
115 CH.-HD. SCREW } BEARING RETAINING
116 SELF LOCKING NUT } PLATE CLAMPING
117 BEARING RETAINING PLATE
118 MOTOR CASING (DRIVE END)
119 MOTOR CASING & STATOR ASSEMBLY
120 BRUSH BOX ASSEMBLY
121 BRUSH BOX RIVET INSULATOR
122 SPRING WASHER } MOTOR FRAME CLAMPING
123 NUT } MOTOR FRAME CLAMPING
124 HX.-HD. TIE BOLT } MOTOR FRAME CLAMPING
125 PRE-LOAD WASHER
126 BEARING HOUSING
127 LOCK RING
128 CLAMP WASHER
129 SELF LOCKING THIN NUT
130 BALL BEARING (COMMUTATOR END)
131 SPLIT COTTER PIN
132 CH.-HD. SCREW } BRUSH BOX
133 SPRING WASHER } SECURING
134 BRUSH BOX RETAINER
135 INSULATING SLEEVE
136 MOTOR CASING ASSEMBLY (COMMUTATOR END)
137 RD.-HD. SCREW } BRUSH TAG
138 SPRING WASHER } SECURING
139 BRUSH & SPRING ASSEMBLY
140 ARMATURE ASSEMBLY
141 BALL BEARING (DRIVE END)
142 DISTANCE PIECE (SHORT)
145 CLAMP WASHER

Assembling the motor end casing sub-assemblies (fig. 10)

38. (1) Enter the commutator end of the selected armature shaft through the bore of the bearing in the commutator end-casing. Take care not to scratch the commutator on the brush boxes.

(2) Guide the yoke and field coil assembly over the armature and locate the commutator-end casing on the spigot on the end face of the yoke.

(3) Carefully position the drive-end casing over the armature shaft and locate the shaft in the bearing bore. Locate the casing on the spigot of the yoke face.

(4) The field leads should be threaded through an aperture provided in the drive-end casing.

(5) Insert the two-tie bolts (124) through the length of the motor casing, from the drive-end, and secure both bolts on the face of the commutator-end casing with spring washers (122) and locknuts (123).

Note . . .

Ensure that the end casings align with the marks made on the yoke during dismantling, before tightening the tie bolts.

(6) Fit the temporary distance piece (143 fig. 9) over the shaft and secure it with the clamp washer (145) and sleeper nut (144 fig. 9).

Pre-bedding the brushes

39. At this stage pre-bedding of the brushes should be completed (para. 33). This will apply to both new and original brushes.

Determining the brush gear geometric neutral axis

40. (1) Identify each brush with the box in which it is fitted. Remove the brushes from the motor unit and clean the face with a soft bristle brush.

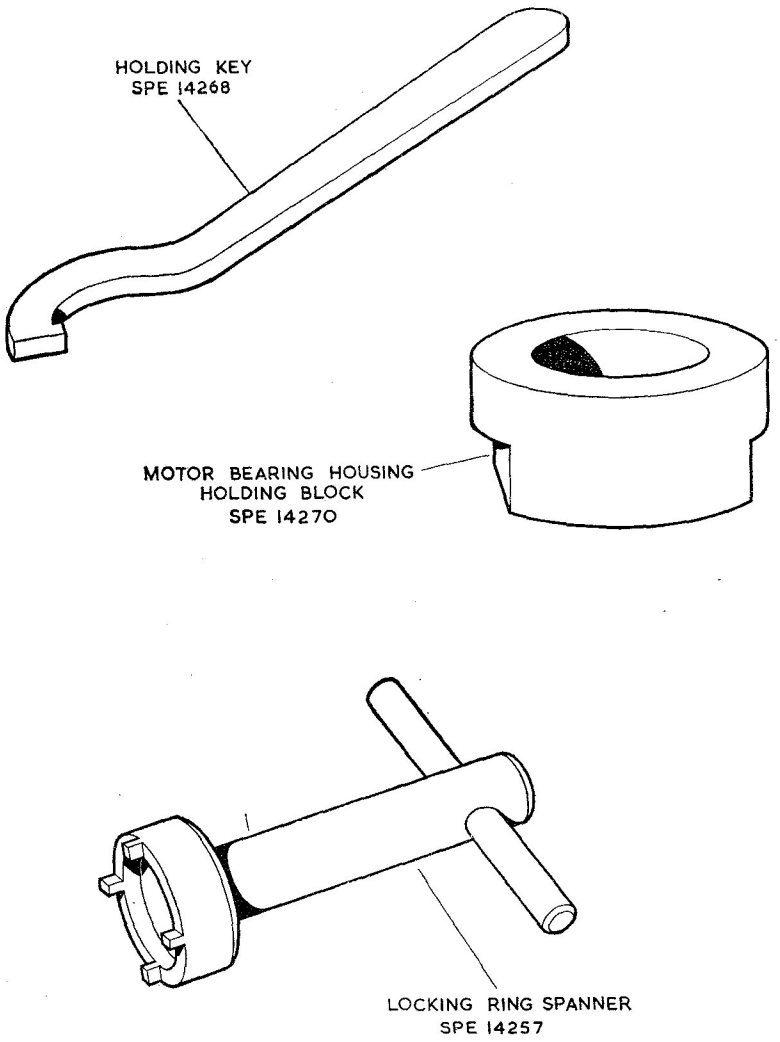


Fig. 11. Bearing housing dismantling and re-assembly tools

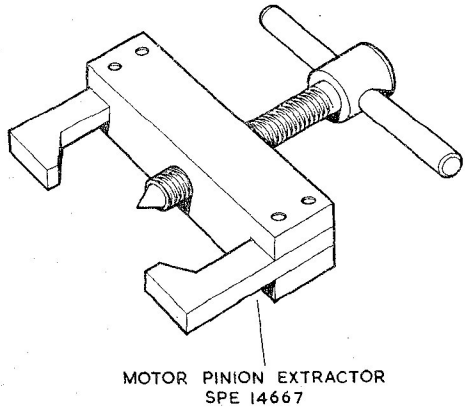


Fig. 12. Motor pinion extractor

(2) The motor speed should be set by retarding the brush gear 27 + 3, − nil degrees from its geometric neutral axis. To determine the geometric neutral axis, proceed as follows :

(a) Isolate the field coils from the brush boxes and insert the special setting brushes SPE. 17404 and SPE. 17405 (fiig. 13) in the brush boxes.

(b) Locate the vee-contact of the brush SPE. 17405 in a commutator slot and secure in position with the locking screw. Secure the brush (SPE. 17404) in the second brush box.

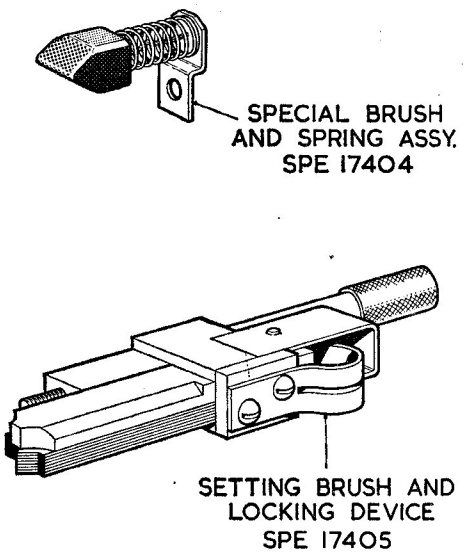


Fig. 13. Geometric neutral setting brushes

(c) Clamp the motor unit in a bench clamp, with the commutator-end towards the operator.

(d) Connect up the circuit as illustrated in Fig. 14, with the motor field leads isolated from the brushes but connected to the oscilloscope, and with the resisted input voltage across the slave brushes as shown in the diagram.

(e) Scribe a datum line A and B (fig. 15) across the commutator-end casing stator joint as detailed in Fig. 15. On a suitable plate scribe a circle of 67·0mm. dia. and two radii which subtend an angle of 10° as illustrated (not to scale). With dividers set to the chord length of this segment,

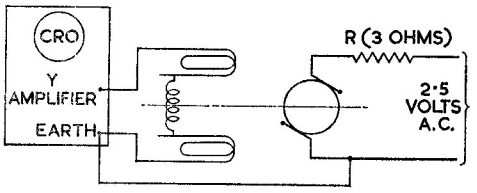


Fig. 14. Circuit diagram for determining the geometric neutral axis

secure a further mark C (fig. 15) on the motor end casing in a clockwise direction using the point A.

(f) Slacken and remove the tie-bolt nuts and spring washers and withdraw the tie-bolts to clear the commutator-end casing location holes. Rotate the end casing assembly anti-clockwise until the scribed line C aligns with the datum B or the stator assembly.

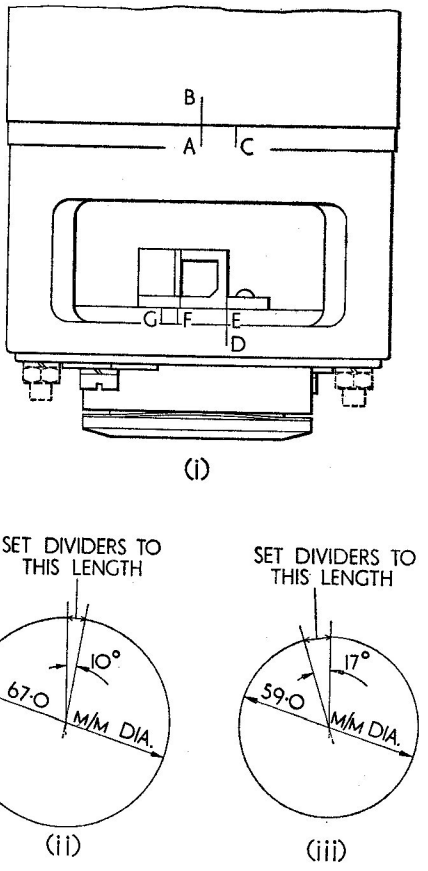


Fig. 15. Retardation from geometric neutral axis

(g) Slacken the brush-box securing screws and rotate the brush gear and armature assembly carefully so that the trace attains maximum amplitude (vertical displacement) or overload. Manipulate the 'Y' amplifier gain

control, bringing the amplitude of the trace to just below overload. If overload is not obtained the 'Y' amplifier should be set at full again and the oscilloscope left at this setting.

(h) Rotate the brush gear and armature until the narrowest possible horizontal line is displayed on the cathode ray tube. Continue to rotate the brush gear until the width of the line increases, reverse the direction of rotation and continue turning until the narrowest line is again obtained. Mark the position of a datum of the brush gear relative to the stator assembly (e.g. in line with the outer edge of the brass brush holder).

(i) Rotate the armature through 90 degrees and determine the geometric neutral axis at the new position. Mark the stator assembly in line with the original brush gear datum. Repeat this procedure twice more at 90 degree intervals of commutator/armature rotation. Align the original brush box carrier datum with the mean of the four marks made on the stator casing. Tighten the brush box securing screws and remove the special brushes.

Note . . .

It is important that the end casing/stator alignment C and B (fig. 15) should remain unaltered during the above operation.

Retarding the brush gear

41. (1) Rotate the end casing on the spigot of the stator assembly until the original datum lines A and B (fig. 15) are in alignment. Refit the tie-bolts and secure with spring washers and locknuts.

Note . . .

This operation in effect retards the brush gear the first 10 degrees of the required retardation of 27+3, −nil degrees.

(2) Scribe a circle of 59mm. dia. on a suitable plate. Mark two radii which subtend an angle of 17 degrees. Set dividers to the chord length of the segment formed by these radii.

(3) Mark the brush box carrier and the end casing with a common datum line D and E (fig. 15). Use the dividers set as in sub-para. (2) of this paragraph to scribe a further line F (fig. 15) in an anti-clockwise direction from point B, on the brush box carrier.

(4) Slacken the brush carrier securing screws and rotate the brush box assembly in a clockwise direction until the scribed line F on the brush box carrier aligns with the mark D on the end casing. Tighten the brush box securing screws.

Brush bedding, motor run

42. (1) Replace the brushes removed after the preliminary brush bedding, to their original positions as indicated by the markings. Secure the brushes with the round head screws and spring washers, connecting a field coil lead under each washer. The motor is now ready for a final brush bedding run.

(2) Connect the motor to a suitable d.c. power supply, and with the input voltage set at 60V d.c., run the motor without load, until the brushes are bedded over their full width of arc with at least 80 per cent of their face area making contact with commutator. The running of the motor should be continued until this condition is achieved for all brushes.

Note . . .

Ensure that after examination the brushes are located and returned to their original boxes.

Motor speed setting

43. (1) Instal the motor unit on a suitable clamp. Using calibration fan SPE. (14451) or a suitable dynomometer apply a torque loading of 19 oz. in. to the motor unit. Run the motor unit under load gradually increasing the d.c. input to 110V until the motor is warm.

(2) Check the motor speed (8,500 rev./min. minimum), and the current consumption, which must not exceed 2 A, with a strobo-flash Ref. No. 6C/610.

(3) Adjustment of the brush box position to obtain the correct motor speed is permitted to the extent of an additional 3 degrees retardation only. Set the dividers to 1·5mm. and scribe a further line G on the brush box carrier in an anti-clockwise direction from point F. Adjustment of the brush box position is permissible such that the scribed line D on the end casing is always between the lines G and F on the brush box carrier. Reject the motor if the adjustment necessary is outside the limits quoted.

(4) When the speed has been correctly set, securely tighten the brush box securing screws.

(5) Check the insulation resistance of the complete motor whilst it is still warm using a standard 500V insulation resistance tester the reading obtained should not be less than 20 megohms.

Pump unit

Pump casting sub-assembly (fig. 3)

44. (1) Pre-heat the pump casting (60), to between 125 and 150°C.

(2) Smear the 1·062 in. dia. of the stationary seat (73) with 'Wellseal' jointing compound and press the seal into the casting using the tools illustrated in Fig. 16.

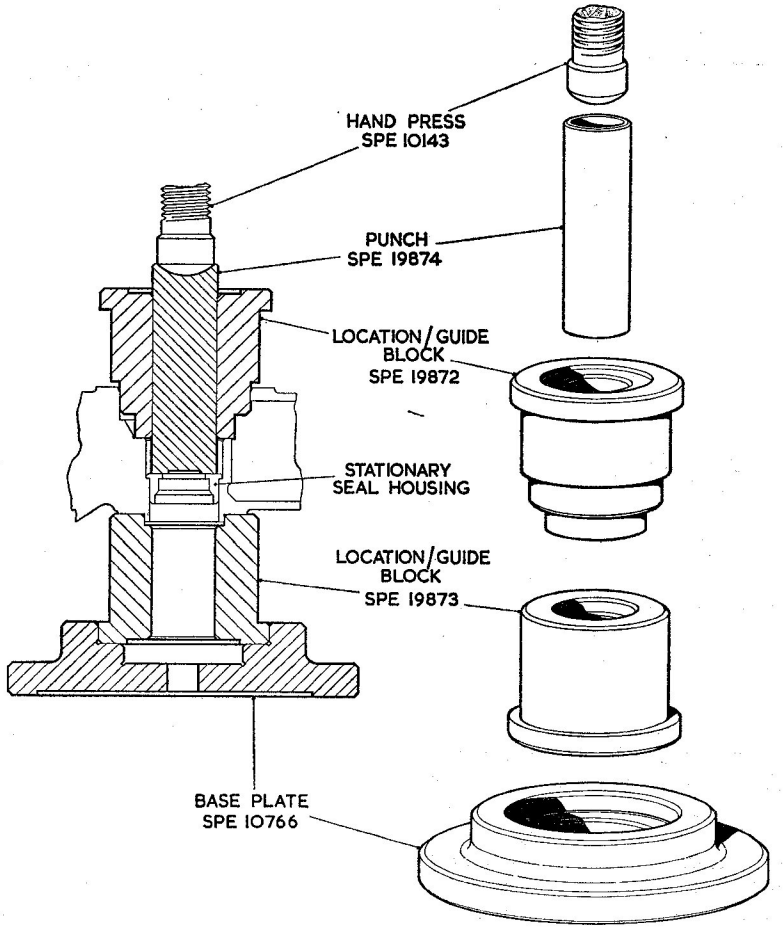


Fig. 16. Tools for assembling the stationary seal seat to the pump casting

(3) Remove the tooling and wipe off any surplus jointing compound.

(4) Replace any damaged studs (39 and 40) in the mounting face. The six studs around the outlet project 0·8 in. all others 0·5 in.

(5) Refit the dowel (71) in the motor housings of the pump casting.

Assembling the volute (fig. 3)

45. (1) If the volute was dismantled, ensure that the original paired upper and lower castings (80 and 81) are rebuilt into the same sub-assembly. Ensure that mating surfaces are cleaned of all jointing compound.

(2) Replace any studs (105) in the lower volute casting. Projection of the stud should be 10·0 — 13·0mm.

(3) Smear the mating surfaces with 'Wellseal' jointing compound and fit the two halves together, locating them with the two spring dowels (82).

Assembling the delivery outlet (fig. 3)

46. (1) Smear the mating surfaces of the delivery outlet casting (36) and sleeves (30) with 'Wellseal' jointing and press a sleeve into each end of the outlet casting.

(2) Fit a new rubber joint ring (31) in the groove in each outlet sleeve.

(3) Lubricate the volute/delivery outlet casting joint ring with a smear of Silicone MS.4 compound XG-250, Ref. No. 34H/9424829 and press the sleeve into the open end of the volute assembly

Note . . .

The position of the delivery outlet should be such that when viewed on the open end with the volute casting assembly horizontal, vertical centre-lines through the two sleeves should be in the same place with the open end above the entry into the volute assembly.

Assembling the volute assembly to the pump casting (fig. 3)

47. (1) Smear the mating surfaces of the volute assembly and pump casting with 'Wellseal' jointing compound, and apply a smear of Silicone MS. 4 compound XG-250, to the delivery sleeve 0-ring.

(2) Fit the combined volute and delivery outlet assembly by pressing the open end of the delivery outlet into the pump casting and locating the volute assembly over the spigot on the underside of the same part.

(3) Secure with five 4 BA countersunk-head screws (110) through the flange of the upper volute casting into the pump casting. Lock these screws in position by centre-punching metal from the volute casting into slots, making sure that no metal is raised above the machined surface of the volute casting.

Assembling the upper bearing and pump shaft (fig. 3)

48. (1) Pre-select a ball bearing (62) that is a firm slide fit under thumb pressure both on the pump shaft (66) and in the housing (61). Suitably mark the shaft and housing so that they can be paired with the selected bearing at a later assembly stage. Check that the selected bearing is smooth running, with no roughness of the tracks when the inner race is rotated by hand.

(2) Check that the bearing housing (61) is perfectly clean, and that the wall surface is smooth and free from score marks, burrs and adhering swarf.

(3) Fit the selected bearing into the paired housing.

(4) Place the thrower disc (72) in position on the pump shaft.

(5) Enter the shaft through the bore of the paired ball bearing journal (*sub-para.* (1) *of this paragraph*).

(6) Insert the shaft through the stationary seal seat and press the bearing housing into position in the pump casting, lining up the four holes in the housing flange with the tapped holes in the casting.

(7) Place shims (13) of approximately 0·010 in. total thickness on the shaft (66) and fit the key (12) in the keyway.

(8) Place the bearing retainer plate in position over the bearing and secure it through the housing to the pump casting with four 6BA cheese-head screws (69) and spring washers (70). The threads of these screws should be smeared with 'Wellseal' jointing compound before insertion.

(9) Fit the special spacing bush (63, fig. 2) to the pump shaft and secure it with the clamp washer (64) and a 2BA nut.

Note . . .

If the spacing bush is not available, a gear can be fitted in its place, but must be removed at a later stage when ssembling the motor unit to the pump unit.

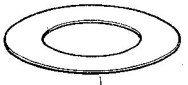


Fig. 17. Impeller spacing shim

Shimming and centrifugal impeller (fig. 3)

49. (1) Place the special spacer shim SPE. 10786/A, (fig. 17) used to set the clearance between the centrifugal impeller and the upper volute casting (50) in the volute assembly (79).

(2) Fit a spacer shim (86), which also acts as a seal washer in position between the centrifugal impeller and the pump shoulder, and fit the impeller sub-assembly (87).

(3) The thickness of the shim fitted, should be such, that the impeller helix (90) assembled to the pump shaft by the nut (97) and washer (99) gives a frictional contact between the impeller and the spacer shim SPE. 10786/A, and should be sufficient to impede the free turning of the pump shaft, but not so great as to prevent it. When this condition is satisfied remove the components from the shaft and withdraw the vapour shim.

Note . . .

It is important that the number of shims (86) *initially fitted should be greater than that finally required, and that the thickness is progressively reduced by minimum amounts until the conditions outlined are achieved. The thickness of shim recommended for the initial fitting is approximately* 0·060 *in. and shims are available in four thicknesses (i.e.* 0·020 *in.* 0·030 *in.* 0·040 *in. and* 0·050 *in.). The final clearance between impeller and upper volute casting is as detailed in Table* 3.

(4) Lightly smear the impeller shim (86) with 'Wellseal' jointing compound before replacing it on the pump shaft.

Fitting the mechanical seal (fig. 3)

50. (1) Smear a new stationary seal O-ring (74) with Silicone MS.4, XG-250, and position it over the stationary seal ring (75). Fit this sub-assembly into the stationary seal seat (73) in the pump casting.

(2) Lubricate a new rotary seal O-ring (77) with Silicon MS.4, compound XG-250, and position it in the bore groove of the rotary seal ring (76).

(3) Fit a right hand spring (78) over the rotary seal ring, and locate it against the flange of the ring.

(4) Fit the rotary seal sub-assembly over the central embossment of the selected centrifugal impeller (para. 47). Position the impeller and seal sub-assembly over the shaft making sure that the shims (86) previously selected and fitted are included between the impeller and the shaft shoulder.

Assembling the helix casing and impeller helix (fig. 3)

51. (1) Place the inlet shroud fixing plate (109) over the volute studs, position the helix casing (91) and tap it into position with a hide-faced mallet. Tighten securely to the volute studs with six self-locking nuts (106).

(2) Refit the impeller helix (90) and shims (107) locating them over the dowel (88) in the lower face of the centrifugal impeller stem.

(3) Position the lock washer (99) so that the three lugs seat in the three slots machined in the end of the helix (90). Tighten the nut (97) down hard as far as it will go using the special tool SPE. 19875 (fig. 4). Do not bend a lug of the lockwasher to lock the nut at this stage.

Assembling the base bearing (fig. 3)

52. (1) If the plain carbon bearing in the base casting needs replacing the complete sub-assembly (98) must be renewed. If the sub-assembly includes the vapour guide cone (100) this part must be removed before proceeding.

(2) Insert the end of the pump shaft carefully into the carbon bearing and hold the bearing assembly in position with the three fixing feet making flush contact with the helix casting (91).

(3) Using feeler gauges check that the clearance between the underside of the impeller helix (90) and the upper surface of the carbon bearing is as detailed in Table 3. If this clearance is not obtained it will be necessary to remove the shaft nut and impeller helix and increase or decrease the number of shims (107) fitted between the centrifugal and helical impellers. Re-assemble and re-check until correct.

(4) When correct shim thickness has been determined, lock the nut (97) by bending one lug of the washer (99) into a rim slot of the nut. If it is necessary, slacken the nut by the minimum amount necessary to align one lug of the washer with a slot in the nut.

(5) Fit the circular filter assembly (95) in the base bearing casting, retaining the wire locking ring (94) and the external circlip (96).

(6) Replace the vapour guide cone (100) on the three fixing feet forming part of the base bearing housing (98) and secure with three 6BA countersunk head screws (93).

(7) Place a cylindrical filter assembly (92) on the shoulder of the helix casing. Enter the end of the pump shaft carefully into the carbon bearing and secure the base bearing assembly with countersunk-head screws (101 — 2 off: 102 — 1 off) and self-locking nuts (103).

(8) Attach an approved seal (89) to the drilled screw (102).

(9) Refit the inlet shroud (104), securing it to the fixing plate (109) with three Phillip type round-head screws (108).

Fitting the by-pass valve assembly (fig. 3)

53. (1) The flap valve and by-pass casting from the sub-assembly (35) should be secured to the studs (34) of the outlet casting (36) with two 4BA self-locking nuts (33). When fitting check that the flap valve operates freely without sticking and that the valve seat is not damaged. Secure an end gap of the bonding strip (32) under one of the locknuts (33).

Note . . .

On pumps used in fuel transfer positions the by-pass assembly is replaced by the blanking plate (52).

(2) Secure the other end of the bonding strip under the first nut (85) securing the volute plates. When assembled the bonding strip must not project beyond the line of the side of the mounting face.

Motor unit/pump assembly (fig. 3)

Bevel pinion shimming

54. (1) Remove the nut and clamp washer securing the bevel gear or spacer to the pump shaft (66). Using the special extractor tool SPE. 16983 (fig. 7), remove the gear.

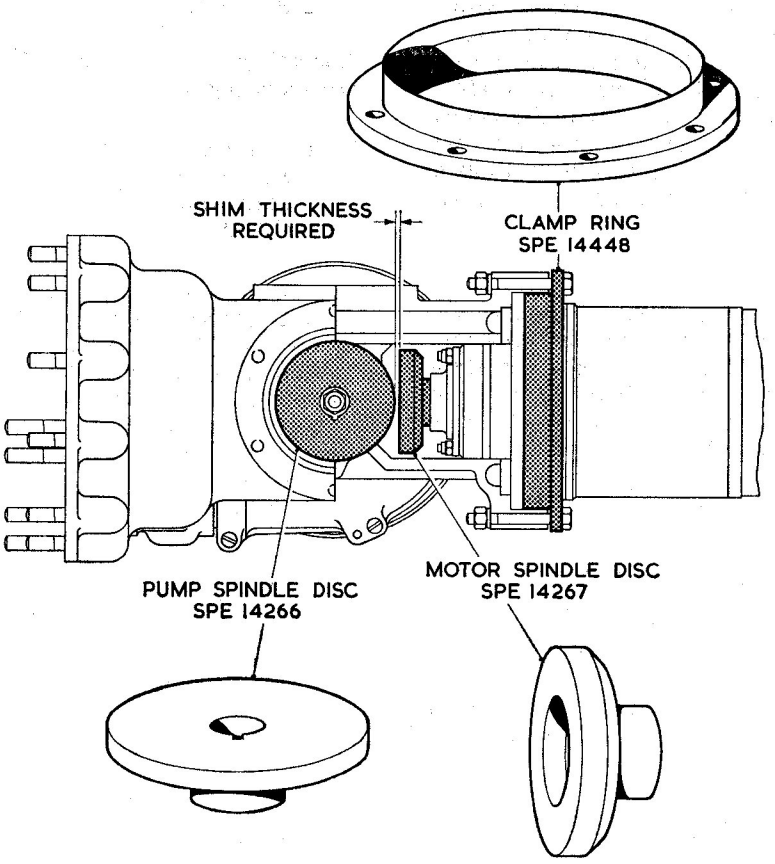


Fig. 18. Tools for shimming the bevel pinion

(2) Fit the special pump shaft disc SPE. 14266 (fig. 18) in place of the removed gear.

(3) Remove the bevel pinion or spacer fitted to the motor unit. Fit the distance piece (142, fig. 10) and key (18). Assemble the special motor shaft disc. SPE. 14267 (fig. 18) and secure.

(4) Locate the motor unit on the dowel in the recessed housing of the pump casting, threading the motor leads into the kidney shaped casting conduit. Secure in position with the special clamping ring SPE. 14448 (fig. 18) and 4BA bolts (23) and nuts (28, fig. 3). Use the latter in four positions only.

Note . . .

To facilitate location of the motor end casing on the pump casting dowel, mark the end casing in line with the dowel hole before inserting.

(5) Using feeler gauges measure the gap between the outer edge of the pump shaft disc and the front face of the motor shaft disc (refer to fig. 18). This is the thickness of shim required for correct assembly of the spiral bevel pinion on the motor shaft.

(6) Remove the motor unit from the pump casting. Unscrew the nut securing the disc to the motor shaft.

(7) Select shims (29, fig. 10) of the required total thickness to correctly position the motor unit. Ensure that these are free of edge burrs before fitting. With the drive key (18) in position, press on the spiral bevel pinion (14). Replace the clamp washer (145) and self-locking nut (15) and securely tighten. Check that the motor unit turns freely and that the pinion is centralised in the bore of the bearing retainer plate (117).

Note . . .

The bevel gear and pinion are supplied as paired components together with a record of their backlash characteristics. Ensure that paired components are built into the same unit and that the backlash record is retained.

Fitting the pump gear (fig. 3)

55. (1) Remove the special pump shaft disc SPE. 14266 (fig. 18) and refit the spiral bevel gear (14, fig. 3) paired with the pinion fitted to the motor unit.

(2) Place the starwheel SPE. 14449 fig. 19) on top of the gear and align it so that one arm is between the markings X-X engraved on two adjacent gear teeth. Secure the starwheel with a 2-B.A. nut.

Assembling the motor unit to the pump unit (fig. 1)

56. (1) Fit a new seal ring (26, fig. 10) in the groove in the motor drive-end casing. Smear with Silicone MS. 4 compound XG-250.

(2) Ease the complete motor unit into the recessed housing of the pump casting, at the same time threading the motor leads into the kidney shaped channel leading to the capacitor chamber. Align the gear and pinion so that the pinion tooth marked X meshes with the gear teeth marked X-X; this alignment being important. Locate the motor on the pump casting dowel.

Note . . .

Align the marks made on the drive-end motor casing and pump casting with the dowel hole and dowel respectively this will facilitate the correct location.

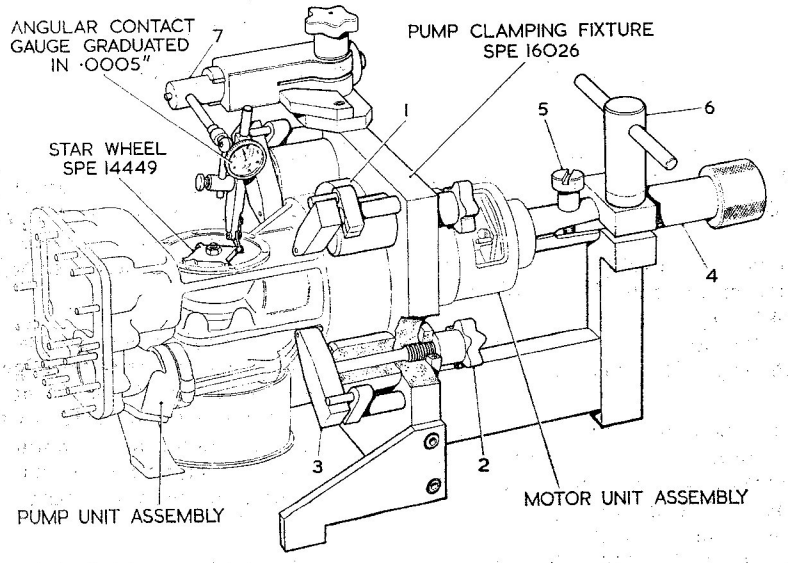


Fig. 19. Tools for checking gear alignment

Gear alignment (refer to fig. 19)

57. (1) Enter the motor unit of the pump/motor unit assembly (para. 54) through the bore of the centre spigot ring SPE. 16026, and clamp securely in position by tightening the thumb nuts (2) and clamps (3). Locate the clamp pins in the pump casing bolt holes.

Note . . .

The motor unit is not secured to the pump unit during this operation and care should be exercised to ensure that the two units are kept in close contact with one another until they are clamped in the fixture.

(2) Clamp the motor shaft nut in the indexing rod (4, fig. 19) by tightening the clamp screw (5).

(3) Fit the angular contact clock gauge (graduated in 0·005 in.) to the fixture shaft.

(4) Set one arm of the starwheel SPE. 14449 in line with the centre line of the motor unit, and locate the ball of the clock gauge in the starwheel.

(5) To prevent any movement of the motor shaft secure the index rod (4, fig. 19) in position by tightening the locking screw (6).

Note . . .

The indexing rod will be freed for each new setting of the starwheel and tightened before readings are taken.

(6) Check that pinion tooth X still meshes with similarly marked gear teeth (para. 54, sub-para. (2)

(7) Take up the backlash between the gears and note whether the reading on the dial gauge indicates that it is (a) within the limits 0·002 in./0·006 in. or (b) in accordance with the first backlash figure quoted on the label supplied with the paired gears built into the pump under check. If the reading is outside the specified limits, remove the starwheel, withdraw the bevel gear using the extractor tool SPE. 16983 (fig. 7) and reduce the thickness of shims (13, fig. 3) fitted. Re-assemble and align the gear and the starwheel, particularly noting the meshing points as in sub-para. (6) of this paragraph. Re-check the backlash. Continue to reduce the thickness of shims until the reading on the dial gauge indicates that the backlash at the starting point is :

(a) within specified limits or

(b) when figures are available, in accordance with the first figure on the label supplied with the paired gears being assembled.

(8) Release the indexing rod, rotate the starwheel through 3 complete revolutions in a clockwise direction, tighten the indexing rod and re-check. The backlash must be within 0·002 in. of the reading at the initial check point. Adjust the shim thickness (13) if outside this limit and re-check at the initial and second position.

Note . . .

Any alteration to the shimming of the bevel gear during any stage of the backlash setting procedure necessitates a complete re-check at all previously completed check points.

(9) Check the backlash at each of the following six positions — after 3, 3, 3, 1/4, 1/4 revolutions of the gear in a clockwise direction. The backlash figures at all light check positions must be within 0·002 in. of one another and within the range 0·002 in./0·006 in.

(10) Remove the starwheel from the pump gear shaft, refit the clamp washer (64) tag washer (67) and nut (65). Holding the gear wheel with the key SPE. 16982 (fig. 7), securely tighten the nut with a box spanner. Lock the tab washer against the flats of the nut.

Gland pressure test

68. Swing the lower tank to its normal operating position and run fuel into the tank by releasing the cock in the gravity feed pipe. Fill the tank to approximately 12 in. over the pump mounting flange. Release the air vent whilst filling the lower tank.

69. Apply air pressure over the fuel at 16 lb/in² set the input supply to the motor at 116V d.c., close the flow regulating valve, and run the pump for 15 mins. Observe for:

(1) External leakage of fuel.

(2) Gland drain leakage. The allowable rate of leakage past the gland is 2 cc per hour with the pump running and 1 cc per hour when it stationary.

Starting test

70. With the fuel still maintained at 12 in. above the mounting flange, adjust the input power supply to the motor to 75V d.c. Close the flow regulating valve and switch on the supply; the pump should start immediately. Check the starting operation of the pump by interrupting the supply several times.

Proof test

71. With a 6 in. head of fuel over the pump inlet, run the pump for 1 hour at each of the conditions detailed in Table 4. The pump should be rejected if any appreciable change is observed other than that caused by the initial warming period of the pump.

TABLE 4

PROOF TEST

Volts d.c.	Pressure lb/in.	Flow gall/hr.	Current consumption amps.
110	10	400 (min.)	2·0 (max.)
116	11	400 (min.)	2·2 (max.)

TABLE 5

CALIBRATION TEST: ACCEPTANCE PERFORMANCE

Volts d.c.	Flow gall/hr.	Pressure lb/in.	Current consumption amps.
116	400	11 (min.)	2·2 (max.)
110	800	7 (min.)	2·1 (max.)
110	400	10 (min.)	2·0 (max.)
100	400	8 (min.)	1·9 (max.)

Calibration test

72. With a 6 in. head of fuel over the pump inlet check the calibration of the pump with the figures quoted in Table 5.

73. After satisfactory completion of the previous tests the pump can be removed from the test rig. Before removing the pump, ensure that the bottom tank has been drained of fuel, the gravity feed cock is closed, and the power supply to the motor switched off.

Dry test

74. With the input power supply to the motor set at 116V d.c. run the motor 'dry' for a period of five minutes. The current consumption during this test should not exceed 1·4A.

Note . . .

The 'dry' test should be made as soon as possible after the previous test. If more than a few hours has elapsed between the two tests immerse the pump in fuel for a few seconds to lubricate the seal faces, to prevent damage to them.

Final insulation resistance test

75. Make a final insulation resistance test as detailed in para. 65.

Wire locking

76. After satisfactory completion of the previous tests, the pump should be locked at the following positions.

(1) Gearbox to pump casting.

(2) Outer motor casing; clamping ring to the top web of the pump casting.

(3) Pump casting to the suppressor chamber cover plate; (already completed).

77. The pump should be sealed during the locking operation and Repair Depots should use their own lead seals for this purpose. Retain the pump pin in a polythene bag or other suitable packing after completion.

TABLE 6

FAULTS, POSSIBLE CAUSES AND REMEDIES

(1) Motor unit (*before or after assembly to the pump unit*)

Fault	Possible cause	Remedy
Sparking at commutator	(a) Brush sticking in brush box.	Clean brush faces and inner surface of brush box. If necessary, rub sides of brush with grade 000 glass paper. Remove minimum amount of carbon to ensure that brush slides easily in box.
	(b) Brush incorrectly bedded.	Re-bed brush as detailed in assembly instructions.
	(c) Broken brush.	If edge is chipped, re-bed or if excessive, fit new brush. Check commutator for high segments which might cause chipping.

TABLE 6 (Continued)

Fault	Possible cause	Remedy
Sparking at commutator (Cont.)	(d) Low brush spring.	Check that springs are locating correctly on the brushes and not off-set on to brush box. Check spring characteristics as detailed in Table 2.
	(e) Dirty commutator.	Clean brushes and commutator with a petrol moistened cloth.
	(f) Brushes too short.	Refer to Table 3 for minimum re-usable length. Rapid wear indicates commutation faults.
	(g) Loose or damaged brush box	Tighten all securing screws. Renew a damaged box.
	(h) Unequal current distribution between brushes.	Check brush connections for tightness.
	(i) Commutator tracked out of true or with mica insulation between segments standing proud of commutator surface.	Remove the armature and diamond turn the commutator. Check concentricity with shaft journals. Refer to Table 2.
	(j) Defective armature winding.	Test armature by voltage drop method. Fit a new armature if fault is discovered.
	(k) High armature current.	May be caused by loose connections, short circuit in armature or an overload.
Chattering brushes	High, low or loose commutator segments, proud micas ridges or flats on commutator.	Dismantle and diamond turn commutator. Refer to Tables 2 and 3.
Overheating	(a) Overload.	Reduce load.
	(b) Low insulation resistance.	Clean thoroughly. Dry windings (Refer to Table 2).
	(c) Faulty field assembly.	Examine leads and connections, for serviceability.
Over-speeding	Weak field.	Examine all connections. Check field assembly. Refer to Table 2. Renew if necessary.
Low torque	(a) Dirty commutator.	Clean commutator and brushes with petrol moistened cloth.
	(b) Open circuit.	Check connections for tightness and cleanliness. Check field coils for continuity.
	(c) Excessive friction.	Test armature for fouling. Check bearings. If fault persists, ascertain cause.

TABLE 6 (Continued)

Fault	Possible cause	Remedy
Motor runs too slowly	(a) Excessive friction.	Refer to Low Torque (c).
	(b) Faulty armature.	Check by voltage drop method.
	(c) Overload.	Reduce load.
Motor fails to start	(a) Overload.	Reduce load.
	(b) No supply.	Check voltage at motor terminals.
	(c) Excessive friction.	Refer to Low Torque (c).
	(d) Short circuit in field assembly.	If windings are damp, dry as detailed in Table 2. If windings are faulty, renew field assembly.
	(e) Open circuit.	Remove armature and check voltage drop method. Check field circuit for continuity.
	(f) Brushes not contacting commutator.	Various : See Sparking at commutator (a), (c), (d), (f) and (g).
(2) Complete pump assembly		
Gland leakage	(a) Bad finish between gland seal faces.	Dismantle pump and relap gland seal faces.
	(b) Insufficient pressure between gland seal faces.	Reduce thickness of shims (86) fitted, maintaining impeller/volute clearance within limits specified in Table 2.
Excessive current consumption	(a) Excessive loading on bellows gland.	Increase thickness of shims (86) maintaining impeller/volute clearance within limits specified in Table 2.
	(b) Faulty motor unit.	Refer to section (1), motor unit.
	(c) Fouling of impeller by foreign matter.	Examine pump unit and check for obstruction. Check that impeller is not fouling the volute or helix casing. If components are undamaged, clean and re-assemble.

TABLE 6 (Continued)

Fault	Possible cause	Remedy
Low delivery pressure	Faulty motor.	Refer to section (1), motor unit.
Pressure surge	(a) Excessive loading on bellows gland.	Refer to notes on excessive current.
	(b) Tight or pre-loaded bearings.	Dismantle. Check fits and ease or replace as necessary. Refer to section (1), motor unit.
Low or fluctuating amps.	(a) Impeller impedance.	Check for obstruction. Check clearances.
	(b) Faulty motor unit.	Refer to section (1), motor unit.
Very high current consumption	Short circuit.	Refer to section (1), motor unit.
High noise factor	Faulty gear meshing.	Dismantle and examine gears. Whether original or new gears are fitted, position and check backlash as detailed in assembly instructions.

Appendix 1

RECONDITIONING SPE. 404 Mk. 1D and 1E FUEL PUMPS

LIST OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

General

1. This appendix details the differences in the dismantling and reassembly procedure for the SPE. 404 Mk. 1D and 1E fuel pump as compared with that given for SPE. 404 Mk. 1G pump in the basic chapter. Full details of the differences between the various SPE. 404 series pumps are given in A.P.4343D, Vol. 1, Book 2, Sect. 8, Chap. 8. It should be noted that although instructions are given for repairing the Mk. 1D and 1E pump to their original standard, all retrospective modifications should be incorporated when the unit is rebuilt.

TABLE 1

SPECIAL TOOLS AND EQUIPMENT

Nomenclature		Part No.	Fig. No.	Ref. No.
* Hand press		SPE. 10143		
Driver for pump shaft nut		SPE. 13831	App. 1, Fig. 4	
* Helix casing extractor		SPE. 14450	5	
* Impeller extractor		SPE. 17339	6	
* Bevel gear holding key (Mk. 1E)		SPE. 16982	7	
* Bevel gear extractor (Mk. 1E)		SPE. 16983	17	
Bevel gear holding key (Mk. 1D)		SPE. 14666	App. 1, Fig. 5	
Bevel gear extractor (Mk. 1D)		SPE. 14271	App. 1, Fig. 5	
Punch	Metallic bellows gland extractor	SPE. 10785	App. 1, Fig. 6	
Guide bush		SPE. 10784	App. 1, Fig. 6	
Base		SPE. 10783	App. 1, Fig. 6	
Base plate		SPE. 10766	App. 1, Fig. 6	
* Holding key		SPE. 14268	11	
* Motor bearing holding block		SPE. 14270	11	
* Locking ring spanner		SPE. 14257	11	
* Motor pinion extractor		SPE. 14667	12	
* Setting brush	determining geometric neutral axis	SPE. 16333	13	
* Setting brush and locking device		SPE. 16334	13	
Spigot	Bellows gland pre-assembly	SPE. 14709	App. 1, Fig. 7	
Locking ring		SPE. 14708	App. 1, Fig. 7	
Collar	Bellows gland positioning	SPE. 14710	App. 1, Fig. 8	
Adaptor		SPE. 14711	App. 1, Fig. 8	
* Impeller positioning spacer shim		SPE. 10786/A	17	
* Pump shaft disc	Bevel pinion shimming	SPE. 14266	18	
* Motor shaft disc		SPE. 14267	18	
* Clamping ring		SPE. 14448	18	
* Starwheel	Backlash check	SPE. 14449	19	
* Gear alignment checking fixture		SPE. 16026	19	
* Blanking plate	Pressure test fixture	SPE. 16997	20	
* Blanking plate gasket		SPE. 16998	20	
Calibration Fan		SPE. 14451		

Note.—*Tools marked * are common to Mk. 1G*

RECONDITIONING

Tools and test equipment

2. In addition to the standard bench tools, the special tools listed in Table 1, or their equivalents, are required to overhaul type SPE. 404 Mk. 1D and 1E fuel pumps. Tools marked with an asterisk are common to the Mk. 1G pump. The universal fuel pump test rig should be used to test these pumps and reference should be made to para. 2 of main chapter.

DISMANTLING

Detailed procedure

3. Where no details are given under the stage headings in the following breakdown, refer to the equivalent paragraph in the dismantling instructions for the SPE. 404 Mk. 1G pump given in the basic chapter. Refer to App. 1, Fig. 3 for all pump unit parts, and to Fig. 10 of the basic chapter for motor unit components.

(1) General.

(2) Disconnecting the electrical connection.

(3) Removing the suppression units.

(4) Separating the motor and pump units.

(5) Dismantling the pump unit. Generally as for Mk. 1G but cover (53 — App. 1, fig. 3) and separate gasket (55) are fitted in place of the cover with integral bonded gasket.

(6) Removing the inlet shroud and base bearing assembly.

(7) Dismantling the base bearing assembly.

(8) Removing the by-pass casting assembly.

(9) Withdrawing the helix.

(a) Use the special driver SPE.13831 (App. 1, fig. 4) to remove the circular nut (113) and shakeproof washer (114) securing the impeller helix (90A) to the pump shaft.

(b) Withdraw the helix together with any adjusting shims fitted.

(10) Withdrawing the centrifugal impeller. Generally as for Mk. 1G but the impeller assembly (87A) is of different design, incorporating the carbon seating for use with a metallic bellows type gland.

(11) Removing the bevel gear. For Mk. 1E pumps, the procedure is as detailed for Mk. 1G pumps in the basic chapter. For Mk. 1D pumps proceed as follows :—

(a) Locate the special tool SPE. 14666 (App. 1, fig. 5) in two of the six holes in the face of the spiral bevel gear (54) and with a suitable spanner remove the self-locking nut (65A) and withdraw the clamp washer (64).

(b) Remove the bevel gear using the extractor tool SPE. 14271 (App. 1, fig. 5). Insert the two arms of the tool through two holes in the top surface of the gear, twist slightly to engage the tool, and withdraw the gear by tightening the central stud on to the end of the pump shaft.

Note . . .

Identify the removed gear with the pinion of the motor unit. It is recommended that a new set of gears should be fitted at each servicing of the pump. If however, it is intended to refit the original gear, it must be re-used with the pinion of the motor assembly removed from the pump unit.

(12) Removing the upper bearing housing. Generally as for the Mk. 1G but shaft (66A) is of different design.

(13) Removing the volute assembly.

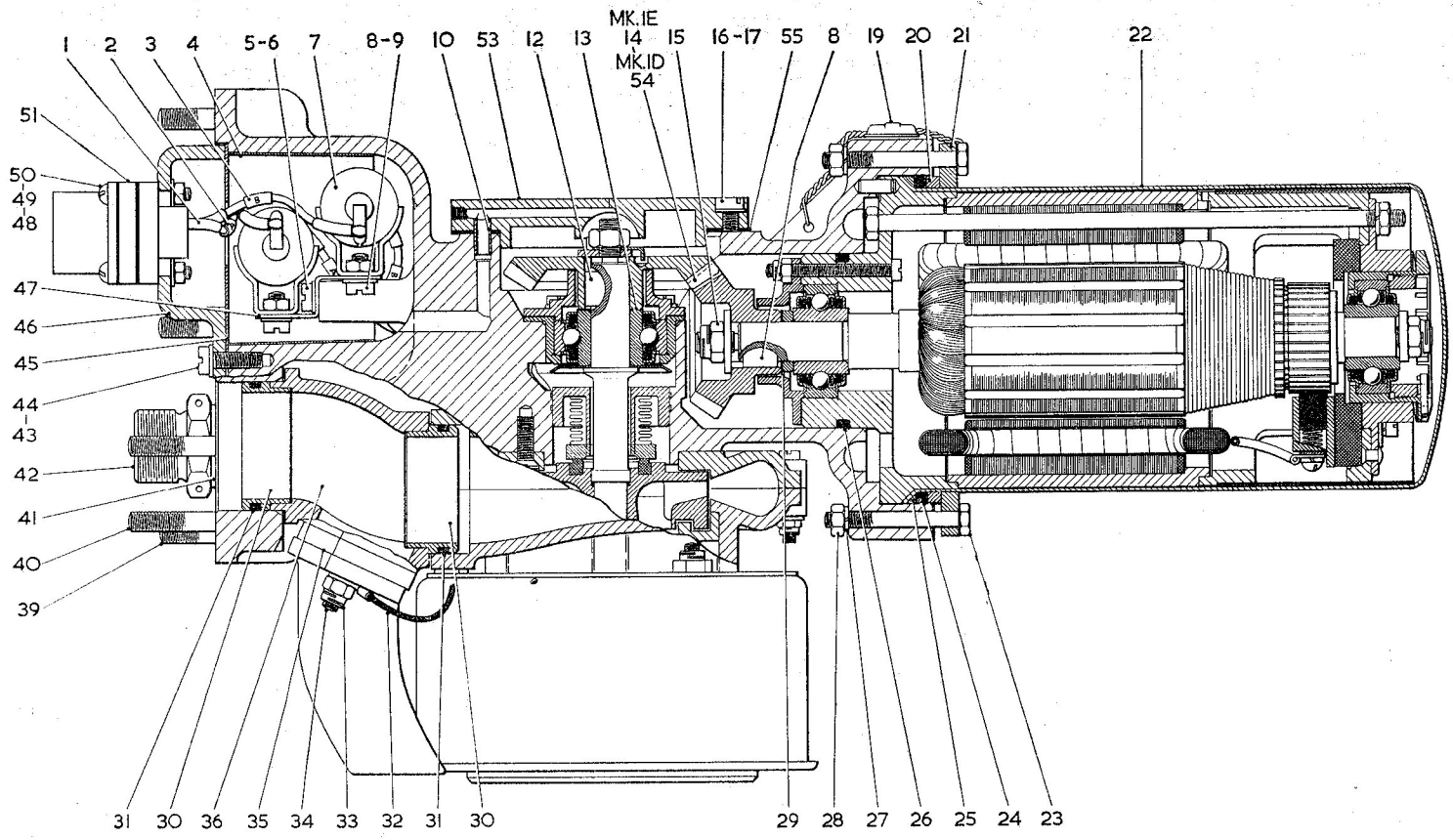


Fig. 1. Sectional view of pump/motor assembly (SPE. 404 Mk. 1D and 1E)

Key to fig. 1

1 RUBBER SLEEVE (¾ IN.)
2 IDENTIFICATION SLEEVE 'A'
3 IDENTIFICATION SLEEVE 'B'
4 INSULATING PAPER
5 CH.-HD. SCREW } CAPACITOR BRACKET
6 SHAKEPROOF WASHER } SECURING
7 CAPACITOR
8 CH.-HD. SCREW } CAPACITOR TO
9 SHAKEPROOF WASHER } BRACKET FIXING
10 SPRING DOWEL
12 DRIVE KEY (GEAR)
13 ADJUSTING SHIM (GEAR)
14 GEAR & PINION (PAIRED COMPONENTS)
15 SELF-LOCKING THIN NUT
16 CH.-HD. SCREW } GEAR BOX COVER
17 SHAKEPROOF WASHER } SECURING
18 DRIVE KEY (PINION)
19 SEAL
20 SEAL SEATING RING
21 CLAMPING BOLT RING
22 OUTER CASING
23 HX.-HD. BOLT. OUTER CASING CLAMPING
24 RUBBER SEALING RING
25 INNER SEAL RING
26 MOTOR SEALING RING
27 SPRING WASHER } OUTER CASING
28 NUT } CLAMPING
29 ADJUSTING SHIM (PINION)
30 DELIVERY OUTLET SLEEVE
31 RUBBER JOINT RING
32 BONDING STRIP
33 SELF LOCKING NUT } DELIVERY OUTLET/
34 STUD } BY-PASS FIXING
35 FLAP VALVE & BY-PASS ASSEMBLY
36 DELIVERY OUTLET CASTING
39 STUD (SHORT)
40 STUD (LONG)
41 UNION JOINTING WASHER
42 GLAND DRAIN UNION
43 CH.-HD. SCREW } COVER PLATE
44 SHAKEPROOF WASHER } SECURING
45 COVER PLATE GASKET
46 COVER PLATE ASSEMBLY
47 CAPACITOR BRACKET
48 RD.-HD. SCREW } ELECTRICAL
49 SHAKEPROOF WASHER } CONNECTION SECURING
50 NUT
51 ELECTRICAL CONNECTION
52 BLANKING PLATE (not illustrated)
53 GEAR BOX COVER ASSEMBLY
54 GEAR & PINION (PAIRED COMPONENTS) — Mk. 1D only
55 GEAR BOX COVER GASKET

(14) Dismantling the outlet casting.

(15) Extracting the metallic bellows type gland.

(a) Pre-heat the pump casting to 125-150°C. Using the tools illustrated in App. 1, Fig. 6, press the gland (112) out of the pump casting (111-Mk. 1D, 111A-Mk. 1E).

(b) Remove the gland drain union body (42) and washer (41) to complete the dismantling of the pump unit.

Dismantling the motor unit

(16) Disconnecting the brushes.

(17) Withdrawing the motor unit tie-bolts.

(18) Separating the motor end castings.

(19) Dismantling the commutator end motor casting sub-assembly. Generally as for Mk. 1G but the brush box assembly is used without a rivet insulator plate.

(20) Removing the bevel pinion and drive-end bearing. Generally as for Mk. 1G but the Mk. 1D is fitted with bevel pinion (54) in place of (14).

CLEANING, EXAMINATION AND REPAIR

General

4. All instructions in basic chapter are applicable to the Mk. 1D and Mk. 1E pump with the exception of those relating to the mechanical seal. Additional inspection and repair tolerances to be noted are detailed in the Tables 2 and 3 of this appendix.

ASSEMBLING

Detailed procedure

5. Where no details are given under the stage headings in the following assembly sequence, refer to the equivalent paragraph in the assembly instructions for the SPE.404 Mk. 1G pump given in the basic chapter.

(1) Assembling the drive-end casing.

(2) Assembling the commutator-end bearing.

(3) Assembling the commutator-end

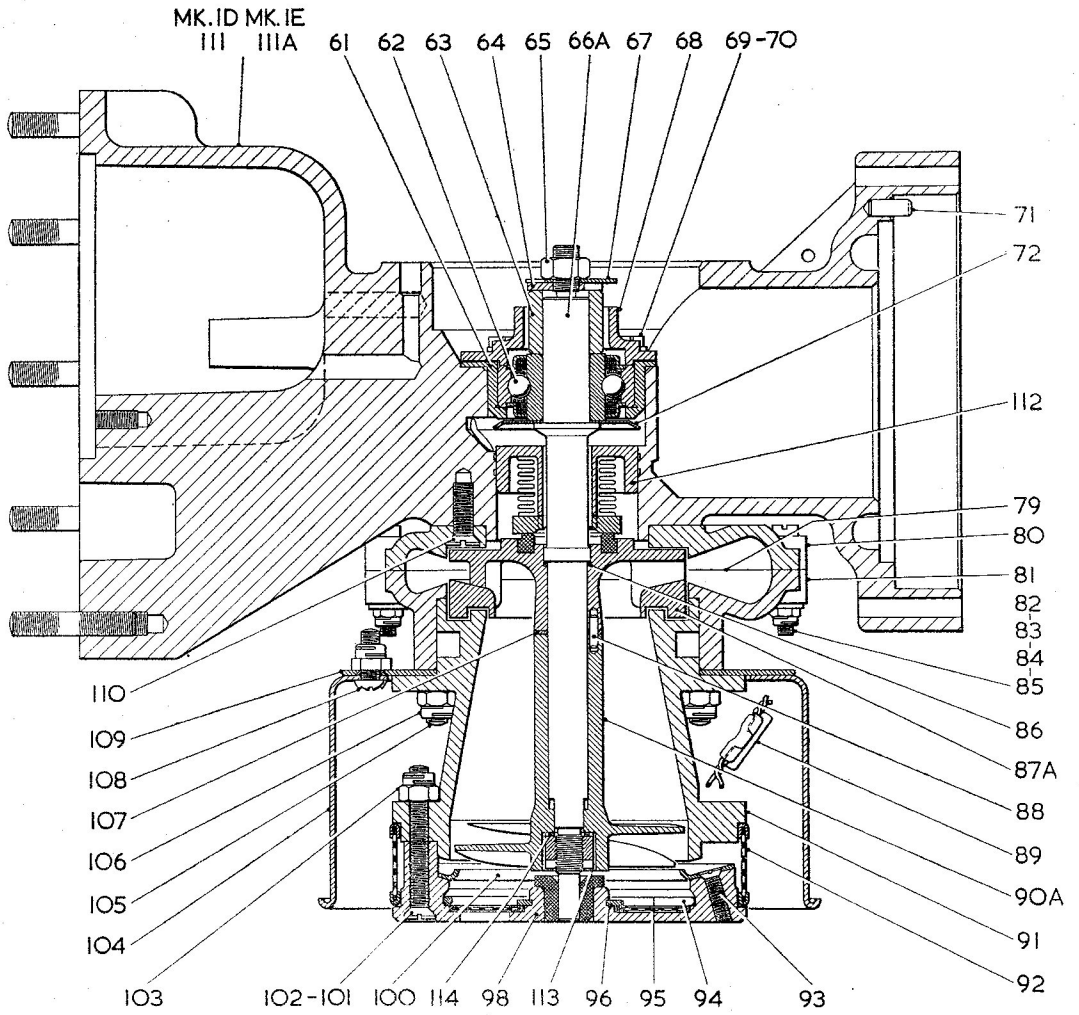


Fig. 2. Sectional view of pump assembly (SPE. 404 Mk. 1D and 1E)

casing. Generally as for Mk. 1G but no brush box rivet insulator (121, fig. 3) is fitted. The brush box assembly with a thicker carrier plate is used in place of (120).

(4) Assembling the motor end casing sub-assemblies. Generally as for Mk. 1G but no alignment hole and slot in the end casing and stator assembly respectively.

(5) Pre-bedding the brushes.

(6) Determining the brush gear geometric neutral axis. The procedure is the same as that described in the main chapter but the motor speed is set by retarding the brush gear 30 ± 2 degrees from its geometric neutral axis.

(7) Retarding the brush gear. The procedure as detailed for Mk. 1G but the brush gear is to be retarded 30 ± 2 degrees — that is 20 degrees after refitting the tie-bolts. Using a dynometer apply a torque loading of 21 oz. ins. to the motor unit. Run the motor unit under load for 30 minutes at 110V d.c. and then check the motor speed (8700

Key to Fig. 2

61 BEARING HOUSING
62 BALL BEARING
63 DISTANCE PIECE
64 CLAMP WASHER
65 NUT
66A PUMP SHAFT
67 SPECIAL TAB WASHER
68 BEARING RETAINING PLATE
69 CH.-HD. SCREW } BEARING RETAINING
70 SPRING WASHER } PLATE SECURING
71 MOTOR LOCATING DOWEL
72 SLINGER
79 VOLUTE ASSEMBLY
80 UPPER VOLUTE CASTING
81 LOWER VOLUTE CASTING
82 DOWEL PIN
83 CH.-HD. SCREW } UPPER/LOWER VOLUTE CASTING LOCATING
84 WASHER
85 SELF LOCKING NUT } AND CLAMPING
86 IMPELLER SEAL WASHER/SHIM
87A IMPELLER/CARBON SEAL SEAT ASSEMBLY
88 IMPELLER/HELIX LOCATING DOWEL
89 SEAL
90A IMPELLER HELIX
91 HELIX CASING
92 FILTER ASSEMBLY (CYLINDRICAL)
93 CSK.-HD. SCREW VAPOUR GUIDE CONE FIXING
94 CIRCLIP FILTER RETAINING (OUTER)
95 FILTER ASSEMBLY (FLAT)
96 CIRCLIP FILTER RETAINING (INNER)
98 BASE BEARING SUB-ASSEMBLY
100 VAPOUR GUIDE CONE
101 CSK.-HD. SCREW } BASE ASSEMBLY/
102 SPECIAL CSK.-HD. SCREW } HELIX CASING FIXING
103 SELF LOCKING NUT
104 INLET SHROUD
105 STUD } VOLUTE ASSEMBLY/
106 SELF LOCKING NUT } HELIX CASING FIXING
107 HELIX ADJUSTING SHIM
108 'PHILIPS' RD.-HD. SCREW INLET SHROUD SECURING
109 INLET SHROUD FIXING PLATE ASSEMBLY
110 CSK.-HD. SCREW VOLUTE ASSEMBLY SECURING
111 PUMP CASTING (Mk. 1D only)
111A PUMP CASTING (Mk. 1E only)
112 METALLIC BELLOWS GLAND ASSEMBLY
113 HELIX LOCKNUT
114 SHAKEPROOF WASHER

rev./min. minimum) with a stroboscope. Check the current consumption, which must not exceed 2·2 amps. Adjustment of the brush box position is permissible to the extent of ±2 degrees. Set the dividers to 1·0 mm. and scribe a line at this distance on each side of the point F on the brush box carrier. Adjustment of the brush box position is permissible such that the scribed line representing 20 degrees retardation on the end casing is always between these two points. Reject the motor if adjustment is necessary outside these limits.

(8) Pump casting sub-assembly.

(a) Place a new metallic bellows gland (112) in the fixture illustration in App. 1, Fig. 7. Secure with the locking ring (SPE. 14708).

(b) Pre-heat the pump casting (111-Mk. 1D, 111A-Mk. 1E, app. 1, fig. 3) to between 125 and 150°C. Smear the shroud of the bellows unit with 'Well-seal' jointing. Insert the bellows unit into the pump casting using the tools illustrated in App. 1, Fig. 8 in the hand press SPE. 10143. Turn the handle of the press to the limit of its travel as determined by the tooling to correctly position the gland in the casting.

(9) Assembling the volute.

(10) Assembling the delivery outlet.

(11) Assembling the volute assembly to the pump casting.

(12) Assembling the upper bearing and pump shaft. Generally as for the Mk. 1G but the pump shaft is of different design to suit the bellows gland.

(13) Shimming the centrifugal impeller. Generally as for the Mk. 1G pump but the impeller incorporates a carbon gland seating (87A) in place of (87, fig. 3).

(14) Assembling the helix casing and impeller. Use impeller helix (90A, app. 1, fig. 3) in place of (90, fig. 3). Use a shakeproof washer (114, app. 1, fig. 3) and the round nut (113) to secure the helix. Tighten the nut with the special driver SPE. 13831 (app. 1, fig. 4).

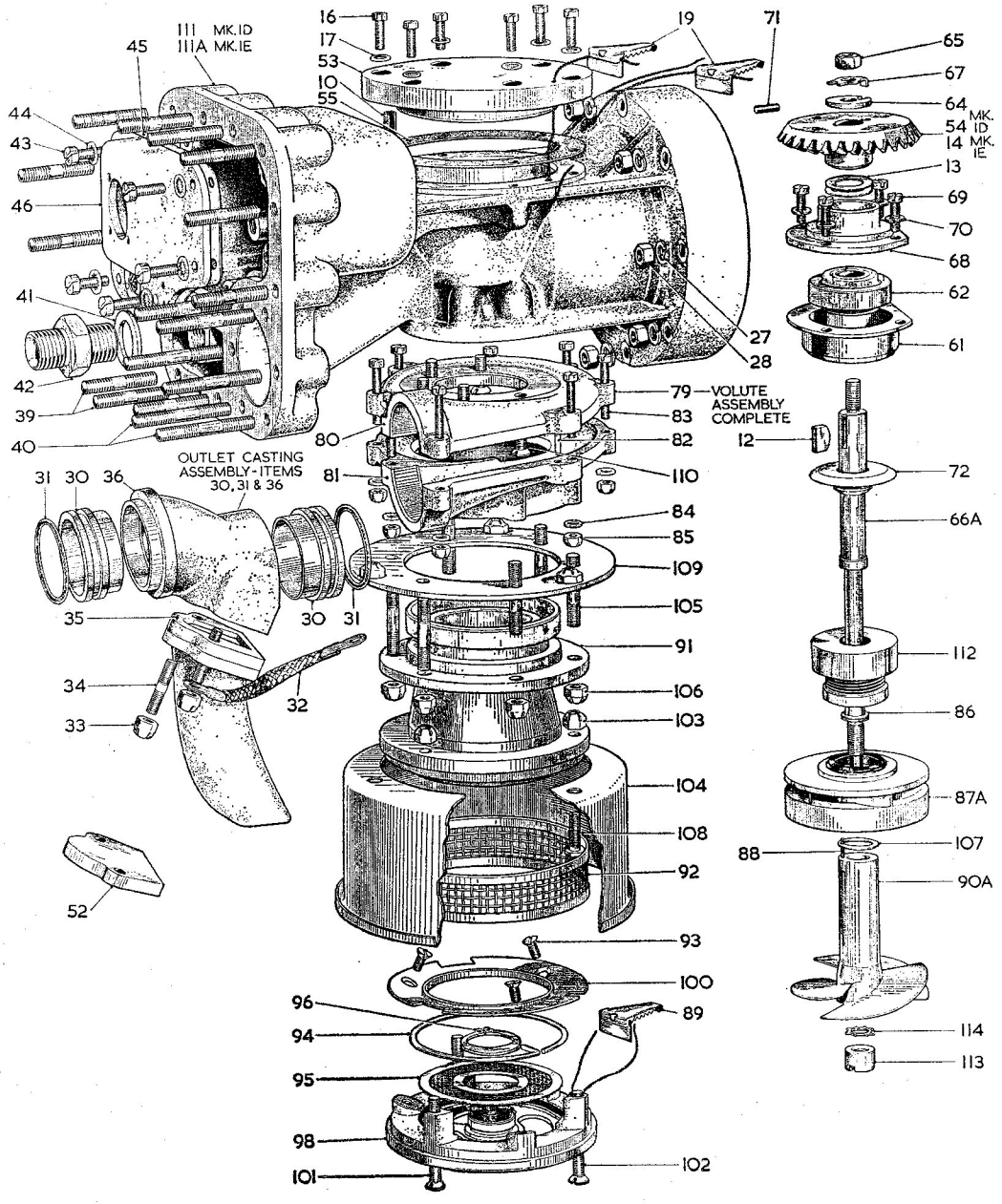


Fig. 3. Exploded view of pump unit (SPE. 404 Mk. 1D and 1E)

Key to Fig. 3

10 SPRING DOWEL
12 DRIVE KEY (GEAR)
13 ADJUSTING SHIM (GEAR)
14 GEAR AND PINION (PAIRED COMPONENTS) — Mk. 1E only
16 CH.-HD. SCREW } GEAR BOX COVER
17 SHAKEPROOF WASHER } SECURING
19 SEAL
27 SPRING WASHER } OUTER CASING
28 NUT } CLAMPING
30 DELIVERY OUTLET SLEEVE
31 RUBBER JOINT RING
32 BONDING CLIP
33 SELF LOCKING NUT } DELIVERY OUTLET/
34 STUD } BY-PASS FIXING
35 FLAP VALVE AND BY-PASS ASSEMBLY
36 DELIVERY OUTLET CASTING
39 STUD (SHORT)
40 STUD (LONG)
41 UNION JOINTING WASHER
42 GLAND DRAIN UNION
43 CH.-HD. SCREW } COVER PLATE
44 SHAKEPROOF WASHER } FIXING
45 COVER PLATE GASKET
46 COVER PLATE ASSEMBLY
52 BLANKING PLATE (ALTERNATIVE TO ITEM 35)
53 GEAR BOX COVER ASSEMBLY
54 GEAR AND PINION (PAIRED COMPONENTS) Mk. 1F only
55 GEAR BOX COVER GASKET
61 BEARING HOUSING
62 BALL BEARING
63 DISTANCE PIECE
64 CLAMP WASHER
65 NUT
66A PUMP SHAFT
67 SPECIAL TAB WASHER
68 BEARING RETAINING PLATE
69 CH.-HD. SCREW } BEARING RETAINING
70 SPRING WASHER } PLATE SECURING
71 MOTOR LOCATING DOWEL
72 SLINGER
79 VOLUTE ASSEMBLY
80 UPPER VOLUTE CASTING
81 LOWER VOLUTE CASTING
82 DOWEL PIN } UPPER/LOWER VOLUTE
83 CH.-HD. SCREW } CASTING LOCATING
84 WASHER } AND CLAMPING
85 SELF LOCKING NUT } AND CLAMPING
86 IMPELLER/SEAL WASHER/SHIM
87A IMPELLER/CARBON SEAL SEAT ASSEMBLY
88 IMPELLER/HELIX LOCATING DOWEL
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112 METALLIC BELLOWS GLAND ASSEMBLY
113 HELIX LOCKNUT
114 SHAKEPROOF WASHER

TABLE 2

DETAILED EXAMINATION OF COMPONENTS

Item	Examination	Action if faulty
Metallic bellows gland	Scoring of seal face.	If slight, relap to a mirrow finish. If excessive, renew gland.
	Damage to bellows convolutions.	Renew assembly.
		Note . . . *It is recommended that whenever possible, the metallic bellows gland should be renewed at each overhaul of the pump.*

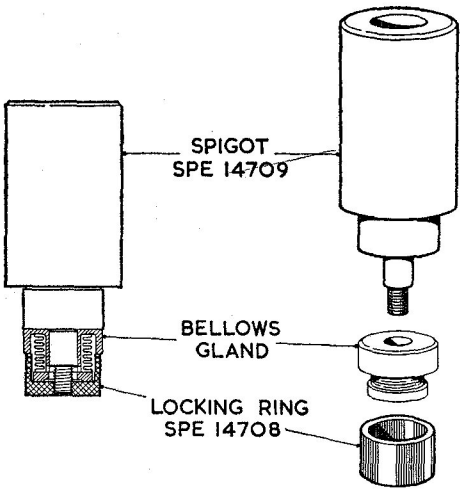

Fig. 7. Tools for pre-assembling the bellows gland

Proof test

7. With a 6 in. head of fuel over the pump inlet, run the pump for 1-hour at each of the conditions detailed in Table 4 of this appendix.

Calibration test

8. With a 6 in. head of fuel over the pump inlet, check the calibration of the pump with the figures quoted in Table 5 of this appendix.

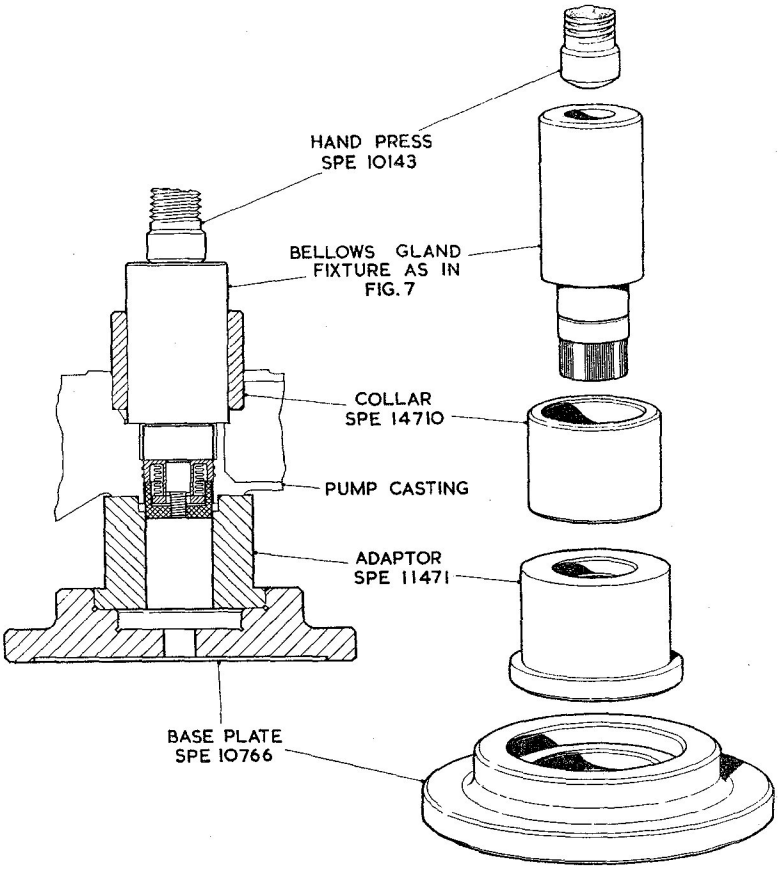

Fig. 8. Tools for positioning the bellows gland

Note—*Adaptor SPE* 11471 *should read SPE* 14711

TABLE 4

PROOF TEST

Volts d.c.	Pressure lb/in.	Flow gall/hr.	Current consumption amps.
110	11	400 (min.)	2·2 (max.)
116	12	400 (min.)	2·4 (max.)

TABLE 5

CALIBRATION TEST: ACCEPTANCE PERFORMANCE

Volts d.c.	Pressure lb/in.	Flow gall/hr.	Current consumption amps.
116	400	12 (min.)	2·4 (max.)
110	800	8 (min.)	2·3 (max.)
110	400	11 (min.)	2·2 (max.)
100	400	9 (min.)	2·1 (max.)

Appendix 2

RECONDITIONING SPE. 404 Mk. 1F FUEL PUMPS

LIST OF CONTENTS

LIST OF TABLES

General

1. This appendix details the differences in the dismantling and re-assembly procedure for the SPE. 404 Mk. 1F fuel pump as compared with that given for SPE. 404 Mk. 1G pumps in the basic chapter. Full details of the differences between the various SPE. 404 series pumps are given in A.P.4343D, Vol. 1, Book 2, Sect. 8, Chapter 8. It should be noted that although instructions are given for repairing the Mk. 1F pumps to their original standard, all retrospective modifications should be incorporated when the unit is rebuilt.

RECONDITIONING

Tools and test equipment

2. In addition to the standard bench tools, the special tools listed in Appendix 1, Table 1 are also required to overhaul SPE. 404 Mk. 1F units. The universal fuel pump test rig should be used to test these pumps and reference should be made to para. 2 of the main chapter.

DISMANTLING

Detailed procedure

3. The instructions given in Appendix 1 for Mk. 1E fuel pumps are applicable throughout to the Mk. 1F pump, with the exception that the latter is fitted with a rivet insulator plate (121, fig. 10) behind the brush box carrier of the motor unit (refer to app. 1, para. 3).

CLEANING, EXAMINATION AND REPAIR

General

4. All instructions in the basic chapter are applicable to the Mk. 1F pump with the exception of those relating to the mechanical

seal. The Mk. 1F pump is fitted with a metallic bellows type gland and the additional inspection and repair tolerances listed in Appendix 1, Tables 2 and 3 should be noted.

ASSEMBLING

Detailed procedure

5. Where no details are given under the stage headings in the following assembly sequence, refer to the equivalent paragraph in the assembly instructions for the SPE. 404 Mk. 1G pump given in the basic chapter.

(1) Assembling the drive-end motor casing.

(2) Assembling the commutator-end bearing.

(3) Assembling the commutator-end motor casing.

(4) Assembling the motor end casing sub-assemblies.

(5) Pre-bedding the brushes.

(6) Determining the brush gear geometric neutral axis.

(7) Retarding the brush gear.

(8) Pump casting sub-assembly.

(a) Place a new metallic bellows gland (112, app. 1, fig. 3) in the fixture illustrated in App. 1, Fig. 7. Secure with the locking ring (SPE. 14708).

(b) Pre-heat the pump casting (111A) to between 125 and 150°C. Smear the shroud of the bellows gland with Wellseal jointing compound and press the gland into the pump casting using the tools illustrated in App. 1, Fig. 8 in the hand press SPE. 10143. Turn the handle of the press to the limit of its travel as determined by the tooling to correctly position the gland in the casting.

(9) Assembling the volute.

(10) Assembling the delivery outlet.

(11) Assembling the volute assembly to the pump casting.

(12) Assembling the upper bearing and pump shaft. Generally as for the Mk. 1G but the pump shaft is of different design to suit the bellows type gland.

(13) Shimming the centrifugal impeller. Generally as for the Mk. 1G pump but an impeller assembly incorporating a carbon gland seating is fitted in place of (87, fig. 3).

(14) Assembling the helix casting and impeller helix. Use the impeller helix (90A, app. 1, fig. 3) in place of (90, fig. 3). Use the shakeproof washer (114, app. 1, fig. 3) and the round nut (115) to secure the helix. Tighten the nut with the special driver SPE. 13831 (app. 1, fig. 4).

(15) Assembling the base bearing. Generally as for the Mk. 1G pump but use the round nut (113) and shakeproof washer (114) to secure the helix.

(16) Fitting the by-pass valve assembly.

(17) Bevel pinion shimming.

(18) Fitting the pump gear.

(19) Assembling the motor unit to the pump unit.

(20) Gear alignment.

(21) Assembling the outer motor casing.

(22) Completing the gear box assembly. Generally as for the Mk. 1G pump but use the gear box cover (53) and separate gasket (55) in place of the gear box cover with integral gasket. Do not use jointing compound on the gasket.

(23) Pressure testing the pump assembly.

(24) Fitting the radio interference suppressors.

(25) Fitting the electrical connection.

TESTING

General

6. The complete schedule of tests for the SPE. 404 Mk. 1F are the same as those for the SPE. 404 Mk. 1G, given in the main chapter, with the exception of the test given in Table 1.

TABLE 1

ACCEPTANCE PERFORMANCE: PROOF AND CALIBRATION TESTS

Volts d.c.	Flow gall/hr.	Delivery Pressure lb/in.	Current consumption amps.
116	400	11·0 (min.)	2·2 (max.)
110	800	7·0 (min.)	2·1 (max.)
110	400	10·0 (min.)	2·0 (max.)
100	400	8·0 (min.)	1·9 (max.)

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