

## Chapter 2

### SERVICING AND MINOR REPAIRS

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#### INTRODUCTION

1. It is important that the starter generally and the breech in particular be kept perfectly clean. Only approved oil and greases should be used, and the following instructions regarding servicing strictly adhered to.

#### BREECH

2. The breech should be wiped occasionally with a piece of clean non-fluffy rag moistened with a light lubricating oil OM-170. The breech sealing piston should be lubricated regularly at every breech reloading period of five cartridges. This is effected by one full turn of the hexagon-headed grease container (Stauffer type lubricator). The grease container, accessible near the breech loading door, should be packed with high temperature grease XG-270 or grease XG-271, which is conveyed to the sealing piston cylinder by a small diameter pipe.

#### STARTER

3. As the starter is packed with lubricant during assembly, little maintenance is required during its period of service, apart from an occasional wipe down with a clean oily rag.

4. A periodical check must be made to ensure that the air vent holes ((4), fig. 1) are kept clear to allow efficient ventilation of the starter body.

#### SAFETY DISC REPLACEMENT

5. Ensure that the starter breech does not contain a live cartridge. Cut the locking wire between the safety disc holder and the exhaust tube locating stub.

#### Note . . .

*Care must be taken to remove all pieces of wire as any loose portions of locking wire may be drawn into the air intake when the engine is started.*

6. The safety disc is located in a hexagon-headed holder which screws into the combustion chamber. The disc for use with this starter is K.1908. The part number is marked on each disc, and no other disc may be used unless it has been officially approved.

7. To fit a new disc, unscrew the holder, making certain that both portions of the old disc are removed, place the new disc in the holder, and screw the holder firmly into place in the combustion chamber, and wire-lock the hexagon head of the holder to the starter exhaust tube locating stub.

#### Note . . .

*If the safety disc shears, do not attempt to use the starter until a new disc has been fitted.*

8. Ensure that the locking wire, which connects the safety disc holder head to the starter exhaust pipe stub on the combustion chamber, is renewed each time that the disc is changed. Use non-corrodible locking wire of 22 S.W.G. (Stores Ref. 30A/3055).

#### DECARBONIZING

#### General

9. This servicing should be carried out at periods specified in the appropriate aircraft Servicing Schedule, the object being to decarbonize and clean the interior of the starter. In this instance,

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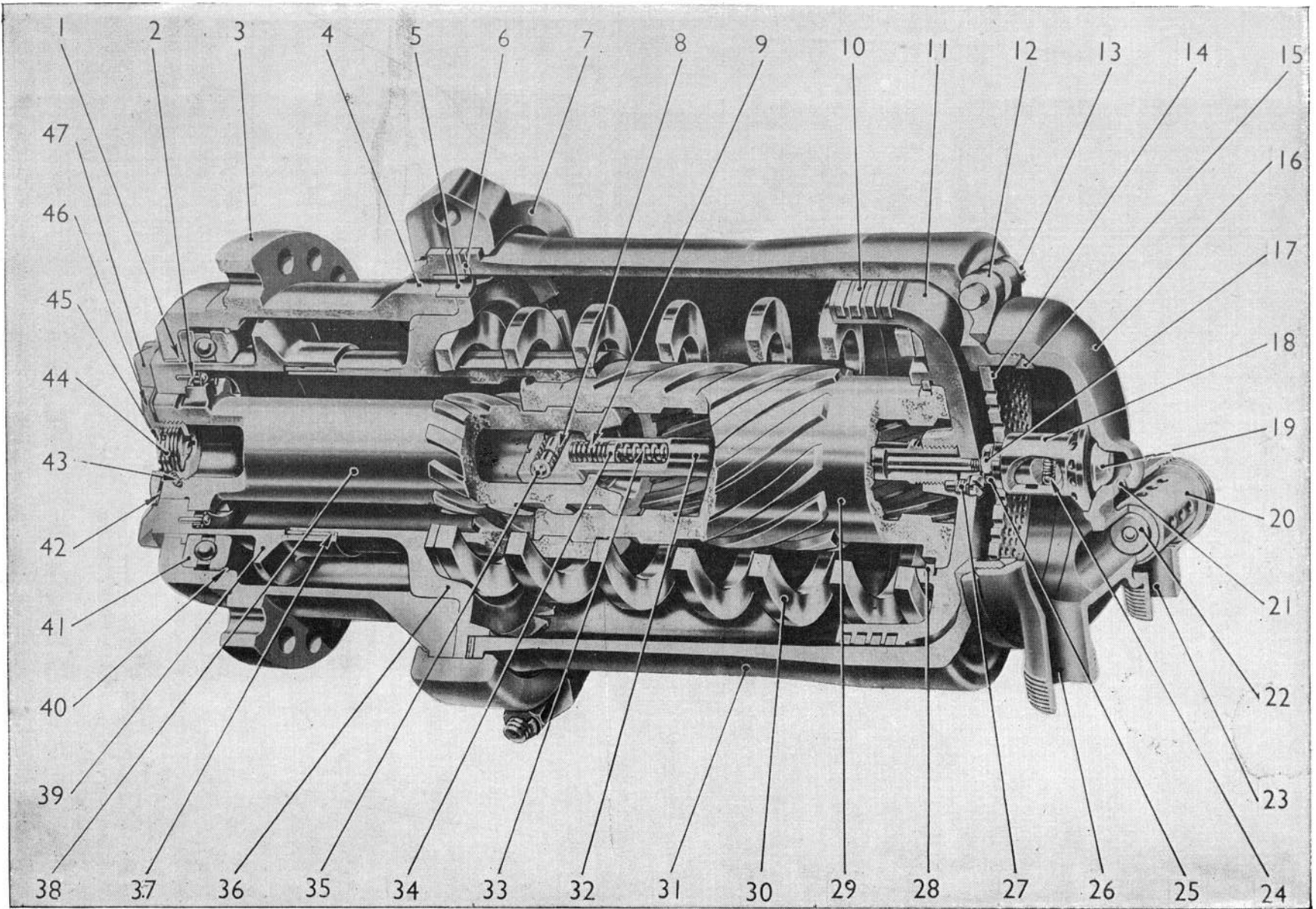


Fig. 1. Starter unit

**KEY TO FIG. 1**

- 1 BRONZE BUSH
- 2 CLUTCH SPRING
- 3 HOUSING
- 4 VENT HOLE
- 5 HOLLOW DOWEL
- 6 SHIM
- 7 SPLIT CLAMP RING
- 8 PLUNGER SPRING
- 9 SPRING
- 10 PISTON RING
- 11 PISTON
- 12 V-SECTION LOCKING RING
- 13 LOCK SCREW
- 14 PERFORATED DISC
- 15 SEALING RING
- 16 COMBUSTION CHAMBER
- 17 LOCK-NUT
- 18 VALVE HOUSING
- 19 EXHAUST VALVE
- 20 SAFETY DISC HOUSING
- 21 GAS PASSAGE
- 22 SAFETY DISC
- 23 EXHAUST PORT
- 24 BALL AND SPRING ASSEMBLY
- 25 SPECIAL TAB-WASHER
- 26 INLET PORT
- 27 DOWELLED LOCKING SCREW
- 28 SPLIT RING
- 29 INTERNALLY AND EXTERNALLY SPLINED SHAFT
- 30 MAIN SPRING
- 31 CYLINDER
- 32 CLUTCH JAW BOLT
- 33 SPRING
- 34 VALVE ROD
- 35 PLUNGER
- 36 HUB
- 37 PHOSPHOR BRONZE BEARING
- 38 EXTERNALLY SPLINED SHAFT
- 39 CLUTCH JAW
- 40 RING
- 41 THRUST BEARING ASSEMBLY
- 42 WASHER
- 43 SET SCREW
- 44 PLUG ASSEMBLY
- 45 RING
- 46 HOLLOW SCREW
- 47 CLUTCH JAW TEETH

partial dismantling of the starter is sufficient to allowing cleaning of the affected parts. More involved dismantling is necessary only in cases where servicing has not been undertaken at regular intervals, resulting in severe gumming-up of the starter, or where internal wear or damage has occurred. Under these conditions the starter should be replaced by a serviceable unit.

**10.** The special tools required for the following operations are:—

<i>Nomenclature</i>	<i>Part No.</i>
(1) Cartridge extractor	K.1215
(2) Exhaust valve gauge	K.3435
(3) $\frac{9}{16}$ in. tommy bar	K.1200
(4) Spring clamp	CK.1230
(5) Flanged adapter	K.3769
(6) Spacer ring	K.3770

**Preparation for dismantling**

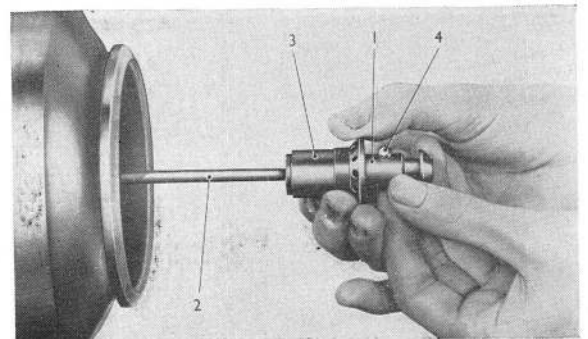
**11.** The following operations must be carried out before dismantling the starter unit:—

- (1) Remove all cartridges from the breech, using extractor, Part No. K.1215.
- (2) Disconnect the breech operating cable from the operating lever situated on the breech.

- (3) Disconnect the electrical supply lead from the rear beam.
- (4) Unscrew the union nuts from the ends of the combustion and exhaust tubes.
- (5) Unscrew the nuts and bolts securing starter and breech to the engine and remove the starter, breech, and combustion and exhaust tubes. On installations using Mk. 5/2 and 6/1 breeches, an auxiliary exhaust tube must also be removed. On installations using close coupled breeches, the starter and breech are to be removed as one unit.
- (6) On directly coupled breeches, remove the breech from the starter unit by removing the two nuts and bolts from the split clamp ring, which couples breech to the starter, and remove the split clamp ring. Lift the grid from its housing with a pair of pliers, and remove the liner. (Where the breech is direct-coupled at right angles, as on a type L7S starter, with Mk. 8B breech, the two nuts and bolts are to be removed from the supporting frame before commencing the above operation.)
- (7) Position the starter horizontally in a vice, so that it is gripped by its mounting flange, ensuring that the vice jaws are suitably protected with lead or copper plate.

**Dismantling**

- 12.** (1) Remove the locking wire and unscrew the safety disc holder from the combustion head.
- (2) Remove and discard safety disc.
- (3) Unscrew the locking screw from, and remove the V-section locking ring.
- (4) Insert a  $\frac{9}{16}$  in. tommy bar, Pt. No. K.1206, in the bore of the exhaust adapter and remove the combustion head from the cylinder by unscrewing in an anti-clockwise direction.
- (5) Raise the exhaust valve assembly, complete with the valve bolt.

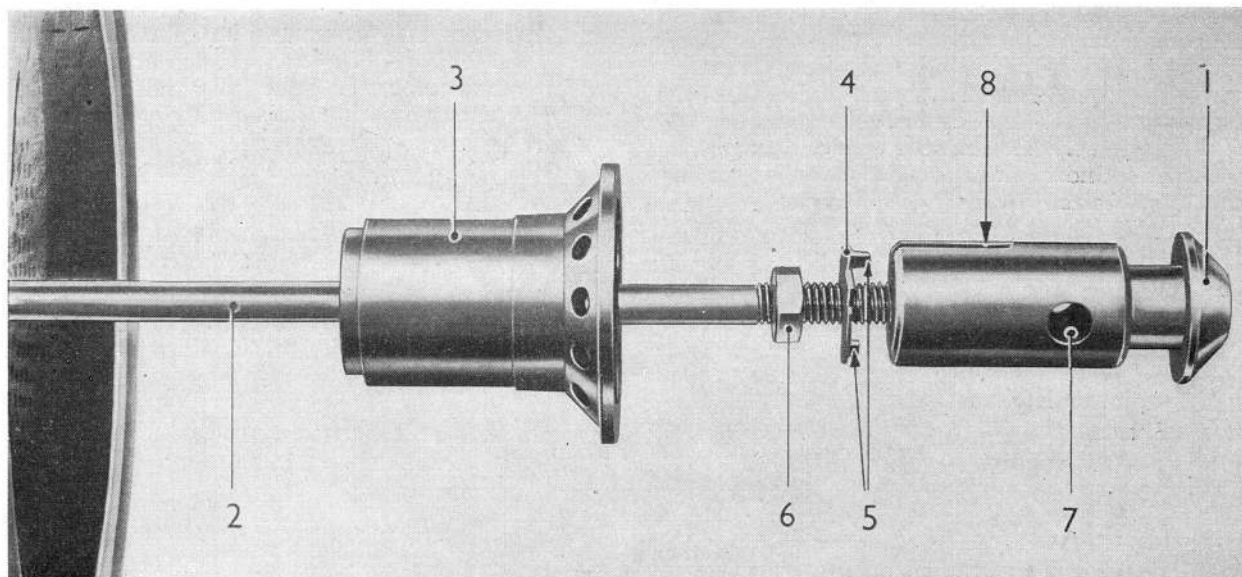


- 1 EXHAUST VALVE
- 2 VALVE ROD
- 3 VALVE HOUSING
- 4 STEEL BALL

**Fig. 2. Removing exhaust valve assembly**

(A.L.5, Jan. 57)

- (6) Remove the spring and two steel balls by sliding the valve housing away from the valve, taking care to trap the spring loaded balls as they emerge (fig. 2).
  - (7) Unlock the tab washer ((4), fig. 3), slacken off the valve lock-nut (6), using a short  $\frac{3}{16}$  in. dia. bar in the transverse drilling of the valve body to obtain a purchase, unscrew and remove the exhaust valve (1).
  - (8) Remove perforated disc from the cylinder ((14) fig. 1).
  - (9) Remove the two  $\frac{5}{16}$  in. B.S.F. nut and bolts which retain the split clamp ring, and using a hammer and copper drift, ease off each half of the clamp ring.
  - (10) Lift and remove the cylinder; ensuring a vertical lift to avoid jamming on the piston. Remove any brass shims which are fitted.
  - (11) Remove the piston rings by springing open each ring until it can be lifted clear of the piston lands.
- WARNING**
- Before commencing removal of cylinder, care must be taken to ensure that the piston is not stuck at the bottom of, or along, the cylinder bore and that the piston is not butting against the top of the cylinder. The correct position for the piston is approximately  $\frac{1}{8}$  in. from the inner face of the cylinder measured from below the shoulder which locates the perforated disc.*
13. If the piston is seized, but the valve gear can be removed, the following action should be taken:—
    - (1) Unpeen and remove the clutch jaw bolt locking screw ((27), fig. 1).
    - (2) Remove the two nuts and bolts which retain the split clamp ring (7), carefully remove ONE HALF of the clamp ring with a hammer and a copper drift, LEAVING THE OTHER HALF IN POSITION.
    - (3) Position the spring compressing tool, Part No. CK.1220 on starter unit. The two hooks at the end of tension arms should locate in two diametrically opposite holes in the mounting flange, or as near to this position as the half of the clamp ring still in position will permit. The screw of the compressing tool should be screwed in about three-quarters of its length, and the remaining space between the end of the screw pad and the top of the piston must be taken up with a suitable spacer.
    - (4) Screw down on the spacer, and hence on the piston, until the tension of the main spring is taken.
    - (5) Remove the circlip retaining the brass plug in the hollow screw in the clutch jaw face, and unscrew and remove the brass plug.
    - (6) Passing a long screwdriver through the hollow screw, and locating the screwdriver in the slot machined in the head of the clutch jaw bolt, unscrew the clutch jaw bolt until the threads are disengaged.
    - (7) Position the starter vertically in the vice, and unscrew the spring compressing tool to its fullest extent. This will allow the main spring to expand until it is no longer in compression. The spring compressing tool may now be safely removed.
    - (8) Remove the cylinder, piston and splined shaft from the main spring as one assembly.



- |                      |                       |
|----------------------|-----------------------|
| 1 EXHAUST VALVE      | 5 RADIAL LUGS         |
| 2 VALVE ROD          | 6 LOCK-NUT            |
| 3 VALVE HOUSING      | 7 TRANSVERSE DRILLING |
| 4 SPECIAL TAB-WASHER | 8 LONGITUDINAL SLOTS  |

Fig. 3. Exhaust valve assembly

**RESTRICTED**

- (9) Pass the piston and cylinder through a suitable degreasing plant after which dismantling of the piston and its associated components is easily effected.

14. If the piston is found to be butting against the top of the cylinder, exactly the same procedure must be followed as that detailed in para. 13, except that a spacer between the screw pad of the compressing tool and the piston will not be necessary. A butting piston denotes incorrect assembly or component failure, and a very thorough inspection should be made to ascertain the cause and its possible effect on the starter generally.

#### Cleaning

15. Thoroughly clean the piston, piston rings, perforated disc, valve assembly combustion head, grid and liner. Remove all grease, sludge and carbon deposits with lead-free gasoline, kerosene, or boiling water. A small quantity of soda in boiling water, used in conjunction with a hard wood scraper and soft wire brush will remove any stubborn carbon deposits.

16. It should be noted that as the piston is still attached to the remainder, immersion of this component in water is to be avoided. Failure to observe this point will result in corrosion of the interior mechanism. The piston should be cleaned by the local application of kerosene soaked rags and hardwood scrapers.

17. Unlined combustion tubes should be cleaned by pulling them through with a kerosene soaked rag. No attempt must be made to clean lined combustion tubes either by pulling them through or by washing, owing to their very fragile nature, but should be blown through with dry compressed air. Exhaust tubes should be treated as unlined combustion tubes and cleaned accordingly.

18. Ensure that all components are thoroughly dried after cleaning. Dry compressed air should be used for this purpose if available.

#### Inspection

19. A general inspection for signs of obvious damage, wear, pitting and distortion should be carried out. Where such defects are found, reference should be made to Vol. 6, Part 4, for appropriate action, alternatively the affected component should be replaced. Lined combustion tubes must be carefully examined for signs of lining failure, which is generally indicated by a local discoloration of the metal; where this occurs the tube should be rejected.

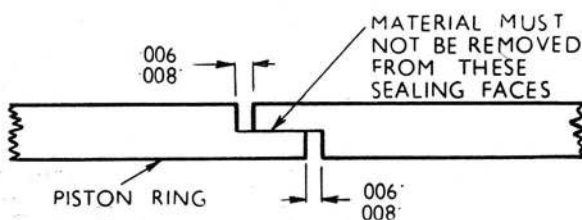


Fig. 4. Piston ring gap

20. The following points should receive special attention:—

- (1) Broken or worn piston rings must be renewed. New rings should be gapped to the limits shown in fig. 4. Note that two gaps must be filed on each ring, using a file with a safe edge to avoid damaging the lap faces. The dimensions given in fig. 4 must be checked with the ring symmetrically located 1 in. along the cylinder bore.
- (2) Examine the exhaust valve ((1), fig. 3) for ringing and pitting. If necessary, lap the valve on to its seat using a fine grinding medium. The valve housing (3) should be used as a guide and a suitable spindle screwed into the valve to facilitate the operation. Ensure that the exhaust valve bolt is not bent nor the threads distorted.
- (3) Place a straight edge across the diameter of the perforated disc ((14), fig. 1) and check for dishing. Dishing should be rectified by flattening the disc in an arbor press or a vice.
- (4) Check with a piece of  $\frac{1}{8}$  in. wire that the breather holes in the hub and housing are clear of foreign matter.
- (5) Thoroughly clean and inspect the breech for signs of obvious damage. If such damage exists, reference should be made to Vol. 6, Part 4 for appropriate action, or, alternatively, replace with a serviceable breech. Check the operation of the indexing mechanism, which should have a slow smooth return motion, and ensure that the breech is indexing correctly.

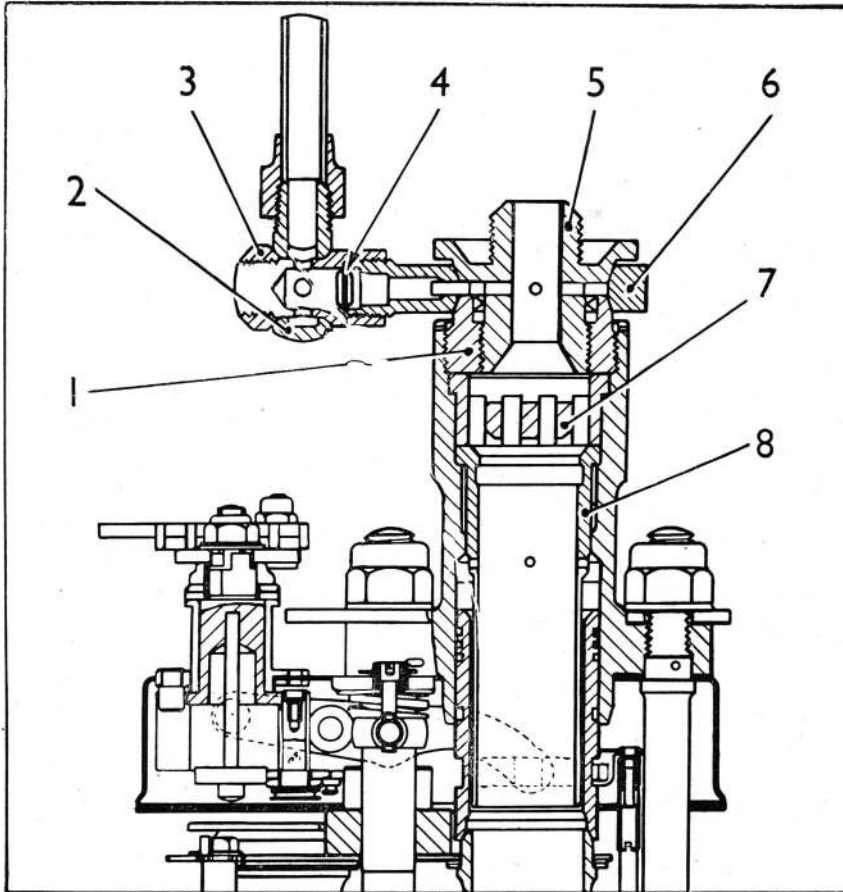
21. On Breeches Mk. 6/1 and 5/2 only, in addition to the work already detailed, the following attention is also required:—

- (1) Unscrew and remove the sealing nut ((3), fig. 5) lift off the ejector nozzle and unscrew and remove the nozzle assembly.
- (2) Remove and discard the safety disc.
- (3) Unscrew and remove the connector, and lift off the connector assembly.
- (4) Locate a box spanner in the internal hexagon of the connection. Unscrew and remove the connection, lift out the grid with a pair of pliers, and slide out the liner.

22. The cleaning of these dismantled components should be in accordance with the instructions given in para. 23. Following cleaning, inspect for corrosion and thread condition. Smear threads of the safety device with graphite grease, ZX-13 and reassemble by reversing the sequence for dismantling as given in para. 21.

#### Lubrication

23. During assembly of the starter, special attention must be given to correct and adequate lubrication in accordance with the following table:—



1 CONNECTION	5 CONNECTOR
2 EJECTOR NOZZLE	6 CONNECTOR ASSEMBLY
3 SEALING NUT	7 GRID
4 SAFETY DISC	8 LINER

**Fig. 5. Breech safety device**

Main spring	} Grease, ZX-13
Accessible splines	
Exhaust valve bolt	
Cylinder bore	} Light grade engine oil OM-170
Piston	
Piston rings	
Valve assembly	

**24.** Recharge the Stauffer type lubricator with high temperature grease XG-270 or XG-271, ensuring that the delivery tube is also full, and give the cap one half-turn.

**25.** With a grease gun inject two shots of high temperature grease (reference above) through the nipple located on the breech nose body. Lightly oil the spring return cylinder, on the indexing mechanism.

**Assembling**

**26.** Refit the piston rings by locating the ring gap in the relevant piston groove and firmly pressing down the back of each ring until it slips into position. Set the ring gaps at 90 deg. positions in relation to each other.

**27.** To replace the cylinder the following sequence of operations should be adopted:—

(1) Locate on the hub assembly any shims originally fitted ((1), fig. 6).

(2) Compress the piston rings with a spring clamp (3), slide the cylinder over the piston and locate the base of the cylinder on the hub assembly.

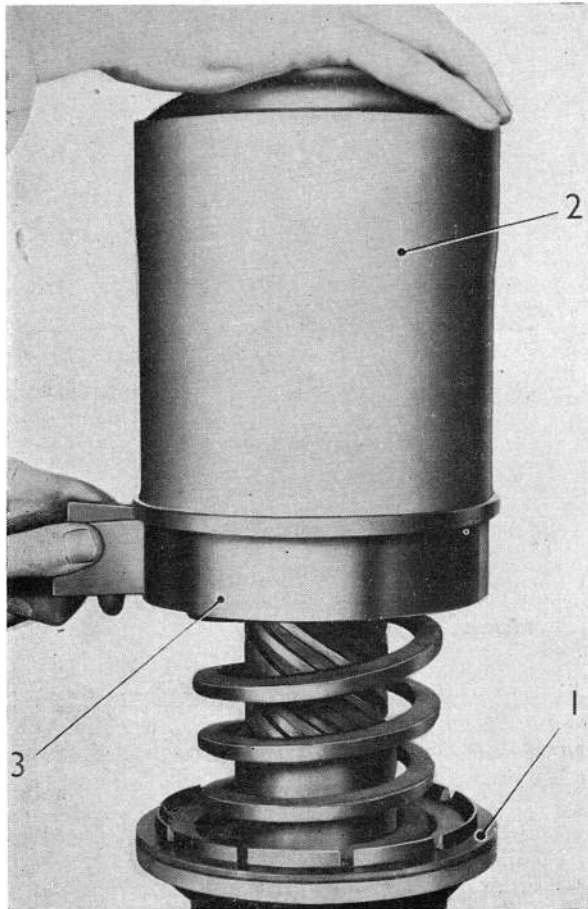
(3) Position the split clamp ring ((7), fig. 1) about the cylinder and housing mounting flanges, ensuring that the clamp ring is the right way up. No error will occur if the longer side of the V-section mates with the housing flange (fig. 7).

(4) Drive the two halves of the ring firmly into position with a lead mallet, maintaining an equal distance between the adjacent ends.

(5) Replace and tighten the securing bolts and nuts.

(6) Measure the gaps between the two ends of the clamp ring. They should be equal and conform to the dimensions given in fig. 8. Ensure that the inner circumference of the ring does not bottom on the cylinder wall.

(7) Adjustment to these dimensions is made by fitting 0.005 in. brass shims ((6), fig. 1), in which one radial cut is permitted to facilitate fitting to the assembled starter. Not more than three shims may be fitted.

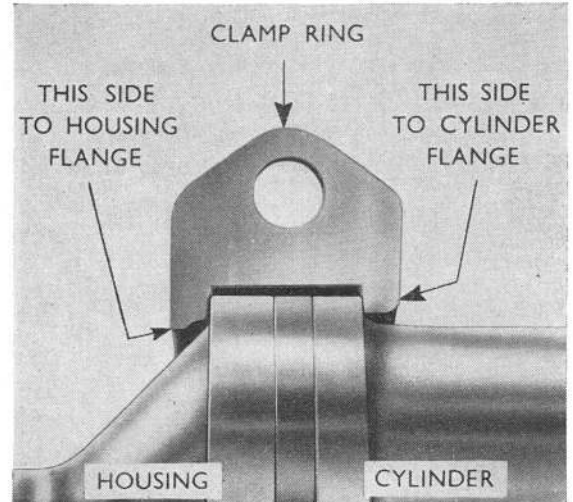


1 HUB ASSEMBLY  
2 CYLINDER  
3 CLAMP RING

**Fig. 6. Replacing the cylinder**

28. To replace the exhaust valve assembly proceed as detailed in the following sequence:—

- (1) Position the starter horizontally.
- (2) Slide the valve housing (*fig. 2*) over the exhaust valve bolt.
- (3) Place a new tab washer over the 2 B.A. lock-nut, with the two radial lugs away from the nut.
- (4) Screw on the exhaust valve and locate the spring and two steel balls in the transverse drilling in the valve body.
- (5) Slide the valve housing over the valve body, the two steel balls of which should click into position within the housing.
- (6) Withdraw the valve assembly to its fullest extent until the 30 lb. spring ((33), *fig. 1*) is fully compressed.
- (7) Measure the distance between the perforated disc (14) and the locating shoulder of the valve housing. This distance must be  $4\frac{5}{16}$  in. to  $4\frac{11}{16}$  in. The use of special tool, Pt. No. K.3435 to facilitate this operation is illustrated in *fig. 9*. If this tool is not available, a steel rule should be used, ensuring that the valve rod is held straight on the starter centre-line to avoid a false setting.



**Fig. 7. Fitting cylinder clamp ring**

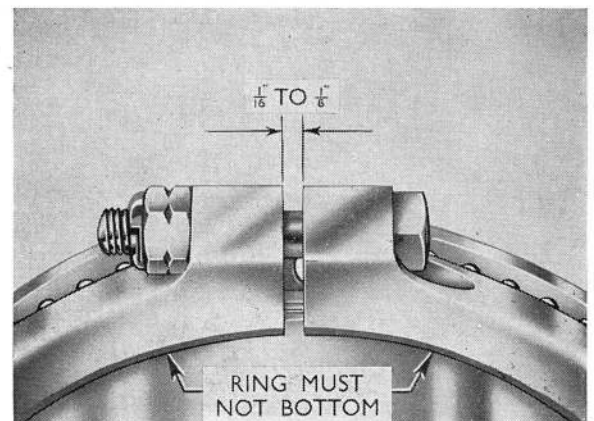
- (8) Screw the valve in the direction required to conform with these dimensions, and then, maintaining this setting, locate the tab washer lugs in the longitudinal slots in the valve body, tighten the lock-nut and lock it with the tab-washer.

29. Replace the combustion chamber by screwing it on to the cylinder and tighten with the aid of a  $\frac{9}{16}$  in. tommy bar, Pt. No. K.1206, inserted in the bore of the exhaust adapter. Lock the chamber in position by replacing the V section locking ring and tightening the lock ring screw.

30. Fit a new safety disc in the safety disc holder, and screw the holder tightly in the combustion chamber. Wire-lock the holder to the exhaust adapter with 22 s.w.g. stainless steel wire.

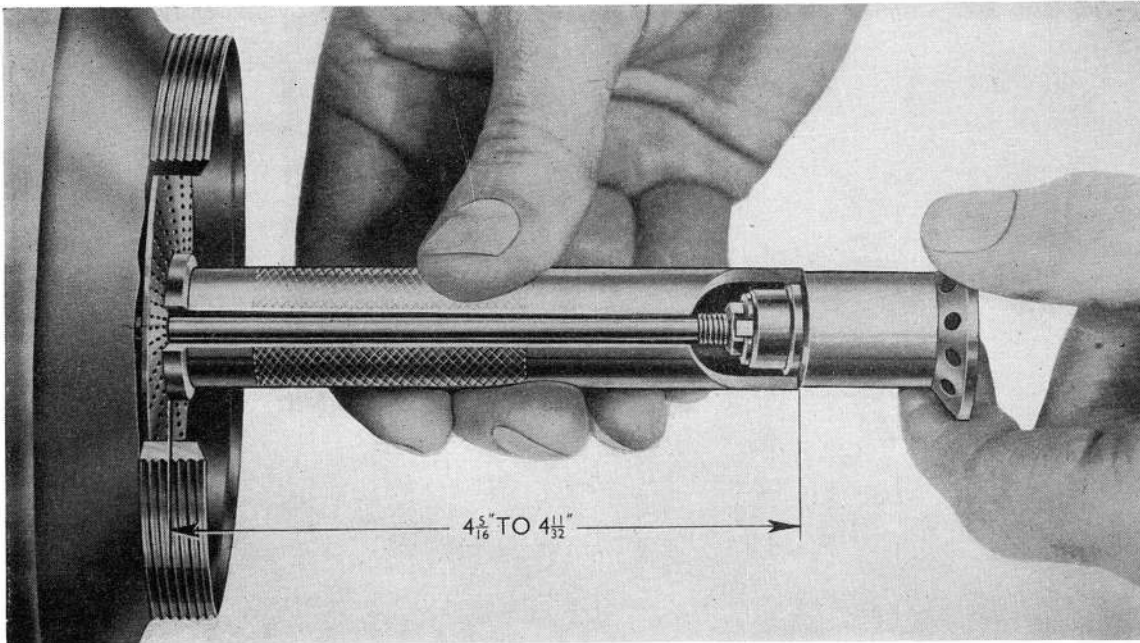
**Testing after assembly**

31. After the starter is assembled, it should be tested with dry compressed air at a pressure of approximately 150 lb. per sq. in. to check that it is functioning correctly. For the purpose of this test, the air supply should be connected to the inlet port of the combustion chamber. In the case



**Fig. 8. Cylinder clamp ring setting**

(A.L.5, Jan. 57)



**Fig. 9. Checking exhaust valve setting**

of type L.5 starters which have a flanged inlet port, a flanged adapter, Pt. No. K.3769, and a spacer ring, Pt. No. K.3770, will be required to effect coupling between the port and the airline. When the air pressure is applied, the starter clutch jaw should move forward approximately  $\frac{1}{16}$  in.

**32.** During the power stroke of the starter piston, there should be no evidence of air leakage from the exhaust port of the combustion chamber. This can be checked by placing a finger over the exhaust port during the power stroke, when any escape of air will indicate that the exhaust valve is not seating correctly, and requires lapping-in, as detailed in para. 20 (2).

**33.** As the piston reaches the end of its working stroke, the exhaust valve is automatically opened

and the air pressure passes through the exhaust port to atmosphere, when the air supply should be turned off. The clutch jaw will then return to its static position, and the piston will be returned to the top of the cylinder by the starter main spring. At this point, the exhaust valve closes, and the starter is ready for a further cycle of operation. The above procedure should be repeated a number of times to ensure correct operation of the starter.

**34.** After the starter has been tested and found satisfactory, disconnect the air-supply line. The procedure for installing the starter assembly on the engine is detailed in Vol. 1 of the relevant aero-engine Air Publication.

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