Chapter 2

SERVICING AND MINOR REPAIRS

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LIST OF ILLUSTRATIONS

INTRODUCTION

1. The starter requires very little attention between the routine servicing periods stipulated in the aircraft Servicing Schedule. All internal parts requiring independent lubrication are packed with grease during assembly and no replenishment is normally necessary. Such servicing as is necessary must be closely observed if efficient operation is to be maintained.

2. It is important that the starter generally, and the breech in particular, be kept perfectly clean. During re-loading operations, advantage should be taken when the firing head is removed to ensure that the sealing pads, index pin wheel and geneva wheel, are kept free from dirt and grit. Clean these items as necessary and maintain a light film of grease XG-278 on the index pin wheel and geneva wheel.

Safety discs

3. At each reloading of the breech, always check whether any of the safety disc assembly spigots are protruding from their safety disc holders. Such a condition indicates a blown safety disc which should be rectified by renewing the safety disc assembly.

Renewing a safety disc assembly

4. Ensure that the starter breech does not contain a live cartridge. Break the locking wire between the safety disc assembly and the nozzle body blanking plug and remove the locking wire.

Note . . .

Care must be taken to remove all pieces of wire as any portion of the locking wire left in the vicinity of the starter may be drawn into the air intake when the engine is started.

5. When renewing the safety disc assembly, the following sequence should be followed:—

(1) Remove the locking wire from the head of the holder and unscrew and remove the holder from the nozzle body.

(2) Remove the sheared safety disc assembly and all carbon deposit from the holder and renew the safety disc assembly.

(3) Ensure that all remnants of the sheared bursting disc are removed from the housing in the nozzle body before replacing the holder fitted with the new disc. Special care must be taken to clear the inner sealing face of the housing in the nozzle body of the sheared rim from the burst disc, together with all traces of carbon deposit. A small screwdriver may be used for this purpose, but care must be taken to avoid damaging the shearing edge of the inner sealing face.

(4) Screw the holder lightly, but firmly, into the nozzle body and lock the head of the holder with 22 s.w.g. stainless steel wire.

Note . . .

Old assemblies should not be discarded, they should be returned to stores for servicing as described in para. 6.

Reconditioning a safety disc assembly

6. A burst or damaged safety disc assembly may be made serviceable by renewing the safety disc, as follows:—

(1) Remove the nut on the end of the stainless steel spindle.

(2) Detach the remains of the burst or damaged safety disc.

(3) Assemble a new disc (*Part No. CK.*3251) to the spindle, replace and tighten the nut and lock with a centre-punch mark.

Removing carbon deposit from safety disc housings

7. Remove the starter from the engine as follows:—

(1) Disconnect the cable leading from the indexing motor to the control panel and uncouple the oil drain pipe and the exhaust duct. Suitably blank the pipe union in the starter to prevent escape of oil.

(2) Remove the nut, plain and spring steel washer, from each mounting stud, lift the starter off the mounting elbow and place on a clean bench.

8. Remove each of the six safety disc assemblies (*fig.* 15), from the nozzle body by breaking the locking wire, and unscrewing each holder in turn.

Fig. 3. Removing firing head

◂ Renewal of shear pins

17. Shear pins must be renewed whenever the overspeed safety device has operated and at each minor and major servicing; detailed instructions for their renewal are given in para. 39. ▸

DISMANTLING THE FIRING HEAD

General

18. A vice fixture for holding the starter during the early stages of dismantling is illustrated in fig. 1. This fixture must be firmly gripped in a vice, after which the starter mounting flange can be located over the inner circle of bolts and retained by four washers and nuts (*fig.* 2). Remove the firing head but before proceeding further remove all cartridges left in the barrels.

Removing the firing head from starter body (*fig.* 3)

19. (1) Rotate the two handles on the handle assembly into the vertical position.

(2) Depress the handle assembly as far as possible then turn it in an anti-clockwise direction until it is felt to come against the pin stop. The firing head must not move during this operation.

(3) Depress the head to disengage the head studs from the recesses on the underside of the keyhole slots in the barrel plate and turn the firing head in an anti-clockwise direction until the heads of the studs line up with the holes in the barrel plate.

(4) Remove the head by lifting it vertically off the starter.

Removing the front plate

20. Prior to commencing work on the firing head ensure that the sealing pads are in the forward position and that two of the firing pins have dropped. To accomplish this, depress the handle assembly and turn it clockwise until it is felt to move up into the locked position. Two firing pins may now be dropped by manually indexing the geneva wheel in a clockwise direction using the indexing key ◂ MK 3851 ▸. Access to the firing mechanism is obtained as follows:—

(1) Remove the nut, spring and pen steel washers from each locking stud (1, *fig.* 4), using a spanner on the stud flats to hold the stud.

(2) Invert the head and remove the five studs.

(3) Remove the cheese-head screw which is adjacent to the geneva wheel (*fig.* 5) from the front plate and lift the plate off the firing head.

(4) Lift out the idler gear (*fig.* 6).

Removing the firing pin assemblies

21. To remove the six firing pin assemblies commence with No. 6 assembly (*fig.* 6) and proceed as follows:—

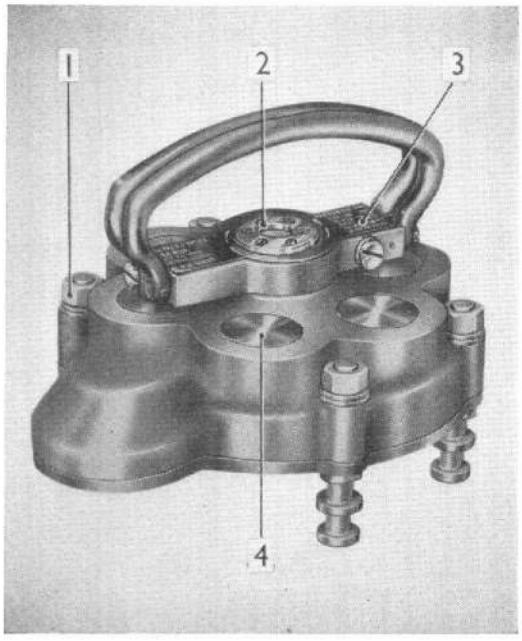
(1) Unscrew anti-clockwise and remove No. 6, 4, and 2 sealing pad assemblies, after which No. 1, 3 and 5 pad assemblies may be unscrewed and removed.

Removing the geneva assembly

22. This assembly (*fig.* 6) is removed by unscrewing the four countersunk screws by which the flanged bush is secured to the firing head. Access to the screws is obtained through the holes in the flange of the geneva gear.

Centre plate

23. The centre plate (*fig.* 6) is retained by five cheese-head screws and a countersunk locating screw. Remove these items and ease the plate off the ends of the thrust nuts.



1 STUD NUT
2 LOCKING NUT
3 HANDLE ASSEMBLY
4 SEALING PLUG

Fig. 4. Firing head

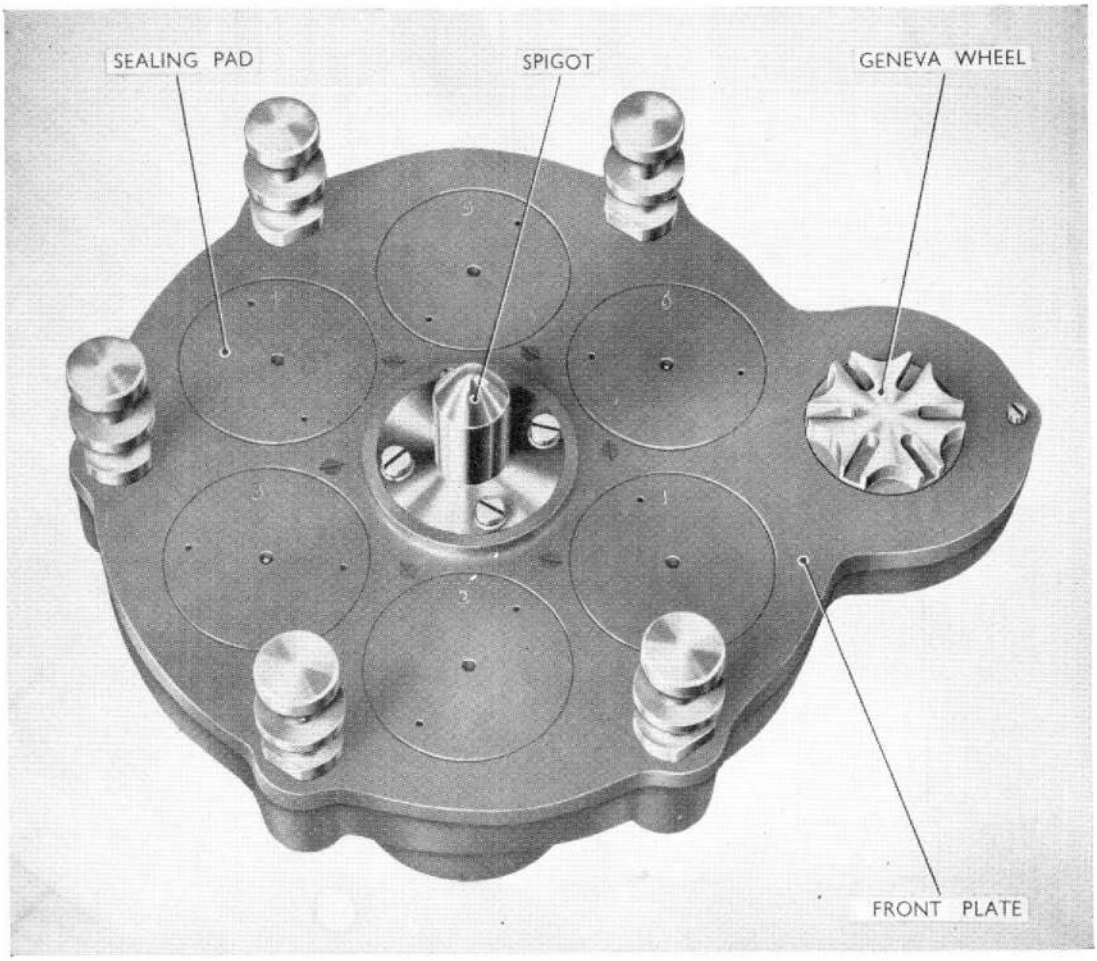


Fig. 5. View of firing head on locking plate

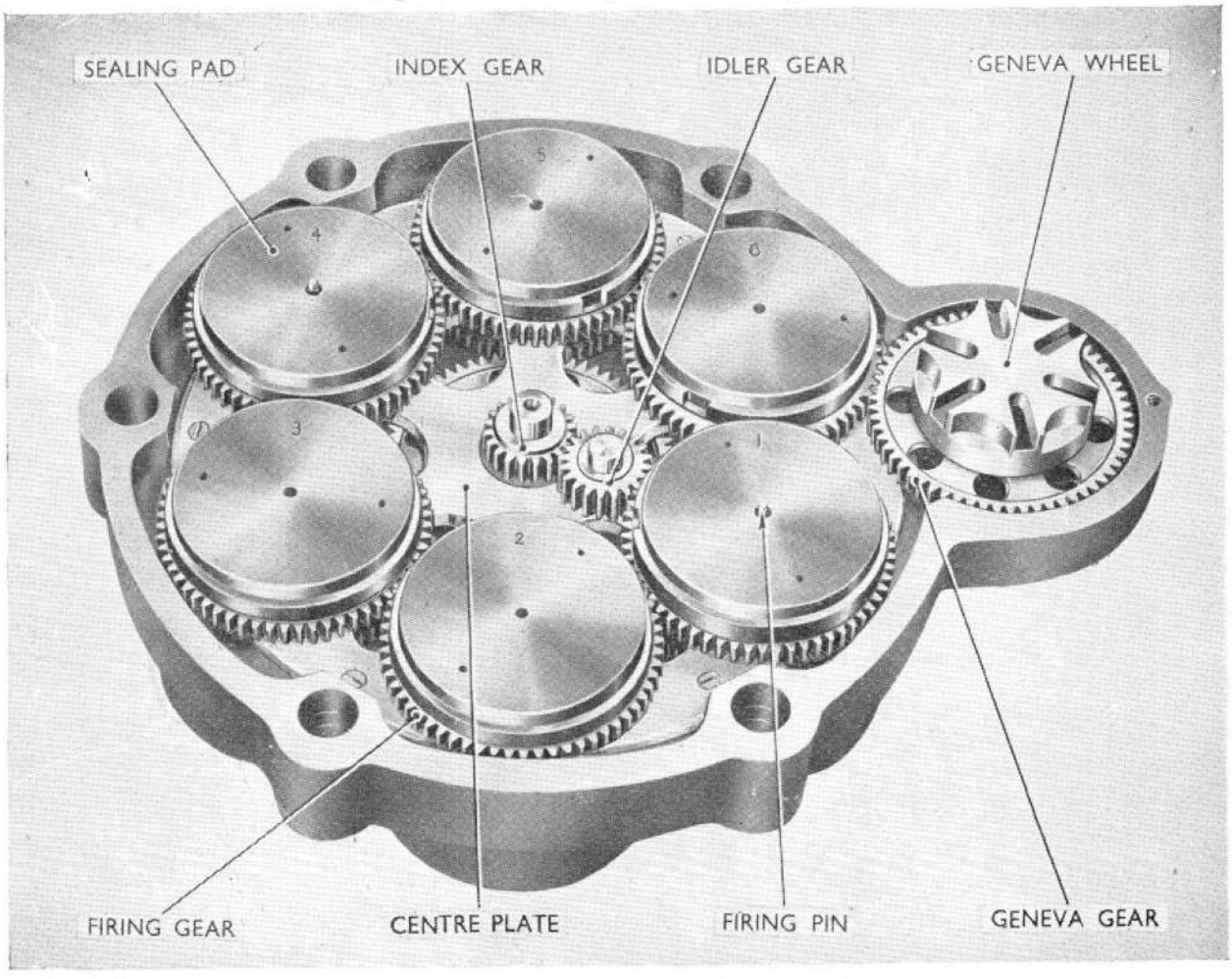


Fig. 6. Firing head with locking plate removed

Note . . .

When obtaining access to the various disc assemblies, avoid rolling the starter on the bench. Such treatment may easily cause damage to the exhaust port studs and the external oil pipe.

9. To remove the carbon from the housings a ◄ special tool decarbonising bit Mk. 3835, ► comprising a cutter and a cutter bush will be required. Carry out the operation in the following sequence:—

(1) Screw the bush into one of the six disc housings.

(2) Position the starter on the edge of the bench so that the housing in question has its opening pointing downwards, i.e., so that the carbon, as it is removed, will fall away from the starter and not into the nozzle body.

(3) Enter the cutter into the bush and, by the handle provided, rotate the cutter and at the same time move it forward into the housing. Carefully proceed in this manner until all the carbon deposit has been removed.

(4) Remove the cutter and cutter bush, and ensure that any loose carbon particles fall clear of the housing.

(5) Proceed as above for the remaining housings.

10. Fit a serviceable safety disc assembly to each of the six housings as detailed in para. 5, sub-para. (3) and (4). Install the starter on the engine as described in the relevant aero-engine Air Publication Vol. 1, Part 2.

MINOR REPAIR

General

11. Minor repair, consists of decarbonizing the nozzle body, barrels and associated components, renewing shear pins in the brake assembly and renewal of safety discs. Renewal of the rotor, oil pump and gearbox assembly are permissible where necessary.

Tools required for servicing and minor repair

12. In addition to a fitter's tool kit and suitable containers for storing the parts of a dismantled starter, the following special tools and equipment will be required:—

Part No.	Description	Function
	General tools	
◄ MK 10425	Cartridge extractor	For removal of cartridges from barrels
MK 3836	Starter mounting assembly	For mounting starter during servicing and testing
MK 3858	Air line adapter	For testing after assembly
MK 3837	Locking spanner	For outlet nut on overspeed cable
MK 3397	Bearing extractor (interchangeable head)	For ball races should they not come away when first- and second-stage gear assemblies are removed
MK 3838	Oil seal inserting tube	For pressing "GACO" oil seals into their housing
MK 3839	Oil seal mounting sleeve	To protect oil seals from splined shafts during servicing
MK 3840	O-ring mounting sleeve	To protect O-ring K.3243 on final drive gear bearing housing from teeth of final drive gear during servicing
MK 3835	Nozzle body decarbonizing bit	To remove carbon accumulations from safety disc housings
MK 3834	Oil U-pipe assembly	For flush-lubricating starter
	Nozzle body assembly	
MK 3394	Barrel extractor	For extracting and tightening the cartridge barrels
MK 3852	Barrel locking nut spanner (large)	For use with barrel extractor
MK 3853	Barrel locking nut spanner (small)	For use with barrel extractor
MK 3400	Starter plate locking ring spanner	For barrel ring-nuts
MK 3395	Nozzle body extractor screw	For removing nozzle body
	Clutch assembly	
MK 3392	Clutch setting rig	Bench fixture for setting and adjusting clutch torque
MK 3391	Spanner assembly for locking clutch adjustment	For clutch locking ring
MK 3390	Spanner assembly for adjusting clutch	For clutch adjuster ring
MK 3855	Clutch stripping tool assembly	For withdrawing inner clutch housing
MK 3860	Drive shaft locking piece	For locking final drive shaft
	Firing head	
MK 3383	Setting spacer for firing head	For use in timing the mechanism
MK 3843	End cap key	For cap retaining the firing spring
MK 3851	Geneva indexing key	For manual indexing of the geneva wheel
MK 3862 ►	Firing pin depressor (2 off)	

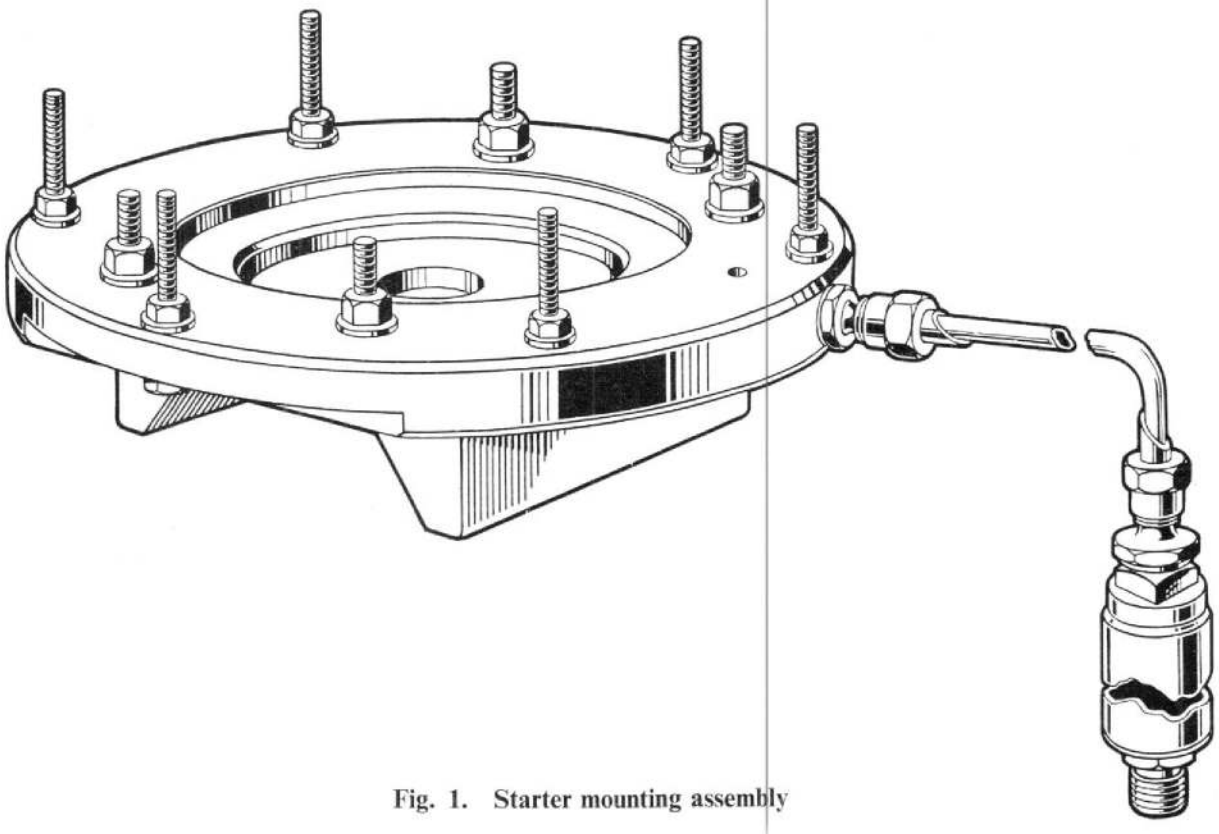


Fig. 1. Starter mounting assembly

CHART OF REPAIR PROCEDURE

13. For all starters, whether requiring replacement of major parts or not, the sequence of repair procedure is as follows:—

External examination
|
Dismantling
|
Cleaning
|
Inspection and report
|
Assembly
|
Function test
|
Final inspection and preparation for despatch

REPAIR PROCEDURE

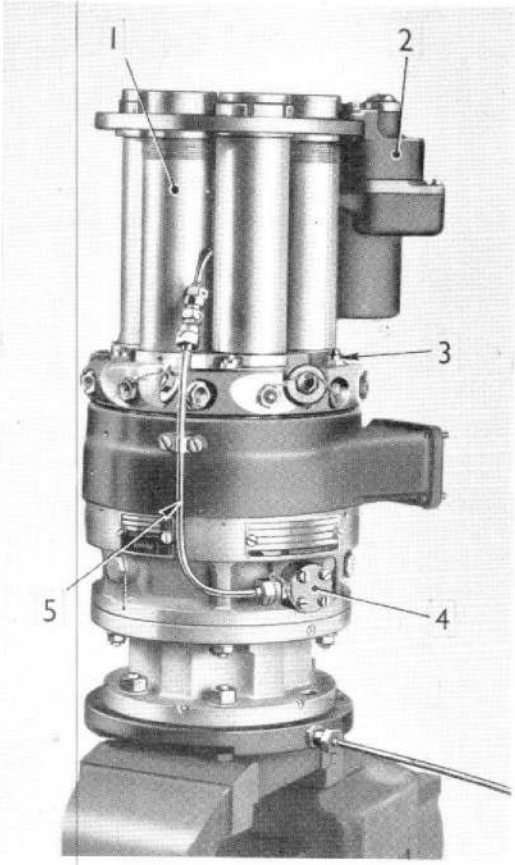
14. Upon receipt of a starter it is to be externally examined, then dismantled and the parts assessed for general condition.

External examination

15. Make a general examination of the starter to assess its suitability for repair. This is essential to prevent unnecessary work being carried out on a starter which comes within the unrepairable category.

Renewal of safety discs

16. The safety discs must be renewed as detailed in the relevant aircraft Servicing Schedule.



1 BARREL
2 INDEXING MOTOR ASSEMBLY
3 NOZZLE BODY RETAINING NUT
4 OIL PUMP ASSEMBLY
5 OIL PIPE SUB-ASSEMBLY

Fig. 2. Starter on mounting assembly

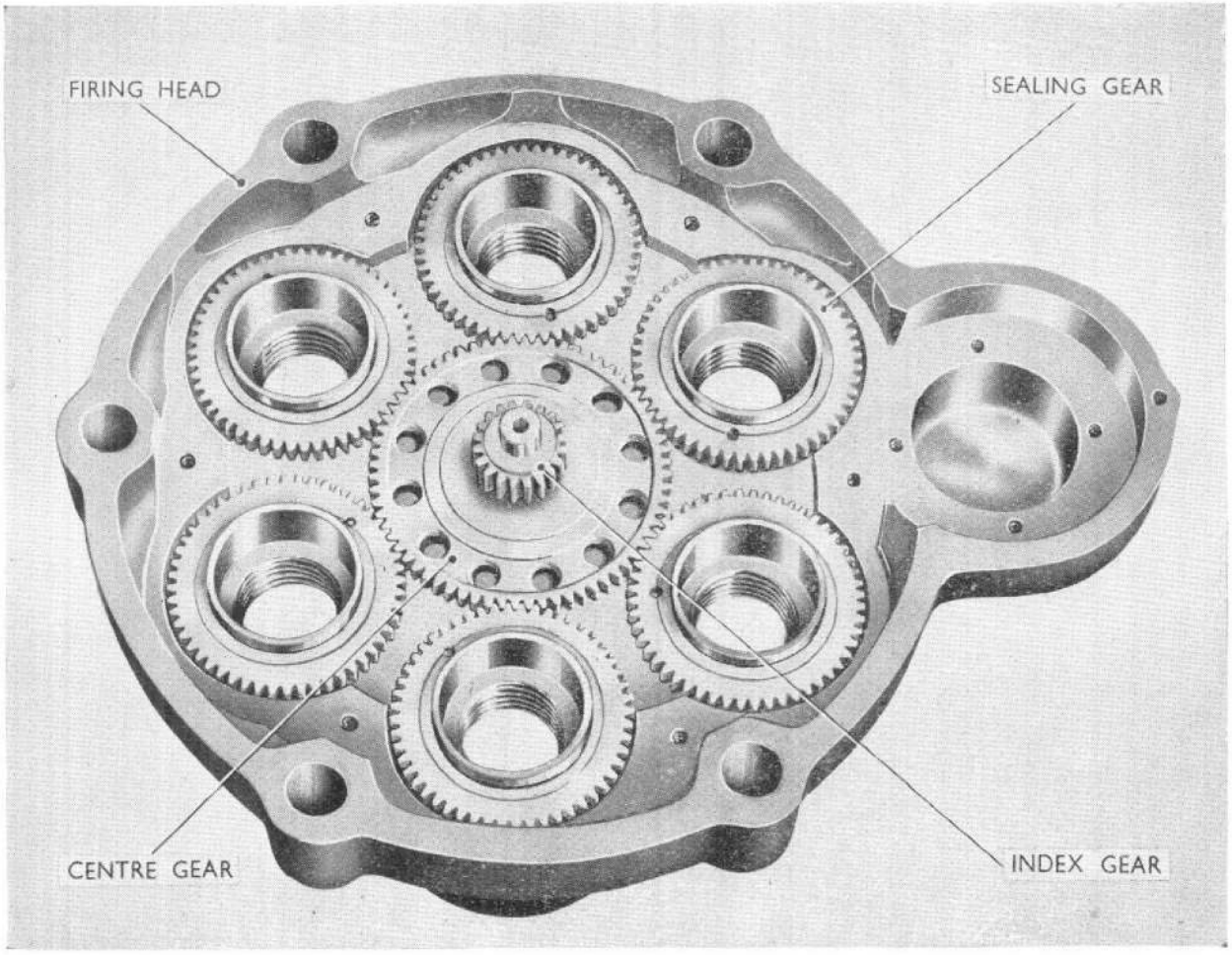


Fig. 7. Firing head showing sealing gears

Sealing gear and indexing gear

24. The six sealing gear assemblies (*fig.* 7) may now be lifted from their respective housings in the firing head and the index gear removed from the centre gear.

Centre gear and stop assembly

25. Access to the screws retaining the assembly is obtained through the holes in the flange of the centre gear (*fig.* 7). Remove the assembly as follows:—

(1) Depress and turn the handle assembly to rotate the centre gear to such a position that access to the retaining screw is obtained.

(2) Unscrew and remove the five screws.

(3) Invert the firing head and with a light scribe line, mark the position of the handle relative to the head. Remove the six screws (2, *fig.* 4) by which the handle assembly is attached to the handle sleeve.

(4) Remove the locking disc, the instruction label and the handle assembly. Invert the firing head and lift out the centre gear and stop assembly, and the stop sleeve locating dowel.

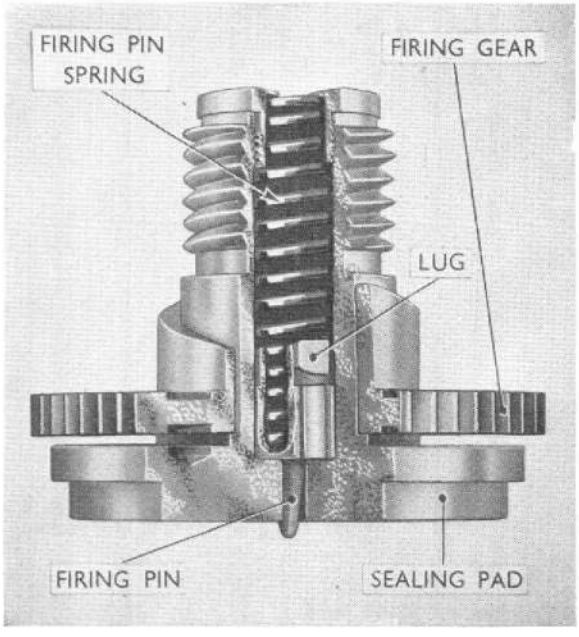


Fig. 8. Firing mechanism shown partly sectioned

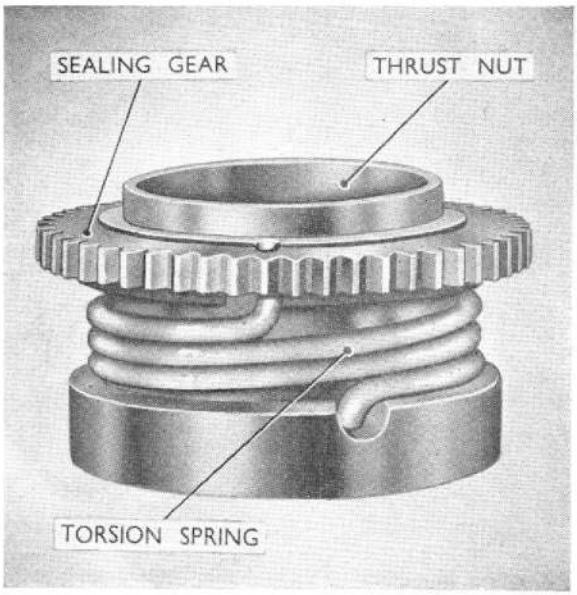


Fig. 9. Sealing gear assembly

Sealing plugs

26. To remove the six sealing plugs (4, *fig.* 4) tap them out of the firing head using a hard-wood drift.

Dismantling the firing pin assembly

27. This firing pin assembly—the removal of which is detailed in para. 20—should be dismantled into component parts as follows:—

(1) Observe that the lugs of the firing pin are at the lowest position of the cam track as illustrated in fig. 8. The firing gear may be rotated relative to the sealing pad to obtain this condition.

(2) Using cap-key (MK 3843) unscrew and remove the end-cap and withdraw the firing spring and firing pin.

Note . . .

The end-cap can normally be unscrewed by firmly grasping the sealing pad and applying the cap-key. The use of a vice should be avoided. ◄ *If difficulty is experienced, replace the sealing pad in the front plate and locate this in the keyway, then remove the end cap with the cap key.* ►

(3) Separate the firing gear from the sealing pad.

(4) Repeat the foregoing operations to dismantle the remaining five assemblies. Each assembly is coded as a set and must be segregated to avoid any possibility of the components becoming mixed during assembly.

Dismantling the sealing gear assembly

28. It is not necessary to dismantle this assembly unless the torsion spring is distorted in which case, ease the sealing gear off the thrust nut and remove the spring. The remarks in para. 26, sub-para. 4, regarding coding apply equally to the sealing gear assemblies and should be closely observed.

Dismantling the geneva assembly

29. If as a result of component failure or wear, it is necessary to dismantle this assembly, proceed as follows:

(1) Remove the lock-nut (1, *fig.* 10) and lift off the bronze bush.

(2) Remove the stop-pin from the geneva gear, separate the geneva gear and geneva wheel and remove the torsion spring from the bore of the geneva wheel spindle.

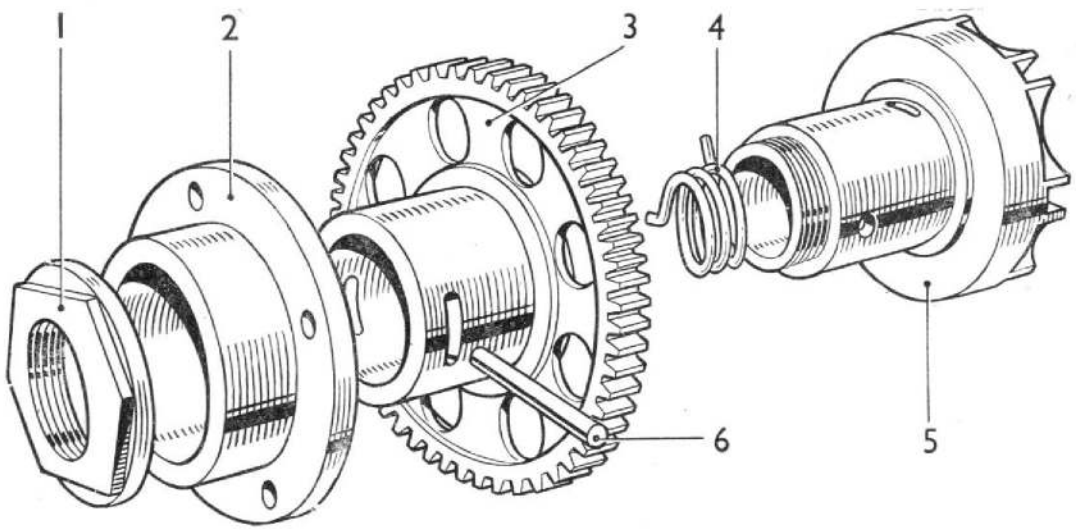
Dismantling the centre gear and stop assembly

30. This assembly is dismantled by removing the stop-pin (6, *fig.* 11). To do this, position the assembly on a bench with the centre gear at the bottom and apply pressure to the centre sleeve to overcome the spring pressure. The pin may now be pulled out after which the assembly can be separated into its component parts.

DISMANTLING THE STARTER BODY

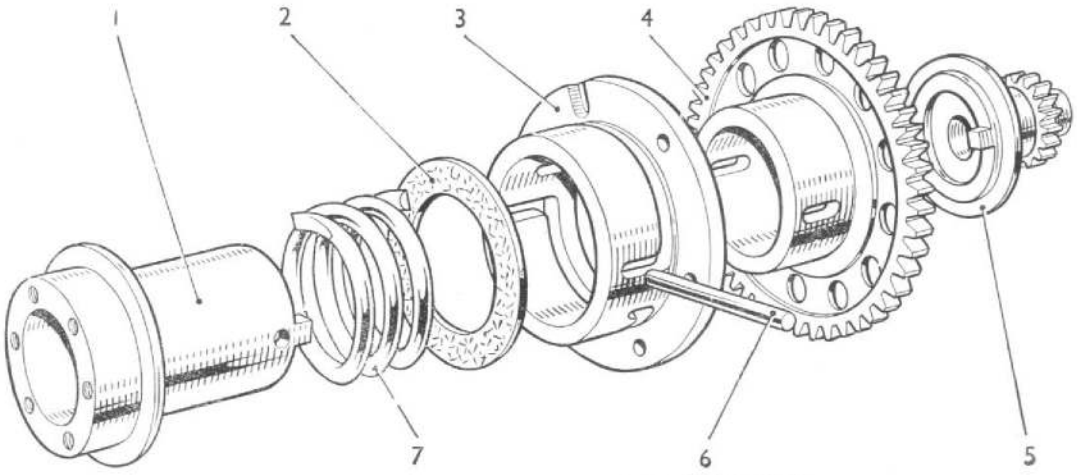
General

31. A fixture for holding the starter during the early stages of dismantling is illustrated in fig. 1.



1 LOCK-NUT
2 BRONZE BUSH
3 GENEVA GEAR
4 TORSION SPRING
5 GENEVA WHEEL
6 STOP-PIN

Fig. 10. Exploded view of geneva assembly



1 CENTRE SLEEVE
2 WASHER
3 STOP SLEEVE
4 CENTRE GEAR
5 INDEXING GEAR
6 STOP-PIN
7 SPRING

Fig. 11. Exploded view of centre gear and stop assembly

Nozzle body assembly

32. Remove the nozzle body as follows:

(1) Remove the oil-pipe clip from the rotor housing, disconnect the upper and lower oil-pipe unions and remove the pipe (*fig.* 2).

(2) Remove the split pins, castellated nuts and plain washers from the retaining studs and lift the nozzle body off the rotor housing.

If difficulty is experienced in removing the nozzle body it may be withdrawn with the aid of the extractor (MK 3395) screws which screw over the two studs located in enlarged and tapped stud holes. Pull down the two screws evenly to raise the nozzle body.

◄ (3) Remove the starter from the mounting fixture. ►

Barrel plate

33. To remove the barrel plate (*fig.* 12) ◄ fit the nozzle body to fixture MK 3836 ► disconnect the overspeed cable assembly from the indexing motor housing then bend down the tabs locking the three ring nuts and remove the nuts using spanner MK 3400. Lift the plate, complete with indexing motor, off the barrels.

Barrels

34. To remove the barrels an extractor will be required. It comprises a left- and right-hand nut assembly, a spacer and two ring spanners (*fig.* 13), and is used as follows:

(1) Insert the spacer in the large nut and screw the nut assembly on to the end of one of the shouldered barrels; if necessary, unscrew the smaller nut (which has a left-hand thread), to permit ample thread engagement. Now screw down the smaller nut until it abuts the end of the barrel.

(2) Position the two ring spanners, one on each nut, and tighten the smaller nut by moving the spanner handles towards each other.

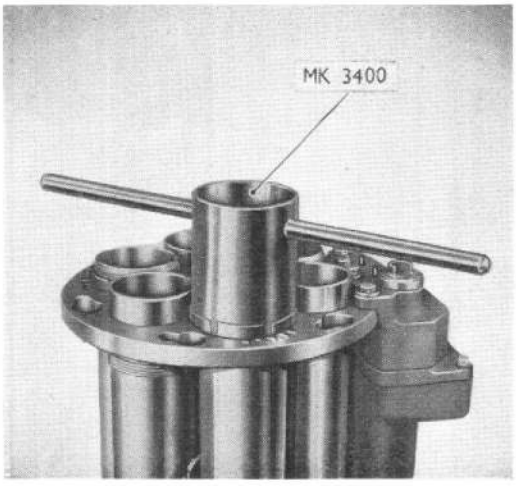


Fig. 12. Spanner for barrel ring-nuts

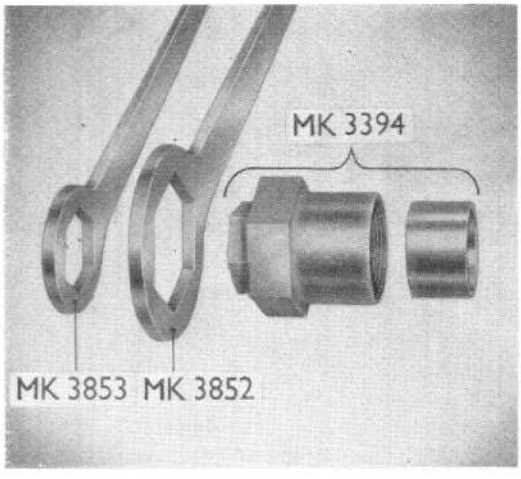
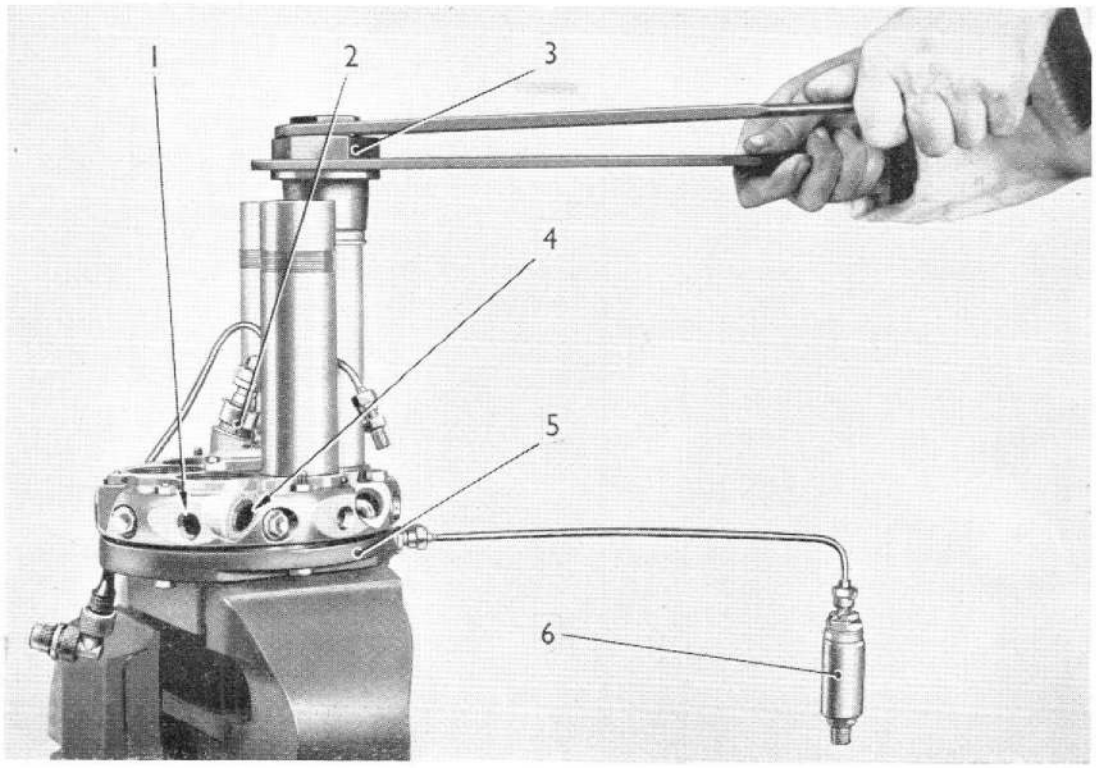


Fig. 13. Barrel extractor components



1 SAFETY DISC ASSEMBLY HOUSING
2 OVERSPEED CABLE ASSEMBLY
3 BARREL EXTRACTOR
4 NOZZLE BLANKING PLUG HOUSING
5 STARTER MOUNTING ASSEMBLY
6 OIL FILTER

Fig. 14. Barrel extractor in use

(3) The barrel can now be unscrewed by applying pressure to the large spanner in an anti-clockwise direction

(4) Repeat this procedure to remove the remaining two shouldered barrels.

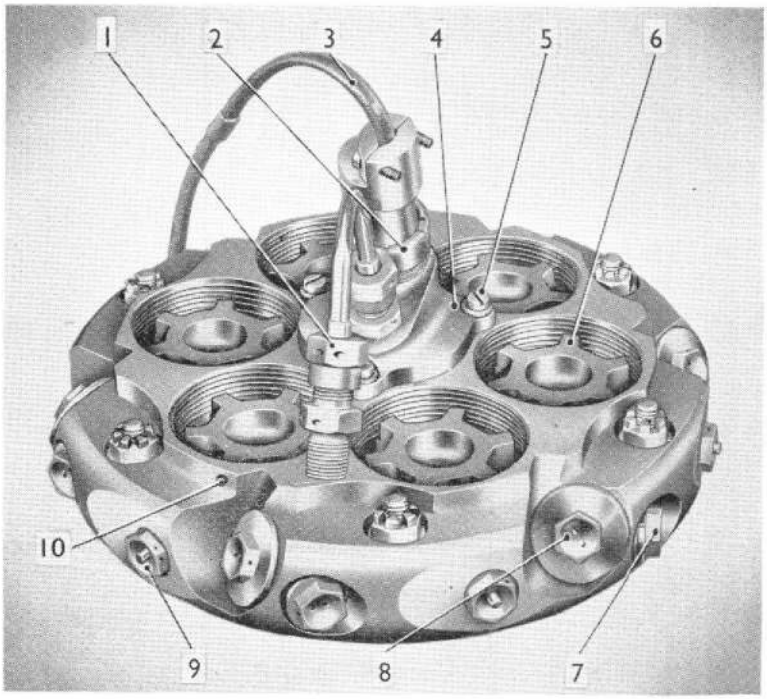
(5) To remove the three non-shouldered barrels, first remove the three Allen screws (10, *fig.* 15) which lock the barrel to the nozzle body, then follow the procedure detailed in sub-para. (2) to (5), with the exception of that in sub-para. (1) as the spacer should not be used.

Grids, safety discs and blanking plugs

35. Lift the six grids out of the barrel housings in the nozzle body (*fig.* 15) and then remove the locking wire and unscrew the twelve blanking plugs and six safety disc assemblies which are located in the circumference of the nozzle body.

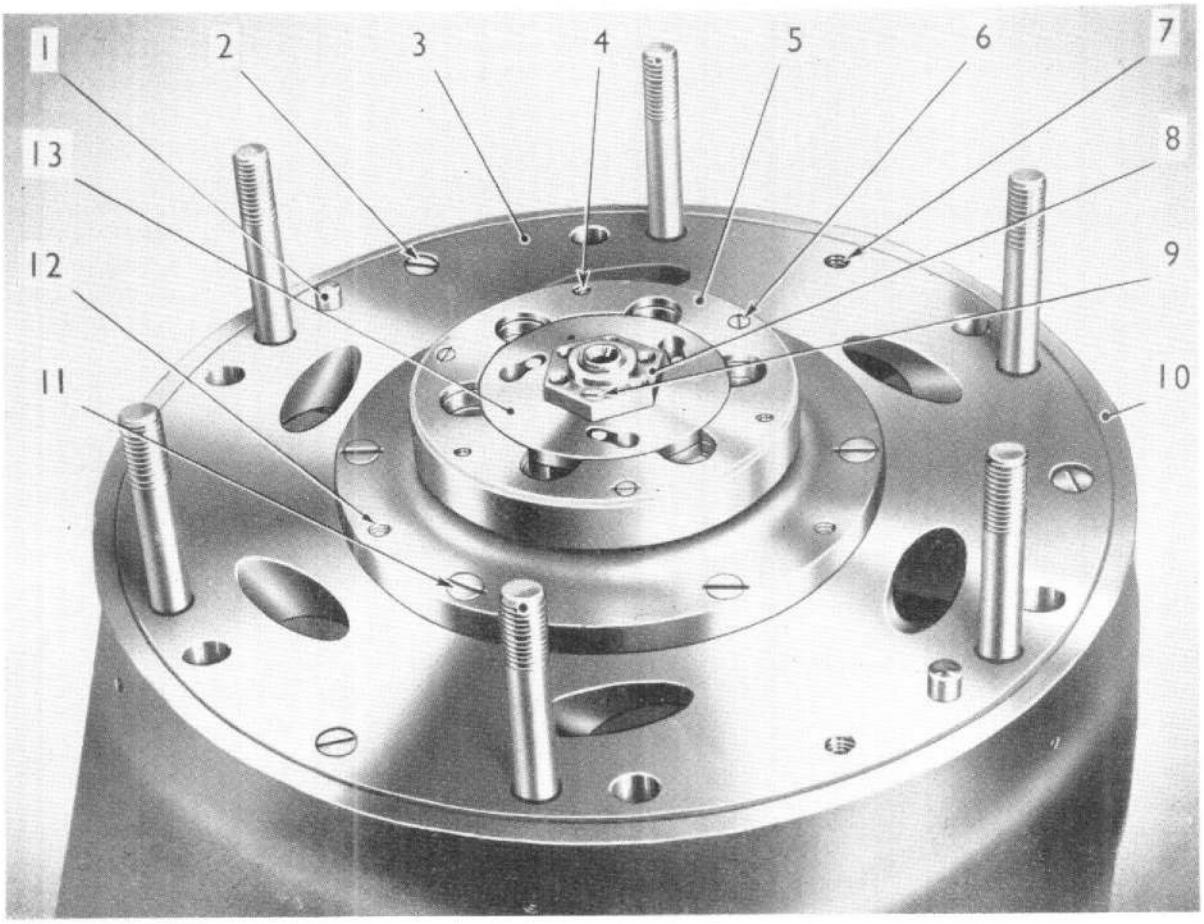
Overspeed cable assembly

36. Using spanner (MK 3837) unscrew the ring-nut (*fig.* 15) which retains the cable assembly to the nozzle body oil-plug. Carefully withdraw the cable end,



1 OIL-PIPE
2 CABLE ASSEMBLY RING NUT
3 OVERSPEED CABLE
4 NOZZLE BODY OIL-PLUG
5 NOZZLE BODY OIL-PLUG RETAINER SCREW
6 GRID
7 and 8 } BLANKING PLUGS
9 SAFETY DISC ASSEMBLY
10 ALLEN LOCKING SCREW HOLE

Fig. 15. Nozzle body assembly



1 NOZZLE BODY LOCATING DOWEL
2 NOZZLE PLATE RETAINING SCREW
3 NOZZLE PLATE
4 BRAKE DRUM SLEEVE EXTRACTOR HOLE
5 BRAKE DRUM SLEEVE
6 SLEEVE RETAINING SCREW
7 NOZZLE PLATE EXTRACTOR HOLE
8 BRAKE BODY RETAINING NUT
9 RETAINING NUT LOCKING SCREW
10 ROTOR HOUSING
11 BRAKE DRUM SCREW
12 BRAKE ASSEMBLY EXTRACTOR HOLE
13 OVERSPEED GOVERNOR ASSEMBLY

Fig. 16. Overspeed assembly unit

complete with its insulating bush and spacer, which may be removed from the cable end if required. Ensure that the pin locating the insulating bush and spacer is removed from the shoulder in the housing.

Nozzle body oil plug

37. To detach the oil-plug from the nozzle body, remove the three screws from the oil-plug (*fig.* 15) then lift the plug, complete with its short length of pipe, off the nozzle body and remove the gasket. ◄ Remove the nozzle body from the mounting fixture. ►

Overspeed assembly

38. Under normal conditions no attempt must be made to repair a starter in which the overspeed safety device has operated. The starter should be returned to a Maintenance Unit for reconditioning and replacement of the overspeed assembly. If, however, it is necessary in an emergency to repair a starter after the overspeed assembly has functioned, it is admissible to render the starter serviceable by renewing the shear pin ◄ and brake drum. It will also be necessary to clean up the profile of the brake shoes with a smooth file. Reference must be made to para. 58 before undertaking an emergency repair to the overspeed assembly. ► Beyond this no further dismantling or repair work must be undertaken.

Renewing overspeed shear pin

39. The pin should be removed as follows:—

◄ (1) Fit the starter body in the mounting fixture MK 3836.

(2) Unpeen and remove the screws (11, *fig.* 16) mounted in the flange of the overspeed drum and remove the drum.

Note . . .

If the assembly is difficult to remove after an overspeed, the complete assembly may be extracted by inserting the screws removed from the flange of the overspeed drum into the

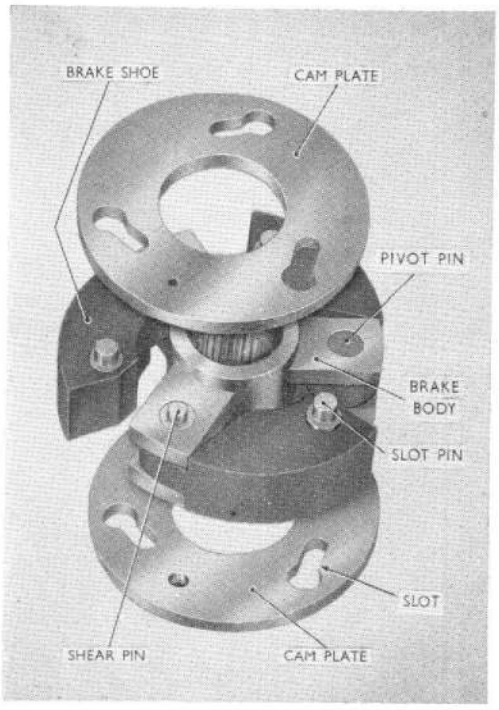
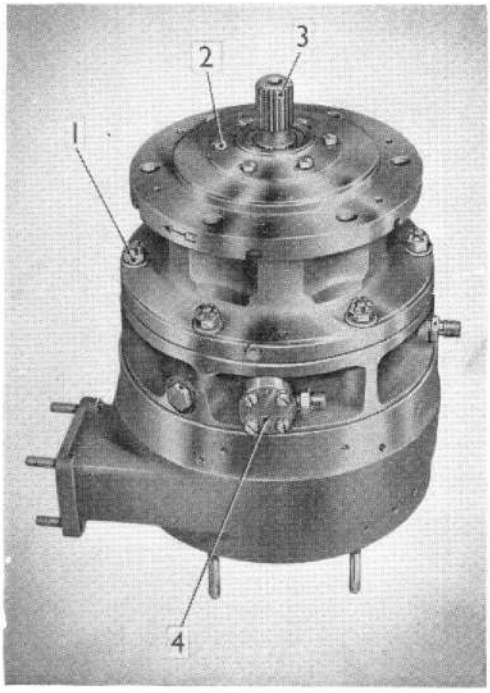


Fig. 17. Brake assembly

tapped holes (12, *fig.* 16) *of the mounting flange and screwing them down evenly.*

(3) Unpeen and remove the 10 BA screw (9) which locks the overspeed governor nut (8). Insert a wooden pencil or peg in one of the nozzle holes between the nozzle plate (3) and the rotor assembly. Remove the overspeed nut and lift off the top cam plate (13), remove pencil.



1 MOUNTING FLANGE RETAINING NUT
2 CLUTCH ASSEMBLY RETAINING SCREW
3 FINAL DRIVE SHAFT
4 OIL PUMP ASSEMBLY

Fig. 18. Drive end of starter

(4) Using a pair of pliers, remove the overspeed shear pin (*fig.* 17) from the brake body.

(5) Fit a new shear pin (K.3288) and ensure that the end of it locates in the drilling in the lower cam plate. Position the top cam plate in the brake body so that the shear pin also enters the drilling in this plate.

(6) Fit and tighten the overspeed nut; a pencil inserted through the nozzle plate will hold the rotors stationary during the operation. Fit the locking screw and centre punch to lock.

(7) Fit a new overspeed brake drum and peen the screws. ▶

Clutch unit

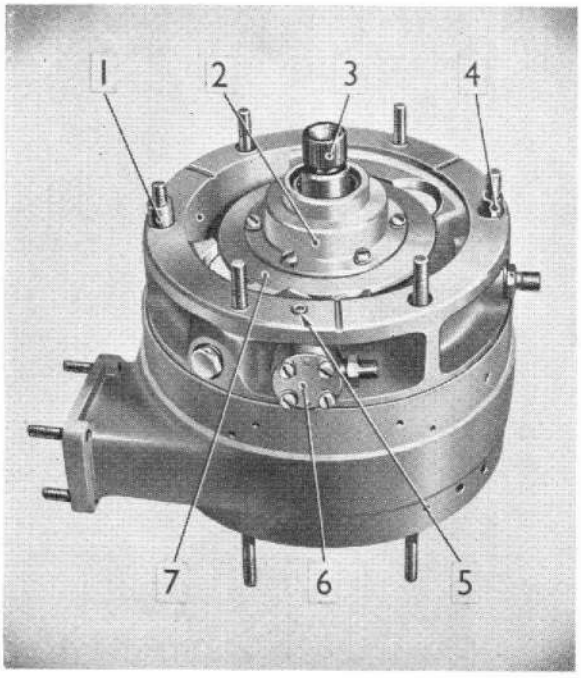
40. To remove the clutch unit—comprising the clutch and mounting flange—invert the starter on a clean bench and proceed as follows:—

(1) Remove the split pins, plain washers and nuts from the clutch housing retaining studs (*fig.* 18) and lift the housing—complete with clutch—from the intermediate bearing housing. Remove the small rubber ring (5, *fig.* 19) and the flange gasket.

◀ (2) Remove the O-ring housing and two O-rings from the top of the flange of the bearing housing (7A, *fig.* 22, *Sect.* 2, *Chap.* 1). ▶

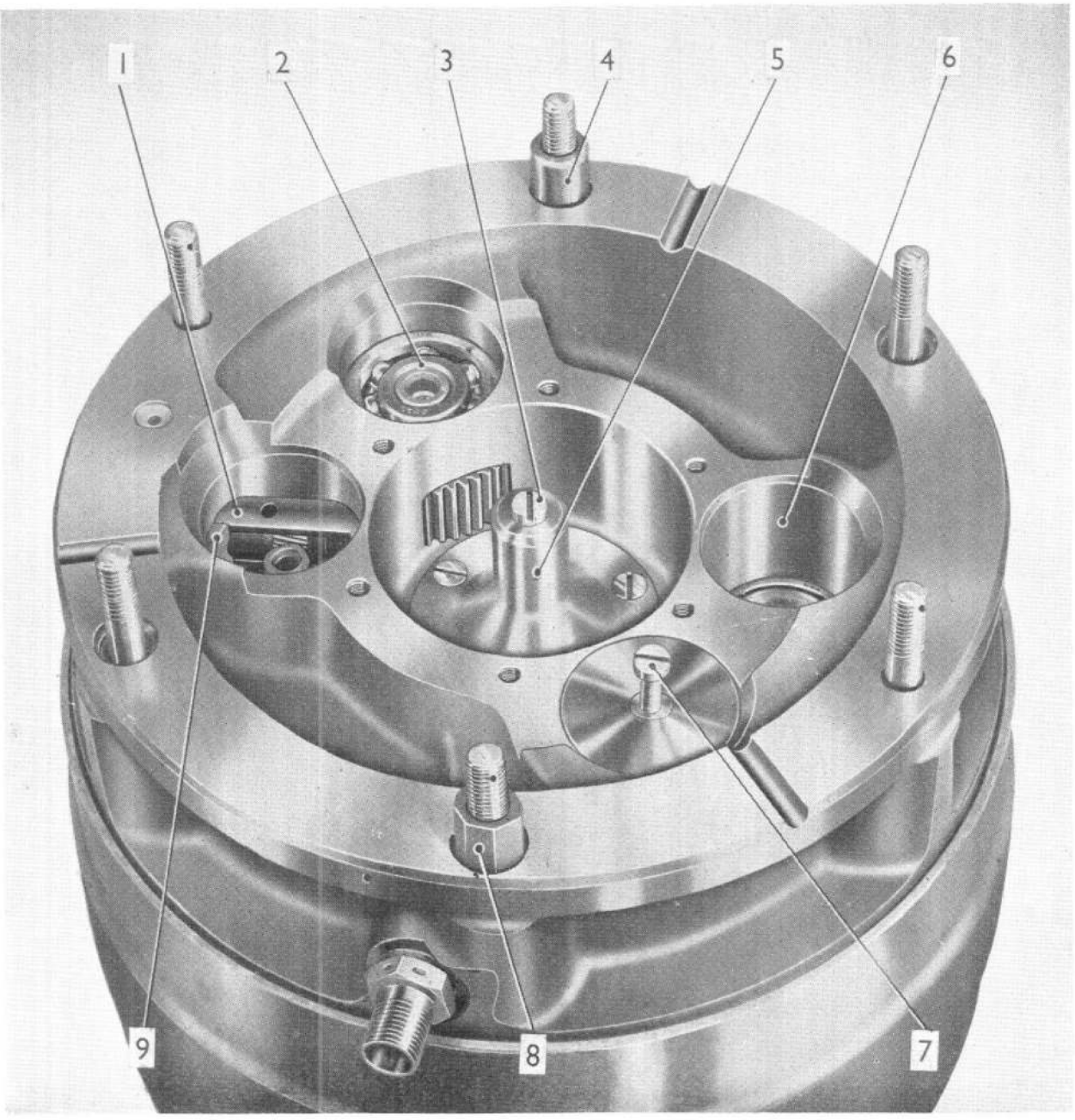
Final drive gear assembly

41. Remove the six cheese-head screws and Grover washers from the mounting flange when the final drive gear (*fig.* 19) together with its bearing housing and the main oil seal housing, can be withdrawn from the intermediate bearing housing.



1 PLAIN DOWEL (Bearing housing)
2 OIL SEAL HOUSING
3 FINAL DRIVE GEAR SHAFT
4 DOWEL
5 OILWAY O-RING
6 OIL PUMP ASSEMBLY
7 BEARING HOUSING FLANGE

Fig. 19. Final drive gear assembly



1 SHAFT TAIL BEARING
2 FIRST-STAGE GEAR BEARING
3 SPRING RETAINER SCREW
4 PLAIN DOWEL
5 SPRING RETAINER
6 BLANKING PLUG HOUSING
7 PLUG EXTRACTOR SCREW
8 DOWEL
9 CUTAWAY SPACER

Fig. 20. Forward end of intermediate bearing housing

Locate the protective sleeve (MK 3829) over the splined end of the final drive gear and remove the oil seal housing (8, *fig.* 33), If it is necessary to remove the bearings detach the retaining circlip and slide the bearing assembly off the shaft.

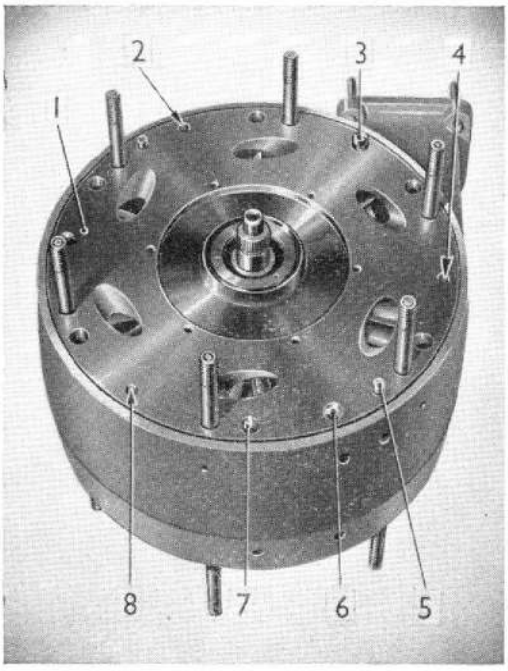
Rotor assembly

42. The rotor assembly, its associated reducing and combining gear train and the intermediate bearing housing are not to be dismantled for servicing and minor repairs. These component parts of the starter are set to fine limits when the starter is assembled by the manufacturer for despatch; reconditioning, when necessary, cannot be carried out without the aid of special tools and jigs. In the event of failure of these components a new starter is to be installed, and the old starter returned to a Maintenance Unit for complete reconditioning.

Oil pump and drive

43. The oil pump may be removed as follows:—

(1) ◄ Remove one screw from the pump and screw it into ► each sealing plug in turn then



1 NOZZLE PLATE
2 EXTRACTOR SCREW HOLE
3 RETAINING SCREW
4 EXTRACTOR SCREW HOLE
5 DOWEL (NOZZLE BODY PLATE)
6 RETAINING SCREW HOLE
7 GAS PASSAGE FROM SAFETY DISC ASSEMBLY
8 EXTRACTOR SCREW HOLE

Fig. 21. Rotor housing

remove the plugs by pulling them from their respective housings.

(2) Remove the three screws from the pump body (*fig.* 19) to release the pump and gasket.

(3) Remove the spigot from the worm wheel shaft and carefully slide the tail shaft bearing (1, *fig.* 20) and worm wheel from its housing.

Note . . .

There is a drilling in the tail shaft bearing in which a small-ended punch can be inserted to facilitate this operation.

Nozzle body plate

44. Invert the rotor housing and proceed as follows:—

◄ (1) Remove the brake drum and overspeed assembly. ►

(2) Remove the three cheese-head screws from the nozzle plate (3, *fig.* 21) and lift the plate off the rotor housing. If necessary the three retaining screws may be inserted in the tapped holes (2), (4) and (8) and evenly screwed down to extract the plate.

(3) Remove the cage and balls from the rear first-stage rotor shaft.

Note . . .

The outer race is removed with the nozzle plate from which it may be detached if renewal is necessary. ◄ *by inserting a small punch through each of the holes drilled in the nozzle plate* (*fig.* 21) *and tapping out.* ►

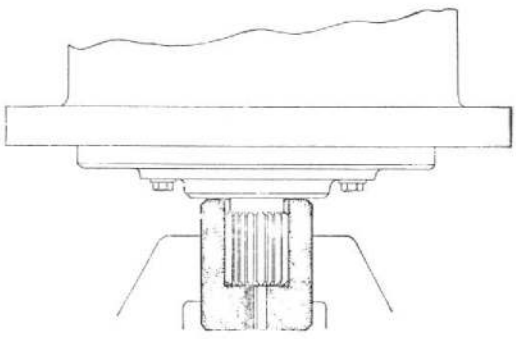


Fig. 22. Clutch assembly in holding fixture

Clutch assembly

45. Normally, it is sufficient to leave the clutch in the mounting flange and to check the torque setting as described in para. 55. If, however, oil ingress to the clutch is suspected, or if difficulty is experienced in obtaining the clutch setting, the clutch may be dismantled as follows:—

(1) Remove the six tab-locked screws from the face of the mounting flange (*fig.* 18); locate the protective sleeve over the final drive shaft and withdraw the clutch from the housing by pushing the shaft and sleeve through the main oil seal. Remove the gasket located between the clutch locking plate and the bottom of the housing.

(2) Locate the final drive shaft in the final drive shaft locking block MK 3860 (*fig.* 22) and remove the four Allen screws from the adjuster ring.

(3) Using spanner MK 3390 unscrew and remove the adjuster ring.

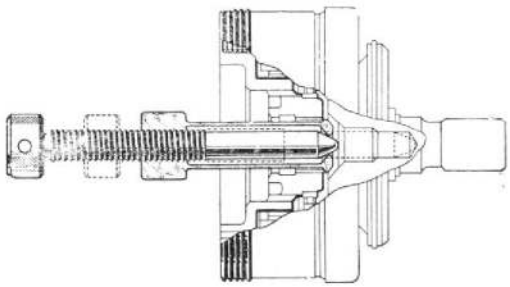


Fig. 23. Clutch housing extractor

(4) Remove the inner housing using extractor MK 3855 (*fig.* 23), taking care to collect the twenty-eight springs located in the inner housing flange. Unscrew the bolt to permit the split collet to be engaged in the final drive shaft, and then screw the bolt down to effect removal. If necessary, the bearing on this housing may be removed by inserting a punch through the small holes inside the housing (17, *fig.* 30), and tapping off the inner race.

(5) Tap out the steel and friction clutch plates but before removing the last plate, i.e., the clutch backing plate (22, *fig.* 30), mark its position relative to the housing to facilitate the alignment of the dowel holes when assembling the clutch.

(6) Remove the circlip and if fitted, the shims from the final drive shaft and withdraw the

shaft bearing and its retainer. The remaining clutch components can now be removed from the drive shaft.

Note . . .

The clutch backing plate is drilled to receive the locking ring dowels. These dowels may fall clear during dismantling and must be accounted for.

Indexing motor and reducing gear train

46. This assembly, which is attached to the barrel locking plate, is removed and dismantled as follows:—

(1) Remove the bolts which attach the assembly to the barrel locking plate (1, *fig.* 24) and remove the two locating dowels which are threaded internally for extraction purposes.

(2) Remove the six cheese-head screws which secure the motor cover (12) to the motor mounting plate (5) and gently separate these two components to obtain access to the breeze plugs (8) and (10). Be careful not to pull on the wiring.

(3) Remove the two breeze plugs from the motor cover and the two screws which secure the limit switch assembly (24) then unscrew the four bolts which retain the motor (11).

(4) Lift the motor, switch assembly and breeze plugs—together with the associated wiring—from the motor mounting plate and remove the greaseguard assembly (6).

◄ (5) Remove the gasket (9) from the motor mounting plate. ►

(6) Remove the locking screw and plate from the cam (16) and withdraw the cam—together with the fibre and steel washer—from the output shaft (22) and recover the drive key (21).

(7) Remove the five screws from the motor mounting plate. Lift off the plate and gasket from the reduction gearbox (2) and remove the four reduction gears (27) leaving the remaining gear (28) in position on the output drive shaft.

◄ (8) Remove the four bearings (29) from the mounting plate by lightly tapping the plate on a wood block. ►

47. If further dismantling of the reduction gear is necessary, remove the locking screw (32) and washer from the pin indexing wheel (34) and remove the wheel and key from the shaft. Hold the output gear (28) and withdraw the shaft from the gear. Remove the shims from the shaft housing and the washer from the shaft. ◄ Remove the four bearings from the reduction gear housing by lightly tapping the housing on a wood block; this block must not foul the two steel dowels in the housing or they may be dislodged. ►

CLEANING

48. Remove all grease, oil and carbon from the dismantled components with lead-free gasoline or trichlorethylene. The nozzle body itself may be effectively decarbonized in a vapour bath, or by repeated immersion in boiling water to which a small quantity of washing soda has been added. On some occasions a stubborn wall of carbon is formed in the safety disc housing. Where this is observed, a decarbonization bit assembly should be employed to cut away the carbon. To use this tool, screw slowly into each safety disc housing in turn. This action will remove the carbon.

49. After cleaning, thoroughly dry all the components with compressed air and protect the surfaces against corrosion by applying a light film of oil OM-13.

INSPECTION

General

50. Although the minor repair is essentially a cleaning and decarbonizing operation, advantage should be taken at this stage to visually inspect the components for obvious damage, pitting, scoring, distortion and corrosion. If any such defects are found, reference should be made to Volume 6, Part 2 of this Air Publication for appropriate action.

51. Observe whether any oil has accumulated in the mounting flange. Oil streaks may be disregarded but oil in a quantity in excess of about 5 C^2 indicates failure of one or more rubber seals in the flange or intermediate bearing housing. These rubber seals comprise an O-ring on each sealing plug in the intermediate bearing housing, both main oil seals and an O-ring on the final drive shaft bearing housing and the final drive gear bearing housing. Also renew the gasket beneath the flange of the rear main oil seal housing, and the gasket between the face of the final drive shaft bearing housing and mounting flange. Each of these items should be replaced.

52. Make a visual inspection for signs of obvious damage such as scored mating surfaces, distortion and corrosion. Generally, corrosion which cannot be removed from a mating or bearing surface by normal cleaning operation will entail rejection of the affected component. Corrosion of other parts may be removed by the usual methods at the discretion of the inspecting authority.

Barrels

53. Inspect the condition of the threads of the barrels.

Nozzle body

54. Inspect the conditions of the threads of the barrel housings and examine the underside and edges of the nozzle body for burrs. Small burrs may be stoned away but further rectification is not permitted.

Clutch

55. Load the clutch into the clutch setting fixture (*fig.* 25) and observe the torque at which the clutch slips. Slip should occur at a torque of 83 lb ft

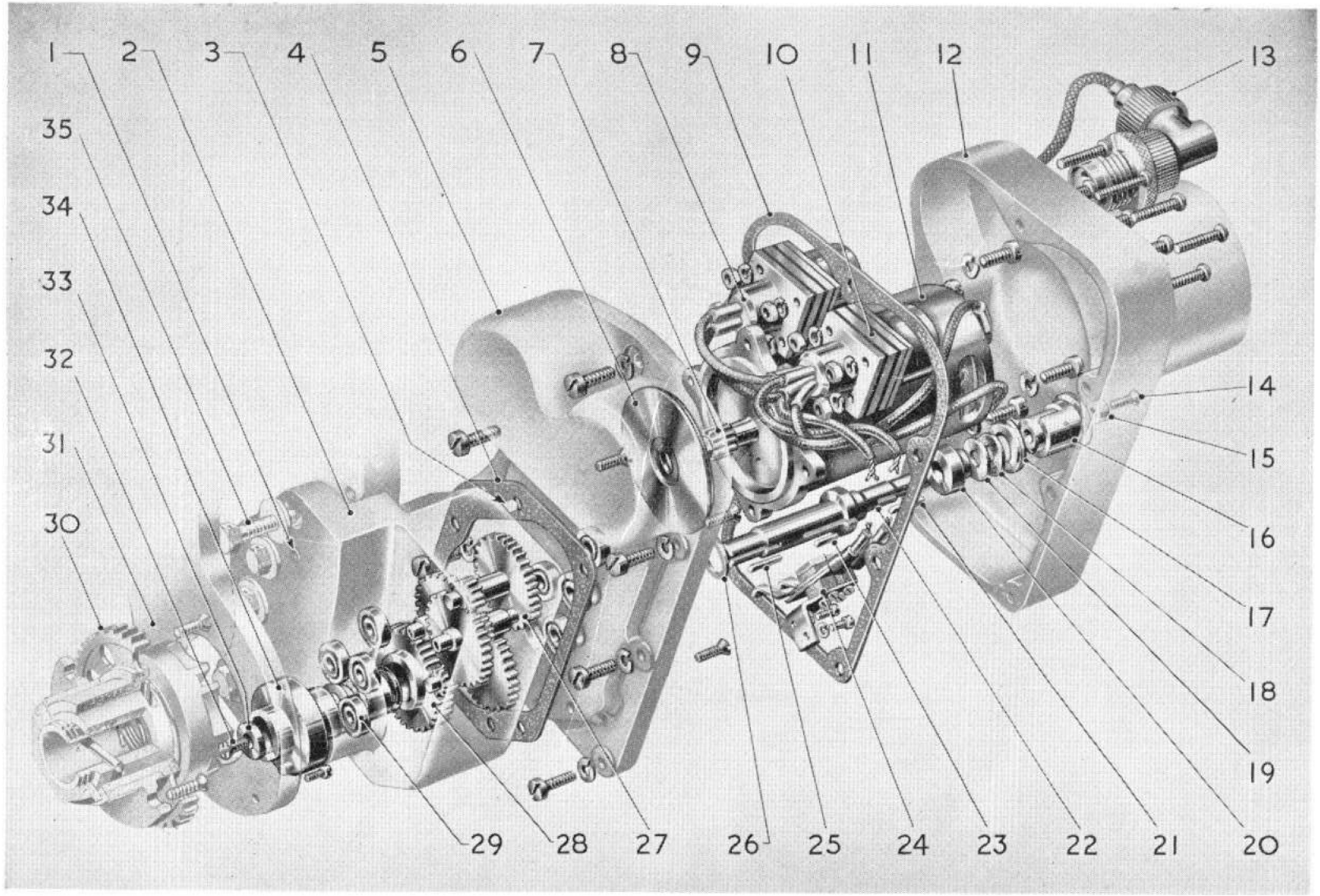


Fig. 24. Exploded view of indexing motor and switch gear

KEY TO FIG. 24

1 GEARBOX BODY LOCATING DOWEL
2 GEARBOX
3 MOTOR PLATE LOCATING DOWEL
4 GASKET
5 MOTOR MOUNTING PLATE
6 GREASE GUARD ASSEMBLY
7 MOTOR DRIVE GEAR
8 BREEZE PLUG
9 GASKET
10 BREEZE PLUG
11 ELECTRIC MOTOR
12 MOTOR COVER
13 OVERSPEED BREEZE SOCKET
14 SWITCH CAM LOCKING SCREW
15 CLAMPING PLATE
16 CAM ASSEMBLY
17 LOWER INSULATOR (Cam)
18 INSULATING WASHER (Cam)
19 WASHER (Cam)
20 MOTOR PLATE BUSH
21 KEY (Cam)
22 OUTPUT DRIVE SHAFT
23 GEAR KEY
24 SWITCH ASSEMBLY
25 PIN INDEXING WHEEL KEY
26 WASHER
27 GEAR TRAIN
28 OUTPUT GEAR
29 BALL BEARING
30 GENEVA ASSEMBLY
31 FRONT PLATE
32 PIN INDEXING WHEEL LOCKING SCREW
33 WASHER
34 PIN INDEXING WHEEL
35 GEARBOX MOUNTING SCREWS

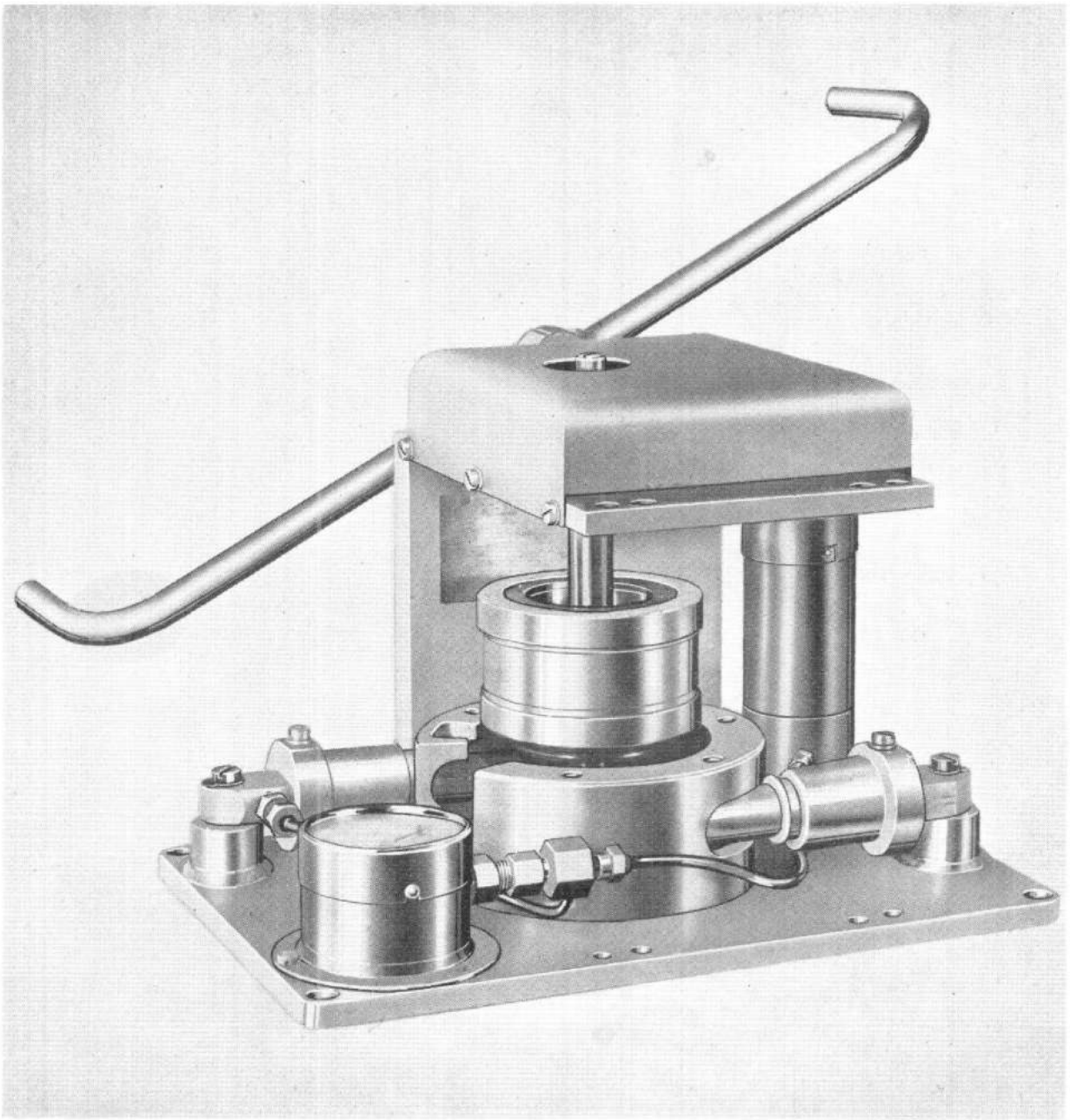


Fig. 25. Clutch setting fixture

to 92 lb ft; the steady slip torque should not be less than 76 lb ft. If an adjustment is necessary, proceed as follows:—

(1) Remove the four Allen locking screws (*fig.* 30).

(2) Apply the adjusting spanner MK 3391 to the end-cap and screw the cap in or out to increase or decrease the torque to obtain a figure within the limits quoted. The cap must be turned by increments so that the Allen screw holes are always aligned with four of the circle of holes drilled in the flange of the inner housing. Use one Allen screw to lock the cap after each adjustment.

(3) To ensure that a constant torque setting is obtained the clutch should be exercised 50 times through 90° (approximately) and reset as necessary during this operation. The intervals between exercising should be sufficient to prevent overheating; i.e. 30 sec minimum.

(4) Fit the four Allen screws and lock them by peening.

56. If the required torque is difficult to obtain or if the torque measured initially on a removed clutch is excessively high or low, the clutch should be stripped as detailed in para. 45. The clutch plates should then be inspected for oil ingress and for deep scoring, corrosion and burning. Renew damaged plates. Also examine the bearing surfaces between components (8), (22) and (3) (*fig.* 30), to confirm that they are smooth. If they are scored the parts should be renewed. When this work is completed the clutch may be re-assembled as detailed in para. 80; the correct adjustment should be obtained without difficulty if the instructions are followed.

Overspeed assembly

57. Before any repairs are made to the overspeed assembly reference should be made to the limitations imposed by para. 38.

58. If the overspeed assembly has operated, the brake unit and the drum must be renewed. The overspeed cable assembly can be used again provided the insulated pins are not burnt or welded. It is most important that the cause of the overspeed be determined to avoid an immediate repetition when the starter is next fired. Apart from the control panel and the engine, to which separate reference should be made, the most likely cause of an overspeed is a sheared starter component or ingress of oil into the clutch unit.

LUBRICATION

General

59. During the assembly of the starter and firing head, special attention should be given to the following instructions to ensure correct and adequate lubrication. All lubrication should be applied progressively as the assemblies are built up and in the assembling instructions these lubrication notes will be taken as read.

Grease XG-285

60. A light coating of this grease must be applied to all items in the firing head, with the exception of the firing pins.

Grease XG-278

61. The following items must be lubricated with this grease:—

(1) The indexing gear train and bearings

(2) Pin indexing wheel

(3) Geneva wheel

(4) The forward final drive shaft bearing

(5) The internal bearing between the final drive shaft and the clutch inner housing (apply sparingly)

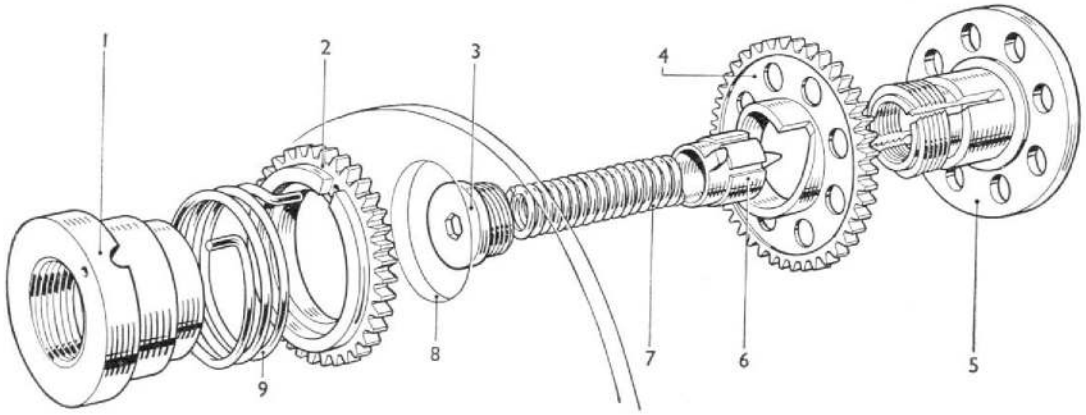
(6) Firing pins and springs.

Oil OM-13

62. Apply this oil to the remaining parts of the starter—including the reducing and combining train—and all ball bearings except the two detailed in para. 61, sub-para. (4) and (5).

Note . . .

Except for lubrication of the two ball bearings detailed in para. 61, *sub-para.* (4) *and* (5) *and a very*



1 THRUST NUT
2 SEALING GEAR
3 END-CAP
4 FIRING GEAR
5 SEALING PAD
6 FIRING PIN
7 FIRING PIN SPRING
8 CENTRE PLATE
9 TORSION SPRING

Fig. 26. Exploded view of sealing and firing mechanism

light smear of grease XG-275 to the O-rings; on no account must any form of lubrication be applied to the clutch assembly.

Other lubricants

63. ◂(1) Use grease XG-275 sparingly on all renewed O-rings.

(2) Use compound PX-7 on the inner race and cage of the rear rotor bearings.

(3) Use grease ZX-13 on all threaded components in the nozzle body.▸

ASSEMBLING FIRING HEAD

Firing gear assembly

64. Each firing gear assembly should be provisionally assembled as follows, care being taken that the sealing pad and firing gear of each assembly carry the same code number.

(1) Locate the firing gear (*fig.* 26) on the sealing pad.

(2) Slide the firing pin—pin first—into the sealing gear and position the firing pin lugs on the lowest point of the cam.

Note . . .

Each cam and firing pin is "handed" right or left as an assembly. It is important to check that the firing pin used in each assembly has the same "hand" as the cam of that assembly. Correct positioning in this respect is denoted when the chamfer on the firing pin lug mates with the top surface of the cam.

(3) Replace the end-cap finger-tight.

Note . . .

The firing pin spring is not included at this stage.

Centre gear and stop assembly

65. To re-build this unit, position the stop sleeve, washer, spring and centre sleeve over the centre gear so that the slots in the centre gear and stop sleeve and the hole in the centre sleeve are all aligned. (*Refer to fig.* 11.) Depress the centre sleeve against the spring pressure so that the two slots and the hole are aligned and insert the stop pin.

66. The assembly (2, *fig.* 27) is fitted to the firing head as follows:—

(1) Enter the centre gear and stop assembly into the central housing in the firing head so that the cut-away machined in the flange of the stop sleeve locates over the dowel.

(2) Fit and tighten the five retaining screws and lock them by peening.

Note . . .

Unless the assembly has been disturbed, its position will be as stated in para. 26, *sub-para.* 1, *i.e. access to the screw holes will exist. If the setting has been disturbed, depress the handle sleeve and rotate it until the holes in the flange of the centre gear uncover the screw holes.*

(3) Looking on the underside of the firing head (*fig.* 7), turn the centre gear anti-clockwise until the stop pin is heard to click home in the stop sleeve. This corresponds to the forward position of the sealing pads when fitted.

(4) Invert the head and position the handle assembly on the centre sleeve in the position denoted by the lines previously scribed (*para.* 26, *sub-para.* 3).

(5) Fit the instruction label, locking disc and the six retaining screws and peen the screws into position.

Warning . . .

From this point onwards it is essential that the centre gear and stop assembly be kept in the position detailed in sub-para. (3). *If any attempt is made to assemble the sealing or firing gears with the centre gear in any position, mistiming of the mechanisms will result which may cause serious damage to the starter when it is operated.*

Sealing gear assembly

67. If, as noted in Para. 29 a new torsion spring is required, it should be fitted as follows:—

(1) Locate the spring (*fig.* 26) over the thrust nut so that the longer of the two legs enters the drilling in the thrust nut collar.

(2) Position the sealing gear on the thrust nut so that the short leg enters the drilling in the flange of the sealing gear.

(3) Repeat this procedure for the five remaining assemblies.

Timing the sealing gear assemblies

68. It is important that the following method of assembly be closely observed.

(1) Locate the spacer in the thrust nut of No. 6 sealing gear assembly.

(2) Remove the end-cap, firing pin and firing gear (*fig.* 26) from No. 6 sealing pad and screw the pad finger-tight into the thrust nut.

(3) Enter the thrust nut in No. 6 housing on the firing head and position the assembly so that the key-way in the pad points to the centre of No. 2 housing. Refer to fig. 28.

Note . . .

The position of the key-way is indicated by a line etched on the face of the pad.

(4) Maintaining the sealing pad in this position, mesh the sealing gear to the centre gear at the nearest tooth setting.

(5) Locate the front plate in position over the sealing pad so that the key in the plate enters the key-way in the pad. In this position the stud holes in the locking plate and in the firing head should align. If they fail to do so, remove the plate and adjust the mesh of the sealing gear in the appropriate direction to

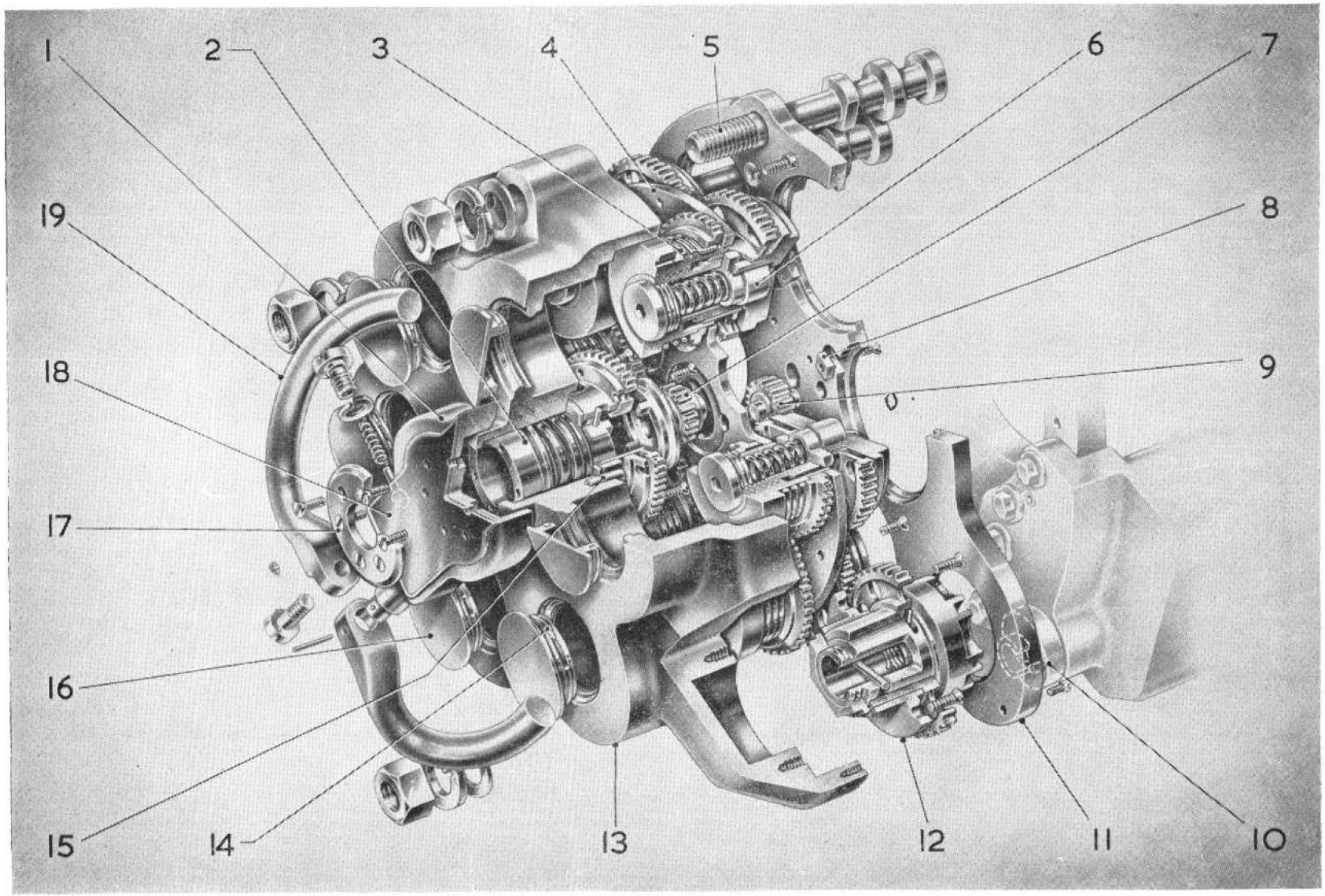


Fig. 27. Exploded view of firing head

KEY TO FIG. 27

1 HANDLE ASSEMBLY
2 CENTRE GEAR
3 SEALING AND FIRING ASSEMBLY
4 CENTRE PLATE
5 STUD
6 FIRING PIN
7 INDEXING GEAR
8 SEALING PAD LOCKING KEY
9 IDLER GEAR
10 PIN INDEXING WHEEL
11 FRONT PLATE AND KEYS ASSEMBLY
12 GENEVA (HEAD) ASSEMBLY
13 FIRING HEAD
14 CIRCLIP
15 STOP SLEEVE LOCATING DOWEL
16 SEALING CAP
17 LOCKING DISC
18 INSTRUCTION LABEL
19 HANDLE

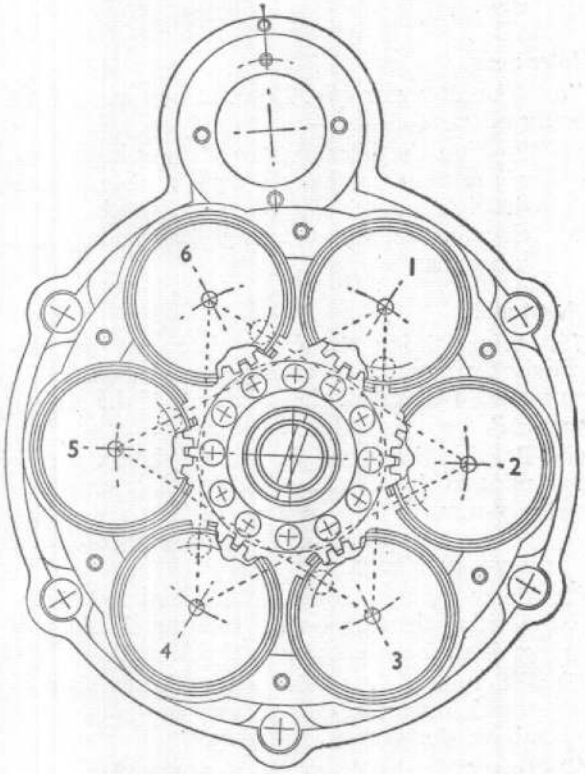


Fig. 28. Timing the sealing gears

obtain alignment. A single tooth re-setting is usually sufficient. When checking the alignment of the front plate make sure that the sealing pad remains nipped against the spacer.

(6) Remove the locking plate and *leaving the sealing gear in mesh*, unscrew and remove the sealing pad and spacer.

(7) Assemble the firing pin assembly as detailed in para. 64.

(8) Repeat the foregoing procedure for each sealing gear assembly in turn, working anti-clockwise from No. 6 to No. 1; always ensure that the coding of each sealing pad, sealing gear and housing coincide. The respective housing to which the key-way in each sealing pad should point is clearly indicated in fig. 28. Counting clockwise, it is in fact, the second housing from the assembly in question.

Index gear

69. To position the index gear (*fig.* 7), locate the spigot of the gear in the bore of the centre gear. Check that this gear is free to rotate, since failure to do so will indicate an incorrect handle position.

Centre plate

70. Fit the centre plate as follows:—

(1) Position the centre plate (*fig.* 27) over the thrust nuts so that the screw holes in the plate and in the firing head coincide, then press the plate down into position so that each of the six thrust nuts is located at its forward end by the plate.

(2) Fit and tighten each of the five cheese-head screws complete with a single coil spring washer.

(3) Fit and tighten the countersunk locating screw which should be locked by peening.

(4) Operate the handle assembly and check that the gears move smoothly then return the handle to the pad forward position.

Geneva assembly

71. Assemble this unit as follows (*refer to fig.* 10):—

(1) Position the torsion spring in the bore of the geneva wheel spindle so that the long leg is located in the slot and the short leg in the drilling of the geneva wheel spindle.

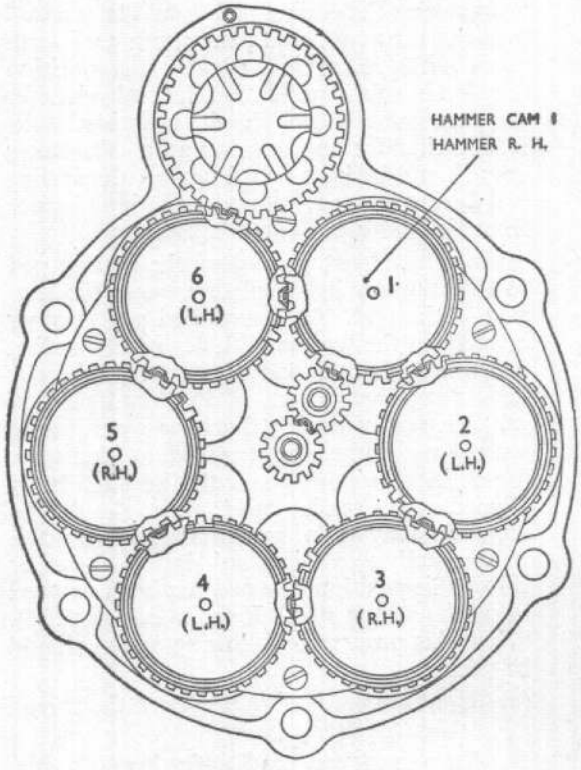


Fig. 29. Timing the firing gears

(2) Assemble the geneva wheel to the geneva gear, align the slots and the drilling in the gear and insert the stop-pin.

(3) Assemble the bronze bush to the geneva wheel and retain it in position with the lock-nut.

72. To fit this component (*fig.* 5 *and fig.* 27) proceed as follows:—

(1) Locate the bush of the geneva assembly in the housing in the firing head.

(2) Align the four holes in the bush flange with the screw holes in the housing.

(3) Obtaining access through the holes in the flange of the geneva gear, fit and tighten the four countersunk screws and lock them by peening.

Timing the firing gear assemblies (*fig.* 29)

73. To obtain the correct position of the firing gears and geneva gear, certain of the gear teeth are marked with a male or female chamfer. A male chamfer is denoted by a chamfer on the tooth itself whilst a female chamfer is denoted by a chamfer between two adjacent teeth. Before commencing assembling operations, ensure that the handle assembly is locked in the pad forward position and then proceed as follows:—

(1) Position the geneva gear so that the male chamfer points to the centre of No. 6 housing.

(2) Locate No. 6 firing mechanism in No. 6 thrust nut so that the three female chamfers on the firing gear point to No. 5 housing, to No. 1 housing and to the male chamfer on the geneva gear respectively.

(3) The firing assembly, the sealing pad spindle of which has a two start thread, should now be rotated a short distance in each direction to find the nearest start. Having found the nearest start the sealing pad should be screwed into the thrust nut until the firing gear teeth mesh with the geneva gear in the position detailed in sub-para. (2), i.e. the male chamfer on the geneva wheel should now bisect the female chamfer on the firing gear. The firing gear should be kept raised against the sealing pad during this operation to avoid interference from the firing pin lugs.

(4) Position the front plate over the sealing pad so that the key in the plate engages the key-way in the pad. An improvised peg spanner inserted in the two small holes in the sealing pad will enable the pad to be rotated thereby facilitating engagement of the key and key-way, especially during the later stages when several pads must be engaged at the same time. In this position, with the stud holes aligned, the sealing pad face should be approximately $\frac{1}{16}$ in. proud of the front plate. If the sealing pad is considerably above or below this position, the pad has been screwed in on the wrong start. Refer to sub-para. (3). When this occurs the following action should be taken:—

(*a*) Unscrew the sealing pad until the thread is felt to disengage.

(*b*) Turn back the pad a further 180 deg. until the next start is felt.

(*c*) Proceed as in sub-para. (3) except that there will now be no need to rotate the assembly to find the correct start.

(5) Remove the front plate and position the firing gear as in sub-para. (2) and the key-way as in sub-para. (6).

(6) Locate No. 5 firing mechanism in No. 5 thrust nut so that the male chamfer on the firing gear points to the centre of No. 6 housing and the female chamfer points to the centre of No. 4 housing.

(7) Proceed as from sub-para. (3) to (7) except that in sub-para. (3) and (6) the mating chamfers and the direction of the pad key-way will be as shown in fig. 29.

(8) Assemble the remaining four assemblies as detailed in sub-para. (3) and sub-para. (7) referring to fig. 29 for correct firing gear and sealing pad positions. Check the position of the sealing pad with the front plate in each case.

Idler gear

74. The idler gear (*fig.* 29) must be timed to the index gear as follows:—

(1) Position the idler gear in its housing in the centre plate so that the female chamfers on the idler gear are bisected by the male chamfers on the indexing gear and No. 1 firing gear.

Front plate

75. When fitting the front plate, use the improvised peg spanner as suggested in para. 73, sub-para. 4 to adjust the positions of the sealing pads. Proceed as follows:—

(1) Position the plate (*fig.* 5) over the six sealing pads so that the keys on the plate enter the key-ways of the sealing pads, to do this, commence with No. 6 pad and locate each pad key-way in turn.

(2) Enter the five studs in the stud holes and position the flats on the locating shoulder of each stud tangentially to the firing head.

(3) Fit and tighten the cheese-head screw—together with a Grover washer—in position above the geneva assembly.

(4) Invert the head and fit a pen steel washer, spring washer and nut to each stud and tighten the nuts.

Firing pin springs

76. The fitting of the firing pin springs should be carried out as follows:—

(1) Unscrew and remove the end-cap from each firing assembly (*fig.* 26) access to which is obtained through the top of the firing head.

(2) ◂ Insert a firing hammer spring in each assembly then replace and tighten each end cap using tool MK 3843. ▸

Checking the assembly of the firing head

77. To prove correct assembly of the firing head the following three checks should be made.

(1) Lay a straight-edge across two sealing pads at a time and ensure that all the pads stand proud of the locking plate by the same amount.

(2) Depress the handle assembly and rotate it anti-clockwise and clockwise a number of times to check the following points.

(*a*) All six firing assemblies should move backwards and forwards in unison.

(*b*) The mechanism should operate smoothly and silently.

(*c*) The handle assembly should lock completely and securely at each end of its travel.

Warning . . .

At the conclusion of these checks the handle assembly must be locked in the pad forward position before proceeding with the next check. Any attempt to operate the indexing mechanism when the sealing pads are retracted will cause the gears to jam, and necessitate corrective action as described in para. 79.

(3) Insert the indexing key in the slots of the geneva wheel and rotate the wheel clockwise. As the wheel is rotated the following pairs of firing pins should fall simultaneously, and in the order given: 1 and 4, 2 and 5, 3 and 6. No. 1 and 4 need not necessarily be the first pair to fire, but after No.1 and 4 have fired No. 2 and 5 and 3 and 6 should follow. If this sequence does not occur the firing gears have been incorrectly assembled. Refer to para. 73.

After the foregoing checks have been satisfactorily completed, retract the sealing pads and then bring them forward again. This will withdraw the firing pins into the sealing pads where they may safely remain.

Sealing plugs

78. The six sealing plugs should not be replaced until inspection after testing as (*detailed in para.* 95) has been satisfactorily concluded, following which each plug should be pressed down flush with the top of the firing head. Refer to fig. 4.

Jammed firing head

79. If, as stated in para. 77, the firing head is indexed with the sealing pads retracted, the firing gears will jam. When this occurs the following corrective action should be taken.

◄ (1) Invert the firing head and secure it in a soft-jawed vice by the handle attachment.

(2) Locate a firing head depressor MK 3862 over the head of each firing pin which is in the fired position.

(3) Depress the pins to the limit of their travel and rotate the firing head clockwise. This action will automatically retime the firing mechanism.

(4) Remove the firing pin depressors and carry out the checks detailed in para. 77. ►

ASSEMBLING THE STARTER BODY

Assembling the clutch

80. When assembling the clutch the friction plates must be perfectly clean and dry. The steel plates should be handled by the edges to avoid hand perspiration marking the surfaces. ◄ Apply a smear of grease XG-275 to all O-rings before assembling. ► Proceed as follows:—

(1) ◄ Locate a new O-ring K.3240 ► in the groove of the clutch backing plate (*fig.* 30) and fit the plate over the final drive shaft—dowel holes facing forward.

(2) Locate a new O-ring (K.3239) in the second groove in the backing plate.

(3) Fit the spacer—inner chamfered edge first—and then the bearing and the retainer, over the final drive shaft and retain these items with a new circlip (P.79667/8). Any shims originally positioned between the circlip and inner race must be re-fitted, adding additional shims if necessary to ensure a snug fit.

(4) Locate the copper gasket in the outer housing, align the marks previously scribed on the backing plate and outer housing and fit the plate and final drive shaft into the housing. Push the plate well down, ensuring that the O-ring does not become displaced, and check that the dowel holes in the plate, gasket and locking ring are aligned.

(5) Commencing with a fibre plate, load alternative fibre and steel friction plates to the splined length of the outer housing and drive shaft, finishing with the steel clamping plate—coded side outwards.

(6) Place a new O-ring (K.3241) in the groove machined in the inner housing and lightly grease the bearing on this component.

(7) Fit the twenty-eight springs in the flange of the inner housing and enter the inner housing in the outer housing. Ensure that the O-ring and bearing on the inner housing enter the final drive shaft, their correct location being made by "feel".

(8) Fit new O-rings (K.3242 and K.3239) to the O-ring retainer and locate the retainer between the inner and outer housings. Note from figure 30 the correct method of assembling the retainer and avoid pinching the rings during this operation.

(9) Screw the adjusting ring finger-tight on to the outer housing.

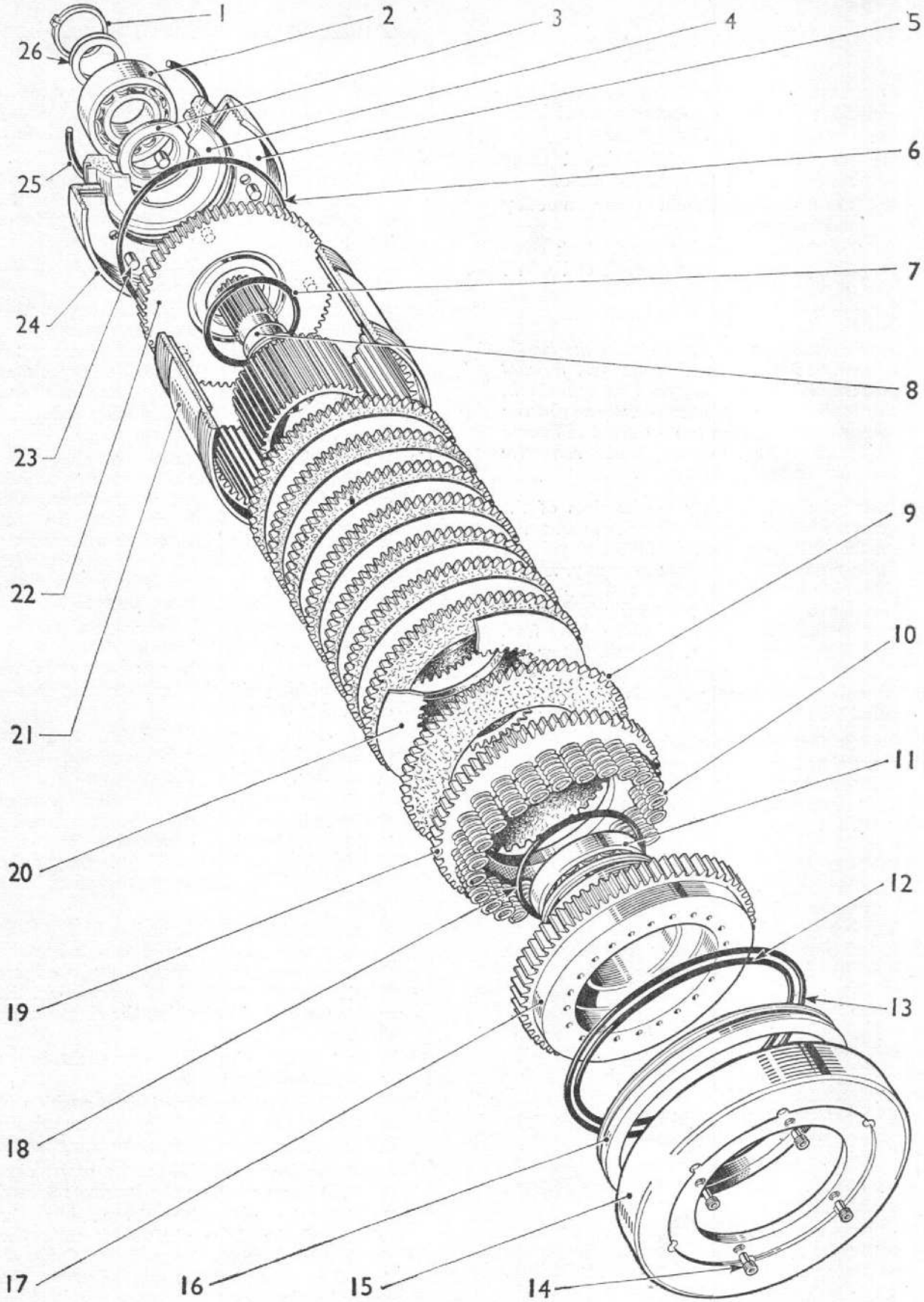
(10) Lightly tap the three dowels into position in the locking ring and backing plate and retain the dowels by peening the surrounding metal.

(11) Locate an O-ring (K.3238) and a new gasket (K.3156) in position on the bearing retainer.

(12) Position the protective sleeve over the splines of the drive shaft and enter the clutch assembly into the mounting flange so that the screw holes align. Remove the protective sleeve.

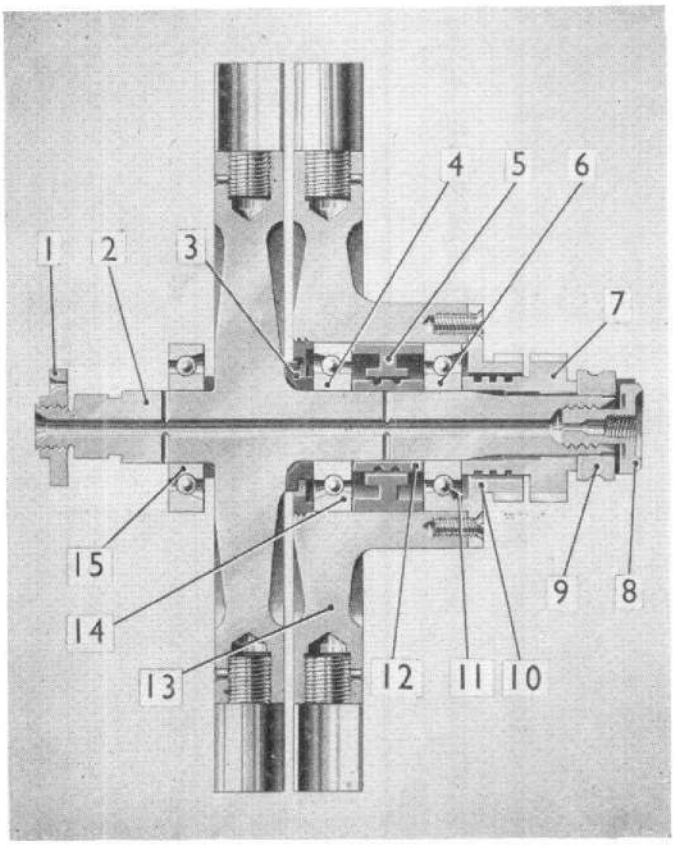
(13) Fit and tighten the six retaining screws and lock them with new tabwashers.

(14) Set the clutch torque as detailed in para. 55 then fit the four Allen screws which lock the adjuster ring, and finally lock the screws by peening the surrounding metal.



1 SEAGER CIRCLIP
2 FINAL DRIVE SHAFT BEARING
3 SPACER
4 BEARING RETAINER
5 GASKET
6 O-RING
7 O-RING
8 DRIVE SHAFT
9 FIBRE CLUTCH PLATES
10 CLUTCH LOADING SPRINGS
11 BALL BEARING
12 O-RING
13 O-RING
14 ADJUSTER RING LOCKING SCREWS
15 ADJUSTER RING
16 O-RING RETAINER
17 INNER CLUTCH HOUSING
18 O-RING
19 STEEL CLAMPING PLATE
20 STEEL CLUTCH PLATE
21 OUTER CLUTCH HOUSING
22 CLUTCH BACKING PLATE
23 LOCKING PIN
24 LOCKING RING
25 O-RING
26 SHIMS

Fig. 30. Exploded clutch assembly



1 BRAKE ASSEMBLY RETAINING NUT
2 FIRST-STAGE ROTOR SHAFT
3 SPACER
4 SECOND-STAGE REAR INNER RACE
5 OUTER SLEEVE
6 SECOND-STAGE FORWARD INNER RACE
7 FIRST-STAGE ROTOR GEAR
8 CLAMPING PLUG
9 FIRST-STAGE FORWARD INNER RACE
10 SECOND-STAGE ROTOR GEAR
11 BALL BEARINGS (PAXOLIN CAGED)
12 LABYRINTH SLEEVE
13 SECOND-STAGE ROTOR
14 SECOND-STAGE REAR OUTER RACE
15 FIRST-STAGE REAR INNER RACE

Fig. 31. Section of rotor assembly

Nozzle plate

81. Before fitting the nozzle plate, the rear first-stage bearing (15, *fig.* 31)—the outer race of which is carried in the nozzle plate—must be assembled. A new paxolin ball cage (K.3228) will be required. This should be checked and the utmost cleanliness observed in the assembly. Inspect the ball housing and with a sharp knife remove any fibrous hairs from the perimeter of the housing.

(1) Lightly apply grease PX-7 to the inner race and cage of the rear rotor bearing, place the cage over the inner race and load the ball bearings into the cage.

(2) Locate the nozzle plate over the nozzle body studs so that:—

(*a*) Gas passages line up.

(*b*) Dowels are positioned as shown in fig. 21.

(3) Retain the plate and shroud ring with three cheese-head screws—no locking device is necessary.

(4) Invert the rotor housing.

◂ Pump assembly

82. Ensure that the mating surfaces of the pump housing and mounting flange are perfectly clean, then proceed as follows:—

(1) Locate the cut-away spacer, with the cut-away section to the top, in the bearing carrying the worm drive.

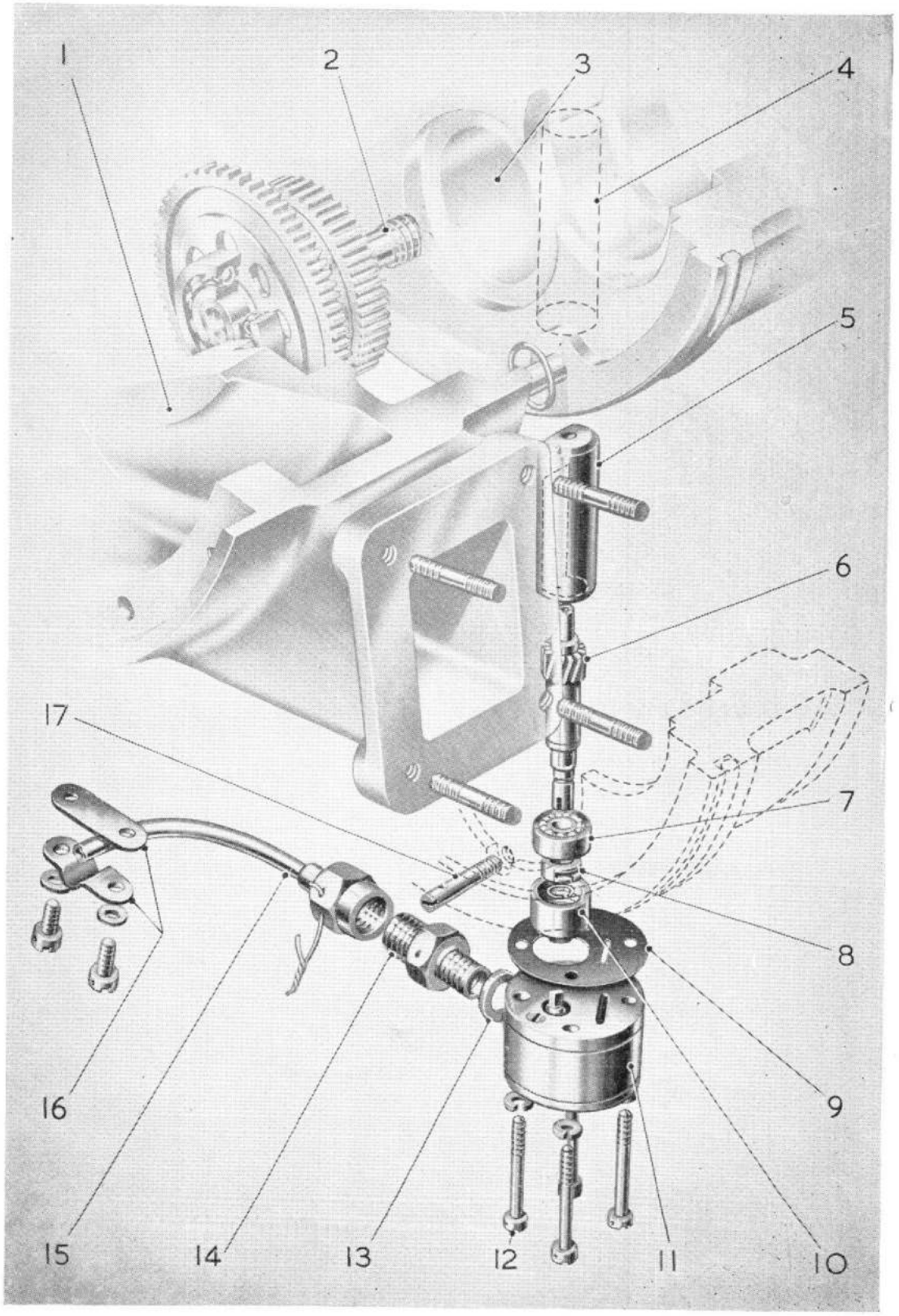
(2) Position the worm wheel in the tail shaft bearing and enter it into the transverse housing in the intermediate bearing housing. Engage the worm and wheel by rotating the rotors, then push the tail shaft bearing right home.

Note . . .

The bearing and retaining clip usually remains assembled to the worm wheel shaft.

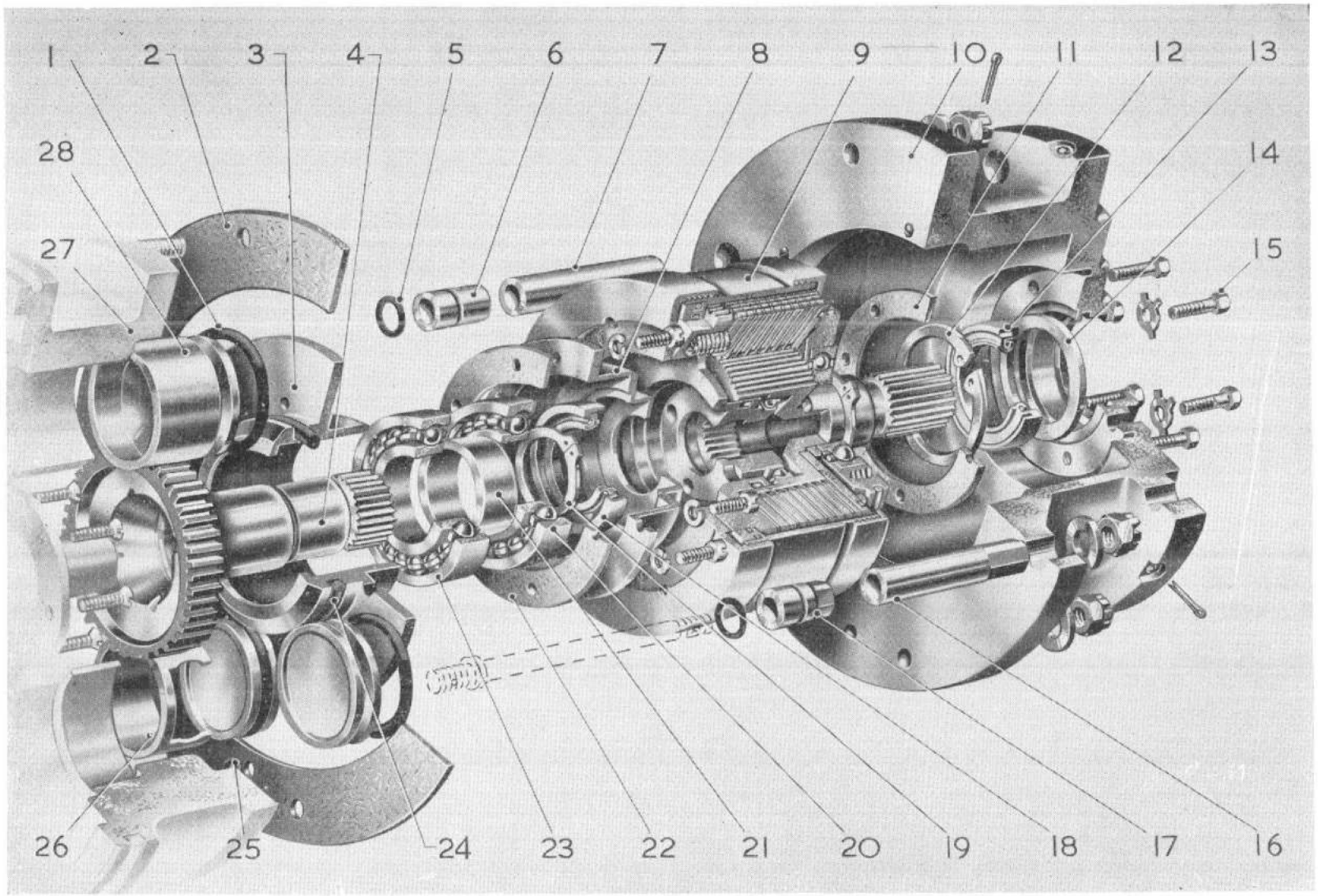
(3) Place the spigot, large end first, over the worm wheel shaft.

(4) Fit a dry gasket to the face of the pump and engage the tongued end of the pump with the slotted end of the worm wheel shaft.



1 ROTOR HOUSING
2 WORM DRIVE
3 PUMP DRIVE WELL
4 TAIL SHAFT BEARING POSITION
5 TAIL SHAFT BEARING
6 WORM WHEEL ASSEMBLY
7 BALL BEARING
8 BEARING RETAINER CLIP
9 GASKET
10 SPIGOT
11 OIL PUMP ASSEMBLY
12 OIL PUMP RETAINING SCREWS
13 GASKET
14 MALE UNION
15 OIL PIPE SUB-ASSEMBLY
16 PIPE CLIP

Fig. 32. Exploded view of oil pump and drive



1 O-RING
2 GASKET
3 BEARING HOUSING
4 FINAL DRIVE GEAR
5 O-RING
6 PLAIN ROTOR HOUSING DOWEL
7 PLAIN BEARING HOUSING DOWEL
8 OIL SEAL HOUSING
9 CLUTCH ASSEMBLY
10 MOUNTING FLANGE
11 GASKET
12 SEEGER CIRCLIP
13 OIL SEAL
14 OIL SEAL BACKING PLATE
15 CLUTCH RETAINING SCREWS
16 DOWEL
17 DOWEL
18 OIL SEAL
19 SEEGER CIRCLIP
20 FINAL DRIVE GEAR BEARING
21 SPACER
22 GASKET
23 FINAL DRIVE GEAR BEARING
24 O-RING
25 O-RING
26 CUTAWAY SPACER (Oil pump drive)
27 INTERMEDIATE BEARING HOUSING
28 SEALING PLUG

Fig. 33. Exploded view of clutch from mounting flange

(5) Rotate the pump housing to line up the pump retaining screw holes. Insert and tighten three of the cheese-head screws complete with spring washers.

Note . . .

The fourth screw is with the spring retainer.

(6) Fit the remaining sealing plug, threaded hole uppermost, in the race housing. ▶

Final drive gear assembly

83. This assembly should be fitted as follows:

(1) Locate a gasket (22, *fig.* 33)—in good condition—on the flange of the oil seal housing.

(2) Fit the oil seal mounting sleeve over the final drive gear shaft and slide the housing and seal over the sleeve until the flanges of the oil seal housing and bearing housing are in contact. Remove the oil seal mounting sleeve.

(3) Lightly smear grease XG-275 on a new O-ring (K.2343) and locate the ring on the bearing housing with the aid of the mounting sleeve. Position the bearing housing in the central bore of the intermediate bearing housing (*fig.* 19) so that the final drive gear engages the top driven gear of each first-stage assembly.

(4) Retain the bearing housing by fitting six cheese-head screws, with spring steel washers.

Clutch and mounting flange

84. Remove the nuts and distance pieces from the rotor housing studs and then proceed as follows:

(1) Insert the two long dowels over the two studs located in enlarged stud holes in the intermediate bearing housing (*fig.* 19). Both the intermediate bearing housing and the clutch housing flatted dowels must be located on the same stud.

(2) Replace O-ring housing (K.11548) and fit two new O-rings on the forward end of the intermediate bearing housing. ▶

(3) Place a new O-ring (V.8301) over the oilway in the flange of the intermediate bearing housing (5, *fig.* 19), and position a new gasket (K.3829) on the face of the flange so that the oilway is clear.

(4) Locate the mounting flange and clutch over the final drive shaft and retaining studs so that the oilways are aligned.

(5) Fit plain washers and castellated nuts to the retaining studs, tighten and lock each nut with a new $\frac{1}{16}$ in. stainless steel split pin.

(6) Mount the starter in the vice fixture.

Overspeed assembly

85. Prior to commencing any work on the overspeed assembly reference should be made to the limitations imposed by para. 38.

86. Special attention should be given to the following sequence of operations to avoid assembling the brake shoes incorrectly.

(1) Position the brake body on the bench so that the lock screw holes for the overspeed nut are uppermost (9, *fig.* 16).

Note . . .

The shear pin (K.3288) *must be renewed every time this assembly is rebuilt.*

(2) Fit the three shoes to the brake so that with the body positioned as in sub-para. (1) the shoes point clockwise; i.e. the shoes must trail in the direction of rotation. (*Refer to fig.* 34).

(3) Position the two overspeed plates, one each side of the brake body, so that the small hole on each plate locates over the reduced end of the shear pin and the cam pins locate in the cam slots.

(4) Place the overspeed clamping sleeve (22, *fig.* 34) shouldered end first over the rotor shaft so that the collar locates on the rear race.

(5) Maintaining the position detailed sub-para. (1) locate the brake assembly on the splines of the rotor shaft.

(6) Fit, and nip tight, the overspeed nut, inserting a piece of wood in a nozzle plate to hold the rotor. Check that one of the two locking holes in the brake body line up with one of the holes in the lock-nut. If this condition cannot be obtained without forcing the nut, reposition the brake body on the rotor shaft splines.

(7) Fit and tighten the 10 B.A. locking screw which should be locked by peening.

(8) Locate the brake drum (*fig.* 16) over the overspeed assembly, align the screw holes and fit and tighten the six 4 B.A. countersunk screws. Lock these screws by peening.

(9) Spin the rotors and ensure that they are free to rotate.

Nozzle body oil plug

87. Mount the nozzle body assembly on the fixture MK 3836. Fit a new gasket (K.3358) on the mounting face of the oil plug, then proceed as follows:—

(1) Reference to the nozzle body will show that one of the oil plug screw holes in the top of the nozzle body is almost in line with one of the locating dowel holes on the underside of the nozzle body. The oil plug must be positioned so that the oil pipe points in the direction of this dowel hole (*fig.* 15.)

(2) Fit and tighten the three 4 B.A. × $\frac{1}{2}$ in. cheese-head screws complete with spring washers.

Overspeed cable assembly

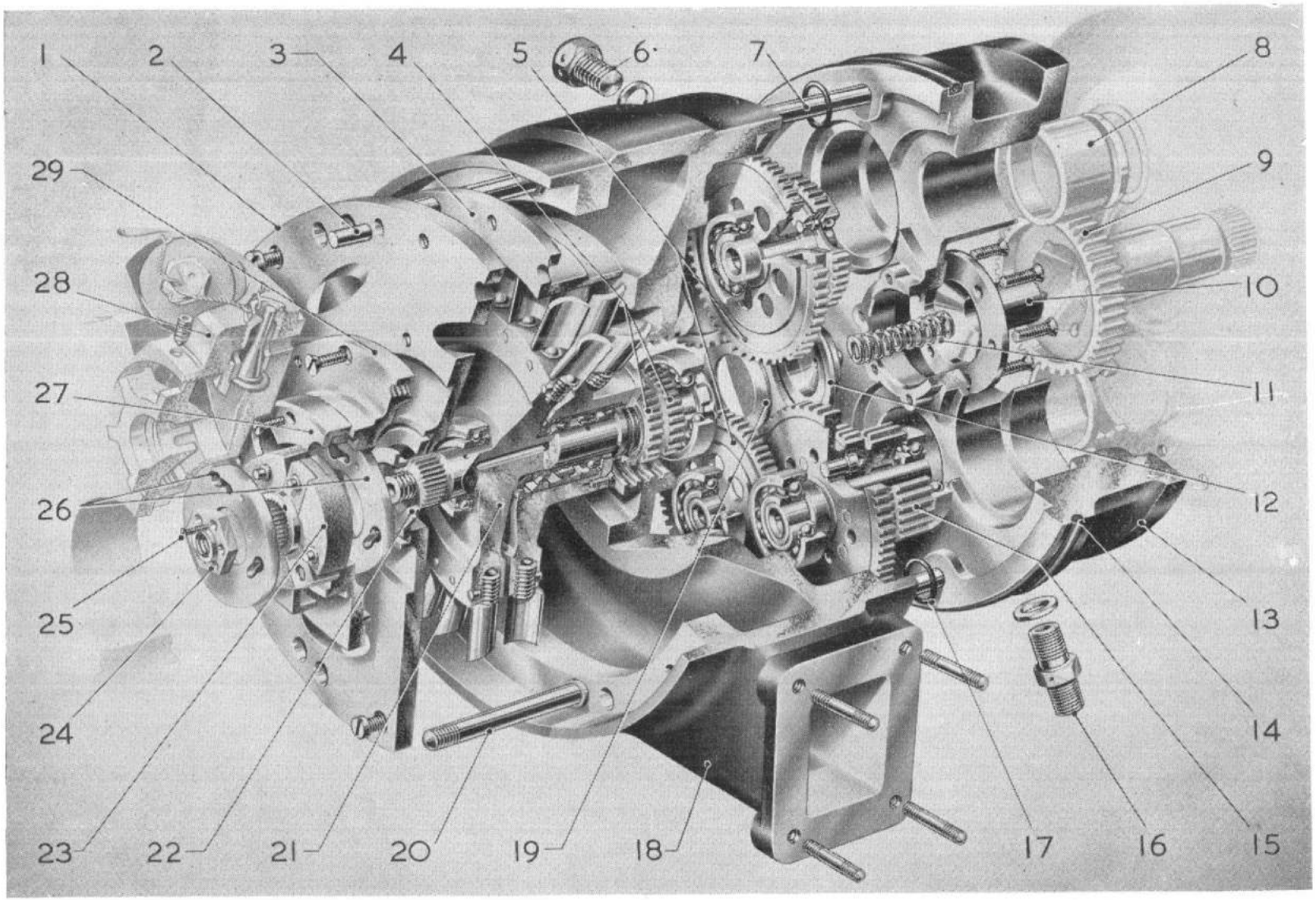
88. In addition to its function in the lubrication system, the nozzle body oil plug also houses one end of the overspeed cable assembly which should be fitted as follows:—

(1) Place the insulating bush pin (8, *fig.* 35) in position in the housing.

◀ (2) Replace the insulating bush so that the insulating bush pin can be observed entering the hole in the bush.

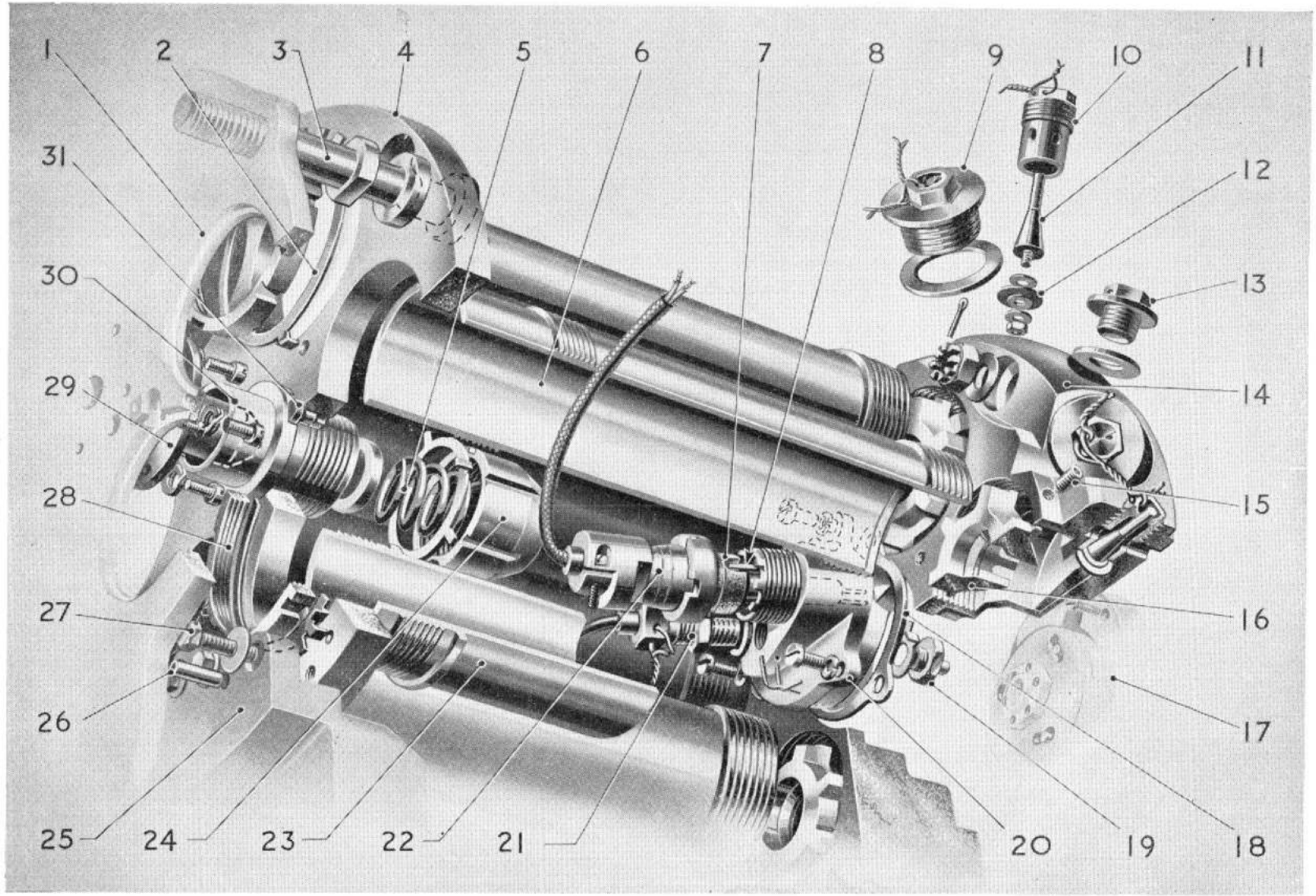
(3) Pass the pronged end of the cable assembly through the insulating bush. ▶

(4) Position the cable so that it lies between the two barrel housings as shown in fig. 15, this position being referred to the oil pipe position. Maintaining this position, screw on and tighten the screw-cap.



1 NOZZLE PLATE
2 DOWEL
3 SHROUD RING
4 FIRST- AND SECOND-STAGE ROTOR GEARS
5 SECOND-STAGE GEAR ASSEMBLIES
6 BLANKING PLUG
7 ROTOR STUDS (Intermediate bearing housing)
8 SEALING PLUG
9 FINAL DRIVE GEAR
10 SPRING RETAINER
11 THRUST PLATE
12 THRUST PLATE
13 INTERMEDIATE BEARING HOUSING
14 O-RING
15 FIRST-STAGE GEAR ASSEMBLY
16 DRAIN UNION
17 O-RING
18 ROTOR HOUSING
19 SHIMS
20 ROTOR STUDS (Nozzle body)
21 ROTOR ASSEMBLY
22 CLAMPING SLEEVE
23 BRAKE BODY
24 BRAKE RETAINING NUT
25 NUT LOCKING SCREW
26 CAM PLATES
27 OVERSPEED SLEEVE
28 NOZZLE BODY
29 OVERSPEED DRUM ASSEMBLY

Fig. 34. Exploded view of intermediate bearing housing and rotor housing



1 FRONT PLATE
2 RING-NUT TABWASHER
3 STUD
4 BARREL PLATE
5 SPRING
6 "LONG" BARREL
7 INSULATING SPACER
8 SLEEVE LOCATING PIN
9 NOZZLE BLANKING PLUG
10 SAFETY DISC HOLDER
11 SPIGOT
12 SAFETY DISC
13 BLANKING PLUG
14 NOZZLE BODY
15 BARREL LOCKING SCREW
16 GRID
17 OVERSPEED ASSEMBLY
18 COPPER GASKET
19 OIL NOZZLE
20 NOZZLE BODY OIL-PLUG
21 OIL-PIPE MALE UNION
22 OVERSPEED CABLE ASSEMBLY
23 SHORT BARREL
24 CAP NUT
25 INDEXING GEARBOX
26 GEARBOX LOCATING DOWEL
27 GEARBOX MOUNTING SCREW
28 BARREL LOCK RING
29 SPIGOT
30 SPIGOT SLEEVE
31 LOCKING PIN

Fig. 35. Exploded view of nozzle body and barrel assembly

Grids, safety discs and blanking plugs

89. Replace these components as follows:—

(1) Locate a grid (*fig.* 15), fluted end downwards, in each barrel housing.

(2) Fit and tighten the twelve blanking plugs—each complete with an aluminium sealing washer—to the nozzle body (*fig.* 15 *and* 35) using grease ZX-13 on the threads.

(3) Fit a new safety disc assembly in each safety disc housing and then smear the housing threads with grease ZX-13. Screw each housing into the nozzle body and tighten lightly but firmly.

(4) The safety disc housings and sealing plugs should now be locked together in threes, using 22 s.w.g. stainless steel wire (*fig.* 2).

Barrels

90. It will be noted that three of the six barrels are provided with a shoulder which locates against the barrel plate. These barrels are termed "short barrels" and the remaining three are termed "long barrels". During assembly, grease ZX-13 should be applied to the threads as necessary.

(1) Screw a "long" barrel into each of the three barrel housings provided with a tapped screw hole (*fig.* 15). Tighten each barrel with the barrel extractor which is used as detailed in para. 34 and illustrated in fig. 14; move the handles in a clockwise direction to tighten the barrels.

(2) Insert an Allen screw in each barrel tapped hole; tighten each screw on to its barrel and lock the screws by peening the barrel housing.

(3) Replace the "short" barrels and tighten as detailed in sub-para. (1).

Note . . .

The overspeed cable should now be in position between No. 2 *and* 3 *barrels as shown in fig.* 15.

Barrel plate

91. To fit this item proceed as follows:—

(1) Locate the barrel plate over the barrels so that the bolt holes for the indexing motor assembly are positioned above the exhaust port in the rotor housing. (*Refer to fig.* 2.)

(2) Place a new tab-washer over each of the three short barrels. Note that the two legs of each tab-washer locate in drillings in the plate. Using a starter plate locking ring spanner MK3900, fit and tighten the three ring nuts, locking them by turning up a tab on each tabwasher.

Nozzle body assembly

92. Fit this item as follows:—

(1) Remove the nozzle body assembly from the fixture and locate it over the studs on the rotor housing so that the two dowels on the nozzle plate enter the dowel holes in the nozzle body.

Note . . .

It is possible to incorrectly fit the nozzle body 180°. *out of position. The correct position is denoted in fig.* 2 *where the oil pipe from the nozzle body points to the two screw holes which locate the oil pipe clip on the side of the rotor housing.*

(2) Place a plain washer over each stud and fit and tighten the six castellated nuts which are locked with $\frac{1}{16}$ in. stainless steel split pins.

(3) Refit the external oil pipe and clip, and lock the unions with 22 s.w.g. stainless steel wire.

Indexing motor and reducing gear train

93. The following instructions are given on the assumption that the original assembly is being fitted. If a new assembly is to be fitted, dowel holes will have to be drilled, pilot holes being provided in the gearbox mounting bracket. The procedure in this instance is to follow the instructions given below except that the dowels, sub-para. (11) cannot be fitted. At this point refer to Para. 95 for the correct procedure. *On no account should dowel holes be drilled without following this procedure.*

◄ (1) Replace the four bearings in their respective housings in the gearbox. ►

(2) Place the washer (26, *fig.* 24) over the shaft (22) so that it rests against the shaft collar. Position the output gear key (23) in the shaft key-way, grease will retain the key in position, then fit the output gear (28) over the shaft and key so that the gear bears against the washers.

(3) Enter the output shaft in the bearing in the gearbox body and position over the shaft end any shims originally fitted.

(4) Locate the index pin wheel key (25) in the shaft keyway and slide the index pin wheel (34) over the shaft and key. Retain the wheel by fitting the wheel washer and screw (31) (32) and lock by peening.

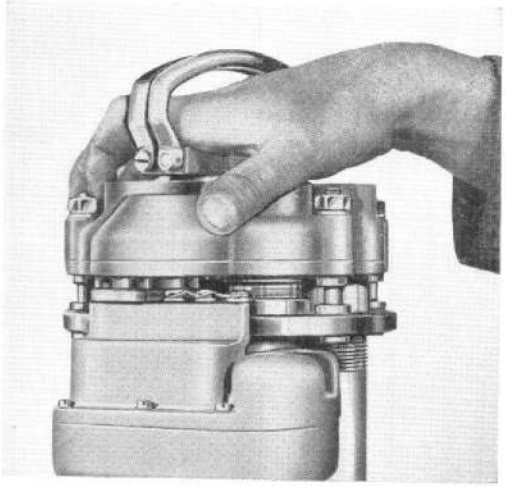


Fig. 36. Replacing firing head

◄ (5) Replace the four gears in the gearbox, as follows:—

Position the housing with the drive shaft at the top i.e. away from the operator and assemble the gear train, then

(*a*) Insert the gear wheel with the pinion on the long bearing into the right-hand centre bearing bore, pinion uppermost.

(*b*) Next insert the gear with the pinion on the shorter side into the left-hand bearing bore, pinion uppermost, mating it with the first gear.

(*c*) The two gears remaining are identical. Insert these, pinions down, into the right-hand bearing bores above and below the centre bearing.

(*d*) Rotate the drive shaft by hand to ensure that all the gears move. ►

(6) Position the remaining four ball races, one on each gear shaft, fit the gasket (4) to the face of the gearbox body and very carefully fit the motor plate so that the output drive shaft and the four ball races are located simultaneously.

(7) Retain the motor plate by fitting the retaining screws and lock these by peening.

(8) Place components (20) (19) (18) (17) on the output shaft and position the cam key (21) in the output shaft key-way. Fit the cam (16) ◄ cutaway portion downwards ► and retain it with the clamping plate and locking screw (15) (14); secure the screw by peening.

◄ (9) Replace the motor unit mounting plate gasket. ►

(10) Place the grease guard (6) in position on the motor shaft and carefully offer up the motor so that the motor drive shaft engages the first-stage reduction gear. Position the motor so that the wiring runs easily to the switch gear then fit and tighten the four motor retaining bolts.

Note . . .

The short retaining bolt is fitted in position over one of the gear races next to the cam (16).

(11) Mount the switch assembly (24) on the motor mounting plate and refit the two breeze plugs in the motor cover. Lock the breeze plug screws by applying shellac varnish to the threads.

◄ (12) Fit the motor cover and screws taking care not to foul the electrical cable. ►

(13) Fit the assembly to the barrel locking plate by means of the four bolts and two dowels. Lock the bolt heads with 0·028 in. dia. stainless steel wire. The two dowels, each of which is threaded internally at one end, should be entered into their holes, threaded end first.

Fitting the firing head

94. If the firing head has not been dismantled it may be fitted to the starter in the normal manner as follows:—

(1) Locate the firing head over the starter so that the index pin wheel, viewed from above, is just to the right of the geneva wheel, and position the stud heads over the holes in the barrel plate.

(2) Grip the firing head as shown in fig. 36, enter the heads of the studs into the holes in the barrel plate; push the firing head well down against the spigot spring loading and turn the firing head in a clockwise direction as far as possible. Ensure that the heads of the studs click up into position in the recess machined on the underside of the barrel locking plate; check this by attempting to turn the firing head, first in one direction and then in the other. Do not use the handle assembly for this operation, as the sealing pads may be inadvertently brought forward before the head is properly located.

(3) Depress the handle assembly and rotate it in a clockwise direction to the limit of its travel.

(4) Release the handle assembly and ensure that it moves up into the locked position.

(5) Turn down the handles so that they rest flat on top of the firing head.

◄ Adjusting the pin indexing wheel

95. The geneva wheel must be rematched to the pin indexing wheel if the gearbox, barrel plate or firing head are renewed, as manufacturing tolerances may affect interchangeability. It may be necessary to drill fresh dowel holes in the existing gearbox. In each case the following procedure must be adopted:— ►

(1) Attach the gearbox to the barrel plate by means of the four bolts. Do not tighten the bolts at this stage.

(2) Fit six dummy cartridges to the breech.

(3) Fit the firing head with the pads retracted and ensure that the stud heads are fully located in the recesses in the barrel plate.

(4) Adjust the gearbox position so that the half moon in the indexing wheel fits snugly in, and just touches, the geneva wheel (*fig.* 37) then tighten the bolts.

(5) Remove the head and tighten the gearbox bolts.

(6) Refit the head, and bring the pads forward.

(7) Connect the starter to a D.C. supply through a suitable ON/OFF switch and carefully inch

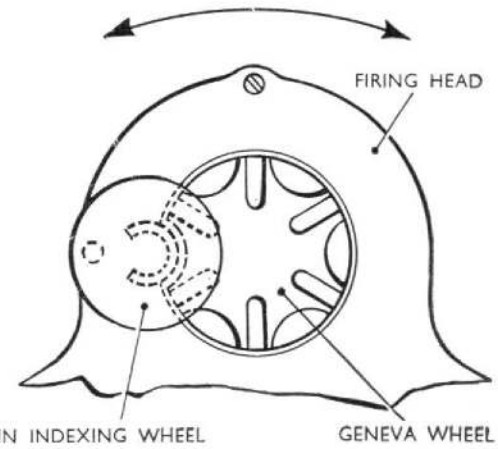


Fig. 37. Adjusting of pin indexing wheel

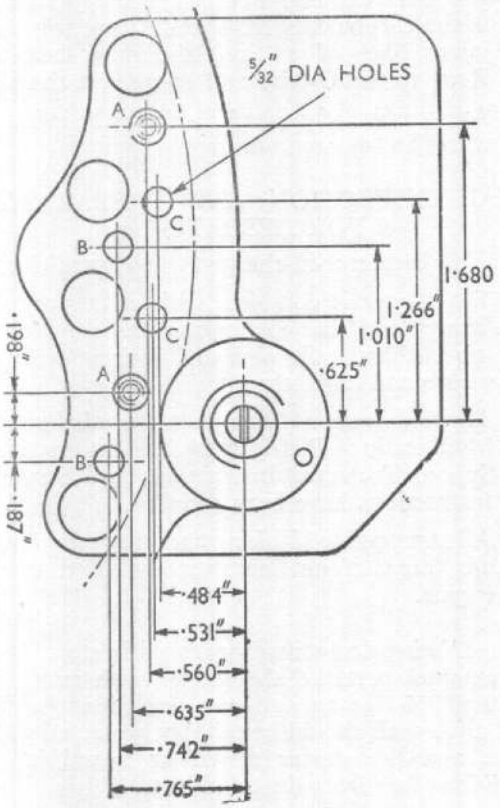


Fig. 38. Pilot hole positions

the pin indexing wheel through one complete revolution. Carefully observe that the pin enters the geneva wheel slot cleanly and that the wheel is actuated continuously until the pin is disengaged from the slot. Remedy any tendency to jam or bind by easing the mounting bolts and moving the gearbox in the appropriate direction, ◄ tighten the bolts before making any further checks. Shims are fitted below the pin indexing wheel for the adjustment of clearance between it and the geneva wheel. ►

Note . . .

The mechanism is designed to operate with an applied voltage of 18 *to* 29*V D.C. and the adjustment should be sufficiently precise to permit operation at* 19*V.*

(8) After the final adjustment and functional test, remove the firing head and, using two of the pilot holes in the gearbox mounting bracket as a guide, drill and reamer two dowel holes through the bracket and barrel plate to $\frac{7}{32}$ in. dia. There are three sets of pilot holes marked as A, B, and C, and they should be utilized in this order as required.

(9) Fit the two dowels, internally threaded end first, and lock them by peening.

(10) Wire-lock the four bolt heads with 0·028 in. dia. stainless steel wire.

(11) Re-check the operation of the mechanism.

Note . . .

On a number of early starters the pilot holes referred to above in sub-para. (8) *will not have been drilled. Reference should therefore be made to Fig.* 38 *for the correct drilling positions.*

TESTING

Testing after assembly

96. (1) Clamp the vice fixture (*fig.* 1) firmly in a vice and ensure that a clean gasket—in good condition—is located on the face of the fixture.

(2) Connect the end of the pipe to a supply of oil OM-13 and prime the pipe run.

(3) Mount the starter on the fixture and fit and tighten the four retaining nuts.

(4) Screw the special adapter MK3859 (*fig.* 39) on to one of the barrels and attach an air line to the adapter.

Important . . .

The air supply should be pressure-regulated to deliver a pressure of 70 *lb/in², on no account must a pressure greater than* 90 *lb/in² be used, otherwise an overspeed may occur.*

(5) Turn on the air supply and air-exercise the starter for a period of one minute, during which time special care should be taken to observe signs of rough running, metallic interference, or any other irregularity.

(6) If the above test proves satisfactory, slacken the external oil pipe of the starter at the pump union and check that the pump is delivering a smoth flow of oil.

(7) Reconnect the oil pipe and run the starter for a further 30 sec. to re-establish complete internal lubrication. This completes the functional test which must be followed by a drying-out shot as detailed in para. 97.

Note . . .

Care should be taken not to drain the oil which is now retained in the starter, otherwise the oil

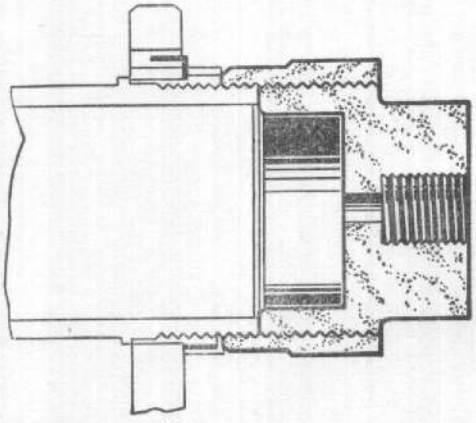


Fig. 39. Air line adapter

priming procedure detailed in the relevant aero-engine Air Publication Vol. 1 will have to be observed. If necessary the oil drain plug in the bearing housing may be suitably plugged.

Drying-out shot

97. A drying-out shot with one cartridge is carried out to remove any moisture which may have been introduced into the starter during air-exercising. The starter must be mounted on the engine as detailed in the relevant aero-engine Air Publication Vol. 1 and ONE cartridge loaded into the breech. Fit the firing head and fire the cartridge.

Note . . .

(1) *It should be appreciated that the purpose of the engine is to provide a load against which the starter can operate. There is no intention of starting the engine and consequently no starting procedure, other than the usual precautionary measures, need be adopted.*

(2) *It is not necessary to determine which particular barrel must be used in order to fire the cartridge the first time. Hence the firing button may have to be depressed three times to fire the cartridge, remembering that at least 30 sec. must elapse between each attempt.*

Lubrication after testing

98. Following the drying-out shot and inspection after testing, the starter should be lubricated as follows:—

(1) Remove one of the drain plugs from the intermediate bearing housing and drain the oil. Inject 15 c^3 of clean oil OM-13 through the drain plug hole and replace the plug.

(2) Break the external oil pipe at the upper union, fit the U-tube MK 3834 to the upper pipe and inject 10 c^3 of oil into the rotor bearings. Remove the U-tube and re-connect the pipe.

(3) Apply a film of grease XG-275 to the index pin wheel and geneva wheel.

FINAL INSPECTION AND PREPARATION FOR DESPATCH

99. The Inspector-in-charge is to ensure that:—

(1) The starter is complete with all appropriate fittings and that all locking devices such as tab-washers, split pins and locking wire are secure and correctly fitted.

(2) All modifications have been recorded on the Modification Plate and that all relevant Special Technical Instructions and Servicing Instructions have been satisfied.

(3) All appropriate blanking and protective covers are fitted, if not immediately fitted to the engine.

100. If being despatched or placed in store, spray the external parts of the starter with protective solution PX-1 as an anti-corrosive measure. The quill drive shaft should be suitably protected with a sleeve and the starter stored or boxed in dry conditions free from dust and dirt.

101. This concludes the minor repair, and the starter can now be fitted to the engine. If, however, the starter is to be held in stores, inhibiting action should be taken as detailed in A.P.4471A.

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