CAV
Workshop Manual

Axial Starters

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INTRODUCTION

The starters dealt with in this workshop manual have the basic type symbols, BS5, BS6, SL5, SP5, SP6 and U6 and are all of the same 'axial' design. Added to these type symbols are further figures and letters which vary. They indicate voltage, design changes and individual features; for example:- BS524P153M. Figure 24 is the voltage, P; design change, 153; special features and M is for marine finish. This group of symbols is stamped on the type plate affixed to the starter and provides a means of recognition and cross reference to the appropriate spare parts list. A further seven figure 'despatch' number is also added to the type plate, for use of the customer when ordering, and it serves to simplify internal records.

DESCRIPTION

'Axial' starters are designed for use on the larger type of engine where, because of the high inertia of flywheel and crankshaft, the starter pinion is required to engage with the engine flywheel before the starter develops full torque, thus avoiding heavy engagement shock and excessive wear on the gear teeth. Engagement between the pinion and the flywheel is effected by a forward and rotational movement of the complete armature assembly, and it is from this movement that the term 'axial' is derived.

The field windings consist of a main series winding, an auxiliary series winding and an auxiliary shunt winding. A solenoid-operated two-stage switch forms an integral part of the starter and is used to control the starting cycle, consequently a small external switch only is required to control the solenoid current.

An overload clutch is interposed in the drive between the armature and pinion, and has a slipping torque well above the lock torque of the starter but below the shearing strength of the pinion teeth. An effective safeguard is thus provided against damage to the pinion teeth, due to excessive loading.

Starters fitted to certain engines, the flywheels of which run in oil, and those where extra protection against ingress of water and abrasive dust is required, are provided with additional sealing. The precautions comprise fitting an oil seal in the drive end shield and a rubber sealing ring inside the pinion.

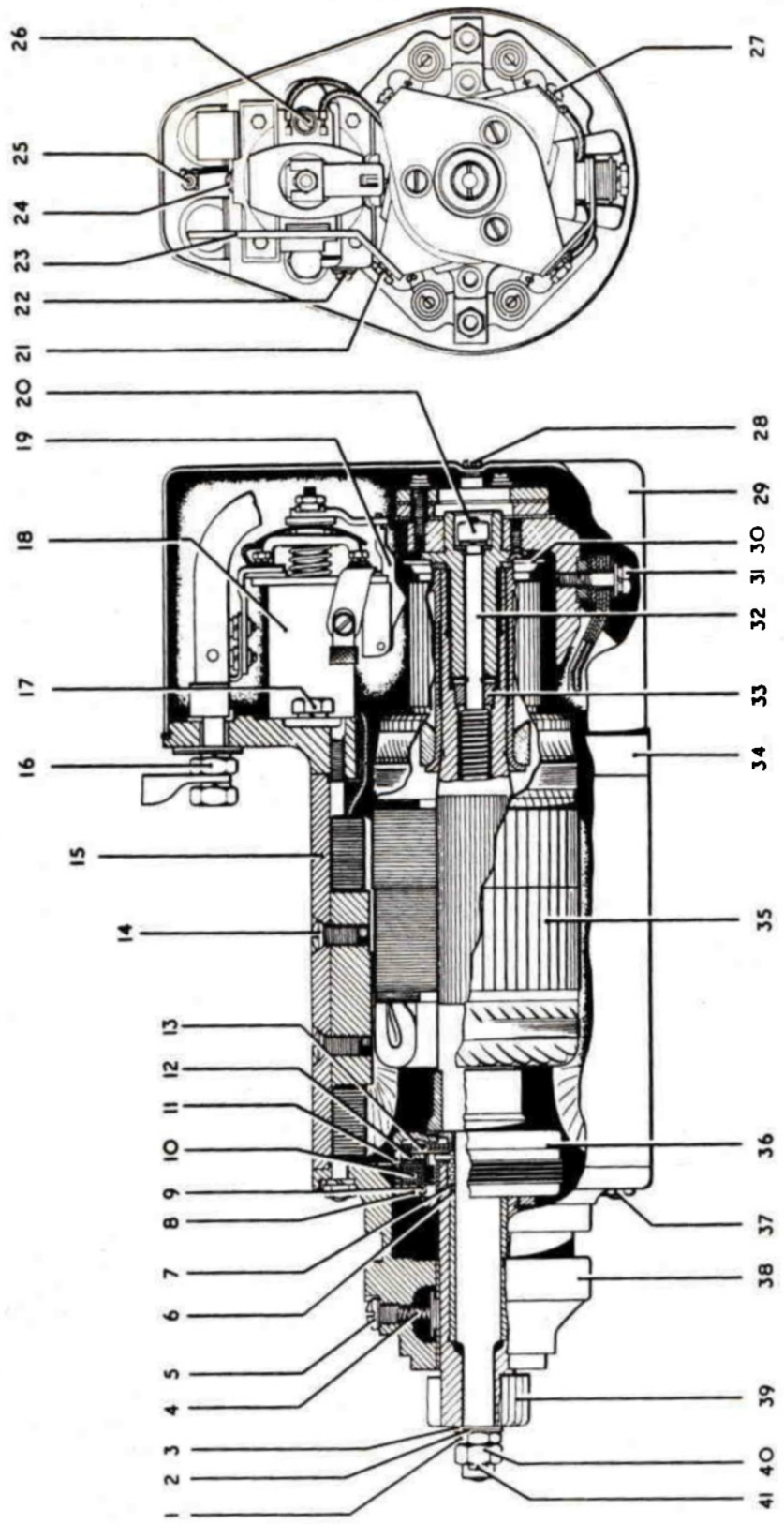

Fig. 1. Sectioned view of typical 'Axial' starter with 'cast' brush gear

OPERATION

When starting a vehicle engine, strict observance should be paid to following points:

1. Ensure that all engine controls are correctly adjusted.

2. Press the starter button firmly and release it immediately the engine fires.

3. If the engine does not fire at once, allow the flywheel to come to rest before pressing the starter button again.

4. Do not drain the battery by keeping the starter button pressed when the engine refuses to fire. Discover the cause.

5. With certain engines it may be advantageous to depress the clutch pedal when starting from cold.

6. Do not operate the starter when the engine is running otherwise serious damage to the pinion and flywheel teeth may result.

When the starter switch is operated, the first stage contacts on the solenoid switch (18) Fig. 1 close, and a small current passes through the auxiliary field windings, causing the armature to rotate slowly. Simultaneously, the complete armature assembly (35) is drawn towards the driving end of the machine by the magnetic field set up in the windings, and the pinion (39) is brought into mesh with the engine flywheel gear. As the armature nears the end of its axial travel, the tripping disc (30) operates the trigger (19) on the solenoid switch, causing the second stage contacts to close and complete the circuit to the main series winding. The starter then exerts its full torque on the engine. The overload clutch (36) will come into operation should an excessive load be applied to the pinion.

When the starter button is released, the armature is returned to its disengaged position by the coiled spring on the armature plunger (32).

Generally, the auxiliary windings are so arranged as to hold the pinion in mesh until the starter button is released. This reduces the number of engagements used to start heavy engines as the pinion will remain in mesh despite irregular firing of the engine. For certain applications however, the windings are so arranged that the pinion automatically disengages once the engine fires.

MAINTENANCE

During service, very little attention should be necessary but to ensure maximum life and trouble-free starting, the starter should be examined at regular intervals to check that its mounting bolts or straps are fastened securely and that all electrical connections are clean and tight. The cables should be examined for fractures, particularly at the point where the cables enter the terminal lugs. The cable insulation must be free from signs of chafing, and from deterioration by oil products.

Check that the battery is at least half charged and capable of giving the heavy current required by the starter.

It is also recommended that the maintenance procedures described in the following paragraphs should be undertaken at regular intervals, the length of which are dependent upon conditions of service.

Brushgear

The brush leads should be clear of any obstruction likely to impede movement, and the brushes should be free in their holders. If a brush is inclined to stick, it should be removed and the inside of the holder cleaned with a clean cloth moistened in white spirit. The brush must be replaced in its original position so that the curvature of its contact surface conforms accurately with the commutator periphery.

Where spiral fibre insulation is provided on the brush leads, ensure that it has not become burnt or charred, thus creating the danger of short circuits.

The brushes should be well 'bedded', that is, worn to the periphery of the commutator over at least 80% of their contact area.

The brush spring pressure should be checked by means of a spring balance hooked under the spring or trigger lip as shown in Fig. 2.

Fig. 2. Checking brush spring pressure

The pressure of each spring when taken at the point of contact with the brush should be within the limits shown below:-

Brush spring pressures

Unit	Voltage	Brush spring pressure	
		oz	g
BS5, SP5	12	28 to 35	790 to 990
BS5	24 and 32	42 to 53	1190 to 1500
BS6, U6	12, 24 and 32	18 to 24	510 to 680
SL5	24	40 to 52	1134 to 1474
SP6A	24	32 to 40	907 to 1134

The brushes must be renewed if they are worn to approximately half their original length or to a point where the springs no longer provide effective pressure. Replacement brushes should be fitted in complete sets. Under no circumstances should brushes of different grades be used together, therefore only genuine C.A.V. spares should be specified.

It is not practicable to supply replacement brushes already 'bedded', as the diameter of the commutator will vary according to the number of skimming operations performed on the armature. Replacement brushes must therefore be 'bedded' to the commutator prior to use.

Commutator

The surface of the commutator should be clean and entirely free of oil, any trace of which should be removed by pressing a dry, clean cloth against the commutator while the armature is rotated by hand. In the case of starters fitted to engines with oil-immersed flywheels, an excessive amount of oil may indicate a defective oil seal. In these circumstances the starter must be removed from the engine and completely overhauled.

If the commutator is very dirty or badly discoloured, the entire armature assembly should first be removed from the starter body as described in DISMANTLING. With the armature held securely, a strip of very fine glass paper (not emery cloth or carborundum paper) abrasive side inwards, should be pulled to-and-fro around the commutator until the surface is clean. All traces of dust and abrasive should be removed by means of compressed air, or by the use of hand bellows.

Lubrication

The drive-end bearing of earlier type starters is supplied with oil from a lubricator fitted to the drive-end shield. This lubricator should be filled with oil at regular intervals during service.

The drive-end bearing of all later type starters is lubricated by oil from a large reservoir contained in the drive-end shield, the capacity of which is sufficient for approximately three years normal running time. Refilling can be carried out most conveniently when the starter is dismantled at overhaul periods; the procedure described in ASSEMBLY should be adopted.

The oil recommended for temperate climates is grade SAE10W/30W or grade SAE5W/20W for sub-zero climates.

An oil impregnated bearing is fitted at the commutator end and does not require attention during service, but should be replaced when the starter is overhauled.

FAULT FINDING WITH THE STARTER FITTED TO THE ENGINE

If the starter does not function, or is sluggish or intermittent in operation, check that the state of charge of the battery is satisfactory and that all cable connections are clean and tight. With starters designed for earth-return systems, particular attention should be paid to the earth strap between starter and frame. A defective starter button or badly worn starter brushes are other possible causes of failure.

Difficulty in obtaining a smooth engagement between pinion and flywheel may be due to incorrect flywheel-to-pinion clearance. This clearance should be 0·125 $\pm$ 0·031 in (3·18 $\pm$ 0·79 mm) between the face of the flywheel and the engaging face of the pinion when the pinion is at rest.

Check that the solenoid switch inside the starter is working satisfactorily and the first and second contacts close in succession.

DISMANTLING

As individual mounting arrangements vary, reference should be made to the engine makers manual for the correct method of removing the starter. However, it is recommended that the battery should be disconnected before any attempt is made to remove the unit.

Before overhauling the starter, it is advisable to obtain the special tools listed below. These tools are not essential, but will reduce the time spent on overhauling the starter and will enable a closer approach to factory standards to be obtained.

List of tools

Unit	Description of tool and use	Tool No.
BS5, BS6, SL5, SP5, SP6, U6.	Socket, for checking clutch torque (11 tooth pinion)	6244/1
	Socket, for checking clutch torque (13 tooth pinion)	6244/2
	Extractor for clutch outer race	5693/61
	Faceplate for rebushing drive end shield	5693/93
BS6, SP6 and U6 only	Key, for plunger nut	5693/45
	Key, for plunger stop	5693/100
	Key, for plunger stop (Modified slot)	5693/103
	Dolly for pressing on clutch housing	5693/94

Unit	Description of tool and use	Tool No.
BS5, SL5 and SP5 only	Key for plunger stop	5693/190
	Key for plunger stop (modified slot)	5693/106
	Dolly for pressing on clutch housing	5693/95

The following dismantling instructions are set out to deal with starters having 'cast' brass brush holders and the figures in brackets refer to Fig. 1. Other starters of the same basic design have 'pressed' type brush holders as well as other small modifications and the construction is shown in Fig. 3. Dismantling procedure is virtually the same. Exceptions are noted.

1. Unscrew nuts (28), and remove the commutator cover (29). On SL5 starters, also remove retaining clips and screws.

2. Unscrew the brush lead screws (27), lift the brush springs and remove the brushes from their holders. Removal of the brush lead screws also frees the field connections to the brushgear.

IMPORTANT

At this stage the leads to the brushgear and solenoid switch should be marked so that they can be identified easily when the starter is assembled.

3. Remove the nut (20) from the armature plunger by means of tool 5693/45 for BS6, SP6, and U6 or box spanner for BS5, SP5 and SL5.

4. Remove the main fixing bolts or screws (37). Tap the drive-end shield (38) gently away from the yoke (15) with a hide or wooden mallet, and withdraw the shield complete with armature (35).

5. Hold the armature in an armature clamping device, or in a vice fitted with soft metal or wood jaw clamps.

6. Remove the lubricating plug (5) and the spring (4) from the drive-end shield. On some starters the spring is fitted on the opposite side of the casting to the lubricating plug and cannot be removed at this stage.

7. Remove the split pin (41), nuts (40) and (1), and washers (2) and (3) from the front end of the pinion (39), and slide the pinion and drive-end shield off the armature shaft.

8. Remove the pinion spring (7).

9. Collect the clutch inner race (8), clutch plates (10), shim washers (11), back plate (12) and pressure plates (13) from the clutch assembly.

NOTE: The clutch plates should be tied together in the order of removal so that they can be replaced in their original positions in the clutch when the starter is assembled.

10. Withdraw the shim(s) (6) and rubber sealing ring (when fitted) from the bore of the pinion.

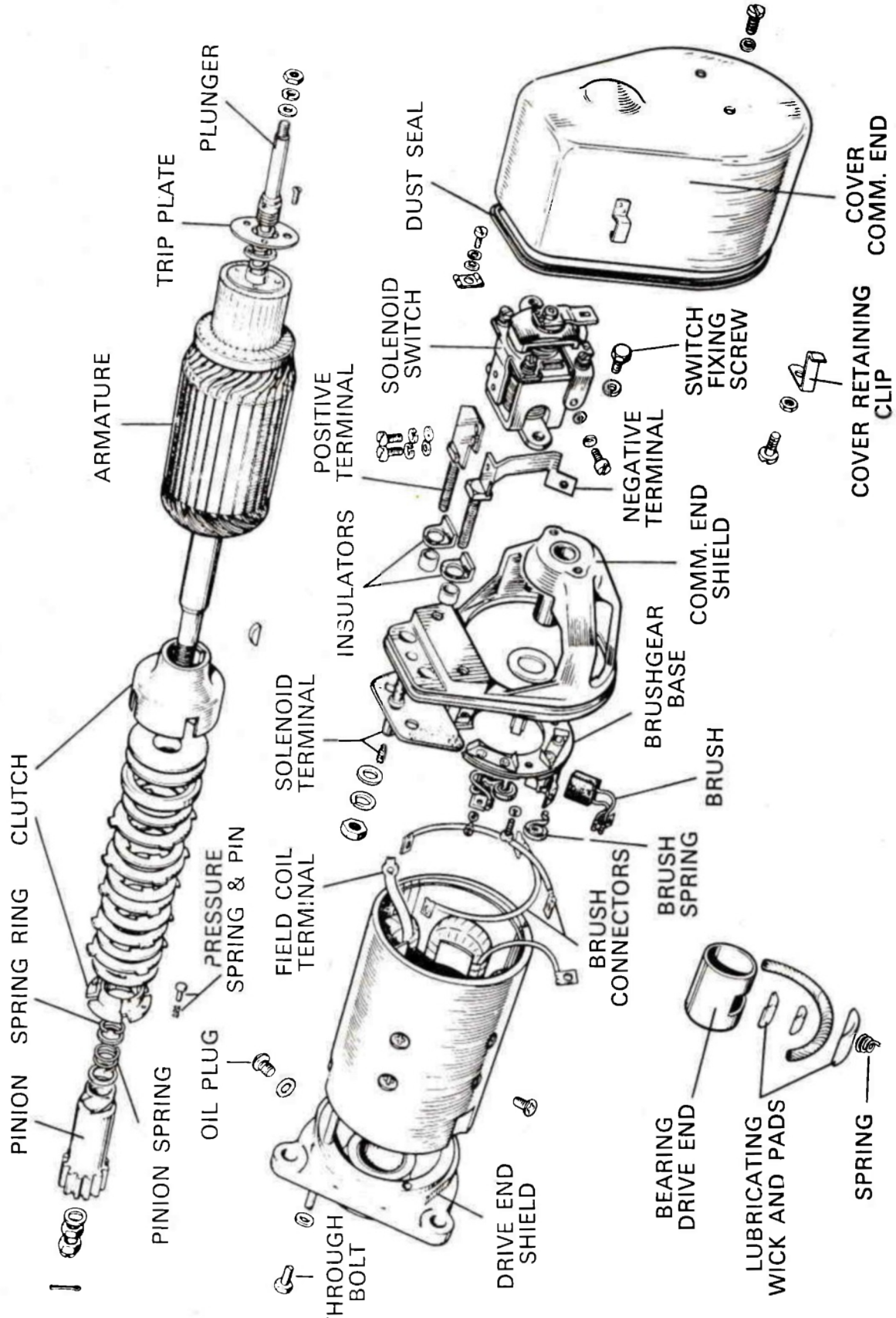

Fig. 3. Exploded view of SL5 starter with 'pressed' brush gear

11. Unscrew the armature plunger retaining nut (33) by means of tool 5693/103 for BS6, SP6, and U6, tool 5693/106 for BS5, SL5, and SP5. Earlier starters were fitted with retaining nuts having a narrow slot, and in these cases tools 5693/100 or 5693/190 respectively should be used.

12. Withdraw the armature plunger (32) from the bore of the armature.

13. Remove screws (24), (22) and (26) securing the positive terminal connector, main field coil ends and auxiliary field connections to the solenoid switch, duly marking them for ease of assembly.

14. Remove the screw (31) holding the main field connections to the connector at the bottom of the commutator-end shield. Not applicable to those starters with pressed brush gear.

15. Separate carefully the commutator-end shield from the yoke by tapping with a hide or wooden mallet.

16. Disconnect the solenoid coil leads, duly marking them for ease of assembly.

17. Unscrew the negative terminal nuts (16), and also the screw (21) securing the negative connector to the brushgear. Remove the negative connector. (Not on earth return machines).

18. Unscrew the solenoid fixing screws (17), and remove the solenoid switch.

INSPECTION AND REPAIR

Commutator

The surface of the commutator should be clean and free from grooves, pits, or uneven discolouration. For moderate surface cleaning, a very fine grade of glass paper (not emery cloth or carborundum paper) may be used, as described under MAINTENANCE. If the surface condition is severe however, the component should be set up on a lathe and the commutator skimmed.

A coarse cut should first be made to remove sufficient copper to clear traces of pitting or distortion. If mica is used as the insulating material between the commutator segments, this insulation should be undercut, that is, it should be removed to a depth not exceeding the width of the insulation. Certain proprietary tools are available for this purpose, but an old hacksaw blade, ground to the width of the insulation, will make a serviceable tool in case of emergency, See Fig. 5. Where melamine is used as the insulating material no under cutting is normally necessary but on SL5 Starters undercutting must be carried out.

Finally, the component should again be set up on the lathe and a fine finishing cut taken using a diamond or tungsten carbide tipped tool to obtain the desired quality of finish. After machining, the commutator and armature must be cleaned thoroughly preferably by means of compressed air, or by the use of hand bellows.

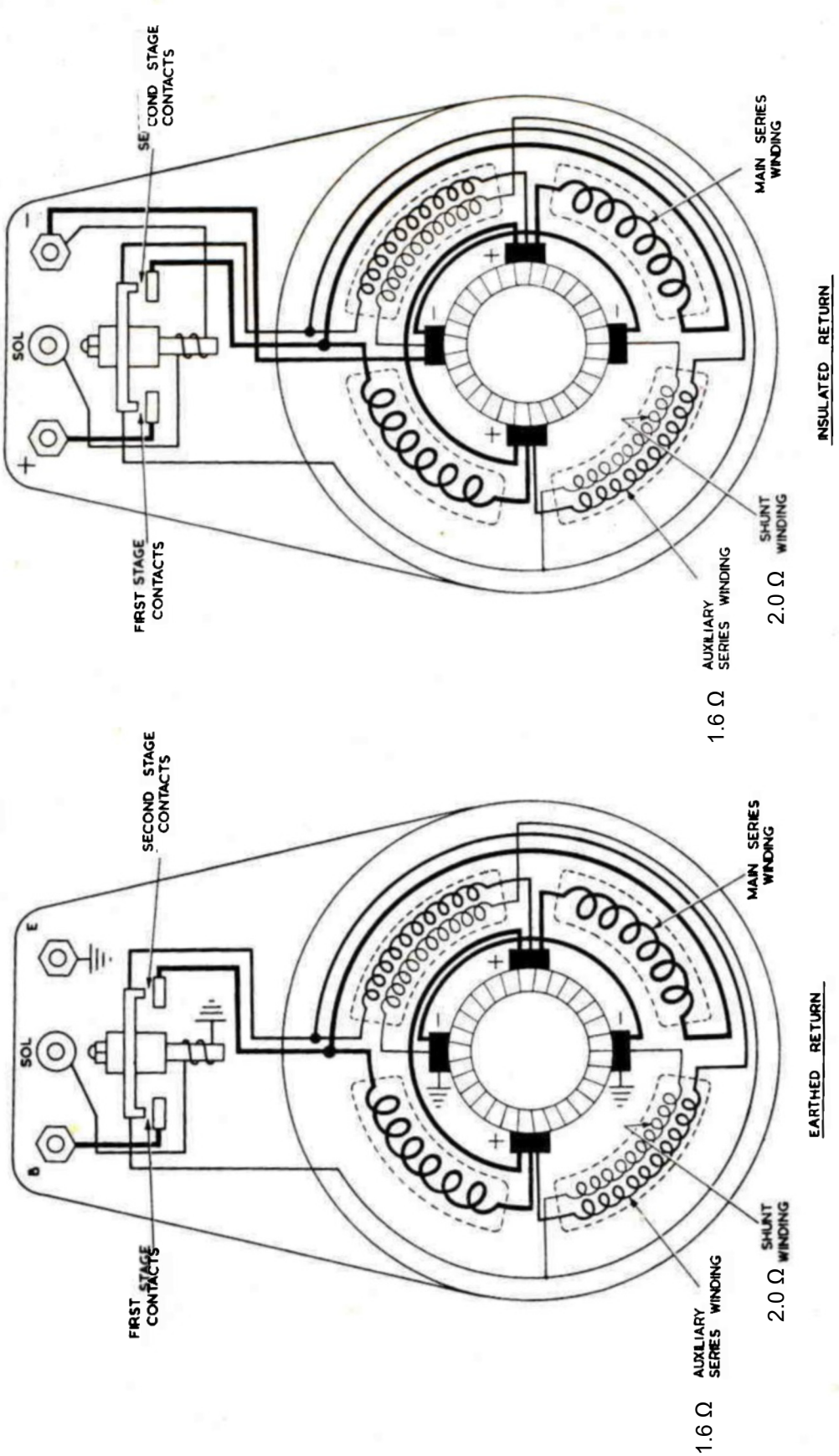

Fig. 4. Typical internal wiring diagrams

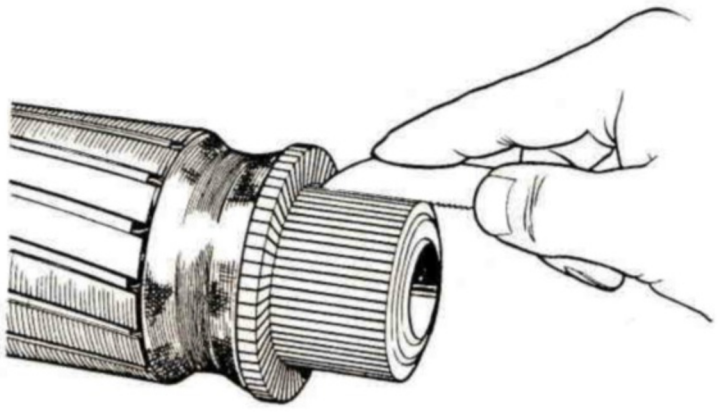

Fig. 5. Undercutting commutator

Armature Windings

Armature windings can be tested for continuity and short circuits by means of a 'growler' armature tester. If a 'growler' is not available, the armature should be tested by substitution. Should the armature be faulty, the clutch outer race (36) should be pressed off the shaft with the aid of tool 5693/61, and the armature returned direct to the nearest C.A.V. agent.

Note: For certain SL5 starters, tool 5693/61 is not suitable and should be adapted.

When the clutch outer race is pressed onto the shaft of the new or replacement armature, tool 5693/94 for BS6, SP6 and U6, or tool 5693/95 for BS5, SL5 and SP5 should be inserted into the armature bore as shown in Fig. 6 so that the press bears upon the tool and not upon the end of the commutator. If this procedure is not followed, the force exerted by the press may distort the commutator segments.

Field Windings

Field windings can be tested for short circuits to the yoke and poles by means of test probes connected to a mains supply not exceeding 110 volt and in series with a 15 watt lamp of suitable voltage positioned on the live side of the system. One probe should be applied to the yoke at a position where it is free from enamel and insulation, and the other applied to the ends of each of the windings in turn. If the lamp does not light then the insulation is intact. Alternatively a 100v Megohm meter can be used.

Open circuits can be detected easily be means of an ohmmeter. The instrument should be connected across each of the windings in turn, and, if infinity or maximum ohms is obtained, then an open circuit is indicated in the winding being tested.

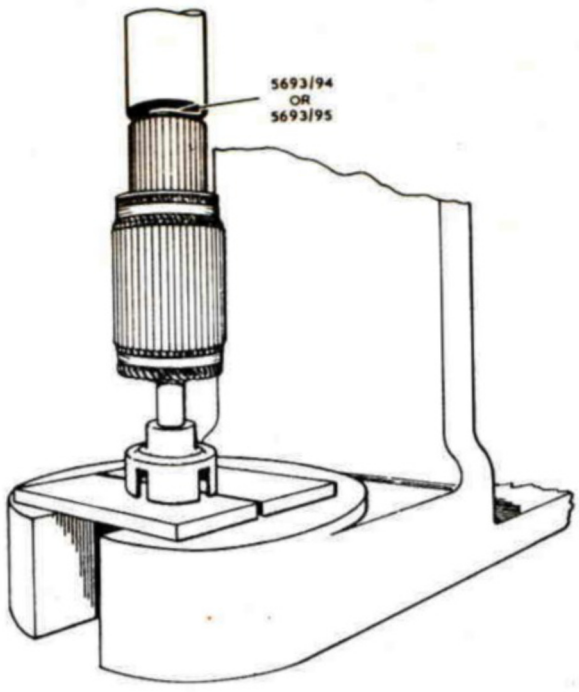

Fig. 6. Pressing on clutch outer race

Internal short circuits in the coils can best be detected by means of a low reading ohmmeter. If such an instrument is not available and the existing windings are suspect, they should be checked by substitution.

Unserviceable coils should be renewed as follows:

1. Unscrew the pole fixing screws (14) and withdraw the poles and windings, noting the position of the windings to facilitate reassembly. Each pole has a small step machined on its surface, and is marked with a number which corresponds with a number stamped on the end of the yoke. When replacing the pole, the steps should all be positioned towards the commutator end of the yoke, and the numbers should correspond.

2. Fit the new windings to the poles as dismantled, so that they bed down as far as possible on the poleshoe wings.

3. Assemble the poles and the windings into the yoke, and insert the pole fixing screws.

4. Apply 'Duralac' sealing compound (specification DTD 369A) to the pole screws and seats and tighten the screws using a proprietary pole screwdriver. The screws should be tightened down firmly to exclude any space between the mating surfaces of the poles and the yoke. This condition can be checked by a thin feeler gauge.

NOTE: The windings will bed down more easily if the yoke windings and poles are heated gently in an oven before the pole fixing screws are tightened. If the coils are loose on the pole shoes they must be tightened either by fitting a leatheroid spacer or taping the coils otherwise insulation is liable to break down due to fretting.

Bearings

The pinion should be inserted into its bearing in the drive-end shield, and the commutator end of the armature pushed onto the bearing pin in the commutator-end shield. Both bearings should then be checked for excessive sideplay.

If the bearing pin is worn, it is recommended that the complete commutator-end shield assembly should be replaced, as the shield spigot is machined concentric with the bearing pin after the pin has been assembled.

Provided facilities exist for accurate machining, the drive-end bearing may be removed from its shield and renewed. If such facilities are not available, the complete drive-end shield and bearing assembly should be returned to C.A.V. Depot or Agent for replacement. If the bearing is to be renewed the following procedure should be adopted:

1. Push the lubricating wick well away from the bore so that it does not get trapped during the pressing operations.
2. Press the old bearing out of the shield.
3. Press in the new bearing from inside the shield, using a split dolly to prevent the lubricating wick from being trapped between the end of the bearing and the edge of the oil reservoir. If the pads have hardened they should be replaced.
4. Set up the shield in a lathe in such a manner that when machining of the bearing bore is complete, the bore is perfectly concentric with the shield spigot where it registers with the yoke. This can be best done by means of faceplate 5693/93 which is designed to be located in a recess machined in the faceplate of the lathe, and is itself provided with accurately machined recesses for locating the shield spigots of the various sizes of starter.
5. Turn the bearing bore to between 35·05 and 35·10 mm diameter, and ensure that the surface finish is of the highest quality.
6. Turn both ends of the bearing flush with the faces of the castings if necessary.
7. When fitting a new or used pinion, a clearance between the pinion and bearing should be 0·05 to 0.10 mm.

Brushgear

The brushgear insulation should be checked as detailed below, using a 110 Volt mains supply, test probes and lamp as described under Field Windings. If the lamp lights during any of these tests the insulation is faulty. Alternatively a 100 Volt Megohm meter can be used.

1. Insulated Return Machines

(a) Between the positive and negative brush holders.

(b) Between the positive brush holder and the frame.

(c) Between the negative brush holder and the frame.

2. Earth Return Machines

(a) Between the insulated and earthed brush holders.

(b) Between the insulated brush holder and the frame.

Clutch

If tne clutch plates (10) are badly worn or discolo ıred they must b renewed. Individual new parts should not be inserted unless facilities exist for testing the slipping torque. If such facilities do not exist, and parts of the clutch n ed renewing, a complete new interior should be fitted, or alternatively, he clutch together with the armature, pinion and drive-end shield should b returned to a C.A.V. Depot or Agent for attention. The method of adjusting the slipping torque is given on page 19.

Pinion

If the teeth of the pinion (39) are badly worn or damaged, the pinion should be changed. Ensure that the new pinion has the same number of teeth and is made of the same material as the old component, that is either bronze or steel.

Oil Seals

On those starters fitted with seals (see DESCRIPTION Page 3), the rubber sealing ring inside the pinion and the oil seal in the drive end shield should be discarded and a new item fitted each time the starter is dismantled. The sealing ring inside the pinion must be fitted with a shim either side. The new oil seal in the drive end shield must be fitted with its plain side facing inwards and should be sealed into its recess with a suitable compound such as 'Durulac' or 'Wellseal'.

Faulty engagement of the pinion is sometimes caused by excess friction between the pinion and oil seal in the drive end shield which prevents the complete withdrawal of the pinion after a tooth to tooth abutment. This can be remedied by highly polishing the pinion sleeve and ensuring that the oil seal is free from embedded grit or other foreign matter.

Solenoid Switch

The method of overhauling the solenoid switch is described in the second section of this publication (page 22).

ASSEMBLY AND ADJUSTMENT

The figures in brackets refer to Fig. 1.

1. Hold the armature in an armature clamping device, or in a vice fitted with soft metal or wood jaw clamps

NOTE: In all cases where grease is referred to in the following text, use Shell Nerita or B.P. Energrease.

2. Smear the spring and thrust washer on the armature plunger (32) liberally with grease. Insert the plunger into the bore of the armature, and tighten the plunger retaining nut (33) using the appropriate tool, see page 8.

NOTE: Before assembling the clutch, carefully examine all parts for wear, distortion and the presence of burrs or sharp edges which can cause clutch slip. Burrs or sharp edges should be removed with an abrasive stone from the following parts in working contact leaving a minute radius.

(a) Thread tops on inner race and pinion sleeve.

(b) Slots on inner and outer races

(c) Edge of clutch plates.

3. Insert the pressure plates (13), back ring (12) and shim washers (11) into the clutch outer-race (36).

4. Smear the clutch springs (9) lightly with grease, and place them in their holes in the clutch inner race (8). Each spring should be inserted with its largest diameter first.

5. Grease the clutch plates (10) lightly and place them on the splines of the clutch inner race, taking care to fit bronze and steel alternately. Fit a steel plate first so that it takes the pressure of the clutch springs.

NOTE: On later production models of SL5, BS5 and U6 starters a modified clutch has been fitted incorporating guide pins, a spring locking ring and a new pinion spring with spacing ring and these should be fitted to any starters of this type when under repair. See Fig. 7.

Starters type SL5..40, 41 and 41M and similar types have steel clutch plates 'Sulfinuz' finished (dull grey) and these must be assembled 'dry' no grease to be applied. These new steel plates supplied as spares have a protective covering of grease which must be removed with a suitable solvent, wiping only will not suffice.

6. Assemble the clutch inner race complete with clutch plates and spring ring (if fitted, see Fig. 7).

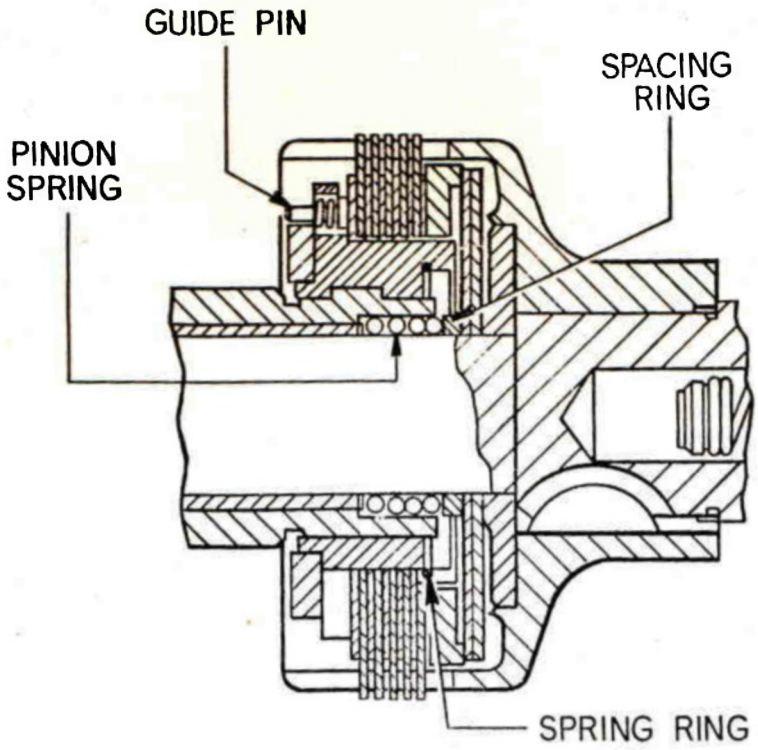

Fig. 7. Section through clutch assembly

7. Grease the pinion spring (7) Fig. 1 and slide it onto the armature shaft, together with spacing ring (if fitted).

8. Grease the bore of the pinion (39) and insert the rubber sealing ring (when fitted) also shims (6). See page 16 headed 'Oil seals'.

9. Insert the pinion into the drive-end shield (38). To prevent damage to the felt lubricating pad, the pinion should be twisted in the direction of the spiral of the pinion thread whilst the lubricating pad is lifted from inside the casting.

10. Slide the pinion and the drive-end shield onto the armature shaft. Push the pinion forward and rotate until its thread engages in the internal thread in the clutch inner race. Hold it in this position and replace the shim (3), washer (2), and nut (1). Make sure that the shim locates over the shoulder of the shaft and tighten the nut securely. After the nut has been tightened, the pinion must be capable of a small endways movement on the armature shaft.

11. Where facilities exist, the slipping torque of the clutch should now be adjusted as follows:-

(a) Clamp the armature to the bench using a clamp bracket or in a workshop vice the jaws of which are protected by aluminium, wood or soft brass shields and fit torque socket 6244-1 (for 11 teeth pinions) or socket 6244-2 (for 13 teeth pinions). Should it be required to test a starter having other than 11 and 13 teeth pinion it will be necessary to fit temporarily a pinion of 11 or 13 teeth and use the appropriate socket. The original pinion is afterwards replaced. A standard torque spanner calibrated to 150 lb ft with a $\frac{1}{2}$ in square drive shaft should be fitted to the torque socket and the applied torque will be shown on the calibrated scale in the usual manner.

(b) Adjust the clutch to an initial slipping torque as follows:-

5 in dia starters 100 - 120 lb ft (13·8 - 16·6 Kg m)

6 in dia starters 120 - 140 lb ft (16·6 - 19·4 Kg m)

Exception SL5..40, 41, 41M starters and similar types should be set at:-

Clutches re-assembled with new steel plates 55 - 65 lb ft (7·6 - 9·0 Kg m)

Clutches re-assembled with used steel plates 70 - 80 lb ft (9·66 - 11·0 Kg m)
(or checking undisturbed clutch)

(c) Adjustment is made by removing or adding shims (11) Fig. 1 between the clutch plates (10) and back plate (12). The shims are made in two thicknesses 0·1 mm and 0·15 mm. Adding shims will increase the slipping torque and vice versa.

(d) Slip the clutch 10 times and then re-adjust the clutch to slip at the following final setting:-

5 in dia starters 80 - 100 lb ft (11·1 - 13·8 Kg m)

6 in dia starters 100 - 120 lb ft (13·8 - 16·6 Kg m)

NOTE: Starters type SL5..40, 41 and 41M and similar types to be maintained at the initial setting of 55 - 65 lb ft (new) and 70 - 80 lb ft (used). There is a tendency for these starter clutch settings to climb during service by amounts varying between 5 - 20 lb ft so that a routine check should be made when they come in for repair to see that the torque setting has not exceeded 80 lb ft. Wear on these 'Sulfinuz' finished plates is negligible, therefore used plates can be built into clutches and adjusted up to 80 lb ft but new plates must be adjusted at 55 - 65 lb ft.

12. Replace the castellated nut (40) tighten securely and insert the split pin.

13. Pour approximately 12 cc of oil into the oil filler holes in the drive-end shield. Allow sufficient time for the lubricating pad to absorb the oil, and then replace the spring (4) and lubricating plug (5). Wipe off any surplus oil which may have run into the inside of the drive-end shield.

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Axial Starters

Paragraph (b) should read as follows:-

(b) Adjust the clutch to an initial slipping torque as follows:-

5" DIA Starters (SL5, B55)		80-100 lbf ft (11-13.8 Kgm)
5" DIA Starters with miniclutch (SL5) Assy Part Nos	5586-517	75-85 lbf ft (10.3-11.6 Kgm)
	5586-517A	
	5586-517D	
Assy No	5586-488E	70-85 lbf ft (9.6-11.6 Kgm)
6" DIA Starters (BS6-U6-SP6)		100-120 lbf ft (13.8-16.6 Kgm)

Exception SL5 .....40, 41, 41M Starter and similar types should be set at 70 to 85 lbf ft (9.6-11.6 Kgm)

Paragraph 'd' should be deleted.

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14. Fit the commutator-end shield to the yoke (15), with 'Durulac' sealing compound ensuring that the dowel in the yoke is correctly located.

15. Fit the solenoid switch (18) to the commutator-end shield (34) and secure in position with the fixing screws (17), after applying 'Durulac' sealing compound to threads.

16. Assemble the negative connector (23) to the commutator end shield and replace nuts (16) and screw (21) where applicable.

17. Reconnect the solenoid winding leads to their respective terminals.

18. Replace screws (22), (24) and (26) securing the main field coil ends, positive terminal connector, and auxiliary field connections to the solenoid switch.

19. Replace the screws and insulating pieces (31) holding the main field connections to the connector at the bottom of the commutator-end shield. Not applicable to those starters with 'pressed' brush gear, the main field connection being secured by one of the screws (27).

20. Assemble the armature and drive-end shield to the yoke and apply 'Durulac' sealing compound to spigots and register between yoke and end-shields.

21. Replace the main fixing bolts or screws (37) together with sealing washers and tighten to 6 - 8 lb ft.

22. Spin the armature to ensure that it is not binding and is free to rotate.

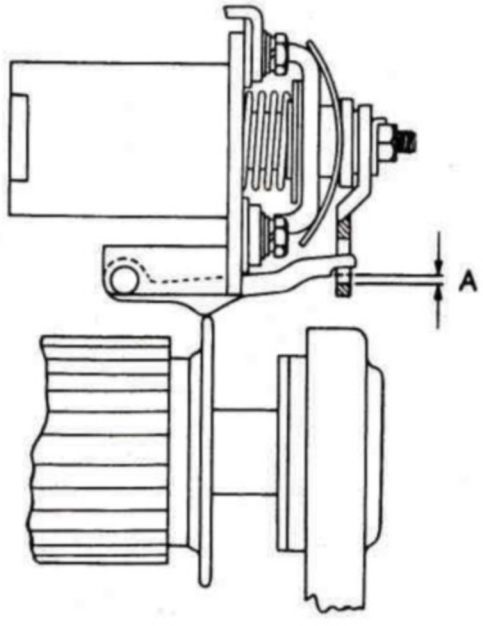


Fig. 8. Relationship between trigger and tripping disc

23. Fit the washers and nut (20) to the armature plunger, and tighten.

24. Replace the brushes, taking care that each brush is replaced in its original position. If new brushes are to be fitted, they must be bedded to the commutator as described under MAINTENANCE.

25. Connect the brush leads and field leads to the brush gear with screws (27) On those starters with pressed brush gear do not forget to fit the brush interconnectors. All these leads should have been duly marked during dismantling as the number and disposition of the leads vary with the starter type.

26. Check that the relationship between the trigger (19) and the tripping disc (30) is correct, by pulling the armature forward until the trigger is raised to its highest extent by the tripping disc. When the trigger is raised there should be an ample gap between the shoulder on the trigger and the bottom of the slot in the catch plate, see Fig. 8 'A'.

TESTING

Engagement Mechanism

The following procedure should be adopted:

1. Connect the starter to a battery of suitable voltage.

2. Insert a strip of insulating material between the moving contact and the second stage contact of the solenoid switch (18) to prevent the second stage contacts from closing.

3. Press the starter button. The first stage contacts of the solenoid switch should close, and the pinion should revolve in its normal direction of rotation. At the same time, the pinion should move forward a distance of approximately 1 inch (25·4 mm).

NOTE: Do not keep the starter button depressed longer than is necessary to check that the starter is functioning satisfactorily, otherwise the auxiliary windings may be damaged by overheating.

4. Remove the insulating strip from the second stage contacts.

Performance Tests

For the purposes of these tests, the brushes must be bedded over at least 80% of their contact area. The following procedure should be adopted:

1. Fit the starter to a starter test rig and connect the power supply. The gap between the starter pinion and the test rig flywheel must be set at 0·125 in (3·175 mm).

2. Check the lock torque, the running torque, and the light running torque of the starter. Test figures for particular versions of the starter are given in our Electrical Test Data Sheets, Publication No. 11501/1.

3. When these tests have been successfully completed, the commutator end cover and sealing ring should be fitted carefully and the machine subjected to insulation tests. Fit nuts (28) and locking washer. Certain starters also have a securing clip.

Insulation Tests

Using test probes connected to a mains supply of 110 Volt maximum and in series with a 15 watt lamp of suitable voltage, check the insulation of the machine as detailed below. If the lamp lights during any of the tests the insulation is faulty. Alternatively a 100 volt megohm meter can be used.

1. Earth Return Machines

   (a) Beween terminal 'B' and the frame.

2. Insulated Return Machines

   (a) Between the positive terminal and the frame.

   (b) Between the negative terminal and the frame.

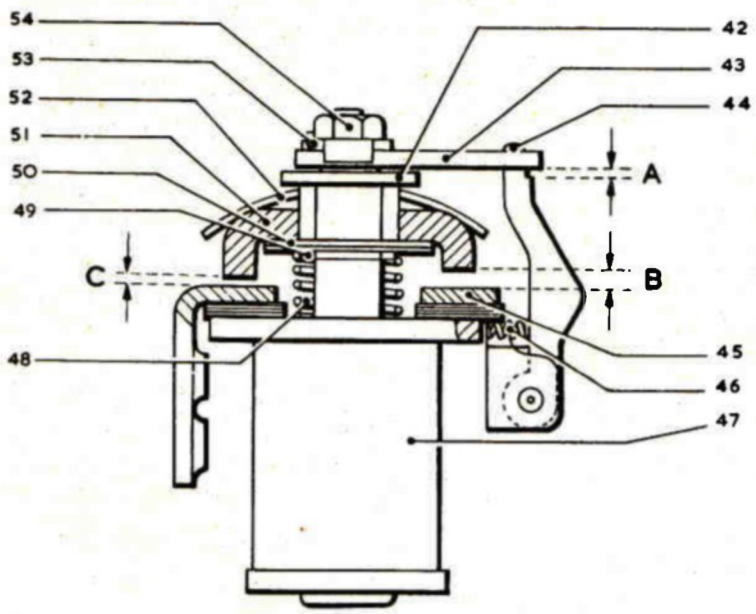
SOLENOID SWITCHES BBNG, BBNFA, 267

DESCRIPTION

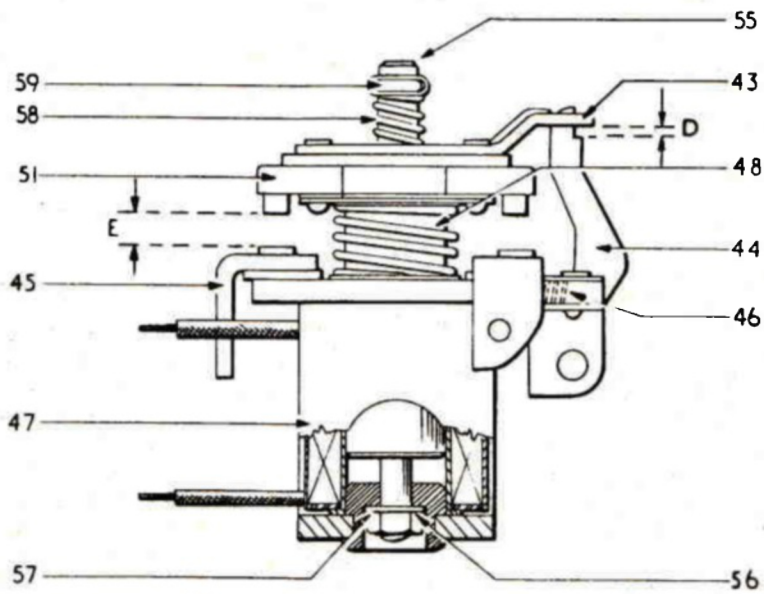
Solenoid switches BBNG, BBNFA and 267 are simple two-stage units designed for use with axial-type starters, and consist of a solenoid operating coil assembly and two pairs of contacts. The switches are mounted inside the starter housing above the commutator, and protected by the commutator end cover.

OPERATION

When the solenoid operating coil (47), Fig. 9, is energised, the magnetic field set up in the winding draws in the solenoid plunger until the first stage contacts are closed, and the catch plate (43) rests on the step in the trigger (44). This position is held until the trigger is raised by the tripping disc on the starter armature, thus allowing the plunger to travel fully home and close the second stage contacts. Both contacts will remain closed until the operating coil is de-energised. The moving contact actuated by the coiled spring (48), will then return to its normally open position.



TYPES BBNG AND BBNFA



TYPE 267

Fig. 9. Sectioned views

DISMANTLING

Dismantling of the units should be carried out as follows:

BBNG and BBNFA SWITCHES

1. Bend back the tags of the lock washer (53) Fig.9 and unscrew the nut (54).

2. Withdraw the catch plate (43), contact guide (42), contact leaf spring (52), moving contact (51), adjusting washers (50), insulating washer (49) and return spring (48).

3. Remove the trigger spring (46).

267 SWITCHES

1. Remove the spring clip (59) using suitable pliers.

2. Withdraw the contact spring (58) and moving contact assembly (51).

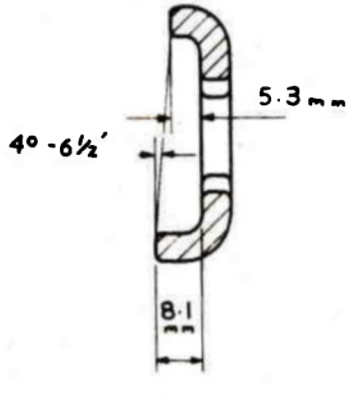
3. Remove the trigger spring (46).

4. Remove the nut (57) and washer (56) from the bottom of the switch, by means of a box spanner, and withdraw the plunger (55), and return spring (48).

INSPECTION AND REPAIR

Moving Contact

The moving contact (51) can be cleaned with spirit or very fine carborundum paper. If it is very badly burnt or pitted however, it should be set up in a lathe and refaced. As shown in Fig. 10 the moving contact for types BBNG and BBNFA is machined at an gle, and this angle must be maintained when the contact is refaced. It is important that after machining, the contact surfaces are smooth, flat, and on the same plane. An uneven surface will result in poor contact and the whole operation will have to be repeated. A maximum of 0·5 mm may be removed from the contact faces. If this is insufficient, a new moving contact or moving contact assembly should be fitted.



MOVING CONTACT FOR TYPES BBNG AND BBNFA.

MOVING CONTACT FOR TYPE 267.

Fixed Contacts

The fixed contacts (45) can also be cleaned with spirit or very fine carborundum paper. If the contact faces are badly burnt or pitted they should be refaced on a lathe while still in position on the switch. A maximum of 0·5 mm should be removed and if this is insufficient to remove all traces of burning and pitting, the contacts should be renewed. As new contacts are supplied in an unmachined state, they must be assembled to the switch and faced on a lathe before being placed in service. A simple fixture for holding the switch in the lathe is shown in Fig. 11.

If machining facilities are not available, the switch should be returned to a C.A.V. Agent for attention.

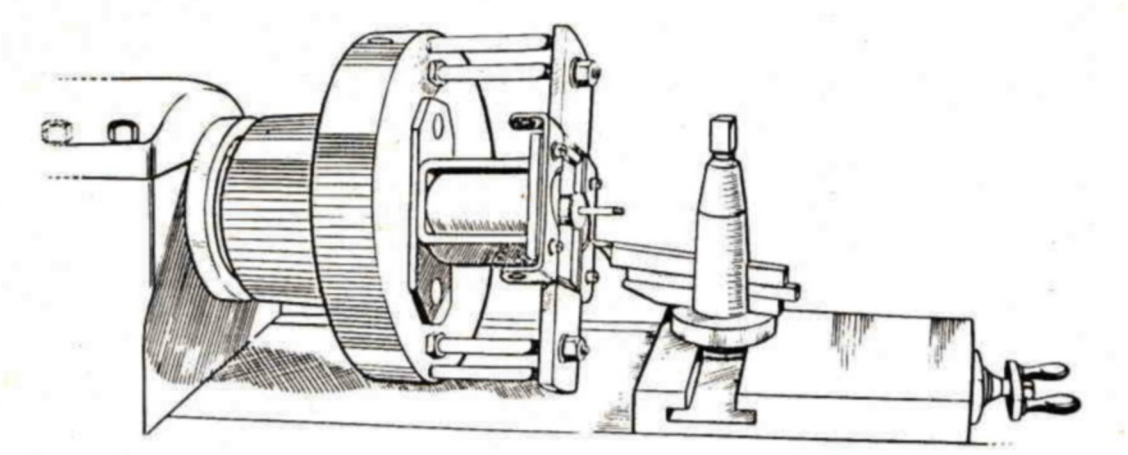


Fig. 11. Fixture for holding switch in a Lathe

Solenoid Winding

If the solenoid winding becomes broken or damaged, the complete switch should be returned to a C.A.V. Agent for attention, as the stirrup surrounding the operating coil is riveted in position and must not be removed.

Catch Plate and Trigger

The catch plate and trigger should be inspected for wear. If the shoulder on the trigger, and the bottom of the slot in the catch plate, show signs of "rounding off" the two components must be renewed.

ASSEMBLY AND ADJUSTMENT

The units should be assembled as follows:

BBNG and BBNFA SWITCHES

1. Smear the solenoid plunger at the point of entry into the switch body lightly with petroleum jelly, and also the leaf spring (52) Fig. 9 at the point of contact with moving contact (51). Apply sparingly to avoid any surplus getting on to the contact faces.

2. Replace the return spring (48), and ensure that it locates over the lip on the periphery of the switch bore.

3. Replace the trigger spring (46).

4. Assemble the insulating washer (49), adjusting washers (50), moving contact (51) contact spring (52), contact guide (42) and catch plate (43).

5. Locate the end of the trigger in the slot in the catch plate, and then replace the lock washer (53) and nut (54). Tighten the nut securely.

6. Check that gaps between the contacts 'B' and 'C' (Fig. 9) are within the limits detailed below. If not, adjusting washers (50) must be added or removed until the correct gap is obtained. The washer (49) must not be removed as it acts as a locating spigot for the return spring. The adjusting washers are made in four thicknesses, 0·1, 0·2, 0·3 and 1·0 mm, and a combination of these sizes should be used to obtain the correct gaps.

7. Check that gap 'A' between the catch plate and the shoulder on the trigger is within the limits detailed below:

8. After the adjustments have been successfully completed, lock the nut (54) by means of the tabs on the lock washer (53).

BBNG Switch

Voltage	Gap A mm	Gap B mm	Gap C mm
12	2·0 ± 0·1	3·8 ± 0·3	1·0 ± 0·1
24	2·0 ± 0·1	3·8 ± 0·3	1·0 ± 0·1
32	5·0 ± 0·1	6·6 ± 0·2	4·0 ± 0·1

BBNFA Switch

Voltage	Gap A mm	Gap B mm	Gap C mm
12	2·0 ± 0·1	3·8 ± 0·3	1·0 ± 0·1
24	2·0 ± 0·1	3·8 ± 0·3	1·0 ± 0·1

Simple Service Setting

BBNG 12 and 24 Volt

After the mechanical settings have been carried out the following check may be made. Push the plunger forward until the first contacts just touch; the gap between the trigger and catch plate should then be approximately 1 mm, that is, the plunger can move a further 1 mm before the catch plate hits the trigger.

Trip the trigger and push plunger until second contacts just touch, from this point until the plunger completes its travel the distance should be approximately 1 mm.

267 SWITCH - ASSEMBLY

1. Smear the plunger (55) lightly with petroleum jelly. Slide the return spring (48) onto the plunger, and insert the two components into the switch body.

2. Replace the washer (56) and nut (57). Seal the nut to prevent it loosening under vibration.

3. Replace the trigger spring (46).

4. Slide the moving contact assembly (51) and contact spring (58) onto the plunger.

5. Locate the end of the trigger in the slot in the catch plate and replace the special spring clip (59).

6. Check that contact gap Fig 9 'E' is within the limits 0·149 $\pm$ 0·013 in (3·79 $\pm$ 0·33 mm). If not, the gap should be adjusted by adding or removing pieces beneath the fixed contacts.

7. Check that gap 'D' is between the limits 0·081 $\pm$ 0·024 in (2·06 $\pm$ 0·61 mm).

TESTING SWITCHES

The units should be tested as follows:

Mechanical Tests

1. The force required to overcome both the return spring and the contact spring, applied at the tip of the plunger.

	lb	kg
(a) Type 267	15·0 $\pm$ 1·0	6·80 $\pm$ 0·45
(b) Type BBNG	27·0 $\pm$ 2	12·25 $\pm$ 0·90
(c) Type BBNFA	15·5 $^{+2}_{-1}$	7·04 $^{+0.90}_{-0.45}$

2. The force required to overcome the trigger spring, applied at the peak of the tripping face while the switch is in the "off" position.

	oz	g
(a) Type 267	14 $\pm$ 2	400 $\pm$ 55
(b) Type BBNG	9 $\pm$ 1·5	250 $\pm$ 50
(c) Type BBNFA	9 $\pm$ 1·5	250 $\pm$ 50

Electrical Tests

1. Ensure that both contacts close when the following voltage is applied to the solenoid winding:

Voltage	Type 267 Max. volt (cold)	Type BBNG Max. volt (cold)	Type BBNFA Max. volt (cold)
12	8·0	7·5	8·0
24	15·0	15·0	15·0
32	17·0	18·0	-

2. Subject the switch to a test of a few seconds duration at twice the normal voltage, to ensure that the trigger operation is satisfactory. Any faulty assembly or 'rounding off' of the trigger or catch plate will cause the catch to trip.