# PRE-ENGAGED STARTING MOTOR MODEL M35J PE
## (WITH ACTUATING SOLENOID MODEL 17S AND ROLLER CLUTCH DRIVE MODEL 7SD)

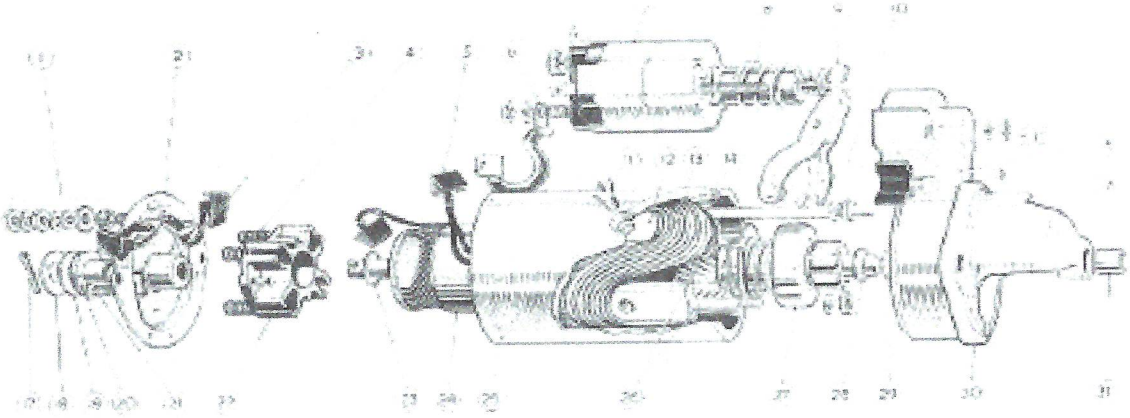

**Fig. 1 Starting motor, dismantled**

1 Terminal nuts and washers
2 Commutator end bracket
3 Bush housing
4 Brush springs
5 Brushes
6 Connector link, solenoid to starter
7 Solenoid unit
8 Return spring
9 Engagement lever
10 Rubber seal
11 Pole screw
12 Pole shoe
13 Field coils
14 Field to earth connection
15 Pivot pin
16 Retaining ring
17 Cotter pin
18 Shim washer
19 Thrust plate
20 Bearing bush
21 C.E. bracket fixing screws (2)
22 Brush box moulding
23 Thrust washer
24 Armature
25 Yoke
26 Fixing studs
27 Drive assembly
28 Thrust collar
29 Jump ring
30 Drive end bracket
31 Bearing bush

## 1. DESCRIPTION

This starting motor is a four-pole four-brush 3½" (88.9 mm) diameter machine with a series field and a solenoid-operated roller clutch drive. The motor is shown dismantled in Fig. 1 and the internal connections in Fig. 2.

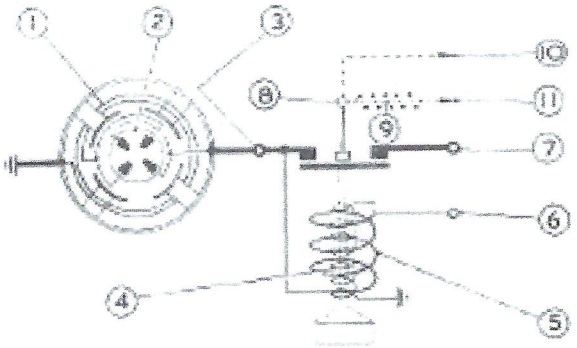


**Fig. 2 Internal connections of starting motor and solenoid. (Broken lines applicable only when ballast ignition coil is used)**

1 Field
2 Armature
3 Terminal 'STA'
4 Hold-on winding
5 Closing winding
6 Small (unmarked) terminal on solenoid
7 Battery supply terminal
8 Terminal 'IGN'
9 Ballast resistor
10 To ignition coil
11 To ignition switch

New features in this design include:—

A face-type moulded commutator assembly on the end-face of the armature.

A fully-insulated brushgear assembly comprising wedge-shaped brushes and coil-type springs assembled into a plastic brushbox moulding which is riveted to the commutator-end bracket. The brushes are provided with a keyway to ensure correct fitting, and the springs are held captive in the brushbox moulding.

A continuously wound field-winding: the winding has no interconnecting joints, one end being earthed to the yoke by a soldered connection, while the other end terminates at a pair of brushes.

A windowless yoke with independently fixed end brackets and no through-bolts: two of the pole-shoes are fitted with threaded studs on which nuts and spring-washers fix the drive-end bracket to the yoke. The commutator-end bracket is fixed to the yoke by two screws into tapped holes in the end-face of the yoke.

Brushgear axial thrust and armature end-float: this is controlled at the commutator end by a thrust plate and a required number of packing shims, which are assembled on the armature shaft extension. The parts are retained by a cotter pin secured through the end of the shaft, and this also serves to lock the thrust plate and shims together so that they rotate with the armature shaft. This limits the thrust wear to the bearing surfaces of the thrust plate and the external shoulder of the bearing bush.

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Drive engaging mechanism: the actuating position of the engaging lever in the drive-end bracket is pre-set and cannot be altered. This eliminates setting the pinion position to obtain the correct operation of the actuating solenoid. The lever swivels on a non-adjustable pivot pin which is retained in the drive-end bracket by a special type of retaining ring which is a spring fit into a groove in the pin.

## 2. ROUTINE MAINTENANCE

Routine maintenance is not necessary, but an occasional check should be made on the tightness of the electrical connections. The motor should be dismantled for detailed examination on the occasion of major engine overhaul, when the brushes and the bearing bushes should be renewed.

## 3. TECHNICAL DATA

### (a) Starting Motor

(i) Lock torque: 7.0 lbf ft (0.97 kgf m) with 350-375 amperes.

(ii) Torque at 1,000 rev/min.: 4.4 lbf ft (0.61 kgf m) with 260-275 amperes.

(iii) Light running current: 65 amperes at 8,000-10,000 rev/min.

The motor performance is dependent on the capacity and state of charge of the associated battery. The figures given are typical performance characteristics obtained with a 12 volt 43 Ah (20h. rate) battery in a good state of charge.

### (b) Solenoid

(i) Closing (or series) winding resistance: 0.21–0.25 ohm (measured between the small unmarked 'Lucar' terminal and the main terminal marked STA).

(ii) Hold-on (or shunt) winding resistance: 0.9–1.1 ohm (measured between the small unmarked 'Lucar' terminal and a good earth point on the solenoid body, e.g. either of the solenoid assembly screws).

## 4. SERVICING

Assuming the battery to be in a good state of charge, and the wiring between battery, starting motor and operating switch to be satisfactory, failure of the motor to crank the engine will mean that it must be removed from the vehicle for detailed examination.

### (a) Checking Starting Motor Operation under Light Running Conditions

Clamp the motor in a vice and, using a 12-volt battery and a moving coil ammeter of suitable range, check the light running current and armature speed. To do this, use heavy-duty starting motor cable to connect one terminal of the battery, via the ammeter, to the unmarked main input terminal of the solenoid and from the same solenoid terminal connect a short test link to the small unmarked 'Lucar' terminal blade to energise the solenoid. Again with heavy-duty cable, connect the remaining battery terminal to a clean part of the yoke. If the solenoid is heard to operate and the motor runs, compare the current and the speed with the figures quoted in para. 3a(iii) and then proceed to para. (b).

If the solenoid does not operate or is heard to operate but the motor does not run, transfer the battery supply lead to the terminal on the motor commutator-end bracket, when the motor should run. If it does so, and the light running current and speed are satisfactory, the fault is most likely due to the actuating solenoid, which should be tested in accordance with para. 5.

Non-operation of the motor, or incorrect values of light running current and speed, indicates the motor has an internal fault and must be dismantled for detailed examination (refer to para. c).

### (b) Measuring Lock Torque and Current

If the lock torque performance of the motor does not conform with the figures quoted in para. 3(a), the motor must be dismantled for detailed examination (refer to para. c).

### (c) Checking Brushgear and Commutator

Before proceeding to full dismantling (para. d) remove the commutator-end bracket and inspect the brushgear and commutator.

#### (i) Brushgear

Each of the four brushes should be free to move in the brushbox moulding. Sticking brushes can usually be freed by cleaning the brushes and moulding with a petrol-moistened cloth. Brushes which are worn to or approaching ⅜" (9.5 mm) in length must be renewed as a set. Note the fitting arrangement of the long and short brush flexibles in regard to the commutator-end bracket and field winding (Fig. 3) and proceed to fit the new brushes as follows:—

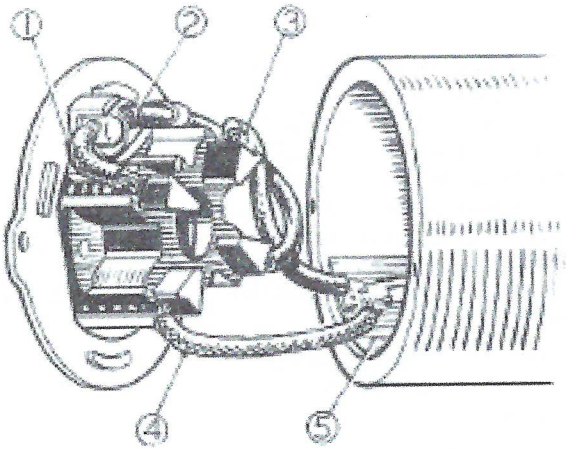


**Fig. 3 Brushgear arrangement**

1 Short brush-flexible, C/E bracket
2 Long brush-flexible, C/E bracket
3 Long brush-flexible, field winding
4 Short brush-flexible, field winding
5 Yoke insulation piece

**Commutator-end Bracket Brushes**

Cut the brush flexibles away from the terminal post. Use a file (or hacksaw) and make a groove in the head of the terminal sufficiently deep to accommodate the new brush flexibles. Solder the long and short brush-flexibles into the terminal groove.

**Field Winding Brushes**

Cut the brush flexibles about ¼" (6.35 mm) from the joint of the field winding. Solder the new long and short brush-flexibles to the ends of the original brush-flexibles.

Ensure that the insulated sleeving on the new brush-flexibles provides the maximum coverage consistent with satisfactory soldering.

### (ii) Brush Springs

To measure the spring pressure, position a new brush in each of the brushboxes in turn and then press on top of the brush with a push-type spring gauge (see Fig. 4) until the top of the brush protrudes about $\frac{1}{16}$" (1.5 mm) from the brushbox moulding, when the spring pressure reading should be approximately 28 ozf (0.8 kgf).

If the spring pressures are appreciably incorrect, the bracket assembly complete with springs and moulding must be renewed.

### (iii) Commutator

A commutator in good condition will be burnished and free from pits or burned spots. The surface of the commutator can be cleaned with a petrol-moistened cloth. Skimming the commutator will not normally be required, but if the surface is badly worn the armature must be removed and the commutator serviced as described in para. e(i).

## (d) Dismantling

### (i) Removing the Solenoid

Remove the flexible link from between the solenoid "STA" terminal and the motor terminal. Remove the nuts and washers which fix the solenoid to the drive-end bracket. Withdraw and remove the main part of the solenoid, the plunger and its drive-return spring remaining coupled to the drive engagement lever. Remove the plunger and return spring assembly by lifting it from the top of the engagement lever.

**Note:** The solenoid plunger is individually suited to the main part of the solenoid and is not interchangeable separately.

### (ii) Dismantling the Motor

Remove the rubber sealing block from between the drive-end bracket and the yoke.

Remove the retaining ring from the groove in the engaging lever pivot-pin and withdraw the pin.

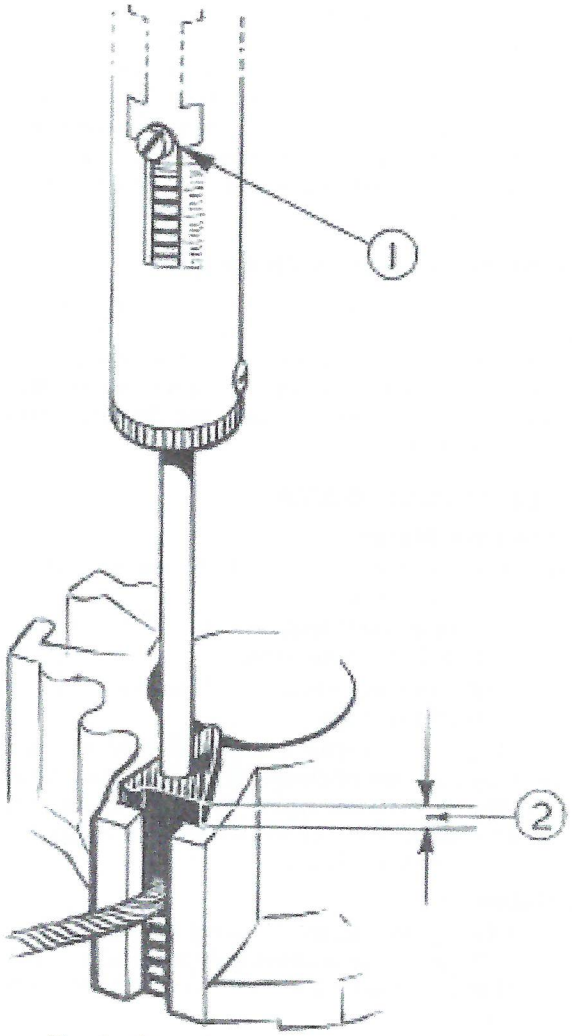


**Fig. 4 Checking brush spring pressure**

1 Push type spring gauge, with sliding marker indicating reading where 'arrowed'
2 $\frac{1}{16}$" (1.5 mm) approx.

Remove the drive-end bracket fixing nuts and washers and withdraw the bracket from the yoke and fixing studs.

Lift the drive engagement lever off the drive operating plate.

Remove the cotter pin, shim washers and thrust plate from the armature shaft extension at the commutator-end. Withdraw and remove the armature, complete with the internal thrust-washer and drive assembly, through the drive end of the yoke. Remove the thrust washer from the commutator end of the armature shaft.

Remove the two commutator-end bracket fixing screws and part the bracket from the yoke. Disengage the field winding brushes from the brushbox moulding and then completely remove the bracket from the yoke assembly.

Do not at this stage dismantle the field winding from the yoke assembly (refer to para. e(ii) ).

The drive assembly is removable from the armature as a complete unit. Remove the thrust collar from the jump ring by using a mild steel tube with a suitable bore, remove the jump ring from its groove and then slide the drive assembly off the end of the armature shaft. Do not at this stage dismantle the drive assembly (refer to para. e(iv) ).

## (e) Bench Inspection

After dismantling the motor, examine the individual items, as follows:—

### (i) Armature

If the commutator needs to be serviced, the minimum thickness to which the commutator copper may be skimmed before a replacement armature assembly becomes necessary, is 0.080" (2.05 mm). The commutator surface should be finally polished with very fine glass paper. The insulation slots MUST NOT BE UNDERCUT.

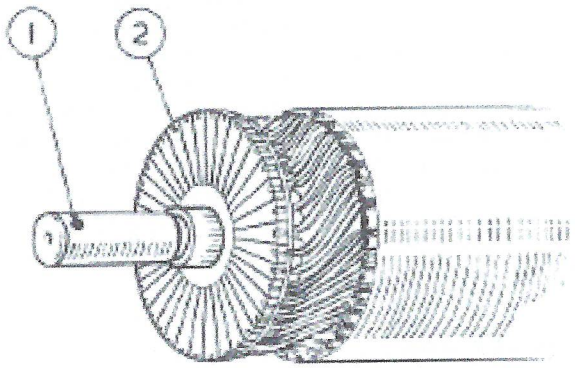


**Fig. 5 Armature with face-type commutator**

1 Cotter pin hole (end-float and thrust)
2 Face-type commutator

If the solder appears to have "thrown", or the conductors to have "lifted" from the commutator segments, overspeeding of the motor is indicated and the operation of the roller clutch drive should be checked (para. iv).

If the armature shows signs of fouling the pole-shoes, worn bearings or an untrue armature shaft is indicated. Check the armature in a lathe and if found to be out of true, fit a replacement. An untrue armature shaft cannot be satisfactorily rectified. If the armature is satisfactory, renew the bearings in both end brackets (para. v).

Check the armature insulation with a 110-volt a.c. 15 watt test lamp connected between one of the commutator segments and the shaft. The lamp will light if the insulation is not satisfactory. Replace the armature if a fault is indicated.

Check the armature for short-circuited windings, using "Growler" equipment. Replace the armature if a fault is indicated.

### (ii) Field Winding

#### Continuity

Connect a 12-volt battery-operated test lamp between each of the brushes in turn and a clean part of the yoke. The lamp will light if continuity is satisfactory between each of the brushes, the field winding and the yoke.

#### Insulation

To make a positive check on the insulation between the field-winding and yoke, it will be necessary first to disconnect the earthed end of the winding where it terminates in a soldered connection at the yoke. (The hot-pressed joint of the copper-link to the field winding must not be disturbed).

However, to avoid disturbing the soldered joint unnecessarily, first inspect the inside of the yoke for obvious signs of insulation breakdown, and, if so, rectify or replace the field winding assembly as necessary. If there are no obvious signs of a fault, consider the results of the light running and lock torque tests carried out previously. If the speed and torque were low and the current consumption high, faulty field winding insulation could be the cause and this interpretation of the motor performance would justify disconnecting the end of the field winding to enable a positive check to be carried out. The field winding insulation can be checked, after disconnecting the end of the winding at the yoke, by connecting a 110-volt a.c. 15 watt test lamp between the disconnected end of the winding and a clean part of the yoke. Care should be taken to ensure that neither of the brushes nor bare parts of their flexibles contact the yoke during the test. The test lamp will light if the insulation is not satisfactory.

#### Field Winding Replacement

Unsolder the earthed end of the winding at the yoke.

Slacken the four pole-shoe retaining screws with a wheel-operated screwdriver. Remove the retaining screws from a diametrically opposite pair of pole-shoes and remove the pole-shoes from the yoke. Note that the remaining pair of pole-shoes need only be slackened sufficiently to enable the winding to be withdrawn from the yoke. The winding assembly can be slid out from beneath the shoulders of the slackened-off pole shoes and out through the end of the yoke.

Wipe out the inside of the yoke and clean the insulating piece which separates the field winding brush joint from the yoke. Loosely fit the new field winding assembly and the pole shoes into the yoke, and place the insulation piece correctly between the winding brush joint and the yoke. Tighten the pole-shoes evenly, and re-make a good soldered earth joint between the winding connector and the yoke.

### (iii) Commutator End Bracket

The brushgear should be checked, if this has not previously been done. Refer to para. 4c(i) and (ii).

Check the insulation of the springs and terminal post by connecting a 110-volt a.c. 15 watt test lamp between a clean part of the bracket and each of the springs in turn and then between the bracket and the terminal post. The brushes and their flexibles (where bared) must not come into contact with the bracket during the test. The lamp will light if the insulation is not satisfactory.

### (iv) Roller Clutch and Drive Operating Mechanism

The roller clutch is an over-running or free-wheeling device, which prevents the armature from being rotated at an excessive speed in the event of the drive being held in engagement after the engine has started.

A roller clutch drive assembly in good condition will provide instantaneous take-up of the drive in one direction and rotate smoothly and easily in the other. The assembly should move freely round and along the armature shaft splines without roughness or tendency to bind. Should the assembly not meet these requirements, a replacement unit must be fitted.

All moving parts should be smeared liberally with Rocol "Molydest" grease, starting motor grade, or equivalent alternative.

The setting of the pinion and satisfactory operation of the solenoid and the drive are dependent on the condition or amount of wear between the moving parts associated with the drive operating mechanism. For this reason, it is important to replace any part which shows signs of wear. The solenoid plunger is individually suited to the main part of the solenoid and is not interchangeable separately. For this reason, wear to the solenoid plunger stirrup linkage will necessitate a new solenoid unit being fitted.

### (v) Bearings

Both end brackets are fitted with self-lubricating porous bronze bearing bushes. New bushes must be immersed in clean engine oil (S.A.E.30/40 grade) for a minimum of 24 hours before fitting and they must not be reamed after fitting otherwise the self-lubricating qualities will be impaired.

Bushes must be replaced when worn to the extent of allowing excessive side-play of the armature shaft.

The bush in the commutator end bracket can be removed either by inserting a suitably-sized thread-tap squarely into the bush and then withdrawing it with the tap, or by supporting the bracket and lightly tapping the bush out with a mandrel.

The bush in the drive-end bracket can be removed either with a press or, after supporting the bracket, by carefully tapping out with a mandrel.

New bushes should be pressed or carefully driven into position by using a suitably dimensioned, shouldered polished mandrel. Because the thrust and end-float is controlled at the commutator end, it is important to ensure that the shoulder of the commutator-end bearing bush is fitted tight up to the bracket.

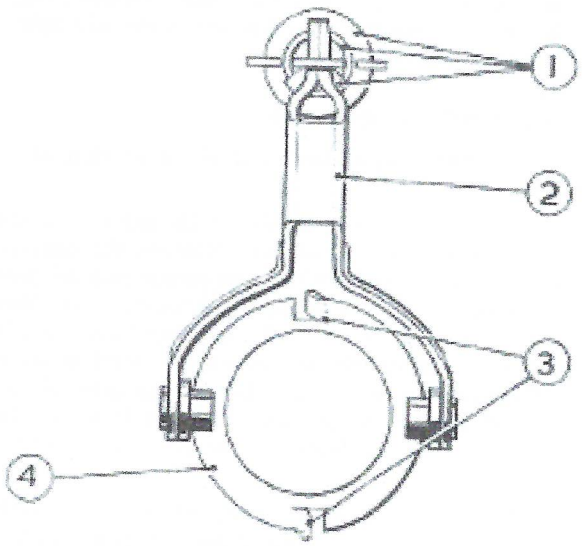


**Fig. 6 Method of assembling engagement lever and solenoid plunger**

1 { Plunger / Lost-motion spring / Retaining-plate
2 Drive engagement lever
3 Locking shoulders
4 Drive operating plate viewed from pinion end

## 5. SOLENOID

The solenoid plunger is fitted with a 'lost-motion' spring which provides a measure of lost motion in the drive operating mechanism. The measure of lost motion takes place at the commencement of disengaging the drive, its purpose being to ensure that the main solenoid contacts will always open prior to pinion retraction. This will also take effect if, for other reasons, the pinion fails to become disengaged from the flywheel ring gear when the solenoid switch is released.

### (i) Checking the Windings

**Note:** If the solenoid is checked in situ on the motor, first disconnect the connecting link to the motor terminal at the 'STA' terminal on the solenoid.

The continuity of the windings can be checked by connecting a 12-volt battery-operated test lamp of low wattage between the solenoid main terminal marked 'STA' and a good earth point on the solenoid body, when the lamp will light if both windings are satisfactory in regard to continuity.

The resistance of each of the windings should now be checked (see para. 3(b) ).

### (ii) Checking the Contacts

After long service the contacts may require renewing. In the event of this becoming necessary,

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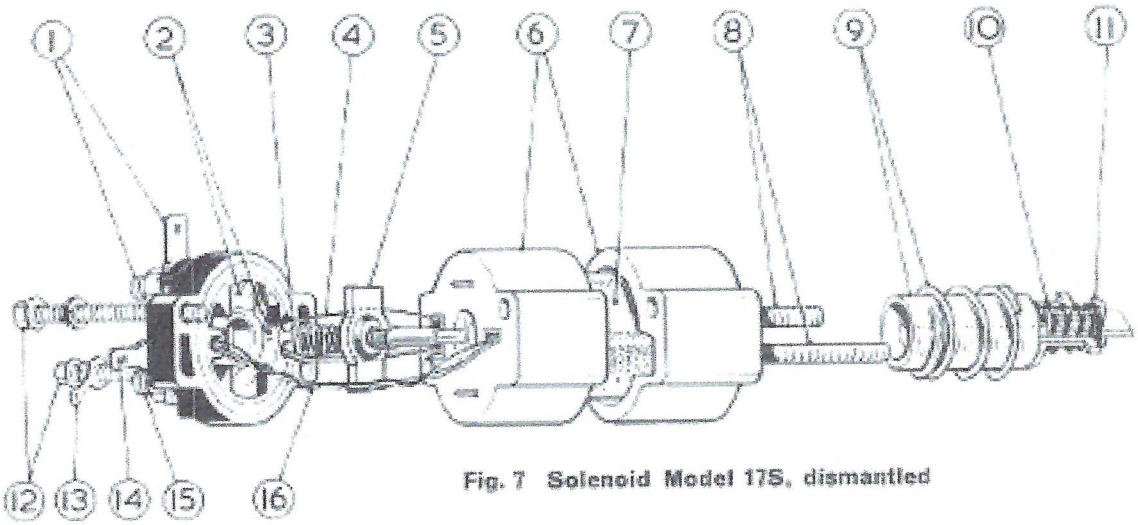


Fig. 7 Solenoid Model 17S, dismantled

★1 Main input terminal and 'Lucar' terminal (main external circuits)
2 Base assy. comprising: fixed 'main contacts and ballast ignition (IGN) contact
3 Closing coil connection to 'STA' terminal
4 Hold-on coil connection to earth strip
5 Moving spindle and contact assy.
6 Solenoid body
7 Coil or winding assy.
8 Solenoid fixing studs
9 Plunger and drive return spring
10 'Lost motion' spring
11 Spring retaining-plate
12 Solenoid assy. screws
13 Earth strip, hold-on coil
★14 Small unmarked 'Lucar' terminal (solenoid operating)
15 Main 'STA' terminal
16 Closing and hold-on coil connections to small (unmarked) 'Lucar' blade terminal

the fixed contacts (which are an integral part of the moulded cover) and the moving spindle and contact assembly, must always be replaced as a set. Check for satisfactory opening and closing of the contacts by connecting a separate circuit consisting of a 12 volt battery and a high wattage (say 60 watt) test lamp between the solenoid main terminals. The lamp should not light. Energise the solenoid with a separate 12-volt circuit connected between the small unmarked 'Lucar' terminal and a good earth point on the solenoid body. The solenoid should be heard to operate and satisfactory closing of the contacts will be indicated by the lamp lighting with full brilliance.

**Note:** The solenoid may incorporate a very small additional 'Lucar' terminal blade (marked ★ 'IGN'), which is for use in conjunction with ballast ignition systems. It is sufficient to check that this terminal becomes electrically connected to the solenoid main input terminal, when the solenoid is energised.

To gain access to the contacts, withdraw the two screws which fix the moulded cover and the two halves of the solenoid body together. Unsolder the three winding connections in the moulded cover (the small unmarked 'Lucar' terminal, the STA terminal and the earth connector strip which fits beneath one of the assembly screws) and at the same time carefully pull the moulded cover away from the ends of the windings and the solenoid body.

If the two halves of the body are separated for any purpose, e.g. coil renewal, a petrol-resistant sealing compound must be used between the joint when reassembling. Also, when reassembling, ensure that the separated ends of the windings protrude through the insulated body slot which is parallel to the body shoulder. The thicker of the two wires (closing coil winding) goes into the 'STA' terminal, and the thin one (hold-on coil winding) into the earth connector-strip. The internal connections of the solenoid are illustrated in Fig. 2.

## 6. REASSEMBLY

Reassembling the starting motor and solenoid is in general a reversal of the dismantling procedure, but the following special points should be considered.

When assembling the commutator-end bracket to the yoke, it is important to position the brushes and their flexibles correctly (see Fig. 3).

When reassembling the drive operating lever to the operating plate, and the solenoid plunger assembly to the lever, first refer to Fig. 6 to ensure the correct and easiest method of assembly.

Discard the original 'spire nut' retaining-ring which secures the drive engaging lever pivot pin and fit a new one.

Take care to re-fit the internal thrust washer which goes on to the armature shaft at the commutator end.

When assembling the parts to the armature shaft extension at the commutator end, note that the end-float is 0.010" (0.25 mm) max., which is obtained by fitting the required number of shims (usually one or two). Assemble the parts in the sequence illustrated in Fig. 1 and ensure that they are locked together and prevented from rotating separately by the cotter-pin, which should engage with the locking piece on the thrust plate.

★ *Amendment to previous issue*